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RADIO BROADCAST

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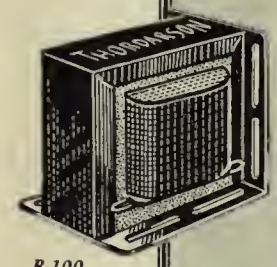
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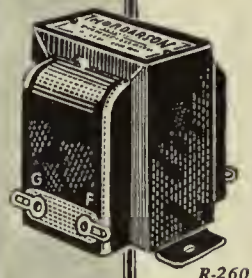
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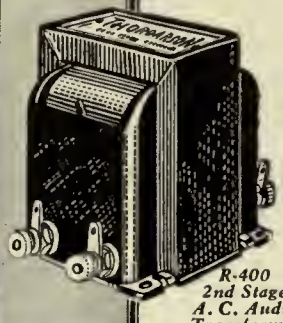
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RADIO BROADCAST

VOLUME XV

MAY, 1929, to OCTOBER, 1929



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Model 400A — Patents Applied For

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RADIO BROADCAST

ENGINEERING · THE LABORATORY · SERVICING

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The contents of this magazine is indexed in *The Readers' Guide to Periodical Literature*, which is on file at all public libraries

. . . *among other things*

WE MUST apologize this month and all because the table of contents directly west, as your eye travels, must be set in smaller type than is our custom. But the horrible truth is that it had to be set smaller in order to get everything in. We hope the increased scope of the contents will make up for the slightly decreased legibility.

THIS May issue now before you covers a pretty wide range. For those interested primarily in merchandising, we have the leading article on the relation of sales and service; a description of a small successful radio shop in Washington, D. C.; an exclusive statement for RADIO BROADCAST by President Frost of the R. M. A. on the importance to the radio sales structure of good radio service; the very interesting article on page 15 on how to use technical facts in selling (this particular story is based on the Radiola 60), and finally, the special trade news section on page 45.

AN INDUCTANCE which has no appreciable external field is described by Emil Reisman on page 21 and it should be of great interest to our engineering readers. G. F. Lampkin of the University of Cincinnati details some interesting data he gathered on crystals (page 23). The articles by Prof. Terman of Stanford on detection have attracted wide attention and the last and perhaps the most interesting of the series is presented on page 37.

H. S. PARSONS, chief, Periodical Division, Library of Congress, Washington, asks our aid in completing the files of the Library of Congress. The following numbers of RADIO BROADCAST are missing from their files: Vol. 7, Nos. 2, 3, 4, 5 (June—Sept., 1925); Vol. 10, No. 2 (Dec., 1926). Any reader who is able to spare those copies should communicate with Mr. Parsons.

THE June issue of RADIO BROADCAST will be the Trade Show Issue and it will contain the most inclusive data on the way the radio world is going, written by those who are making radio industry history. The leading article, by Ralph H. Langley of the Crosley Company is a stimulating discussion of present trends in cabinet design, another deals with latent sales possibilities in phonograph pick-ups, another deals with how a radio dealer solved some of his most vexing problems in store management. Besides these there are many other special articles and all our regular departments, a description of an unusually interesting v.t. voltmeter, simple to build and unusually stable in its calibration, and a new method of presentation of our popular "Set-Data Sheets." We believe you will like the June issue.

—WILLIS KINGSLEY WING.

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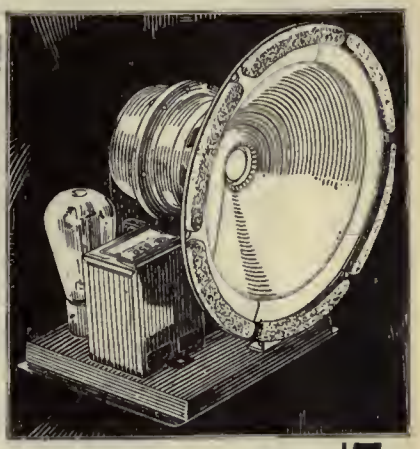
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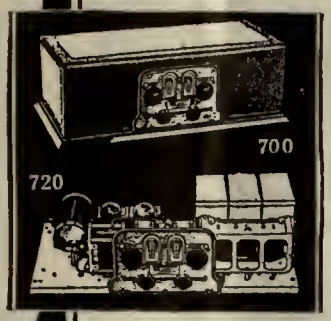
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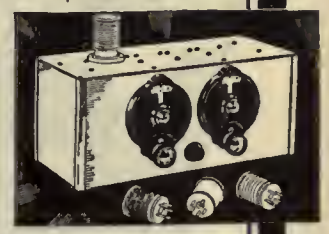
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(*All-Electric*)



The 720AC is giving to experimenters everywhere a preview of radio as it will be in 1930—combining the sensation of the 1928 season—*all-a.c. operation*—with the sensation of 1929—*screen-grid r.f. amplification*—and with them the *entirely new* 1930 features of a screen-grid tube almost 100% better than the d.c. operated '22, and a *moderate-voltage* output tube (the '45) nearly as powerful as the high-voltage '50. And, with these, the S-M precision engineering which has brought in broadcasting from across the Pacific with six tubes—*and even with four.* S-M tone quality is the accepted criterion of the audio transformer industry. All these things in the 720AC (*licensed under patents of RCA and associated companies*), at only $70.20 *net* for the set completely wired in the 700 two-tone shielding cabinet, less tubes and power units. Component parts total $47.07 *net*; cabinet $5.55 *net* additional. S-M 669 power unit, furnishing all A, B, and C power required, wired complete $34.50 *net*. S-M 720 receivers can be changed over at slight cost to the 720 AC circuit; full directions in Data Sheet No. 10.

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....No. 5. 720 Screen Grid Six Receiver
....No. 6. 740 "Coast-to-Coast" Screen Grid Four
....No. 7. 675ABC High-Voltage Power Supply and 676 Dynamic Speaker Amplifier
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AIR-MAIL PLANES TO HAVE RADIO BEACON RECEIVING EQUIPMENT

Radio has been called upon to solve the problems caused by aviation's greatest foe—bad weather. As a culmination of over a year of intensive tests, all the airplanes of National Air Transport, Inc., operators of air-mail and express lines, are being equipped with radio receiving apparatus, and radio beacon stations are being constructed at the company's principal airports. The receivers on the planes will pick-up beacon signals and weather reports. The pictures on this page show (above) an N.A.T. radio-equipped plane with vertical antenna, (center) the receiving equipment which is installed to the rear of the pilot's cockpit and which is tuned remotely with the cable shown, and (below) an interior view of the transmitting station at the Cleveland airport.

HOW SALES AND SERVICE ARE RELATED

By WILLIS KINGSLEY WING

THE radio dealer is primarily concentrating on the sale of a new radio set to his customer. He bends his chief efforts toward that end. When the immediate sale is consummated, the dealer looks to another new set sale and, in the main, is inclined to breathe a sigh of relief at the conclusion of the sale and to congratulate himself that it is out of the way. The customer who has just bought this new set, on the other hand, has a rather different point of view. He, the buyer, has just started his radio life. It has begun with the purchase and installation of his set. He looks on the dealer as the local representative of the entire radio industry structure. Only through the dealer can this interested customer attain good radio entertainment. The customer has bought a thing of wood and metal, whose technical working he does not understand, which promises him unlimited entertainment in his own home.

Having spent his good money, the buyer expects to receive continued return on his investment in the form of constant dividends of entertainment. In other words, although the buyer may not actually phrase it in his own mind in just this way, he expects his set to be serviced properly. The buyer regards his actual act of purchase as merely the first step in his radio experience. The continued good operation of his receiver is to the buyer the most important thing.

Here we have an interesting situation with the buyer and seller taking almost diametrically opposite points of view. The dealer looks toward new buyers to bring into camp—new sales, while the buyer looks toward continued and satisfactory service from what he has bought.

The dealer quite naturally is apt to feel that his chief job is sales. He knows that sets, being what they are—devices with the equivalent of electrical and mechanical moving parts—will require expert attention, occasional adjustment, and repair. This repair and adjustment branch of his business, however, is frequently regarded as the minor one. Service work is, then, a kind of necessary evil. The dealer realizes that technical men must be hired and their work supervised, testing equipment bought, and a shop equipped. So the sales side of the dealer's business looks more attractive, more potentially productive of results, than the service branch. And, in many cases, the dealer unconsciously separates these two chief activities.

If sales and service are separated in the dealer's outlook on his own business, isn't it because the dealer himself has made this arbitrary division? The customer surely has not. So it can be said fairly, that in extreme cases, the dealer and his customer are working at cross purposes. And it takes no massive brain to see that such a condition is not good for the dealer, the customer, the manufacturer, and the entire industry.

When the customer goes to his dealer with a service problem—which to the customer at the moment is just about the most important radio matter in the world—and he senses that the dealer is not nearly so interested in him now he has purchased his set, he is most dissatisfied and disappointed. The customer wants good service and wants it quickly. The dealer may be fidgeting to sell a new prospect in his display room at that precise minute. It he lets that customer feel that service is given grudgingly, then at that moment, the customer's confidence in the entire industry begins to be shaken. The customer looks askance not only at the dealer but at the manufacturer of his set as well.



A well-equipped service car is a great asset to a sales-service organization. Such a car makes it possible for the serviceman to take all necessary equipment with him on every job and it also has a favorable psychological effect on the customer. The car pictured above is an excellent example; it is fully equipped even to a ladder for erecting an antenna.

The dealer is the ambassador of the industry to the customer. He is an ambassador when he sells the set, and he is no less an ambassador when the customer comes to him for service on that set.

The basis for this article was an address delivered before the Retailers' Section of the Federated Radio Trades Association at their recent convention in Buffalo. Here we attempt to point out the important, and inseparable, relation between radio sales and service. Far too many dealers regard sales as the most important part of their activities and relegate service far, far down in the scale of things. Judging the retailing of radio as a whole, the weakest part of the structure is service. It has often been remarked that the radio industry can learn a great deal from a study of the progress of the automobile industry and certainly the automobile owner of to-day can get service of a high order on his car no matter where he may be. The radio dealer should render better service on the sets he sells, not only because it is better for the industry but also for the much better reason that through improved service he will make more money.

—THE EDITOR.

Importance of Service

SERVICE rendered by the dealer is of increasing importance and it has a direct bearing on sales. In April, 1929, RADIO BROADCAST were published reliable figures on the sales of radio sets and radio tubes for the years 1927 and 1928. An appreciation of these figures is helpful in solving the problem under discussion.

In 1926, about 2,000,000 receivers supplied from all sources were sold. In 1927, nearly 1,800,000 sets supplied from all sources were sold. And in 1928, 3,000,000 sets from all sources were sold to the radio public.

The Department of Commerce figures of set sales in 1927—that never-to-be-forgotten year when battles were waged over the respective merits of the standard battery-operated sets and the new a.c.-tube receivers—indicate that about one a.c. set was sold to every three battery-operated sets. No such comparison is available for the year just closed—1928, but it is probable that the majority of sets sold in 1928 were socket-operated a.c. receivers.

Why did 1928 show such an astounding sale of sets? That figure of 3,000,000 is one to conjure with and the men responsible for sales can well be proud of it. Just two factors entered in. First, the public acceptance of the *new convenience* of radio. The light-socket-operated receiver hit their fancy. The a.c. set represented to them the "perfect radio" they wanted to own. Secondly, extraordinarily good broadcasting, represented by general programs of high quality and the

astounding effect of the public interest in the broadcasting of all the events in the political campaign. There is much more to be said on these two points, but this will suffice.

It is no idle phrase to say that the a.c. set has been *accepted* by the public; the sales for 1928 demonstrate that. But in 1929 a.c. sets must be *sold* to the public. A radio set operating direct from the light socket is no longer a marvel to the prospective buyer. The phrasemaker who described radio as a seven-day wonder was more right than he knew and for all practical purposes might have been describing the sales situation last year. When the seven days were up, the a.c. set was *accepted*. From then on, it had to be *sold*.

Now those who bought a.c. sets last year, those represented in that 3,000,000 set market, bought a.c. receivers because they were the cream of the market. Radio for them had arrived and they bought it.

Radio set sales in 1929 will be more difficult. The cream of the market has been skimmed, as far as those interested in a.c. sets for their own sake are concerned. Now how can the tough sales problem in 1929 be licked? In just two ways: first by better, more intensive, more intelligent sales methods. The dealer cannot content himself with taking orders like salespersons in large and successful department stores; he must *sell*. How he must sell, is, as the saying is, another story. The second method by which the sales problem of 1929 can be conquered is in the improvement of *service*.

On January 1, 1929, there were 11,000,000 radio sets in use in the United States. Of these 11,000,000 not more than 3,500,000 are a.c. sets. That last figure is probably high, but will be accepted for the purpose of this discussion. Therefore, there remain 7,500,000 sets now in use which can be replaced with modern complete light-socket-operated receivers. Of course, a respectable quantity of these 7,500,000 sets are in homes which are not supplied with a.c. lines. But if a generous subtraction is made for all reasons, there still remain a tremendous number of battery-operated sets which can be replaced with the a.c. set of 1929.

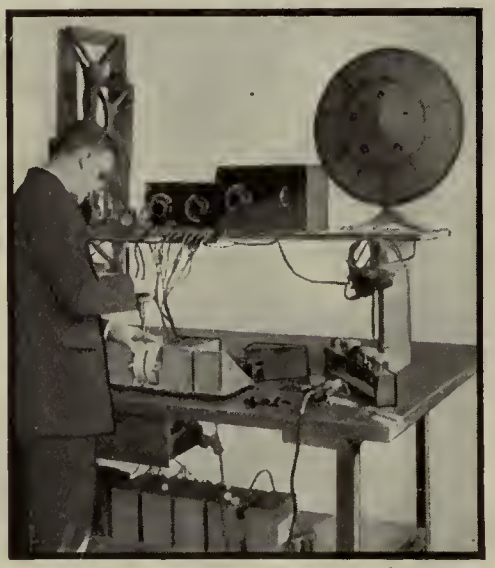
The Resale Market

IN CONSIDERING the 1929 market one cannot avoid the growing importance of the resale market. The dealer can and should sell new sets to people in 1929 who have never owned a radio before, but he also has an enormous prospect list made up of those who have sets, sets which are battery-operated, of poor quality of reproduction, expensive to maintain, and otherwise antiquated and unsatisfactory.

Now most of these present owners of unmodern, outmoded sets are in contact with a local dealer, And the chief contact the dealer has with them is through his service department. When it comes to salesmen everyone is pretty much the same; one does not willingly expose himself to a sales canvass if he is not absolutely convinced he wants what the salesman has to sell. But the dealer with a well-rounded organization has a great advantage. One branch of his organization is welcomed in the home of the prospect for a resale. *And the representative of that branch is the serviceman.*

The customer tends to hang on to his radio as long as he can. He reiterates that his radio is "a little old, but good enough." He loves to tell how his set still gets all the stations he wants, of its "fine mellow tone," and other phrases we all know so well. But when he calls in the dealer's serviceman, he establishes contact with the sales organization again. He asks to be sold service and he should get it. And if the dealer's sales and *service* organization function smoothly, the dealer can get an immediate line on whether or not that customer is a good prospect for a resale, through the report of his own representative—*the serviceman.*

Returning to the 1929 sales problem again, the relation of the resale market to the new sale possibility will be considered. John S. Dunham, president of QRV Radio Service, Inc., one of the largest and best purely service organizations in New York, has told the writer of a situation he has discovered. In a representative Riverside Drive apartment house where, with a total of 73 apartments, only 60 families owned radio receiving sets. That is the condition in one of the wealthiest sections of New York City, where the majority of families can well afford a radio receiver. Every one of these 60 families is a prospect



—F. A. D. Andrea, Inc.

In order to perform tests efficiently the dealer's shop must be equipped with well-designed testing apparatus. This picture shows a serviceman performing a continuity test on a Fada receiver in an approved fashion.

for a new and modern set in 1929, but it is going to take some expert selling to bring the 13 unequipped families into the radio fold.

The dealer is most certainly going to sell many of these families who have never owned a radio before the history of 1929 is written, but he should not lose sight of the ripe prospects among those who already own sets.

What is Good Service?

VOLTAIRE once said, "If you will argue with me, first tell me the terms of your discussion." And it is fair enough here to ask, "What is good service?" Good service is what keeps the customer *sold on radio.* The dealer must render satisfactory service during the period of the free guarantee in order that the set remain in the customer's home; the set must not come back. And barring earthquakes or other acts of God, the set can stay there to the customer's complete satisfaction during that time. If the dealer cannot keep the set sold through good service during that period, it is plain that the customer becomes completely unsold on radio, from the dealer right back to the maker of his set.

And what about the period *after* the free service guarantee has expired?

Here again, the dealer should render the best of service for the best of reasons. Through good service the dealer should keep the customer long enough to sell him another set. Through good service, the dealer can make a profit on service transactions and certainly on the sale of tubes and other accessories the purchase of which results from service calls. And here is a most important point: estimates indicate that about 10 per cent. of the total radio retail outlets are exclusively radio stores. In the case of the remaining 90 per cent., the other outlets, good service on the part of the dealer is going to retain customer confidence and satisfaction and make that customer come to his store for the other merchandise which that dealer handles. Furthermore, the dealer's main interest is in selling radio sets. He has to watch carefully the cost of *getting* his customers. Good service after the free service guarantee has expired means the difference between keeping a customer already acquired and going through the expensive process of getting a new one. Let's put that important point in another way.

If it costs a dealer $5 for each new customer and through poor service he loses half of them it means his year's new customers cost him $10 each. If he gets 100 new customers and poor service loses half of them, he must get 200 new customers to keep 100. So good service is closely connected with the dealer's new set sales, not only to those customers already in hand but to the friends of those customers. And the recommendation value of good service with customers already owning sets is no small factor in entirely new sales to the friends of the dealer's present customer. Almost every radio dealer, no doubt, recalls many instances in his own experience where satisfying his customer through accommodating and efficient service resulted in a good prospect and sale among one or more of that customer's friends.

Now is this good service which has been discussed too heavy a burden on the dealer? Well, the customer looks on the dealer as a means through which he can get good radio reception. Good broadcast reception is to the customer the only end. To the customer the dealer represents the chief source of radio information and expert ability. In the customer's eyes, the dealer sells him first, the mechanical-electrical means through which he gets the broadcast reception he desires, and through that same dealer he buys the continuance of the reception on which he insists. Good service on the dealer's part to the customer does not represent men or materials but only the restoration of good broadcast reception.

Service Requirements

GOOD service on the dealer's part requires: first good servicemen; secondly, a simple and easily maintained system of service records at the store; and thirdly, good testing and repair equipment in the hands of the servicemen.

Perhaps the average dealer, looking at his service problem as of secondary importance to his sales problem, has been prone to hire the cheapest men he could get, or to put it another way, has felt that servicemen were not worth a very large salary. It is probably true that the average serviceman makes little more than $25 or $30 per week. However, would it not be better for the dealer to hire fewer men and pay them more?

Even the simplest system of cost accounting applied to the dealer's service work will show that it is more economical to reduce the total number of service calls. For example, a mediocre dealer's serviceman makes two calls within ten days at a customer's house, each call involving in time alone a charge of not less than $1.50. The two calls cost $3.00. One call, which in the charge of an expert efficient serviceman at $3, is better economy. Economy from the dealer's standpoint, certainly from the customer's angle, and it is economy of the time of the serviceman himself.

It would be better from the dealer's position to hire one serviceman at $50 per week and expect topnotch performance than to hire two fair servicemen at $25 each. The dealer has a right to expect the very best of work from the good man, while he always knows in the back of his mind that the mediocre men cannot be expected to do really first-class work. The importance of having the service job done right the first time cannot

be overestimated. And getting it done right means that a first-class man must do the work and must be paid well for doing it. And from the dealer's cost standpoint, it does not mean that he has to spend more money than he can afford. Good service done by the best possible serviceman is actually cheaper than "cheap" service.

Relation of Service to Sales

IN THIS discussion the serviceman has been considered as a different person, a different type from the sales staff of the dealer. But in the last analysis, and it is the honest analysis, the serviceman is a salesman just as much as anyone in the dealer organization is. The serviceman is *selling* service. If he is not, the dealer has deadwood on his hands. And service to the broadcast listener means only one thing—good broadcast reception. When the customer bought from the salesman originally, he was also buying broadcast reception and not merely radio furniture.

The good serviceman is really keeping radio sold and that is real salesmanship. The serviceman, it is true, differs greatly from the pure salesman in the radio store. But it must be remembered that after the customer has actually bought his set from the dealer, it is the serviceman who maintains that contact of the customer with radio reception.

Everyone is human and the good serviceman who enters the customer's home gets into as human a situation as can be found anywhere outside of a doctor's office. The patient goes to the doctor with an ailment and implicitly trusts the doctor to draw on his fund of medical knowledge and recommend and apply the cure. The radio owner, calling the radio serviceman in, is in exactly the same position. He is putting his trust in a technical expert to restore to him good reception.

Now the intelligent serviceman, backed up by a good system of customer-service records, goes into the home. He examines the set with practised eye and sure hands, using his test equipment surely and expertly, just as the doctor uses his thermometer and stethoscope to detect the patient's physical ailment. The good serviceman knows what will restore the set to working order, how much it will cost, and how long it should take. He does not talk circuit-diagram language, which the customer does not understand and, therefore, suspects. He tells the customer in words he can understand what his set needs. And he gives the customer's set that cure. But the good serviceman does more.

He returns to the shop and notes down on his service record—which should be available to the purely sales staff—his analysis. That analysis may show, as it often does, that the customer really needs, not a new set of tubes, or a new a.f. transformer to restore him to the enjoyment of good broadcast reception, but a new set. The serviceman does not try to sell that new set, but, while on the job and being entirely honest, he can in his analysis to the customer plant the seeds of desire for a new set and can give him reasons. The serviceman, as a sideline to his main task, is really a most important feeder of replacement sales to the retail shop.

In this connection it should be pointed out that only a very small number of the sets now in use are designed to give what we all know to-day to be good broadcast reception. The advances in design in the past 18 months or more have been too rapid. It is invariably true that the customer is satisfied with his present set until he hears something better. Servicemen of wide experience say that one of the most common complaints of owners runs something like this: "Please come out and fix my set. It still plays, but its quality doesn't seem to be as good as when I first got it." Now, barring such proper complaints as failing tubes and incidental circuit conditions causing temporarily impaired quality—which the serviceman quickly repairs—what is the true situation? Simply this: the set, after minor repairs, is as good as it ever was, but what has happened is that the customer has revised his ideas of what good quality is. His set, in other words, has not failed him, the set is no different, but the *customer* is different. His ideas of good quality have been revised without his knowing it.

How Servicemen Aid Sales

WHAT does the good serviceman do in this case? Does he merely tell the customer that his set is as good as it ever was? That, the customer will never believe because he *knows* in his heart that the set isn't. No, the good serviceman, working under proper direction from his chief, explains how reproduction has improved in new models, tells him of the merits of the new loud speakers, revises, in fact, for the benefit of the sales staff, the customer's ideas about modern radio. Of course, the serviceman can explain that he can install special high-quality transformers and a dynamic loud speaker but he can show at the same time that the $50 or $60 involved in materials alone in this improvement in his old set might better be put toward an entirely new and modern set which has all these improvements as an integral part. Or take another frequent situation. While the serviceman is making repairs in the home to an old set, the customer plies him with questions. "What do you think of this set of mine? Is the new X-phonic receiver all the advertisements say? How much does it cost to operate one of the a.c. receivers? What set do you recommend?" These questions and a lot more like them are fired at the serviceman, and, if he is good, he answers them honestly. And when he returns to the shop his analysis of that customer's possibilities can appear laconically in the remarks column: "customer's set repaired with set of new tubes; good prospect for new a.c. set."

Here the dealer makes a profit on the service call, satisfies his customer, and gets absolutely invaluable information leading to the sale of a new set. Had his reputation for service been poor his competitor's serviceman would have been there, paving the way for a replacement sale. So is good service tightly linked to increasing sales.

Now where are good servicemen to come from? How much responsibility rests on the dealer and how much on the serviceman? Although an attempt has been made to show that the intelligent and alert serviceman, working in the customer's home, has a tremendous advantage in influencing new sales, he is not a salesman primarily. But if he is not used by making him an integral part of the sales plan, the dealer is leaving a big part of the store's sales possibilities untouched. During the regular sales meetings the dealer should help the serviceman to understand the importance of his part in the sales plan and should instruct him on how he should answer the customer's questions about new sets.

The dealer's main effort should be to improve his servicemen and that means leaving no stone unturned to see that he is getting every bit of technical information which will help him. He needs the best possible tools of his profession, to be sure; good meters, set-checkers, etc., but he needs the technical knowledge of how to use them, he needs background on radio generally, he must know what other manufacturer's sets are like, technical short-cuts in his work, etc. In short, he must study. The dealer sees that he is equipped with the proper meters—the tangible necessities—but he must also see that he has the intangibles—the knowledge based on study.

There are some textbooks which give servicemen the background they need or which help to develop that which they already have, there is a lot of excellent printed matter from various radio manufacturers which has lots of useful information, and there are periodicals which will help servicemen to keep abreast of the technical side of this rapidly moving industry. In this connection, one of the most encouraging signs which has been manifest is the deep interest of radio dealers and their service staffs in acquiring more accurate technical information on what is going on. Thousands of letters are received at RADIO BROADCAST from dealers and servicemen, and these communications are from men who are greatly interested in improving themselves with more information.

The serviceman's work bench should be well lighted and free from obstructions to permit most efficient work. Each tool should have a place and small parts should be stored in some orderly manner.



The MARCH OF RADIO

Will Synchronization Bring a Radio Panacea?

WHENEVER an experiment in the synchronization of broadcast station carriers is announced, articles appear in the press to the effect that, should the experiment be successful, the number of stations operating simultaneously in the broadcast band may be increased greatly. In most instances, this impression is entirely erroneous because only approximate carrier-frequency regulation is attempted. Only when absolute synchronization of both carrier and program signal is the objective is there any hope of increasing the number of transmitters which may operate simultaneously. Absolute synchronization has been accomplished successfully only when the stations are linked by wire lines and both carrier and program signals are supplied from a common originating point, as in the case of WBZ and WBZA.

However, there are definite limitations even to absolute synchronization. It is useful only when the signal received at any one point comes from but one of the two synchronized stations. A receiver, so located that it receives equal signals from both synchronized stations, is subject to serious distortion because the two signals are out of phase due to the differing time required to transmit them by wire and back through the air. Usually, because of fading and field-strength variations in the received signal, this phase difference is emphasized by a swinging effect. Consequently, undistorted reception with absolute synchronization is possible only when the signals of one of the stations predominate over the other at all reception points within their respective service areas.

We are informed of practical experiments conducted in Germany in the field of absolute radio program synchronization, employing wire distribution of both program and carrier. A definite interference pattern, which changed not only from day to day but hour to hour, was found to exist, due to the interaction of the signals received from two points simultaneously but out of phase. Reception, good at one point, would be found to be practically nil at another but a few score yards distant. This experience corresponds to theoretical conceptions of phase difference effects encountered in radio transmission from two different points. Authorities differ on these questions, it is true, but until we have actual demonstration of successful wire-line synchronization under the practical conditions of the present broadcast spectrum, glowing descriptions of this would-be panacea to broadcast allocation ills are rather the expression of a hope than a justified assertion.

In the case of approximate synchronization, attempted by means of independent crystals accurately matched, very serious limitations to its application exist which do not appear to be generally understood. The principal object sought in approximate carrier synchronization is to eliminate carrier whistle on regional channels. This is the most annoying type of interference, now widely experienced on all the crowded regional channels. For example, WCCO and WPCH, now engaging in a synchronization experiment, operate simultaneously only during the day. If their carriers are approximately synchronized, they may also operate simultaneously during such evening hours as the program service areas of the stations do not overlap. If the separation between these stations were reduced by 500 miles, approximate synchronization would still eliminate the carrier whistle, but the distortion due to the simultaneous reception of two programs and the effects of the sub-audible beat note, created by their carrier interaction, would cause disruption of the service of both stations. While a 50- or 60-cycle carrier heterodyne of approximately synchronized stations is not reproduced by the loud speaker, the sub-audible beat occurring interacts with the audio-frequency or program component, affecting musical quality. WPCH serves only a small area, surrounding New York, and, during the early evening hours, WCCO's signal is of such a low field strength that it would not produce an audible effect in WPCH's service area. At the same time, WPCH, being a low-powered station, would have no noticeable effect in WCCO's territory. But, as the later evening hours approach, and good transmission conditions prevail, WCCO may, under certain conditions, deliver sufficient signal in the New York area to affect the quality of WPCH's transmissions. The success of the WPCH-WCCO experiment, therefore, means only that, in certain instances, where a low- and high-powered station, widely separated, are paired on the same channel, their respective service may be somewhat improved at those times that their audio-frequency and carrier signals are of a widely diverse field strength within their service areas. Two or three hours' service in the early part of the evening is a valuable addition to WPCH's opportunity to serve its audience and the experiment of carrier stabilization is thereby justified. But station managements are warned that that is the maximum effectiveness of the experiment. Amateur allocation experts should realize that approximate synchronization will not increase the number of stations which may be assigned in regional channels.

The Federal Radio Commission has issued permission to the Continental Broadcasting Corporation of New York to attempt an experiment in synchronization of two broadcasting stations in Virginia. The frequencies assigned for the purpose are 3257, 3256, and 4795 kc. These high frequencies, when heterodyned, produce a 1539-kc. carrier, the frequency of the two stations in the broadcast band associated in the experiment. The employment of two or three high-frequency transmitters for generating a desired broadcast carrier frequency at several separated broadcasting stations by heterodyning may or may not have advantages over the distribution of a single frequency, which is stepped to the desired broadcast frequency by means of a frequency multiplier or harmonic producer. The latter method requires the use of but one high-frequency channel instead of two or three. The conclusion that a demonstration over short distances will make possible long-range synchronization of chain stations is unwarranted because it still remains to be proved that fading and noise effects do not cause instability in reception of the synchronizing frequencies and that skip-distance effects limit synchronization to very long spans only, so that amplifying such a signal to serve as the carrier for broadcasting is impractical.

Canada's High-Frequency Allocation

AN AGREEMENT has been reached between the State Department and the Canadian Government on continental high-frequency assignments, in accordance with the report of the majority of the American delegation at the recent conference at Ottawa. That report, with which ex-Commissioner O. H. Caldwell of New York dissented, gives the United States a total of 146 of the 228 general communications channels, of which 112 are exclusive and the remaining 34 shared with Canada and Newfoundland. Canada is allocated 38 exclusive channels, to be shared with Newfoundland, and 48 shared with other nations. Newfoundland received 17 channels, shared with the United States, Cuba five exclusive and 15 shared with Canada; Mexico and other nations, eight exclusive and 16 shared with Canada. Of the 65 channels below 3412 kilocycles, the United States holds 34, shared with Canada and Newfoundland; Canada has 48, shared with other nations; Newfoundland 17, shared with the United States; Cuba 15 shared with Canada, and other nations have 16 shared with Canada.

Apparently, the meetings leading to this agreement were not in the nature of a negotiation but rather a presentation of frequencies to Canada. With utter disregard of the future needs of the United States for essential high-frequency communication channels, an extraordinarily liberal award has been made to Canada. Considering that our population and habited area is roughly ten times that of Canada, there is no possible excuse for the present ratio, which gives Canada more than 70 per cent. of the number of frequencies assigned to the United States. Furthermore, the precedent established by this agreement will be pressed by Canada as applicable in the broadcast band. If our broadcast channels were divided in the same ratio, the American allocations would amount to approximately 48, the Canadian 34, and other neighboring countries 14. The same arguments which swayed the State Department into accepting the Canadian proposal for this disproportionately large share of high-frequency channels are certainly applicable to broadcast channels.

It seems to us that the only just basis upon which the 293 high-frequency channels can be divided among Canada, Newfoundland, Cuba, the United States, and the remaining countries in the North American continent is a scientific appraisal of their present communications and future needs. This requires that consideration be given to area, the determining factor in appraising the distances to be linked; population, determining the number of persons to be served, and any special factor which may be necessary to correct inequalities arrived at by this method. In the matter of area, Canada gains an undue advantage because a large part of its area is uninhabited and, therefore, requires little or no communication facilities. Although our population is larger, it is also growing at a rate which would make assignments on the basis of population quite fair. On the basis of area and population alone, Canada rates about one-tenth as many frequency facilities as the United States, although it is entitled to a better ratio than this because many small but important communities cannot be served by any other means of communication than radio. But this consideration does not justify the one-and-a-half-to-one ratio adopted.

Commission Permits Limited Picture Broadcasting

THE Federal Radio Commission has ruled that visual transmissions in the broadcast band will be permitted hereafter between 1 and 6 a.m. Seventeen companies have been granted high-frequency channels for experimentation in the field, including Westinghouse, Radio Corporation, General Electric, Jenkins, WAAM, Inc., Lexington Air Station, Pilot Electric, Chicago Federation of Labor, William Justice Lee, and Aero Products, Inc. Other applicants, while not denied licenses, were ordered to appear at hearings for the purpose of showing why they should be granted television-channel assignments.

This outcome of the visual broadcasting hearing should be encouraging to those interested in its development because it gives them opportunity to demonstrate the possibilities of the art both on high frequencies and in the broadcast band. It is perfectly proper to restrict visual broadcasting to obscure hours until its program value is demonstrated more fully. The present hours, however, should be modified slightly because station personnel is not available at the hours now specified. If the visual broadcasting period were moved forward to midnight instead of 1 a.m., and a morning hour, such as from 8 to 9 a.m., a silent period with most stations, added, much more effective work could be done without, at the same time, affecting entertainment audiences. However, if any progress is made at all, the Commission is likely to consider the merits of the case.

The consensus of those appearing at the hearing was that television and still-picture broadcasting should have opportunity to prove their prospective service value before any attempt is made to determine their future. Representatives of the Radio Corporation of America and allied interests were flatfooted in their statement that there is no place whatever in the broadcast band for television because there is no public interest in the subject. Other authorities, including Dr. Lee deForest, C. Francis Jenkins, and John V. L. Hogan testified that television and still-picture broadcasting may ultimately have real service value in the broadcast band. Broadcasting stations can be relied upon to radiate picture signals only if there are appreciative and responsive audiences. Therefore, there is no wisdom in arbitrarily preventing experimental progress in what may become a useful broadcasting service.

World Peace Via the High Frequencies

IN AN effort to conduct world-wide communication from the Secretariat of the League of Nations, arrangements have been made by that body for a series of high-frequency radio telephone transmissions, utilizing the Dutch station at Kootwijk. A similar attempt in May and June of last year resulted in 92 reports of successful reception in all parts of the world. This year, transmissions to the American continent will be attempted on Tuesday evenings, to Japan on Wednesday and Australasia on Thursdays. For point-to-point communication, this service is likely to meet the needs for diplomatic message exchange with the same reliability that obtains in all short-wave transmissions. If a world-wide broadcasting service is contemplated, however, no single station is likely to be of use. The bulletin, issued by the League's Secretariat, is rather naïve, indicating a somewhat incomplete knowledge of radio transmission phenomena. The only hope for a world-wide broadcasting system lies in the utilization of established broadcasting systems, linked by short-wave transoceanic networks of a nature now being tried by the National Broadcasting Company and the British Broadcasting Corporation. A great deal of time and money could be saved if the League took advantage of the experimental work being done by others.

The occasional rebroadcasting of foreign programs by established systems will undoubtedly do more to promote international understanding than all the lofty declarations of politicians and diplomats. Science is rapidly building the means of promoting peace among nations and, in so doing, is incidentally developing the agencies which will make warfare all the more effective and, therefore, the more destructive.

Municipal Regulation of Man-Made Interference

THE Federal Radio Commission, through its legal staff, has made an investigation of state and municipal regulations applying to radio communications. This body is prepared to give advice and assistance to municipalities and states desiring to formulate ordinances which will not conflict with federal regulation. Only one decision has been made in the courts, demarking the field of federal and state regulation of communication. In that opinion, rendered by the District Court of the Eastern District of Kentucky, Whitehurst V. Grimes, held that an ordinance, attempting to license radio stations, is unconstitutional on the grounds that "radio communications are all interstate."

The Board of Trustees of Boonville, N. Y., adopted an ordinance, providing that no person shall maintain or operate any electrical device or apparatus causing interference with radio receivers within the village of Boonville. No electric sign or other so-called blinking device whereby a make-and-break contact is maintained, shall be operated unless equipped with condensers properly grounded so as to limit interference, nor shall electric pianos or other similar machines be operated. Violet ray or other X-ray machines shall not be used between 6 and 10 p.m. except in emergencies. Anyone violating this ordinance shall be considered a disorderly person and subject to a penalty of a hundred dollars.

We learn from a correspondent of another proposed ordinance being considered by the Brandon City Council of Manitoba, Canada, prohibiting the use of electrical equipment which causes radiations of a type interfering with radio reception. There have been several attempts to pass similar municipal regulation in the United States and, in the few instances that such regulations have actually become ordinances, they have been found to be unenforceable. The attack on electrical interference does not lie in prohibiting the use of equipment of a radiating character. The solution of this problem, which is gradually becoming of greater and greater importance as other causes of interference with radio reception are eliminated, lies in compelling the manufacturers of electrical appliances to equip their devices with filter systems which prevent radiation. Those who cause interference are usually the innocent victims of the manufacturer of the device.

The Press Continues Bungling

THE National Radio Press Association, Inc., of New York City, has been formed for the purpose of supplying spontaneous news and sports reports exclusively for radio stations and, through them, to the radio public. It proposes to build stations in New York, Washington, Chicago, Cleveland, Columbus, Cincinnati, Detroit, Kansas City, St. Louis, New Orleans, Atlanta, Salt Lake City, San Francisco, Los Angeles, Seattle, Philadelphia, Dallas, and Minneapolis. It has made application before the Federal Radio Commission for twenty continental short-wave channels, to be taken from the channels assigned to the American Publishers Committee. There is not the slightest indication of the competence of the organization, but it has been said that Herbert Bayard Swope, former executive editor of the New York *World*, is behind the project.

John Francis Neylan, attorney representing the Hearst newspaper interests, has protested to the Federal Radio Commission about the distribution of the twenty frequencies assigned to newspaper use under the management of Joseph Pierson of the Chicago *Tribune* and president of the American News Traffic Corporation. Under the plan, the Hearst newspapers received three transoceanic channels and three intra-continental, while the United Press and the Scripps-Howard newspapers receive a total of six and a half wavelengths. In a telegram to the Commission, Mr. Neylan states that Mr. Pierson is without authority to represent any newspaper or news association of the Hearst interests and is without authority to speak for ninety per cent. of the press of the United States. The press continues to show marked incompetence in managing its radio affairs.

The Board of Directors of the Associated Press adopted a resolution to the effect that a member newspaper may not establish a chain by which a station in another city than the city of publication may broadcast news of the A. P., unless that member joins with and shares the credit with the originating newspaper. A member may not tie-up the broadcasting of Associated Press news with any advertising program. —E. H. F.

RUNNING A SMALL RADIO SHOP

By MARY TEXANNA LOOMIS

President, Loomis Radio College

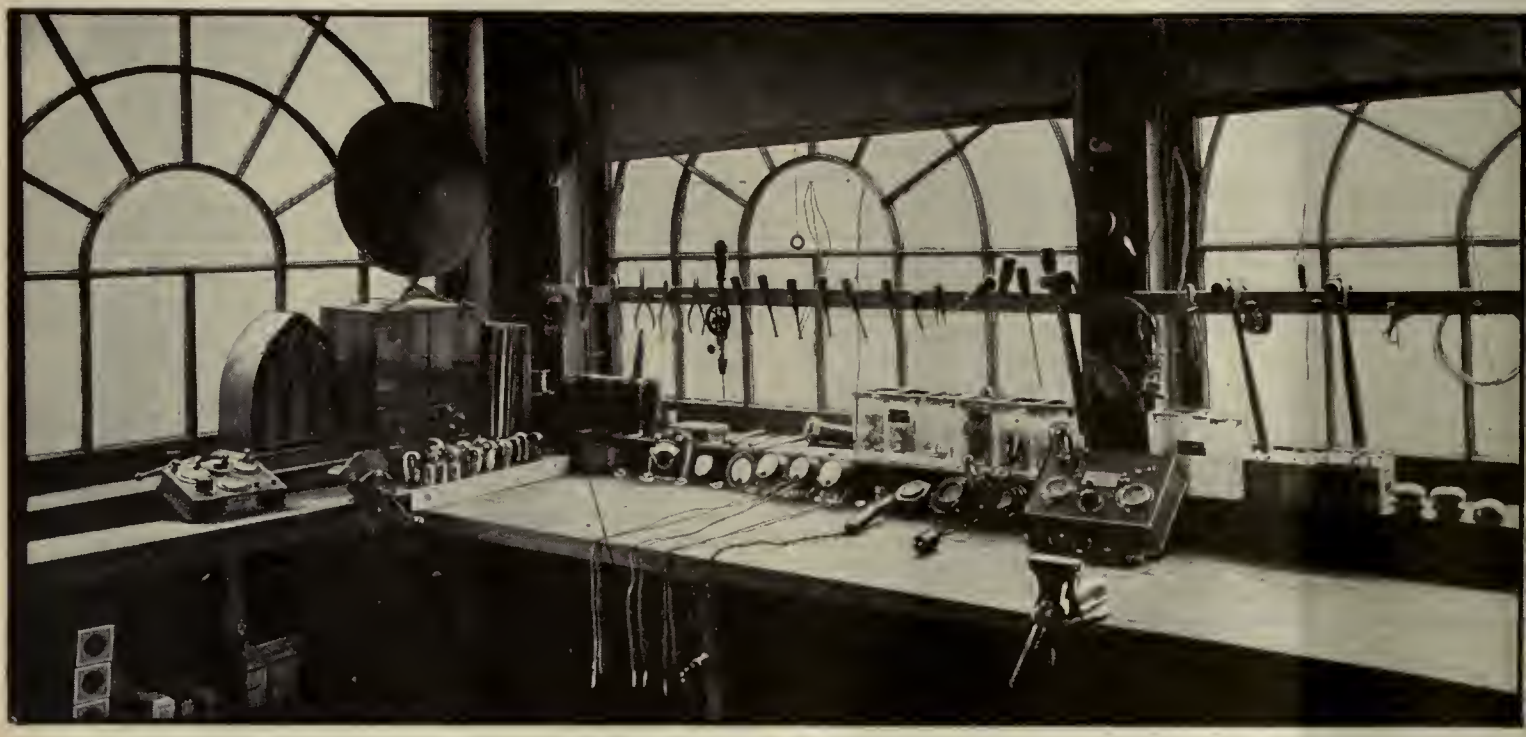


Fig. 1—A well-equipped work bench for the efficient servicing of radio receivers. Note especially the convenient arrangement of tools and testing equipment.

The author of this article looked into the shop of a typical dealer in Washington, D. C., and reports what was found. Particular stress is laid on the physical service equipment of this shop and how it is employed, and from this description dealers may compare their own problems and how they are trying to solve them with what the Capitol Radio Service organization is doing. Servicemen who find their businesses expanding to the point where they need a shop from which to operate will find this story especially useful.

—THE EDITOR.

WHEN the editor of RADIO BROADCAST asked me to prepare an article giving details of a small radio retail and servicing business, it was obvious that the service-shop classroom of the Loomis Radio College did not answer this description, and that the most effective way of making such an article practical would be to pick out some prospering little shop as a model. Naturally the choice would have to be made from available material. I have chosen to describe the Capitol Radio Service, of the Mount Pleasant suburban section of Washington, D. C., hoping that the ideas gathered may be of assistance to persons contemplating going into a similar line of business.

The shop referred to is located in a remodeled house, giving two floor levels, as indicated in Fig. 3. Many such store buildings exist throughout the country, and this is mentioned merely to explain the drawings and pictures which accompany this article. The showroom, with a small array of high-class broadcast receiving apparatus, is shown in Fig. 2, and the service shop in Figs. 1 and 5. Several antenna-ground wall outlets, such as used in apartment-house installations, are arranged around the showroom and wired in parallel so that any set can be conveniently plugged into contact with the antenna and ground without having to move it.

The retailing branch of any radio store is a matter of buying wisely and selling at a reasonable profit. Most dealers have arrangements with two or more manufacturers of standard sets as their representatives in their localities. One high-priced and one low-priced set from different manufacturers need not conflict. All sets are purchased on either cash payment or short-time credit, with standardized discounts. Manufacturers of standard radio equipment will not release goods on consignment.

Side Line Advisable

IT IS a good plan, especially in suburban districts, for the radio dealer to handle a small stock of electric lamps, flash lights, etc. Even a few standard automobile electrical devices may go well. The prospective radio merchant will profit by making a study of the location that he has chosen, to check up on the field that is likely to be open to him in electric side lines. In the matter of purchasing stock, the older experienced dealers could give valuable advice, if they could be induced to talk about their mistakes. They would no doubt tell newcomers in this field to proceed cautiously, without permitting conservatism to stand in the way of progress. One must always take a certain amount of chance in any business, but it is wise to avoid risking too much until the way ahead can be seen clearly. It is very easy to clog the stockroom shelves of a small radio store with a quantity of obsolete goods which only bargain sales at great sacrifice can move.

In the matter of receiving sets, and auxiliary equipment, the best goods, with the dealer's and factory's guarantees back of them, will pay best in the long run. Sets designed to meet the means of customers who can afford to invest only modestly may be as good, of their kind, as the more elaborate and costly apparatus. Often a large portion of the difference in price between two models from the same manufacturer may be due merely to the difference in design and finish of the cabinets or consoles. If the prospective customer cannot afford to buy beautiful furniture with his radio set, he should be advised to put his money into the "works."

The Service Department

THE service department of any radio store is the cause of its showings steady increase in business and profits. On the other hand, an inefficient service department is the cause of a store losing its business and finally, in extreme cases, of bankruptcy. The sets sold must be kept in working order, usually for people having only the vaguest of ideas concerning their operation. A short term of free servicing following a sale is standard practice. The dealer must deal pleasantly and patiently with his customers if he intends to make a success of his business. Therefore, the service department is a most important factor and worthy of careful consideration.

The first step toward installing a practical

service shop is a list of apparatus to be used. As there are still a great many battery-operated sets in use as well as the various types of electric sets, adequate apparatus must be available for testing and repairing both types. All instruments should be purchased for their accuracy, convenience, and ruggedness. They will be subjected to hard wear.

An ample outfit, containing meters and tools which will enable any qualified radio serviceman to make any test required in locating set troubles, and for making all repairs, is suggested as follows:

The work bench: The design of this piece of equipment is most important. It should be 2 feet deep, 36 inches high, and made of heavy pine boards 2 inches thick. (Two 12″ x 2″ planks 12′ long recommended.) The legs should be made of 4″ x 4″ lumber, so that it will be perfectly steady. The bench should be located in such a way that daylight comes in from the back, with each serviceman facing a window. There should be from 4 to 5 feet of bench room allowed for each man, and each man should have a drop light hung directly over his work. A stool of comfortable height should be provided each man for long jobs.

Shop servicing equipment: Electric soldering irons, capable of giving sufficient heat for extended work without burning out (One large electric shop in Washington uses the old-time plain irons, keeping several of them hot around a small gas ring.); wide assortment of well-constructed steel screw drivers; set of small open-end hexagonal wrenches; assortment of pliers and wire cutters of a good grade; set of hexagonal socket wrenches; assortment of fuses used in sets to be serviced; assortment of spring clips for making quick connections; several pairs of test prongs with wires; a small jaw vice; hydrometer; package of 00 sandpaper, and an electrician's steel knife.

Instruments needed: High-frequency oscillator; a.c. and d.c. tube tester; d.c. voltmeter with double-reading scale, 0–15 and 0–150; high-resistance voltmeter, 0–10 and 0–200; d.c. ammeter, 0–5; a.c. voltmeter, 0–3 and 0–5; and d.c. milliammeter, 0–100.

Power: All A, B, and C voltages for testing battery-operated sets should be wired to binding posts or clips on the work bench, as indicated in Fig. 4. There must also be a double outlet from the a.c. power line wired to the bench for use in testing a.c.-operated receivers. Where the shop is in the d.c. district of a city the most convenient method of handling the a.c. set problem is to install a motor-generator, running on d.c. and giving 110 to 115 volts a.c. output. The power rating of this generator depends on the load to be placed on it. A one-fourth-kilowatt generator is about sufficient for operating one a.c. set at a time. Two popular motor-generators, designed for this purpose and including filter, are the 250-watt, 115-volt, type BE-24, made by the Bodine Electric Co., Chicago, and the 500-watt, 115-volt, type LF-85, made by the Electric Specialty Co., Stamford, Conn.



Fig. 2—In this carefully planned showroom antenna-ground outlets have been installed in several convenient positions.

Antenna and ground: Erect separate antenna for shop, and wire to bench. Also wire good ground to bench.

Loud speaker: Place good loud speaker on a wall shelf, or other elevated position above bench for convenient plugging in. It is generally necessary to use an extension cord for this purpose.

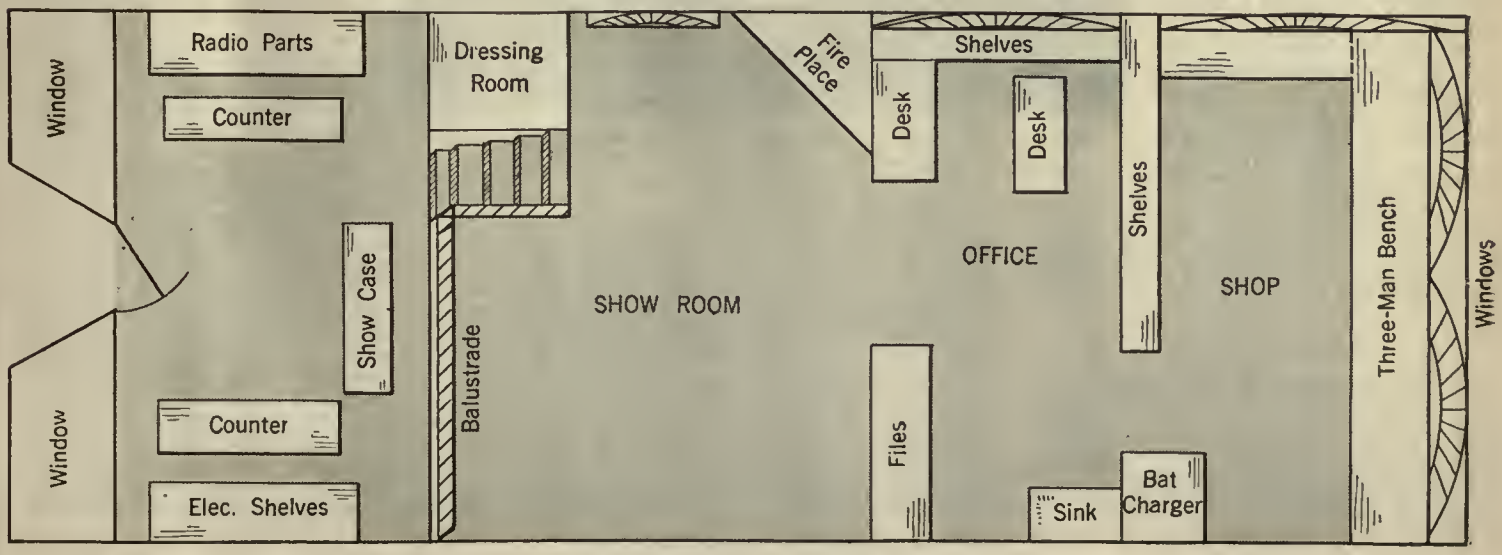
Outside serviceman's equipment: One oscillator voltmeter test combination; one test set, or assortment of meters with prongs or wires; such hand tools as are required for making minor repairs—screw driver, knife, hydrometer, pliers, soldering iron, phones, and a number of spare tubes of different types.

The equipment listed above should represent the initial outlay for a small radio service shop. Special tools may of course be added. Among these would be special wrenches, neutralizing tools which some sets require, etc.

Fig. 3—Diagram showing the floor plan of the Capitol Radio Service Shop, Washington, D. C.

Layout of Equipment

THE service shop should be located, when possible, in the rear of the salesroom, so that customers can be referred readily to the service department, using a minimum of the sales force time. The outside serviceman should have access to the serviceroom through the rear of the building. The shop should be well lighted, if possible by daylight. The lighting shown in Fig. 1 is ideal. Glass jars, seen in the photograph on the wide window sill, are used for holding spare parts for repairs. Adequate shelf room must be provided for holding incoming and outgoing sets, and a carefully handled system of tagging and filing is necessary in order to avoid confusion concerning ownership of the sets, their history, etc. Stout paper shipping



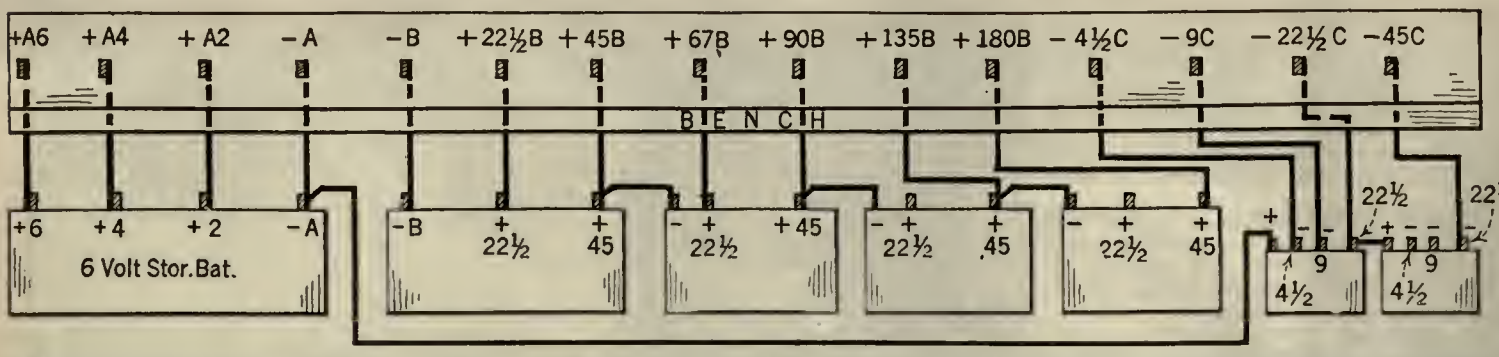


Fig. 4—Diagram showing the arrangement of battery clips on the work bench pictured in Fig. 3. As indicated all potentials are provided by batteries, thus assuring best results.

tags with fine stout twine are useful in labeling the incoming sets.

After placing the major equipment in the shop, the arrangement of instruments and tools on the bench is the next consideration. The hand tools most frequently used should be placed in a definite location, as shown in Fig. 1. The old adage, "Have a place for everything and everything in its place," will save much friction and loss of time. The bench beneath a radio set which is being serviced must, of course, be clean and free from tools. We have seen some servicemen actually working with a radio set placed on top of a pile of tools and débris on the work bench. Both radio set and tools suffer from such treatment.

All testing meters should be placed in a definite location, and supplied with long test leads. In some servicing shops the meters are mounted on a wooden or bakelite panel. However, as the leads must reach any set on any part of the bench, and be in such a position as to be easily read while putting the test leads to different parts of the set under test, this may not be found as convenient in practice as might be supposed. It is often found desirable to install a single-throw switch, or a locking push-button, in the lead from each meter, this will prevent accidents to the meters from picking up the wrong leads, if the switch is kept open except when the meter is in use.

The location of the tube rack, or racks, is a matter of personal preference in the individual shop. Safety from dropping objects and jolts is a point to consider in planning this.

Fig. 4 shows battery terminals as wired to the work bench in the Capitol Radio Service Shop. Fahnestock clips are located at the rear of the bench and permanently wired to the batteries under the bench. They could also be wired to a power unit in the same location. These clips are located between and in front of the meters, as pictured in Fig. 1. It will be noticed that the —B post is separate and requires a separate wire. This is intentional, as some of the battery-operated sets are designed for —B and —A together while others require connecting —B and +A together. This row of connections makes available the voltages required for all sets of battery type and also for connection in series with any meter for continuity tests.



Fig. 5—Making a continuity test on a radio receiver under ideal conditions with plenty of daylight and the proper test equipment.

Choosing Servicemen

WITH comparatively simple and inexpensive equipment, a capable serviceman can accomplish more than can a poor man with all the apparatus on the market laid before him. The servicemen who do outside work are representatives of the shop employing them, and customers are generally inclined to judge the shop and its proprietor by the class of servicemen employed. An efficient serviceman must be sufficiently well educated in radio to understand technical instructions and drawings, and to be able to converse with customers on technical points, explaining the theory intelligently and giving concise advice to customers as to the operation of their apparatus. He must be backed by radio, mechanical and electrical experience. In many cases the serviceman is called upon to refer to the lighting circuits in a house or to make simple connections to them. "Radio tinkerers," who have "just picked it up," and who not infrequently advertise themselves as "radio engineers," should not be eligible to employment in a first-class radio servicing shop. The fact that many such people have been permitted to work on the public's radio sets has done considerable harm to the business by creating a feeling of suspicion and distrust on the part of many set owners. Efficient and honest dealing with the customer is invariably the surest road to real success. It is well known that many servicemen have, in times past, made a practice of condemning various parts of a set, the favorite parts being audio-frequency transformers, and of selling new ones for replacement, when the parts condemned were not really damaged. Such practices must sooner or later come back on people who are guilty of them, or who permit their employees to be guilty of them. There are a few pioneer schools in broadcast radio servicing and the prospective employer will profit by selecting his servicemen from the graduates of such training classes, or from men who have been practical commercial radio-telegraph operators. There are many ex-seafaring operators available, who have kept up with the times in broadcast receiving apparatus and who, for various reasons, wish to remain ashore and find work where their experience in radio will count.

The outside radio serviceman must have a good personality and a neat appearance. If he is gifted with diplomacy, he can often keep customers and make friends, when conditions might otherwise lose their business. If the volume of business requires, two servicemen are employed, one for shop and bench work and one for outside calls, with the understanding that if necessary either one will help the other. The larger shops, of course, employ many more servicemen than this.

Naturally, good men, coming up to the requirements given, cannot be hired for a pittance. If they are really well-trained and experienced men who can prove that they know their business, they are well worth a reasonably high salary. The proprietor of the small radio shop will find that he will make more sales and have a better paying business if his servicemen are able to add continually to his list of pleased customers.

Articles which have been published in recent issues of RADIO BROADCAST should be of great assistance to the dealer who is faced with the problem of engaging men for his service staff. In particular, the article, "An Examination for Radio Servicemen" by J. F. B. Meacham, on page 405 of April, 1929, RADIO BROADCAST will be found of value. This article includes the examination for radio servicemen which has been used with success for a number of years by one of the largest service organizations in New York City. This examination has been designed to determine the general radio knowledge of the applicant as well as his ability to service radio receivers and it has been found that the man who can pass an examination of its scope is usually quite efficient in the field as a serviceman. The examination is divided so that fifty credits are given the questions on servicing and fifty credits for general information. The subjects considered in the various sections of the examination are fundamentals, tubes, batteries, power units, diagrams, and servicing.

[The second of this series of articles will deal with the technical problems encountered by the serviceman and the most effective methods for handling them, with diagrams and descriptions of testing apparatus. *Editor.*]



STRAYS *from* THE LABORATORY

Distortion of Broadcast Harmonics

LISTENERS on short waves who occasionally run into telephone conversation or broadcasting which they cannot "clear up" may wonder what kind of stuff it is. The material is probably a harmonic of some broadcasting station and the "sour" quality is the result of the following phenomenon. The oscillator of the broadcasting station generates harmonics as well as the fundamental frequency. These harmonics are modulated as well as the fundamental, but the chances are that the amplifiers following the oscillator do not have linear characteristics as regards the harmonics. Let us consider only the second harmonic. If the fundamental is modulated with a frequency of 1000 cycles and at a modulation percentage of 60 per cent.; the second harmonic will have sidebands corresponding to the original modulation, i. e., 1000 cycles, and in addition a carrier of twice the original frequency with sidebands of double the original modulating frequency. This in itself would not account for the horrible garble that may often be identified as the harmonic of an otherwise well-thought-of broadcasting station. The additional distortion results from the fact that the percentage modulation on the second harmonic is doubled—and if the fundamental is modulated 60 per cent. the second harmonic will be overmodulated and, of course, distortion is inevitable.

The mathematics on this subject will be found on page 95 of February *Experimental Wireless and the Wireless Engineer* in a communication from A. B. Howe of the British Broadcasting Corporation.

Cut-off of Dynamic Reproducers

WHERE does a moving-coil loud speaker in a baffle-board cut off? In other words what is the lowest frequency to which it will respond with any degree of efficiency? Consider Fig. 1. A sound wave originates at the rear of the baffle as well as at the front. If these two waves come together at the correct phase, they will interfere, and the resultant sound to the listener will be less than if the radiation from the rear of the cone were suppressed. The purpose of the baffleboard is to increase the path through which the air waves must travel from front and back before they can interfere.

The distance from front to back via the shortest mechanical path must be at least one quarter the wavelength of the lowest tone desired. Sound in air travels at about 1110 feet per second. A frequency of 110 cycles, then, has a wavelength of 10 feet from the familiar formula—useful at radio or audio frequencies—that the wavelength is equal to the velocity divided by the frequency. Thus, if the shortest mechanical path is one quarter the wavelength, $10 \div 4 = 2.5$ feet, and so the distance from the center of the hole in the baffle around to the back must be at least 2.5 feet. This means that if the moving coil is in the center of a square board, this board must be 2.5 feet across. For 55-cycle reproduction the board must be 5 feet on a side and so on. A board three feet on a side will give good reception to all tones now being broadcast from the majority of stations.

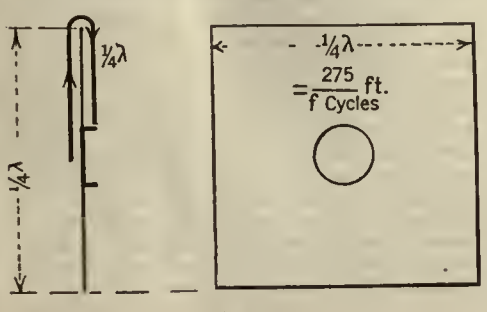


Fig. 1.

The following are among the subjects discussed in "*Strays*" this month:

Distortion of Broadcast Harmonics
Cut-off of Dynamic Reproducers
Simplifying Filament Transformers
Argument on Power Vs. Energy
Series-Filament Circuits
Data on Carborundum Crystals
Movie Men Make a Discovery
Power Output Requirements

Simplifying Filament Transformers

INTRODUCTION of the 2.5-volt power tube, the UX-245, will make unnecessary more than one winding on filament transformers. This is one step in doing away with the 1.5-volt winding and the center-tapped 5-volt winding. Thus, the introduction of a single tube standardizes and simplifies the construction of filament transformers. The winding for the rectifier tube, however, must be distinct from the filament winding. Will not someone develop a rectifier tube which can be operated from this same 2.5-volt winding? The solution seems to be a heater-type tube—but can someone develop a tube which will not break down under the comparatively high voltages?

An Argument on Power Vs. Energy

MR. HUBERT WOODS, of Riverside, California, takes us to task in the following vein:

"Under 'Strays from the Laboratory' in your issue of February, 1929, your first remarks are concerned with power, energy, and efficiency, and are well taken, in general.

"You define power as the 'rate of doing work.' Accepting this definition, how can you possibly 'consider a tube, such as a 171, feeding power into a load, etc.,' as you attempt to do in a subsequent paragraph? Do you mean that the tube feeds 'a rate of doing work' into a load?

"What the tube really feeds into the load is electrical energy, not power, nor work. Work is the final result.

"It seems to me you are guilty of the same lack of discrimination against which you properly protest.

"The units of energy and work are the same, but are not those of power, which is a rate, according to your definition. My company purchases electrical energy, which we convert (most of it) into work immediately, by use of motors. We do not purchase power (per your definition) although each motor has a certain power rating, because it can do work at a certain rate.

"If you had not burned your bridges behind you by defining power in one way only, you might possibly be justified in your usage of the term, since a common definition of power makes it synonymous with energy (ability to do work)."

Data on Series-Filament Circuits

READERS who have written this office for data on series-filament receivers will be interested to know that a collection of blueprints has been prepared by the Raytheon Company on how to wire well-known makes of receivers for series-filament operation. These diagrams may be had by applying to the Raytheon company, but it is earnestly requested that something more than curiosity be the basis of writing to this company for them. The diagrams will tell a serviceman how to rewire a receiver for series-filament operation, or will give him service data on a receiver of a given type that is already wired in this manner.

Sensitivity of Carborundum Crystals

THE curves in Fig. 2 were taken in the Laboratory by measuring the current through a Carborundum Company detector as the voltage across the crystal was changed. Several readings were taken in an effort to show the effect of varying the pressure of the con-

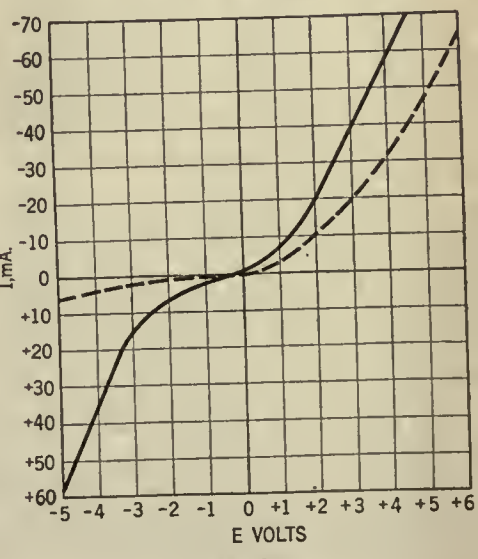


Fig. 2.

tact point. The weakest pressure on the crystal gave the best detection—that is, the greatest variation in current on positive and negative half cycles of input voltage. Of course, a weak pressure indicates an unstable one, and so if, as on shipboard, one wants stability a comparatively heavy contact is used. The experimenter can have considerable excitement by plotting a.c. voltage waves and the rectified current waves as various a.c. voltage waves are placed on such a diagram. The effect of sliding the average value of the input a.c. voltage wave up and down the curve will show how such a rectifier detects.

Movie Recorders Make a Discovery

SOUND-Movie recorders have discovered that audiences are not very critical regarding the quality of the miscellaneous sounds that make up a picture. That is, if the villain shoots a revolver, it is not necessary to shoot a revolver in the studio, provided someone whacks something at the exact moment. In one test case there were several kinds of airplanes on the screen, and, while great efforts had been made to simulate the distinct sounds emitted by the individual planes, only a small percentage of the audience admitted they knew the difference. Half of this percentage were aviators. And so now, when you hear a talking moving picture, note how little difference it makes to you if a series of revolver shots sounds like someone throwing a bucket of coal down the cellar stairs—provided the sounds and sights are synchronized properly.

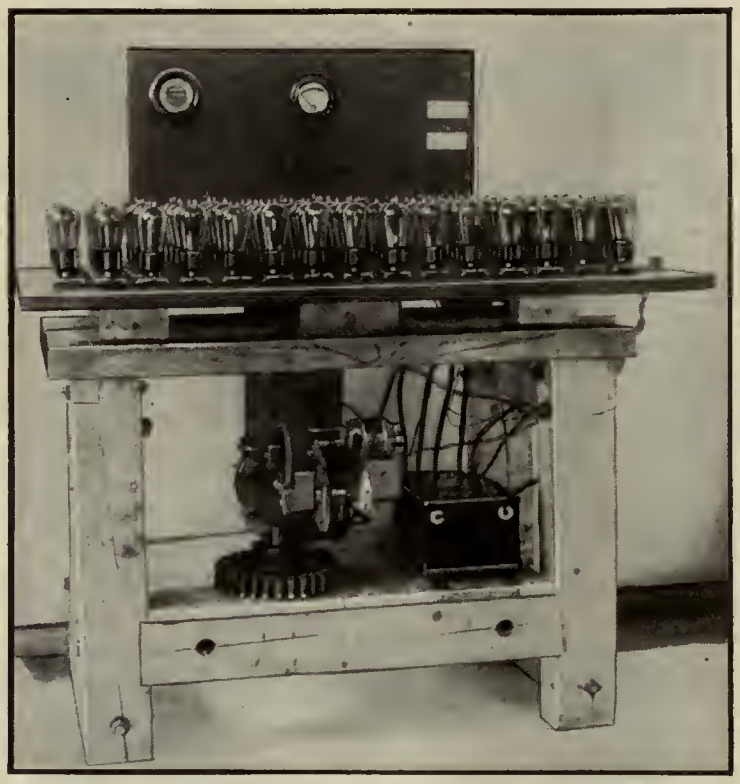
Power Output Required

MANY READERS take exception to our statement that a single 171-type tube provides sufficient power output for home reception. Many state that this is the maximum power output that can be used with the majority of cone-type loud speakers and several state that when they changed from a 171- to a 210-type tube (twice the power output) the difference on a cone-type loud speaker was barely noticeable. The fact that many loud speakers rattle if you put 1.5 watts of audio power into them is irrelevant. Our contention was that the sound output from a good loud speaker when less than one watt of electric power went into it was sufficient for home reception.

It is certain that, as the response to low frequencies is built up, either by using amplifiers with a hump at some low frequency, or by using a flat amplifier with a moving-coil loud speaker, the power output required increases. It is probable that an output of a full watt is desirable, and this may be obtained easily with the new power tube (the 245-type) that is now on the market.

The difference between a single 171-type tube and a single 210-type tube is only 3 DB, which is scarcely noticeable to the ear, and if a loud speaker or amplifier, or both, is used which does not reproduce the bass, the difference is not worth while. It is on the low notes, 150 cycles and less, that considerable power output is desirable—and there is no use in providing this power unless there are frequencies of this order to be reproduced, or if the loud speaker will not respond to the fundamental of such frequencies.

This seems to indicate that with cone-type loud speakers which do not respond to low frequencies, and which do not show distortion in the amplifier until this distortion is excessive, a power output of less than a watt is sufficient. With a moving-coil speaker in a three-foot baffleboard, or larger, an output of a watt is probably necessary, and more power than this will make less remote the possibility of overloading. We have operated a single 250-type tube with about 250 volts on its plate, which indicates a power output of less than one watt, but on loud low-frequency notes it does overload. Boosting the plate voltage to 300 or 350 will give all the power that is needed for home reception.



The vacuum-tube test rack pictured above was designed by Herbert H. Chun, of the Arcturus Radio Tube Company. The rack is vibrated by an eccentric cam and at the same time the tubes are turned on and off by an automatic switching arrangement. Any defect in a tube becomes apparant within thirty minutes when treated in this manner.

Now will the adherents of high-powered receivers come forward and tell us that we are still old-fashioned, and that two or three watts is absolutely necessary for modest home reception? We may, in time, be forced to admit even this!

One reader, Fred D. Pinkham, of Topsham, Maine, points out that the problem for the listener far from stations is decidedly different from that of the listener within the shadow of a local station. We admit this but cannot agree with his contention that the receiver must have sufficient power output to handle the following case. Suppose the volume control is fixed so that when a station which fades badly, is at a minimum, it is delivering an audible signal. Then the power output must be sufficient so that when the station "fades in" to a maximum the amplifier will not overload. Let us suppose the minimum signal that is satisfactory is one milliwatt. A station can fade at least 60 DB which represents a power ratio of one million. When the station fades in 60 DB the power output from the set must be *one kilowatt*—which is considerably in advance of the most hardened user of power tubes. If the maximum power output is one watt, which is reasonable, the least signal that will be heard, if there is a 60-DB fade, will be one microwatt, which is pretty far down. It is our hunch that even with one watt output, there must be a time when a fading signal will be inaudible—or will overload when "fading-in." The following from R. J. Kryter, Engineering Department, Prest-O-Lite Storage Battery Sales Corp., Indianapolis, gives some interesting data on this problem of power output necessary. It checks very closely the data taken by the Everyready engineers a year or so ago. This test determined that a 171-type tube was about all that anyone needed for home reception. It was before the days of moving-coil loud speakers, however.

"Some time ago the writer conducted a series of tests in which the signal currents and voltages occuring in the loud speaker circuit were measured for various types of music and with various types of loud speakers. The music was supplied both by phonograph and radio and included concert orchestra, jazz orchestra, military band, various trios, violin and piano, solo piano, singing voices from bass to soprano, and speaking voice. The loud speakers included short-horn, orthophonic-horn, magnetic-cone, and dynamic-cone types. The input to the loud speakers was supplied by a high-quality push-pull 210-type amplifier. The listening tests were made by persons of widely differing tastes and musical accomplishments.

"The results of these tests were as follows:

(1) "Low" volume was produced with an average signal voltage of 8 volts and an average current of 1.7 mA., corresponding to an output of 14 milli-voltamperes.

(2) "Normal" volume was produced with 18 volts and 3.8 mA., or 68 milli-voltamperes.

(3) "Loud" music was produced by 40 volts and 10 mA., or 400 milli-voltamperes.

(4) "Very loud" music was produced by 120 volts and 24 mA., or 2900 milli-voltamperes.

(5) The extreme limits were: Minimum 0.4 volt and 0.5 mA.; Maximum 195 volts and 55 mA.; maximum power ratio, 53,000. It is of interest to note that both the minimum and maximum values occurred in concert orchestra music, although the maxima were closely approached by the piano.

(6) The "average frequency" of music and speech as determined by correlating the average impedance calculated from the above figures with the impedance curves of the loud speaker units was 380 cycles.

(7) The impedance of the various loud speakers averaged about 3000 ohms at 50 cycles, 7200 ohms at 400 cycles, 13,000 ohms at 1000 cycles, and 25,000 ohms at 3200 cycles, ranging all the way from 1500 to 60,000 ohms in the 50–5000-cycles band.

"You will note that the power is given in milli-voltamperes rather than in milliwatts because the measurements were taken on actual loud speakers rather than on a fictitious resistance load. Calculations made by the writer, however, indicate that the distortion occurring in a vacuum tube feeding into a reactive load will be determined by the volt-amperes rather than the actual watts expended in the output.

"This data lends further weight to your conclusion as to the adequacy of the 171-type power tube for average home use. At the same time it demonstrates in startling fashion the great increase in power necessary for a given increase in sound output. Also, it is to be noted that peak values were frequently twice and sometimes three times as great as the above average values. Therefore, if overloading is to be avoided on sustained bass passages or on sudden fortissimos, an output stage capable of supplying 1 to 2 watts is justified."

—KEITH HENNEY.

IF I WERE A SALESMAN

By AN ENGINEER

IF I WERE a salesman and a prospective customer wanted to know why the Radiola 60 was "the one receiver that is built for all broadcasting conditions"—to quote from an advertisement in the *New York Evening Post*—I should use the following sales argument. The points are somewhat technical because all matters relating to what is inside the cabinet of a radio receiver concern technical matters, just as talk about the vermiform appendix, the dorsal fin, the intake manifold, or wing struts concern technical things, and naturally must be couched in technical jargon.

"There is little use in telling you as a customer that you need a selective set if you have listened-in at all, or have read or heard the tirades against the present overcrowded condition of the radio channels. There is no use to remind you that the multiplicity of stations, many of them on very high power, the general increase in high-quality programs more hours per day, and the more general use of high-quality loud speakers mean simply that the receiver must be designed for conditions that were undreamed of four years ago. What you want to know is how the Radiola 60 meets these problems.

"The Radiola 60 is a combination tuned radio-frequency receiver and a super-heterodyne. These two receiver systems are fundamentally different. The majority of receivers now made are tuned radio-frequency sets only. Some receivers are super-heterodynes only. This receiver is a combination of both of them. The object is first to gain selectivity, second to gain voltage amplification, and third to secure these essential receiver characteristics without destroying the fidelity with which the receiver will translate radio signals into audible sounds.

"The tuned radio-frequency receiver first picks up the desired signal from an antenna, amplifies it, separates the audio modulations from the inaudible radio or carrier wave, and then amplifies these audible tones. Now here, in this complicated process which may involve six or more tubes and a corresponding number of electrical circuits, distortion must not occur.

"Radio stations are now put on channels which are 10 kilocycles apart, just as keys on a piano are stationed along the keyboard a certain number of tones apart. When one wants to listen to one station, he does not want to listen to several others, but at the same time he wants to get all the desired station is transmitting—all tones from the highest to the lowest. He must select a certain radio signal but not select it so well that he loses part of the desired signal in the process.

"The usual tuned radio-frequency amplifier is inherently more sharply tuned at low frequencies—at the left-hand end of the usual radio keyboard—and broader at the other end. Thus, it is more difficult to separate two stations that occupy adjacent channels at the high frequencies. At the same time the amplification at the high frequencies is higher than at the low end of the keyboard. And these two difficulties work together to make the problem of the radio-frequency-amplifier-design engineer anything but pleasant. The ideal condition would be to make the amplification and selectivity the same all along the radio keyboard.

"The usual radio-frequency amplifier is composed of a tube and a transformer which connects this tube to the following tube. This transformer has a few turns on the primary and many turns on the secondary. The primary tends to resonate at some frequency higher than any to which the secondary is ever tuned. This tendency to resonate at some high frequency makes the receiver have greater amplification and less selectivity on the high frequencies.



The Radiola 60 receiver in a table-type cabinet.

"The Radiola 60 uses large primary coils instead of small ones, so that the primary tends to resonate at a lower frequency than any to which the receiver will be tuned. This tends to bring up the amplification at the lower radio frequencies, and to prevent such selectivity at these frequencies that part of the audio tones are cut off.

"The direct result of making the primary of the transformer large instead of small is, first, an increase in amplification at low radio frequencies, second, prevention of 'side-band cutting' at low radio frequencies, and third, the amplification over the whole keyboard of radio channels is even. Fig. 1 shows what this amplification is.

Believing the importance of using technical facts in selling radio receivers was being overlooked by the majority of salesmen, the Editors asked an engineer to write the article which appears here. The data for it were taken from a paper presented before the Institute of Radio Engineers, March, 1929, by G. L. Beers and W. L. Carlson, which are the result of the development work on the Radiola 60 series.

Although the facts used here apply only to this particular receiver, similar presentations of sales points could be prepared on any other receiver—and in our opinion ought to get many salesmen out of tight places when the prospective customer demands facts, instead of glib phrases about excellent tone quality, extreme selectivity, and perfect "DX."

—THE EDITOR.

"Such is the radio-frequency amplifier of the Radiola 60. It is followed by a detector, just as in any receiver, but into this detector is introduced another frequency coming from a tube acting as a miniature transmitter, the oscillator tube. The frequency at which this tube oscillates is varied automatically at the same time that the radio-frequency amplifier is tuned to the desired signal and the frequency it introduces into the detector always differs from the incoming signals by 180 kc. The modulations which are separated from the radio wave in this detector are impressed on this 180-kc. signal and modulate it. Thereupon amplification takes place again at 180 kc. instead of the frequency to which the receiver is tuned.

"So the Radiola 60 in addition to amplification at broadcast frequencies amplifies again at 180 kc. Finally these 180 kc. signals are fed into a second detector which separates the audio frequencies.

"The 180-kc. frequency to which the second or intermediate-frequency amplifier is tuned was chosen for the following reasons. If this frequency were low, it would amplify audio tones and any noises appearing in the preceding tubes; that is, microphonic bongs, tube hiss, etc., would be passed through and amplified in the intermediate-frequency amplifier. If the frequency were made too high, trouble from oscillation, and lack of amplification would occur. The 180 kc. is a compromise frequency.

"Let us look into this mixing of frequencies in the detector tube. Suppose the intermediate frequency is 50 kc. If we are receiving a 1000-kc. station we can set the oscillator at either 1050 kc. or 950 kc. and still have the desired 50-kc. intermediate frequency modulated by the audio tones. For this reason we can receive a 1000-kc. wave at two points on the oscillator dial. Again let us suppose we have the oscillator tuned to 1000 kc. and that two stations equally powerful are transmitting on 950 and 1050 kc. Both of these signals enter our first detector and with the 1000-kc. oscillator frequency produce a 50-kc. wave modulated with the audible tones of both stations. The result is hash; both stations are spoiled.

"If the intermediate frequency is 180 kc. such trouble cannot possibly take place at frequencies lower than 1140 kc. Suppose the

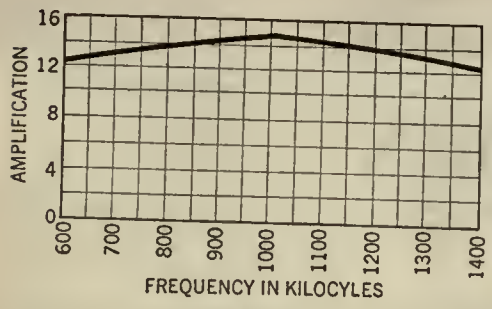


Fig. 1.

oscillator is set at 1160 plus 180 kc. or 1340 kc. The only other station that could produce the 180-kc. intermediate frequency in the first detector would be 1340 plus 180 or 1520 kc.—and the broadcasting keyboard extends only to 1500 kc.

"Here again is a virtue of the radio-frequency amplifier ahead of the intermediate-frequency amplifier. This first amplifier builds up the desired signal and discriminates against the unwanted, so that even if two stations offer equal signals at the antenna, one of them desired and one of them not, the undesired will be reduced—compared to the desired—by the amplification of the radio-frequency amplifier and when the two signals get to the first detector or mixing tube, the unwanted signal is already reduced so far it does not bother the listener.

"So far the result is a tuned radio-frequency amplifier of such a design that all stations scattered over the radio keyboard can be received with equal facility; the quality of reproduction from these stations will depend only upon the stations—there is inappreciable loss of quality in the receiver; after amplification at the frequency of the stations, the signals are changed in frequency and amplified again. The first amplifier acts not only as a kind of filter letting in only the desired signals, but it gives some amplification too.

"The intermediate-frequency (180-kc.) amplifier is of the type that has attracted considerable attention from radio editors. It is a band-pass amplifier which means simply that it is tuned so broadly on the top of its response curve and so steep on its sides that all desired audio tones are admitted and amplified, and others are rejected. This result is secured by tuning both primary and secondary of the intermediate-frequency transformers (the usual transformer has only the secondary tuned). The response characteristic is shown in Fig. 2A. The overall characteristic—which shows how the intermediate-frequency amplifier discriminates against unwanted signals is shown in Fig. 3.

"And so the intermediate-frequency amplifier not only amplifies but selects as well. The Radiola 60 amplifies, selects, and detects twice.

"The second detector is the increasingly popular 'power detector,' which means, so far as the layman is concerned, that it eliminates the distortion and noise that frequently occur in the first stage of a.f. amplification. It does this by eliminating the first stage of a.f. itself. Such elimination is possible by the great amount of amplification that has taken place in the preliminary amplifier and in the intermediate-frequency amplifier.

"This power detector is adjusted so that it overloads at the same time the power tube does. When the detector overloads its output decreases as shown in Fig. 6.

"Some of the Radiola 60 series (the 64 for example), have automatic volume controls. It is this device which makes the receiver suitable for reception in a transmitter-cluttered neighborhood, or out in the rural areas far from stations. Once the listener sets the volume-control dial to the maximum output he desires he cannot get a louder signal no matter how powerful the station is that he tunes to. In a local area this is of undoubted advantage. In the country the automatic volume control will tend to build up weak signals to the desired level. Of course, if the weak signal is surrounded by noise—static, arc lights, X-ray machines, etc.—the volume control cannot eliminate the noise and get the signal, and so the noise background comes up along with the station. But on a good night when the noise level is down all stations that deliver a certain minimum signal to the antenna will deliver a certain maximum output loud speaker signal, this output always at the control of the listener. The effectiveness of the control at the output levels A and B compared to no control, C, is shown in Fig. 4.

"This receiver has eight tuned circuits. One's first reaction to such a statement is that there would be no high audio frequencies at all—but a look at Fig. 5 shows that such is not the case. The large primary winding of the first amplifier transformer, the band-pass effect in the intermediate or second amplifier, and the characteristics of the a.f. amplifier are such that undue suppression of the high audio notes does not take place. In other words, *it is a high-quality receiver.*"

If I were a salesman, I should use technical facts to back up my sales arguments. I should state that this particular receiver is selective because of the radio-frequency amplifier and because of the selecting effect of the second or 180-kc. amplifier. It is sensitive because amplification takes place at three different frequencies, first the frequency of the incoming signals, next at 180 kc., and finally at the audio or audible frequency. It has a power detector which eliminates some noise and some distortion. It is a high-quality receiver because its radio-frequency amplifier does not cut "sidebands," because its intermediate-frequency amplifier employs the band-pass idea, and because its a.f. system is good. In addition to all these advantages, the Radiola 64 has an automatic volume control which keeps down strong local signals, and boosts weak distant signals.

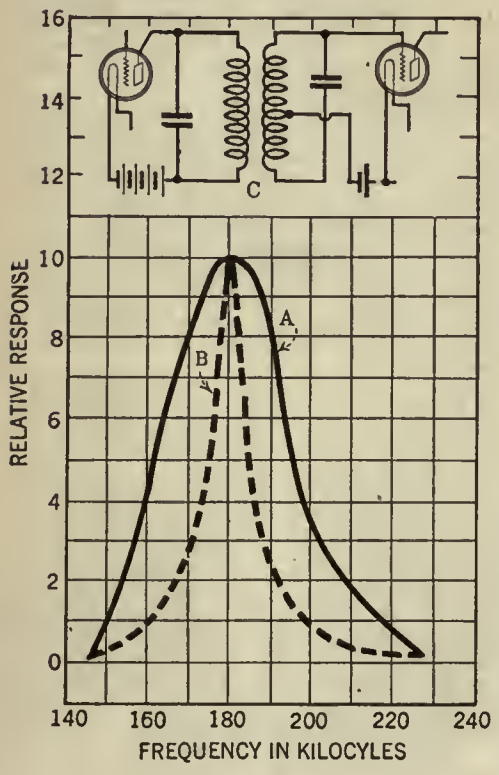


Fig. 2.

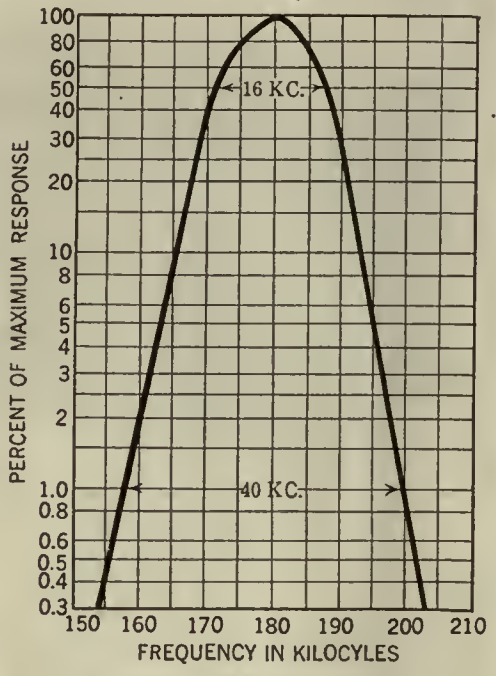


Fig. 3.

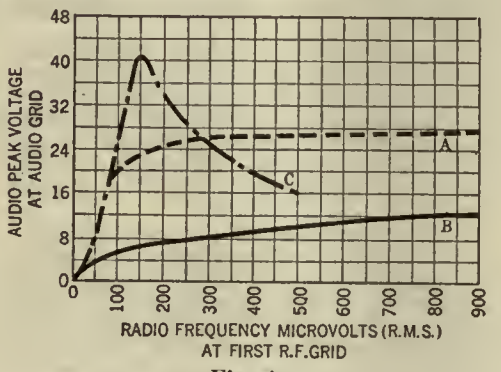


Fig. 4.

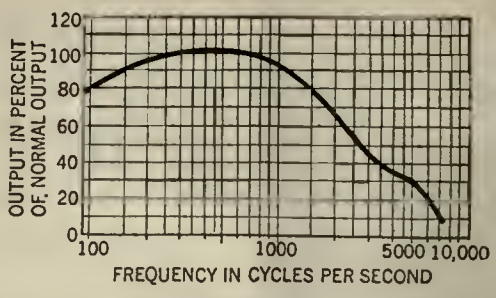


Fig. 5.

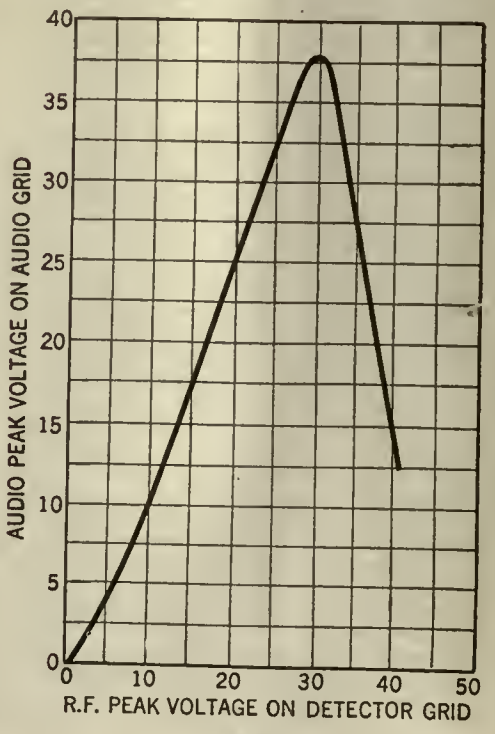


Fig. 6.

RADIO AMBASSADORS OF GOOD WILL

By HERBERT H. FROST

President, Radio Manufacturers Association

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Herbert H. Frost

"In the long run, it is not the cost of giving service that is to be considered, but the expense in not giving it."

"A SATISFIED customer is your best advertisement." That is an old statement, but it's especially true in radio.

In this industry, there are many ways of interesting a customer, but no matter what sales talk may be given him, what promises may be made, or how good-looking the radio set may be, unless it continues to function properly and to his satisfaction, you have anything but a satisfied customer. Here enters the *serviceman.*

He is to-day different from the serviceman of the past, as he is not only a trained mechanic, but he must also have sales ability, personality, and tact to allow him to meet unexpected situations in his work.

The importance of a serviceman having these qualifications is becoming more pronounced each year, and the capabilities of these men are advancing in accordance with advances made in the radio art. It has been proved repeatedly that when a dealer sells a radio set without having a capable serviceman, it results in the set being installed in a haphazard fashion. Eventually the customer has cause to become dissatisfied. He reports his dissatisfaction to the dealer, but finds no success. The ultimate result is that this disgruntled consumer tells his friends about the dealer, and before long that dealer realizes he has a poor reputation, which finally results in the closing of his store because he has lost his patronage.

Traveling public officials are sometimes called "ambassadors of good will." I believe that a field serviceman, whether he comes from the dealer, the distributor, or the manufacturer, is in all truthfulness an ambassador of good will, as he is never called upon unless there is some sort of trouble to be straightened out, and if he is successful it most assuredly results in good will. Who is more appreciative than an ardent radio fan whose balky receiver is once more playing merrily?

The reason for stressing the importance of a dealer maintaining an adequate and efficient service department, rather than having his service work done by his distributor or manufacturer, is because he is familiar with the conditions surrounding that particular sale. If the service is handled by a jobber or manufacturer, all personal touch between the dealer and his customer is lost.

In the long run, from the standpoint of the dealer, it is not the cost of giving service that is to be considered, but the expense in not giving it. Of course, there are some people who demand excessive service, and again this brings out the desirability of having the dealer handle the situation, as he alone knows that particular consumer's peculiarities.

The distributor and manufacturer should also maintain adequate service personnel, as the dealer looks to them for technical information and necessary spare parts material.

The more assistance that the jobber and manufacturer give the dealer in the form of instructions, the less that dealer is apt to call for assistance, and the more willing he is to maintain his own service department, as, having a thorough knowledge of the merchandise, he then realizes how easy it is to accomplish the normal service repairs.

There is a growing tendency on the part of the manufacturer to maintain a staff of traveling men, whose main duty is to give instructions to various groups of dealers, supply the dealer with a complete and easily understood service manual, and to assist the dealer in every possible manner to enable him to help himself. It has been found that most dealers prefer to handle their own service problems.

A service manager has to be farsighted enough to study the products being sold by his organization and to be prepared to eliminate any defect which may present itself in the merchandise, in the course of the year. His clear directions on how to handle these possible difficulties are an important part of the service manual which makes a large number of minor service calls unnecessary.

New Standard

SEVERAL manufacturers, distributors, and dealers were called upon not long ago, by the Vocational Training School Board of Essex County, New Jersey, to give the qualifications for a successful serviceman. Following this, a general course of instructions was made up, covering a three-year period of instruction for a selected group of young men, as it was the opinion of everyone that the efficiency of the average serviceman must be increased and expanded beyond that of an ordinary mechanic.

A great deal of good can be accomplished by service companies, formed by a group of servicemen, to handle the service work of various small dealers, who are not in a position to maintain their own department, but unfortunately they do not have that much-needed close contact with the sales, the merchandise, and its acceptance by the consumer.

The field of service work is fast increasing in its responsibilities and as soon as the responsibilities are recognized and advantages of a capable service department are appreciated fully by the dealer, jobber, and manufacturer, then will the sale of radio receivers increase still more rapidly. At the same time, the profits will increase, a result to which no objection has ever been found.



THE SERVICEMAN'S CORNER

IN "The Serviceman's Corner" we are endeavoring to group contributions on related subjects. Aside from the convenience of future reference, the expression of half a dozen minds on one subject is generally of more value than an isolated opinion. So you will find this month, and in future editions of this department whenever the number of related contributions justifies it, a symposium of service information on one particular receiver. Such considerations will not necessarily reduce publication of comments on unrelated and interesting items in service routine, nor should they be taken as indicative of an unusual amount of trouble with the receivers made the subject of group discussion.

Your comments on this, as well as our handling of other phases of radio servicing, are always welcomed by the department editor.

Test Set Reduced to Lowest Terms

THE necessity for radio voltage and current testing equipment, along with the high cost of the same has presented a problem to many servicemen that has often echoed its way to this department in the form of a request for data on inexpensive and reliable test equipment.

As a matter of fact, the entire gamut of d.c. tests, requiring milliammeters covering ranges from one milliampere to a hundred and high- and low-resistance voltmeters reading A, B, and C potentials from batteries or power-supply arrangements, can be covered with adequate accuracy with one meter in conjunction with an inexpensive assortment of wire-wound fixed resistors used in a combination of series and shunt connections. A satisfactory meter which may be used for this purpose is a standard 0-1 milliammeter.

Differences in voltmeters and ammeters of various ranges are principally differences in the resistance characteristics of the instrument, based on the simple and fundamental statement of Ohm's law: viz, voltage equals the current in amperes multiplied by the resistance in ohms. More simply, $E = I \times R$.

The fundamental circuits of a milliammeter employed as voltage and current indicators are shown respectively in Fig. 2 (A and B). Resistors R are connected exterior to the meters. In the circuit of Fig. 2 (A) R is always so much higher than the internal resistance of the meter, that this latter resistance may be neglected in all calculations.

If a source of unknown voltage is connected across the terminals of the circuit, Fig. 2 (A), the voltage will be equal to the resistance of R in ohms multiplied by the number of amperes indicated on the meter. In the specific cases under discussion, R will always be so high that the combination is a so-called high-resistance voltmeter (it may be used for measuring B and C potentials furnished by a B-power supply unit) and the meter will be a milliammeter, preferably having a range of from zero to milliampere. The voltage will then be the resistance of R, divided by one thousand, multiplied by the reading on the meter (in factions of a milliampere).

The following table indicates the proper values of resistors for full-scale deflection on the indicated voltages when using a 1.0-mA. meter.

VOLTAGE	RESISTANCE
5	5000 ohms
10	10,000 ohms
100	100,000 ohms
500	500,000 ohms

Any fraction of full-scale deflection indicates a similar fraction of the full-scale voltage. For instance, if the one-milliampere scale is broken up into 20 equal divisions, and an unknown voltage is measured with R = 100,000 ohms, ten divisions (0.5 milliamperc) indicates a potential of 50 volts, 12 divisions, 60 volts and so on.

An ideal instrument for this purpose is the Weston type 301 milliammeter, zero to one milliampere range, which lists at $12.00. Daven "Super-Davohms" are economical resistors, sufficiently accurate for the purpose of voltage multipliers.

The calculation of the resistor values required as shunts in Fig 2 (B), to increase the current range of the instrument, is a bit more complicated, so that only the results will be indicated.

The following table shows the current for full-scale deflection on a 1.0-mA. meter with the indicated resistor shunts.

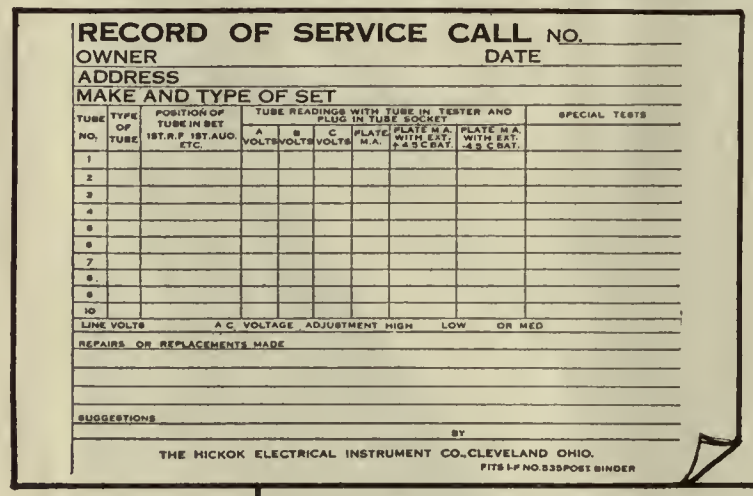
CURRENT	RESISTANCE
1 mA.	no shunt
50 mA.	0.57 ohm
100 mA.	0.27 ohm

As with the voltmeter arrangement, any fraction of full-scale deflection indicates a similar fraction of full-scale current in milliamperes. (These current multiplier figures are based altogether upon a 0 to 1 milliammeter having an internal resistance of 27 ohms, the characteristics of the Weston type 301 already recommended. While the *voltage-multiplying* resistors will be correct for any zero to one milliammeter, the current shunts will apply only to a meter of the characteristics indicated.)

It should not be difficult to secure the proper resistors for the current shunts. A simple way is to secure the winding from a one- or two-ohm rheostat, determine the resistance of the wire per foot, and cut off the correct amount.

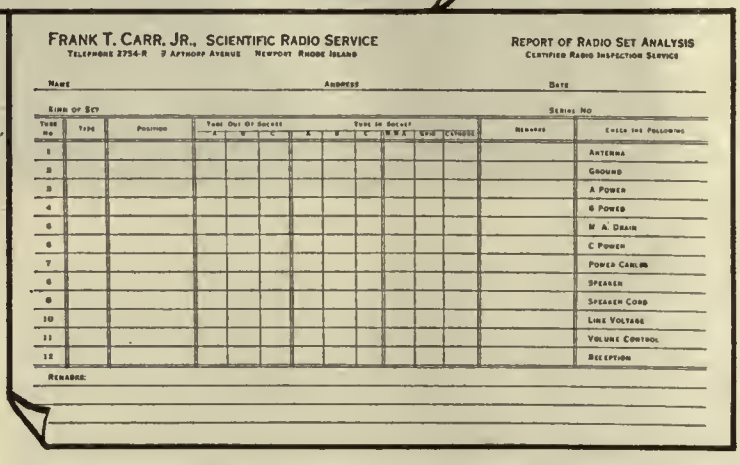
A simpler way of obtaining various shunts is as follows. So adjust the circuit including the milliammeter to a predetermined value, preferable full-scale deflection. Now shunt any low-range variable resistor across the meter and, vary the resistor until any convenient fraction of the original current is shown on the meter. Leaving this resistor so connected, the same fraction will hold true for any indicated current.

It is obviously possible to arrange a zero to one milliammeter, by means of suitable resistors and switches, so that the voltages and currents generally encountered in radio testing and servicing can be measured conveniently on the one instrument. An arrangement of this type was described by G. F. Lampkin in RADIO BROADCAST for June, 1928. Fig. 1 suggests a neat and convenient method


RECORD OF SERVICE CALL NO.
OWNER DATE
ADDRESS
MAKE AND TYPE OF SET

TUBE NO.	TYPE OF TUBE	POSITION OF TUBE IN SET 1ST R.F. 1ST AUD. ETC.	TUBE READINGS WITH TUBE IN TESTER AND PLUG IN TUBE SOCKET: A VOLTS	B VOLTS	C VOLTS	PLATE M.A.	PLATE M.A. WITH EXT. +45 C BAT.	PLATE M.A. WITH EXT. -45 C BAT.	SPECIAL TESTS
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									

LINE VOLTS A.C. VOLTAGE ADJUSTMENT HIGH LOW OR MED
REPAIRS OR REPLACEMENTS MADE
SUGGESTIONS
BY
THE HICKOK ELECTRICAL INSTRUMENT CO., CLEVELAND OHIO.
FITS 1-F NO. 533 POST BINDER


FRANK T. CARR, JR., SCIENTIFIC RADIO SERVICE
TELEPHONE 2754-R 9 ARTHOFF AVENUE NEWPORT RHODE ISLAND
REPORT OF RADIO SET ANALYSIS
CERTIFIED RADIO INSPECTION SERVICE
NAME ADDRESS DATE
KIND OF SET SERIES NO

TUBE NO	TYPE	POSITION	TUBE OUT OF SOCKET: A	V	C	TUBE IN SOCKET: X	B	C	M A.	GRID	CATHODE	REMARKS	CHECK THE FOLLOWING
1													ANTENNA
2													GROUND
3													A POWER
4													B POWER
5													M A. DRAIN
6													C POWER
7													POWER CABLE
8													SPEAKER
9													SPEAKER CORD
10													LINE VOLTAGE
11													VOLUME CONTROL
12													RECEPTION

REMARKS:

Service record charts that contribute efficiency to the service business by facilitating a check up on repeat calls.

of mounting and adjusting a combination volt-milliammeter of this design.

AN INEXPENSIVE TEST SET

R. K. WHEELER, of the Wachstetter Radio Company and General Radio Laboratory, of Indianapolis, Ind., solves the equipment problem of the serviceman in a similarly economical manner. He writes:

"Many excellent suggestions have been made in reference to radio set testing and servicing. However, all have employed comparatively expensive apparatus, and there are, no doubt, many servicemen, and set owners, who would be glad to have an inexpensive, reasonably accurate outfit, such as I have been using for the past year. The entire test set cost less than $8.00, and it will do practically everything that the more expensive ones will do.

"The main item of the test set is a combination tube tester, milliammeter, and two-range voltmeter, Figs. 3 and 4, composed of the following parts:

One Readrite 0–25 mA. meter	$1.00
One 2000-ohm resistor, Bradley	.50
One 250-ohm resistor, wire-wound	.25
Four Binding posts	.20
One Wood case, home-made	
One tube base, UX-type	.35
TOTAL	$2.30

"This is wired as per diagram, Fig. 3 and is plugged directly into a receiver to test tubes. The 0—6- and 0–50-volt taps are provided for battery checking and continuity tests, and are, of course, worthless for power-pack testing. However, for this purpose an excellent plug-in meter is made by Beede, 0–300-volt range, which shows voltages at the various sockets and is also a good check for continuity of the various plate circuits. This meter is sold at the local Kresge store for $1.75, and, while readings cannot be made with an exactness of 2 or 3 volts on account of the 0–300-volt scale, the writer's meter has been checked several times with Weston and Jewell high-resistance meters and found sufficiently accurate for the serviceman's purpose.

"The other item in this kit is a Beede, 0–7.5 a.c. voltmeter, (price $1.00), also plug-in type, for checking filament voltages at the socket. This meter has been found accurate and has been an important item in the writer's kit. As the voltage reading at the filament is one of the most important considerations, it was not felt necessary to invest in an 0–150 a.c. voltmeter."

Service Hints on Radiolas

WHEN receivers are as widely circulated, as the various models made by the R. C. A., it is logical and inevitable that the service problems should increase in some way proportionate with their popularity. The serviceman will find it worth while jotting down this page number for future reference.

FRANK M. COATES, with the McGraw Electric Company, Sioux City, Iowa, has run into the following interesting cases:

"Probably the most baffling troubles in radio receivers are those which do not affect the normal voltages at the tube sockets. The following are very peculiar and interesting cases of this nature which I have found in service work.

"1. The antenna lead of a Radiola 18 became pinched in such a way that the wire broke inside the insulation which was intact. The trouble was located by connecting the antenna to the volume control where the antenna lead terminates.

"2. On a Radiola 60 it was found that by moving the oscillator grid resistor the set would work. Inspection showed that where the bus wire lead connects to the tube socket the paint had not been removed, and this insulated the wire from the solder around it. As the oscillator tube has zero d.c. grid voltage, a meter test would be useless in this case.

"3. Another case of intermittent trouble on the model 60 was an open connection to the output condenser. The metal tab became broken under the insulating cover. The trouble was found by connecting a good 0.5-mfd. condenser across the two terminals of the output condenser.

"4. The most freakish case I have seen was a power unit that was connected to a light line which was struck by lightning. The transformer, choke, and filter condensers were not damaged but the flexible wiring had the strands fused into little globules inside the insulation which was not burned in the least."

HELP FROM THE G. E. COMPANY

M. G. MCCARROLL, with the Radio Engineering Department of the General Electric Company at Schenectady helps the cause along:

"I have run across the following trick faults while trouble shooting radio receiving sets. One of the commonest causes of 'no signals' in a Radiola 60, super-heterodyne, is found in a short circuit between one of the r.f. coils and a socket prong. The coils, not being mounted very rigidly, get pressed over sometimes so that when the tube is inserted in the socket there is a contact made between the socket prong and a terminal lug on the top of the coil. It usually is the coil located under the sixth socket from the left end of the set, and sometimes a person can reach down behind the chassis and with his fingers move the coil away from the socket prong without removing the chassis from the cabinet.

"The hardest case ever encountered of a loose connection was on a Radiola 60, and after exhaustive searching, in which everything checked out ok. it turned out to be a faulty tuning condenser on one of the intermediate-frequency transformers. The screw holding the plates of this small condenser had come out and while the set operated fairly well, the scraping sound of a loose connection was present with any slight vibration. The variable condenser tab had to be removed in order to get the i.f. transformer out of the chassis for repair, the small defective condenser being located inside the case of the i.f. transformer.

"Another unusual incident on Radiola 60's was a case of extreme fading on local signals. The volume would go clear down and then gradually come back to full strength, repeating this several times a minute. The trouble was a dirty contact on the potentiometer used as a volume control. Since the r.f. and i.f. tubes get their bias through this potentiometer it is obvious that when poor contact occurred with the arm the grids of these tubes were left free and consequently caused the fading mentioned above."

DATA FROM N. Y. C. SERVICEMAN

A categorical source of trouble in the Radiola 17 has been located by J. C. YAEGAR, man-



Fig. 1—A neat and efficient mounting arrangement for a universal volt-milliammeter.

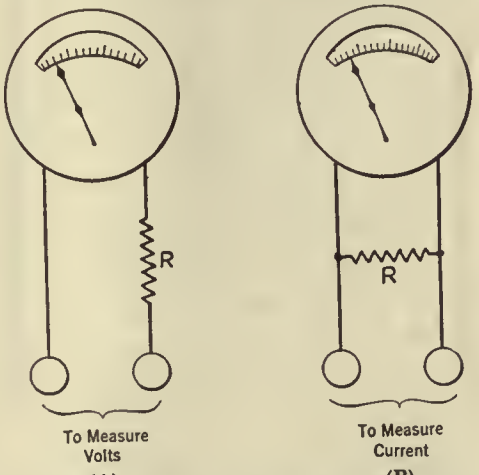


Fig. 2—(A) An elementary voltmeter consisting of a low-range milliammeter with a series resistor. (B) A low-range milliammeter, with a series of shunt resistors, R, can be made to cover a variety of high-current ranges.

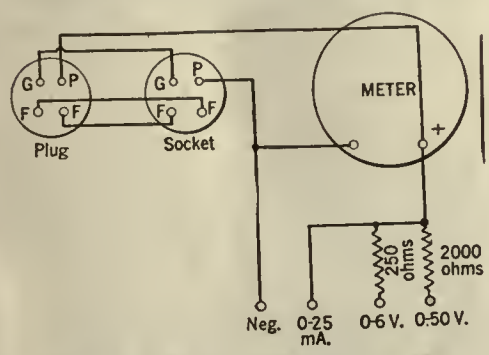


Fig. 3—Circuit diagram of Mr. Wheeler's test set costing $2.30.

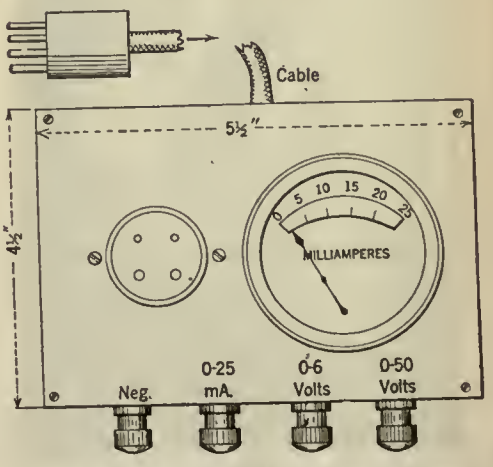


Fig. 4—Constructional details on another single-meter test set.

ager, Domestic Radio Service, New York City, as follows:

"What causes a set to have 'no volume' when all the circuits test ok., all the parts appear to be, and test, in good mechanical and electrical condition, tubes of known performance are used, and a power supply furnishing standard operating voltage is connected?

"Some R. C. A. 17's suffered from this trouble last summer in the territory along the eastern coast states and the cause and correction is now fairly well known over this territory. The forms on which the radio-frequency coils were wound in some cases absorbed sufficient moisture to cause a high r.f. loss in the amplifier circuits. The popular remedy has been to remove the radio-frequency coil assembly and dry it out thoroughly in a moderately heated oven, or to dry it out less quickly by placing the whole set in a warm dry place, for a few days. In almost every case, the original performance has been obtained after this treatment."

This condition will be met with in many other types of receivers. A simple method of cure is to increase the plate voltage applied to the r.f. tubes, feeding it through a by-passed high-range variable resistor, which functions as an auxiliary volume and regeneration control.

A BAFFLING PROBLEM

A. J. Barron, radiotrician and electrician of Shawnee, Okla., hit upon the same trouble and solves a little less easily:

"When you are called on to service a Radiola 17 and give it more volume on weaker stations and find that all of the tubes test ok., you will probably wonder what to do. My method is to get at the grid suppressors and unwind 10 or 15 turns of the resistance wire on them to lower the oscillation point in the r.f. circuit: it seems that after the r.f. coils season a while they raise the original oscillation point and the only remedy is to unwind some of the resistance wire from the grid suppressors or put in some of a lower resistance."

NOISY RECEPTION

Carlton W. Croteau, of Mount Carmel, Conn., goes into some detail:

"Being called upon to locate the cause of considerable noise in a Radiola 30, I soon found out that it was not interference. Walking near the receiver would create a terrible scratch and snap. This naturally sounded like a loose connection. The receiver was taken out of the console and checked thoroughly for loose and poorly soldered connections. None was found. Taking hold of the catacomb and holding it perfectly still would stop the noise. On top of the catacombs are several screws that keep the bakelite socket assembly in place. Two or three of these screws were found to be loose. When these were tightened the noise disappeared and even pounding on the receiver with the fist would not produce the noise.

"A dealer called me in to service two Radiola 18's that oscillated persistently regardless of where the compensating condensers were set. Touching the stator plates of the first r.f. condenser would stop the oscillating and the stations would tune in normally. By bending the two outside rotor plates in toward the stator of the first condenser the trouble was cured. In the second receiver, however, it was necessary to add more capacity than was needed in the first. To add this capacity it was necessary to take a piece of 0.010" brass about $1\frac{3}{8}$" x 2" and fastening it on to the stator by means of the (2) screws that hold the stators to the bakelite strip.

"The method is shown in Fig. 5.

"Another Radiola 18 had a case of a short in the plate circuits of every tube, except the 171A. All plate voltage was at zero value with the exception of that on the plate of the 171A which was down to about 100 volts. After checking for shorted by-pass condensers the trouble was found to be in the third coil. In the center of this coil there is a small honeycomb coil wound with enamelled wire. It is mounted on a bracket made of brass which is grounded to the frame. A portion of the wire had worked its way against the bracket and was causing the short.

"Receiving nothing but a local station was the complaint I received from a dealer. The receiver was a Radiola 60. Every circuit was tested and found to be ok. with one exception. The oscillator tube did not draw any plate current. Other tubes were tried but the results were the same. With the tube out of the socket the local station came in with the same volume. After testing various parts of the oscillator circuit I found the oscillator series or grid condenser to be leaking. When this condenser was tested it was found to be passing about 0.1 volt. The replacement of this condenser cleared up the trouble and the receiver was restored to normal operation.

"Another Radiola 60 that was intermittent in operation required considerable time to locate the cause. This set would play for days at a time and then suddenly cease. By taking out most any one of the 227-type tubes and then inserting it into its socket the set would again function normally. This was most discouraging as then there was a long wait for it to stop again. I had taken it out of the cabinet by this time and finally it ceased to function. Then taking a lead pencil and by pushing and prying different connections I came upon the trouble. It was in the third i.f. transformer. Pushing down on one of the terminals would start the set. Releasing the pressure would cause it to stop. It was necessary to remove the transformer from the chassis and also take it out of the brass case. A high-resistance connection was found where one of the fine wires from one of the coils soldered to a small terminal within the assembly. Soldering this wire remedied the difficulty and after re-assembling the transformer the receiver worked normally and has continued to do so since."

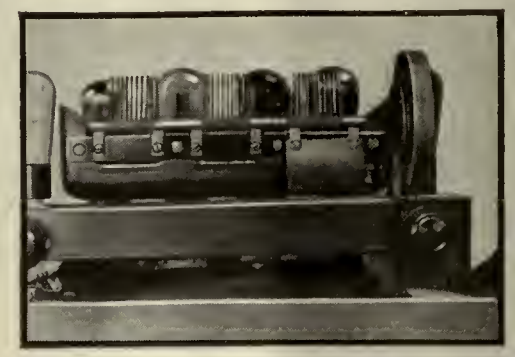


Fig. 5—Adding additional capacity to one section of a Radiola condenser to stabilize the circuit.

This month "The Serviceman's Corner" is inviting contributions on the use and servicing of relays. Relays, intelligently applied, should contribute greatly to the convenience and ease of operation in many radio installations. The use of relays is by no means limited to controlling the power-supply device and trickle charger. The possibilities of relays suggest themselves in all but the most simple installations in the way of receivers remotely controlled, either by hand or clock. In the more simple arrangements, the relays may be used merely to turn on and off a receiver, and in conjunction with phonograph pick-ups; more elaborate arrangements will control volume from a distance, while still more ingenious installations may effect a certain amount of station selection by remote control.

—The Editor.

POOR LOCATION

And concluding this little symposium on the eccentricities of Radiolas, the following comes to us from Indianapolis, Ind.:

"I made a service call on complaint of the owner of a Radiola 28, on account of poor volume, and no reception of distant stations. A check was made of tubes and batteries and all were found good. There was nothing in the set to suggest trouble, and a loud speaker of known efficiency was substituted, thinking that perhaps part of the trouble lay in weak magnets in the original loud speaker, but this made no difference. As the neighbor next door was getting excellent reception at that time on the same model set and loud speaker, the trouble could not be reasonably be blamed to the location. Finally I asked the owner where his furnace was located, and, as I suspected, he pointed directly below the set. We then moved the set across the room, and the first station tuned in was WPG, Atlantic City, with enough volume to necessitate turning the volume control back slightly. As the owner had had the set for several months, with such poor reception, it is needless to say he was not only surprised but delighted."

R. K. Wheeler, Wachstetter Radio Company and General Radio Laboratory.



Frank M. Coates (right) takes a day off from Radiolas.

Items of Interest

¶THE use of report sheets, describing the electrical characteristics of a receiver, tubes used, correct voltages, results under average good conditions, etc. are finding favor among systematic servicemen. We reproduce elsewhere in this department two good samples of these forms, one used by Frank T. Carr, of Newport, R. I., and the other supplied by the Hickok Electrical Instrument Company, of Cleveland, Ohio, for use in conjunction with their test equipment.

A Recent Technidyne Development

A SELF-SHIELDED RADIO INDUCTANCE

By EMIL REISMAN
Technidyne Corporation

THE coil described in this article, because of its self electrostatic shielding and absence of external magnetic field, requires no shielding when used in multistage radio-frequency amplifiers. The advantage of this feature may be appreciated better when it is understood that heretofore it has generally been found necessary to carefully shield all coils used in radio-frequency circuits in order to prevent interstage feedback. Where such shielding has not been used, methods of preventing oscillations due to interstage coupling have been resorted to. Practically all such methods involve the introduction of losses in the circuit to such an extent that oscillations cannot be sustained. While such methods of preventing parasitic oscillations are effective and quite easily applied, the loss in efficiency in such a circuit is quite a serious matter.

To help prevent oscillations caused by interstage coupling, individual shielding of every radio-frequency stage in the set is becoming quite a common practice. In addition to the shields, coils having a fairly small external electromagnetic field are sometimes used. Among such coils may be mentioned the toroid, binocular, and double D. It is found, however, that even such methods are insufficient to prevent intercoupling of the various stages of a multistage amplifier. In spite of seemingly impregnable shields and windings having small external fields, it is found that electromagnetic and electrostatic fields do link adjacent and even distant stages of the radio-frequency amplifier; sometimes to such an extent that oscillations are produced. Many inductances having so-called "concentrated" fields are found to have fields which are not so concentrated. It is also found that shielding is not always as effective as it looks.

Shielding, even at its best, introduces losses in the circuits where it is used. As the effect of shielding depends upon the setting up of eddy currents in the metal of the shield, the radio-frequency resistance of the shielded circuit must necessarily be comparatively high. High-resistance circuits in a receiving set make for insensitivity and poor selectivity.

Proof of Immunity

THE self-shielded coil described in this article is one of the recent developments of Lester L. Jones, of the Technidyne Corporation. This coil has no external field to speak of and hence does not require shielding. The coil is self shielded electromagnetically and electrostatically, and may be placed in close proximity to other apparatus and even to similar coils of the amplifier without disturbing the balance of the system. A set made by a mid-western manufacturer utilizing self-shielded coils is perfectly stable and shows no traces of feedback even though the coils are all mounted in the same plane and are placed less than two inches from one another.

This coil is so immune to outside influences that a heavy hand of copper may be wrapped tightly around the coil, and the ends soldered together with no detuning effect while the coil is in a sharply tuned circuit. The losses introduced under such conditions are practically negligible. Under similar conditions all other coils would be completely detuned; and almost all of the energy dissipated in the short-circuited copper band.

In Fig. 1 is shown a cross-section view of the self-shielded coil. It is seen to consist of an inner coil section, A, and an outer coil section, B. The coils are so related to each other that the outer coil, B, forms a magnetic and electrostatic shield for the inner coil.

Coils A and B are connected in series in such way that the magnetic fluxes produced by the coils oppose each other. Such an opposition of fluxes is accomplished by having both coils wound in the same direction and connected together at the same ends. The free end of the inner coil is the high-potential end and would normally go to the grid or other high-potential part of the apparatus in which it is used. The free end of the outer coil is the low-potential or ground end and would be connected to ground or low-potential part of the circuit.

Many attempts have been made to develop coils which require no shielding. In other words, inductances that have no external field have occupied the thought of a number of engineers. Some coils of this type have been developed, but in the process other faults arise which vitiate the advantage of the small external field. For example, one such coil that was tested in the Laboratory had no means of getting current into or out of it! The coil described in this article was invented by Lester Jones of the Technidyne Corporation. It is a low-loss, low-external-field coil. It can be used without shielding.

—THE EDITOR.

In the diagram it may be seen that the ground end of coil section B overlaps the high-potential end of coil section A. This is done mainly to improve the electrostatic shielding of the high-potential end of the coil.

The principle of the self-shielded coil is based upon careful mathematical design. It has been found that the ratio of the turns of the inner and outer coils must bear a very accurate relation to the ratio of the areas of the two coils. The product of the area and the number of turns on one coil section must be equal to the product of the area and number of turns of the other coil section. When this condition is realized, the external magnetic field due to the coil is at a minimum and is practically zero, because the field produced by the inner coil section neutralizes the field produced by the outer coil section. Conversely, magnetic disturbances in the vicinity of the self-shielded coil cannot affect the coil because the voltage induced in the inner coil section is of the same magnitude and opposed to the voltage induced in the outer coil section; therefore, the resultant voltage is zero.

Electrical Design

IN order to produce the electrostatic shielding of the coil, it is required that the self inductance of the outer section be equal to the mutual inductance between both coil sections. This condition is obtained when the product of the area and number of turns on one coil section is equal to the product of the area and number of turns on the other coil section. The requirements, therefore, for maximum electromagnetic and electrostatic shielding are identical.

In a properly built self-shielded coil a curious effect will be found to exist. By measurement it will be found that there is no potential drop across the outer coil. This may seem absurd to some, but, when it is considered that the voltage drop across the outer coil due to its inductance is neutralized by an opposing voltage induced by the inner coil, it may be realized that in effect the entire surface of the outer coil is at one potential. The reason for the balance of potentials in the outer coil is that the self inductance of the outer coil is equal to the mutual inductance between the inner and outer coils.

To produce self-shielded coils having high efficiency, the ratio of the area of the winding of the inner coil and the outer coil should bear a given relationship. It has been determined that for producing coils of greatest efficiency, the ratio of areas should be about 2, 2.1, and 2.2 for coils having ratios of outer coil diameter to length of 1.26, 1.58, and 2.1, respectively. When these area ratios are used, a high degree of static shielding with low distributed capacity is obtained in addition to maximum inductance with minimum radio-frequency resistance. In order to comply with these ratio requirements it may be found necessary to bank wind the inner coil or use a small size wire. The outer coil section in most cases will have to be space wound, or wound with large diameter wire.

The radio-frequency resistance, determines the efficiency of an inductance at radio frequencies. The high-frequency resistance of a coil is due to the combined effects of the skin effect in the wire of the coil, the d.c. resistance, eddy-current losses, distributed capacity in the coil, and mutual induction between the coil and neighboring circuits.

Efficiency of Coil

THE efficiency of the self-shielded coil as compared to other coils is quite high. It is superior to other coils having concentrated fields, such as the toroid, binocular or duo-solenoid, and the double-D. The self-shielded coil is not as efficient as a well-designed single-layer solenoid, which is perhaps the most efficient type of inductance in use. It is, though, far superior to a single-layer inductance of approximately the same size when the inductance is completely shielded with copper, and when the shield has about three times the volume of the coil. (It is obvious that the efficiency of a copper-shielded solenoid becomes greater as the size of the shield is increased, due to the decrease in eddy-current losses.)

A self-shielded coil having an inductance of about 125 microhenries has a distributed capacity of about 5 micromicrofarads. This is a slightly higher value than that for a corresponding single-layer solenoid, but is lower than that of the metal-shielded solenoid or the toroid.

It should take but little imagination to realize how wide the range of application of the self-shielded coil really is. A coil of this type can be used to great advantage in tuned radio-frequency circuits, neutrodyne circuits, radio-

frequency oscillators, and, in fact, in any type of circuit where it is required that the coupling between coils and other apparatus be at a minimum.

Very compact sets may be built incorporating these coils without being troubled by excessive oscillation. As stated previously, self-shielded coils may be placed quite close to each other and at any desired angle without harmful coupling effects; hence they are ideal for use in compact sets.

In tuned radio-frequency sets when self-shielded coils are used, less than the usual amount of oscillation may be expected. In fact, such a tuned radio-frequency set when carefully built will, in many cases, operate like a neutralized set in that almost complete freedom from internal oscillation will be experienced.

Also, as these coils are not susceptible to outside influences, the individual coils will not pick up near-by broadcasters as other coils often do, thereby causing much interference.

Radio-frequency oscillators require that no energy be radiated by the tuning coils of the oscillator. Radiated energy will cause serious interference when radio-frequency measurements are in progress. Self-shielded coils will be found to be ideally suited for oscillators, because the energy radiated by the coil is almost negligible in comparison with that radiated by the usual type of inductance.

For short-wave work the self-shielded coil should give very satisfactory results. At short waves especially, magnetic and static coupling between coils and other parts becomes very strong. This is the cause of much of the energy loss and inefficiency on short waves.

Design Data

THE design of a self-shielded coil will be found to be more involved than the design of a single-layer solenoid, but by following these instructions the experimenter who can work out the constants of the single-layer coil will be able to determine the constants of a self-shielded coil of the desired inductance.

The first step in the design of any inductance coil is to determine the inductance needed. This may be calculated from a fundamental formula much used by radio engineers:

$$L = \frac{\lambda_2}{3.55 \times 10^6 \times C}$$

where L = inductance in microhenries.
λ = wavelength in meters.
C = capacity in microfarads.

In this case, where the inductance of a coil which is to be used with a variable condenser is desired, λ is the highest wavelength to which it is expected to tune, and C is the full-scale capacity of the condenser. In order to compensate the effects of distributed capacity in the coil, and other capacities such as the tube input capacity, several microhenries may be deducted from the inductance of the coil just calculated.

The outer tube diameter should now be decided on. For reasons of economy of space small diameters may be used, but from the viewpoint of efficiency a larger coil is preferable. Coils for covering the broadcast band may have an outside diameter of from 2¼ inches to 3½ inches. The length of the outer coil winding should be within 1.2 to 2.2 times its diameter in order to maintain high efficiency.

The dimensions of the inner tube depend upon the area and length of the outer tube. As stated previously in this article, the length of the inner winding should be a little less than the length of the outer winding. It was also stated that for high efficiency and good shielding, the ratio between the areas of the inner and outer coil windings should be 2 when the outer winding has a ratio of diameter to length of 1.26, 2.1 when the ratio of diameter to length is 1.58, and 2.2 when the ratio is 2.1. The diameter of the inner tube may be calculated easily from the area and length of the winding.

After determining the dimensions of the inner coil winding, calculate the number of turns needed on the inner tube to give about one third more inductance than desired for

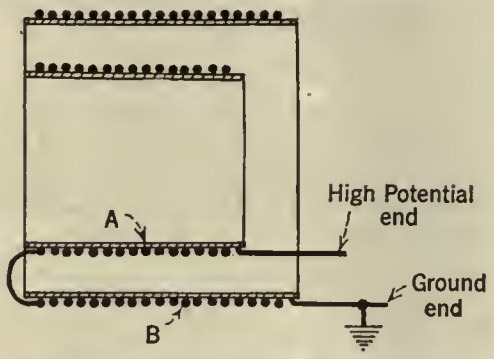


Fig. 1—Detail of the self-shielded coil.

the completed coil. For this calculation Nagaoka's formula may be used. This formula for the calculation of inductance of solenoids may be found on page 252 of the Bureau of Standards Circular No. 74, *Radio Instruments and Measurements.*

The number of turns needed on the outer tube is based on the ratio of the turns and areas of the inner and outer coil windings. The following formula gives the number of turns to be used on the outer winding:

$$N_1 = \frac{A_2 \ N_2}{A_1}$$

where N_1 = number of turns on outer tube.
N_2 = number of turns on inner tube.
A_1 = area of outer winding.
A_2 = area of inner winding.

After the number of turns on the outer tube has been determined, calculate by means of Nagaoka's formula the inductance of the winding. Subtract the inductance of the outer winding from that of the inner winding, and the result is equivalent to the total inductance of the coil. In the self-shielded coil it is permissible to subtract the inductance of one

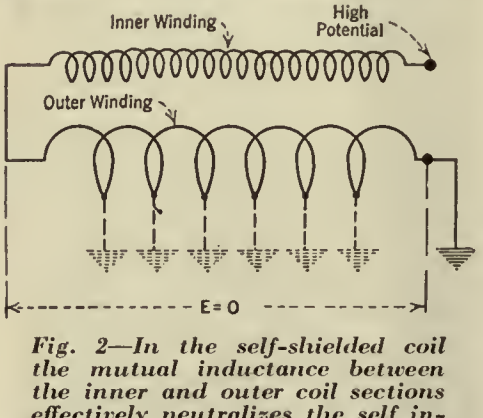


Fig. 2—In the self-shielded coil the mutual inductance between the inner and outer coil sections effectively neutralizes the self inductance of the outer coil; therefore, the outer coil is at the same potential throughout and has no external magnetic field. For the same reason the outer section serves as an excellent electrostatic shield for the inner coil.

winding from the other to obtain the total inductance, because the inductance of the outer coil is equal to the mutual inductance. This may be clearly demonstrated by means of the formula for the inductance of coils in series:

$$L_0 = L_1 + L_2 + 2M$$

where L_0 = total inductance.
L_1 = inductance of coil No. 1.
L_2 = inductance of coil No. 2.
M = mutual inductance between both coils.

In the self-shielded coil, L_1 is numerically equal to M; and, as M is negative because the fields of both coils are opposed, therefore, the formula may be rewritten:

$$L_0 = L_1 + L_2 - 2L_1$$

Reducing the formula we have

$$L_0 = L_2 - L_1$$

This is true only in a properly designed self-shielded coil.

In order to obtain the desired inductance for the coil, it may be found necessary to repeat the calculations several times, using a different inductance for the inner winding each time until the proper inductance for the entire coil is obtained. It will not be necessary to make more than three calculations for a given coil if good judgment is used.

When the entire inductance has been calculated properly a wire table should be consulted, and the size of wire to be used for the inner winding decided upon. The wire size used is limited only by the number of turns which must be wound within a given space. The outer winding may be space wound with No. 18, 20, or 22 wire. To obtain higher efficiency the coil should be constructed of litz wire throughout, and the inner winding hank wound. Extreme care should be taken that each strand of litz is unbroken, and is properly soldered at the ends.

Broadcast-Band Coil

THE following data may be used for constructing a coil which is to be used in conjunction with a 0.00055-mfd. condenser for covering the broadcast wave band:

OUTER COIL SECTION

Diameter	2½"
Length of winding	1⅝"
No. of turns	33
Wire	No. 20 double silk covered

INNER COIL SECTION

Diameter	1½"
Length of winding	1"
No. of turns	72
Wire	No. 32 double silk covered

If instead of winding the inner coil with fine wire, a heavier wire is used and the coil bank wound, a higher efficiency will be obtained. The bank winding should cover the same area and have the same number of turns as the winding specified in the above table.

The outer coil should be arranged in respect to the inner coil section so that it slightly overlaps the high-voltage end of the inner coil in order to produce more thorough shielding. Also, the inner coil section must be concentric with the outer coil. Both coils must be wound in the same direction and connected in series at one end as shown in the diagram.

For coupling purposes a few turns of wire may be wound over or near the low-voltage end of the inner coil. When such a winding is used, the end farthest away from the high-voltage terminal of the inner coil should be connected to the plate of the preceding tube or to the antenna. The other end of the winding goes to the plate battery or to the ground.

The author leaves the constructional details of the self-shielded coil to the builder's judgment. No doubt, many ways will be devised for fastening the coil sections together, and for mounting the completed coil.

Unlike other forms of "concentrated-field" inductances, the self-shielded coil just described is unique in that it is electrostatically shielded, and has an extremely limited magnetic field; while other coils having concentrated fields are not shielded statically.

OPERATING DATA ON QUARTZ CRYSTALS

By G. F. LAMPKIN

THE manner of obtaining quartz crystals from the raw quartz has been covered rather thoroughly in numerous publications. The article in December, 1928, RADIO BROADCAST (pages 85–87) by R. C. Hitchcock, gives valuable data on this subject. The manner of their application to oscillating or transmitting circuits has also been the subject of several writings. Data on the operating characteristics of quartz crystals themselves, however, have not been brought forward so frequently. One item which is of pressing interest is the accuracy to which the crystals can be made to hold their frequency. The present-day crowding of broadcasting stations, their wandering from assigned frequencies, heterodyning of carrier waves, and so on, make it necessary that the accuracy of crystal control be determined definitely. A more recent reason is concerned with determination of the number of practicable channels available among the short waves.

It is the purpose of this article to record a few data concerning the operation of crystal oscillators, including some notes on frequency variation of crystals. The work was done at the University of Cincinnati in connection with the development of a 50–100-meter, crystal-controlled transmitter for duplex radiophone communication. The advantages of single-sideband, or double-sideband, climinated-carrier transmission over ordinary transmission are several, including power saving, duplexing, more uniform reception, and so on. Either system requires reintroduction of the carrier at the receiver. In the case of single-sideband transmission, the carrier, which is replaced at the receiver, must be within some 50 cycles of the carrier frequency which was suppressed at the transmitter; in double-sideband transmission, the carrier must be replaced within 1 or 2 cycles, in order that reception may be reasonably intelligible. For a single-frequency radiotelephone system using one of the above types of transmission, each station would require a matched crystal both to control the transmitter frequency and to supply the carrier at the receiving end. Successful operation of such a system, of course, is dependent on the constancy of frequency from the matched crystals.

Types of Short-Wave Crystals

THE data given below are not particularly comprehensive—for one thing, they cover only a restricted wavelength range—but they will serve to indicate what may be expected in crystal operation, and may stimulate other investigations. In order that better comparison, or judgment, may be made of the results, brief descriptions of the apparatus and methods used in measurement will be given.

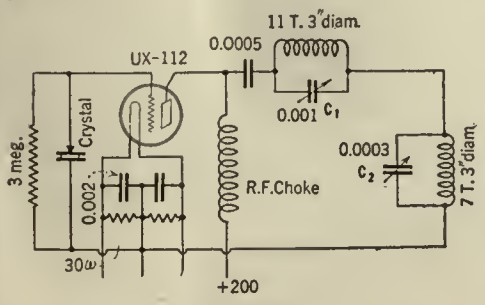


Fig. 1

The usual method of cutting a blank from the raw quartz yields a slab whose surfaces are perpendicular to one of the prismatic faces of the crystal. This section is shown at (A) in Fig. 3. An alternative method is to cut a slab parallel to a face of the prism, as at (B). A crystal cut in the first method has a wavelength constant of 104 meters per millimeter thickness; or, in everyday units, 2.64 meters

It is commonly thought that a properly cut slab of quartz crystal will hold an oscillating tube to the exact desired frequency regardless of the mounting, plate and filament voltages, and other tube variables. Mr. Lampkin shows how these factors, as well as pressure on the crystal, temperature, etc. influence the frequency generated by the quartz-controlled transmitter.

—THE EDITOR.

per thousandth inch of thickness. The parallel-cut crystal has a fundamental wavelength of 3.87 times thickness in thousandths of an inch. Apparently any slab cut at an intermediate angle between the two above will also oscillate. Wavelength constant, temperature coefficient of frequency, and magnitude of fundamental and harmonic radio-frequency outputs, are quantities, among others, that vary with the angle of cutting. However, only crystals from the parallel- and perpendicular-cut slabs were ground and measured. In the table of Fig. 3 are listed some of the crystals that were completed. It may be seen that the wavelength constant varied from 2.59 to 2.66 in the one case, and from 3.85 to 3.89 in the other. For any given wavelength, the parallel-cut section produces a crystal that is thinner than the corresponding perpendicular-cut crystal.

The blanks were sliced from the raw quartz by a muck saw of 0.022" steel, 6" in diameter, motor-driven at 300 or 400 r.p.m., and fed with No. 90 carborundum and water. The finishing grinding was done by hand on a cast-iron plate with No. 200 carborundum and water. The surfaces of the crystal were not polished smooth, but had the appearance of ground glass.

Some of the crystals, particularly No. 1 and one of the 159-meter matched crystals, oscillated strongly when the two surfaces lacked as much as 1 or 1.5 thousandths inch of being parallel. As a rule, however, the tolerance was only one or two ten thousandths of an inch. Crystal No. 5 was surfaced closer than could be measured on the micrometers and would not oscillate; then putting a smooth, rounded bevel on all the edges brought it into strong oscillation. Crystal No. 6 would not oscillate at all unless its temperature was within a certain critical range. When a hot soldering iron was placed under the crystal holder, oscillations began and their strength, as shown by a vacuum-tube voltmeter, increased as the temperature of the crystal went up; they passed through a maximum, and then decreased with further increase of temperature. When the soldering iron was removed, the oscillations again rose to a maximum as the crystal cooled through the critical temperature, and then dropped off.

Harmonic Operation

CRYSTAL-CONTROLLED transmitters whose outputs are much below 80 meters usually operate on a harmonic of the crystal. Crystals whose fundamentals are less than 80 meters become too thin to handle conveniently. In grinding, if the surfaces of a 160-meter crystal must be parallel within a ten thousandth inch, the tolerance for an 80-meter crystal is only five hundred thousandths inch. An 80-meter crystal is thin enough that pressure on one spot in grinding will hollow out that part more than the surrounding surface—the crystal actually gives and bends. A crystal with a 40-meter fundamental is very fragile, being no thicker than a heavy piece of paper. These disadvantages of the short-wave crystals do not work extreme hardships, however. It is feasible, and comparatively easy, to employ the harmonics of 100- to 200-meter crystals to produce crystal-controlled outputs from 100 meters down. The usual method is to impress the output of the crystal oscillator on a heavily biased radio-frequency amplifier, and to tune the amplifier output to a harmonic of the crystal Ordinarily the second harmonic is picked out, so that the tube works as a combined amplifier and frequency doubler. The process is repeated, if necessary, until the desired wavelength of output is secured.

In order to determine what strength of harmonics could be obtained directly from the crystal oscillator, the circuit of Fig. 1 was set up. It may be seen to be the usual hook-up except for the extra tuned circuit in the output. A 112-type tube with plate voltage at 200 and filament voltage at 5 was the oscillator tube. Other dimensions are included in the figure. Trap circuit, L_1C_1, was tuned to the fundamental of the crystal. To measure the magnitude of radio-frequency voltage across this circuit, L_2C_2 was shorted out. A vacuum-tube voltmeter was connected across L_1C_1, and for each setting of the condenser the voltage was read. This voltage, of course, was at the fundamental wave of the crystal, or 159 meters. The values, plotted against dial reading, are given in Fig. 5, curve E_1. As the resonant wave of the tank circuit, L_1C_1, approached the fundamental of the crystal, from below, the magnitude of radio-frequency voltage increased steadily, until, just as the tuned circuit passed the crystal wave, the oscillations broke sharply. Maximum strength of fundamental radio-frequency voltage output was obtained just before the crystal ceased operating.

To measure the harmonic voltages, the short on tank circuit, L_2C_2, was removed and the vacuum-tube voltmeter was connected across it. Circuit L_1C_1 was kept tuned to the

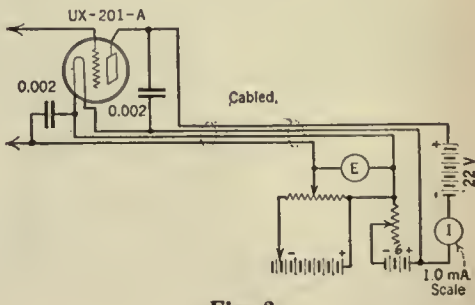
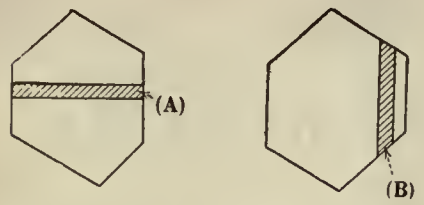


Fig. 2



NO	THICKNESS	WAVE	METERS/MILL
1	0.0515"	198.0	3.85
2	0.0642"	167.5	2.61
3	0.0410"	159.0	3.88
4	0.0410"	159.0	3.88
5	0.0575"	155.0	2.66
6	0.0367"	142.8	3.89
7	0.0535"	139.0	2.60
8	0.0535"	139.0	2.60
9	0.0480"	124.0	2.59
10	0.0460"	120.0	2.61

Fig. 3

fundamental of the crystal, in order to keep it oscillating. The second circuit was first tuned to 79.5 meters—the crystal's second harmonic. The point of maximum voltage occured at only one point on the dial of C_2, for any one position of C_1. However, the magnitude of the second-harmonic voltage did vary, as C_1 was tuned, in the manner of curve E_2 of Fig. 5. As the condenser in the fundamental tank circuit was brought up to the crystal wave, the second harmonic voltage at first increased, reached a maximum, and then dropped off until the oscillations again broke. The interesting point is that maximum harmonic voltage is not obtained at the same setting of the fundamental circuit dial as gives maximum fundamental output. When the trap, L_2C_2, was tuned to the third harmonic of the crystal, the same type of radio-frequency voltage output curve, E_3, resulted. The curves for a perpendicular-cut crystal, No. 7, were in no way dissimilar to those for the parallel-cut specimen.

Parallel Vs. Perpendicular Cuts

THE maximum voltages obtainable at the optimum tuning of both condensers, for harmonics up to the fifth, were determined. In Fig. 6, the curves show for four crystals, two parallel-cut and two perpendicular-cut, how the strengths of harmonic and fundamental voltages compare. The fundamental was measured across circuit L_1C_1, and the harmonic voltages were measured across circuit L_2C_2 when it was tuned to the given harmonics.

Under the test conditions, the parallel-cut crystals gave a greater magnitude of radio-frequency voltage than did the perpendicular-cut plates. Also, any given harmonic of the parallel-cut crystal was a greater percentage of the fundamental than was the corresponding harmonic of the other type. In either case, harmonics that are a goodly proportion of the fundamental can be obtained directly from the crystal oscillator, so that it is possible to eliminate one or more frequency multiplying amplifiers in a transmitter layout. It may be noted that a grid leak was used on the oscillator tube. The relative strength of harmonics could probably be changed, and favorably, by using grid bias. A more intensive study on the matter of harmonics should certainly prove fruitful.

Radio-frequency voltages across the tuned circuits were measured, instead of reading the tank-circuit currents, because the voltages are more indicative of the true output of the oscillator. Voltage, only, is useful in feeding the next amplifier. The tank-circuit current for any one harmonic could be made to vary widely by merely changing the ratio of inductance to capacity, so that readings of current would mean little. The radio-frequency voltages were measured by impressing them on the grid of a vacuum tube, and then bucking out with direct voltage until the plate current returned to its initial value of 100 micro-amperes. The direct voltage, minus a small correction for initial bias, was, of course, equal to the peak of the radio frequency. The voltmeter tube was fitted with long leads to the battery and meter assembly, so that it could be brought right to the tuned circuit which was to be measured. By-pass condensers to filament were connected at the tube. The picture on the next page and the diagram of Fig. 2 give further details of the electrical and mechanical designs of the meter.

Frequency variation in crystal oscillators is a problem whose difficulty of solution varies directly with the frequency. That is, a broadcast station on 500 kc., having to maintain its frequency within 500 cycles of that which was assigned, has to work within limits of 0.1 per cent. A station assigned a frequency of 1500 kc., and required to hold that within 500 cycles, has to maintain an error of less than 0.03 3 per cent. Thus, as the operating wavelength of the station goes down, the percentage accuracy which has to be maintained for a given permissible frequency variation increases.

The use of harmonics of a crystal oscillator does not improve matters in this respect, except indirectly. If the frequency variation of a 400-meter crystal is 50 cycles, say for a certain change in temperature, the frequency variation of its fourth harmonic, at 100 meters is 200 cycles. A 100-meter crystal whose temperature was changed the same amount would have exactly the same frequency variation—i.e., 200 cycles. The change of frequency with temperature is due to the expansion of the crystal; and the above conclusions are evident from inspection of the equations for thermal expansion. Indirectly, however, frequency stabilization is aided by using crystal harmonics, because the thicker crystals are much easier to handle and to mount.

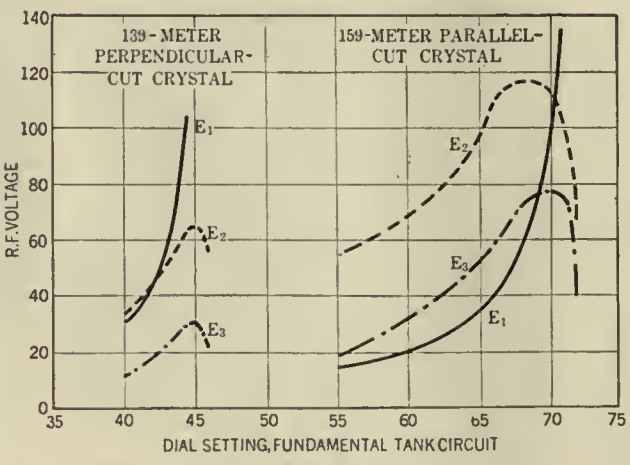


Fig. 5

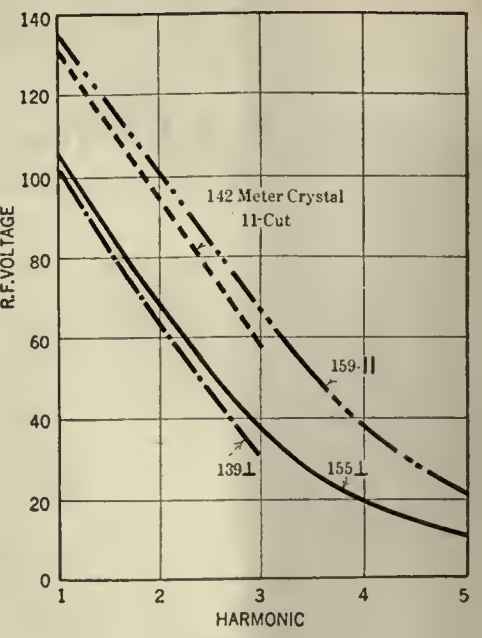


Fig. 6

Matching Crystals

TWO pairs of crystals were cut and ground to approximately zero beat. One pair, crystals No. 3 and No. 4, were cut parallel to a face of the raw quartz. By careful hand grinding with fine carborundum, and continual checking against each other as oscillators, the frequencies of the crystals were brought within one or two hundred cycles. The fundamental wavelength of the two was 159 meters. Two other crystals, No. 7 and No. 8, cut perpendicular, were ground and matched in the same way at a fundamental wavelength of 139 meters.

In order to measure frequency variation of the crystal, the layout depicted in Fig. 4 was utilized. The second harmonics of the crystals in the 50-to-100-meter band were to be used for controlling the transmitter, so the receiver was tuned in this band to the second harmonics of the two crystals. The crystal oscillators were spaced some 15 feet across the room, and were run from entirely separate A and B supplies. The frequency of the audible beat note, present at the receiver output, due to the two harmonics, was measured with a beat-frequency oscillator. For this purpose a 10-mmfd. semi-circular plate condenser was used as a vernier on the beat-frequency oscillator. When calibrated against a Western Electric 8A audio oscillator, a linear frequency variation of slightly more than 300 cycles was had over the dial. Thus, by beating the sound output from the receiver against that from the calibrated audio source, changes in frequency of one cycle in the crystal oscillators could be detected. One of the oscillators was left

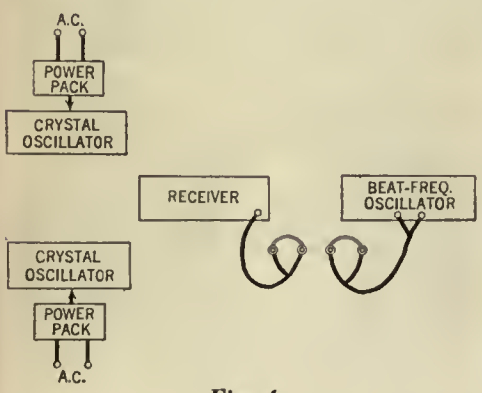


Fig. 4

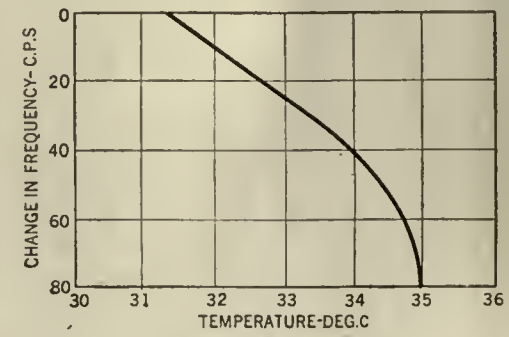


Fig. 7

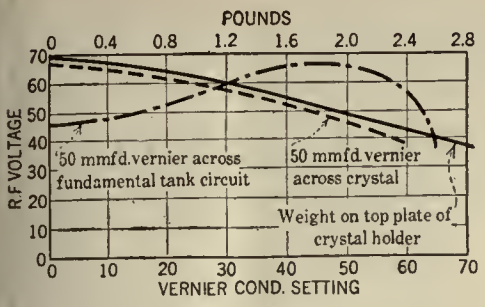


Fig. 8

untouched during a test run, while a variable on the other was changed. Then the variation in beat note between the two crystals was due solely to the change in the variable on one crystal. Since variation in frequency of the second harmonic was measured, the values given are twice the variation that occurred in the fundamental frequency.

Because the crystal oscillators were to be supplied with operating voltages from a 60-cycle a.c. source, the parallel-cut and perpendicular-cut types were compared as to frequency variation when the line voltage changed. The oscillator tube was supplied with 5 volts a.c. on the filament, and 200 volts d.c. from a B-power unit. Both these voltages had as their source an a.c. supply which could be varied from 110 to 130 volts. In the case of the parallel-cut crystal this change in line voltage caused an average frequency shift of 20 cycles. The same test applied to the perpendicular-cut crystal caused the frequency to change 35 cycles in two or three seconds, and then drift slowly to a total change of 92 cycles in some three minutes—again average values of several trials. This comparison, coupled with the fact that the parallel-cut plates gave a higher radio-frequency output, was the reason for confining subsequent measurements to this type of crystal.

Variations Possible

IN FIGS. 8 and 9 are shown the frequency variations that may be obtained by three means of intentional tuning. In the dash curve a small semi-circular plate condenser of 50 mmfd. maximum capacity was connected across the crystal itself. Variation of this capacity caused a nearly proportional change in crystal frequency. The total variation in frequency when the capacity went from 0 to 30 mmfd. was 450 cycles. At the same time, however, the second harmonic output voltage dropped from 67 to 38 volts, peak.

The variation of frequency resulting when the vernier condenser was placed across the fundamental tank circuit was determined, and is given in the dot-dash curve. The total change in frequency with tuning of the main condenser, from the point where the oscillations started to where they broke, was some 800 cycles. (For the perpendicular-cut crystal, this figure was 250 cycles.) The frequency varied in much the same manner as did the fundamental voltage, in curve E_1, Fig. 5. That is, the change in frequency was slight at first, then became greater until, at the point of oscillation cessation, the frequency change per increment of setting was a maximum. The dot-dash curve in Figs. 8 and 9, then, is a small portion taken from this larger curve that would be obtained were the main condenser varied. The hump in the second-harmonic output-voltage curve is also a portion of the larger curve E_2, Fig. 5.

Variation of pressure on the crystal surface constitutes another means of shifting the crystal frequency. The total change experience when the weight on the top plate of the crystal holder was run up to 2.8 pounds was 845 cycles. This represents a greater change in frequency for a given drop in output voltage than either of the other methods of tuning. The relation between pressure and frequency increment is nearly linear, so that tuning in this manner is better than, for instance, the use of a 50-mmfd. vernier across the fundamental tank circuit. Another advantage incurred by the use of pressure on the crystal is that it makes for stability. Jars or bumps suffered by the crystal and mounting are not so likely to disarrange the holder.

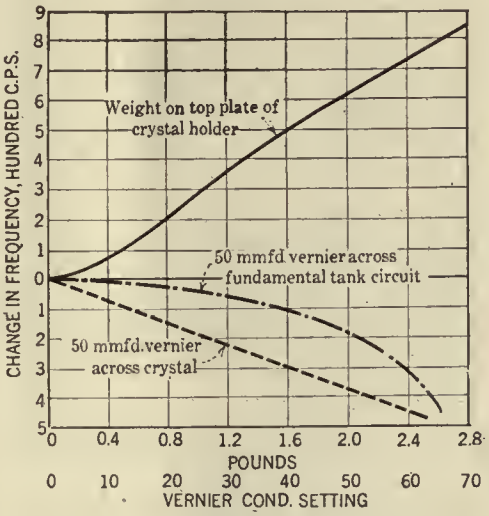


Fig. 9

The latter point was one of the most troublesome in bringing and keeping the two crystals to zero beat. For each slightly different position of the holder plate, the crystal took up a new oscillation frequency that was possibly two cycles, or as much as two thousand cycles removed from the original. It is physically impossible to grind the two surfaces of an 80-meter crystal parallel within five or ten "cycles." A ten thousandth of an inch on such a crystal represents some 13,000 cycles. It seems that for each new position of the plate a new portion of the crystal has a major effect on the frequency. It was necessary to place and replace the top plate of the mounting till the frequency of one crystal came within a hundred or so cycles of that of the other. A holder designed to maintain the relative positions of the crystal and plate within close limits; or one designed to give intimate electrical contact over both crystal surfaces, should aid in overcoming the difficulty. In the case of the longer-wave crystals, it is possible to operate them with no contact whatsoever between plates and crystal.

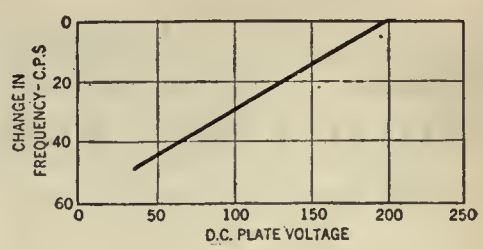
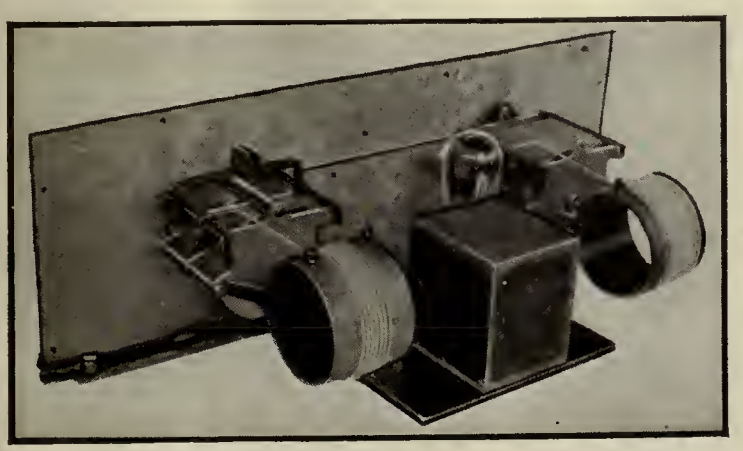


Fig. 10

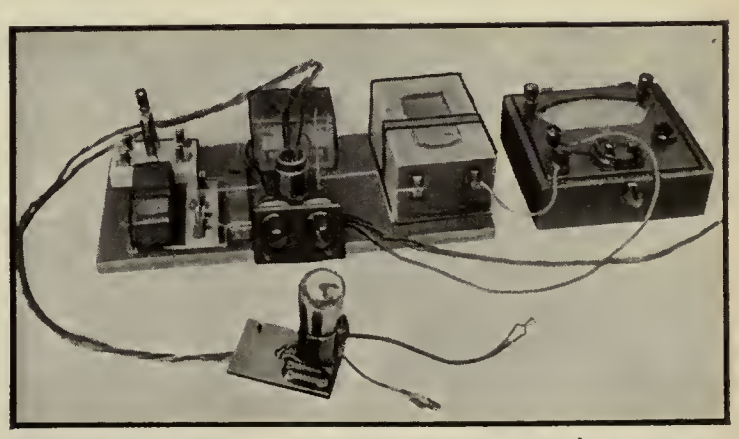
Maintaining Frequency Constant

THE frequency shift which occurred when both the filament and plate voltages on the oscillator tube were changed has been mentioned. In Fig. 10 the change in frequency that is due to plate voltage variation alone is shown. To maintain the frequency constant within one cycle the plate voltage must not be allowed to vary more than 1.5 per cent. To hold the frequency invariant to the same degree, temperature variation cannot exceed 0.66 degrees Centigrade. Thus, the major problem in frequency stabilization is that of temperature control. Other factors such as operating voltages and circuit constants can be fixed so that frequency shift due to them becomes negligible when compared with that due to temperature variation. Fig. 7 contains the points, plotted, which were obtained when the temperature inside the container for the crystal mounting was increased slowly by means of a resistance heater. Readings of temperature and frequency were taken at intervals of five minutes over the period of 45 minutes which the curve data cover.

Over the straight-line portion of the curve the frequency changed 15 cycles per degree Centigrade. The lower bend in the curve furnishes another example of the discontinuities encountered in crystal operation. As the temperature slowly approached 35° the frequency began to change more rapidly, and at that point the heat note suddenly jumped to 2973 cycles, where it had been 429 cycles previously. For no apparent reason the frequency shifted 2544 cycles. Thus, not only must the crystal temperature be held within extremely close limits, but the absolute value of the temperature is important. It is not safe to calibrate the crystal in one range of temperature, and assume that the frequency in another range can be obtained by application of the temperature coefficient of frequency.



The author's crystal-oscillator unit



The vacuum-tube voltmeter shown schematically in Fig. 2

ROUTINE TESTING OF FILAMENT CIRCUITS

By JOHN S. DUNHAM

QRV Radio Service, Inc.

THE chart which is reproduced as part of this article describes a *method* of testing the continuity of filament circuits in radio receivers. It does not apply to any particular make or model of receiver, but is intended only to apply to the three commonly used *types* of filament circuit. It does not pretend to contain all of the tests which may be necessary on a given receiver, but was designed to serve as a guide in developing an orderly, thorough, and rapid system of testing. There may be variations of the order given which will save more time. It is certain that precisely the same order cannot always be followed, because there is such wide variation of physical construction of receivers in use to-day. The important thing is that *some* carefully designed order of testing must be used consistently in order to gain at once the two-fold advantage of thoroughness and rapidity.

Socket Trouble

STARTING at the sockets, it is always well to ascertain visually the state of cleanliness, or dirtiness, of the socket prongs before inserting the diagnoser plug for testing. If they are not bright over the area in which contact is made with the tube prongs, they should *always* be cleaned before going farther. Many a no-charge call has been the result of failure to perform this simple operation, a fact especially true when servicing old sets with open, flat-prong sockets. Fortunately, it is less prevalent with the newer types of socket. In the old types, scraping the prongs with the end of a screw-driver is the easiest and quickest method of cleaning them, after which process it is usually advisable to bend them upward to insure proper tension.

With the newer type of construction which does not readily permit visual inspection of the socket prongs, moving the top of the tube, in any socket, along the circumference of a small circle will produce noise from the loud speaker if the contacts are not clean and tight. That test may have to be deferred because of other troubles, but it should always be made. Such socket prongs may be cleaned from the top by the use of a piece of No. 14 solid antenna wire, bent over slightly at the end and sharpened, somewhat like an automobile carbon scraper. If the tension of the prongs has become insufficient, it usually can be remedied only from underneath the tube panel. However, the type of prong that is used in the Radiola 25 and other models may be tightened up from above with a special tool provided by RCA for that purpose. (Some servicemen always carry a crotchet needle in their kit as this may sometimes be used as a tool for the repair of sockets from above. *Editor.*)



On every service call the battery terminals should be carefully examined.

Continuity Tests

WITH the diagnoser plugged into a socket, if filament voltage is not obtained, the next place back along the line of supply which can be tested readily is usually the terminal strip of the set. If filament voltage is obtained there, it establishes the continuity of the remainder of that supply circuit, and at the same time narrows down the search for trouble to that portion of the circuit which lies between the terminal strip and the socket prongs. Each of the two legs of that portion may then be analyzed separately. Speaking of a parallel d.c. circuit, for example, if voltage is obtained by testing from the negative strip terminal to the positive socket prong, the continuity of the positive leg of the circuit is established, thus further narrowing the search down to the negative leg. If the filament-control rheostat is in that leg, testing for voltage from the positive strip terminal to the rheostat will determine whether the trouble is there, between there and the strip, or between there and the socket. When the open has been located definitely in a small portion of a circuit by such an orderly process of elimination of other parts of the circuit, then in most cases it may be found quickly by visual examination.

One of the primary interests of radio dealers who write us about servicing seems to lie in determining the best methods of going about service problems in general. In the April RADIO BROADCAST, *Mr. Dunham wrote the first of a series of articles on routine testing of radio sets. This was most favorably received and this article which deals with routine tests of the receiver in the customer's home presents some interesting thoughts on routine tests for filament circuits. The table at the end of the article should be especially useful.*

—THE EDITOR.

When the trouble is not a complete open, but is a partial break or a resistive contact, as indicated by low voltage, or fluctuation of voltage, at the socket, but with steady voltage of the proper value appearing at the terminal strip, the parts of the circuit in which the trouble does *not* exist may be eliminated by the same process. Then, if visual examination does not disclose the fault, it may be found by watching the voltage across the tube in the diagnoser socket, with the diagnoser plug in the set socket, while vigorously moving and pulling the particular length of wire to which the trouble has been traced.

Rheostats are the most common source of noise and fluctuation of voltage in d.c. filament circuits, as are any continuously variable resistors in any receiver circuit. If turning a filament rheostat—whether it be the common control for all tubes, or simply used as a volume control affecting only a few tubes—produces noise from the loud speaker, that rheostat should be thoroughly cleaned. Fine sandpaper is the best thing with which to clean the contact arm and the surface of the resistance wire on which it rides. If it cannot be reached easily to use sandpaper, in those sets which are designed without apparent thought to the difficulties of servicing them, a pipe-cleaner, dipped in alcohol, will sometimes suffice. If cleaning the end of the arm and the surface on which it makes sliding contact does not entirely eliminate the noise, then the rheostat should be dismantled and the sliding contact which connects the shaft to one terminal lug of the rheostat should be thoroughly cleaned, as well as the stationary part of that contact. Oil should never be used on the shaft bearings of a rheostat, for oil happens to be an insulator, a fact which seems to be ignored by a good many servicemen who ought to know it. There is one exception to the statement that oil should not be used on rheostat bearings. There is one manufacturer of rheostats in the United States (there may be a few others, but the author has never seen their product) who makes rheostats with a pigtail connection from the shaft to the terminal. Oil may be judiciously used on the bearing of that most excellent job. If you have not guessed it, the name of the wise manufacturer mentioned is the Yaxley Mfg. Co. Long may they prosper!

Still using the battery-operated set as an example, if proper voltage is not obtained at the terminal strip, the next logical test point is the terminals of the A battery. If normal voltage appears there, it is obvious that the trouble exists between that point and the set terminals. If no voltage at all is obtained at the set terminals, one of the two filament leads in the cable must be broken at some point. The continuity of the positive one may be determined by a voltage test from its terminal strip end to the negative battery terminal, and that of the negative lead from its terminal strip end to the positive battery terminal.

Corrosion on Terminals

IF THE more usual trouble of slightly fluctuating voltage at the terminal strip is observed, the most probable cause is corrosion on the battery terminals, creating a varying resistive contact between them and the cable lugs or clips. On every service call, the storage-battery terminals should be examined carefully, and if the contact is not perfect they should be thoroughly cleaned and thickly coated with vaseline. Also, if battery clips are not being used, or if those used are small and have weak springs, then large clips with very strong springs should *always* be put on. Failure to do those things is another prolific cause of no-charge calls and dissatisfied customers.



Oil should never be used on the shaft bearings of a rheostat for oil happens to be an insulator.

A few words about lead-cell storage batteries may not be amiss at this point. A voltage reading taken across the terminals of such a battery without the set load is valueless for the practical purpose of determining its condition and state of charge. The no-load voltage may be high, but the voltage with even the small load of the tube filaments may be very low. Neither is a voltage reading under that load a *sufficient* indication of the state of charge. The change of terminal voltage, even under normal load, is not a linear function of the change in ampere-hour capacity. During discharge, for example, the voltage curve is only a gradual slope downward until



After the fault has been localized it may be found by watching the voltage across the tube in the diagnoser socket, with the diagnoser plug in the set socket, while vigorously moving and pulling the particular wires to which the trouble has been traced.

nearly the end of the discharge, when it finally begins to fall rapidly. It is possible for the terminal voltage to be high enough to supply five volts at the tubes when the battery is more than three-quarters discharged and, therefore, in need of recharging.

Likewise, a hydrometer reading alone is not a sufficient indication of the condition of a battery. A cell may be reversed, or contain damaged or shorted plates without giving any indication of that condition by the specific gravity of its electrolyte. Therefore, a voltage test under the set load should be made and the state of charge should also be determined, either by measuring the specific gravity of the solution with a hydrometer, or by employing one of the various ammeters put on the market for that purpose which place a comparatively heavy load across the cell and measure the current on a scale which is roughly calibrated to show the approximate state of charge. The latter is preferable for the practicing serviceman. While not as accurate as the hydrometer, it is sufficiently so, and it is more compact, does not break easily, *and cannot drip acid solution.*

Trickle Chargers

WHEN a trickle charger is used, its rate of charge should always be measured by inserting the one-ampere range of the diagnoser ammeter in series with one of the leads between the charger and the battery. If the rate is adjustable, a good deal of possible future trouble can be avoided by adjusting it to approximately the rate which is needed for that particular set. Careful questioning will usually extract from the customer a fairly good estimate of the average number of hours the set is used daily. If he is not home to be questioned, and in the absence of other evidence, an average of four hours is a safe assumption. Multiplying that figure by the current drain of the tubes gives the number of ampere-hours taken from the battery every twenty-four hours. Dividing that figure by the remaining hours of each twenty-four, during which the battery is being charged, gives the rate of charge needed to replace the same number of ampere-hours. That figure plus 30 per cent. is the rate to which the charger should be adjusted. The computation may be expressed in the following formula:

$$\frac{\text{hours of drain} \times \text{drain in amperes}}{\text{hours of charge}} + 30\% = \text{charging rate.}$$

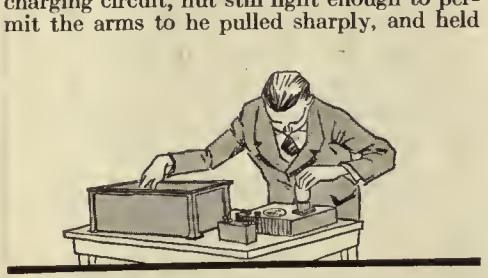
If the charger is adjustable in steps instead of continuously, it is better to use the rate which is a little higher, instead of the one which is a little lower than the desired rate.

If the rectifier is one of the wet types, and does not give the output which is necessary, the only reasonable remedy is to throw out the inexcusable thing and substitute for it a good dry rectifier replacement unit, such as Elkon or Kuprox, made especially for that particular charger. Dry rectifiers do not, of course, last forever—because it they were made that way the manufacturers' future replacement market would not exist—but at least they may be replaced, when exhausted, by others of the same make and type without causing the serviceman that feeling of guilt which he has when he supplies any accessory or part which he knows to be inferior. A similar dry type is also made to replace Tungars, and is preferable because of its economy in operation and life, and its quietness.

Charger Connections

IT IS rather important to remember that the positive terminal of the charger must be connected to the positive terminal of the battery. If that order is reversed the battery will be discharged rapidly, and then very slowly charged again in the opposite direction, a process which materially shortens the life of both the battery and the charger. When a storage battery using a trickle is found to be fully discharged, or partially or fully charged with the polarity reversed, it is well to be sure of that point. The foregoing would seem to be information of the kindergarden variety, but the number of times QRV servicemen have discovered exactly the described state of affairs is amazing. When the condition is found, the only remedy is to have the battery sent to a battery service station for proper recharging.

When an ammeter test does not show any output, or an intermittent output from a trickle charger, a very probable place of trouble is at the points of the relay. Those points are slightly burned by sparking each time contact is broken, and, therefore, require cleaning occasionally. A very few strokes with fine sandpaper or a very fine file, held flat against the points by closing them against it, will suffice to clean them properly. The relay switch arms can get out of adjustment, so that they do not close firmly in one or the other direction, and may need bending back into their original shape. The spring against which the switch arms work may gradually lose its tension and require shortening. The tension should be adjusted so that good firm contact is made to close the charging circuit, but still light enough to permit the arms to be pulled sharply, and held



In series-filament circuits much time may be saved by testing the continuity of each tube filament separately with a C battery.

firmly, against the opposite points when the magnet is energized.

We have spoken so far only of a.c. trickle chargers. There is no difference in method of testing or connection where d.c. is the supply, but there is one caution about such equipment which is important. Whenever a d.c. trickle charger is installed, fixed condensers of any convenient value larger than 0.001 mfd. should always be put in both antenna and ground leads, *between* the set and the lightning arrestor, *before the charger is connected to the line.* This is also essential when installing d.c. sets, with the exception that the manufacturer usually takes care of putting a suitable capacity in the ground lead, within the set or power pack. If there is none for the antenna within the set, then it can be connected externally by the installer. Observance of that rule will avoid the evaporation of relay switch points, parts of primaries of antenna input transformers (in the event of a grounded antenna or shorted lightning arrestor), parts of tube filaments, and lighting circuit fuses, at a cost which is comparatively low. If you don't know the reason for those possibilities, draw a circuit diagram starting at the line, going through the relay, charger and battery to the filaments, showing the antenna-ground system with its connection to the filaments, remembering that either side of the line may be grounded and that, when the relay switch is in the charging position the points do not open until *after* the set has been turned on at the filament switch. The same situation exists with a set operated from the d.c. line.



A common cause of "dead" d.c.-powered receivers is ignorance on the part of the housemaid concerning the manner in which the plug should be placed in the wall socket.

Perhaps some enterprising manufacturer will put a variable-rate d.c. trickle charger on the market before battery-operated receivers become obsolete. Until that time, in cases where the rate of the present manufactured article is not reasonably near that required, and where the battery and charging equipment can be kept entirely out of sight, a good substitute for it is a porcelain lamp socket screwed to a wooden base, into which may be put a size of lamp which has approximately the right resistance to give the desired rate. Then, if it becomes necessary to change that rate, a different size of lamp may be substituted easily.

Series Filament Circuits

THE testing of series d.c. filament circuits is just as easy and may be done just as quickly as the testing of parallel circuits, if a logical routine is followed, When the tubes are not paralleled with resistances, there is but a single series circuit extending from one filament terminal on the strip to the other filament terminal, and consisting of alternate sections of tube filaments and single wires connecting those filaments, like a string of sausages. There may also be a section at one end consisting of a rheostat. Testing for voltage from the negative end (negative terminal on the strip) first to the positive end, and then successively to each joint between sections, will quickly disclose the point at which the open occurred.

While it would be just as effective to use the positive end as the point in the circuit from which to start testing, it saves time to get into the habit of always starting at the same point, and the negative end is preferable as the base of operations for all circuit tests, except when testing a.c. circuits—which obviously have no polarity to an a.c. meter.

It is, of course, necessary to keep the tubes

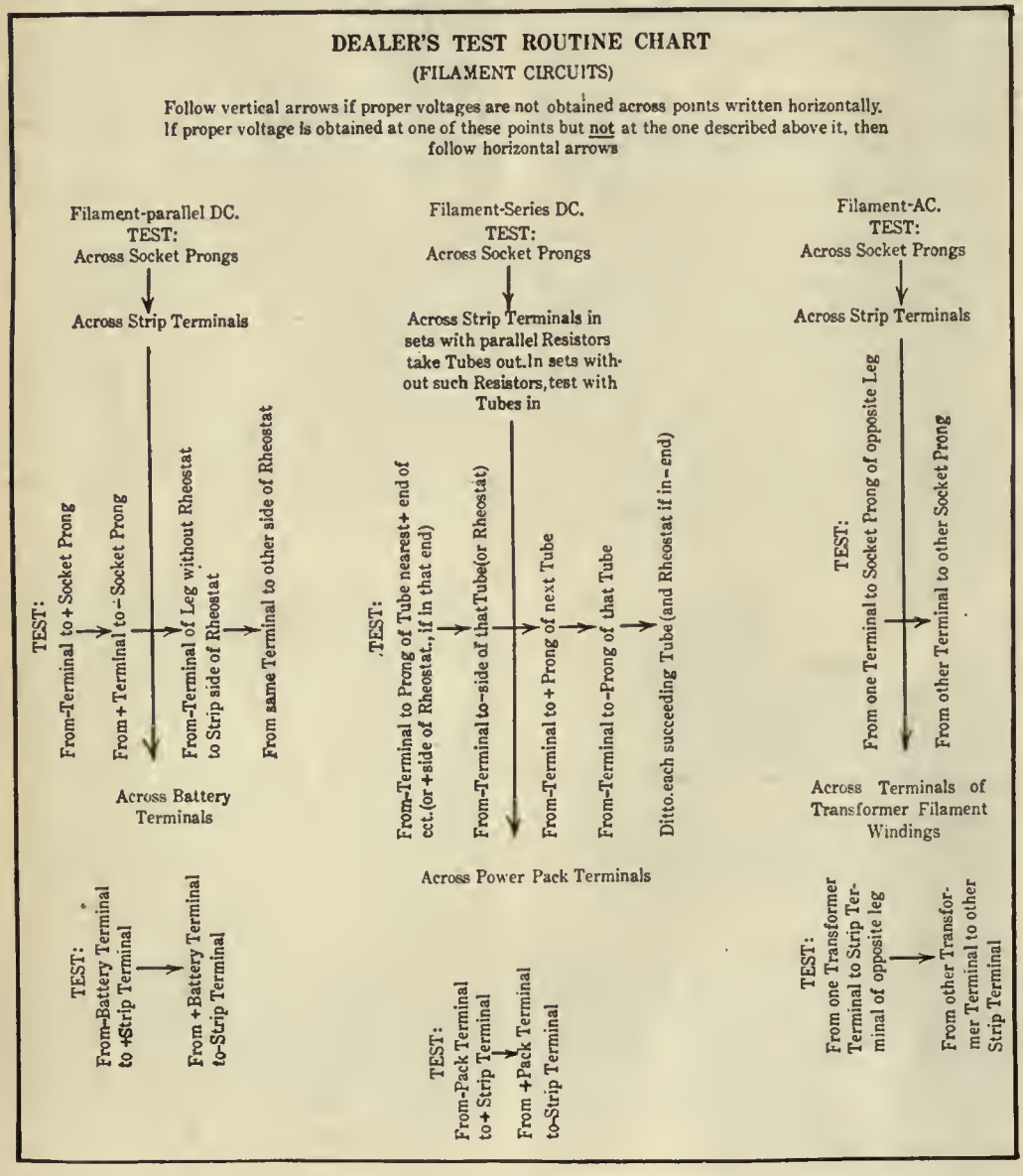
in the sockets when testing such single series circuits, and get at the contacts elsewhere. If the construction of the set is such that the socket contacts cannot be reached from above the panel when the tubes are in the sockets, time may be saved by testing the continuity of each tube filament separately with a C battery. If none of the tubes is open, then, to get at the socket contacts before removing the chassis from the cabinet, a piece of stiff wire bent into U shape may be substituted successively for each tube by inserting it across the filament prongs of each socket. After testing at one socket, the tube should be replaced in that socket, and the wire moved to the next socket to permit test there.

Radiola 28 Circuit

WHEN each tube in a series arrangement is paralleled with a resistance, such as in the Radiola 28 when operated from the 104 loud speaker, there are two series circuits which are parallel to each other throughout the length of the filament circuit, and are connected to each other between each tube. It should, therefore, be tested for continuity with the tubes out, but otherwise in the same order used when testing a single series circuit. As the continuity of the part of the whole circuit across which a tube filament is connected does not depend solely upon that tube, but depends also upon the parallel resistance, the opening of one filament is self evident because the others do not thereby go out. Similarly, if one section of the resistance opens, but the tube across it does not, the continuity of the whole circuit remains unbroken. In that particular case the tube filament will be carrying very nearly the current which was divided between it and the resistance section before the latter opened, so that it will be burning with abnormal brilliancy, a fact which is usually evident visually and hence removes the necessity for continuity testing.

Special Cases

IN SOME sets a series-parallel arrangement of tubes is employed. That is, in a set using six tubes, for example, there will be two series circuits containing three tubes in each, and the two circuits connected in parallel across the supply. Continuity testing of each of those circuits may then be done separately. That type of filament circuit is sometimes used in sets operated from a d.c. lighting supply. The serviceman should be very careful to refrain from changing tubes in that type with the power switch on, unless he is familiar enough with the circuit diagram of that particular model to know that it can be done without damaging other tubes. In some models there is but a single resistance used to drop the line voltage down to the voltage required for the two filament circuits. In such atrociously designed jobs, if one of the filament circuits is opened by removing a tube, or in any other way with the power on, the current drain is halved, the IR drop across the single resistance decreases, thus increasing the voltage across the remaining filament circuit. That increase of voltage in turn increases the current through the filaments, resulting in paralysis of all of them and often the burning out of one of them.



General Rules

WHATEVER type of filament circuit is used, if proper voltage is not obtained at the set terminal strip, the next logical place to test is at the filament terminals on the power pack, regardless of what type that may be. If proper voltage is secured at that point, each leg of the supply from there to the set terminals should be analyzed separately as previously described in this article. If proper voltage is not obtained at the terminals of the power pack, then it becomes necessary to trace back through that supply unit. If the supply is d.c., one side of it goes back from the terminal strip of the pack directly to the line, while the other side goes back to the other side of the line through a fixed resistance, or a variable resistance, or both in series. One may, therefore, test for voltage from the terminal of the side which is connected directly to the line, to each end of the resistor or resistors in the other side and to any other joints which may exist.

It is assumed in outlining these filament tests in receivers supplied from either a.c. or d.c. lines that the serviceman knows he has "juice" at the outlet used. When servicing any socket-powered receiver, if both filament and plate voltages are noticeable by their absence at the first socket from which a test is made, and there is no evidence of voltage at that outlet such as a lighted standing lamp supplied from it, then a voltage test should be made before resuming the regular routine.

A common cause of "dead" d.c.-powered receivers is ignorance on the part of the housemaid, and often the customer, that when the little black plug which goes into the outlet is removed for any reason, it should be put back in *exactly* the same position. All servicemen who work in d.c. neighborhoods should carry small tags with them to be tied to the cord close to the plug, on which can be written: "*Always replace plug with the notched side up.*" Then a small notch can be cut into the edge of the plug with a knife or file. The same thing applies to d.c. trickle chargers. If the polarity is reversed, the same thing will happen that happens when the polarity of the output of an a.c. trickle is reversed in its connection to the battery. The average customer is loath to pay a service charge to have a serviceman do nothing but reverse a plug in an outlet, especially if the call happens to follow closely one made to cure other trouble. No matter how carefully he may have been cautioned by previous servicemen about that particular thing, such is the nature of humans that in many cases the customer will not only commit perjury by definitely denying that he was so instructed, but he will also complain about the gross negligence of those preceding servicemen for their alleged failure to do so.

As the d.c. supply for series filaments obtained from a.c. power packs is closely associated with the plate supply, testing of such supply between the power pack terminals and the line will not be considered in this article, but will be discussed in some detail in a future installment.

The testing of parallel a.c. filament circuits differs from d.c. filament circuit testing only in that fewer stops are required. There are no rheostats to worry about, and in many sets the only point at which joints in the supply are not permanent soldered connections is the terminal strip to which the lugs on the cable from the power pack are screwed. When voltage tests made successively at the socket, set terminal strip, and transformer winding terminals to which the cable leads are soldered do not reveal voltage, then there can be only one trouble and one practical remedy (assuming, as before, that line voltage is getting to the primary of the transformer). The trouble is an open (or possibly shorted) transformer winding. The remedy is to replace the transformer.

No. 21 *Radio Broadcast's Home-Study Sheets* May 1929

THE USE OF A BRIDGE

THE usual method of measuring the inductance of a coil is to compare it with a coil whose inductance is known—either having been calculated, or compared to some other standard. One method by which this comparison may take place is indicated in "Home-Study Sheet" No. 15. Another, and more often used method, is to employ a Wheatstone bridge by which the unknown inductance, or capacity, may be compared directly to a known inductance or capacity.

Such a bridge may be a simple affair, like the one illustrated in this "Home-Study Sheet," or it may be much more complicated and costly.

As this piece of apparatus probably has a more varied field of usefulness than any other single piece of equipment in the laboratory, the experimenter will be well repaid for any effort expended in its construction.

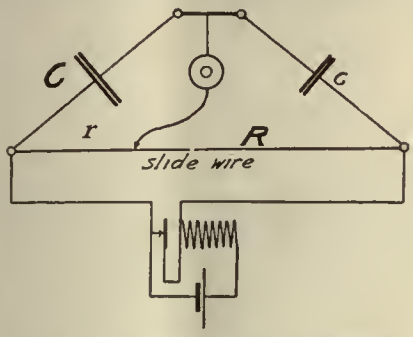


Fig. 1—Connections for a simple slide-wire bridge.

The simplest form and one with which a great deal of practical work may be done is the slide-wire bridge—a type that is greatly improved by the use of a wire of one of the modern high-resistance alloys, such as number 36 nichrome, which has a resistance of about 25 ohms per foot.

The reader is doubtless familiar with the connections as set forth in Fig. 1, in which condenser C is being compared with condenser c, the relation being expressed by the simple proportion $\frac{C}{c} = \frac{R}{r}$

It is, of course, unnecessary to know the absolute values of R and r. If, for example, the scale has 300 uniform divisions, and the sound in the telephone receiver vanishes at a point on the wire 100 divisions from the left, the $\frac{R}{r} = \frac{200}{100}$ or 2, which tells us that the capacity of C is twice that of c.

Practical work may be done by using about two feet of the wire referred to above, stretching it between metal connecting blocks and providing a paper scale. If the scale has twenty divisions to the inch, under proper conditions, it should be readily possible to read to the nearest division, which means a possible accuracy of a fraction of 1 per cent.

Those who have had some experience in lettering and drafting will have no difficulty in producing an accurate and professional-looking scale. Procure a piece of durable and smooth-surfaced card. Mark out the lines for the scale, but do not cut off the required strip until the work is complete. To subdivide, use a steel rule, holding it on edge and running the sharp point of a hard pencil down each engraved division line. This procedure will result in a series of fine dots, more accurately spaced in this mechanical manner than could possibly be done were the pencil point directed by the eye. A straight edge may now be placed parallel to the length of the scale, and, by using a small triangle against it, just as a T square is used against the edge of a drawing board, the division lines may be drawn in readily with a right-line pen and waterproof drawing ink. When the numerals have been lettered, the scale may be given a coat of transparent radio varnish or lacquer.

The chances of error due to inequalities in the wire, which are never very serious, can be reduced greatly by dividing the wire into two equal parts as shown in Fig. 2. When a reading has been taken, connections A and B may be reversed and another reading taken. If the two results differ materially, one or both wires should be replaced. When approximately the same reading is obtained on either side, it is evident that a mean between the two will be quite accurate.

For the measurement of resistance where inductance is also involved, as in the case of a coil, direct current must be employed, and a galvanometer used to locate the zero point on the slide-wire. For capacity measurements, alternating current is required and should also be used for non-inductive resistance determinations (e.g., grid leaks), as the telephone receiver is much more sensitive and more convenient than the usual galvanometer. For practical work a very satisfactory source of alternating current is a fairly high-pitched buzzer. In Fig. 1 the bridge wire is connected across the two contact points. Another method is to connect it directly across the buzzer coil, and sometimes the bridge, battery, and buzzer are all placed in series. For any given buzzer the best plan may be determined by using the bridge to compare two variable air condensers, preferably of the same make or type. The buzzer connection that results in most completely eliminating all residual sound from the telephone receiver when the bridge is balanced is the best. Make the test in a quiet room at different adjustments of the buzzer tone and at different points on the slide-wire.

It is very important to have a buzzer that will produce practically no residual sound under the foregoing conditions, as it enables one to identify defective condensers. If one of the air condensers referred to is replaced with a small fixed condenser which may have a poor dielectric, the sound in the telephone receiver cannot be made to disappear completely when the bridge is balanced, and the amount of this residual sound is a measure of the quality of the dielectric. The faint note that remains in the telephone receiver is simply due to what is termed *phase difference*. This may be made clear by referring to the mechanical analogy illustrated in Fig. 2, "Home-Study Sheet" No. 19, in connection with which it was pointed out that the spring had its maximum velocity at the moment when it was free from all stress, and that the stress was at a maximum when the velocity was zero. Representing the complete cycle of the spring, one extension and one compression, as 360°, it will be evident that velocity and stress are 90° out of phase. Similarly, in a perfect air condenser, the voltage and current are said to differ 90° in phase. In the mechanical analogy a perfect spring is assumed—one that responds instantly to any difference in pressure. If, however, the spring were made of a sluggish or faulty material that required a little time to conform to the pressure, the phase difference would no longer be exactly 90°. Similarly, with a poor dielectric, the phase difference is not precisely 90°, as it is in a perfect air condenser. When a condenser with a poor dielectric is balanced against an air condenser, the bridge will determine the point at which the opposing voltages balance, but as the phase of the current on one side is not exactly the same as on the other side, there will be a slight but unavoidable flow of current. After the experimenter has become familiar with the action of his bridge, he will be surprised to note the marked differences in fixed condensers, not only in regard to the quality of the dielectric, but also as to their stated capacities.

Fig. 3 illustrates a slide-wire bridge which, though it may be somewhat more elaborate than the reader may care to construct, will be described briefly, as certain features may prove suggestive. It is built on a strip of wood ¾" thick, 3" wide, and 21" long. On one end is a buzzer and on the other a galvanometer. One or two dry cells are used, and, by throwing the six-arm switch, the telephone receiver and buzzer are disconnected and the galvanometer and battery are connected directly to the slide-wire.

The slide-wire is in two sections, which are connected through two brass blocks and a taper plug. By removing this plug, two large equal and non-inductive resistances may be placed across the binding posts indicated at R-R, thus greatly increasing the resistance of the bridge at the 1:1 ratio. This ratio is very generally used in measuring capacities within the range of a calibrated variable condenser, the balance being accomplished by varying the latter. The use of the high resistance in the two arms adds greatly to the sensitivity of the bridge.

At the two free ends of the slide-wire is a switch, which reverses the arms of the bridge, so that a mean of two readings may be used.

The movable contact should have a fine point and be mounted in an insulating handle, and is connected through a flexible conductor to a small binding post at A, which is in connection with a small switch arm. When the bridge is being used at the 1:1 ratio, this switch is placed on the inner contact point, which makes the desired connection to the mid-point permanent.

At B, provision is made for throwing in a high resistance in the lead to the galvanometer in order that the deflections will not be violent while attempting to find the point of balance. When this has been determined approximately, this resistance may be switched out. A piece of card heavily coated with pencil lead will answer and may be slipped readily under a pair of spring clips.

The wiring is all done on the underside, appropriate grooves being cut for the necessary leads. These should not be larger than No. 22 or 24 wire, except for the two short connections between the reversing switch at the end of the slide-wires and the two binding posts, which connections should be made with No. 14 or 16 wire in order that no extra resistance will be interposed beyond the points where the current divides.

The galvanometer used will be referred to later when the subject of galvanometers is taken up, and the necessary resistance units will be considered in a separate "Home-Study Sheet."

Using the Bridge

In practice one lead of the unknown capacity, inductance, or resistance is attached to the binding post X, one lead of the standard to which this unknown is being compared is connected to the post

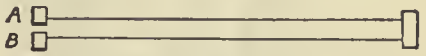


Fig. 2—A double slide-wire tends to eliminate error.

Y, and the remaining two leads are both attached to the post to the right of these two posts. Then the slider is moved until silence is secured in the head phones—it may be necessary to use an audio amplifier between the phones and the bridge if the room is noisy—the value of the unknown resistance or inductance is equal to the standard times the ratio of the two resistances, thus,

$$L_x = L_y \times R/r \text{ and } R_x = R_y \times R/r$$

but if two capacities are being compared, the ratio of the resistances (the lengths of the slide wire on either side of the slider) must be inverted; thus

$$C_x = C_y\, r/R$$

because the larger the capacity the smaller its reactance.

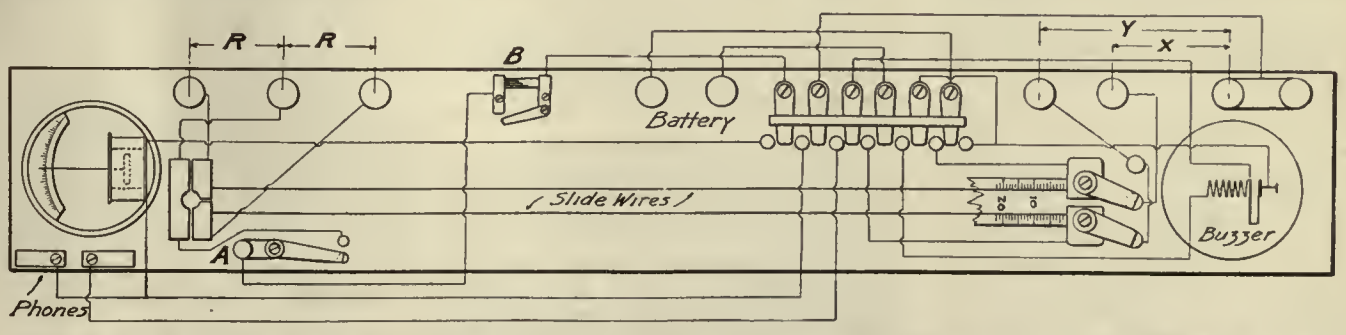


Fig. 3—Diagram of a reversible slide-wire bridge which may be used with either direct or alternating current.

No. 22 *Radio Broadcast's Home-Study Sheets* May 1929

RADIO-FREQUENCY AMPLIFIERS

A RADIO-FREQUENCY amplifier consists of a tube and some means for connecting that tube to an output circuit. In this "Home-Study Sheet" we shall learn how to design a single atage of radio-frequency amplification.

The circuit diagram of such a atage is shown in Fig. 1. Evidently there are several variable factors. We can use a low- or high-mu tube; the number of turns on the secondary, the size of the tuning condenser, the number of primary turns, and the coupling to the secondary are all variable and at the control of the designer.

Tuning Capacity

The size of the tuning condeaser and the secondary inductance are related definitely to the frequency band to be covered. The present broadcasting band covers a range of from 200 to 550 meters, or about three to one. If the wavelength varies as the square root of the tuning condenser capacity, what range in capacity must he available to tune from 200 to 550 meters? As shown in "Home Study Sheet" No. 19 the wavelength is proportional to the square root of the product of L and C. That is, 600 meters $= 1.884\sqrt{LC_1}$ and 200 meters $= 1.884\sqrt{LC_2}$ where the two values of C (in mmfd.) are the capacities required to tune the fixed inductance (in μh) to 200 and 600 meters. Dividing one equation by the other we get $3 = \sqrt{\frac{C_1}{C_2}}$ or $9 = \frac{C_1}{C_2}$ which atates that the capacity for 600 meters must be 9 times the capacity for 200 meters.

This is the first design problem. We must be able to use a condenser that has a capacity ratio of at least 9 to 1. If the maximum capacity is 0.00035 mfd., the minimum must not be greater than 0.000039. Because of (a) the input capacity of the tube, (b) the capacity of leads to the coil and to the tube, and (c) the distributed capacity of the coil to which the condenser is attached, all of which are in parallel with the condenser, the minimum capacity of the condenser must be less than this nmount hy at least 30 mmfd., or it must be as small as 9 or 10 mmfd. If it is larger, or if the distributed capacity of the coil is high, the lower wavelengths cannot be reached.

A large-diameter coil with large wire closely wound will have a large distrihuted capacity. This is one reason why commercial manufacturers nse small coils wound with fine wire carefully apaced. A ahort aingle-layer solenoid haa a distributed capacity in mmfd. nearly equal to 7 per cent. of its circumference in centimeters. (Breit, *Physical Review*, Aug. 1921.)

Secondary Inductance

The greatest perceatage of the amplification factor of a tube will be obtained when the load into which it works is high. The effective resistance of a coil-condenser combination at resonance (see "Home-Study Sheet" No. 12) is equal to

$$R_{eff} = \frac{L^2\omega^2}{r} = \frac{L}{C_r}$$

Where L is the inductance of the coil
ω is 6.28 times the frequency
r is the aeries high-frequency resistance of the coil.

This shows that the effective resistance, whieh is the load presented to the tube, increases as the square of the inductance, and so if we can keep the resistance of the coil fairly low, a large iuductance is better than a small one.

The selectivity, S, of such a tuned circuit is proportional to $L\omega/r$, and the width of the resonance curve, at a point where the response is 0.707 of the value at exaet resouance, is related to this ratio, i.e., $S = \frac{L\omega}{r} = \frac{fr}{f_2 - f_1}$ (see Fig. 2) which is another reason for using as large a coil as possible.

Problem 1. Assume a fixed capacity of 50 mmfd. across whieh the condenser is to be placed. This includes the minimum capacity of tho condenser. Calculate the inductance of the coils to be used to cover the broadcasting band if the maximnm capacity of the condenser is 250, 350, and 500 mmfd.

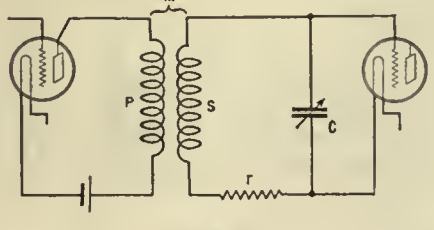


Fig. 1

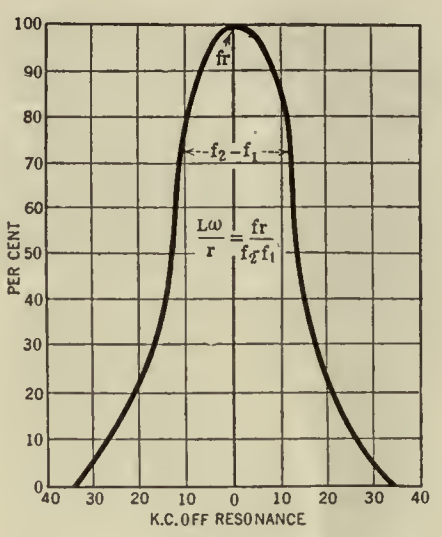


Fig. 2

If they have the same resistance (assume 20 ohms) at 1000 kc., calculate the effective resistance, or the load presented to the tube in each case. Calculate the width of the resonance curve aud the selectivity factor, S.

Coupling to Previous Tube

How a'hall we couple the coil-condenser combination to the previous tube? One way is by means of a transformer. At first let us use an auto-transformer as in Fig. 3. Also, let us fur the moment consider a tube with an amplification factor of 8 and n plate resistance of 6000 ohms (a 112-type tube), and connect it across the entire coil. What is the amplification and effect on selectivity?

The voltage amplification of auch a tube nnd coupling device cannot be greater than the mu of the tube, and will be more nearly equal to it the larger the effective resistance of the tuned circnit becomes compared to 6000 ohms. As a matter of fact the voltage amplification will be eqnal to $G = \frac{\mu \times R_{eff}}{R_{eff} + R_p}$; in this case it will be equal to

$$\frac{8 \times R_{eff}}{R_{eff} + 6000}$$

so that, if the effective resistance of the tuned circuit is 50,000 ohms, the voltage amplification, G, will be about 7.3.

What happens to the selectivity of the tuned circuit? We have placed directly across this circuit, which has an effective resistance of 50,000 ohms, a 6000-ohm resistance. The resistance of these parallel resistances is now equal to $(50{,}000 \times 6000) \div (50{,}000 + 6000)$ ohms or 5860 ohms. Now what resistance added to the series resistance of the tuned circuit would reduce its effective resistance to this low valne? Let us put down two equations, assuming the series resistance equal to 20 ohms

$$\frac{L^2\omega^2}{20} = 50{,}000 \quad \ldots\ldots (1)$$

$$\frac{L^2\omega^2}{20 + R} = 5860 \quad \ldots\ldots (2)$$

dividing (1) by (2) we get $\frac{20}{20 + R} = \frac{5860}{50{,}000}$

from which R (added resistance) = 150 ohms so the total series resistauce is now 170 ohms and the selectivity is $\frac{L\omega}{170}$ where it was equal to $\frac{L\omega}{20}$ for the coil-condenser alone. From this we learn that the selectivity has been reduced $170 \div 20$ or a factor of 8.5.

Many investigators have experimented with this problem and the solution is to use a two-winding transformer with a primary of such an inductance and so coupled to the secondary that the effective resistance of the tuned circuit is stepped down so that it "looks," to the tube, like a resistance eqnal to the plate resistance.

What is the result? We can aee that, if the tuned circuit is shunted, not by 6000 ohms but by its equivalent, 50,000 ohms, the selectivity has been decreased only hy a faetor of two, and we get some voltage step-up hecause of the transformer. Whereas it was possible to get an amplification of only 7.3 without the transformer, it is now possible to get more than the mu of the tube. Where the selectivity was cut down by n factor of 8.5 it is now reduced by a factor of only 2.

What should the turns ratio be? From transformer design theory the proper turns ratiu is $N = \sqrt{\frac{R_{eff}}{R_p}}$

$= \sqrt{\frac{50{,}000}{6000}} = 2.9$ for the given conditions. The voltage gain, so far as the tube is concerned is, as before, mu times the ratio between the load resistance (as stepped down by the transformer) and the aum of the load and plate resistances. This voltage gain is stepped up by the turns ratio of the transformer and becomes

$$G = \frac{\mu \times R_{eff}/N^2}{R_{eff}/N^2 + R_p} = \frac{8 \times 6000}{6000 + 6000} = 4 \times 2.9 = 11.6$$

$$= \frac{\mu L\omega}{2\sqrt{r} \times \sqrt{R_p}}$$

Prohlem 2. Consider a coil of 180 microhenries inductance and a high-frequency resistance of 15 ohms at 1500 kc., 10 ohms at 1000 kc., and 7 ohms at 505 kc., and a 112-type tube. Calculate the proper turns ratio for maximum voltage gain at 1500 kc., 1000 kc., and 550 kc. Assume that the proper ratio fur maximnm amplification at 550 kc. is employed. Calculate the voltage gain at this frequency, and using the same turns ratio, calculate the voltage gain at other frequencies in the broadcast band. Then, remcmberiug that the resistance across the secondary is the tube plate resistance times the turns ratio squared, calculate the increase in series resistance of the tuned circnit at this frequency aad the aelectivity factor, $L\omega/r$. Calculate the width of the frequency band at the 0.707 poiut at 550, 1000, and 1500 kc. Plot all nf this data against frequency in kc. Do you see why most tuned r.f. receivers do not have equal amplification at all frequencies? Why the selectivity ia poor at high frequencies, the gain low at low frequencies?

Problem 3. Repeat using at 201A tube, a 240 tube, and a 222 tube. The constants are for the 201A, $\mu = 8$, $R_p = 12000$ ohms; for the 240, $\mu = 30$, $R_p = 150{,}000$ ohms, and for the 222 screen-grid tube, $\mu = 200$, $R_p = 200000$ ohms.

Problem 4. A 600-turn honeycomb coil has an inductance of 20 millihenries. A variable condenser is placed across it, and the circuit is coupled to a 40 kc. circnit. The voltage across the coil is measured as the tuning condenser is varied. Then a pair of ateel wire cutters is placed near the coil and another resonance curve is plotted. The results are given below.

In such a circuit the high-frequency resistance can be obtained when the capacity is the variable factor, just as when the frequency is variable. It is only necessary to plot the resonance curve showing response against capacity and to ascertain the two values of capacity which make the response 0.707 of its value at resonance. Then, if C_r and C_2 are these two capacities and C_r is the capacity at resouance,

$$\frac{2\pi fL}{R} = \frac{2\ C_r}{C_2 - C_1} = \frac{L\omega}{r} = \frac{f_r}{f_2 - f_1}$$

Plot the results given in the table, and find out the resistance of the coil in the two cases; calculate the width of frequency band passed at the 0.707 response point; calculate the value of the circnit's effective resistance, $L^2\omega^2/r$; calculate the proper turns ratio if this coil is to be tapped and used between a 227-type tube and the grid-filament input of a following tube; calculate the voltago gain at 40 ke. Would such an amplifier be a high-quality unit?

	f=40 kc.	
C mmfd.	E	E when pliers are near coil
780	0.40	
760	0.68	0.45
750	1.43	0.82
740	2.30	1.26
735	1.53	1.22
720	0.60	0.60

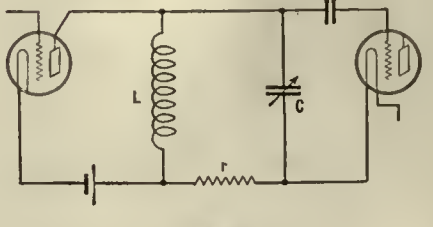


Fig. 3

THE EXPERIMENTER'S ARMCHAIR

By ROBERT S. KRUSE

LAST month we seemed to be giving the transmitter the most consideration. By way of evening up matters, we begin this time with a pure receiving story, having to do with the things that cause trouble in radio sets on airplanes and likewise in the ordinary home broadcast receiver.

Mr. H. A. Snow, of the Radio Frequency Laboratories, Inc., Boonton, New Jersey, now has the floor.

Vibration tests were made on several vacuum tubes to study microphonic noises produced in amplifiers when one or more of the tubes are jarred, or vibrated, by sound waves set up by loud speakers. These tests were made to determine at what frequencies in the audible range such microphonic noises occur and to determine the source of the noise. At that time (January, 1928) studies were made on only the 201A- and the 222-type tubes.

The method of study was as follows:

The tube was mounted on a specially constructed vibrator unit adapted from a Western Electric loud speaker unit. The mounting of the tube was such that it received vertical and horizontal components of vibratory force produced when the vibrator unit was energized from a variable audio-frequency beat-frequency oscillator and power amplifier. The tube was connected as a detector in a typical two-stage amplifier such as used in broadcast receivers so that sounds produced in the amplifier by mechanical vibrations of the tube could be observed aurally by means of phones in the amplifier output. The tube under test was also observed visually by means of a magnifying lens system to determine just what element was vibrating and causing the sound in the amplifier.

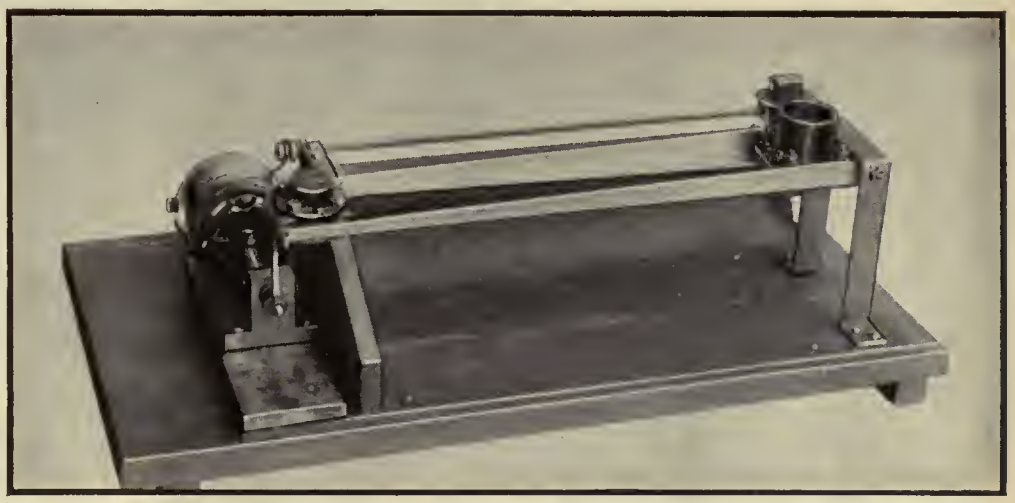
In examining a tube, the audio frequency supplied to the vibrator unit was slowly varied and the tube watched closely to observe element vibrations, and the sound produced by such vibrations observed by means of the head phones. Quantitative measurements of sound produced were not attempted, but the vibratory periods of various elements were measured accurately. It was found that elements of different tubes of the same type had different natural periods, as might be expected. However, the following series of natural periods of the 201A type tube was found to be representative:

TUBE ELEMENT	VIBRATING DIRECTION	FREQUENCY (cycles)
Plate and supports (as unit)	Lateral	150
Filament and supports (as unit)	"	280
One leg of filament	"	*360
Second leg of filament	"	*370
Plate	—	1700
Grid (*as unit*)	Lateral	330

*At normal filament voltage. These frequencies vary with filament temperature.



A vibrator unit employed in tests to determine the conditions under which vacuum tubes are microphonic.



A motor-driven tube shaker used to produce vibrations of low frequency in testing microphonic vacuum tubes.

At the frequencies shown above, each corresponding element would vibrate with considerable amplitude and produce a corresponding sound in the a.f. amplifier. The greatest amplitudes of vibration occurred laterally (considering tube held vertically).

In addition to the vibrations listed above the individual grid wires each had natural periods which were difficult to observe separately but resulted in a considerable series of resonance vibrations in the neighborhood of 1000-2000 cycles. Also, there were many smaller vibrations of the elements in different modes that could be heard in the amplifier output but could not be observed in the tube with the crude lens system used. It was interesting to note that the natural period of the filament legs varied over a considerable range as the temperature was varied, due, no doubt, to the changing elasticity of the filament.

TESTS WITH 222-TYPE TUBES

Type 222 tubes were also examined, but in this case it was more difficult to attach a resonance frequency to one particular element because the tube structure is such that several elements are attached together at the top more or less rigidly so that at the natural period of any one element the entire system vibrated. There were, as a result of this, a number of combination natural periods, due not only to one element, but to the combination of several.

The most pronounced amplitudes of vibration in the 222-type tube were at 130, 150, 220, and 500 cycles.

The greatest amplitudes in most of the tubes examined were in a lateral direction; that is, with the tube held vertically, vibration of the elements occurred laterally.

The conclusions reached from tests made are that the greater part of microphonic noises set up in tubes occurs from lateral vibrations of the various elements at their natural periods and that in the types of tubes studied, these vibration frequencies range from as low as 150 cycles to about 2000 cycles or higher, there being a large number of natural periods in each tube. Since so many natural periods exist in the audible range, it is a difficult matter when using a sensitive amplifier to prevent sound from a loud speaker being fed back into a tube and vibrate one or more of the elements at its natural period and so set up a howl, without radically changing the structure of a tube, or thoroughly shielding it from external vibrations by using some type of "shock-proof" mounting. The latter method is the only one available for sensitive amplifiers with the present tubes.

In some recent broadcast receivers the effects of microphonic noise have been reduced greatly by eliminating one audio stage and using a high-voltage detector, thus reducing the audio amplification in the set which reduces the sound produced by tube vibration.

It is interesting to hear the actual sounds produced when a tube is vibrated by means of the above unit over the audio range. The effect heard as the frequency is varied is as if the audio oscillator were producing its sound in a large hall made of sheet tin and half filled with tin cans, sheet metal, and other similar materials having a large number of resonant frequencies.

For low-frequency vibrations there was also made a motor-driven tube shaker, which is shown in one of the accompanying pictures. An adjustable eccentric on the motor shaft and moveable sockets permit changes of stroke and the motor speed-control rheostat provides frequency change. The speed could be determined by comparing the pitches of

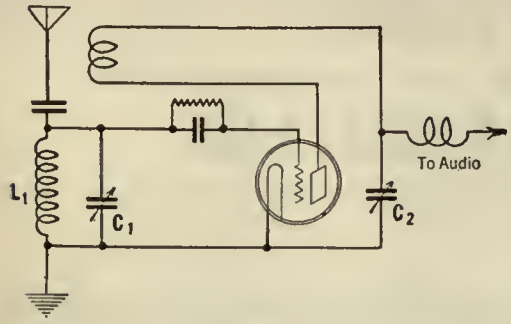


Fig. 1

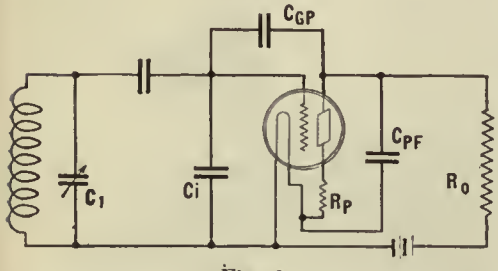


Fig. 2

tuning forks with the audio-frequency output of the tube.

THE USUAL COMMENT

Speaking as interlocutor permits me to say that immediately after seeing Mr. Snow's apparatus I went home and repeated his work in a slightly different manner. One thereby gains new understanding of R. A. Heising's remark that "A vacuum tube is something that hasn't anything in it and out of which you get a lot of things you don't expect."

One of these unexpected things is the tiresome tuning effect of everything about a short-wave receiver that is moveable or changeable. In most tuners, especially for code reception, this is deliberately made worse by using very small tuning capacity in an attempt to spread the scale. Intelligent use of lumped capacity accomplishes the same thing and in addition washes out some disagreeable effects. Concerning a method of doing this we will now hear from Mr. L. W. Hatry, of Hatry and Young, a radio service organization at Hartford, Connecticut.

A Stabilizing Device

SINCE the war the short-wave amateur has had trouble with the tuning effect of his regeneration control. The effect has received generous attention but to my knowledge no theory of its possible cause has been used as a weapon in overcoming it.

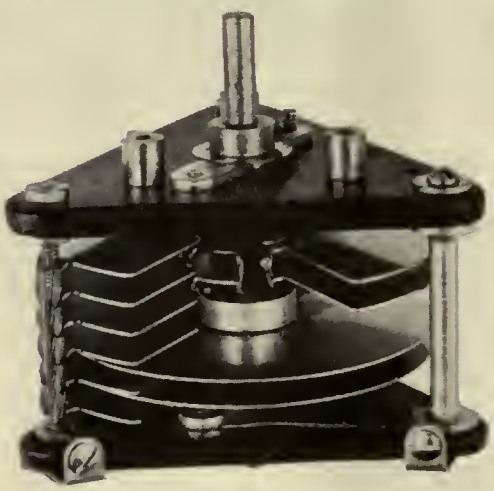
In speculating toward the cause amateurs have suggested inductive and capacitive changes due to moving parts. A marked improvement resulted from making the tickler small and putting it at the low-potential end of the tuned grid circuit. Likewise, improvement resulted from making the coil stationary and controlling regeneration by variation of a "throttle" in the shape of a variable bypass condenser. Thus, the speculations were to a degree confirmed and the effect of the regeneration control reduced until a c.w. beat note did not disappear (above audible pitch) with one degree of movement of the regeneration control but stayed in for ten or more.

The circuit for throttle regeneration control used in the majority of short-wave detectors to-day is shown in Fig. 1. Guesses as to the cause of the tuning effect of C_2 must have died nascent, for few reached print and the oral discussions seemed to equate to zero. One point seemed accepted, that L_1, C_1, being the frequency-determining circuit, must suffer a change in constants when C_2 is varied. But how? Since the tickler is fixed, coupling changes between the coils seem unlikely. With no change in L_1 we are left with the probability of such a change in C_1. Capacity effects between the rotor of C_2 and other parts of the set can be considered but a simple sheathing experiment eliminates that explanation. Thus we are referred back to the tube for the explanation.

The input capacity, C_i, of the tube is in shunt with C_1 and, therefore, is of importance. The simplest formula offering an explanation is:

$$C_1 = C_{gf} + C_{gp}\left(\frac{\mu R_o}{R_o + R_p} + 1\right)$$

This means that C_1 can be several times as large as C_{gp} if the load resistance, R_o, (See Fig. 2) is several times larger than R_p, the plate resistance of the tube. The simple formula applies only to a pure resistance load but illustrates the point. Usually R_o is replaced by a reactive load of which C_2 is a part, therefore, the load changes with changes in C_2 and we have at hand a plausible explanation of our effect.



The General Radio type 557 band-covering variable condenser.

The increased effect shown by a relatively small increase in C_{gp} lead to other attempts involving the use of a 199-type tube and eventually a 222-type tube as a detector because of low values of grid-plate capacity. The screen-grid tube when correctly wired gives less tuning effect of the regeneration control than any other equally well-designed set-up. However, the 222-type tube has disadvantages on short waves since the large plate-to-screen (and therefore to filament) capacity prevents oscillation, sometimes even at 20 meters. A special screen-grid tube might be devised as a short-wave detector and for the further confusion of the innocent.

A refinement of Fig. 1 outwits the tuning effect. Fig. 3 gives the diagrams. In (A) the minimum capacity of C_1 is made large so that the variations of C_i have little effect on the total capacity. The added capacity can be fixed and attached to the plug-in coil; an old trick that is too little used for band-covering tuners. Likewise it may be built into the tuning condenser as shown in one of the pictures. This condenser has a maximum of 70 mmfd. but the minimum is over one half as great—namely 43 mmfd. In Fig. 3 (B) the input capacitance of the tube is swamped by a condenser on the tube side of the grid condenser and the grid condenser is made as small as 0.000025 mfd. The only other detail to be observed is to keep the grid and plate leads apart.

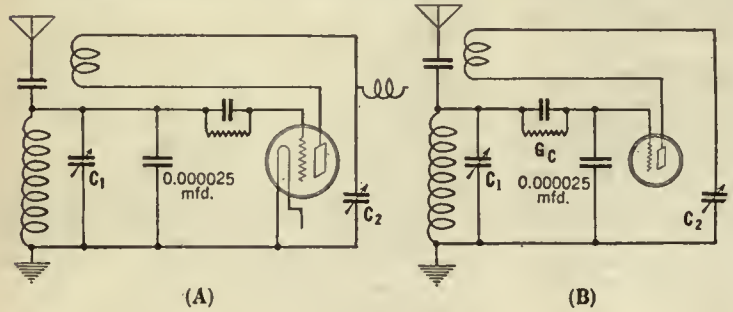


Fig. 3

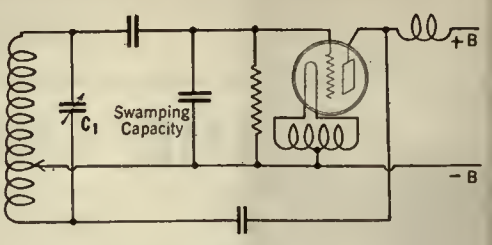


Fig. 4

As a test of this scheme such modifications were made in a commercial kit set with an especially bad tuning effect from the regeneration control. The 0.0002-mfd. grid condenser was replaced by the smallest available (0.00004 mfd.), which in itself made an improvement. The effect of a 0.000025-mfd. (25-mmfd.) swamping condenser was then tried on the tube side and condenser side of the grid condenser. As expected it had about 4 times as good an effect on the tube side and the tuner became a thoroughly workable one.

AS TO TRANSMITTERS

Just as the short-wave oscillating detector suffers from frequency changes not under control of the tuning circuit so does any other oscillator. In the transmitter no frequently varied oscillation control is used: the unit is required to generate a steady frequency and changes cannot be blamed on an altered condenser in the plate circuit. However, changes in frequency can be proved to occur with changes in plate voltage or tube temperature. Changes in plate voltage, E_p, result in changes of plate-to-filament resistance, R_p. In the formula, R_p is important when R_o is small and fixed, both of which are true in a transmitter or test oscillator. Accordingly, variations in E_p vary C_i. Thus, the high-capacity tuned circuits of the present vogue are seen to be good logic as well as good practice.

High-capacity tuned circuits have certain uncomfortable disadvantages, especially at high powers, and beside they should not be the only fruit of the seed of knowledge. Input capacity variations can be swamped out in a transmitter as has just been shown in receivers. For instance, in Fig. 4 we have a transmitting application of Fig. 3. This circuit has demonstrated its ability but neither it nor the so-called "H_i-C" arrangements are of much use if the builder permits parallel or lengthy plate or grid leads to augment the grid-plate capacitance.

I am not insisting that C_i is the entire theoretical flea in the ointment, but practice supports the theory's implications. We have here also an explanation of the popularity and success of the tuned-grid tuned-plate transmitter circuit. The TGTP circuit is different from the Hartley circuit in one large respect, the larger reactive plate load. By formula, if R_o is high enough, variations of R_p are swamped out and C_i variations cannot occur harmfully. Accordingly, the TGTP circuit should be stable without "H_i-C" complications. Don't try to reverse my earlier tricks and apply this to a tuned-plate receiver for there you *vary* your large R_o and acquire critical detuning like that which made the 1920 variometer tuner such quicksilver in the band.

TECHNICAL DATA

SOUND MOTION PICTURES

BY CARL DREHER

Magnitudes in Reproduction

THE principal job of the engineer in any field is to know quantitative relations. The purpose of this article is to discuss the usual light intensities, energy levels, and degree of amplification in sound motion picture reproducing systems. Some of this material has been presented from one viewpoint in the February issue of this department under the heading of "Further Data on Photo-Cell Characteristics." Much of the additional data given below is from the paper by Arthur C. Hardy, "The Optics of Sound Recording Systems," published in Vol. XII, Number 35, of the *Transactions of the Society of Motion Picture Engineers*.

Given a point source of light (one which is relatively small compared to other dimensions in the optical system) the intensity in a given direction depends on the amount of radiation from the source per unit of solid angle in that direction. If the source radiates L lumens in the solid angle w, the intensity, I, is given by

$$I = \frac{L}{w} \qquad (1)$$

When the light from a point source of intensity, I, falls on a surface placed at right angles at a distance d, the illumination is given by

$$E = \frac{I}{d^2} \qquad (2)$$

The above equations differ in some respects from their analogues in radio transmission, but only because of practical differences resulting from the order of dimensions in the two fields and the technique used in transmission, pick-up, and measurement. The lumen, the unit of light radiation or flux, is analogous to the watt, but it is a narrow unit, applicable only to radiation of a certain kind, i.e., visible radiation, while the watt is a general energy unit. In the region of maximum visibility a lumen corresponds to about 1.5 milliwatts. Light intensity as expressed by (1) above is expressed in terms of energy in a given solid angle, while radio field intensity is expressed as a potential (volts per meter) because of the method of pick-up used, involving an antenna.

The unit of light intensity is the candle, corresponding to one lumen per unit of solid angle. Illumination may then be expressed in foot-candles, meter-candles, or centimeter-candles. The last, as may be noted from a further inspection of (1) and (2), is the same as lumens per square centimeter. The latter is a good practical unit to keep in mind.

If the source of light is too large to be considered as a point, the concept of *brightness* must be introduced. Brightness may be defined as intensity over a given area. It is, therefore, measured in candles per square centimeter. Since one candle is, by definition,

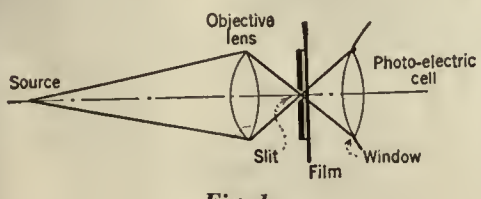
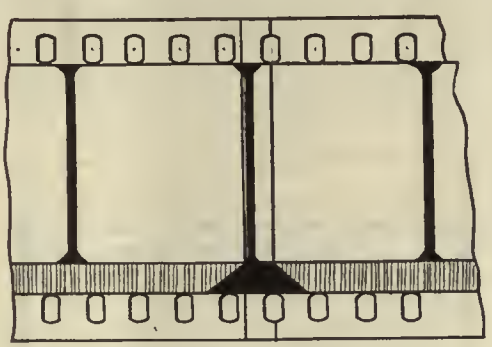


Fig. 1.



(A) Correct splice, quiet

Fig. 3.

a radiation of one lumen per unit solid angle, it follows that a surface of unit brightness, as an incandescent lamp filament, sends out in a given direction one lumen per unit solid angle for each square centimeter of its area.

Professor Hardy, in the paper cited, sums up the photometric units in the following table:

Table of Photometric Units

QUANTITY	UNIT	SYMBOL
Flux	Lumen	F
Intensity	Candle	I
Illumination	Lumen per square centimeter or centimeter candle	E
Brightness	Candle per square centimeter	B

In reproduction from film the track is run at a constant speed past a thin rectangle of light, which shines through the film onto the window of a photo-electric cell. In its simplest form the mechanism may consist of a slit about 0.001 inch in width close up against the film and brightly illuminated. Such a system is shown in Fig. 1. The light rectangle on the film must be narrow compared to the highest frequency it is proposed to reproduce, so that 6000 cycles, for example, with one cycle occupying 0.003 inch on the track, requires an 0.001-inch slit close up against the film (say the same distance) to prevent the light from spreading out between the slit and the film. The area of such a slit is roughly 0.0005 square centimeter (0.001 inch in the direction of travel of the film by 0.1 inch transversely, corresponding to 0.00254 cm. by 0.254 cm.)

A good commercially available photo-cell may have a sensitivity of 10 microamperes per lumen. (See "Sound Motion Pictures," February, 1929, RADIO BROADCAST, page 244). It is not desirable to operate with a photo-cell output of less than 1.0 microampere, because of noise interference considerations. It follows that we have to get at least 0.1 lumen of light into the cell. This necessitates illuminating a slit with the above dimensions with not less than 200 lumens per square centimeter, which, as the lumen per square centimeter corresponds to the centimeter candle, may be secured from a 200 candle-power lamp at a distance of one centimeter. Because the bulb of the lamp would be in the way if this were attempted, the lens system shown in Fig. 1 is employed. By this means the lamp may be moved away a convenient distance and the light focussed on the slit. It is found that the filament must be operated at a brightness of 1200 candles per square centimeter to meet these conditions. This is about the limit, in practice, at which a reasonable life may be expected.

The close-up slit shown in Fig. 1 is not practicable for actual use in theatres, since an opening 0.001 inch wide up against a rapidly moving film cannot be kept free from foreign matter for any length of time. The optical expedient shown in Fig. 2, which, like Fig. 1, is copied from Hardy's paper, is accordingly adopted. The slit is moved away from its exposed position near the film, sealed within a lens system, made considerably wider and longer (say 0.004 by 0.4 inches), and then optically reduced to a light rectangle 0.001 by 0.1 inches on the film. With proper design of the optical elements the results are equivalent to the close-up slit system.

With the light levels assumed above the photo-cell receives 0.1 lumen and, with the stipulated sensitivity of 10 microamperes per lumen, will yield an output of 1.0 microampere through the anode resistance of 2 megohms, corresponding to an output of 2.0 microwatts. If this is amplified by 70 DB, or 10,000,000 times in energy, the amplifier output in, let us hope, undistorted audio energy, will be 20 watts. This output is, in fact, required to fill the average theatre of about 2000 seats. Assuming that the loud speakers have an efficiency of 20 per cent., we get four watts of sound energy out into the house after all the transformations of the system.

Splicing Sound Films

A VALUABLE article of a practical nature appearing in the January 5 *Movietone Bulletin* concerns the method of making a splice in a sound-movie film. If the splice is not properly treated a lamentably loud thump startles the audience in the theatre, as a result of the electrical impulse sent into the amplifier by the discontinuity in the sound track. Fig. 3, reproduced here from the drawing in the *Movietone Bulletin*, shows how this is obviated. The light is gradually shut off by a triangle painted with black or red lacquer (India ink is sometimes used) onto the sound track. The base of the wedge should be about $\frac{3}{8}$ inch long along the line of sprocket holes, while the apex is at the splice on the inner edge of the sound track. If the splice is covered by too short a triangle the change in light intensity will remain abrupt and more or less noise in reproduction will result. If too long a triangle is painted, on the other hand, enough of the track may be obliterated to cause an interruption in the record. Some care is, therefore, necessary. The painting is done on the celluloid side of the film.

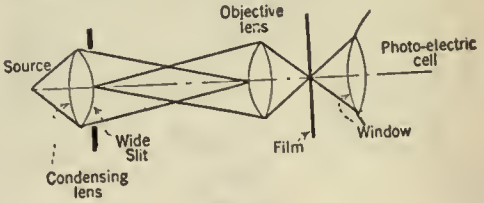


Fig. 2.

NOTES ON A. F. TRANSFORMER DESIGN

By J. KELLY JOHNSON

IT IS the purpose of this paper to present in a simple, practical form the general considerations involved in the design of audio-frequency transfer apparatus. The curves accompanying this article are first hand, except when specified otherwise, are solely for illustrative purposes, and are intended to show comparative rather than absolute values. They have been taken in the radio laboratory at Columbia University with the coöperation of the Engineering Department of the Pacent Electric Company.

Measurement of Output Voltages

THE measurement of output voltage of voltage transformers must be done without excessive loading. This eliminates ordinary a.c. instruments. The electrostatic voltmeter might be used but the voltages to be measured are normally too small and the internal capacity of the meter too large. The vacuum-tube voltmeter in some of its many circuit variations is very satisfactory.

Regardless of the accuracy of the measuring voltmeter or its sensitivity, true curves cannot be obtained unless actual operating conditions obtain, or are simulated.

With normal grid bias on an amplifier tube the loading of the transformer by grid conductance is far greater than it would be with a one-tube V.T. voltmeter load. The grid-conductance changes sufficiently with a.c. voltage applied to make it quite desirable to specify actual loading conditions, when making the test. The one-tube voltmeter circuit falls down from the very start.

The diagram in Fig. 1 shows a circuit which has been used with most satisfactory results by the writer. To avoid any error in calibration of the voltmeter, a comparison method is used. This permits of a very high degree of accuracy without extreme care in setting the input voltage. An accuracy of 1.0 per cent. is easily obtainable.

In the input circuit, the applied voltage, d.c., and equivalent tube resistance may be adjusted to simulate any type of tube. The current, I, through R_1 is set to give the desired voltage on the primary of the transformer. With the switch down the reading at I_p is noted. Then the switch is flipped up and R adjusted until the same reading is obtained. By rapid flipping of the switch and a low-inertia meter a very accurate setting may be made.

Figs. 3, 4, 6, and 8 show the effect of variation in applied a.c., d.c., load, both resistive and capacitive, and grid bias of the loading tube on the characteristic curve. They supply ample evidence to justify the specification of measurement under actual load conditions.

Fig. 8 was taken with a single-tube voltmeter using the method of comparisons which greatly increases the obtainable accuracy. The high bias used rendered the effect of grid conductance negligible. The improvement in the transformer characteristic with increase of applied voltage is quite pronounced. To make characteristic curves on transformers comparable, therefore, the same a.c. voltage must have been applied to their primaries.

In this article are presented considerable valuable data on audio transformers, showing how the conditions under which the transformer is measured affects its characteristics. The frequency characteristic, for example, is shown to vary widely with the load into which the device works, the value of the a.c. measuring voltage, and the d.c. current in the primary. The definite quantitative figures given by Mr. Johnson will be found very useful.

—THE EDITOR.

In Fig. 3 is shown the effect produced by d.c. passing through the primary coil. The dotted curves show that a transformer with a heavy silicon-steel core was not much affected, while the curve for the high-permeability alloy core transformer was badly damaged by the d.c. The value of current used was about normal for a d.c.-type tube and considerably less than those encountered with the new a.c. types. The transformers were recommended by their respective manufacturers for use in the same point in the circuit.

Fig. 4 shows the effect of a resistive load placed on the secondary of a transformer. The peak voltage at resonance is cut down appreciably by even a load of very low conductance. The next, Fig. 6, shows the effect of grid conductance in flattening out the transformer curve. Although the grid did not swing positive, the conductance caused sufficient regulation to flatten the curves as shown. It must be noted that the previously mentioned effect of increased voltage applied on the primary raised the low-frequency portions of the 0.5- and 1.0-volt curves and lowered their peaks.

Special Test Apparatus

MEASUREMENTS on power audio-frequency transformers may be made using the same apparatus as described above. Ordinarily, however, the actual loading conditions require the employment of higher voltages than are conveniently measured with this layout.

The fact that these are power-transfer instruments immediately suggests the use of standard alternating current voltmeters, ammeters, and wattmeters. But the power required to operate the average a.c. ammeter is often as high as 5.0 watts, and the voltmeters are but slightly more sensitive. Wattmeters, partaking of the characteristics of both voltmeters and ammeters, consume about twice this power. Thus, it is seen that ordinarily the total output of the transformer under normal loading is insufficient to operate the meter alone. In addition, the inductance of the iron vane, or dynamometer type of meter movement is quite appreciable, and would give very great variation in indicated voltage values with frequency. The ordinary meter is not accurate beyond one-hundred-twenty cycles.

The circuit used in Fig. 5 is probably the simplest and the first to suggest itself. It requires a thermocouple meter and resistor to fix the input voltage, and another to measure the output voltage. This makes necessary a "mark" reading or requires an oscillator of a high degree of stability and high power output.

The V. T. voltmeter comparison method can be used to advantage, a single-tube voltmeter with a direct indicator in the plate being sufficient, as the output voltage of the transformer is high, and the added loading of the measuring device low enough to be neglected. It is possible that an inverted V. T. voltmeter might be evolved which would simplify measurements.

As regards the simulation of loads for power transformers, the curves of Fig. 5 show how a characteristic is altered by the secondary load. At the low frequencies the load reflected from the loud speaker would give a very low-impedance load on the tube, while at high frequencies the opposite is true. A resistive load, on the other hand, will not have unpredictable resonance points as shown on the loud speaker

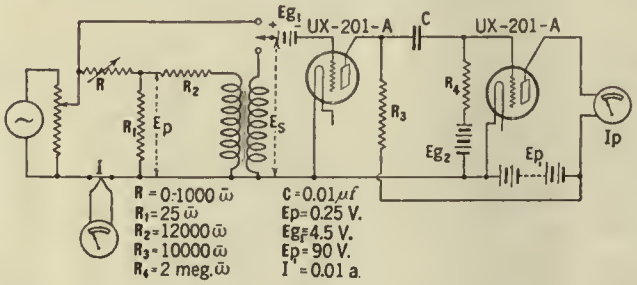


Fig. 1.

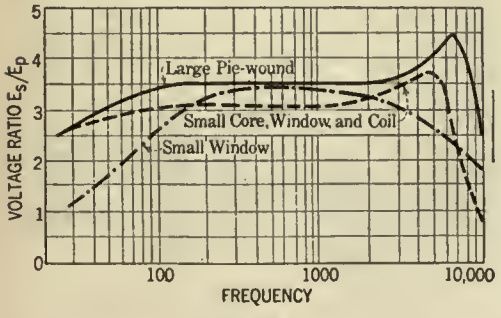


Fig. 2.

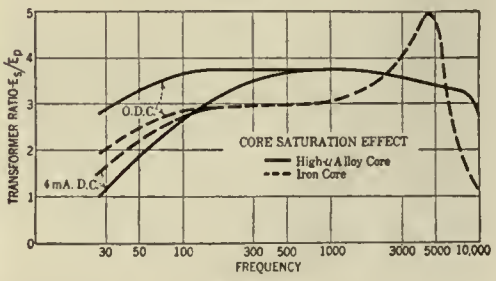


Fig. 3.

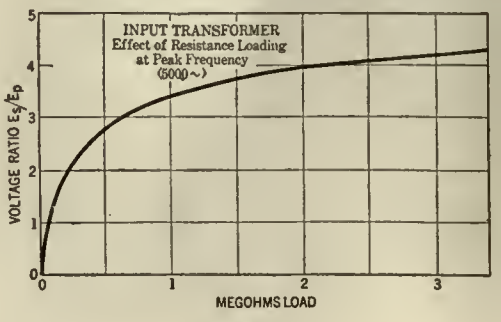


Fig. 4.

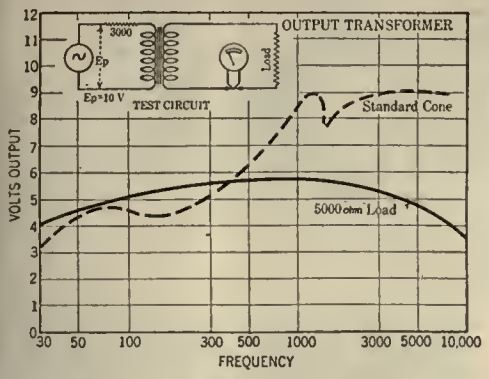


Fig. 5.

curve and will give a fairly constant reflected load. In view of the fact that many types of loud speakers might be used, any of which might well vary with time or change of manufacturing conditions, it is probably best to use a resistive loading, preferably one of twice the a.c. tube resistance, for a one to one transformer. This will facilitate the comparison of various transformers against a standard.

Two Kinds of Distortion

WAVE-SHAPE distortion may be caused either in the tube, or the transformer. A curved tube characteristic or d.c. saturation in the transformer will produce even harmonics of the initial wave, and a.c. saturation in the transformer core will produce odd harmonics. Tubes are usually worked on as straight a portion of their curve as possible, or are connected in push-pull so as to eliminate the effect of the even harmonics. The only remedy for distortion introduced by transformer saturation is to run the transformer core at low flux densities, i.e., at values of d.c. plate current and a.c. signal voltage which will not cause the core to become saturated.

Amplitude distortion may be divided into two classes. In the first, the output voltage of the amplifier is not directly proportional to the input voltage. At low frequencies low voltage inputs will not be amplified as much as higher ones due to the change of inductance of the transformer primary. The second class is that of frequency discrimination. Certain characteristics of the transformer and associated circuit cause it to pass some frequencies with less loss than others.

In Fig. 9 are shown the actual circuit diagram, the equivalent diagram, and the vector diagram of the loaded transformer. The effective alternating current plate impedance of the tube must be added to the effective primary resistance of the transformer. As shown in the vector diagram, the leakage reactance causes a voltage drop in quadrature with the effective resistance in both the primary and secondary which causes voltage regulation. The greater the load, the greater the regulation from these causes. It is therefore desirable to have the effective tube, primary, and secondary resistances as low as possible in order that the voltage output may be proportional to the voltage input.

Fig. 5 shows a curve of output voltage against frequency for a resistive load. With a constant voltage input the curve drops off at both ends. The drop at the high-frequency end is due to the leakage reactance whose effect increases with frequency. The drop at the low end is due to the increasing magnetizing current causing magnetic saturation of the core, and increased IR drop in the primary circuit. The leakage reactance can be neglected where this effect comes in.

The cone loud speaker load curve introduced on the same sheet shows the effect of an impedance load which is low at low frequencies and high at the high ones.

Apparent Losses

FIG. 7 illustrates the effect on the apparent resistance and inductance of the primary circuit of a voltage transformer, of the addition of a secondary circuit. The added losses are very noticeable, the added capacity lowers the resonant frequency, and the loading lowers the effective low-frequency inductance. A coupled circuit effect produces an added

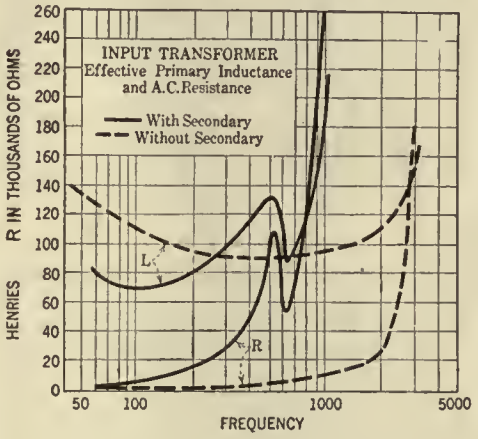


Fig. 7.

jag in the curve about midway, and there is some parallel resonance effect at low frequencies. This curve illustrates the way a voltage transformer load looks to the tube which is feeding it.

Therefore, the actual and equivalent circuits of the voltage transformer must include the distributed capacity of the secondary to enable a correct design to be worked out. In the equivalent circuit the leakage reactance is in series with the effective resistance and the distributed capacity of the secondary and the associated circuit. Of this associated capacity a large portion is formed by the effective tube capacity.

At some frequency the circuit will be in series resonance and will give a high voltage drop across the capacity due to the resonant current. This produces a peak on the characteristic curve of frequency vs. ratio, as was to be noted in several of the figures. If the effective reactance and capacity can be made small enough the peak may be moved out of the normal range of transmitted modulation frequency. If the effective resistance is increased sufficiently the resonant current can be reduced to a value which will not produce a prominent peak.

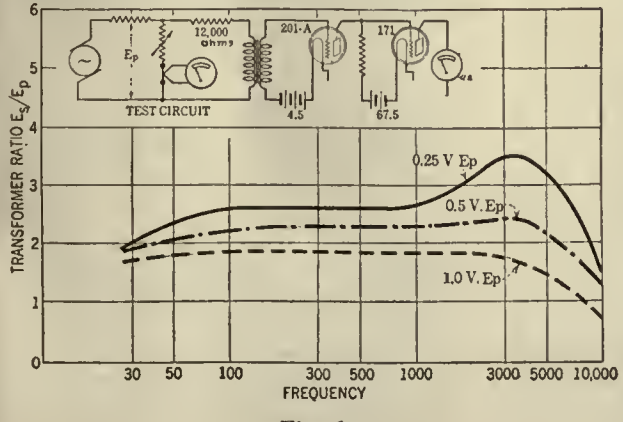


Fig. 6.

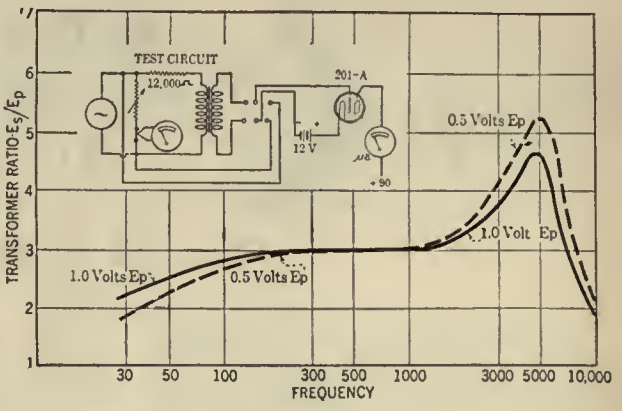


Fig. 8.

In Fig. 2 are shown curves for various improved designs of audio-frequency voltage step-up transformers. By pie winding, sufficiently low distributed capacity and leakage reactance are obtained to put the resonance frequency peak above the normal range of the radio-frequency band-pass of a receiving set.

The curve shown for the transformer with a small window is an example of the tendency toward improvement in transformer design. This had a comparatively small core weight and a high primary inductance, but showed practically no tendency to saturate with normal d. c. applied.

The small type transformer whose curve is shown, is interesting chiefly because of the method of manufacture. It is wound with a high space factor so that the turns in a layer bunch up during winding. This automatically short circuits enough turns to iron out the resonance peak. The cheapness of the core, winding and assembly enables this transformer to compete successfully with a much higher grade product.

A carefully designed voltage transformer with a value of primary inductance to give a 3.0 per cent. drop at 60 cycles with a 10,000-ohm tube, that is, 110 henries, can be made with such a low leakage reactance that it will peak at above 7000 cycles. If the core laminations are so made that the eddy currents are large, they will increase the effective resistance sufficiently to flatten the resonance peak completely. This will not affect the gain over the lower frequencies, however. Such a transformer is fully sufficient for covering the range of frequencies from 30 to 5000 cycles which is considered as perfectly satisfactory for the reproduction of voice or music.

In conclusion, the writer wishes to express his appreciation of the assistance in compiling this data rendered by the Engineering Department of the Pacent Electric Company.

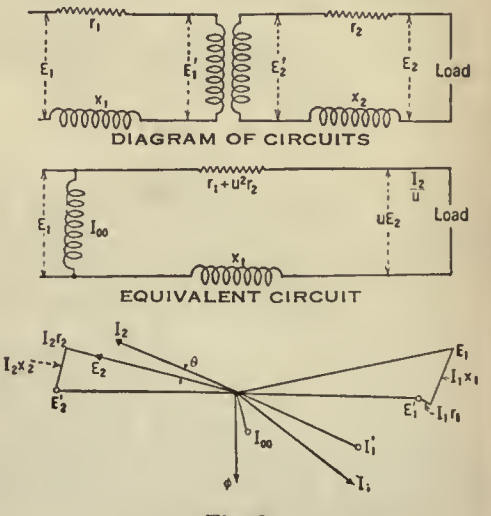


Fig. 9.

BROADCAST ENGINEERING

BY CARL DREHER

Power and Current in Modulation

ALTHOUGH the theory of modulation of a radio-frequency wave by a tone was quite completely worked out by R. A. Heising in 1920, it still remains obscure to many broadcast operating engineers. The references, for those who want to go into the problem thoroughly, are Heising, "Modulation in Radio Telephony," *Proc.* I. R. E., Vol. 9, No. 4, August, 1921; and Kellogg: "Design of Non-Distorting Power Amplifiers," *Journal*, A. I. E. E., May, 1925. Edward L. Nelson, has some less technical discussion on the subject in the December, 1928, I. R. E. *Proceedings* (Page 1776).

Modulation in radio telephony consists in varying the amplitude of a sustained radio-frequency current in accordance with the signal which it is desired to transmit. Mathematically the combination of radio- and audio-frequency currents is represented by the equation

$$i = A \sin \omega t \, (1 + K \sin \psi t) \qquad (1)$$

In this equation both waves vary according to a sine law, A is the average sustained amplitude when no signal is impressed on the carrier, ω and ψ are the angular velocities (2π times the frequency) of the carrier and the modulation tone, respectively. Since the expression shows the variation of current with time, t occurs twice. K is the modulation constant; it is a measure of the extent or "depth" of modulation. Its maximum value is unity, corresponding to complete modulation. When the carrier is unmodulated K equals zero, whereupon (1) becomes.

$$i = A \sin \omega t \qquad (2)$$

which is the usual expression for a sine wave alternating current.

The power corresponding to (1), in a circuit of resistance R, is

$$i^2R = RA^2 \sin^2 \omega t \, (1 + K \sin \psi t)^2 \qquad (3)$$

Integration gives a value for the power

$$p = \frac{RA^2}{2} (1 + 2K \sin \psi t)^2 \qquad (4)$$

$$= \frac{RA^2}{2} (1 + 2K \sin \psi t + \frac{K^2}{2} - \frac{K^2}{2} \operatorname{Cos} 2 \psi t)$$

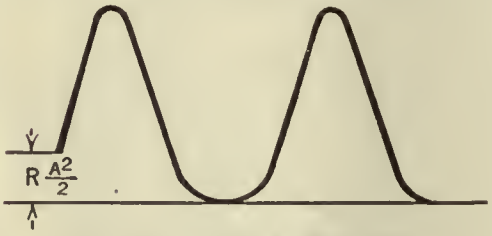
When the carrier is blank ($K = 0$) the power is seen to be $RA^2/2$. When modulation takes place single- and double-frequency audio components ($\sin\psi t$ and $\cos 2\psi t$) are present. If the carrier is completely modulated integration over an audio- or signal-frequency cycle gives

$$P = \frac{3}{2} \times \frac{RA^2}{2} \qquad (5)$$

Comparing this result with the power $RA^2/2$ for no modulation, we note that the power of a completely modulated wave is $\frac{3}{2}$ that of an unmodulated wave of the same average current. The effective radio-frequency power rises to a peak value 4 times the non-signalling power level, as shown in Fig. 1.

This mathematical description supplies an answer to the question frequently asked by broadcast operators—whether the antenna ammeter reading should change when the wave is modulated. The answer is that the reading will increase with modulation, since the power in the antenna is actually greater when modulation is in progress than when the carrier is blank. If the modulation is 100 per cent., the power increase is given by the factor 1.5, but as the antenna ammeter reads the effective value of the current, and not the power, the reading will increase by the multiplier $\sqrt{1.5}$, or 1.226. A radio-frequency ammeter in the antenna of a fully modulated radio-telephone transmitter will therefore swing at syllable frequency to a reading about 20 per cent. higher than the unmodulated reading.

The received signal depends, in general, on the variation in the amplitude of the transmitted wave. Under the two conditions of K = 1 and K = 0.5 the antenna ammeter reading will be the same when there is no modulation, and almost the same even when modulation is impressed at these two levels, there being a little more swing, merely, under the complete modulation condition. But, even though the transmitting antenna current readings are practically identical, the received signal energy corresponding to K = 1 will give four times the received signal energy of K = 0.5



EFFECTIVE POWER IN ANTENNA-
COMPLETE MODULATION

Fig. 1.

Or, putting it another way, doubling the percentage modulation of a transmitter is equivalent, in improving reception, to holding the modulation constant and multiplying the carrier power by four. These results follow from the fact that the received radio-frequency current is directly proportional to the transmitting current at each instant.

In modern broadcasting, however, this must be accomplished without distortion. The early broadcast transmitters were defective in this respect. A high-quality transmitter, by 1924 standards, rated at 500 watts output, usually consisted of two oscillators and two modulators, each rated at 250 watts—as an oscillator. That was the nigger in the wood-pile. The two oscillators drew about 400 milliamperes plate current at 2000 volts, or 800 watts, putting somewhat less than 500 watts into the antenna. The two modulators, running on the same plate source, drew something like 80 milliamperes when the microphone was inactive. Under this condition they were getting only 160 watts, or one-fifth as much plate power as the modulators.

The design engineers, and some of the operating engineers as well, became cognizant of the defect outlined above quite early in the game, and as soon as the transmitter investments could be amortized—and some of them were amortized with horrifying haste from the economic standpoint—they took a step in advance. This consisted of increasing the number of modulators, in proportion to the oscillators, and running the two banks so that equal plate power was fed to each set.

The ideal design would appear to be one in which modulation can be carried to 100 per cent. without distortion, the peaks being allowed to hit this level. Actually, high modulation runs into a quality defect of another sort in that a second harmonic becomes prominent after detection and may be annoying with a combination of a good receiver and a critical ear. Also, some margin must be kept in order to prevent over-modulation and kicking off of the transmitter. In practice, the broadcasters work up to the distortion point and drop back four or six DB for a peak operating level. This also provides protection against over-modulation. If, therefore, the transmitter does not distort until the full modulation stage is reached, it will be run at not over 80–85 per cent. peaks in any case, and this also limits second-harmonic distortion to a permissible level, in view of the evils of low modulation operation, such as low service area in proportion to heterodyning potentialities, noise amplification by the carrier, etc. Thus, the best solution appears to be a transmitter which retains quality up to full modulation, and is run with peaks 15 or 20 per cent. lower.

The difficulty in producing such a design economically lies in the low efficiency of "proper", non-distorting power amplifiers. The output stage of a high-quality audio amplifier chain used in public address or sound motion picture work may take about 50 watts plate power. In that case the undistorted audio power output is not likely to be over 10 watts—a practical efficiency of 20 per cent. In the usual Heising scheme of modulation, where both the audio- and radio-frequency plates are fed through a common choke and the plate voltage for both banks is the same, complete undistorted modulation is impossible, since the modulator would have to produce an undistorted alternating voltage equal to the direct voltage supplied to it. Complete modulation is secured when this a.c. peak, added to and subtracted from the direct voltage from the rectifier or generator, swings the r.f. plates from double the latter voltage to zero, at the signal frequency. The only way of getting such a swing without distortion is to run the modulator at a higher voltage than the r.f. tube which it controls. This method is used in modern practice as a more or less fundamental element in design. As the efficiency of the modulator, working as a distortionless audio amplifier, is likely to be only of the order of one-fourth that of a good oscillator, a formidable assemblage of tubes must be provided if modulation is to take place in the power stages, as in the output of the transmitter. This may be obviated by modulating at low power; for example, a 50-watt radio-frequency amplifier along the line may be modulated by a 250-watt (oscillator rating) modulator run at a higher plate voltage. The saving, however, is not all that appears at first glance. The modulated radio wave, it must be again recalled, contains additional power to the extent, for complete modulation, of peaks four times the non-signalling power, and an average value $\frac{3}{2}$ the non-signalling value. The modulated radio-frequency stages following the low or intermediate power modulation stage must be designed with sufficient power to handle these increments. The design problem reduces, in effect, to the question of whether it is best to build a large audio amplifier or a large radio amplifier.

Part III—Practical Aspects

GETTING THE MOST OUT OF A DETECTOR

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THIS article is devoted to a discussion of the practical aspects of detection which come up in connection with broadcast receivers, in contrast with the first two articles, which went into the theory of detection. Problems which the set designer must answer are: Should plate or grid detection be used? Is a power detector advisable? How should the detector be adjusted for best results? How much audio-frequency output will the detector give? It is to questions of this type that an answer will be attempted.

This final article in a series of three on detection summarizes the advantages of the grid leak-condenser type of power detector. Inasmuch as none of the receivers now using power detection employ this type of detector, the Editors hope that the proponents of C-bias detection will step forward and present their side of the discussion. The other articles in this series concerned themselves with weak-signal detection by the grid leak-condenser detector and power detection,

—THE EDITOR.

Detection and Rectification

IN STARTING off it will be well to devote a little time to considering what detection is, and why it is necessary. A typical radio-frequency signal is shown in Fig. 1A, in which the amplitude of the signal varies in accordance with the sound that is being transmitted. A radio-frequency wave of this character will not produce any effect on a telephone receiver because, in the first place, the receiver will not respond to such a high frequency, and second, even if the telephone receiver diaphragm could vibrate at the signal radio frequency, the vibrations would be too high pitched for the ear to hear.

Since the amplitude of the signal varies in accordance with the sound being transmitted, what is desired is a current through the telephone receiver that is proportional to the amplitude of the radio signal. Such a telephone current can be obtained by rectifying the radio frequency, as shown in Fig. 1B, in which the negative half cycles of the signal current have been suppressed. The rectified current of Fig. 1B has the average value indicated by the dotted line. This average current is seen to vary in proportion to the strength of the signal, so in passing through the phones or loud speaker it will produce a response that is the same as the original sound being transmitted. If the signal is not rectified, the average value is zero, and there is no response in the loud speaker. *Detection is the name that has been given to the process of rectifying radio-frequency signals in order that the received energy may be converted to a suitable form for operating audio-frequency reproducers.*

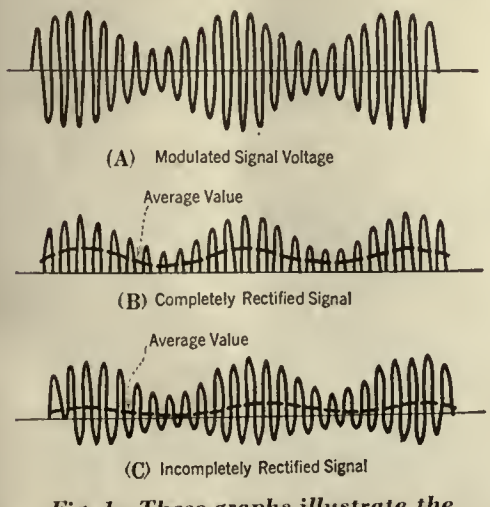


Fig. 1—These graphs illustrate the difference between completely and incompletely rectified signals.

The rectification (i.e., detection) shown in Fig. 1B is complete, which is to say that the negative half cycles are completely eliminated. It is possible for the rectification to be partial, as shown in Fig. 1C, in which the negative half cycles are present, but are smaller than the positive loops. The average value in Fig. 1C is indicated by the dotted lines, and is seen to be smaller because of incomplete rectification.

Grid Detection

IN GRID detection the radio-frequency signal is rectified in the grid circuit. The relation between the grid current and grid voltage of a typical vacuum tube is shown in Fig. 2. When adjusted to the point "O," the grid circuit will act as a very good rectifier, because when a radio-frequency signal is applied and the grid voltage alternately becomes more positive and more negative than "O," there will be considerable current flowing when the grid is on the positive half cycle, while on the negative half cycle there will be only a small grid current, or perhaps none at all. If the radio-frequency signal is a few volts in amplitude the grid current will be substantially as given in Fig. 1B, indicating complete rectification, while if the signal is less than a few tenths of a volt the grid current will be as shown in Fig. 1C, because the rectification is then incomplete.

The grid detector utilizes the rectified grid current to affect the plate current of the tube. Referring to Fig. 2, the rectified grid current must flow through the grid-leak grid-condenser combination. The rapid radio-frequency variations of this rectified grid current that are superimposed on the average get through the grid condenser very easily, but the average of the rectified grid current has great difficulty in getting through the leak-condenser combination, and accordingly produces an appreciable voltage drop across it. This voltage drop exists between the grid and filament; it is thus applied to the grid and is amplified in the plate circuit by the tube acting as an audio-frequency amplifier.

Plate Detection

IN PLATE, or C-battery, detectors the rectification takes place in the plate circuit of the vacuum tube. The relation that exists between grid voltage and plate current in a vacuum tube is given in Fig. 3. Rectification is possible if the grid and plate voltages are adjusted so as to put the operating point within the shaded region. Take the operating point "O," for example, and consider the result of applying a radio-frequency signal to the grid. On the positive half cycles the plate current will be considerable, while on negative half cycles the plate current stays zero most of the time. If the signal is large the rectification is substantially complete, while if the signal is only moderate in strength the rectification will be only partial. In either case, the rectified plate current that is produced flows through the phones, or whatever audio apparatus is present in the plate circuit of the detector, and the effect desired is produced by the average rectified plate current.

The important practical question is not how plate and grid detection take place, but which is best. In this regard grid rectification starts off with the initial advantage in that it rectifies the signal in the grid circuit but obtains the power output in the plate circuit. In this way the grid rectifier can be adjusted to give the most complete rectification possible in the grid circuit without regard to the amount of rectified grid power available, and can then obtain a large output power by suitably adjusting the plate circuit.

In the plate rectifier, on the other hand, the power output is obtained directly from the rectified plate current, and as a result it is not possible to obtain simultaneously complete rectification and high power output. The operating conditions giving most complete rectification are those in which the plate current is low, giving a plate resistance from five to twenty times the value under usual conditions.

The writer has made approximately 1000 measurements of grid detection constants and about 500 measurements of plate detection constants, and *not a single case was found where a tube properly adjusted for grid-leak detection would not put out at least four times as much audio-frequency voltage with weak signals than would the same tube operating under optimum conditions as a plate detector.* In most cases the grid detector will put out ten to twenty times as much audio-frequency voltage as the plate detector when both have the same signal voltage applied. From the point of view of sensitivity to weak signals it is obvious that plate detection has no justifica-

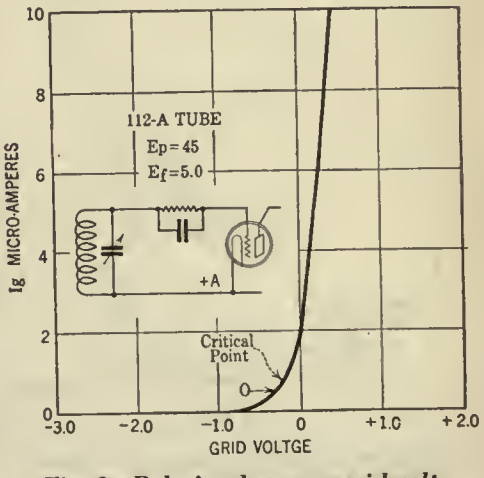


Fig. 2—Relation between grid voltage and grid current.

tion. From the point of view of quality there is no difference, as with small signals both types have a square-law characteristic (i.e. an audio-frequency output voltage proportional to the square of the signal voltage.)

The lack of ability to operate satisfactorily with large signal voltages usually attributed to the grid leak detector *is due to improper use of this method of detection, and not to any defect in the method itself.* In fact, in every case which the writer has examined, power grid-leak detection properly used was found to be from two to five times as sensitive as plate detection with the same tube. That is to say, the grid-leak power detector will give the same output voltage as the plate detector when the signal voltage is only 20 to 50 per cent. as great. Not only is the grid rectifier more sensitive, but it can also put out from two to four times as much undistorted audio-frequency power as the plate rectifier, when both are operating at the same plate voltage. In addition to this, the grid-leak power detector, *when properly adjusted,* will give *less distortion* than the plate power detector.

Fig. 4 gives the rectified plate current of a 210-type tube when operated as a power grid-leak detector and as a power plate detector with 247 volts on the plate in both cases. It is apparent that grid rectification is superior in sensitivity (because it gives more rectified current with the same signal), in power capacity (because it can give more rectified current), and in distortion (because its characteristic is closer to a straight line).

The answer to the question "Plate or grid detection?" is clear in the light of the points that have been considered. Grid-leak detection is superior to plate detection in respect to sensitivity, power capacity, and distortion, and should be used for both weak and strong signals. In view of its all-around inferiority, plate detection need not be given further consideration.

The usual receiver when not using power detection has one stage of audio-frequency amplification between detector and power tube. This stage generally gives a voltage amplification of about twenty-five times. If this tube is removed, and the detector made to supply directly the input to the power tube, an increase in the radio-frequency amplification of fifteen times will about make up for the loss in the audio end. Again, if the power tube is removed and the detector itself is made to supply the power, it will be necessary to increase the r.f. amplification an additional fifteen times, or to a total increment of 200–300 times, in order to keep the volume from the loud speaker the same.

The advantages in putting all possible amplification in the radio end are that the power detector has a straight-line characteristic, and that with each added radio stage one gains additional selectivity that in many cases is badly needed. On the other hand, audio-frequency amplification, while giving no selectivity, also requires no tuning adjustments, needs no shielding, and is relatively stable.

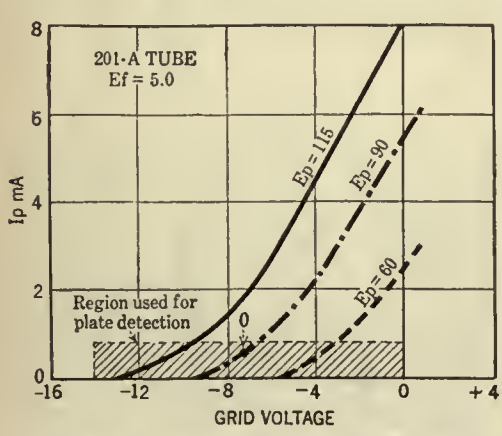


Fig. 3—Relation between grid voltage and plate current in a typical vacuum tube.

In the final analysis the decision as to whether or not to use power detection is determined by how easy it will be to get the extra radio-frequency amplification. If this can be obtained by making the tuning coils a little more efficient and using a little higher plate voltage, as will frequently be the case, then power detection should unquestionably be used. This is also the case when the r.f. amplifier is sufficiently stable to allow an added stage without introducing oscillation troubles, or when the amplifier already has more amplification than is necessary with the usual amount of audio-frequency amplification. A power detector is particularly desirable in the case of screen-grid tubes, where the stable amplification is so great that it is easy to get sufficient voltage to operate the power detector, and at the same time it is necessary to use at least three stages to obtain satisfactory selectivity, even though two stages often give all the amplification required for the weak-signal detector.

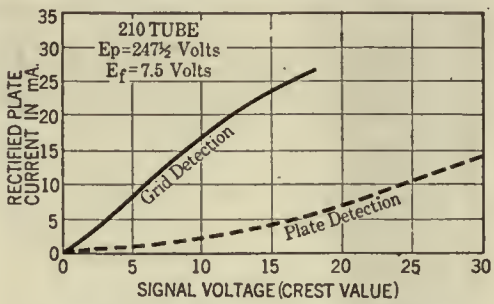


Fig. 4—Rectified d.c. plate current produced by an unmodulated signal applied to the grid of a 210-type tube acting as a plate and as a grid power detector.

Detection of Weak Signals

WHEN the signals to be rectified are weak, which means about 0.1 volt or less, the detector sensitivity and quality are the factors to be considered in adjusting the circuit. The things that have a bearing on these matters are type of tube, grid-leak resistance, grid-condenser size, and plate voltage.

With small signals the rectification will only be partially complete, and will depend upon the operating point on the grid-current curve.

With all types of tubes the rectification is best at small grid currents, but the completeness of rectification is the same for all grid currents below a certain critical value. Adjustment of the detector so as to operate at grid currents greater than this critical value results in loss of sensitiveness. The dividing point is indicated on Fig. 2.

The actual point on the grid-current characteristic used for detection is determined by the grid-leak resistance, as explained in an earlier article. The greater the leak resistance, the smaller will be the grid current at the operating point. Thus, a low-resistance leak causes operation with large currents, and results in poor rectification. On the other hand, all leaks having a resistance sufficient to place the operating point below the critical value of grid current will give the same completeness of rectification of the small signal no matter how small the current is and this degree of rectification will be the maximum obtainable with that particular tube.

Values of grid-leak resistance that will put the operating point at the critical grid current have been determined for various standard tube types, and are tabulated in the fourth column of Table I. Resistances lower than those tabulated give poor sensitivity (i.e., poor rectification), while values much higher than those indicated will tend to cause distortion.

The grid-leak type of detector will reproduce the low notes better than the high ones unless properly adjusted. The loss in sensitivity on the higher notes is due to the fact that when the average value of rectified grid current (see Fig. 1B) is varying at a high audio frequency, this average current will be more or less short-circuited by the grid condenser, and so will not produce much audio-frequency voltage across the leak-condenser combination. The reproduction of the higher notes is improved by using the smallest possible grid condenser, and by operating with the lowest possible grid-leak resistance (in order to put the operating point where the grid current is high and the grid resistance correspondingly low).

The best value of grid-leak resistance to use is approximately that tabulated in Table 1, which is correct to give maximum sensitivity and a minimum of distortion. If the leak resistance is as given in the table, and the grid condenser capacity is that in the last column of Table 1, then the detector will have the greatest sensitivity possible with that tube, and at the same time will reproduce 5000-cycle notes 70 per cent. as well as the lower pitches.

The detector characteristics with different leak and condenser sizes are shown in Fig. 6. The effect of using large grid condensers, or large grid leaks is shown and it is evident that such changes increase the distortion. It must be remembered that grid condensers much smaller than 0.0002 mfd. use up signal voltage and reduce sensitivity.

Slightly improved quality with lower leak resistance is gained at a very great loss in sensitivity, while the effect of too high a leak resistance is the same as a big grid condenser, namely, poor reproduction of the high notes.

In general, whenever the grid-leak resistance recommended in Table I is exceeded, the grid condenser capacity should be correspondingly less than the tabulated figure if the high notes are to be preserved. On the other hand, if the grid capacity used is smaller than that given in the table the grid-leak resistance can be proportionately higher without loss of quality or sensitivity.

The completeness of rectification obtainable with a grid-leak detector when small signals are applied is inversely proportional to a tube constant called the "grid-voltage constant," values of which are given in Table I. The audio frequency that is applied across the grid and filament of a grid detector by the rectification process is inversely proportional to the "grid-voltage constant." Thus, reference to Table I shows that a 227 heater-type tube will have 47/23 as much audio voltage on the grid as a 201A-type tube for the same signal. The best rectifiers are tubes with oxide-coated filaments having high electron emission. The 112A tube is about twice as good a rectifier as the 201A tube, and so is preferable for detector use in storage-battery sets.

The mu of the detector tube, and the plate voltage, determine the amount of amplification given the audio-frequency voltage produced on the grid, and have no effect on the rectification itself. With transformer coupling, a moderate-mu tube and a rather high plate potential (45 to 90 volts) are best, while with resistance coupling it is desirable to use a high-mu detector, and the highest possible plate voltage. With impedance coupling it is best to use a high-mu detector with a moderate plate voltage.

When the detector is adjusted according to the recommendations of Table I, it is a simple matter to compute the approximate detector performance. The effect of applying to the detector grid a radio signal having the carrier wave peak value of E_s and modulated to a degree m, is to produce

a modulation-frequency voltage between detector grid and filament very nearly equal to mE_s^2/V_g audio volts, where V_g is the detector grid-voltage constant, and is given in Table I. This rule holds almost exactly for the lower frequencies of modulation, while for the high notes the output will be a little less. This audio frequency applied to the detector grid by the grid rectification of the modulated signal is then amplified by the mu of the tube and impressed upon the a.f. amplifier in series with the plate resistance of the tube.

Power Detection

WHEN a radio-frequency signal of at least several volts amplitude is applied to a suitably adjusted grid-leak detector the action taking place in the grid circuit with the signal voltage of Fig. 1A is as shown in Fig. 5. The rectified grid current charges the grid condenser negatively and causes the average grid potential to have the value shown by the dotted line in Fig. 5. This average value is always such that the positive crests of the signal make the grid go positive a small amount. Each time the grid goes positive grid current flows, and makes up for the current that leaks off through the grid leak during each cycle.

At times when the signal amplitude is decreasing in size, it is necessary that the grid leak allow the grid condenser charge to leak off at a rate that will cause the average grid potential to reduce at least as fast as the signal amplitude is changing. This requirement calls for values of grid condenser capacity and leak resistance smaller than usually used.

The explanation of the action that takes place in the grid-leak power detector is exactly the explanation usually given of grid-leak detection, i.e., charging the grid condenser and letting the charge leak off through the grid leak. In the detection of weak signals, the situation is somewhat different, because with weak signals the grid condenser charge can leak off through the detector grid filament resistance, thus complicating and changing the action. With large signal voltages the average grid potential is so very negative that the grid current flows only at the positive crests of the radio frequency, and during the rest of the time no grid current can flow.

If high-quality output is to be obtained from the grid-leak power detector it is necessary to have the proper grid leak and condenser combination. Suitable values for any tube are a grid leak of about ¼ megohm and a 0.0001-mfd. grid condenser. With these proportions the average grid potential will be able to change as fast as the signal amplitude up to modulation frequencies of 5000 cycles.

The overloading point of the grid-leak power detector is reached when plate rectification starts to take place. This is because plate rectification causes increase of plate current while grid rectification causes decrease of plate current. Plate rectification thus neutralizes the grid action and causes distortion.

As the maximum amplitude of a fully modulated wave is twice the carrier amplitude, a particular tube will handle half as big a carrier wave acting as a power detector as it can amplify, using the same plate voltage in both cases. Thus, a 201A-type tube with 90 volts on the plate usually uses a 4½-volt C bias. The crest amplitude of carrier wave that can be handled at a plate voltage is one half of this, or about 2¼ crest volts. In the case of the 210 tube of Fig. 4, the normal amplifier C bias for 247½ plate voltage is 18 volts, so that the crest amplitude of carrier that can be handled is 9 volts. Fig. 4 shows distortion beginning at 18 volts, or approximately the maximum signal amplitude when the 9 volt carrier is modulated 100 per cent.

The maximum audio-frequency power output obtainable from the grid-leak power detector is slightly over one fourth of the undistorted power the tube can give as an amplifier at the same plate voltage and a suitable grid bias. Thus, the 210-type tube at 247½ plate volts will put out 340 undistorted milliwatts as an amplifier, and will put out about 100 undistorted audio milliwatts as a power detector.

The approximate audio-frequency output of a grid-leak power detector can be obtained by a simple computation. It is apparent from Fig. 5 that the average grid voltage of the power detector follows the modulation of the signal. This variation in average grid

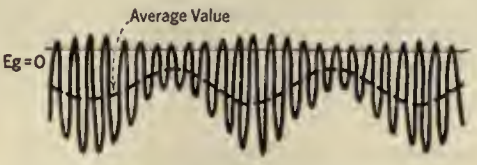


Fig. 5—Curve showing instantaneous and average grid voltages while a modulated signal voltage is applied to a grid-leak power detector.

potential applies an audio-frequency voltage to the grid of the detector tube, and it is this audio-frequency grid voltage when amplified by the tube acting as an amplifier that constitutes the audio-frequency output of the detector.

In the ideal detector the audio-frequency voltage applied to the grid would be equal to the modulation voltage in the signal. If the degree of modulation is m, and the carrier amplitude is E_s, the ideal amount of modulation voltage is mE_s. The actual power detector is only about 75 to 85 per cent. perfect, and will apply to the grid an audio-frequency voltage about 75 to 85 per cent. of mE_s. The percentage tends to rise slightly as the signal amplitude becomes large, but is surprisingly near constant at this approximate range for all tubes under ordinary conditions.

Tubes for Power Detection

IN ORDER to put out power the detector tube must operate with a high plate voltage. At the same time, the grid bias of the grid power detector is approximately zero except when the signal is coming in, and so the allowable plate current sets a limit to the plate potential. Tubes such as the 201A, 112A, 227, and 226 can operate as power detectors with 90 to 135 volts on the plate, and under such conditions will put an audio-frequency voltage of at least two volts on the detector grid without distortion. The 210-type tube can safely operate at zero grid with 250 to 300 plate volts, and will put out from 100 to 150 undistorted milliwatts in the plate circuit, enough to run an efficient loud speaker directly without an audio amplifier.

If the grid return lead of the power detector is brought back to the proper potential the same adjustment that is satisfactory for large signals will give from 50 to 75 per cent. as much output with weak signals as the best adjustment for small signals, and will give this result with excellent quality. The potential for the grid return lead to accomplish this is best determined by experiment. In some cases it will be the positive leg of the filament, in other cases the negative side, while more often it will be a potential intermediate between these. If the detector is to be used only for strong signals the return can be to either side of the filament, with the negative likely to be the best by a small margin.

When the signal voltage has a value between one quarter and one volt it can hardly be classed either as a strong or a weak signal. Such signals will be detected satisfactorily with either a weak-signal or power detector, the latter giving slightly better quality and slightly less sensitivity than the former. The amount of audio-frequency voltage obtainable on the grid with these moderate signal strengths is usually from 20 to 50 per cent. of the ideal value, that is, 20 to 50 per cent. of mE_s.

Receiver Design

IT IS possible, by computing detector performance, to determine just how much radio- and audio-frequency amplification is necessary in a radio receiver to give full output with a given field strength of signal. In order to show how this is done, and to make clear how detector computations are made and used, three typical examples have been worked out.

Case 1: It is planned to use one audio-frequency amplifier feeding a 171A-type power tube with a plate voltage of 135 and a grid bias of —27 volts. A 227-type tube is used as a detector, and it is assumed that the detector and the audio-frequency amplifier each give an amplification of 25 times. How much radio-frequency amplification is required to give full power output from a signal field strength of 1 microvolt per meter (which is about the minimum useful signal)?

The maximum audio-frequency voltage that can be applied to the power tube has a crest value of 27, and this is obtained when $27/(25 \times 25) = 0.043$ volts is applied to the detector grid by the detection process. The detector obviously must be a weak-signal detector, and this 0.043 audio volts is the output when the signal is fully modulated (m=1). Calling E_s the crest value of the radio signal that produces the required output of 0.043 volts, and noting that Table I shows $V_g = -0.23$, then when m=1, a formula already given shows that $\frac{1 \times E_s^2}{0.23} = 0.043$ and solving for E_s shows the required radio signal on the detector grid to be $E_s = 0.10$ crest volts, which, when fully modulated and applied to the detector grid, will put the maximum allowable audio input on the grid of the 171A-type power tube.

If the receiving antenna is 10 meters (about 33 feet) high, a signal field strength of 1 microvolt per meter (crest value) will induce 10 microvolts in the antenna. If a tuned input to the grid of the first r.f. amplifier is used this will be stepped up perhaps 15 times, applying a voltage of 150 microvolts to the first r.f. grid. To bring this up to the 0.1 volts (or 100,000 microvolts) required

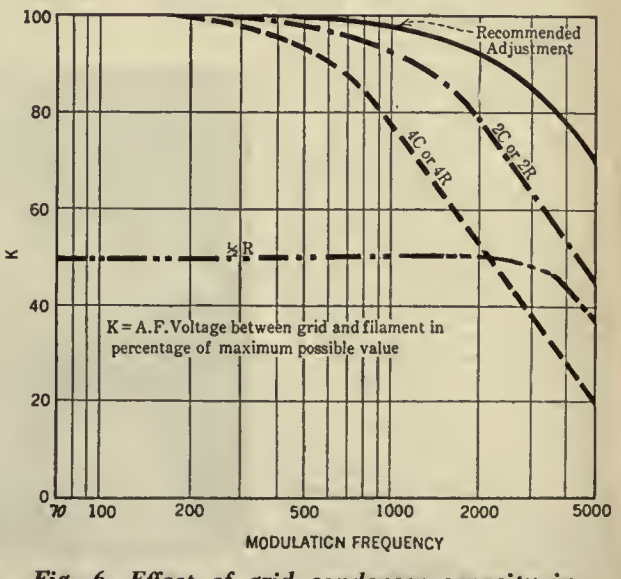


Fig. 6—Effect of grid condenser capacity in grid-leak detector operating with small signals.

by the detector grid requires an amplification of 100,000/150 = 667 times. If the induced antenna voltage had been applied directly to the first r.f. grid through a resistance to ground, the required r.f. amplification would be 100,000/10 = 10,000 times.

Case 2: A 227-type tube power detector with 90 volts on the plate is used to feed a 250-type tube which has a plate voltage of 300 and a grid bias of —54 volts. How much radio-frequency amplification is required to give full output when the signal field strength is 1 microvolt per meter?

The maximum audio voltage that can be applied to the grid of the 250-type tube is 54 volts, and assuming the 227 tube amplifies its audio grid voltage 25 times, the power detector must have 54/25 = 2.16 audio volts produced on its grid by the detection process. With complete modulation (m = 1) and assuming 80 per cent. of ideal detection, then according to the formula already given $0.80 \times 1 \times E_s = 2.16$ and the required radio signal is $E_s = 2.7$ volts, which is a value that can just be handled at 90 plate volts without undue distortion. If the antenna is 10 meters and a tuned antenna circuit with a step-up of 15 is used, the radio-frequency amplification required to put 2.7 volts on the detector grid is 2,700,000/(10 × 15) = 18,000 times. This could be obtained easily with three screen-grid stages. Without a tuned antenna the amplification needed is 15 times as much, or 270,000 times.

Table I

DETECTION CHARACTERISTICS OF THREE-ELEMENT TUBES

Type	Mu	Detector Voltage Constant Vg	Leak Resistance Recommended	Ceff for 70% reproduction of 5000 cycles
201A	9	—0.47	3.20 megohms	0.000212 mfds.
240	30	—0.47	3.20	0.000212
199	6	—0.50	1.50	0.000255
120	3	—0.45	1.67	0.000255
171A	3	—0.28	7.20	0.000160
112A	8	—0.26	5.8	0.000212
226	8	—0.29	1.6	0.000212
227	8	—0.23	7.8	0.000318
12	6	—0.27	8.0	0.000318

Note: Values of Vg are averages for a number of tubes.
Values of effective grid condenser capacity, Ceff, are values of grid condenser capacity plus tube input capacity to audio frequencies, which is usually about 0.00007 mfds. for tubes with a mu of about 8.
The recommended values of grid leak are such as to make the detector input grid-filament resistance at least 100,000 ohms.
All tubes are R.C.A. or Cunningham.

Case 3. A 210-type tube with 300 volts on the plate is used as a power detector and operates the loud speaker directly from its own power output. How much undistorted power is obtainable, and how much radio-frequency amplification with a 1 microvolt per meter field is needed to give this power?

A 210-type tube used as an a.f. amplifier at 300 volts would require a grid bias of —22½ and would put out 600 undistorted watts. As a power detector the tube will handle a fully modulated carrier wave of about 12 radio-frequency volts (which is just more than half of 22½) and will then put out about 600/4 = 150 undistorted audio-frequency milliwatts. This 12 volts of radio frequency will put about 0.85 × 12 = 10.2 audio volts on the grid of the detector to produce the 150 milliwatts output, and, with the 10-meter tuned antenna with a step-up of 15, will require a radio-frequency amplification of 12,000,000/(15 x 10) = 80,000 times. This could be supplied readily by three good stages of screen-grid radio-frequency amplification.

N. E. M. A. ATTACKS SERVICE EDUCATION PROBLEM

THERE has been a general recognition on the part of the radio industry that satisfactory radio reception requires more than the making of good radio receivers. If it is to give the consumer the utmost satisfaction the receiver must be installed in a manner which assures the maximum performance in its particular location with respect to selectivity, sensitivity, and tone quality. While the potentiality of maximum performance in these respects may be built into the receiver by proper design and construction, only when the installation is intelligently and scientifically made is there assurance that the customer will enjoy the highest standards of reception.

The mere realization that the dealer must learn the practical aspects of installation and maintenance is no solution of the complex problem of raising the standards of service rendered the consumer both with the initial purchase and the subsequent maintenance and attention required. The difficulties of dealer education by the manufacturer are increased greatly by the fact that he often has thousands of outlets distributing his product, so that there is no practical way of establishing contact with all of those having a hand in making the radio receiver perform in the ultimate purchaser's home. Many manufacturers issue service bulletins of great value to trained men but they do not fulfil the broad function of teaching servicing.

With a view to meeting the problem of service education the Radio Division of the National Electrical Manufacturers Association has issued a course especially for servicemen and dealers responsible for installations. This course was prepared in collaboration with the Radio Institute of America, a pioneer organization in training men for the various branches of the radio field. Four booklets giving the sort of practical information required in servicing, periodic examinations which are marked and rated, and direct correspondence help are included as a part of the course. The text covers not only installation but all the details of repair and maintenance of radio receivers. It discusses how to hunt for trouble with a view to conserving the time required with each service call. Scores of diagrams of commercial receivers are included in the text so that repairs can be made in the minimum of time by a study of the circuits of all popular models of radio receivers. While the subject of installation is treated in a very thorough fashion, the course does not place undue emphasis on that phase of the radio serviceman's work. Repair problems, trouble hunting and similar questions are presented in a comprehensive manner.

The first of the four textbooks discusses the fundamental principles of electricity involved in broadcasting and explains the magnetic field, electromagnetic induction, transformers, condensers, oscillatory circuits, audio-frequency amplification, and reproduction by the loud speaker. This volume also gives definitions and standard radio symbols for all parts used in radio reception and required of servicing, as well as an outline of the general types of radio receiver including tuned and untuned radio-frequency sets, regenerative detector circuits, super-heterodyne systems, and all types of audio amplifiers.

The second volume contains a discussion of direct-current receivers and the associated battery supply, and it goes into the subject of a.c. receivers exhaustively; also repairing magnetic and dynamic loud speakers. Among many other subjects is that of the installation of a broadcast receiver. This text also includes the construction of a testing set for general repair and test purposes and a modulated oscillator for shop tests.

Servicing, trouble shooting, vacuum tubes, and the elimination of electrical interference are some of the important questions taken up in the third text.

Book four is unique in that it contains complete circuit diagrams of all the leading models and makes of radio receivers on the market. This is the first encyclopedia of radio circuit diagrams which has been prepared to aid the serviceman in the application of the practical service methods explained in the first three text books.

In preparing this service course for the radio industry, the National Electrical Manufacturers Association has endeavored to achieve a high degree of practicability and the widest possible distribution by enlisting the coöperation of the Radio Institute of America which has devoted itself since 1909 to training men for work in all branches of the radio field.

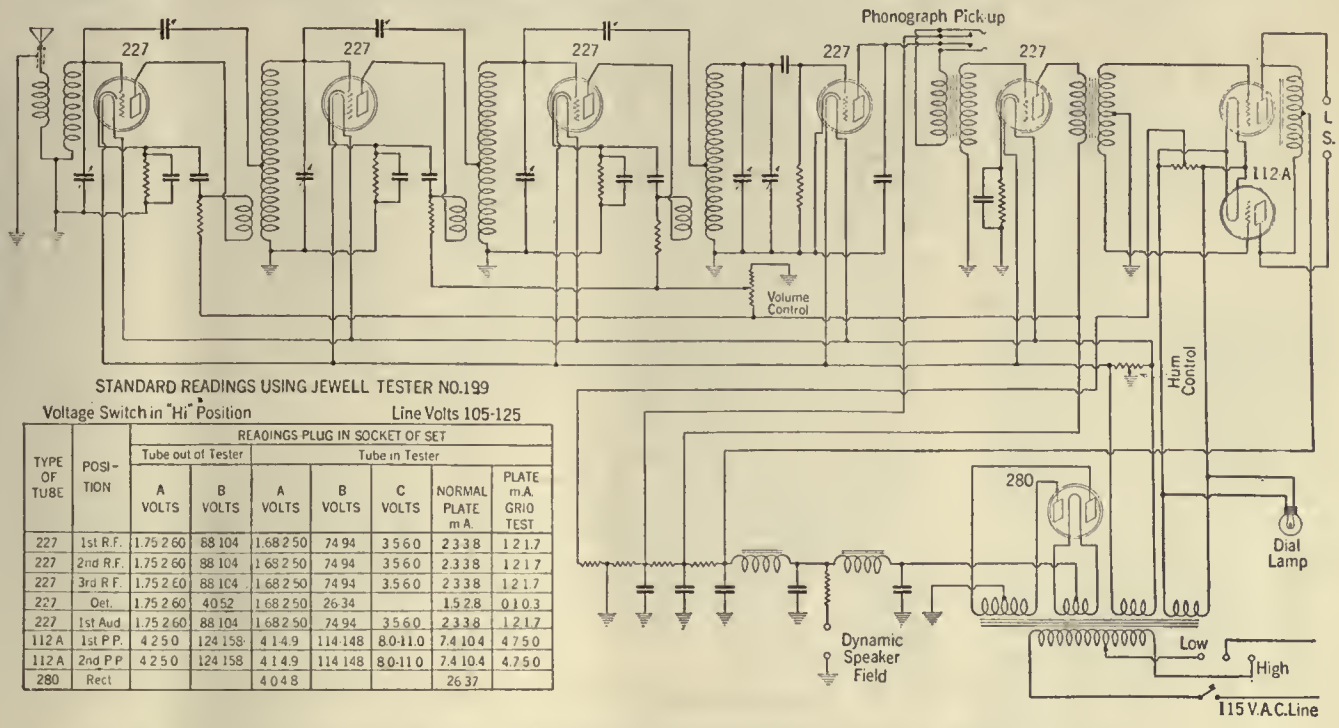


Students receiving instruction in servicing at the Radio Institute of America

No. 23 *Radio Broadcast's Set Data Sheets* May, 1929

THE BALKITE RADIO RECEIVERS, MODELS A-3, A-5, AND A-7

This completely light-socket-operated receiver uses five 227-type tubes and two 112A-type tubes in push-pull in the output. The use of 227-type tubes in all the sockets preceding the power stage somewhat simplifies the wiring since only one filament winding is required to supply all of them. Also the use of 227-type tubes results in less hum output. The volume control varies the plate voltage applied to the r.f. tubes.



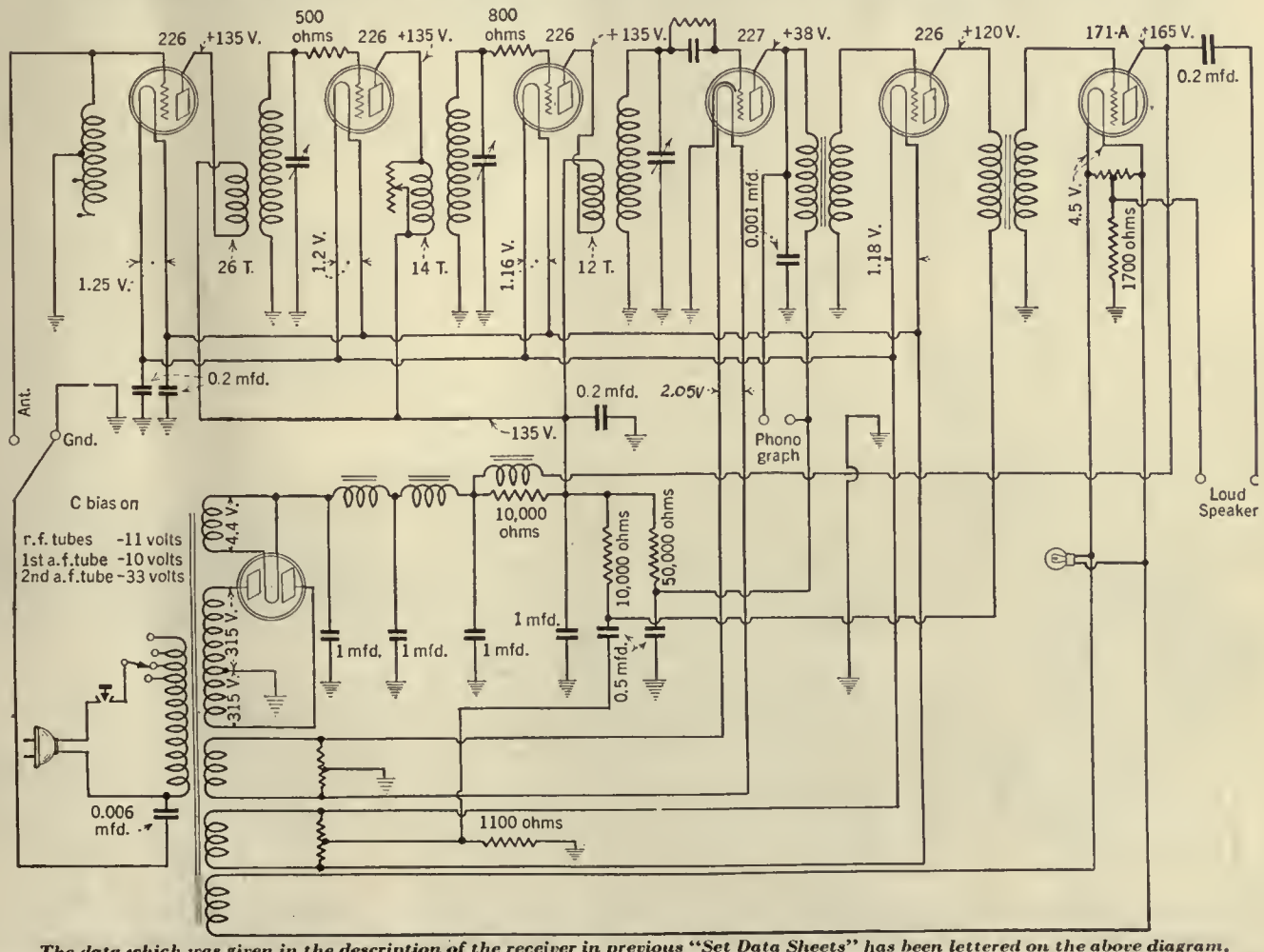
STANDARD READINGS USING JEWELL TESTER NO. 199

Voltage Switch in "Hi" Position — Line Volts 105-125

TYPE OF TUBE	POSITION	READINGS PLUG IN SOCKET OF SET						
		Tube out of Tester		Tube in Tester				
		A VOLTS	B VOLTS	A VOLTS	B VOLTS	C VOLTS	NORMAL PLATE m.A.	PLATE m.A. GRID TEST
227	1st R.F.	1.75 2 60	88 104	1.68 2 50	74 94	3 5 6 0	2 3 3 8	1 2 1.7
227	2nd R.F.	1.75 2 60	88 104	1.68 2 50	74 94	3 5 6 0	2 3 3 8	1 2 1.7
227	3rd R.F.	1.75 2 60	88 104	1.68 2 50	74 94	3 5 6 0	2 3 3 8	1 2 1.7
227	Det.	1.75 2 60	40 52	1.68 2 50	26 34		1 5 2 8	0 1 0 3
227	1st Aud.	1.75 2 60	88 104	1.68 2 50	74 94	3 5 6 0	2 3 3 8	1 2 1.7
112 A	1st P.P.	4 2 5 0	124 158	4 1 4 9	114 148	80 110	7 4 10 4	4 7 5 0
112 A	2nd P.P.	4 2 5 0	124 158	4 1 4 9	114 148	80 110	7 4 10 4	4 7 5 0
280	Rect.			4 0 4 8			26 37	

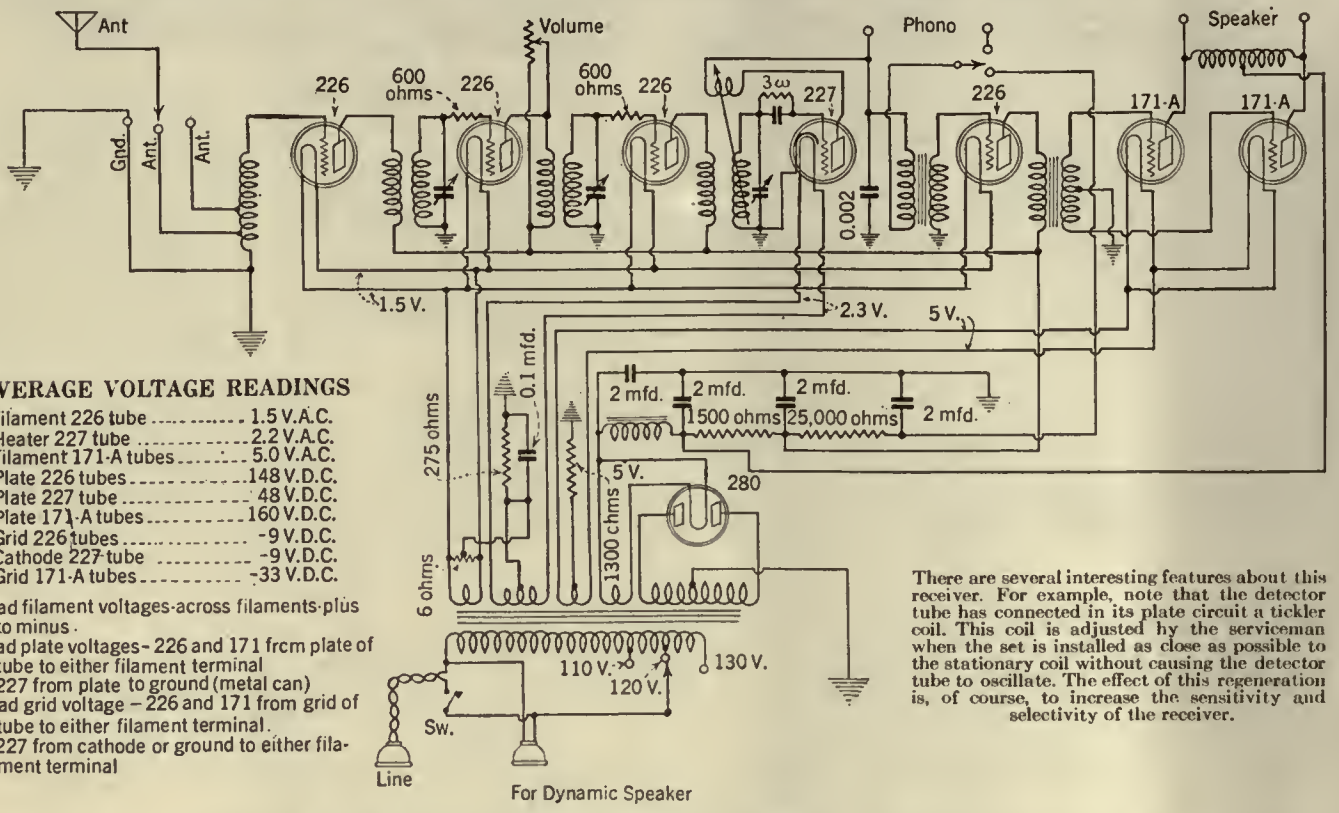
THE STEINITE MODEL 261 ELECTRIC RECEIVER

The circuit diagram published here indicates three taps on the antenna coil. This is correct for all receivers distributed previously to September 20th, 1928. Since that date the number of taps has been increased to seven, controlled by a seven-point switch located near the volume control. This circuit is incorporated in all Steinite receivers, models 261 to 266 inclusive.



The data which was given in the description of the receiver in previous "Set Data Sheets" has been lettered on the above diagram.

THE ARBORPHONE MODEL 45 RECEIVER



AVERAGE VOLTAGE READINGS

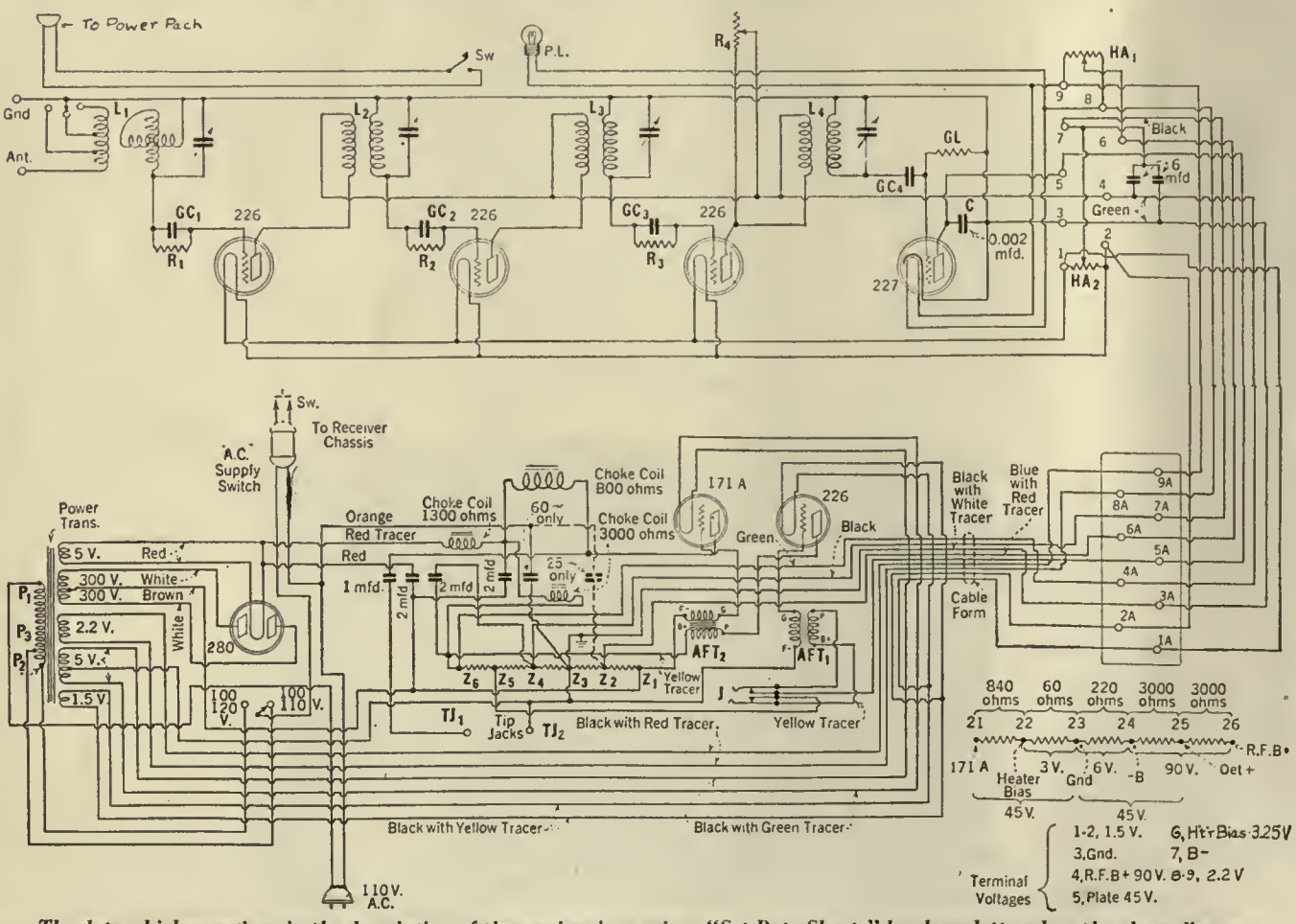
Filament 226 tube	1.5 V.A.C.
Heater 227 tube	2.2 V.A.C.
Filament 171-A tubes	5.0 V.A.C.
Plate 226 tubes	148 V.D.C.
Plate 227 tube	48 V.D.C.
Plate 171-A tubes	160 V.D.C.
Grid 226 tubes	-9 V.D.C.
Cathode 227 tube	-9 V.D.C.
Grid 171-A tubes	-33 V.D.C.

Read filament voltages across filaments plus to minus.
Read plate voltages – 226 and 171 from plate of tube to either filament terminal
227 from plate to ground (metal can)
Read grid voltage – 226 and 171 from grid of tube to either filament terminal.
227 from cathode or ground to either filament terminal

There are several interesting features about this receiver. For example, note that the detector tube has connected in its plate circuit a tickler coil. This coil is adjusted by the serviceman when the set is installed as close as possible to the stationary coil without causing the detector tube to oscillate. The effect of this regeneration is, of course, to increase the sensitivity and selectivity of the receiver.

THE KOLSTER RECEIVERS, MODELS K-20, K-22, K-25, AND K-27

These models consist of a three-stage tuned radio-frequency amplifier, a detector, and a two-stage transformer-coupled audio amplifier. Type 226 tubes are used in the r.f. and first a.f. stages and a 171A-type tube is used in the output stage. When a phonograph pick-up unit is used it should be plugged into jack, J. Note that a variometer is used in the first tuned circuit and also the taps are provided on the antenna coil.



The data which was given in the description of the receiver in previous "Set Data Sheets" has been lettered on the above diagram.

A SUPER-SENSITIVE SHORT-WAVE CIRCUIT

By THOMAS A. MARSHALL

Office of Fleet Radio Officer, Pacific Fleet, U. S. N.

THE short-wave receiver described in this article has several unique points of interest and advantages which clearly distinguish it from the commonplace. The circuit, in its most sensitive form, consists of a single-stage tuned radio-frequency amplifier followed by an autodyne detector and a two-stage transformer-coupled audio-frequency amplifier. In the radio-frequency amplifier and detector modified push-pull circuits are used because of the ease in generating oscillations and because of the low circuit losses on frequencies up to as high as 80,000 kilocycles (3.75 meters).

The conventional types of receiver circuits as developed in the past have been incapable of giving amplification in the upper frequency bands due to the relatively low input impedance of the tubes and the relatively low L/C ratio. The low input impedance is due to the relatively high grid-to-filament capacity which, under actual operating conditions, may be several times the geometrical capacity.

The capacity between the grid and filament markedly affects the input impedance which fact is of importance in determining the input power and the signal voltage impressed on the tube elements. The input impedance of the tube may be represented by a capacity with a high resistance in series. This resistance causes the absorption of power in the input of the tubes to become very high.

In Fig. 1 the value of R_g in ohms is very small compared with the reactance of C_g in ohms. Neglecting the slight effect of R_g we can say that the current will divide between the tuning condenser, C, and the parallel circuit, C_g, in direct proportion to the capacities of C and C_g. The current, I_g, flowing to the grid is obtained by the formula:

$$I_g = \frac{C_g}{C + C_g} \times I$$

The power, P_g, dissipated in R_g may be calculated by the formula:

$$P_g = I_g^2 R_g$$

The power dissipated in the push-pull circuit, as shown in Fig. 5, is approximately one half the value calculated for the circuit shown in Fig. 2.

Features of Push-Pull

FIG. 2 shows a three-electrode tube and its associated circuits as used in single-tube circuits. The points G, F, and P represent the three electrodes, the grid, filament, and plate. The capacities between them are represented by C_1, C_2, and C_3. Fig. 3 shows a similar tube and associated circuits as used in a push-pull receiver, Fig. 5. The inter-electrode capacity, C_1, and the grid resistance, R_g, are in series across the input circuit. Thus, the capacity is halved while the resistance across the input circuit is doubled, giving a much lower conductance for the input grid circuit. The same arrangement of capacities and resistances applies to the output or plate circuit.

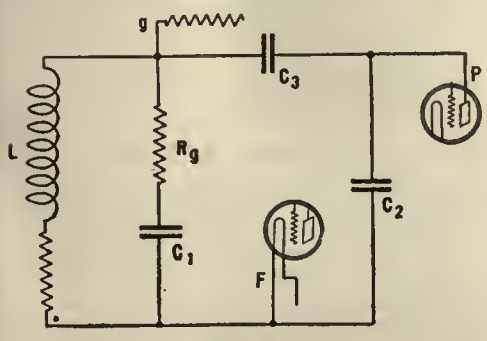


Fig. 2

This article describes a receiver that is more sensitive than the average short-wave set. The author has built a number of such receivers for the Navy where they enable the operators to get down to much weaker signals than with conventional receivers. The model of the set illustrated schematically on these pages was built by Herbert M. Isaacson of the QRV Radio Service. His conclusions, after constructing and operating the receiver, are that it is more sensitive than usual receivers for the high frequencies, and, although not adapted for the usual amateur traffic, it would "prove in" where an operator desired to communicate with a few transmitters whose positions have been located on the tuning dials, and then charted.

—THE EDITOR

In ordinary circuits, as shown in Fig. 2, the fixed capacity, C_1, across the coil system

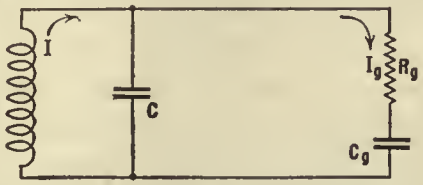


Fig. 1

restricts the tuning range. The circuit as shown in Fig. 5, due to reduced inter-electrode capacity, permits a relatively large L/C ratio, thus giving considerably more inductance than the single-tube circuit. The increased value of inductance with which to couple the tickler feed-back gives stable oscillations over the entire range of frequencies.

By the arrangement as shown in Fig. 5, the intra-electrode tube capacities are reduced by using the two split condensers, C_1, which are in series and by connecting the two tubes so that each grid-to-filament capacity is across one of the series sections. The total effective tube capacity upon the tuned circuit is halved. The two tube grid-to-filament circuits are across each half of the tuned circuit input voltages which decreases the grid-to-filament conductance to half value for each tube. Since the two reactances are in series the total conductance across the tuned circuit is one quarter the value of that in the usual circuit. It is, therefore, quite apparent that the input impedance of the new circuit is increased, making it possible to maintain a much higher signal-voltage potential across the tuning condenser terminals.

The circuit has been operated successfully in the 10-meter band. Reception of second harmonic values from distant stations such as IDG, WIK, WEKQ, NPG, and WGT have often been accomplished during day time. KWE on approximately 1,600 kilocycles may be heard on 32,000 kilocycles, and WIK on 13,930 kilocycles may be heard on 27,860 kilocycles which is very close to the upper limits of the 10-meter band.

The circuit does not radiate energy due to the employment of the tuned radio-frequency amplifier and to the minimum antenna coupling. The antenna circuit within the receiver consists of a small series inductance, L, which is coupled to the amplifier tuned input inductance. These inductances are wound with fixed relationship to one another so that the calibration of each coil system will remain fixed. The receiver may be operated from an antenna of any length from a few feet up to several wavelengths, such as a Beverage system. A doublet type of antenna or a directional loop may be used. European stations may be heard by using a single-turn loop about one foot square and connected directly to the coil jacks. The loop coil will act as an antenna and inductance system. Fig. 4 shows the circuit for loop reception. Note that the circuit preserves symmetry which is so essential to efficient and stable operation of a loop system. Due to symmetrical operation of the loop system, no compensating capacities are required to keep the loop balanced capacitively on each side of the earth.

The second inductance, L_1 of Fig. 5, is connected to the tuning condenser, C_1, and feeds to the grids of the two tubes through the coupling condensers, C_2 and C_4. The grids obtain a negative bias through the one-megohm leaks, R_1 and R_2, which are connected to the battery end of the resistance, R_5, thus giving a bias potential of approximately 1.6 volts which is obtained by utilizing the voltage drop of the series resistance.

Special Apparatus Used

THE condensers C_{10} and C_{12} are shown as having two series sections and a common rotor. This device may be made by cutting the bus bar which holds the stator, thus separating it into two parts. The rotor is connected to the plus filament and is grounded, in this way eliminating hand effect in tuning. It will be observed that the grid coils have no center connection. These coils are permitted to find their own electrical center which may be different from the apparent center due to electrical irregularities existing in the circuits. The choke, L_6 and L_7, isolates the junction

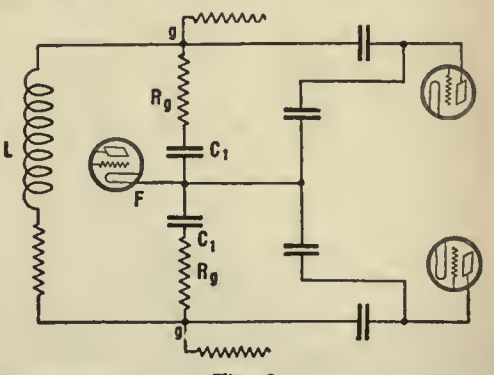


Fig. 3

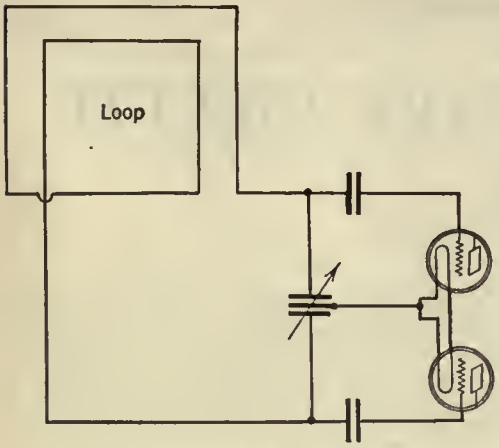


Fig. 4

of the two plate coils which tends to keep radio-frequency currents out of the B-battery supply circuits.

Three-element tubes may be used in the radio-frequency stage with a fair degree of success and Fig. 6 shows the circuit for standard three-element tubes. C_3 and C_4 are neutralizing condensers.

In order to obtain the greatest amplification possible it is essential that the external plate-circuit impedance be kept high. For this reason, greatest efficiency may be obtained by using a tuned plate circuit as shown in the dotted lines of Fig. 5. In this case L_3 should be a center-tapped coil tuned by C_{10} and C_4 in parallel, thus making possible a high-impedance load in the plate circuit. The effective resistance at resonance of this combination, $\frac{W^2 L^2}{R_1}$, may be much higher than the impedance of standard r.f. chokes which may be used (untuned) in place of L_4

The radio-frequency amplifier couples to the detector circuit through two 25-mmfd. condensers, C_5 and C_6. These capacities are made small to prevent reaction of the amplifier on the oscillating detector circuit.

The detector circuit is similar to the radio-frequency circuit. The potentiometer, R_7, is 100,000 ohms and serves to control oscillations by varying the voltage on the plates of the detector tubes. It is bypassed by a 2-mfd. condenser which prevents noise from irregular contacts as experienced with some volume-control potentiometers.

For ruggedness, selectivity, and elimination of vibration and microphonic noises, the receiver box should be built with heavy aluminum shields. If the proper care is taken microphonic noises, due to mechanical vibration, will be eliminated. Rigid bakelite tube sockets should be used rather than the cushion type. The receiver should be mounted upon a shock-absorbing pad such as a sponge rubber pad about one inch in thickness. The plate circuit of the radio-frequency amplifier may be shielded easily by arranging the two tubes so that each plate connection is near the shield and as short as possible. It will, therefore, not be necessary to use copper cylinders for each tube. If the proper care has been taken in mounting and wiring all the parts, the receiver will have a very low noise level, much lower than found on conventional types of receivers where the detector circuit is connected directly to the antenna system.

The condenser C_4 is 25 mmfd. which is sufficient to take care of the difference in tuning of the condensers C_{10} and C_{12} which may be operated on the same shaft.

Construction of Coils

COILS for this receiver may be made on Silver-Marshall plug-in forms. The following data are only approximate, but furnish a good starting point.

Band (Meters)	Ant. (L_1)	Grid r.f. (L_1)	Plate r.f. (L_2)	Grid det. (L_4)	Plate det. (L_5)
10	3	4	4*	3	4
20	3	8	4	6	6
30	4	15	6	12	6
40	4	17	7	14	6

*One half inch in diameter. Cut off top of coil form so that leads will not be too long.

In winding the coils, No. 16 enamel-covered wire should be used for grid coils and No. 22 enamel-covered wire for plate and tickler coils.

The two small coupling condensers, C_5 and C_6, between amplifier and detector may be made from small metal plates, about the size of dimes, and should be arranged so that the capacity of each may be varied slightly.

If the a.f. transformers are ungrounded, an unpleasant squeal may be heard in the phones. This may be eliminated by connecting an 0.05-mfd. condenser between grid of the last stage and the transformer frame. This will not reduce the signal strength.

List of Parts

THE following is a complete list of the apparatus employed by the writer in the construction of this receiver. Other parts may, of course, be substituted with discretion if the parts listed below cannot be obtained.

C_1, C_{12} Two Hammarlund condensers, 11-plate;
C_2, C_3, C_8, C_9 Four Dubilier condensers, 100-mmfd.;
C_4 One Hammarlund Junior 9-plate condenser, 25-mmfd.;
C_5, C_6 Two condensers, 25-mmfd. maximum. (See construction notes);
C_7, Cu Two Parvolt by-pass condensers, 1.0-mfd.;
C_{10} One Hammarlund 7-plate condenser (not used if L_3 is an r.f. choke);
C_{13} One Parvolt by-pass condenser, 2.0-mfd.;
L_1, $L_{1'}$, L_2, L_3, L_4, L_5 Six coils (see coil table for data);
L_6, L_7 Two Samson r.f. chokes, 125-mh.;
R_1, R_2 Two Durham grid leaks, 1.0-megohm;
R_3, R_4 Two Durham grid leaks, 0.5-megohm;
R_5 One rheostat or fixed resistance, 25-ohm;
R_6 One rheostat or fixed resistance, 6-ohm;
R_7 One Carter volume control, 100,000-ohms;
R_8 One Yaxley potentiometer, 200-ohm;
Six Benjamin sockets, four-prong;
Three Benjamin sockets, five-prong;
Two Thordarson transformers, R200;
One Jewell Voltmeter, Pattern-135;
One on-off switch;
Two National dials.

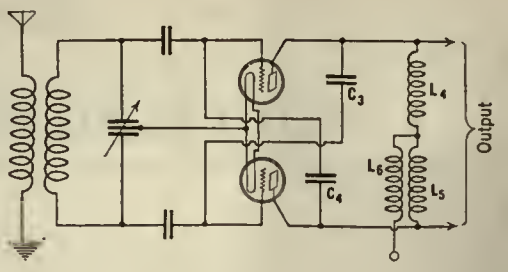


Fig. 6

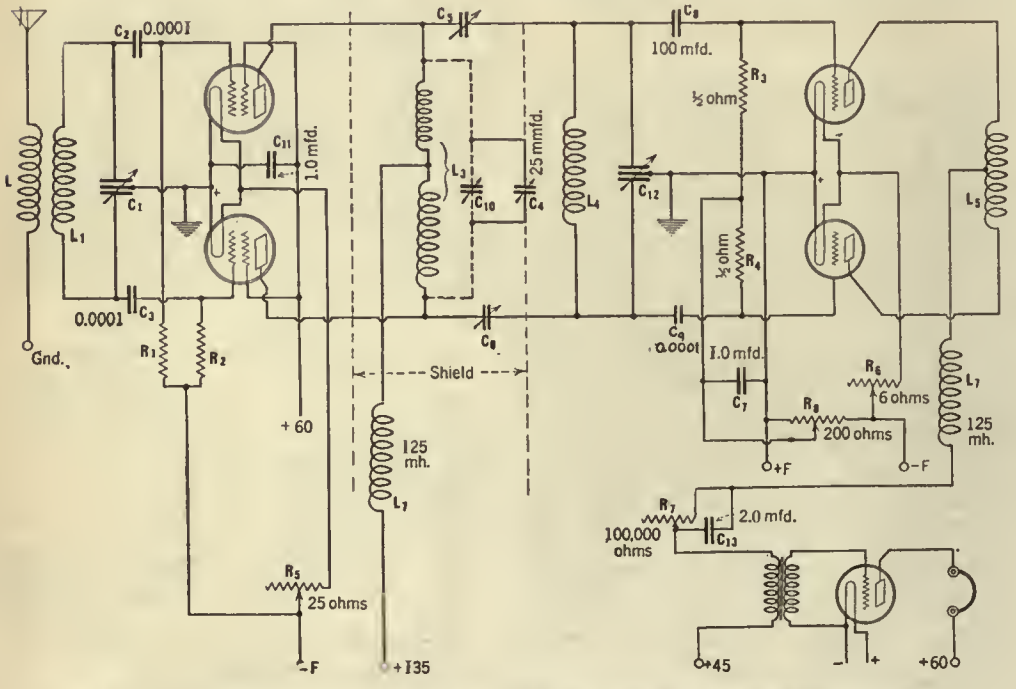


Fig. 5—Complete schematic diagram of the author's short-wave receiver.

SOUND-MOVIE MANUFACTURERS

OF INTEREST to workers in the sound motion picture field is the following list of practically all of the prominent manufacturers making acoustic apparatus for use in sound-movie installations:

LOUD SPEAKERS

Silver-Marshall—Dynamic cone—Silver-Marshall, Inc., 874 W. Jackson Blvd., Chicago, Ill.
Racon—Exponential horn—Racon Electric Co., Inc 18-24 Washington Place, N. Y. C.
Jensen—Dynamic cone—Jensen Radio Mfg. Co., 338 N. Kedzie Ave., Chicago, Ill.
Peerless—Dynamic cone—United Radio Corp., Rochester, N. Y.

DISC REPRODUCER INSTALLATIONS

RCA Photophone, Inc.—411 Fifth Ave., N. Y. C. (Dynamic cones, synchronous and non-synchronous turntables, amplifiers.)
Vitaphone—Electrical Research Products, Inc., 250 West 57th Street, N. Y. (Dynamic horn, synchronous and non-synchronous turntables, amplifiers).
Duotone—Western Electric Piano Co., 850 Blackhawk St., Chicago, Ill. (Dynamic horn, amplifier, non-synchronous turntables).
Motio-Tone—Gates Radio and Supply Co., Quincy, Ind., (Dynamic cone, or horn, turntables, amplifier)
Oganovox—National Sound Reproducing Co., 653 Clinton St., Milwaukee, Wisc. (Non-synchronous turntable, amplifier, dynamic loud speakers).
Good-All Orchestrola—Good-All Electric Mfg. Co., Ogallala, Nebraska. (Dynamic horn, amplifier, non-synchronous turntables).
Duplex-O-Phone—Nelson-Wiggen Piano Co., 1731-45 Belmont Ave., Chicago, Ill. (Amplifier and turntables only, for dynamic reproducers).
Han-A-Phone—Hanaphone Co. of America—6010 38th Avenue, Woodside, L. I.
Sonora—Bristolphone, 50 West 57th Street, N. Y. C.
Pacent Reproducer Systems—Pacent Reproducer Corp., 250 West 39th St. N. Y. C. (Dynamic cone, synchronous turntables, amplifiers).
Cinetone—S and S Enterprises, 46 Church St., Boston, Mass. (Dynamic cone, non-synchronous turntables, amplifier).
Phototone—Phototone Co., North Vernon, Indiana. (Cone, synchronous and non-synchronous turntables, amplifier).

SOUND-ON-FILM INSTALLATIONS

RCA Photophone Inc.—411 Fifth Avenue, N. Y. C. (Dynamic cones, amplifiers, sound reproducer equipment).
Movietone—Electrical Research Products Inc. (Western Electric) 250 West 57th Street, N. Y. C. (Dynamic horns, amplifiers, sound reproducer equipment).
De Forest Phonofilm—General Talking Pictures Corp., 218 West 42d St., N. Y. C.
(Loud speakers, amplifiers, sound-reproducer equipment).

IN THE RADIO MARKETPLACE

News, Useful Data, and Information on the Offerings of the Manufacturer

Industry Briefs

Dr. Frank A. Rafferty has joined the staff of Zenith research engineers. Dr. Rafferty was formerly director of the radio research laboratories of Villanova College, Villanova, Pa.

The Laboratories of the Hazletine Corporation have been removed from Hoboken, N. J., to 333 West 52nd Street, New York City. W. A. MacDonald heads the staff of engineers at the laboratories.

The Radio Division of the Fansteel Products Company, makers of Balkite radio sets, has been incorporated in a separate company operating under the name The Balkeit Radio Company. Their address remains the same as before, North Chicago, Illinois.

Two New Radio Corporation licensees under receiving set and electrical phonograph patents are the Colin B. Kennedy Corporation, 231 South La Salle St., Chicago, Ill., and Silver-Marshall, Inc., 816 West Jackson Boulevard, Chicago, Ill.

J. H. Pressley who made a reputation as designer of an excellent super-heterodyne in years gone by, is now chief engineer of the United States Radio and Television Corporation, 1338 South Michigan Avenue, Chicago, Ill. Other officers of the company are: W. C. Perkins, president; H. T. Roberts, vice-president and sales manager; Arthur E. Case, vice-president and manager of plants; Douglas deMare, director of production; Don Pieri, sales engineer, and A. G. Messick, chairman of the board.

The La Salle Radio Corporation is now installed in a new plant at Ogden, Frontier, and Blackhawk Streets, Chicago, Ill. This company, headed by P. C. Dittman, president, makes a complete line of radio tubes.

Another Vacuum-tube manufacturer has entered the field. The new company will be known as the Triad Mfg. Co. with headquarters at Pawtucket, R. I. George Coby is president, Ely Egnatoff, treasurer, H. H. Steinle, vice-president and general sales manager, and William Cepak, secretary. Officers of the company have long been associated with the tube industry. The new company will make, in addition to a standard line of radio tubes, photo-electrical cells. Distribution of the Triad line will be through franchised jobbers only.

John M. Redell, a well-known figure in the radio sales field, has been appointed Chicago sales representative of the Sonatron Tube Company. Mr. Redell is secretary of the Midwest Radio Trades Association and a member of the executive board of the Federated Radio Trade Association.

Two Branches of the Edison Distributing Corporation, the wholesale distributing organization for Edison radio sets and Edison records have recently been opened, one at Boston and a second at Minneapolis. C. V. Chisholm is manager of the Boston office at 96 South Street. The Minneapolis office at 608 First Avenue, North, is headed by J. W. A. Henderson.

The Empire Electric Company, 25 East Juneau Ave., Milwaukee, Wis., has been appointed Central Wisconsin distributor for the Chas. Freshman Co. The appointment of distributors by the Freshman company is a new policy due to the new president, C. A. Earl. Distribution previously was made directly to dealers.

New Receivers Announced

The New Temple Receivers are available in two console models. The large console is equipped with a fourteen-inch dynamic loud speaker and the complete set sells for $189.00. The smaller console lists at $149.00 and it is equipped with a nine-inch dynamic loud speaker. The receiver circuit in both models is the same. Both sets use six 227-type tubes, a 250-type power tube, and a 281-type rectifier.

The First Set offerings by Silver-Marshall, Inc., of Chicago, as an RCA licensee will include console lowboys and highboys at approximately $149 and $189 list. These models, with identical chassis, will use the new a.c. screen-grid tube in the r.f. stages and the new intermediate power tube in the output stage. These receivers will be marketed through exclusive distributors.

Early in May, S-M expects to occupy a new factory on the west side of Chicago with a capacity of 1000 to 2000 sets per day.

The Kolster Radio Corporation through its subsidiary company, The Brandes Corporation, has entered the low-price set field. Three Brandes receivers are being manufactured, the Model B-10, a table-type receiver listing at $85, the Model B-11, a console set listing at $135, and the Model B-12, a console at $165. All three models use the same circuit which consists of three stages of r.f., detector and three stages of a.f. amplification. Type 227 tubes are used throughout except for the power tube and rectifier, the former being a 171A and the latter a 280. The Models B-11 and B-12 have built-in dynamic loud speakers. The sets are being manufactured at the plants of the Kolster Radio Corporation in Newark, N. J.



An open model console receiver by Temple, Inc.

Aero Products, Inc., of Chicago, Illinois, manufacture a short-wave adapter, the "Aero-Call," designed for use in conjunction with a standard broadcast receiving set to permit the reception of short-wave stations. This is a completely assembled short-wave tuning unit and the tuning range is from 15 to 90 meters with three coils supplied with the unit. Additional coils are available to extend the tuning range up to 550 meters so that all wavelengths from 15 up through the broadcast band can be covered by the use of interchangeable coils. The set is made in two models, one for use with a.c. receivers and one for use with d.c. receivers. Both models list at $25.00.

Miscellaneous New Parts

The National Company's new B-Power Unit, type 7180, was designed especially for use in conjunction with the new 245-type power tube and will deliver 250 volts to the plate of this tube and also supply the necessary 50-volt grid bias.

The Raytheon Manufacturing Company has designed two new high-voltage rectifiers, the Ray-s, $25.00 and the Ray sx-866, $12.50 The Ray-s rectifier is designed to supply up to 300 milliamperes of direct current at 2000 to 3000 volts. The type sx-866 supplies up to 250 milliamperes at 1500 to 2000 volts. Both tubes are designed to supply plate and filament current to the various types of transmitter tubes.

The Arcturus Radio Tube Company offers two new tubes, the type 145 power tube having a maximum output of above 1.8 watts and the type 122 screen-grid a.c. tube. Both tubes are the beater type, the beaters being designed for operation from a 2.5-volt a.c. source.

The Potter Dynamic loud-speaker filter, a product of the Potter Manufacturing Company, is designed for use in conjunction with a.c.-operated dynamic loud speakers to decrease the hum. To install the device it is simply necessary to connect the two leads from the filter across the field of the loud speaker. The price of the device is $7.50.

Items of Interest

The Tobe Deutschmann Corporation have available some excellent bulletins on the subject of radio interference and its prevention. These bulletins can probably be obtained by those having anything to do with the installation of interference-preventing devices. The most recent pamphlet we have received takes up in detail the subject of preventing interference from oil burners. It is written by W. K. Fleming, chief engineer of the company.

Television Programs of an experimental nature are being transmitted regularly from 7 to 9 p. m. by station w2xbs of the Radio Corporation of America. The channel assigned to w2mbs is from 2000 to 2100 kilocycles (142.8 to 149.9 meters). A power of 250 watts is employed at present, although this will probably be increased shortly. Pictures are 60 scanning lines high and 72 elements wide. Twenty complete pictures are transmitted every second. Scanning is in such a direction that looking at the received picture the scanning spot moves from left to right and from top to bottom.

"Present transmissions consist of pictures, signs, views of persons, and objects," said Dr.

THE RADIO DEALER'S NOTE BOOK—NO. 3 TESTING INSTRUMENTS

*Free—Complete Information**

ACCURATE summaries of useful information are constantly of value to those radio folk who deal with the public. This sheet, one of many on various subjects to follow, sets down collected information on testing instruments. The dealer or serviceman can remove this part of the page for his notebook or he can have it photostated.

Good instruments are essential if receivers are to be serviced properly. In this connection, the table below lists the offerings of a few of the prominent instrument manufacturers. A dealer or serviceman ordinarily can make use of two instruments; one instrument is useful for checking the performance of all types of a.c. and d.c. receiving tubes and rectifiers and the other, a set-tester, for checking the performance of a receiver.

Whether a simple or a complicated set-tester is purchased depends upon one's personal preference. Some servicemen prefer the simplest possible instrument. The idea back of this is that if the set only requires a slight repair, it can be done on the job, but if considerable work must be done on the set, it is best to take it back to the shop where complete facilities for testing and repairing receivers are available. Other servicemen, however, prefer to complete the job on the spot and to such servicemen a very complete instrument of tests is probably essential.

In any event, whether or not you have a set-tester and tube-checker, data on all the available instruments should be in the hands of dealers and servicemen.

**As a service to readers, the Editors have arranged that dealers may obtain complete information on all the devices listed in the table by writing to the Service Department of* RADIO BROADCAST *and asking for data on testing instruments. All requests must be written on a business letterhead or a card must be enclosed to identify the writer as a dealer or serviceman.*

MANUFACTURER	DEVICE	TYPE NO.	PRICE	MILLIAMMETER	VOLTMETER	REMARKS
Jefferson Electric Co.	Tube Rejuvenator	175	$ 4.50			For 50 to 133 cycles 100–120 volts a.c.
		180	6.00			For 25 to 40 cycles
Hoyt Electrical Instrument Co.	AC–DC Set Tester	600	65.00	0–30,120	0–12, 120, 600 d.c. 0–3, 9, 150 a.c.	A complete set tester
	Tube Tester	400	22.50	0–10, 50	0–3, 9 a.c. and d.c.	Tests all types of a.c. and d.c. tubes
	A.C. Attachment	101	15.00		0–3, 9 a.c. and d.c.	A device for use with d.c. tube testers to make possible the testing of a.c. tubes
	D. C. Set Tester	300	48.75	0–25, 100	0–10, 500 d.c.	For testing d.c. sets only
Jewell Electrical Instrument Co.	Tube Tester	210	65.00	0–100 and special scale	A.C. line voltage indicator	A tester for all types of tubes, including double-plate rectifiers
	A.C. - D.C. Set Tester	199	97.50	0–15, 150	0–7.5, 75, 300, 600 d.c., 0–4, 8, 16, 160 a.c.	A complete instrument for testing all types of sets
	Test Panel	580	212.00	0–15, 150	0–7.5, 75, 150, 300, 750 d.c., 0–4, 8, 16, 150, 750 a.c.	A special test panel for use in the shop. Contains special meter to measure condensers capacity up to 15 mfd.
	Tube Checker	150	38.00	0–15	0–4, 8 a.c.	Tests all types of a.c. tubes
Sterling Manufacturing Co.	Tube Tester	R–510	35.00	0–15, 100	0–15 a.c.	Checks performance of all types of a.c. and d.c. tubes. For 115 volts, 60 cycles a.c.
	Tube Tester	R–520	37.50	0–15, 110	0–15 a.c.	Same as R–510 except for 25 cycles a.c.
	Tube Checker	R–514	13.50			Special meters indicate short and low emissions in all types of a.c. and d.c. tubes
	Set and Tube Tester	R–522	67.50	0–10, 100	0–150 a.c. 0–3, 15 a.c. 0–10, 125, 500 d.c.	Tests all a.c. and d.c. sets; also a.c. and d.c. tubes, including screen-grid type. Binding posts for separate use of meters.
Supreme Instruments Corp.	Set Tester	400–A	124.65	0–125 0–2½ amperc	0–10, 100, 600 d. c., 0–3, 15, 150 a.c.	An a.c. and d.c. set tester complete with full sets of tools. Contains a modulated oscillator, tube rejuvinator, etc.
	Set Tester	99–A	97.65			A set tester lacking a few of the features of the larger model 400–A
Weston Electrical Instrument Corp.	Set Tester	537	100.00	0–30, 150	0–4, 8, 150 a.c. 0–8, 60, 120, 300, 600 d.c.	A complete a.c.–d.c. radio set tester
	Tube Checker	533	67.50	0–20, 80	A.C. line voltage indicator	For use by dealers in checking tubes at time of sale
Hickok Electrical Instrument Co.	Set Tester	AC-4600	$135.	0-20,200	0.–300, 600 d.c. 0–7.5 d.c. 0–3.3, 15 150 a.c.	A complete set tester
General Radio Co.	Test Oscillator	320				A modulated oscillator for receiver testing

A. N. Golsmith, vice-president and chief broadcast engineer of the Radio Corporation of America.

"Experimental work on such subjects as fading, picture quality, and other phases of television problems is being carried on by w2xbs."

Dr. Goldsmith continued by saying that this will in due course evolve in a service to the public on a basis similar to sound broadcast, and of like high quality.

THE SUPREME INSTRUMENTS CORPORATION, of Greenwood, Mississippi, manufactures a test set, model 400A, capable of making a very large number of tests on tubes and receivers. The device contains several special devices among which are a modulated oscillator which can be used in aligning the various tuning condensers in a single-control set and it also contains apparatus for rejuvenating tubes. The instrument is equipped with Weston meters, and sells for $124.65 list. It can be purchased on the time-payment plan. The down payment is $38.50 to be followed by ten monthly payments of $10.00 each. This company also makes a smaller service instrument, the model 99A, which lists for $97.65. If purchased on the deferred-payment plan, the down payment is $28.50 followed by eight monthly payments of $10.00 each.

THE J. E. JENKINS AND S. E. ADAIR COMPANY, of Chicago, are manufacturers of high-grade, audio-frequency apparatus such as audio-frequency transformers, gain controls, mixing controls, etc. The type GL-35 gain or volume control consists of nichrome-wire resistor units and the total resistance of the device is 350,000 ohms. The various steps give a logarithmic increase in resistance, each step giving a gain of about 3 DB.

THE UTAH RADIO PRODUCTS COMPANY has announced an automatic remote-control tuning device for radio receivers. The remote-control device, by means of which the radio set is operated from a distance, contains two knobs, one a station selector and the other a volume control. The control is small enough to hold in the palm of one's hand. The control box is connected by wires to an electric motor which is fastened to the radio receiver. The control box functions to turn on the set, tune it, and turn it off when the dial on the control box is turned to the "off" position.

DYNAMIC LOUD SPEAKERS in various models are manufactured by Wright-DeCoster, Inc., St. Paul, Minn. The models 105 and 106 are designed for operation from a storage battery, the models 107 and 108 have self-contained rectifiers, and the models 105x and 106x should be supplied with current from the filter circuit. The latter two models normally require a current of about 100 milliamperes. A model 107 loud speaker has been in use in the Laboratory for some time and comparatively it has much less hum than many other a.c-operated dynamic loud speakers which we have tested. Its frequency response range is excellent.

R C A Licenses First Tube Company

THE Raytheon Manufacturing Company has been granted a license to manufacture vacuum tubes under the patents of the Radio Corporation, it was announced by RCA on March 26.

"The license signed by the Radio Corporation and the Raytheon Manufacturing Company is a decided step toward stabilization in the radio tube industry," said L. K. Marshall, president of Raytheon. "Raytheon," continued Mr. Marshall, "through extensive laboratory research, pioneered in the developments that have resulted in electric power sets and made valuable contributions in producing effective tubes for use in B-power units. Recent Raytheon improvements are

TUBE BRANDING MACHINES



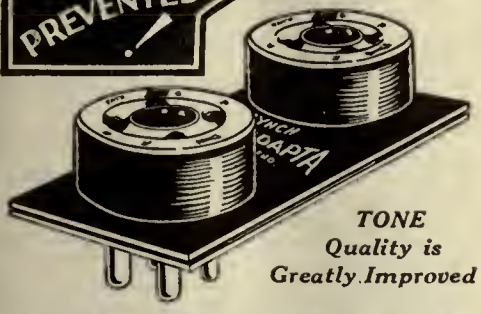
The Latest and Best Machine for Marking Tubes

Impresses Neat Clean Letters Into Your Bases

Designed and Built by

GEO. T. SCHMIDT, Inc.
4100 Ravenswood Avenue
Chicago, Illinois

BLASTING of LOUD SPEAKER *and* **OVERLOADING** OF TUBES **PREVENTED**



TONE Quality is Greatly Improved

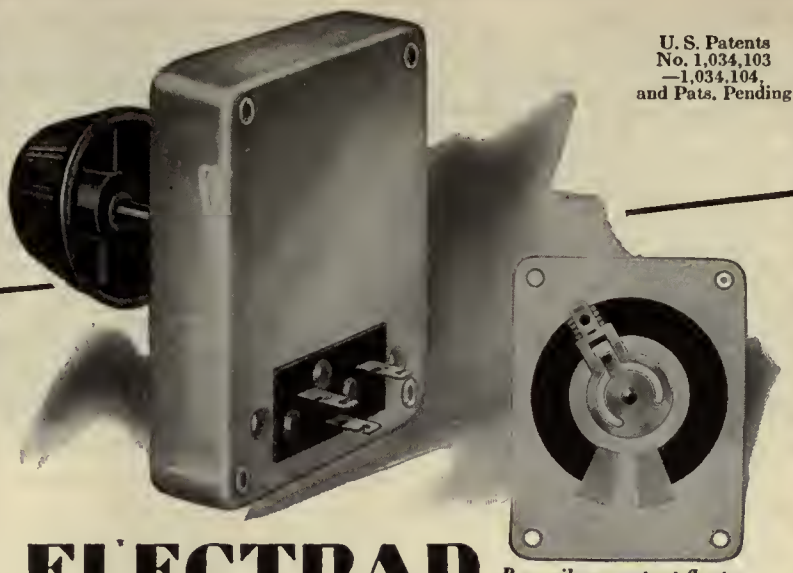
LYNCH TUBADAPTA

Provides for the use of two tubes in parallel, thus reducing the impedance in the power stage. The plate current is almost doubled without making any change in the receiver. 4 Models, to fit any set. Easily installed. Price $2.50.

Write for leaflet illustrating and describing the different models

ARTHUR H. LYNCH, Inc.
1775 Broadway, (at 57th St.) New York

Manufacturers of—LYNCH RESISTORS, EQUALIZORS, SUPPRESSORS, MOUNTINGS, RESISTANCE-COUPLED KITS, *ETC*. . .



U. S. Patents No. 1,034,103 —1,034,104, and Pats. Pending

Pure silver contact floating on fused graphite resistance element gives amazing smoothness and accuracy.

ELECTRAD *Presents* A Remarkable *New* 5-WATT VOLUME CONTROL

THERE is a real need for a reliable volume control capable of carrying the high currents of modern receivers—and Electrad has created it.

A compact unit with predominance of metal that safely dissipates five-watts.

Application of the resistance element and the contact design are unique and thoroughly efficient. A special graphite paint is fused to an enamel metal base so effectively that after 65,000 oscillations of the contact arm, there is no perceptible wear and no appreciable change in resistance value.

The contact is pure silver designed to float over any slight variation of surface, thus insuring unbroken smoothness of travel and perfect current flow. The contact improves with use, owing to a microscopic deposit of silver on the resistance element.

Full description, laboratory graphs and sample for comparative tests sent on request to established manufacturers.

Electrad specializes in controls for every radio purpose, including Television

ELECTRAD, INC., Dept. RB 5, 175 Varick St., New York

Send complete data on new 5-watt volume control and sample for tests.

Individual.....

Title.....

Firm.....

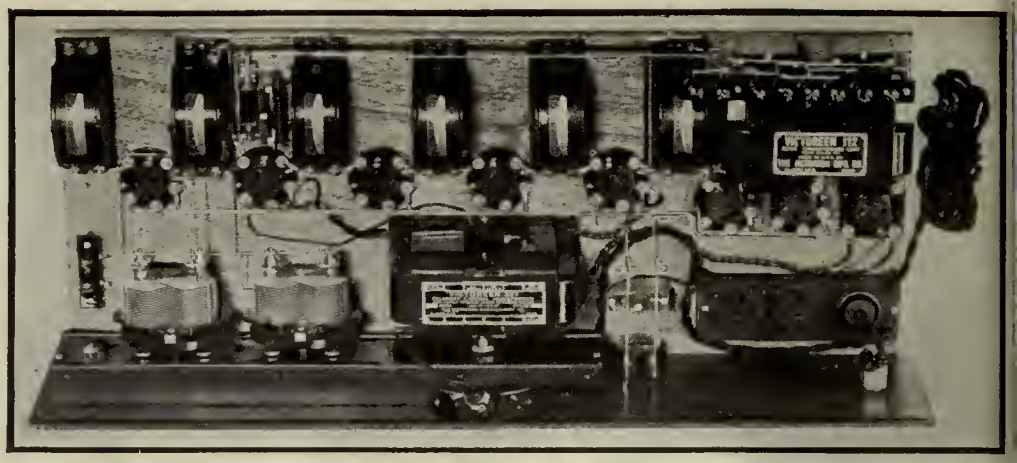
Address.....

City.....State.....

ELECTRAD INC.

another contribution to the tube's part in better radio reception. It is fitting that the Raytheon Company which has rendered so much engineering service to the radio industry, should be the first to take a license from the Radio Corporation, which will insure a close coöperation between the laboratories and should result in benefit to the radio industry in general."

It is understood that licenses under RCA tube patents may be granted to other tube manufacturers. As extensive a family of licensed tube manufacturers may grow up as a result of this new RCA policy as has developed in the set field where there are now more than 31 companies producing receivers under RCA licenses. The first RCA set license was granted to Zenith on March 10, 1927. It is interesting to note that the first tube license was granted in the same month, just two years later.



Baseboard view of the New Victoreen kit receiver.

The 1929 Victoreen Kit Receiver

One of the Most Popular of the superheterodyne kits is the Victoreen 1929 A.C. receiver. We have received from the George W. Walker Company a description of this a.c. receiver and the following paragraphs describe its major characteristics.



The new tube manufacturing plant of the La Salle Radio Corporation, Chicago, Ill.

In designing the 1929 circuit, it was considered advisable to redesign the intermediate-frequency transformers and peak them slightly below former types. Each i.f. unit contains a variable condenser which is tuned to a standard frequency and then sealed at the factory. By this method any four transformers may be used together without the necessity of matching them in sets.

With the new r.f. transformers there has also been designed a special oscillator. The oscillator and antenna circuit tune together throughout the broadcast range, although the circuits naturally operate at different frequencies. Very little compensation is, therefore, required.

For tuning this receiver a single dial control using two 0.0005-mfd. Remler condensers are used. This single dial control unit has no backlash and requires a 360° back-panel-illuminated dial. Vernier capacity adjustments are provided for by a small 0.0001-mfd. variable condenser.

Plate rectification is used in the 1929 Victoreen AC receiver and in a measure this is responsible for the fidelity obtained. Both the second detector and first a.f. tubes operate with the same grid bias. A plate potential of 90 volts is used on the detector and the first a. f. tube operates from 180 volts.

The new Victoreen 327-type filament transformer has been designed to supply the standard a.c. tubes with power at slightly below their rated voltage. As now designed, it is standard only for 50- to 60-cycle current from a standard 108- to 112-volt line. This transformer comes equipped with the leads all attached to facilitate the wiring. It is designed to supply up to five 227-type tubes from each 2½-volt secondary and two 112A-type tubes from the 5-volt secondary.

This circuit uses the 227-type tubes throughout the receiver. They reduce the hum to an imperceptible value and also eliminate variation in volume caused by voltage fluctuations.

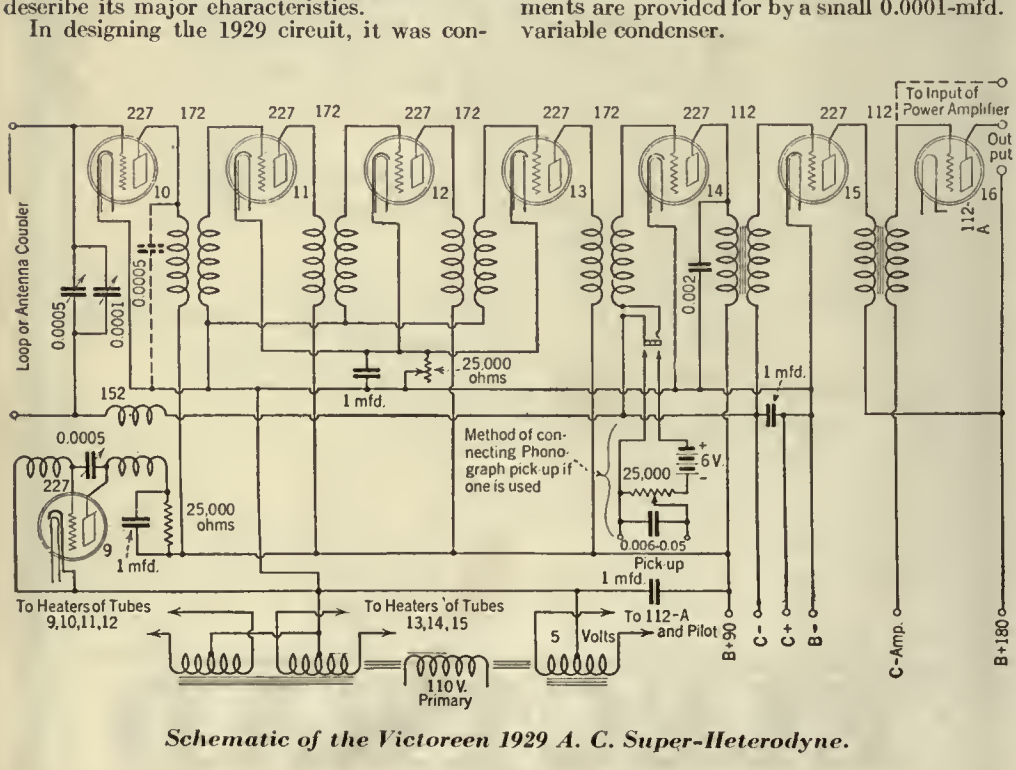
The volume control in the 1929 a.c. circuit consists of a resistor in the common plate return of the i.f. stages. This variable resistor's function is not only to decrease the plate potential but also to provide a high negative bias. This volume control does not change the tuning due to change in the voltage relation in the different circuits and, therefore, readjustment of the dials when the volume is changed is not necessary.

The circuit is adaptated for use with a phonograph pick-up unit which is placed in series with the grid return of the second detector. This receiver is also adaptable both for loop or outside antenna. If an antenna is used it is only necessary to remove the loop leads and connect the antenna coupler secondary to the loop posts. In using an antenna, fifty feet including lead-in should be more than ample.

The Victoreen power supply is a most important essential with the 1929 Victoreen a.c. circuit as it provides the 90- and 180- volt circuits with voltage regulator tubes.

The construction of this receiver is a very simple matter and free blueprints are available giving complete details. These include a point-to-point wiring description and a full-size template which may be used for laying out the parts.

The complete kit of parts for the 1929 Victoreen kit is available from the George W. Walker Co., Cleveland. Price: $141.30.



Schematic of the Victoreen 1929 A. C. Super-Heterodyne.

A CORRECTION

In the List of Books which was included in Mr. Dunham's article, "What the Serviceman Should Study," March, 1929, Radio Broadcast, page 295, two errors in price occurred. The correct price of H. F. Van Der Bijl's *Thermionic Vacuum Tube* is $5.00, and *Practical Radio Construction and Repairing*, by Moyer and Wostrel, lists at $2.50. Both books are published by the McGraw-Hill Book Co., Inc., New York City.

THE NEW CROSLEY GEMCHEST



Chinese Chippendale Cabinet design in three colors, Mandarin Red, Manchu Black and Nanking Green. Contains seven-tube Gembox shielded receiver (three stages radio amplification, detector, two audio tubes and rectifier) and the dynamic Crosley Dynacone power speaker (built on a different principle of armature actuation.) Without tubes $94.

THE CROSLEY RADIO CORP.
POWEL CROSLEY JR., Pres. CINCINNATI, O.

Owners of WLW, the Nation's Station
West of Rockies Prices Slightly Higher

ONLY *CENTRALAB*
makes resistances like these

The construction and design of a variable resistance is of as great importance as the mere fact that it possesses a certain resistance and will carry a specified current load. *CENTRALAB* design is such that the resistance unit not only will handle the power but also vary it in a manner so as to derive the greatest efficiency from the receiving set or power unit.



CENTRALAB RADIOHMS
In following resistances: 0-2,000 ohms, 0-50,000 ohms, 0-100,000 ohms, 0-200,000 ohms, 0-500,000 ohms. List price...**$2.00**

The following features distinguish *CENTRALAB* variable resistances of the Graphite Disc type:

Rocking Disc Contact — Noiseless, smooth and easy adjustment
One turn of knob gives complete variation — Constant resistance
Insulated shaft and bushing — Rigidly built; fully guaranteed

Made in two and three terminal units to be used as Volume Controls, Radiohms and Potentiometers. Special resistance tapers can be had for any circuit. Send for interesting booklet "Volume and Voltage Controls—Their Use."

CENTRAL RADIO LABORATORIES
24 Keefe Avenue — Milwaukee, Wisconsin



The MIDGET *of Many Uses*

"HAMMARLUND, JR." has all of the family characteristics—it is as carefully designed and well made as its bigger brother the famous Hammarlund "Midline" Condenser. For neutralizing R.F. circuits; for balancing the units of a multiple condenser; for vernier tuning; for antenna selectivity — and many other places in modern receivers, here is the biggest little condenser value you can buy. Five sizes: $1.50 to $2.25.

Write Dept. R B 5 for descriptive folder showing diagrams of uses.

HAMMARLUND MFG. CO.
424-438 W. 33rd St., New York

For Better Radio
Hammarlund
PRECISION
PRODUCTS

SHORT CIRCUIT AND 2,000 OHMS



sound alike in the phones when you're making a circuit continuity test by the "click" method. How would you tell the difference?

The progressive serviceman knows the answer. He uses the General Radio Direct-Reading Ohmmeter.

Bulletin 931-T Describes It.

GENERAL RADIO COMPANY

30 State Street — Cambridge, Massachusetts
274 Brannan Street — San Francisco, California

MANUFACTURERS' BOOKLETS

A Varied List of Books Pertaining to Radio and Allied Subjects Obtainable Free With the Accompanying Coupon

1. Filament Control—Problems of filament supply, voltage regulation, effect on various circuits, and circuit diagrams of popular kits. Radiall Company.

5. Carborundum in Radio—Pertinent data on crystal detectors with hook-ups, and information on the use of resistors. The Carborundum Company.

12. Distortion and What Causes It—Hook-ups of resistance-coupled amplifiers with standard circuits. Allen-Bradley Company.

17. Bakelite—A description of various uses of bakelite in radio, its manufacture, and its properties. Bakelite Corporation.

22. A Primer of Electricity—Fundamentals of electricity with reference to the application of dry cells to radio. Constructional data on buzzers, automatic switches, alarms, etc. National Carbon Company.

23. Automatic Relay Connections—A data sheet showing how a relay may be used to control A and B circuits. Yaxley Manufacturing Company.

30. Tube Characteristics—A data sheet giving constants of tubes. C. E. Manufacturing Company.

32. Meters for Radio—A book of meters used in radio, with diagrams. Burton-Rogers Company.

33. Switchboard and Portable Meters—A booklet giving dimensions, specifications, and shunts used with various meters. Burton-Rogers Company.

37. Why Radio is Better with Battery Power—What dry-cell battery to use; their application to radio, wiring diagrams. National Carbon Company.

46. Audio-Frequency Chokes—A pamphlet showing positions in the circuit where audio-frequency chokes may be used. Samson Electric Company.

47. Radio-Frequency Chokes—Circuit diagrams illustrating the use of chokes to keep out r. f. currents from definite points. Samson Electric Company.

48. Transformer and Impedance Data—Tables giving the mechanical and electrical characteristics of transformers and impedances, together with a short description of their use. Samson Electric Company.

53. Tube Reactivator—Information on the care of vacuum tubes, with notes on reactivation. The Sterling Manufacturing Company.

57. Filter Data—Facts about the filtering of d. c. supplied by means of motor-generator outfits used with transmitters. Electric Specialty Company.

58. How to Select a Receiver—A common-sense booklet describing what a radio set is, and what you should expect from it, in language that anyone can understand. Day-Fan Electric Company.

67. Weather for Radio—A very interesting booklet on the relationship between weather and radio reception, with maps and data on forecasting the probable results. Taylor Instrument Companies.

69. Vacuum Tubes—A booklet giving the characteristics of the various tube types with a short description of where they may be used in the circuit; list of American and Canadian broadcast stations. Radio Corporation of America.

72. Plate Supply Systems. Technical information on audio and power systems. Bulletins dealing with two-stage transformer amplifier systems, two-stage push-pull, three-stage push-pull, parallel push-pull, and other audio amplifier, plate, and filament supply systems. American Transformer Company.

73. Radio Simplified—A non-technical booklet giving pertinent data on various radio subjects. Of especial interest to the beginner and set owner. Crosley Radio Corporation.

76. Radio Instruments—A description of various meters used in radio and electrical circuits together with a short discussion of their uses. Jewell Electrical Instrument Company.

78. Electrical Troubles—A pamphlet describing the use of electrical testing instruments in automotive work combined with a description of the cadmium test for storage batteries. Of interest to the owner of storage batteries. Burton Rogers Company.

88. Super-Heterodyne Construction—A booklet giving full instructions, together with a blue print and necessary data, for building an eight-tube receiver. The George W. Walker Company.

89. Short-Wave Transmitting Equipment. Data and wiring diagrams on construction of all popular short-wave transmitters, operating instructions, keying, antennas; information and wiring diagrams on receiving apparatus; data on variety of apparatus used in high-frequency work. Radio Engineering Laboratories.

90. Impedance Amplification—The theory and practice of a special type of dual-impedance audio amplification. Alden Manufacturing Company.

95. Resistance Data—Successive bulletins regarding the use of resistors in various parts of the radio circuit. International Resistance Company.

98. Copper Shielding—A booklet giving information on the use of shielding in radio receivers, with notes and diagrams showing how it may be applied practically. Of special interest to the home constructor. The Copper and Brass Research Association.

99. Radio Convenience Outlets—A folder giving diagrams and specifications for installing loud speakers in various locations at some distance from the receiving set, also antenna, ground and battery connections. Yaxley Manufacturing Company.

101. Using Chokes—A folder with circuit diagrams of the more popular circuits showing where choke coils may be placed to produce better results. Samson Electric Company.

102. Radio Power Bulletins—Circuit diagrams, theory constants, and trouble-shooting hints for units employing the BH or B rectifier tubes. Raytheon Manufacturing Company.

104. Oscillation Control with the "Phasatrol"—Circuit diagrams, details for connection in circuit, and specific operating suggestions for using the "Phasatrol" as a balancing device to control oscillation. Electrad, Incorporated.

105. Receiving and Transmitting Circuits. Construction booklet with data on 25 receivers and transmitters together with discussion of low losses in receiver tuning circuits. Aero Products Company.

Two Books of Interest to Readers of Radio Broadcast

Radio Broadcast Laboratory Information Sheets (*Nos. 1-190*)

●

How Radio Receivers Work

By Walter Van B. Roberts

Ask any newsdealer for *Radio Broadcast Data Sheets* or both books may be obtained by writing to Radio Broadcast, Garden City, N. Y.

Price $1.00 each

108. Vacuum Tubes—Operating characteristics of an a.c. tube with curves and circuit diagram for connection in converting various receivers to a.c. operation with a four-prong a.c. tube. Arcturus Radio Tube Company.

112. Heavy-Duty Resistors—Circuit calculations and data on receiving and transmitting resistances for a variety of uses, diagrams for popular power supply circuits, d.c. resistors for battery charging use. Ward Leonard Electric Company.

113. Cone Loud Speakers—Technical and practical information on electro-dynamic and permanent-magnet type cone loud speakers. The Magnavox Company.

114. Tube Adapters—Concise information concerning simplified methods of including various power tubes in existing receivers. Alden Manufacturing Company.

115. What Set Shall I Build?—Descriptive matter, with illustrations, of fourteen popular receivers for the set-builder. Herbert H. Frost, Incorporated.

118. Radio Instruments, Circular "J"—A descriptive manual on the use of measuring instruments for every radio circuit requirement. A complete listing of models for transmitters, receivers, set servicing, and power unit control. Weston Electrical Instrument Corporation.

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124. Power Amplifier and B Supply—A booklet giving several circuit arrangements and constructional information and a combined B supply and push-pull audio amplifier, the latter using 210-type tubes. Thordarson Electric Mfg. Co.

125. A. C. Tube Operation—A small but complete booklet describing a method of filament supply for a.c. tubes. Thordarson Electric Mfg. Co.

126. Micrometric Resistance—How to use resistances for: sensitivity control; oscillation control; volume control; regeneration control; tone control; detector plate voltage control; resistance and impedance coupling; loud speaker control, etc. Clarostat Mfg. Co.

129. Tone—Some model audio hook-ups, with an explanation of the proper use of transformers and chokes. Sangamo Electric Co.

130. Screen-Grid Audio Amplification—Diagrams and constructional details for remodeling old audio amplifiers for operation with screen-grid tubes. Thordarson Electric Mfg. Co.

131. The Mershon Condenser—An illustrated booklet giving the theory and uses of the electrolytic condenser. Amrad Corporation.

132. The National Screen-Grid Short-Wave Receiver—Constructional and operating data, with diagrams and photographs. James Millen.

133. The National Shield-Grid Five—A circuit diagram with constructional and operating notes on this receiver. James Millen.

134. Remler Service Bulletins—A regular service for professional set-builders, giving constructional data, and hints on marketing. Gray & Danielson Mfg. Co.

135. The Radiobuilder—A periodic bulletin giving advance information, constructional and operating data on S-M products. Silver-Marshall, Inc.

136. Silver Marshall Data Sheets—These data sheets cover all problems of construction and operation on Silver-Marshall products. Silver-Marshall, Inc.

139. Power Unit Design—Periodical data sheets on power unit problems, design, and construction. Raytheon Mfg. Co.

141. Audio and Power Units—Illustrated descriptions of power amplifiers and power supplies, with circuit diagrams. Thordarson Electric Mfg. Co.

142. Use of Volume and Voltage Controls. A complete booklet with data on useful apparatus and circuits for application in receiving, power, amateur transmitter, and phonograph pick-up circuits. Central Radio Laboratories.

143. Radio Theory. Simplified explanation of radio phenomena with reference to the vacuum tube, and data on various tubes. DeForest Radio Company.

144. Low Filament Voltage A. C. Tubes. Data on characteristics and operation of four types of a.c. tubes. Arcturus Radio Tube Company.

145. Audio Units. Circuits and data on transformers and impedances for use in audio amplifier plate and output impedances and special apparatus for use with dynamic speakers. Sangamo Electric Company.

146. Receiver Circuit Data. Circuits for using resistances in receivers, and in power units with descriptions of other apparatus. H. H. Frost, Inc.

147. Super-Heterodyne Construction. Construction and operation of a nine-tube screen-grid superheterodyne. Set Builders' Supply Company.

152. Power Supply Essentials. Circuits and data on power-supply devices, and descriptions of power apparatus. Polymet Manufacturing Company.

155. The Custom Set-Builder—A four-page monthly bulletin containing information of interest to servicemen and custom set-builders. Clark and Tilson, Inc.

156. Photo-Electric Cells—A booklet describing the applications, theory and characteristics of photo-electric cells. The G-M Laboratories, Inc.

157. Uses of Electrical Meters—Set of blueprints showing correct use of meters in laboratory and testing circuits. Weston Electrical Instrument Corporation.

158. The Truvolt Divider. A circular describing ten popular power-pack circuits. Circuits, lists of parts, and pictures are also included. Electrad, Inc.

159. Radio Course of Instruction. A series of five lessons designed to teach boys the principles of radio design and construction. Junior Radio Guild.

160. Precision A. F. Resistance-Coupled Amplifiers. An engineering bulletin giving design data on precision a. f. amplifiers for television and laboratory experimenters. International Resistance Company.

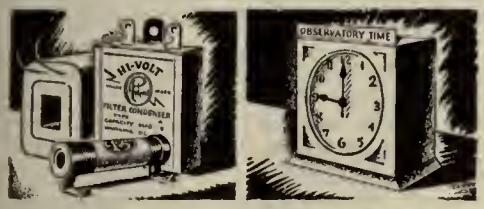
161. Loud Speakers. A booklet considering the requisites of a good loud speaker for broadcast reception. International Resistance Company.

162. Wire-Wound High-Resistance Resistors. Descriptive circular showing uses for wire-wound high-resistance resistors. The Daven Corporation.

163. The Burt Cell. Description of the electrical characteristics and uses of photo-electric cells. R. C. Burt Scientific Laboratories.

164. Characteristics of Radio Vacuum Tubes. Chart giving average characteristics of standard a.c. and d.c. tubes. The Daven Corporation.

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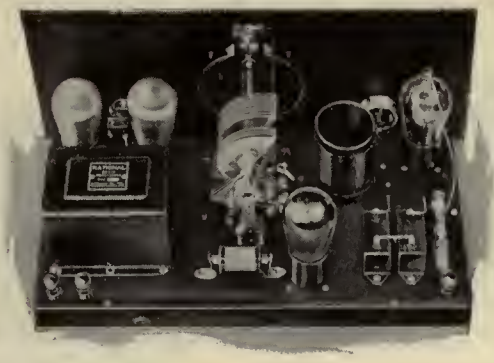
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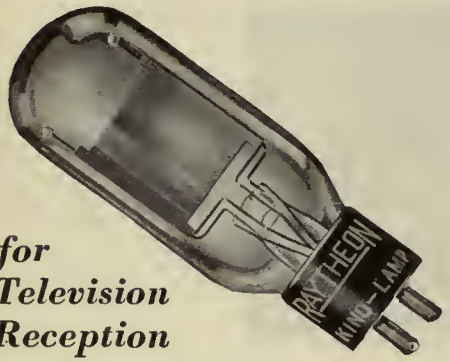
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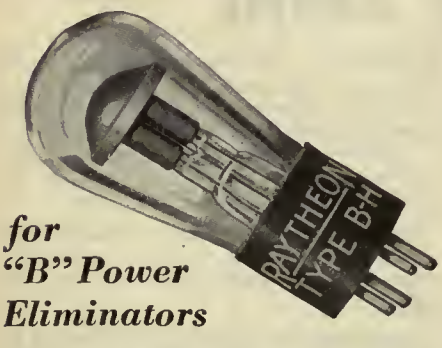


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The *Radio Broadcast* LABORATORY INFORMATION SHEETS

By HOWARD E. RHODES

THE aim of the Radio Broadcast Laboratory Information Sheets is to present, in a convenient form, concise and accurate information in the field of radio and closely allied sciences. It is not the purpose of the Sheets to include only new information, but to present practical data, whether new or old, that may be of value to the experimenter, engineer, or serviceman. In order to make the Sheets easier to refer to, they are arranged so that they may be cut from the magazine and preserved, either in a blank book or on 4″ x 6″ filing cards. The cards should be arranged in numerical order.

Since they began, in June, 1926, the popularity of the Information Sheets has increased so greatly that it has been decided to reprint the first one hundred and ninety of them (June, 1926-May, 1928) in a single substantially bound volume. This volume, "Radio Broadcast's Data Sheets," may now be bought on the newsstands, or from the Circulation Department, Doubleday, Doran & Company, Inc., Garden City, New York, for $1.00. Inside each volume is a credit coupon which is worth $1.00 toward the subscription price of this magazine. In other words, a year's subscription to RADIO BROADCAST, accompanied by this $1.00 credit coupon, gives you RADIO BROADCAST for one year for $3.00, instead of the usual subscription price of $4.00.

—THE EDITOR.

No. 278 RADIO BROADCAST Laboratory Information Sheet **May, 1929**

Inductance-Capacity Products

THE formula for determining the frequency to which a circuit will tune is

$$f = \frac{159{,}000}{\sqrt{LC}}$$

where f equals the frequency in cycles per second
L equals the inductance of the coil in microhenries
C equals the capacity of the circuit in microfarads

It is evident from this formula that the frequency to which a circuit tunes is not determined by the inductance or the capacity alone but by their product. Tables of LC products are to be found in many textbooks, and in "Laboratory Sheet" No. 279 is given a table of LC products covering the broadcast band. The usefulness of this table will become evident from the following examples.

Example 1: Suppose we have a radio receiver which uses 0.0005-mfd. tuning condensers and which tunes-in a station broadcasting on 525 meters at 100° on the dial, i.e., with the condenser plates all in. What is the inductance of the tuning coils used in the set?

Answer: From the table the LC product for 525 meters is 0.0776. Therefore, L times C equals 0.0776. We know that C is 0.0005. Therefore, 0.0776 divided by 0.0005 gives 155 microhenries as the inductance of the coil.

Example 2: Suppose we wanted to rebuild this set to use 0.00025-mfd. condensers? What would the inductance of the coil have to be? The LC product must remain the same, 0.0776. Therefore, 0.0776 divided by 0.00025 gives 331 microhenries for the coil inductance.

Example 3: The receiver described in example No. 1 will tune down to only 230 meters. Therefore, what is the minimum capacity of the circuit and what must it be reduced to to permit the set to tune down to 200 meters?

Answer: The LC product for 230 meters is 0.01489. From example No. 1 the inductance of the coil is 155 microhenries. Therefore, 0.01489 divided by 155 gives 0.000096 mfd. as the minimum capacity of the circuit. To tune down to 200 meters the capacity must be reduced to 0.01126 (the LC product for 200 meters) divided by 155 microhenries. The quotient is 0.000073 which is the minimum capacity (in mfd.) the circuit must have if the set is to tune down to 200 meters.

No. 279 RADIO BROADCAST Laboratory Information Sheet **May, 1929**

Inductance-Capacity Products

THIS table gives the inductance-capacity products to tune to various frequencies throughout the broadcast-frequency band. L is in microhenries and C is in microfarads. The use of the table is explained in "Laboratory Sheet" No. 278.

Meters	f	L × C	Meters	f	L × C
200	1,500,000	0.01126	410	732,000	0.0473
210	1,429,000	0.01241	420	715,000	0.0496
220	1,364,000	0.01362	430	698,000	0.0520
230	1,304,000	0.01489	440	682,000	0.0545
240	1,250,000	0.01621	450	667,000	0.0570
250	1,200,000	0.01759	460	652,000	0.0596
260	1,154,000	0.01903	470	639,000	0.0622
270	1,111,000	0.0205	480	625,000	0.0649
280	1,071,000	0.0221	490	612,000	0.0676
290	1,034,000	0.0237	500	600,000	0.0704
300	1,000,000	0.0253	505	594,000	0.0718
310	968,000	0.0270	510	588,000	0.0732
320	938,000	0.0288	515	583,000	0.0747
330	909,000	0.0306	520	577,000	0.0761
340	883,000	0.0325	525	572,000	0.0776
350	857,000	0.0345	530	566,000	0.0791
360	834,000	0.0365	535	561,000	0.0806
370	811,000	0.0385	540	556,000	0.0821
380	790,000	0.0406	545	551,000	0.0836
390	769,000	0.0428	550	546,000	0.0852
400	750,000	0.0450			

more Mu from Screen Grid Tubes!

ARE you getting full value from screen-grid tubes? Most likely not, for 99 out of every 100 radio men run these marvelous tubes at very low efficiency. Why?

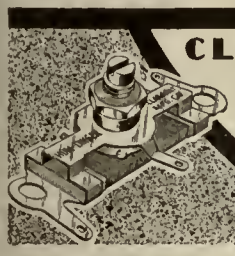
The main reason is failure to bias the control grid at 1½ volt negative potential. Of course that's troublesome if you must use a dry cell in ground lead. Other methods are equally awkward. But now you can use a better way. And here's how:

Try the Clarostat Hum-Dinger as a combination filament resistor and grid bias. Connect between negative A and filament, with center tap to ground side of antenna tuning unit. Adjust for proper grid bias by means of screwdriver, and leave it alone.

Oh boy! What a difference! And if you want to know why, just look up the characteristic curves of the screen-grid tube.

Of course the Clarostat HUM-DINGER is primarily an improved hum-balancer. Use it with your A-C filament tubes, and forget hum.

WRITE for data regarding the Hum-Dinger and other Clarostat products. There's a Clarostat for every purpose—adjustable, variable; fixed and even automatic. Ask your dealer about Clarostats.



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T-2098	Condenser Block for single 210 type tube amplifier.....	$20.00
T-280-171	Condenser Block for power pack with 280 type tube rectifier	$18.00

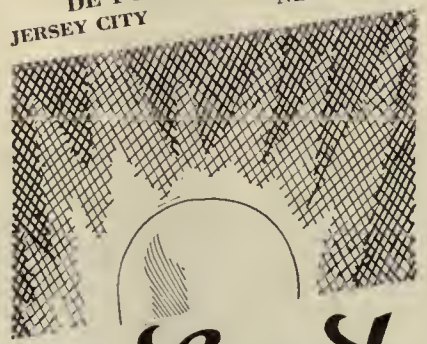
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Stop that hum!

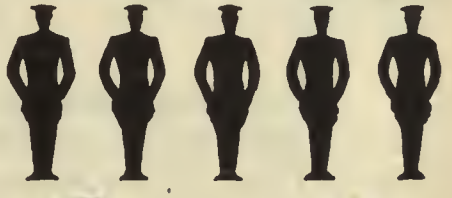
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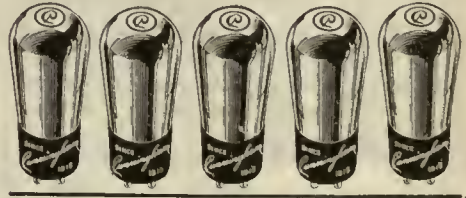
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Listen in on the CeCo Couriers—on the air every Monday evening at 8:30 Eastern time (7:30 Central time) over the Columbia Broadcasting chain.

CeCo MFG. CO., INC., Providence, R. I.

No. 280 RADIO BROADCAST Laboratory Information Sheet **May, 1929**

Characteristics of the Ear

THE ear is undoubtedly the most commonly used of acoustical devices and the curves on "Laboratory Sheet" No. 281 illustrate a very important and interesting characteristic of the ear. These curves are known as curves of "equal loudness," for each curve shows the pressure required at different frequencies, to produce sounds of equal loudness.

The lowest curve marked "threshold curve" is sometimes called the curve of minimum audibility and it indicates the pressures which will produce sounds *just audible* to the average ear. This curve shows that at minimum audibility the ear varies greatly in sensitivity, at different frequencies. The upper curve, which indicates how the sensitivity of the ear varies with loud sounds, shows the ear to be almost equally sensitive throughout the entire range of frequencies.

These curves have a definite relation to the reproduction of radio programs and indicate why we seem to lose the bass when the volume is cut down very low and why a loud speaker seems to boom (too much bass) when the volume is increased greatly. Sounds must be reproduced at a normal volume level, i.e., that level at which we are accustomed to hear music, if the reproduction is to sound natural. Even though the intensity of all the tones in the music are amplified equally well the curves indicate that a relatively increased effect on the ear will come from the bass portion if the sounds are too loud and a relatively increased effect from the treble if the sounds are too low in intensity.

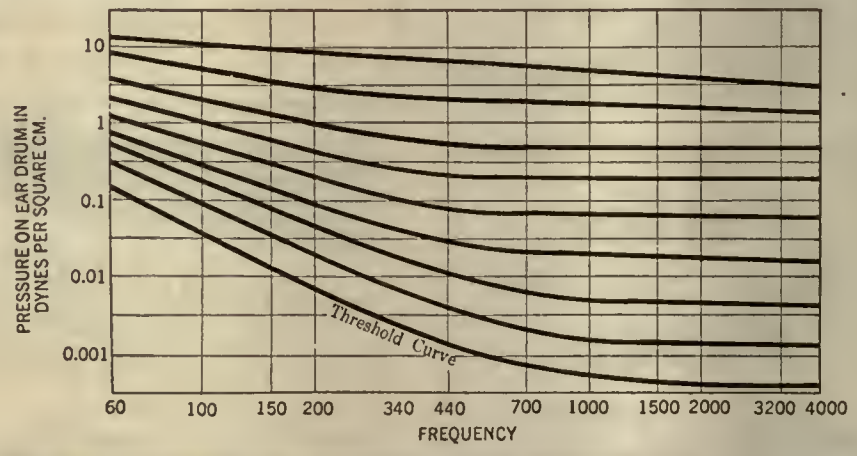
The data from which these curves were plotted was obtained from experiments made in the Bell Telephone Laboratories. The subjects listened to pure tones from a telephone receiver driven by current from an audio oscillator. The listeners compared different tones, two at a time, as to loudness and adjusted the intensity of the two tones so that they were equally loud. All of the apparatus was calibrated carefully and the engineers were able to determine from the setting of the adjustment the sound pressure in dynes per square centimeter.

Some additional data on this same subject will be found in "Laboratory Sheet" No. 109 in the July 1927, issue.

No. 281 RADIO BROADCAST Laboratory Information Sheet **May, 1929**

Characteristics of the Ear

THESE curves show the sound pressures which, acting on the ear, give sensations of equal loudness. They were prepared from data obtained from experiments made in the Bell Telephone Laboratories.



No. 282 RADIO BROADCAST Laboratory Information Sheet **May, 1929**

Amplifier Input Circuits

POWER amplifiers such as are coming into prominent use in auditoriums, theatres, dance halls, etc. may be employed to produce entertainment by connecting the input of the amplifier to a regular receiver, by making connections to a phonograph pick-up so that phonograph records may be played, or, in other cases, by connecting a microphone to the input. The amplifier may be used in any of these ways with practically no change in the circuit—the only change necessary is at the input to adapt the circuit to the source from which the signals are to be obtained.

These amplifiers are arranged normally so that they may be used with either a radio receiver or a phonograph pick-up. Appropriate terminals for these two devices form an integral part of the amplifier. In case the amplifier is designed for use only with a radio receiver, a phonograph amplifier may be used readily by connecting the two terminals of the pick-up across the primary of the first a.f. transformer of the amplifier. However, when it is desired to use a microphone at the input of such an amplifier a change is necessary since the microphone requires direct current for its operation and also the microphone is a low-impedance affair whereas the phonograph pick-up and radio receiver have high output impedances. With a microphone it is necessary that a special microphone transformer be used to adapt the impedance of the microphone to the input impedance of a tube. The primary of the microphone transformer should be connected across the microphone and in series with a few dry-cell batteries or a storage battery, the latter being preferable because of its greater capacity. The secondary of the microphone transformer is connected to the grid of the first a.f. amplifier tube. Microphone transformers are made by most of the well-known transformer manufacturers and complete instructions regarding their use can be obtained easily.

It should be realized that the above notes do not apply to all power amplifiers since some of them are equipped with three sets of input terminals so that either pick-up, radio, or microphone may be used. Obviously, the thing to do when purchasing such an amplifier is to decide what is to be used to supply the input signals and to then make certain that the amplifier under consideration is arranged with the proper input connections.

This sheet is the result of several letters received at the Laboratory from readers who have been under the impression that it is possible to obtain good results by simply connecting microphones across the input of an amplifier originally designed for use with a phonograph pick-up unit or radio receiver.

JUNE 1929

RADIO BROADCAST

PUBLISHED FOR THE RADIO INDUSTRY

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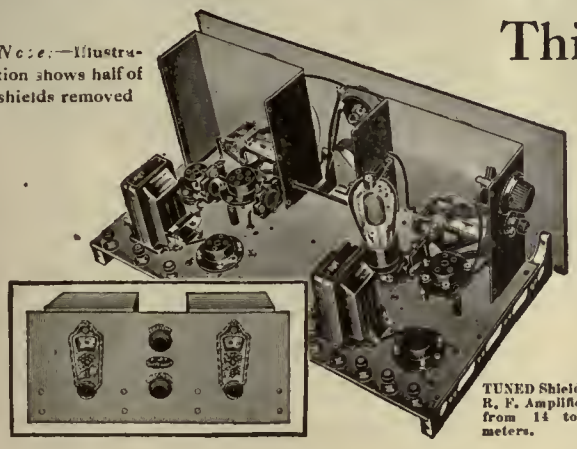
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Announcing-PILOT'S NEW Radio Thrill!



Note:—Illustration shows half of shields removed

TUNED Shield Grid R. F. Amplification from 14 to 500 meters.

This is what R. S. Kruse says:

"In my opinion no receiver manufactured today is better suited to the amateurs' 1929 need than is the Pilot Super Wasp."

World's Finest S-W Set

The Super-Wasp Kit combines in one receiver Short-Wave and Broadcast Reception from 14 to 500 meters.

Not merely a shield grid stage of doubtful value in front of a regenerative detector—but a scientifically engineered receiver with a *tuned* screen grid circuit that provides a gain of from 4 to 20 over the entire amateur spectrum. The SUPER WASP takes the applesauce out of most "QSA-5" reports.

Selectivity is enhanced without tuning complications. The shield grid stage really TUNES! With this receiver you can unscramble the fones on the 80 meter band. These definite superiorities have been acbieved without undue circuit or mechanical complications.

Here's What You Want to Know about the SUPER WASP

The Pilot Super Wasp Kit comes to you complete, with panels and cans accurately drilled and fitted, and with full scale blueprints. Can be assembled in one evening. The short direct leads, required in hooking up, are indicative of its *efficient simplicity.*

The set is completely shielded eliminating all hand capacity effects. *The regeneration control, once set, is consistent over any amateur band.* There remain only two tuning controls—following degree for degree.

A complete set of r. f. and detector plug-in coils comes with each kit, covering all wavelengths from 14 to 500 meters, with a generous overlapping.

One stage of S-G amplification *that tunes and amplifies!* Two stages of audio. 14 to 500 meters with plug-in coils. Two controls over *any* amateur band. Completely and individually shielded. 6 v. A, 9 v. C and 135 v. B. The finest amateur S-W set in the world. Also a splendid broadcast receiver. So simple, the beginner can build it. So effective, the veteran ham cannot afford to be without it.

PILOT SUPER WASP KIT — $29.50
(Catalog No. K-110) — *(Slightly higher West of the Rockies)*
Including 2 sets of 5 coils each, full-sized blue-print and complete assembly data.

Send for Radio Design

50c. brings you one year's subscription to "Radio Design". Quarterly Magazine, chock-full of latest Radio, Short Wave and Television Developments. "Radio Design", 103-E Broadway, Brooklyn, N. Y.

Name .....

Address .....

City ..... State .....

The Pilot Super-Wasp is made in World's Largest Radio Parts Plant

PILOT ELECTRIC M'F'G. CO. INC.
323 BERRY ST. BROOKLYN, N.Y.
ESTABLISHED 1908 — TRADE MARK REG.



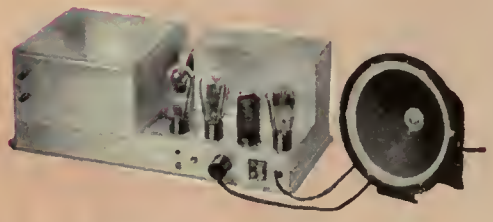
McMURDO SILVER

Announces

Silver

And now, at last, comes Silver-Marshall's entry into the complete RCA—licensed radio receiver field with SILVER RADIO—the most sensational development since a.c. tubes revolutionized radio.

1929 is a Screen-Grid year. Its pace will be set by the new type radio that is SILVER RADIO—so original and so advanced technically as to be *utterly different from any other manufactured receiver.* For SILVER RADIO comes from a designer, a laboratory, and a factory that have *mastered* Screen-Grid technique—and *proved* it by chalking up unbroken records with the Sargent-Rayment Seven, and the famous Screen-Grid Sixes.



The SILVER RADIO chassis and speaker above is made complete in the new home of Silver-Marshall pictured below—the third largest exclusive radio plant in the Chicago area. The eight-tube Model 30 chassis (as furnished in Model 60 Lowboy and Model 95 Highboy) contains the fully shielded, non-oscillating Screen-Grid r. f. amplifier, with band selector, Screen-Grid power detector, push-pull power amplifier and A, B, C, and speaker power supply. It is a marvel of mechanical and electrical engineering. In all comparative tests so far, no other radio has been found which can even equal its performance.



SILVER RADIO is nothing if not *new.* It is first to *eliminate all antenna installation.* It is first to use *three* 224 a. c. Screen-Grid tubes as r.f. amplifiers with *band-selector tuning,* followed by a *fourth* Screen-Grid tube in the newest type of power detector circuit. SILVER RADIO is first to use a pair of 245 power tubes in push-pull; first to use a *matched-impedance* dynamic speaker. And SILVER RADIO is first also with a startling development—the *Overtone Switch,* which brings out all the beauty of ordinarily-lost high notes as does no other radio—yet cuts them out at will to reduce static in bad weather. And prices—SILVER RADIO is first with prices so low that they actually make you gasp, even though they are made possible by tremendous production.

SILVER-MARSHALL, *Incorporated*

SM ***"Silver on Radio is like***

Radio

Just as a.c. tubes changed the "fashion" in radios from battery to light socket in 1927—just as surely will SILVER RADIO revolutionize public demand in 1929. For *you* know that the amazing new features of SILVER RADIO spell *revolution* in radio results—for distance, for selectivity, tone, convenience, and low cost.

Appreciation is due, and is in full measure given, to the many friends whose use and recommendation of S-M products has pushed SILVER-MARSHALL up into the position of dominating leadership in the parts field, now to launch forth, from one of the largest radio plants in America, the self-contained SILVER RADIO receivers. And Silver-Marshall has kept faith with these friends —SILVER RADIO is just the outstandingly superior product that they have always expected from the S-M laboratories.

SILVER RADIO will be distributed through leading jobbers to franchised dealers in exclusively allotted territories —backed by an unprecedentedly large newspaper advertising allowance per set, to "break" in the early summer. Dealer demonstrations are being arranged now, and franchise applications are being received.





Model 60 Lowboy (above) and Model 95 Highboy (below) are finely built of striped walnut, in Sheraton period, finished in high-gloss lacquer. Both contain the same 8-tube a. c. Screen-Grid SILVER RADIO chassis, matched dynamic speaker, and screen antenna. They are absolutely complete, less only 4-'24, 1-'27, 2-'45 and 1-'80 tubes (list price of tubes, $29.50). Model 60 Lowboy is priced at $160. Model 95 Highboy at $195 (slightly higher west of the Rockies). Both models operate on 100 to 130 volt, 50 to 60 cycle a. c. (25 cycle model *special*)

6443 W. 65th St., Chicago, U. S. A.

Sterling on Silver"

SILVER-MARSHALL, Inc.
6443 West 65th Street, Chicago, Ill., U. S. A.

Send me the dope, and tell me where I can see and hear it—I'm interested.

Name.....

Address.....

City.....State.....

SPEED

RADIO TUBES

TESTED and APPROVED by Landay Brothers



AND BY THE METROPOLITAN PUBLIC.

Thousands of radio fans saw
SPEED RADIO TUBES
tested before their eyes

LANDAY BROTHERS, one of the largest radio outlets in the East, tested **SPEED** Tubes, found they were everything we said they were, and then some, and put their o. k. on the **SPEED** Tube Line.

Then Landay showed New York why they chose **SPEED**. All day Saturday, April 27th, thousands of radio users milled into Landay's to see the laboratory tests on **SPEED** Tubes.

"How did it go?" we asked Landay. "It was a great **SPEED** day," they said. (and it certainly looked like it from the sales figures they showed).

But we expected **SPEED'S** success. Every place **SPEED** has gone, it has gone over with a resounding bang. Why not, when the line is right — right in price, right in quality, right all the way through. There's a **SPEED** Tube for every radio and every radio need.

SPEED — short, snappy, easy to remember. A far-flung advertising campaign — Saturday Evening Post, newspapers and fan magazines — will engrave it in every mind — make **SPEED** just another word for Tube. Now's the time to check into the best money-making tube proposition in the field.

SPEED

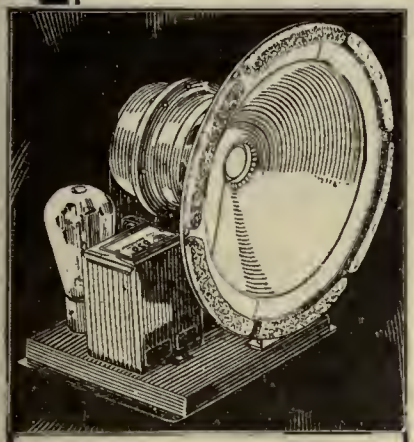
CABLE RADIO TUBE CORPORATION

80-90 N. Ninth St., Brooklyn, N. Y.

MAKERS OF RADIO TUBES SINCE 1924

RMA RADIO MANUFACTURERS ASSOCIATION MEMBER

S-M Reduced Prices Mark a New Era Of Confidence



YES—
Something Happened in Speakers When the S-M Appeared

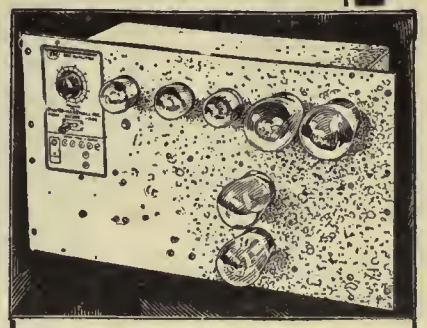
The new S-M speaker is fast becoming as famous an audio product as Silver-Marshall's immensely popular Clough-system audio transformers. So accurately designed is this new speaker unit that it eliminates all objectionable hum as well as "drummy" tones, and brings out both low and high pitches with a fidelity hitherto unobtainable. Two types: 851 for 110-volt d.c., $29.10 *net*. 850, for 50-60 cycle 105-120 volt a.c. (using 1—'80 tube), $35.10 *net*.

FOR a long time Silver-Marshall has felt that the "list price" method of pricing prevalent in the radio parts business was not conducive to public confidence, and that it should be discarded in favor of an honest and straightforward policy. The situation today is that fully 95% of all radio parts sold go to professional setbuilders, service men or experimenters with commercial connections, who buy at a fictitious "list" price less a discount, usually about 40%. As this discount is available thru, actually, millions of mail order and jobber catalogues, to any and every buyer, the list price is indeed fictitious, and serves no purpose except to destroy confidence.

For this reason Silver-Marshall, as America's largest parts manufacturer, believes that the time has come to "clean house" in the industry—alone if necessary. Therefore, effective April 15th, all S-M list prices were reduced about 40%, so that the new *list* prices are now about the *net* prices available to all. No "dollars and cents" change is made—an outworn fiction only is discarded. Henceforth, the professional setbuilder and service man will never be embarrassed when, after selling a set, he is confronted by his customer with a net price catalog. There will be only one selling price on S-M apparatus—the new "net-list," at which consumers, setbuilders, and professional setbuilders can all buy.

This change is intended to, and will, protect service stations and professionals, who, buying parts at the same prices their customers obtain, have their profits insured by a fair and generous differential (to cover their labor) between the cost of parts to their customers and the cost of *factory wired* sets.

S-M believes that this frank and open policy will insure confidence among those it is designed to protect and help—the consumer, the setbuilder, the service station and jobbers, for it protects the professional from cut-price competition, consequently makes selling easier, and inspires confidence, not mistrust, in his customer.



S-M Power Amplifiers With Clough-System Tone

Operating entirely from the a.c. light socket, and using the famous S-M Clough-system audio transformers, these amplifiers give the very finest reproduction at auditorium-volume obtainable on the market today.

S-M 690, to reach 2000 or more people, has three stages (last two push-pull); supplies 6 to 12 or more dynamic speakers. Fading control on panel, and three-point switch for record—microphone—radio input selection. Uses 1—'27, 2—'26, 2—'50, and 2—'81 tubes. Price, less tubes, $147, *net*.

S-M 679, to reach 1000 or more people, has two stages; supplies 2 to 4 or more dynamic speakers. Binding posts for microphone—radio—record pickup input. Uses 1—'26, 1—'50, 2—'81 tubes. Price less tubes, $81, *net*.

S-M "PA" type amplifiers are available for all larger experimental installations at surprisingly reduced prices, as shown in our new April 15th catalog.

S-M's monthly publication, The RADIOBUILDER, is mighty interesting reading these days. Issue No. 12 (April, 1929) contained a forecast of band selector tuning as it will characterize 1930 receivers; also a timely discussion of the "one-stage" audio trend. If you are not getting the RADIOBUILDER, be sure to send the coupon—and send it anyway for the new S-M April catalog, containing new low S-M list prices, which are net.

Authorized S-M Service Stations have made money this season, and still bigger opportunities are opening up for them. Ask us about the Service Station appointment.

SILVER-MARSHALL, Inc.
6403 West 65th St., Chicago, U. S. A.

Silver-Marshall, Inc.
6403 W. 65th St., Chicago, U. S. A.

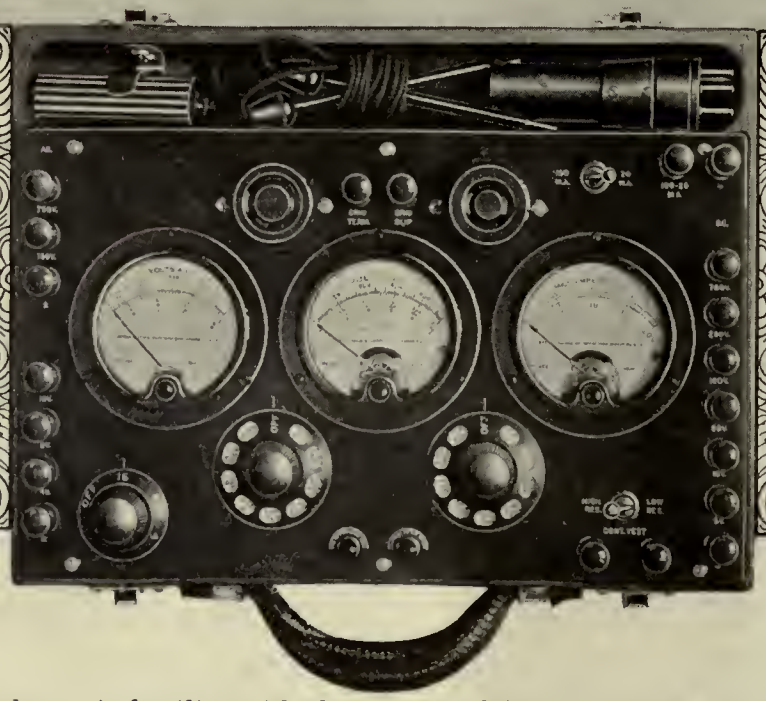
.... Please send me, free, the new April S-M Catalog; also sample copy of the RADIOBUILDER.
For enclosed.....in stamps, send me the following:
.... 50c Next 12 issues of The Radiobuilder
.... $1.00 Next 25 issues of The Radiobuilder

S-M DATA SHEETS as follows, at 2c each:
....No. 1. 670B, 670ABC Reservoir Power Units
....No. 2. 685 Public Address Unipac
....No. 3. 730, 731, 732 "Round-the-World" Short Wave Sets
....No. 4. 223, 225, 226, 256, 251 Audio Transformers
....No 5. 720 Screen Grid Six Receiver
....No .6. 740 "Coast-to-Coast" Screen Grid Four
....No. 7. 675ABC High-Voltage Power Supply and 676 Dynamic Speaker Amplifier
....No. 8. Sargent-Rayment Seven
....No. 9. 678PD Phonograph Amplifier
....No. 10. 720AC All-Electric Screen-Grid Six.
....No. 12. 669 Power Unit (for 720AC)

Name.....
Address.....

THE NEW RADIO SET TESTER

See it at the R.M.A. convention



WESTON
EXHIBIT
AT HOTEL
STEVENS

The radio industry is familiar with the Weston Model 537 Radio Set Tester—for A. C. and D. C. receivers. Service men hailed it with great acclaim a year ago, noting its many advantages over the Weston Model 519—for D. C. only.

And NOW—here is another great advance—the Weston Model 547—incorporating many additional features to meet the service testing requirements of radio's latest developments. And there have been many since the last R. M. A. Convention. But with this NEW SET TESTER radio servieing is still further simplified, even taking into account the number of new tubes, sets and circuits.

Space won't permit description here—nor would words alone do this new set tester justice. You must see it for yourself—operate it—try to think up some service problem it can't solve. Try as you will the Model 547 will give you a quick and accurate answer every time. Convenient—complete—light and rugged. Handsome in appearance—and it will yield you handsome profits. It will increase your business and your prestige. *YOU CAN BANK ON IT!*

OUTSTANDING FEATURES OF THE MODEL 547

First of all it is a WESTON*—assuring you exquisite workmanship and complete service reliability. It is provided with three instruments—all 3¼" diameter and furnished with bakelite cases. Carrying case, removable cover, panel and fittings are also made of sturdy bakelite.*

A. C. Voltmeter—750/150/16/8/4 volts. The three lower ranges are brought out to the Tester plug, and all five ranges are brought out to binding posts. 750 volt range is for testing secondaries of power transformers. 16 volt range is to provide for 15 volt A. C. tubes. Operations have been reduced—only one selector switch being necessary.

D. C. Voltmeter—High range increased to 750 volts. Other ranges—250/100/50/10/5—all six ranges brought out to binding posts and Tester plug.

D. C. Milliammeter—Double range—100/20 M. A. provides for lower readings with better scale characteristics.

Tests—On A. C. sets the heater voltage and plate current can be read throughout the test while the D. C. voltmeter may be indicating plate bias or cathode voltage.

Self-contained, double-sensitivity continuity test provided. This can also be used for measuring resistance as well as testing for open circuits. Grid test can be made on A. C. or D.C. screen grid tubes—also the '27 tubes when used as a detector—without the use of adapters.

Two sockets on the panel—U Y tube adapters eliminated.

Weston
PIONEERS SINCE 1888
INSTRUMENTS

NEW, REVOLUTIONARY, A YEAR AHEAD



Largest Pick-up Ever Put on the Market

The Best *Theatre* Pick-up is the largest, heaviest and most powerful pick-up available to the general public. Naturally, to get power you must have size. And with size you must have weight. The Best Suspension Bridge Counter-Balance makes it possible to use this weight with but the weight of a feather on the delicate record.



Thunderous Volume!

Volume . . . thunderous volume . . . enough to tax the capacity of any speaker . . . and yet you can cut down the volume to the barest whisper. And without the slightest distortion! Performance that beggars description, so much better than ordinary pick-ups, that there is no comparison.

COUNTER BALANCED!



The Best Theatre Pick-up, is built like a suspension bridge. So delicately is it balanced, that only a feather weight is placed on the record. When finished playing a record, simply tip the head — it stays — no danger of ruining record or woodwork. Perfect balance does it.



Know the Best by the Box

Individually packed in the most sumptuous display box known to the Radio Industry. To place one of these display boxes on your counter, is to sell it. Complete with volume control and adapter for four or five prong tubes (in case the set does not have a phonograph jack).

List price $17.50, with long arm for Theatre Records $20.00.

BEST MANUFACTURING CO.
1200 GROVE ST., IRVINGTON, N. J.



The BEST *Theatre* PICK-UP
For Home and Theatre

Best Manufacturing Company,
1200 Grove St., Irvington, N. J.

Send us complete information on the following:—

☐ Best *Theatre* Pick-up
☐ Best *Theatre* Dynamic

Name .....

Address .....

.....

RADIO BROADCAST

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KEITH HENNEY . *Director of the Laboratory*
HOWARD E. RHODES . . *Technical Editor*
EDGAR H. FELIX . . . *Contributing Editor*

VOL. XV. NO. 2

PUBLISHED FOR THE RADIO INDUSTRY

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The contents of this magazine is indexed in *The Readers' Guide to Periodical Literature*, which is on file at all public libraries

. . . *among other things*

HERE WE are at the start of another radio season. How will it compare with other seasons? What are the manufacturers' offerings? What are the trends? In short, how is the radio world going? In the issue now before you, we have tried to provide answers to most of these questions, written by those who are in a large measure responsible for our present advancement.

THE PRICE tendency this year is perhaps the most obvious: manufacturers are giving more value for less money in 1929 than they did in 1928. The sets, from those in the lowest price class to those selling for the highest figure, give improved performance and are generally better values. At least one leading maker offers in his list price the entire receiver equipment: set, loud speaker, cabinet, and tubes. This, in our opinion, is a step of great importance and we believe the practice in time will become more general. The radio sets themselves, although they do not differ materially from those offered in previous years, are definitely improved in exterior appearance. "Beneath the hood," they contain a great number of improvements, which, while not sensational, represent engineering advance, and show that the design engineers have not been idle. All receivers are basically the same yet each has its individual technical points of difference. The engineers now know how to measure these differences and can tell exactly what the real performance of the set is. Models are now thoroughly tested, measured, taken apart, redesigned, and put together again before being put into production and offered to the dealer and to the public. Radio manufacture, in short, is a much more exact operation than ever before. From this, the entire industry benefits, and the public, praises be, receives more for its investment.

HOWARD W. DICKINSON, formerly executive vice-president of the George Batten Company, and a nationally known authority on merchandising problems, begins a series of intensely interesting articles in the July RADIO BROADCAST. These articles, warmly personal and sympathetic, will offer some new and distinctly helpful ideas on radio selling. In addition to many other helpful articles for those who sell radio, our technical section in July will contain the finest line-up of material it has ever been our pleasure to present. For the first time anywhere, we offer in that issue complete technical descriptions of three well-known commercial receivers; a splendid article on loud speaker measuring methods; definite data on the 245-type tube, and numerous other special features.

—WILLIS KINGSLEY WING.

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RAYTHEON

RAYTHEON has done something more than imitate the design of other tubes. Raytheon has made a very real contribution to radio.

RAYTHEON *was FIRST*

To produce a practical, heavy duty rectifier tube for B-elimination.

And when Raytheon brought out a full line of A. C. *and receiving tubes,* RAYTHEON *was FIRST*

To anchor receiving tube elements at the top with mica, increasing rigidity and uniformity of performance.

To produce a long-life, quick-heating tube for A. C. operation.

And RAYTHEON *ALONE*

Builds a tube of FOUR-PILLAR CONSTRUCTION, cross-anchored top and bottom—a tube so sturdy that its laboratory-tested performance cannot be changed by the shocks and knocks of shipment and handling.

In addition to the many outstanding improvements and patents which can be used by Raytheon *only*, Raytheon will benefit by all R. C. A. tube patents, present and future.

Due to the license granted Raytheon—*jobbers and dealers can sell these high-quality tubes with no danger of legal entanglements or "frozen" stock.*

EVEREADY RAYTHEON

EVEREADY RAYTHEON

THE NEWEST NAME IN RADIO

NATIONAL CARBON COMPANY, Inc., now controls production and sale of licensed Raytheon Tubes. This combines not only the names, but facilities of these two companies.

Effective June 1, 1929, Eveready Raytheon Tubes will be produced and merchandised under the control of the great Eveready organization.

Plant enlargements are now under way. Additional equipment is being installed. Production of Eveready Raytheon Tubes will be enormously increased. An adequate supply is assured.

Eveready Raytheon is a large individual division of the National Carbon Company, Inc., and will have all of the usual aggressive Eveready advertising and merchandising activities back of it. Extensive Publicity . . . Broadcasting . . . Advertising.

This means increased opportunities for present Raytheon dealers. Additional franchises will be allotted. There will be full co-operation with the trade.

Plan now to take full advantage of this great new development in the radio tube market. Be sure to order an adequate stock of Eveready Raytheon Tubes.

NATIONAL CARBON COMPANY, INC.
New York, N. Y.

Branches: Atlanta, Chicago, Kansas City, Long Island City, San Francisco

Unit of Union Carbide UCC *and Carbon Corporation*

EVEREADY RAYTHEON

EVEREADY RAYTHEON



EVEREADY Raytheon Tubes will be sold in this package, made in the Eveready colors—red, blue and gray. It brings the prestige of two well-known names together in a striking display.

The change in name will mean even more than a great expansion of production and distribution. In addition to the specialized activities of the famous Raytheon laboratories at Cambridge, Eveready Raytheon will have the benefit of all research and development facilities of the National Carbon Company, Inc.

Eveready Raytheon will continue to lead in radio tube development. As an Eveready Raytheon dealer, the many developments in principle and design which are constantly in progress in the Eveready Raytheon laboratories assure you of radio tubes abreast of the moment . . . ahead of it.

Don't miss this opportunity to profit by all that Eveready Raytheon will have to offer you. Get in touch with your jobber or distributor today.

NATIONAL CARBON COMPANY, Inc., New York

Branches: Atlanta, Chicago, Kansas City, Long Island City, San Francisco

Unit of Union Carbide UCC *and Carbon Corporation*

EVEREADY RAYTHEON



EVEREADY RAYTHEON PACKAGE

and great new

E R 224

Screen Grid Tube

EVEREADY
RAYTHEON



E R 224 *tube with exclusive four-pillar construction, cross-anchored top and bottom*

Eveready Raytheon Tubes are a complete line

E R Rectifier BH
E R Rectifier BA
E R 201-A
E R 200-A
E R 112-A
E R 171-A
E R 210
E R 250
E R 245
E R 240
E R 280
E R 281
E R 226
E R 227
E R 224
E R Type A Cartridge Rectifier
E R Photo-cell
E R Kino Lamp

Announcing

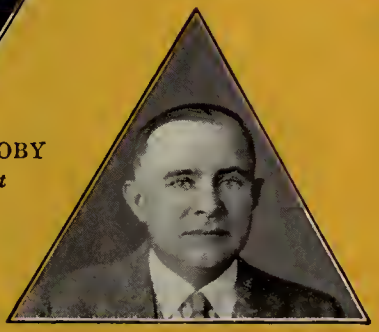
TRIAD

RADIO TUBES

Achieved at last—the tube perfection for which the radio world has waited! Exhaustive research, a radically new engineering process, greatly advanced laboratory methods, a care in production and testing which has never been known before—from all these has been created an infinitely higher standard in tube quality, a standard which only Triad Tubes offer! Tests have proved their unparalleled clarity of tone, their longer life and their greater sensitivity and volume. ▲▲ Back of every Triad Tube is the personal guarantee of a group of pioneers in the radio industry, whose integrity and resourcefulness has been proved through years of intimate contact with both trade and public. ▲▲ Their product, the result of a conviction that better tubes could be manufactured, now makes possible a greater and more economical enjoyment of radio reception!



GEORGE COBY
President



ELY EGNATOFF
Treasurer



WILLIAM CEPEK
Secretary



HARRY H. STEINLE
Vice-President and General Sales Manager



"Quality ▲ Service ▲ Durability"

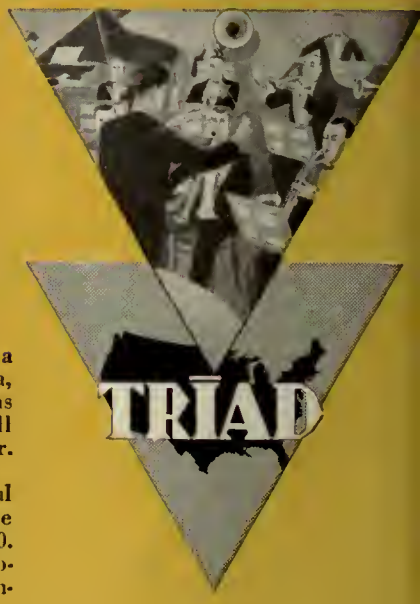
Dealers!

TRĪAD brings you a definite, well-planned policy of sales cooperation. Unequalled quality, a continuous supply, prompt deliveries, close factory contact—in short, every possible bit of assistance will be yours. A tremendous advertising, radio and publicity campaign has been launched that will make Trīad the world's most popular tube. Tie-up material will be provided to each dealer in any quantity desired. And there is a generous profit margin with Trīad—one that will bring real satisfaction to you with every sale. A greater tube business with greater profits is waiting for you in 1929 with Trīad. Write or wire now for the special sales and merchandising proposition we have arranged for you!

The Trīad Line—Complete

A complete line of A. C. tubes included in the Trīad line—also D. types, Special Purpose tubes a Television and Photo Electric Cel The Trīad Line enables you to me your customer's demand instantly and Trīad quality assures absolu satisfaction with every sale.

The TRĪADORS will broadcast a popular program every week over a national network. This selling cooperation will mean a steady consumer demand for Trīad Tubes.



Trīad Publicity

Broadcasting: Fifty-two weeks of broadcasting over a national network, have been arranged. A famous orchestra, stars of the stage and concert world, elaborate presentations of varied nature—all these and many other features will sell Trīad Tubes in the homes of every radio owner.

Newspapers and Magazines: An extensive national newspaper and magazine campaign will keep the Trīad line constantly before the reading millions in 1929 and 1930. This powerful advertising, together with interesting publicity items will aid materially in building a steady consumer demand.

Dealer Helps: Attractive window strips, fliers and broadsides for counter or mailing purposes, plates and matrixes for local advertising—these are only a few of the many merchandising helps available to every Trīad dealer. Every possible aid will be extended in helping the individual dealer to tie up with the national newspaper and radio campaigns.

New! "Tube Insurance"

A certificate is enclosed with every Trīad Tube, guaranteeing thoroughly satisfactory service. Here is a unique and valuable Trīad merchandising feature! It means satisfaction to both customer and dealer—and a saving in the dealer's selling time and expense. Remember—only Trīad offers "*TUBE INSURANCE*".

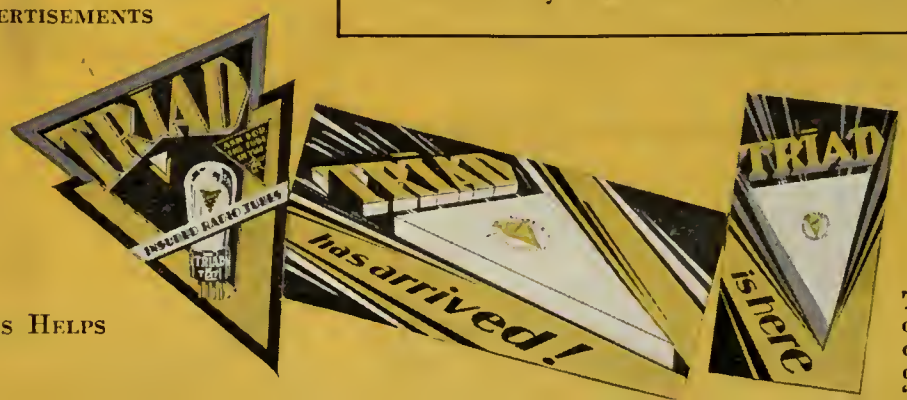


NEWSPAPER AND MAGAZINE ADVERTISEMENTS

"The Tube in the Triangular Box"



The Trīad box itself is of tremendous merchandising value. Its unique shape and design lend themselves easily to spectacular displays. Your trade will soon learn to "Ask for the tube in the triangular box."



DEALER'S HELPS

Seven Seas Console

First With A-C Shield Grid Tubes



ONCE again Leutz leads, introducing the first A/C Console to use the superior A/C Shield Grid Tubes. The result—a superior Console which will meet all competition, 100% shielding, wide spacing between radio frequency transformers and metal and unit construction contribute to make up the finest in radio for the coming season—the new Seven Seas Console by Leutz.

Unit Construction

THE electrical equipment is divided into four separate units: 1, chassis; 2, power amplifier; 3, power pack; 4, dynamic loud speaker. Two 210 tubes in the push-pull amplifier. Three A/C Screen Grid Tubes in the radio frequency amplifier. All heater tubes including one in the detector circuit and one in the first audio stage and a full wave rectifier using two 281 tubes. Here is a radio into which are incorporated the new features of 1930 radio with an unusually perfect audio amplifier. Highest quality dynamic speaker used.

A RADIO that defies competition. A sales leader for the dealer who wants something better than the ordinary to sell. Investigate the Seven Seas Console by Leutz.

Features:

A/C Operation
Single Dial
Dynamic Speaker
Push-Pull Audio
2/210 Power Tubes
100% Shielding
Adjustable Selectivity
Shield Grid Tubes
Heater Type Tubes
Unit Construction
9 Tubes
Maximum Range
Tremendous Volume
Perfect Reproduction
Walnut Console

FRANCHISE APPLICATIONS ARE INVITED
from established dealers
LITERATURE ON REQUEST

C. R. LEUTZ, Inc.

LONG ISLAND CITY, NEW YORK, U. S. A.

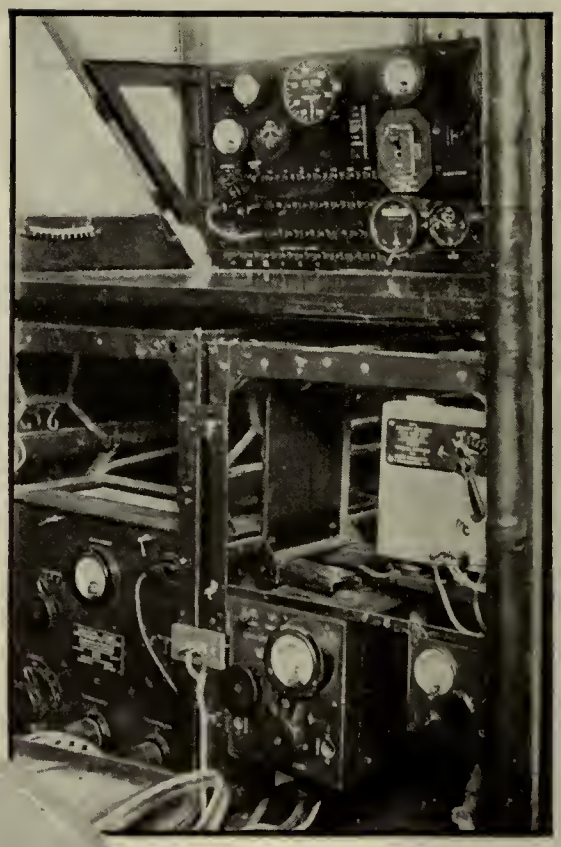
CABLES: "Experinfo"—New York

West Coast Representative
B. J. HOWDERSHELL — Detwiler Bldg., 412 W. Sixth St., Los Angeles



In the "flying laboratory" shielding is used as shown above to prevent the ignition system from causing interference with the reception of beacon signals.

The U. S. Bureau of Standards has equipped an airplane as a laboratory for testing radio beacon signals at night and during foggy weather. On the right is shown the equipment installed in the plane.





Guglielmo Marconi seated in front of an array of radio receiving and transmitting equipment of the vintage of 1901 is shown in an old picture on the left.

View of the dignified modernistic exterior of the Molala (Sweden) broadcasting station.

This attractive new building houses the complete equipment, including studios, of station WENR, *Chicago, Ill.*





INTERESTING RADIO PICTURES OF THE MONTH

How Can Radio Satisfy the Public's Artistic Demands?



RALPH H. LANGLEY, Director of Engineering, Crosley Radio Corporation, says, "Radio . . . is an even greater improvement over the old phonograph than the automobile over the horse and buggy. Surely it is entitled to the same beauty and distinction of design. . . . We need new and honest treatments . . . which make no apology to the past . . ." Mr. Langley, when in charge of receiving set design for the General Electric Company, was responsible for the first super-heterodyne models with sealed "catacombs."

THE TREND IN CABINET DESIGN

By R. H. LANGLEY

Crosley Radio Corporation

WHERE HAVE the modern designs for radio sets come from, and where are they going to? Is there any definite history back of our present radio cabinets, and can we think of them as final, or will there be further developments? These are interesting and important questions, worthy of careful examination.

Radio receivers (they used to be called "wireless receivers") have been built for a great many years. Back in those early days a receiver consisted of but few parts, and they were fastened down to a board, so that the connections would stay in place. It may be somewhat of a surprise to know that our present highly complicated receivers are built on this same plan. To be sure, there have been tendencies away from this arrangement, but to-day, apparently, we are back again at first principles.

The first step away from the "breadboard" design was the introduction of a front panel, with some of the devices mounted on the panel and some on the base. One of our well-known manufacturers has a patent on this construction. Then came sets in which the panel replaced the base completely, and everything was mounted on it. Hundreds of thousands of receivers of this type were built and sold, and many of them are still in service.

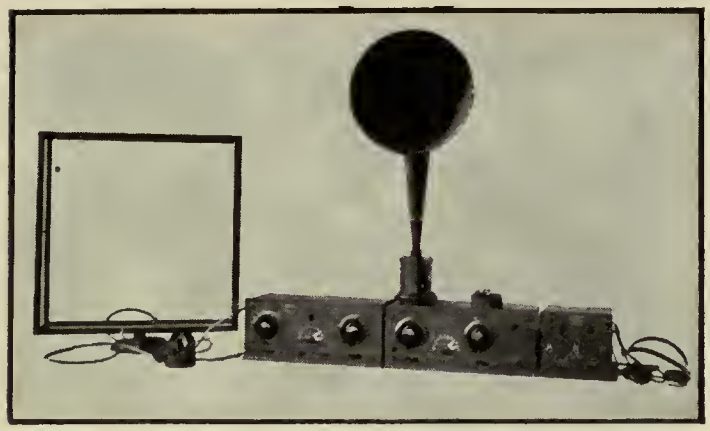
The desire to conceal all the wiring, which at best was unsightly, was the probable reason for the return to the base mounting for all the parts. The old "breadboard" has been replaced by a punched steel chassis, and all the wiring is inside this base. In most modern sets, the a.c. power unit is also mounted on this same steel base, and this form can perhaps be regarded as the highest development in design.

The relation of the loud speaker to the present status of set design is also interesting. Why is the loud speaker still a separate device? The fact is that, in spite of all that can be said about the advantages of having the loud speaker at some different point in the room from the receiver itself, the present arrangement is an inheritance from the earlier days, which we have not yet discarded. It is a relic for which we seem to have some sentimental attachment. The day is probably close at hand when we shall forsake this time-honored division of our equipment and build the receiver and speaker in one unit.

Early Receiving Methods

IN THE EARLY days the only method of hearing radio signals was by use of head telephones, and these had to be at the end of a cord so that the operator could wear them. For some time after broadcasting started, head telephones were used exclusively. When the loud speaker came, it was used for some time interchangeably with the head phones, and a jack was provided by which either might be plugged in. To-day the use of head phones has almost disappeared, but the loud speaker still dangles at the end of a cord, and even in the cabinet sets, is a separate device, mounted independently in the cabinet.

The dealer to-day likes to sell a complete equipment, in one ensemble, at a "complete" price, and the buyer undoubtedly prefers to buy it that way. It is closely parallel to the "completely equiped" automobile which we buy to-day, as against the separate purchase of a dozen necessary accessories, which was the rule a few years ago. To provide this completeness in radio sets, the manufacturer (or in some cases the dealer)



The type of radio cabinet which was popular in 1923.

mounts the radio set and the loud speaker into a wood cabinet, but the loud speaker is manufactured as a separate instrument, and the receiver itself is designed and manufactured as though it were to be placed alone on a table. It is probable that at least 80 per cent. of the sets sold in 1928 were mounted in floor-type cabinets, but neither the sets nor loud speakers were designed specifically for this arrangement.

Here again we find the reason in tradition rather than intention. Until recently, all radio receivers obtained their power supply from batteries. It is only within the last year that a.c.-operated receivers have dominated the market. The old battery-operated sets required space for the batteries, and this, more than anything else, was the justification for a relatively large piece of furniture. A compartment in the bottom of the cabinet, usually reached from the rear, was provided for the batteries, and was made high enough so that the numerous connections that had to be made when the not infrequent battery renewals were necessary could be accomplished with reasonable ease.

The radio cabinet of to-day is large enough to take a complete set of batteries. This empty space, surrounded by beautiful woodwork, is shipped across the continent, and the buyer pays the freight. It will never contain anything but air. Perhaps we shall always be content to buy half-empty furniture, but no other piece in the modern home can justify such inefficient use of space.

Causes of Present Design

TO SUMMARIZE our examination of the present status of design, we can record three facts: first, that the set itself is not yet adapted to the housing in which it is placed; second, that the loud speaker can, and probably will, be combined with the set; and, third, that there is every reason to expect more compact designs, no less artistic, but better suited to the none too generous proportions of the modern home.

Perhaps a more adequate basis for our feeling that the cabinet designs of to-day will undergo further changes and improvements can be found in the automobile. Surely it is not like the horse-drawn vehicle that preceded it. It has but two points of similarity. It runs on four wheels and is arranged so that the passengers may sit down. But the wheels themselves are very different, with their huge tires, and the steering mechanism is different. The bodies, analogous to our radio cabinets, have no precedent in the past. They are beautiful beyond the richest dreams of the old coach builders, and, most important, they are completely and perfectly adapted to the chassis on which they are mounted, the mechanism which they house, and the use to which they are put. They express in every line, the speed, the comfort, and the convenience of a new method of transportation.

Our radio sets may be regarded as a means of transportation into the realms of music. The automobile will take us to the concert hall, the radio set will bring the concert to our homes. But why should it resemble the phonograph, which was the best that an earlier period could provide to give us the pleasures of music? Radio, in the wealth of its possibilities, is an even greater improvement over the old phonograph than the automobile is over the horse and buggy. Surely it is entitled to the same beauty and distinction of design.

Motor cars to-day are much smaller than they were a few years ago; their size has been reduced to the minimum necessary for proper performance. In the same way and for the same reasons we may expect the radio set to grow smaller.

There are two factors not so closely associated with the



One of the earliest designs of commercial console radio cabinets.

story of gradual development, yet having an important bearing on the cabinet designs of to-day. The first of these is the question of style. When we buy furniture, we select from a large number of samples, each expressing a different artistic treatment. If it is a library table we want, there are dozens of them, and our final choice is usually influenced by some slight detail of design. It is necessary for the dealer to have this wide assortment, and after we are once in the store, it is no longer a question of whether we will buy a table, but which one we like the best.

To a very large extent, radio sets are, and perhaps must be, purchased on this same basis of choice between cabinets. We seem to take for granted that all sets are about alike in performance, regardless of the name of the manufacturer. We will, of course, choose between those having the technical features we have been told are essential; we want a set having at least so many tubes, and with the popular type of loud speaker, and operated from the a.c. lines. But beyond this it is almost entirely a question of cabinet design.

It is this style element that makes it necessary for each dealer to carry a wide variety of models. But no manufacturer, in the present state of the industry, can attempt to offer a

sufficiently complete choice of cabinet models in his own line, each built complete in his own factory. It would mean large investments in inventory, not only on his part, but also on the part of his jobbers and dealers, and the progress of the art is so rapid that the less popular models in such a line would have to be closed out at sacrifice prices, before technical advances in design made them entirely unsalable.

Solving the Problem

THIS DIFFICULTY is avoided, or at least minimized, by allowing the dealer to make the installation of set and loud speaker in the cabinet. He can carry an assortment of empty cabinets, and a stock of standard sets and loud speakers, and make up the combinations as they are sold. This method, however, gives the manufacturer two new problems. How can he be sure that the combinations thus made will function properly? He will certainly be blamed if they do not. And again, in order to prevent the obsolescence of the cabinets in which his jobbers and dealers have invested, he must see that each new model is so designed that it can be installed in the cabinets previously used. This makes improvements in technical design difficult and slow.

The furnishings and decorations for the living room are chosen with care and deliberation. Here the guests will be entertained and here the radio set must be placed. *It must fit into this picture harmoniously, attracting attention neither because it is much finer than the other pieces, nor because it is obviously not as good.* It is almost impossible to have it accurately "match" them. It is going to be an "odd piece" at best. It is the necessity for creating cabinet designs that will meet this difficult requirement that gives the furniture craftsmen their greatest problem.

Table types of radio sets are to-day housed to a very large extent in metal cases. The number of such sets sold leaves no question of their acceptability. The necessity for unsightly batteries is gone, and a small table-type receiver, perhaps on a wrought-iron stand, can be fitted into the living room in such a way as to add to the effect of the decorative scheme. It makes no pretense at matching the furniture but it may well be in complete harmony with floor lamps and fixtures.

The demand for floor types, however, cannot be neglected. If these are to be done in metal, rather than wood, any attempt to imitate the beauty of wood veneer must be skillfully done. The possibilities for decorative treatment of metal are almost limitless. Automobile designers have created out of metal, forms both beautiful and satisfying, completely abandoning the types and motifs of earlier vehicles. There is no reason to doubt that radio designers will soon accomplish an equally distinctive and gratifying result. The tendency toward smaller forms, and toward the assembly of set and loud speaker in a single unit, will help in the complete adaptation of the equipment to its housing, and in producing types much finer from an artistic and decorative standpoint.

The same search for new forms in decoration which has brought about the "modern" types of furniture and furnishings, will find expression in radio designs. It is not to be expected, however, that such types will dominate, regardless of the fact that they are well suited to the treatment of metal. Rather, I believe, we may look forward to the creation of types as different as the automobile, and equally pleasing whether they are surrounded by strictly modern, or by the more-conservative and well-established forms of furniture.

New Design Needed

THE GREEKS have been criticized for trying to portray draperies in their statuary. Stone was not a suitable material in which to picture linen and silk. This same objection is valid to-day against an improper combination of material and treatment. Decorative schemes must be suited to the material in which they are to be executed, and no form in one material which could be better done in another can be regarded as good. Thus, metal cabinets and cases call for new and honest treatments, which need make no apology to the past or to other materials, but which in themselves are satisfying and beautiful.

If any of us knew what these new forms would be, we would be building them to-day. It must not be inferred that the cabinets of to-day can be regarded as bad. Some of them are poor, to be sure, but many are excellent, and they all express this very search for something better which I have attempted to outline, and in a few we can read the tendencies which will mature to-morrow. Each new cabinet, in a sense, is an experiment in art, and it will succeed or fail, partly on the excellence of the equipment which it houses, but to a much greater degree because of the discriminating taste of the buyer in choosing, from an artistic standpoint, the furnishings for his home. In the results of these tests the designers will read the outlines for the offerings of another season.



Designed and photographed by Larry June

An imaginative design suggested by this article and made by a* Radio Broadcast *staff artist.

The MARCH OF RADIO

Can Radio Become a Style Product?

RADIO RECEIVERS are sold to two classes of purchasers: first, new prospects who have not previously possessed radio receivers, comprising new families, older families that have reached an improved economic status or become approachable through lowered prices, and those converted to radio because of improved performance, better available broadcasting programs, and simplified operation and maintenance; second, the replacement market, consisting of enthusiastic radio followers who appreciate the improvement in modern radio receivers as to performance, appearance, and ease of maintenance, effected since their own was purchased.

Both of these markets are now at a peak and sales resistance in them is at a minimum. Ten million out of our twenty-four million families have been sold radio and we are douhtless at the steepest part of the increase-of-listeners' curve. The group which are out of reach of the radio market for economic reasons, those not reached by good broadcasting, and those who object inherently to the artificial character of radio entertainment, are becoming a larger and larger percentage of the unsold market, so that, as in the automobile field, the new prospect market is becoming a smaller factor and sales resistance is increasing.



Investigation in major cities, where good broadcasting has been available for a period of years, reveals the astounding fact that over 80 per cent. of the sales made by certain high-class stores, concentrating on the more expensive market, are replacement sales, and the average in such centers is well above 60 per cent. for all classes of stores. Unquestionably, the replacement market is becoming the mainstay of the industry, although there will always be new prospects by reason of the formation of new families or improved economic position of older ones.

The factor which determines the turnover of the replacement market is the percentage of existing owners who renew their radio investment each year. The replacement market, like the new sale market, is also at its major rate of increase.

We cannot continue to expect as radical improvements so definitely obsolescing existing radio receiving sets in future years as the parade of fundamental improvements which we have had for successive years in the past. It is obvious that the improvements of the more recent seasons, such as push-pull amplification and electrodynamic reproducers, already represent a marked diminution in sales power over those of the earlier years. They are, in fact, engineering styles rather than fundamental improvements because their performance could probably now be equalled by the devices which they displace. They are not new or recently invented; they have simply been well exploited as radical improvements and have been adopted as essential to good performance. From an engineering standpoint, the expectancy of replacement due to engineering improvement alone may soon fall from two years to five years within a relatively short time, unless visual reception becomes an influence tending to replace broadcast receivers, and that represents a sixty per cent. reduction in the replacement market!

Unless radio becomes a style product, therefore, we will soon face increased sales resistance in the new purchaser market and a diminishing rate of replacement. Style in outward appearance must fortify the advantages of each new season's products so that owners of serviceable but old-style receivers will be tempted to turn in their equipment long before it is rendered hopelessly obsolete by engineering improvements.

The style factor has become the main reliance for maintained turnover in the automobile market. Substantial price reductions have tapped new economic strata and broadened the field of prospects, but these reductions have required huge increases in production to maintain substantial profits.

It is the pride appeal of modernity rather than real improvement in performance which stimulates the replacement trade of the automotive market; the effect of wear on performance provides the excuse for discarding a car before its service life is exhausted. Thus, the style appeal is supported and encouraged to the point that saturation is no threat to continued sales. The motor car is the symbol of the owner's economic and social status. It stands as a living advertisement in front of his door.



Can radio adopt the pride appeal and make the owners of old receivers replace them, even though the performance of the sets they purchase is only superficially superior to that of the sets they discard? Perhaps engineering improvement cannot continue to be sufficiently radical to force resale turnover at the present rate. Style, therefore, must be definitely introduced to lend support to engineering improvement. To build up the pride appeal is much more difficult for the radio industry than for the automobile trade, because wear is not an aiding factor and the radio receiver does not advertise its owner's financial status as effectively as does the automobile. Instead, the receiver has a modest place in the living room and is subject to about the same style influence as is the living room furniture. We have had but one non-engineering style change since radio began; the substitution of the unit console for the table-type receiver.

While the radio industry grows at its present rate, with both new customer and replacement markets at their peak, it may advantageously lay the foundation for maintained rate of replacement sales. The radio receiver is only moderately well adapted to becoming a style product but unless

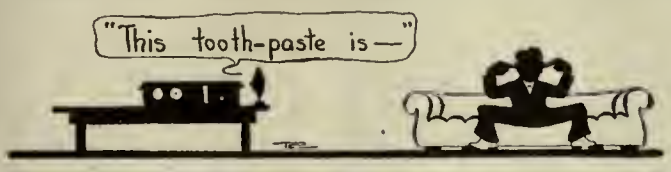
style comes to the aid of maintaining replacement turnover, only engineering improvement will remain as the means of keeping up the growing production rate.

Regarding Direct Radio Advertising

MOST LISTENERS have doubtless appreciated the excellent dance orchestra which punctuates the advertising announcements broadcast by the Lucky Strike people on Saturday nights through the N. B. C. chain. They have become so hardened to the blatant advertising which characterizes a number of so-called good-will programs that they automatically become deaf when the announcer's voice starts. This fact alone accounts for the few protests registered against radio advertising and minimizes the negative reaction which would otherwise be felt by its sponsors as well as their listeners.

By and large, experienced users of the larger chains observe wisdom and restraint in their announcements but there has been, nevertheless, a steady lowering of standards in radio advertising. Those few which exceed the bounds of propriety, however, embolden others to transgress further and further into the realm of direct radio advertising, with the inevitable consequence that an increasing number will search the dials for less offensive programs or shut off their sets altogether. It must be remembered that the listener, unlike the reader of the printed page, is seriously inconvenienced by undesired advertising. He must rise from his comfortable seat by the fireside when silly announcements destroy the program value of the channel to which his set is tuned and he must then find a more attractive and intelligently conducted feature on another frequency. When reading a magazine or newspaper, one glance is sufficient to distinguish between education, entertainment, and undesired advertising.

The managers of broadcasting stations are unfortunately faced with high pressure from radio advertisers, spending large sums of money, for greater and greater concessions, while the listener remains relatively inarticulate. He will remain so as long as he can find satisfactory entertainment on other channels when the offering on one is distasteful. If the blatant advertising vogue, however, becomes universal, the loss of following will no longer be confined to the audiences of unintelligently presented features, but to all broadcast presentations. The fact that direct advertising programs bring satisfactory return encourages this type of presentation, but reliance on returns is deceiving as long as there is available no measure of the unfavorable reaction engendered by misuse of the radio medium. With 80 per cent. of WEAF's time sold between seven and ten P.M., as nearly as we could calculate it for a recent week, and nearly as good a percentage of revenue-producing features on many of the leading stations, there is every reason for observing the utmost caution to guard against the insidious influence of "radio advertising halitosis." The logical outcome of the unfortunate



tendencies gradually developing is an undermining of the good-will influence of radio advertising, a mutual loss to listener, manufacturer, broadcaster, and advertiser.

That this trend is recognized as dangerous to the progress of broadcasting by station managements is indicated by the position taken by several committees of the National Association of Broadcasters at their meeting held in Chicago last March. Their committee on ethics recommended that all programs after six P.M. shall be of an entertainment and good-will character and that "commercial announcements" shall be barred after that hour. Many of the lesser stations disregard their obligations to the public's entertainment needs



and they will discover that adherence to their association's recommendation is the most effective way to increase audience following and thereby their revenue. The code of ethics for the guidance of station managements which was adopted by the committee also advised all broadcasters to prevent the broadcasting of matter which is regarded as offensive, fraudulent, deceptive, obscene, or information regarding products which may be injurious to health; to ascertain the financial responsibility and character of their clients; to stop the broadcasting of statements derogatory to others; and to follow strictly the regulations of the radio law of 1927.

To the listener, who has tired of the growing abuse of the microphone by the radio advertiser, this code may not appear sufficiently stringent, but it must be remembered that it is the work of the broadcast station managements themselves and that it frowns on many of the current practices so detrimental to program standards.

The radio industry is to be congratulated upon the constructive character of the activities of its trade association in the broadcasting end of the business. It is, by such wise and far-sighted recommendations, demonstrating its capacity for leadership in the field.

Tube Makers Sign R.C.A. License

THE FIRST independent tube manufacturer to sign the R.C.A. tube license agreement is the Raytheon Manufacturing Company and a number of independents it is said, may follow shortly. The $50,000 minimum annual guarantee will prove a stumbling block for many of the minor manufacturers in the field, but several of the better-known makers made sufficient tubes last year to meet this figure. Delay is being experienced in several instances in securing signature to the agreement because the prospective licensees are themselves the sponsors of promising improvement and process applications and patents which they feel should be taken into account. Furthermore, with the unfavorable adjudication of the tipless tube and tungsten rolling process patents, considerable encouragement has been given to the belief that the R.C.A. position is not impregnable. It requires a major adjudication, corresponding to the Alexanderson cascade tuned-circuit patent in the receiver field, to win the wholesome respect of the vacuum-tube industry and to precipitate a rush of the field to sign the license. With such a vast and diversified research force to draw upon, there is little doubt that some such adjudication will take place with a consequent further enrichment of the R.C.A. royalty account. A useful by-product of licensing the field on the R.C.A. basis will be the discomfiture of various vacuum-tube manufacturers of a low order of competence which should result in a corresponding improvement of the technical standards of the vacuum-tube products offered the consumer through a certain type of unscrupulous though rather well-patronized radio outlets.—E. H. F.

Fourteen Leading Manufacturers Describe

IMPROVEMENTS IN 1929-30 RECEIVERS

A-C DAYTON COMPANY

FORD STUDEBAKER, Chief Engineer: In designing our receivers for the 1929-30 radio season we have endeavored to combine the following features: selectivity, tone quality, sensitivity, volume, and ease of control. The "pre-selection" method of tuning, which is the most practical for obtaining maximum selectivity without critical characteristics, has been incorporated in the receiver. In order to obtain sensitivity we are using a five-stage r.f. amplifier with a very flat amplification curve. Grid-bias power detection is employed with the output of the detector feeding directly into a push-pull output a.f. stage employing two 245-type tubes. Among the other features which have been built into the set are complete static and magnetic shielding, electrolytic filter condensers which preclude the possibility of breakdown, single-control tuning, a simple positive volume control, a single switch to control the set and loud speaker, devices which provide for any type of loud speaker, a switch which permits instantaneous change from radio reception to phonograph, and a multi-plug which provides a ready means of connecting the integral units. Individuality is maintained by really different cabinet combinations.

BALKEIT RADIO COMPANY

GLENN L. ALSPACH, President and General Manager: One of the most important features of our 1929 receivers is the new dynamic loud speaker which is more sensitive, more brilliant across the entire tonal range, and fully capable of handling the entire volume of the receiver without distortion. In the new Balkeit console receivers five stages of r.f. amplification and a 245-type output tube are employed. Particular attention has been given to the acoustical features of the cabinet in order to insure full volume without distortion. These cabinets have rigidity of construction with ample baffle area, and interfering elements in their structure have been avoided. Another feature of the receivers is dependability and freedom from routine attention. In other words, in the new Balkeit we have striven to make available to the user a high order of selectivity, sensitivity, and tonal quality, at the same time employing improved methods of construction which assure complete satisfaction. It is a balanced set without extremes, its cabinet blending with its surroundings.

BREMER-TULLY MFG. COMPANY

R. E. SMILEY, Vice President: With the recent announcement of the purchase of the capital stock of the Bremer-Tully Manufacturing Company by the Brunswick-Balke-Collender Company, there is placed at the disposal of this company a combination rarely found. This company has always been famous for turning out splendid radio receivers, and our receivers, which will be offered for sale this year, will combine a rare degree of selectivity, sensitivity, and true fidelity of tone. Coupled with these superior qualities to be found in our radio receiver will be finer cabinet work with designs made to fit into the home on the basis of beauty and utility.

These factors, very much in line with the radio trends of 1929, together with keen merchandising policies, will give to the public, a type of product that will insure pleasure and satisfaction in every way.



Ford Studebaker, chief engineer, A-C Dayton Co.



Glenn L. Alspach, president Balkeit Radio Co.

THOMAS A. EDISON, INC.

ARTHUR L. WALSH, Vice President: Greater volume without distortion, the accomplishment of uniform amplification over the entire wave-band, and the advent of the 245 tube, are the outstanding developments of the 1929 radio season. The desirability of having uniform amplification over all graduations of the scale has been an engineering ideal for a long time. That it is now consummated I regard as the engineering accomplishment of the year. Uniform at all dial settings as to selectivity and sensitivity, with faithful reproduction, the best examples of the new radio receiver bring to the public excellent instruments at moderate prices.

Edison Radio embodies these latest ideas in receiver design, including the correct utilization of the 245 tube. The Edison chassis includes two of the 245 tubes in push-pull (the combined undistorted power output equalling that of a single 250-type tube at voltage usually employed), three of the 227 indirect-heater-type tubes used as radio-frequency amplifiers, two 227 tubes employed as detector and as first audio-frequency amplifier, and a 280 tube as rectifier.

The new Edison Radio line, with a single chassis and models varying only in cabinet design, is the finest that can be built.

FEDERAL RADIO CORPORATION

L. W. JAMES, Assistant to the President: Compactness of radio receivers seems to be the trend for 1929. Simplified circuits requiring a minimum of servicing, yet maintaining good fidelity and improved sensitivity and selectivity is another outstanding feature of the new sets. There is also an increasing demand for provision for phonograph pick-up units. Federal's new receivers, notably the model K, lends itself to the desire for compactness. The use of a.c. screen-grid tubes and push-pull amplification increases the amplification and reduces the complications of the circuits. Good fidelity is maintained through the use of a dynamic loud speaker. The cabinet design meets the demand of the apartment-

house dweller for small size and is in good taste. The new model M is unusually selective and sensitive. It is sturdily constructed with a steel chassis base which assures rigidity and protection in shipping. The receiver is very successful in picking up distant stations and in reproducing all programs with fidelity. Provision is made in the chassis for attaching a phonograph pick-up jack.



R. E. Smiley, vice president, Bremer-Tully

FREED-EISEMANN RADIO CORPORATION

JOSEPH D. R. FREED, President: The Freed Radio places its public appeal upon its price as well as on its selectivity and sensitivity. It is possible to achieve the latter or the former but to have attained them both is something of which we may be proud. Freed Radios are all neutrodyne sets of four or five tuned stages. In each we have included a low-loss variometer which in some sets acts as one stage in itself and in other circuits is connected with the detector circuit to obtain finer tuning and greater selectivity.

The more expensive sets make use of the new 245-type tubes in push-pull with 250 volts on their plates. In the popular-priced set we make use of 171A tubes in push-pull, three 126's, in the radio-frequency stages, one 127 as detector, and one 127 in the first audio stage.

We do not use the screen-grid tubes because our tests have not proven them to be of value as they give only increased volume. There is little doubt that new devices may be perfected in the years to come but our policy will always be that untested apparatus must be kept out of our circuits until we have found them fool proof.

CHAS. FRESHMAN COMPANY

CLARENCE A. EARL, President: The line of Earl radio receivers for the season of 1929-30 contains an a.c. console model that meets every price appeal. All but the most expensive models are also available for d.c. operation, and special receivers are made for 25-cycle operation. The complete line includes five receivers ranging in size from a small table model to a nine-tube dynamic-equipped console receiver. The most important feature of the Earl receivers is that they are of "service-proof" design; that is, rugged construction has been used throughout on all models. Protection has been placed where it is needed, pressed-steel frames house most of the equipment, and the end plates of each condenser section are of heavy brass. One main tuning drum is used on all models with selectivity being achieved by a small variometer. By use of either an inductor-dynamic or moving-coil-dynamic loud speaker, together with the utmost refinement in the circuit design of the audio-frequency stages, true reproduction of the full musical range has been obtained.



Curtiss Abbott, sales manager, Eveready

NATIONAL CARBON COMPANY

H. CURTISS ABBOTT, Sales Manager, Radio Division: In developing the new Eveready receiver the aim of the engineering staff was to produce a set which would not only be more stable and sensitive, but which would also give reliable service every day of the year. Greater stability and sensitivity has been achieved through substituting a variable inductance coil for one of the four tuned circuits. One-dial control is accomplished by mounting this coil on the shaft which turns the three-gang condensers. Mechanically, the new Eveready set is so sturdy and rugged that the chances of derangement during transportation and later in use are reduced to a minimum. The foundation which supports the chassis is a deep steel box-section member. Wherever weight is to be supported, metal, usually steel, is used. Insulation is not used to bear the weight of parts. All exposed parts of the chassis are finished with baked enamel, and the chassis itself seals the set against humidity. The receiver is available in a number of beautiful walnut cabinets.



Walter E. Holland, chief engineer, Philco

PHILADELPHIA STORAGE BATTERY COMPANY

WALTER E. HOLLAND, Chief Engineer: The present trend in radio receivers is toward still better fidelity, simpler and more rugged design that will minimize servicing, greater beauty, and tuning scales calibrated in kilocycles. To meet these demands Philco have developed two a.c. receiver chassis, which will be mounted in three types of console cabinets and one table cabinet. An improved Philco electrodynamic loud speaker with a 9″ seamless fabric cone will be used with all models.

Improved fidelity is obtained by using two 245-type tubes in a push-pull circuit, while acoustical improvements in cabinet construction have eliminated booming and other undesirable resonance effects. Trouble-free construction is obtained by providing the receiver and power units with bottom terminals and mounting all on one rigid base of drawn steel. A bottom plate is employed to protect, seal, and shield the "live" parts and wiring. A further simplification is obtained in one model by taking advantage of the characteristics of the new a.c. screen-grid tubes. In this model the number of tubes has been reduced to a total of six, and certain parts have been eliminated, thus simplifying the construction and wiring. The new eight-tube receiver provides the utmost selectivity combined with sensitivity and good tone quality. The tuning scales of Philco receivers are marked with "kilocycle channel numbers."

SILVER-MARSHALL, INC.

MCMURDO SILVER, President: In designing Silver Radio, an attempt was made to incorporate into it every worthwhile feature that would go to make a really fine receiver.

The principal technical features to be found in our receivers are a.c. screen-grid tubes for increased distance and stability, band-selector tuning for improved selectivity and the diminution of sideband cutting, a.c. screen-grid power detector for increased power output and improved fidelity, push-pull power output stage with new 245-type tubes to provide ample undistorted output, dynamic loud speaker of improved high-frequency response, elimination of usual antenna installation which is replaced by a small antenna contained in the console housing the set and loud speaker, and automatic regulation of fluctuating power line voltages.

In S-M receivers will be found an "overtone switch," which cuts down the response to high tones at will.

Two models are available, one a lowboy, at $169.00 list, and the second a highboy with sliding doors, at $195.00 list. Both are of simple, semi-Sheraton design. Striped walnut, finished in gloss lacquer, is used in both models.

STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY

Ray Manson, Vice President and Chief Engineer: Trends in radio receiver construction point to detailed improvements only, and not to any radical changes in fundamental design. The worth-while trends center around improvements that make for better reproduction, as prospective purchasers of new radio receivers now realize that in the last analysis, the only object in owning a radio receiver is to obtain accurate and natural reproduction of what is going on before a distant microphone.



Ray H. Manson, chief engineer, Stromberg-Carlson.

One of the means for obtaining improved reproduction is the use of the new UY-224 a.c. screen-grid tube and the new UX-245 power tube. Three of these new a.c. screen-grid tubes used with four tuning stages increase the amplification possible up to the detector circuit, allowing for improved detector action, such as linear power detection with automatic grid bias.



H. C. Grubbs, vice president, Victor.



Thomas H. Endicott, Zenith Radio Corp.

This year there are four new Stromberg-Carlson receivers, each of which makes use of three of the new a.c. screen-grid tubes. All of these models use the new linear power detection with automatic grid bias, working directly into a power output system employing the new UX-245 tubes.

VICTOR TALKING MACHINE COMPANY

H. C. Grubbs, Vice President: Victor has waited until 1929 to introduce its own radio receiver because we desired to give the public an instrument which would be as close to perfection as engineering ability could devise. Victor Radio and Radio with Electrola is unique in design, appearance, and performance. It is not an assembled set in any respect. A cabinet of exceptional beauty is made of rich walnut veneer. The receiver is a power-operated, completely shielded, tuned radio frequency set of the antenna type, utilizing ten tubes. A mechanical system of micrometer adjustment, which we call "Micro-Synchronism," is employed and this feature permits a precision alignment of the chassis and a high degree of sensitivity and selectivity. Tuning is accomplished with a super-automatic device operating over a full-vision illuminated dial calibrated in kilocycles. The power amplifier employs a balanced push-pull circuit with two 245-type tubes. There is a harmonic modulator which allows the owner to get more or less emphasis on bass notes as he prefers. The dynamic loud speaker is of greatly improved design. The combination radio-instrument is equipped with an improved Electrola, induction disc motor, 12-inch turntable, and a newly designed electric pick-up unit. Victor Radio is very easy to service; it is made up of four individual units any one of which may be disconnected instantly.

THE ZENITH RADIO CORPORATION

Thomas H. Endicott, Zenith Radio Corporation: The introduction of the new Zenith models which will make their appearance at the Chicago trade show will feature, foremost, the popularizing in the price of several Zenith receivers. This is made possible because of the increased manufacturing facilities brought about by the overwhelming demand of the public for high-grade radio receivers.

The Zenith Corporation now makes all of the parts and also the cabinets used for their receivers. Our new cabinet plant is equipped with especially designed automatic machinery of entirely different construction from the type used in the average furniture factory.

The newest design in screen-grid tube circuits will be incorporated in all of the new models for 1929-1930. Improved "Automatic Tuning," will also be found on all models.

COLUMBIA PHONOGRAPH CO., INC.

Harry A. Summers, Research Division: The trend in radio receivers for the 1929-30 season is in the direction of reduction of cost by means of simplification as far as it may be carried without sacrifice of performance. Coupled with this is a reduction in the number of tubes used, which gives simplicity in service and manufacture, resulting in lower cost on both these items.

Our receivers for 1929 respond to these trends, being moderately priced and highly compact. These sets employ 327-type tubes in all sockets except the power stage which uses two 345-type tubes in push pull. In this way we obtain a power output equal to a pair of 210 tubes without the use of high voltages and with resulting economy of parts. The new dynamic loud speakers which we use in these sets do not over accentuate the low frequencies and high frequencies are reproduced at more nearly normal levels. This has been accomplished by redesigning the motor and by the use of a Burtex diaphragm.

PICK-UPS—A WORTH-WHILE ACCESSORY

THE MARKET for phonograph pick-up units is increasing. Radio dealers everywhere are finding that this accessory is helping them toward greater profits. Shops handling only radio sets have found that carrying an electromagnetic pick-up device enables them to sell not only this accessory, but also electric and spring motors and complete turntable assemblies, and in many cases portable phonographs on which the pick-up unit is installed and used in connection with the amplifier system of the radio set. And shops handling phonograph records also have found that the sale of pick-up units definitely increases their sales of records.



Sidney Vorzimer, manager, Yorkville Radio Co., Inc.

The Yorkville Radio Company, 147 East 86th Street, New York, finds that the sale of pick-up units has been greatly increased by the practice of set manufacturers in recent years of affording provision for the connection of these units. Sidney Vorzimer, manager of the Company says: "In our experience, we find that it is very easy to sell customers buying a new radio set with a phonograph pick-up jack, the necessary unit. Furthermore, we make the sale, as an accessory, at the same time the set itself is sold.

"Our average customer pays about $8 for the unit. Some, of course, prefer a higher-priced unit, and we are glad to sell the more expensive units, not alone because of a higher unit of sale but because the more expensive units give better performance.

"Most of our customers who are interested in a pick-up unit do not care to use it with an old phonograph which they may have," adds Mr. Vorzimer. "I believe that these users have let the dust gather on that old phonograph cabinet so long that they would much rather purchase a compact little motor and turntable assembly which can be located close to the radio set than to revive the old phonograph.

"The average price our customers pay for pick-up unit, turntable assembly, etc.," Mr. Vorzimer says, "is about $20, although, of course, we sell a respectable number of more expensive complete units."

The best prospects are not owners of old sets which can be adapted to use a phonograph unit, but the purchasers of new sets. The Yorkville Company has found more success in selling units *with* new sets than in selling the pick-up unit to the customer on a later visit to their store.

One of the most interesting results of the wide use of phonograph pick-up units by Yorkville customers is that it increases the market for new set sales. Customers who have enjoyed the adaptability of their radio set and phonograph when in separate units can readily be interested in a combination radio-phonograph set where the radio and phonograph are housed together in an attractive cabinet.

After the customer has been interested in the widened world of music and all the entertainment offered by the new electrically-cut phonograph records, the price of the pick-up unit, motor, and turntable assembly is not a seriously limiting factor.

The Yorkville Company does not concentrate on one line of pick-up units, but handles five different makes.

Many dealers are interested in a summary of the best sales arguments which have been employed successfully by others in selling the phonograph pick-up devices in the retail store. Here are some of the high lights:

Stress the merits of *new* electrical phonograph recordings.

Explain how the phonograph pick-up unit provides *with* the radio set a *complete* home entertainment unit.

Emphasize the fact that *with* the pick-up unit and the radio set the user can repeat at will his favorite selections.

Show how the pick-up is really an inexpensive accessory to the radio set.

And—don't fail to *demonstrate* to the customer.

The advantages of the dealer pushing the sale of pick-up units are many. The dealer—if his store is exclusively radio—can reap many repeat sales through stocking records. Pick-ups sell records and records sell pick ups. The customer who has bought a pick-up unit to use with his old set is always a good prospect for a new combination radio-phonograph unit. The set-owner who uses a phonograph pick-up unit steadily is an increasingly good customer for replacement tubes.

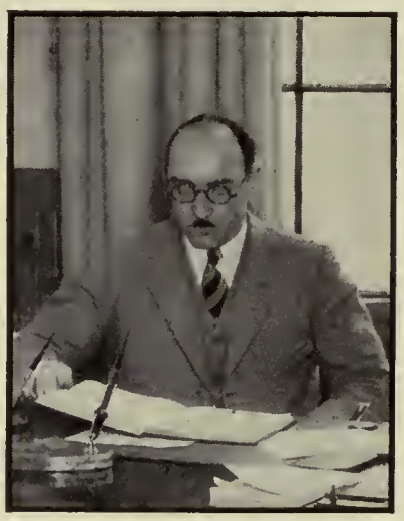
The dealer should find a phonograph pick-up unit the means of extending the summer use of the radio set in localities where broadcasting service is still poor during the summer months. This advantage was found by RADIO BROADCAST particularly important in the Southern states. Many musically inclined listeners have acquired elaborate libraries of electrically-cut records which they play through their radio sets, when reception conditions are not at their best.

On page 87 of this issue appears a list of the leading phonograph pick-up units with full data. Dealers who wish further information direct from the manufacturers should write on their letterhead and one letter to RADIO BROADCAST will bring full information on all the lines.

WHAT THE LICENSING GROUPS OFFER

HAZELTINE'S POSITION IN FIELD

THE HAZELTINE CORPORATION was organized in February, 1924, for the purpose of licensing radio and other manufacturers primarily under the patents of L. A. Hazeltine. Previous to the formal organization of the Corporation, licenses under the Hazeltine patents were granted. Receiver manufacturers have been licensed since March, 1923.



W. A. MacDonald, chief engineer, Hazeltine Laboratory.

Now eighteen radio manufacturers in the United States are licensed. In addition, the American Telephone & Telegraph Company and the Western Electric Company each have acquired rights under this patent structure. Hazeltine patents are used by foreign manufacturers as well. In England, Marconi's Wireless Telegraph Company, Ltd., holds a license for the British Isles and possessions; in Australia, Neutrodyne, Pty. has been organized and has seven Australian manufacturing licensees. In Canada, DeForest-Crosley is the only manufacturer so licensed but many United States manufacturers who hold rights to these patents make sets in their Canadian branches.

The Hazeltine Corporation has licensed set makers under certain LaTour patents and has also licensed other manufacturers, not in the radio field, under certain other LaTour patents, notable among these are some X-ray manufacturers.

The Hazeltine Laboratory has been serving the licensees of the Corporation ever since the inception of the parent organization. This laboratory, headed by W. A. MacDonald as chief engineer, is constantly engaged in studies with the purpose of developing new circuits and methods of value to the licensed manufacturing companies. The research division of the laboratories is separate in purpose but is directly concerned with the problems incident to receiver design and production. This division is an extremely important part of the laboratory and, in the solution of the many problems of this practical nature which continually arise in manufacturing plants, does much to simplify and improve production processes.

The purpose of the Corporation and the value which the licensee companies are expected to receive from their royalty payments is not merely to give passive permission to make radio sets using certain patented circuits, but to give a continual technical service and advice. The licensees are always free to consult with the Hazeltine engineers. The degree of use which any licensee company makes of the Hazeltine technical service, of course, varies with the company. In some instances, the laboratory has completely engineered and designed a receiver for a licensee company and in many others, they have been called in consultation by the engineers of the company. In this way, many important radio manufacturers have found the more or less detached and disinterested technical service of this Corporation of distinct value to them. And this aid has been reflected in the ultimate manufactured product which reaches the customer's home as a set made under Hazeltine patents: in better performance through engineering consultation, in greater value for less money through improvements and economies of manufacture.

—EDGAR RICKARD, *President.*

THE R.C.A. LICENSE POLICY

WHEN THE Radio Corporation was formed in 1919, it acquired through various cross-license agreements from the General Electric Company, Westinghouse Electric and Manufacturing Company, United Fruit Co., and American Telephone and Telegraph Company a very substantial patent situation with regard to the manufacture of broadcast receivers for use in the home. The Radio Corporation decided, in 1927, to extend licenses to a good many radio manufacturers rather than adopt the policy of extensive patent litigation for enforcement of its patent rights.

One of the most important things that radio manufacturers as a whole have been seeking during the past few years is prestige. A large portion of their effort in advertising, sales promotion, and direct sales has been devoted to impressing trade channels and the ultimate consumer that they were building on a solid foundation and were in business to stay. The taking of a license from the Radio Corporation was, in the opinion of many, the biggest thing a manufacturer could do to impress the people concerned that they were building for the future of the industry.

A radio manufacturer to-day practically has to guarantee immunity to his trade from patent difficulties. There are two methods open to him—taking a license for his product, or demonstrating to the trade that he will bear the expense of such suits as may be filed against him or his trade channels. The R.C.A. license policy has almost completely settled this situation for most jobbers and dealers.



A. F. VanDyck, manager, Technical and Test Department, R. C. A.

The Radio Corporation has made available the services of its engineering staff through its Technical and Test Department, to all of its licensees. This service is merely an advisory one but is much appreciated by the licensees. Licensees have expressed themselves as being considerably helped in their planning and development work by

this service. All new vacuum tubes as they are introduced from time to time are available to licensees for experimental work for several months before they are generally released to the trade. About twice a year the R.C.A. has technical meetings with its set licensees at which time subjects of mutual interest are discussed.

It is a very interesting fact that the retail prices of radio sets have not gone up in the past two years, notwithstanding the fact that during that time the industry has completely changed over from battery-operated sets to the now popular set operated directly from the lighting circuit in the home. This means that the consumer's dollar is purchasing considerably more than it did two years ago. In addition to the mechanical features involved, the consumer's dollar is also purchasing greater value in the way of loud speakers and cabinets.

THE R.F.L. PROGRAM

THE LETTERS "R.F.L." seen so often in the advertisements of well-known radio manufacturers, stand for Radio Frequency Laboratories. This company began business in a small laboratory at Boonton, New Jersey, about seven years ago, shortly after popular radio broadcasting was begun. For several years, laboratory research on a variety of electrical communication problems was carried on, including the development of certain amplifier circuits for use in broadcast receivers. Licenses to build sets were then issued to five manufacturers who believed that group-research would produce more and more inventions, and could be made to pay.

The aim of R.F.L. has been to gather together a group of qualified scientists and specially trained radio engineers, and to direct them on problems connected with the design and development of broadcast receivers. Inventions which come from these research workers are turned over to the group of licensees who make practical use of them.

The work comprises two major divisions—Research and Engineering Service. The Research Division endeavors to keep a little in advance of the known science of radio, and to commercialize its research to the extent of furnishing something new and practical for the licensees to manufacture. The Engineering Division keeps up with the advance in the art, helps the licensees with their production problems, and furnishes all the technical facts necessary to keep them fully informed about their own product and its relation to the contemporary art. In addition to this, it often renders special technical assistance on matters outside the scope of set design.



R. W. Seabury, president, R. F. L.

Engineering concerns itself with the present, Research with the future, yet the two are interdependent. The relation is not unlike the building-up process in a regenerative amplifier. The most difficult step is to get research started, and then it must be fed financially for several years, with the help of administration and engineering, before it pays dividends. The idea of group-financed research is based upon the principle that two people with limited research budgets can do more than twice as much operating together as they can operating separately. R.F.L. represents a unique reduction to practice of this idea, and the success and growing reputation of these laboratories is evidence of its economic soundness.

R.F.L. is not a manufacturing corporation, but primarily a research and patent holding company, and, as it goes on doing its share of development work in the radio industry, it would seem that the vision of the founder is likely to be fully realized.—

RICHARD W. SEABURY,
President



Lester L. Jones, president, Technidyne Corporation

TECHNIDYNE'S OFFERINGS

THE TECHNIDYNE CORPORATION, in 1929, will continue its research into circuit and apparatus design in the way it has followed since its inception. That is, by employing inventive, analytical, and design skill. The word Technidyne itself signifies our place in the radio picture; it comes from the two Greek words, *technikos* and *dynamas*, signifying "technical power."

Looked at from the inside, the organization is a place where imagination, invention, and creative ability can flower. Looked at from the outside, it is an institution on which the relatively small producer may lean for those services otherwise beyond his reach. In addition to this important service, it has already developed resources capable of supplementing those of the largest producers.

Our management is free from the direct burden of production and sales problems, and can centralize attention on the well rounded growth of this "technical power." This means simply that our personnel is more actively interested in producing ideas and circuits than in apparatus using these ideas and circuits. While we are not interested primarily in construction or production, believing that our problem is to provide our licensees with something to build, yet we go much further than the usual laboratory in that we engineer our inventions to the practical point and are able to assist the manufacturer in the design of practical production models. Also, we have produced a number of inventions which tend to reduce production problems and in developing our circuits we always keep in mind the requirements of practical production.

The advantages, as we see it, of being free from production difficulties are manifold. We can look into the future more calmly, and into the past achievements of other inventors with more certainty of completely covering the literature if we are not harassed by problems that must be solved within the next day or so.

The engineers of Technidyne have always aimed at ideas leading to patents that were free from difficulty in litigation. Our engineers must know what has already been accomplished. An invention that is really only a copy of another person's idea, is never litigation-free; it is always in hot water.

Our personnel and our policies are guided by the desire to aid our licensees in their present problems, and to provide them with the output of our imagination in the future.

—LESTER L. JONES, *President.*

what they say



Carries Only One Line of Sets

At SOME TIME *or other every radio dealer debates with himself over how many lines it is advisable for him to stock at one time. Some are of the opinion that they can satisfy the demands of every customer by having a large variety of makes and models while others believe that they can obtain best results by concentrating on products of one maker. In this connection a letter from a dealer in Coffeyville, Kansas, is of interest.*

To the Editor:

We have secured very gratifying results for the past two years by specializing on one line of radio receivers. We operate under an exclusive franchise and carry all models of this manufacturer. Before adapting this policy we stocked from three to four makes of receivers at all times but we found that it was practically impossible for a dealer in a town of the size of ours to carry more than one line and make money.

Our experience with vacuum tubes may also be of interest to you. Originally we stocked only one line, but, in order to protect ourselves at the time when the tube shortage became acute, we were forced to add other lines. At present we carry a fairly complete stock of three lines.

RALPH T. FLOREA

How to Make Service Pay

THERE HAS *been considerable controversy among our contributors and readers concerning the type of testing equipment which is best suited to the requirements of the outside serviceman. In his series of articles, B. B. Alcorn advocated a simple, inexpensive, portable test-set for the small radio dealer's serviceman, stating that the high cost of more elaborate equipment is an important objection. On the other hand, John S. Dunham advises all radio dealers to invest in a complete tube- and set-checker, and he claims that such apparatus will pay for itself within three months on the basis of increased efficiency. The following letter from a reader in Pine Bluff, Ark., gives the opinion of a Majestic dealer on the subject.*

To the Editor:

I have just finished reading the letters of John S. Dunham and B. B. Alcorn in March, 1929, RADIO BROADCAST and wish to express myself as in hearty accord with the views of Mr. Dunham. I entered the radio profession last June as an unknown dealer and borrowed money to buy my first set. In my determination to make a success of the business I decided that I *must* provide good service, and I felt that *knowing*—not guessing—what was wrong with a radio would not only save time but make the customer feel that I had an idea of what I was doing. Therefore, after selling two sets, I invested $75 in a set-tester. This more than paid for itself in a very short time.

Since buying the set-tester I have sold 121 receivers and made over 600 service calls. In my opinion it would have been impossible for me to have accomplished this without complete and accurate testing apparatus. When I make a test I know what is wrong and, therefore, as a rule, I am able to repair the trouble quickly. Besides, what would you think of a doctor who came to see you and left his kit at home? Even though you had faith in him, you would be inclined to think that you were not getting your money's worth because he would be guessing instead of testing.

I do not regret a single cent that I spent on my tester and I think it should be one of the first purchases—if not the first—a radio dealer should make.

DAVID WHITE.

Merits of No-Charge Call

MOST RADIO *dealers hold up their hands in horror when the subject of no-charge service calls is mentioned. Many of these men view their entire service department as an unfortunate liability which cannot be avoided and they believe that they must charge for everything in order to "break even." However, R. Ross Wilson, a dealer in Knoxville, Tenn., considers the question from a different angle:*

To the Editor:

Each year during the summer months I make an inspection of every set sold in the past season by my concern. Whenever necessary I rebalance and reneutralize these sets, replacing tubes, and generally placing the receiver in first-class condition. This is to maintain the customer's interest in radio during the summer months, as he has been told that decent reception is impossible at this time of the year. This work is also successful in providing an excellent list of prospects, selling a good number of tubes, retaining our customer's good will, and it assures us that he will be a booster and not a knocker. We are not charging a cent for this service other than the cost of any parts or tubes which may have to be replaced. This idea is not only practical but is also paying substantial dividends.

When I entered the retail field I decided that the average prospect and customer was like the dealers I had met—he wanted to be sure of receiving good service. Therefore, I make it a point to make my own installations, regardless of whether it is a sale or demonstration, as in this way I am able to show the prospect that I am familiar with my line and am not afraid to roll up my sleeves and work. While making an installation I explain to the customer why I do certain things and before I leave his home I make sure that he thoroughly understands the operation of the receiver. Three or four days after installing the set I call again to make sure it is operating satisfactorily, and this gives me an opportunity to learn the names of friends and neighbors who have heard the set. All of this free service requires considerable time but it keeps me well supplied with prospects and it gives me a booster with every sale.

R. ROSS WILSON.



Harry Alter, president, Harry Alter Company, Majestic distributors in Chicago.

Knowing Your Line Facilitates Selling

JUDGING THE MERITS OF A NEW SET

By HARRY ALTER

President, Harry Alter Company, Chicago, Ill.

As Told to Edgar H. Felix

THE PROCESS of testing a radio receiver by a dealer or jobber, when the first sample of a new model is delivered, almost invariably consists of hastily plugging in the candidate for sales records at the nearest light socket, connecting up any antenna that happens to be at hand, and then listening to a number of local programs in tense admiration. A few, more particular, may indulge in a slightly more exhaustive test, installing the receiver in their homes so that they may enjoy a little aimless dial twiddling.

These hap-hazard processes are indeed a compliment to the confidence which the dealer has in the reputation of a manufacturer but such casual observation of performance is hardly an illuminating test. I do not advocate any exhaustive engineering examination because, in most instances, it is neither practicable nor necessary. But, if a dealer is to qualify himself to appreciate fully the merits of a new line, a systematic and comprehensive testing procedure, faithfully carried out, may be of inestimable value. Only by actual experience and intimate knowledge of the performance capabilities of a receiver is it possible to present the advantages of ownership to the prospective purchaser in a clear, concise, forceful, and convincing manner.

The testing procedure suggested is based upon the combined experience of a number of technical advisors of the largest jobbing organizations in the industry. The tests are qualitative rather than quantitative and require facilities which are almost invariably available.

A prime consideration in securing a reliable judgment is that a comparison with known performance be made under standard conditions. Receivers are, therefore, usually tested in the home of a technically qualified employee or executive rather than in the place of business of the dealer or jobber. It is essential that standard conditions, to which the expert is accustomed, be maintained. Usually a standard receiver is permanently installed at the testing location and this, when comparisons are made, should be equipped with new tubes in the same manner as the new receiver to be tested. The most satisfactory results are obtained if a quick change mechanism is available for rapidly switching from the known receiver to the new. This requires not only switching antenna and ground, but preferably the reproducer element as well. Both receivers should be completely wired up through the switching system so that antenna, ground, and reproducer may be instantly changed from one receiver to the other. With alternating-current tubes, filaments on both receivers should remain switched in constantly so that instant comparison is possible.

Three series of tests are suggested: first, tone quality; second, selectivity; and third, sensitivity. These are the three fundamental factors of performance which are readily compared. These tests should first be made through a common reproducer system and, if the receivers are equipped with their own reproducers, the tests should then be repeated with each receiver utilizing its own loud speaking device.

The usual process in fidelity tests is to tune-in to a program which involves the lower notes. If considerable volume is obtained with such program material, the reproduction is generally classed as satisfactory. This is, however, only a partial test because receivers are frequently designed which

do not overload on the lower frequencies but fail to reproduce satisfactorily and in their proper proportion the overtones which lend the distinctness to different instruments of the orchestra and are of especial importance in obtaining clear articulation of speech. A comparison test is excellent indication of the relative audio-frequency range of two receivers. Judgment, however, should also be passed upon the ease with which the low notes are handled as well as the frequency range of the audio system. Freedom from overloading under conditions of normal reception can be detected readily by an experienced ear which perceives manifestations of overloading as tendency to rattle and resonate. More than one receiver has an audio system which tends to oscillate at the low notes, giving it a slight effect of persistence which is even pleasing with certain types of music, such as organ and cello, but is decidedly detrimental to good articulation and brilliance.

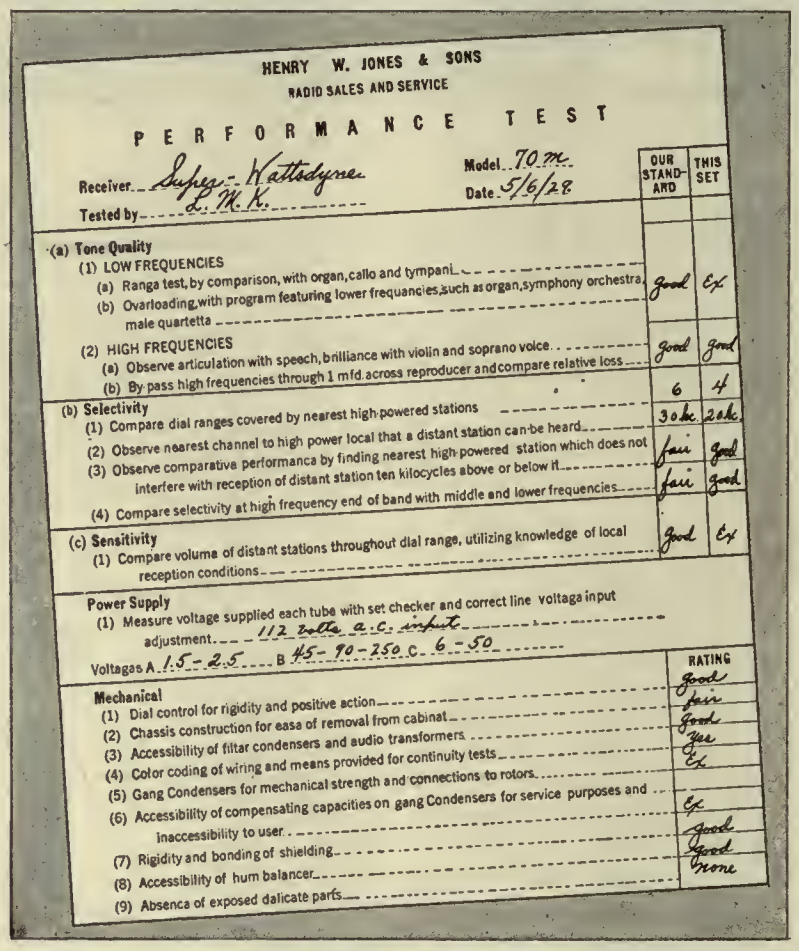
Considerable assistance may be had in this process if a milliammeter is placed in the plate supply of either the output stage or the entire plate supply. If the milliammeter tends to fluctuate while low notes are being reproduced with good volume, it is definite indication that overloading is experienced. Another method, which has been used successfully, is to connect a fixed condenser of one microfarad or more across the loud speaker terminals. The higher frequencies pass more readily through such a condenser than the lower. With some receivers, a one-microfarad condenser so connected makes little difference even in the articulateness of speech, while with others, having faithful amplification not only of the lower frequencies but of the high frequencies as well, there is a marked falling off in clarity. To one not trained in detecting the contribution of the higher frequencies and overtones, this procedure presents a simple, if crude, method of by-passing them so that their effect can be observed by comparison. Compensating adjustment of volume control should, of course, be made before and after connecting the condenser in order that the comparison be made under similar conditions.

Speech is the most ready source for determining the presence of the higher frequencies. Although most of the volume of speech is given by frequencies below 1500 cycles, understandability or articulation is very largely a matter of the higher frequencies. The violin and the soprano voice are also excellent means for determining the presence or absence of amplification at the higher frequencies.

The fidelity tests suggested outline means not only for making a general judgment of the reproduction but for determining the total range of tone amplified by the receiver, checking overloading, and comparing the relative amplification of the lower and higher frequencies. No systematic examination of the receiver's performance fails to include all of these factors.

Tests for Selectivity

TESTING FOR selectivity is too easy and simple to be worthy of detailed description. So long as a standard antenna system is used and the convenience of a comparison switch is available, the procedure is obvious. In almost all locations, high-powered stations are available so that the dial range covered by a strong signal is readily observed. The antenna system used with a receiver should be a normal one and no valid test can be made with an antenna of excessively long or short dimensions. A short antenna gives satisfactory results even with a receiver having unsatisfactory selectivity, while a long one handicaps even the best of receivers. An average antenna, 75 to 100 feet in length, should be used.



HENRY W. JONES & SONS
RADIO SALES AND SERVICE

PERFORMANCE TEST

Receiver: Super-Wattsdyne Model: 70 M.
Tested by: L. M. K. Date: 5/6/28

	OUR STANDARD	THIS SET
(a) Tone Quality		
(1) LOW FREQUENCIES		
(a) Ranga test, by comparison, with organ, callo and tympani	Good	Ex
(b) Ovarloading, with program featuring lower frequancies, such as organ, symphony orchestra, male quartetta		
(2) HIGH FREQUENCIES		
(a) Observe articulation with speech, brilliance with violin and soprano voice	Good	Good
(b) By pass high frequencies through 1 mfd. across reproducer and compare relative loss	6	4
(b) Selectivity		
(1) Compare dial ranges covered by nearest high-powered stations	30 kc	20 kc
(2) Observe nearest channel to high power local that a distant station can be heard	fair	Good
(3) Observe comparative performanca by finding nearest high-powered station which does not interfere with reception of distant station ten kilocycles above or below it	fair	Good
(4) Compare selectivity at high frequency end of band with middle and lower frequencies		
(c) Sensitivity		
(1) Compare volume of distant stations throughout dial range, utilizing knowledge of local reception conditions	Good	Ex
Power Supply		
(1) Measure voltage supplied each tube with set checker and correct line voltaga input adjustment — 112 volts a.c. input		
Voltages A 1.5 - 2.5 B 45 - 90 - 250 C - 6 - 50		

	RATING
Mechanical	
(1) Dial control for rigidity and positive action	Good
(2) Chassis construction for easa of removal from cabinat	Fair
(3) Accessibility of filtar condensers and audio transformers	Good
(4) Color coding of wiring and means provided for continuity tests	Yes
(5) Gang Condensers for mechanical strength and connections to rotors	Ex
(6) Accessibility of compensating capacities on gang Condensers for service purposes and inaccessibility to user	Ex
(7) Rigidity and bonding of shielding	Good
(8) Accessibility of hum balancer	Good
(9) Absenca of exposed dalicate parts	None

Dealers will find a chart of this type helpful in studying the merits of a new receiver.

Every location has its individual possibilities for testing selectivity, such as the reception of a particular distant station on a channel neighboring one assigned to a local, which gives an index to the performance of a receiver. One who is called upon to pass judgment on receivers should be familiar with these characteristics of his location by frequent observation so that judgment may be passed with any receiver. For example, in the New York area, reception of WLW through WOR is usually an indication of excellent selectivity, but only familiarity with the particular points and distance at which the test is made makes this a specific criterion of a receiver's selectivity.

The three points upon which definite judgment as to selectivity should be based are as follows: first, the dial range covered by the nearest high-powered transmitter; second, the nearest channel upon which a distant station may be heard neighboring on the highest-powered local signal; and third, with the receiver set for maximum volume, determination of the loudest station, restricted sufficiently by the selectivity of the receiver so that a distant station may be heard on the neighboring channel without interference.

Comparison tests offer an easy method of judging sensitivity. It must be remembered that tested and measured tubes must be used in sensitivity tests. Also conditions must be observed simultaneously when comparing two receivers because periodic changes take place in the effectiveness of the transmission medium. The advantage of familiarity with

reception conditions at the test point is obvious, but even this is not sufficient to produce positive judgments unless switching arrangements are available which make instantaneous comparison of the attained volume with a given signal possible. With such facilities, tuning in a distant station on two receivers and switching quickly from one receiver to another makes a simple and satisfactory test of radio-frequency amplification.

These performance tests are easily made and give a direct comparison of the factors which determine the service a receiver will give to the consumer. A chart of the type shown on page 82 permits the systematic rating and reporting of this series of tests.

Having completed the performance tests, examination should then be made of the voltages delivered by the receiver's power supply under various conditions. Usually some means is supplied for adjusting voltage input to the power supply for two or more effective line voltages. By means of a good set-checker, the grid and plate voltages supplied each tube should be measured with the input voltage supply properly adjusted. The examination should determine that none of the tubes are operated above their rated voltage. High potentials particularly should not be tolerated because this causes rapid deterioration of tubes in the hands of the consumer and gives exceptionally good performance with respect to selectivity and sensitivity only when the tubes are new. Superiority in these respects, so attained, is certain to cause trouble later because purchasers will soon complain of short tube life.

Mechanical Examination

The receiver should next be subjected to mechanical inspection, preferably aided by the service instruction manual supplied by the manufacturer. The dial-control mechanism should be inspected carefully by applying friction at a convenient point on the condenser drum and observing if there is any play or slip when the knob is turned. Rheostats should work smoothly. Gang condensers should be of rigid construction and the contacts between the rotors should be inspected carefully to assure a permanent electrical connection. For convenience in servicing, the ease with which the chassis and the power supply is removed is of importance. The service manual and the chassis itself should be examined to see if simple wire codes are used so that routine tests may be easily made. Condensers in the power pack and audio transformers should be readily removable and convenient test points should be available. The hum balancing means should be accessible, while the means used to balance the gang condensers should be such that they are accessible to the serviceman but not to the set-owner. The chart also contains a table to aid in making a systematic mechanical inspection.

The experienced dealer knows that convenience in servicing conserves profit and maintains customer satisfaction. Considering the receiver solely from the performance standpoint, without giving thought to future service which may be necessary, has often led to the adoption of a line which may sell readily but which absorbs much of the profit earned by sales because of later service expense. Therefore, the mechanical inspection is most essential as service accessibility and means of detecting and shooting trouble is of considerable importance. While the mechanical inspection should be made with this point in view, general mechanical design should not be overlooked. Rigidity in the chassis, sturdy variable condensers, well anchored wiring, firm shielding compartments, and absence of exposed delicate parts should be observed.

I am certain that dealers inspecting a new line will be greatly aided by following a systematic and comprehensive procedure in making their tests. Furthermore, they will find themselves much better equipped to make a compelling and accurate presentation to prospects of the capabilities which their favorite lines possess.

TRADE MAGAZINE PREJUDICES

IT IS a common idea—all too common—that trade magazines must never talk of technical matters. Such conservatism can be justified up to a certain point, but beyond that, it is harmful. Since their beginning, trade magazines have stressed certain aspects of selling, such as window displays, summer campaigns, over-the-counter selling, etc., to the exclusion of all other matters. Indeed trade magazines, are commonly regarded as properly containing nothing else. Other aspects, such as the semi-technical angle (less important but still deserving some attention), have been neglected completely.

Look at the set advertising in the various trade magazines. Do you not find such statements as, "245-type tubes in push-pull;" "automatic voltage regulation;" "screen-grid tubes;" "dynamic loud speaker;" and "band-pass tuning?" These are technical facts—and salesmen use them. And there are other technical things about radio receivers equally effective in sales, that have never been explained in merchandizing language.

Take a specific case—for example, a Sparton receiver.

As a salesman, do you know in what way Sparton sets are essentially different from any other receivers? On page 99 of this issue will be found an article in which the unusual characteristics of the Sparton are clearly indicated. Read it. Read the article on the Radiola 60 series on page 15 of the May issue, another example of the same type of article. And, after reading them, let us know what you think of them.

—The Editors.

NOTES ON BROADCASTING

An indication of the interest in fight broadcasts is given by a statement of the New York Edison Company. During the Sharkey-Stribling bout, broadcast from Miami, Florida, current consumption began to rise above the normal load at nine o'clock, had risen to 25,000 kw. over that in use on ordinary nights by ten o'clock, soared to 40,000 kw. about the time the fight ended at 10:30, and reached a maximum of around 54,000 kw. at 11 p.m. A lot of late staying up must have been caused because the load did not return to normal until one a.m.

Senator Nye, of North Dakota, will offer a bill for the erection of a Government radio broadcasting station to radiate debates of Congress on important issues. In view of the N.B.C. offer to broadcast important debates over networks and the impossibility that Nye's one station can reach an appreciable part of the listening public, the project is as wasteful as it is useless.

License has been applied for by the Freshman Company to erect two experimental television transmitters at their plant in Clifton, N. J., according to J. D. R. Freed, vice-president of the company.

PROGRESS IN LOUD SPEAKER DESIGN

NATHANIEL BALDWIN, INC.

E. W. Smith, Research Department: Fundamental and accurate data on vibration instruments has enabled manufacturers to set a new standard n moving-iron reproducers as regards efficiency. A very satisfactory response is now obtained with a reduction of the "peaks" that have characterized the performance of these instruments hitherto.

The Baldwin line reflects all the improvements enumerated in a new moving-iron instrument. The improvements are listed as follows: one-piece cast-aluminum frame, laminated pole pieces and armature, new double permanent magnets which offer nearly twice the magnetic flux of the old type, and an improved "Burtex" acoustic diaphragm.

JENSEN RADIO MFG. COMPANY

Peter L. Jensen, President: Loud speaker manufacturers that employ competent and progressive engineering staffs will present to the trade this year new models of dynamic (moving-coil) loud speakers somewhat better in every respect than the 1928 models. The main improvements are made along the following lines: greater dependability on high power; larger cones with consequently less motion for the same output of sound; eliminating stresses and danger of breakdowns; larger voice coil capable of carrying 250 push-pull input without overheating, and finally and most important extending the response to include more of the higher voice frequencies.



Peter Jensen, president, Jensen Radio Mfg. Co.

The voice coil problem has been overcome in the new 1929–30 model Jensen dynamic loud speakers by the use of aluminum wire. As aluminum has about 60 per cent. the conductivity of copper and only about 30 per cent. its weight, its employment gives the required increase in current carrying capacity without correspondingly adding to the weight of the moving parts.

The Jensen Concert Speaker employing a lighter movable system has a response well above a frequency of 5000, and the "boom-boom" characteristic of many dynamic loud speakers has been entirely eliminated without the sacrifice of the pleasing true low notes. It employs a shallow $9\frac{1}{4}''$ cone.

Due to the increased demand, dynamic loud speaker manufacturers have been able to plan more economical production this year by being assured of a larger output and set manufacturers can procure good dynamic speakers at a cost probably not exceeding 25 per cent. over the cost of a good magnetic unit.

OXFORD RADIO CORPORATION

Frank Re chman, Radio Sales Division: Dynamic loud speakers will hold the front rank in loud speaker styles during 1929. The dynamic loud speaker has proven its merit and with another year of development behind it outranks, in fidelity of performance, any other design. Practically all of the leading set manufacturers are planning on using dynamic loud speakers exclusively.

Dynamic speakers will be ever so much lower in price due to set manufacturers incorporating in the power pack of the set the means for supplying the field current to the speaker. This eliminates almost half of the manufacturing cost of the loud speaker proper. However, this means the speaker and the set have to be engineered and sold together.

Oxford loud speakers this year will be available in every type of dynamic. This will include all d.c. models for set manufacturers. The line will also include "hum free" a.c. models in both the dry rectifier and tube types, and theatre models designed to operate on the most powerful amplifiers. All types are made in two sizes, the 9″ and 11″.



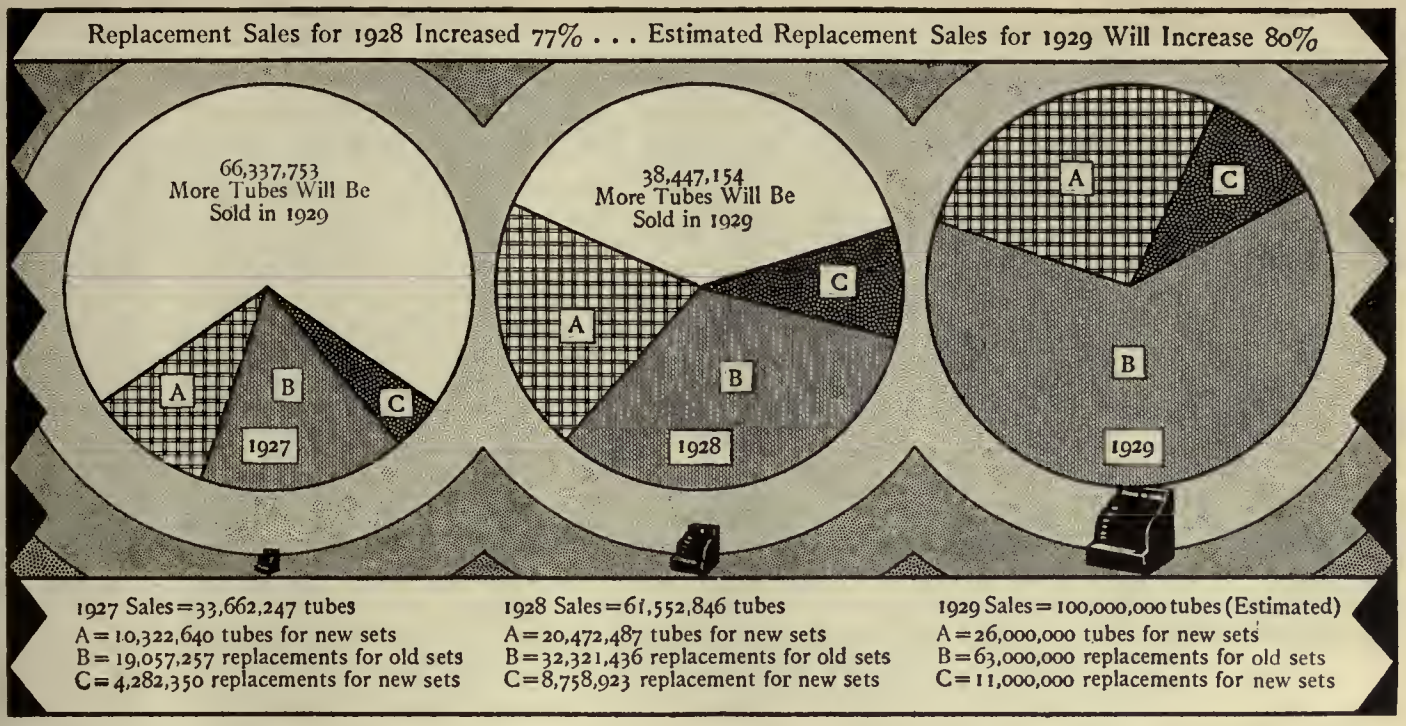
Frank Reichman, Radio Sales Division, Oxford Radio Corp.

Cabinet manufacturers, this year, are designing their cabinets as "baffle boxes" quite as much as beautiful furniture. They realize that the dynamic loud speaker is not a complete operating instrument without its "baffle" and that the cabinet is the "horn," and is an essential, vital part of the loud speaker.

STROMBERG-CARLSON TELEPHONE MFG. COMPANY

Ray Manson, Vice President and Chief Engineer: Last year, the dynamic type (moving-coil) loud speaker came into its own, due to the small space required for a powerful driving unit. Many detailed improvements have been made in this type of unit which provide for increased audio-frequency range and increased electrical efficiency. This result will be obtained by various detailed improvements, such as the use of larger diameter driving cones, more flexible supports for the cone, lighter weight cone materials, the use of stiffening means in the cone structure, etc. The so-called "magnetic" (moving-iron armature type) loud speaker also will be offered in greatly improved forms, which are sure to give better reproduction than many of the dynamic loud speaker offerings of last season. Condenser-type loud speakers will be available as a commercial product before the end of 1929 and no doubt will create considerable interest.

Stromberg-Carlson loud speakers meet these trends in a full line of improved "magnetic" types, model Nos. 14, 15, 16, and 17, and in an improved electrodynamic floor model, known as the No. 25. All of these loud speakers use "large diameter" cones of special construction, arranged to provide the correct frequency range for natural reproduction of speech and music, and a combination electrical and mechanical system which provides high efficiency of sound output as compared to electrical input



1929—THE YEAR OF 100,000,000 TUBES

ESTIMATES OF tube sales during 1929 indicate that dealers may expect an increase of at least 60 per cent. in this part of their business—and, as every dealers knows, this will represent an appreciable part of his yearly increase in revenue. Why this great increase?

Tubes from reliable manufacturers do not, as some customers still believe, fail prematurely. The reason for the accelerated growth in the tube replacement market comes from but one cause—the use of more radios more hours per day. This in turn is caused by the increase in "time on the air" taken by both national and local broadcasters; by the increased number of stations which may be received without interference; by the improved fidelity of transmission and reception; by the rapid betterment of the quality of programs; and by the fact that the moment a radio receiver operated directly from the lamp socket is installed, its user is freed from worry about whether his batteries will need replacement or charging if he works the radio too hard. The result is he listens more than he did before.

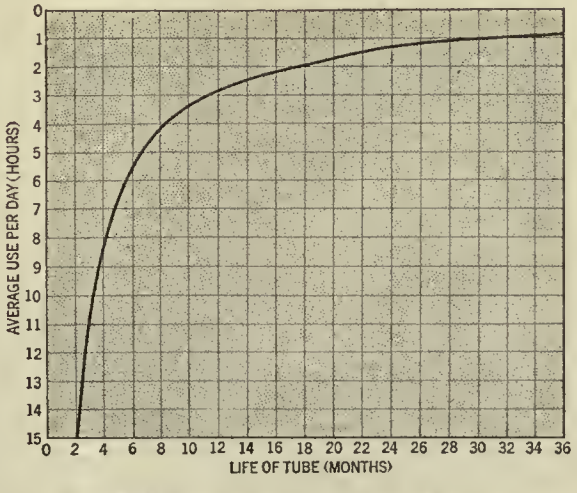
The charts at the top of this page show the extent to which the tube market increased last year, and the expected sales for the current year. (These charts show the various purposes for which the tubes are purchased, such as tubes for use in new receivers, replacement tubes for receivers sold during the current year, and replacement tubes for old receivers.) The fact which is instantly apparent is that the replacement market is growing by leaps and bounds; much faster than the market created by the sale of sets.

Let us consider a few facts, contributed by a recent survey of the National Broadcasting Company. This survey shows that 68 per cent. of the radio owners use their set on an average of at least two hours per day, 44 per cent. use their sets at least three hours per day, and 24 per cent. use their sets more than four hours per day. These figures have been found to hold true irrespective of the section of the country, occupation, or social standing of the individual.

These data, taken in March, 1928, prove that listening to the radio is becoming increasingly popular. More recent surveys indicate that to-day, June, 1929, radio entertainment is even more popular and that many families are using their sets five hours or more a day, or a total of approximately two thousand hours per year! This, in turn, means that many set-owners have to buy at least two complete sets of tubes for their receivers each year (see chart below), and it explains why the replacement tube market is increasing with such rapid strides. And what could be more natural than this increase when it is realized that the better stations are now on the air from 6:45 A.M. until midnight and that over 600 stations are broadcasting?

Better programs, better radio receivers, more stations on the air, widespread acceptance of the radio as a source of entertainment, news, and education, all point toward a still greater use of the receiver than has been customary.

All of these factors should be appreciated by the dealer in radio tubes, and should be pointed out to the irate customer who insists that the tubes in his new a.c. set are ready for the wastebasket much sooner than is proper.



Showing how tube life varies with use.

A GAME FOR RADIO DEALERS

By S. GORDON T. PARKS

President, Parks & Hull, Baltimore, Md.



S. Gordon Parks

HERE IS a list of questions which dealers will find profitable to examine. Take the list and note your answers, "yes" or "no," in the margin—play it as a game, if you like. But the writer feels that this is more than a game—every dealer can with profit use these questions as an aid in taking mental stock of his organization.

The idea of this little game is briefly this: you read the questions carefully, and indicate your answer with a check mark for "yes" and an "X" for "no." After going through the entire list in this way, look at the answers in smaller type at the bottom of the page. These answers, in the experience of the writer, are those which would be made by a one hundred per cent. perfect dealer.

By comparing your answers with this theoretical ideal you will be able to determine readily how closely your organization approaches perfection. And then, what is more important, by concentrating on the problem of making the wrong things right, you will be able to improve your standing in a manner that will be reflected in increased sales and a higher degree of customer good will. And, best of all, you can make this test in perfect privacy, with no one but yourself viewing the outcome, be it good or bad. What happens afterward is up to you.

The hundreds of Atwater Kent dealers who are clients of the writer's firm expressed great interest in this game, which was published in our house organ, *Parks Hullings*, and I am glad to present these questions to a far wider group: for the thousands of other radio dealers who are readers of RADIO BROADCAST.

And now, on with the game!

The Questions

1. Do you reserve about 5 per cent. of your expected gross sales to be used for advertising?
2. Does your advertising in newspapers consist of two or three feature display advertisements per season, rather than regular and consistent efforts?
3. Does your newspaper advertising consist of display advertising used consistently throughout the season?
4. Do you use billboard advertising?
5. Do you advertise over your local broadcasting station?
6. Do you use direct mail advertising, such as the "Tune in the Home" campaign and the "Donnelly Post Card" campaign?
7. Do you use to the fullest extent the window-trimming aids available to you through your jobber?
8. Do you change your window display weekly?
9. Do you maintain at all times an attractive store display of a representative line of sample stock?
10. Do you make full use of the various dealer helps which are available to you?
11. Do you stress the real talking points of the lines you handle?
12. Do you make a practice of knocking merchandise that you do not carry?
13. Do you keep well posted on programs and broadcast features in order to be able to tell prospective customers what they will hear if they buy a radio set?
14. Do you spread your sales efforts over a half-dozen different lines?
15. Do you concentrate on three or less, well-chosen lines?
16. Do you carry consigned merchandise?
17. Do you carry an adequate staff of outside salesmen the year 'round?
18. Do you maintain a staff of outside salesmen during the winter season, cutting that staff down to little or nothing during the summer?
19. Do you demonstrate in the prospect's home?
20. Do you demonstrate only in the store?
21. If your antennas are erected by an outside firm, do you caution your installer to see that the job is properly done?
22. Does your serviceman see that all inside connections, particularly the ground connection, are carefully made?
23. Do you follow up all sales to make sure that the customer is satisfied; and to obtain all possible prospects from this source?
24. Do you answer all service calls as speedily as possible, and as near to the promised time as can be done?
25. Do you maintain adequate service equipment to render service with efficiency and satisfaction to the customer, and with the lowest possible cost to yourself?
26. Do you render free service, except on tubes, for ninety days—thereafter making a fair nominal charge for time and material?
27. Do you train your servicemen to sell accessories such as new tubes, power units, and extra loud speakers, in the course of their regular work as well as to obtain the names of people who have shown interest in the customer's set that is being serviced?
28. Do you maintain your service department so that it is self-supporting and not a drain on your profit and loss account?
29. Do you maintain a clear, up-to-date system of service records so that your billing can be done quickly and fairly, and so that your sales staff can periodically examine the records for live prospects for the sale of a new set?
30. Do you offer favorable terms to those customers of good standing who cannot afford to pay cash?
31. Do you accept small down payments from customers whom credit investigation shows to be worthy of trust?
32. Have you a standing order card on file for new merchandise?
33. Do you hold regular meetings of your organization to discuss new sales efforts?
34. Do you insist that your sales and service staff keep in touch with the progress of radio by reading regularly one or more good trade papers?

The Answers

(Read these *after* you have checked your own replies in the margin of this page).

The perfect dealer—yes indeed there are many of them!—would answer "Yes" to all of the questions with the exception of the following, to which the reply should be "No": Numbers 2, 12, 14, 16, 18, and 20.

And now just a final suggestion to help you make more money and achieve more good will: if you are not letter-perfect make this game serve you by an effort to see how closely you can approach the ideal. Keep the questions and their solution in some convenient place where you can check them over from time to time to determine how quickly you are progressing. You will find, without a doubt, that the more closely you approach the ideal rating, the greater will be your success. *Give it a trial and see!*



General view of test bench in the laboratory of the Loomis Radio College.

Practical Pointers on Servicing

RADIO SHOP PRACTICE

By MARY TEXANNA LOOMIS

President, Loomis Radio College

IN A PREVIOUS article we gave some pointers on "Running a Small Radio Shop" and a description of a service shop in Washington, which had been chosen as a model for other small radio stores. In this article we aim to go more into detail concerning the actual methods used in the servicing branch of the radio business. As stated before, the serviceman, if he is to be successful in his work and make friends for his employer, must be trained in his business. The day of the "just-picked-it-up" serviceman is over.

With the shop properly equipped and running with at least two capable servicemen, one for outside work and one for shop work, a single service job would consist of the following:

(1) Call received by telephone asking for service.

(2) Service ticket made out and serviceman starts out on call.

(3) Serviceman calls at house and checks antenna, ground, loud speaker, tubes, and everything outside set chassis. If any trouble is found during these tests he makes the necessary repair immediately.

(4) When all wiring, apparatus, etc., outside the chassis either checks o.k. or has been repaired or replaced, the serviceman proceeds to check voltages and current in the set as follows: E_p, E_g, I_p, and E_f. He also tests the set for operation, provided the set is working, and checks on selectivity and sensitivity. If set checks o.k. and customer is satisfied with results of such minor repairs or replacements as could be made at the house, he is requested to sign a ticket stating that service is completed and satisfactory. This ticket must be turned in at the office of the shop by the serviceman. If he collects money, this must be signed, accounted for, stating amount, and serviceman must give receipt to customer. If, in the house tests, the set chassis or power unit showed trouble which could not be handled at the house, it should be removed from cabinet or console and taken to the shop for repairs. *It is not good policy to make extensive repairs in the home of the customer,* as it often has a bad effect psychologically for the customer to see the set "all torn to pieces."

(5) When the set or chassis is brought to the shop to be serviced, it is properly tagged and placed on the "incoming" shelf, to be taken up in its turn. It should not be left standing there long enough to accumulate dust.

(6) When the "inside" man takes up this set, he makes thorough tests of all circuits and parts, with the idea of locating defects. The part, or circuit, found to be the cause of trouble is then repaired and the set is checked thoroughly for performance. When perfectly satisfactory, the set is marked "repaired" and placed on the "outgoing" shelf for delivery to the customer.

(7) The repaired set is returned to the hands of the "outside" man, who delivers and installs it, testing it on an outside station in the presence of the customer. If the customer is satisfied, the serviceman obtains a signature to the statement that the set is operating satisfactorily. As before, if any money is exchanged, this must be handled carefully as described in a preceding paragraph.

In connecting the set at the customer's house and in making final tests, everything should be checked again, as this often brings to light some minor defect that might become worse in time and require another service call. This policy

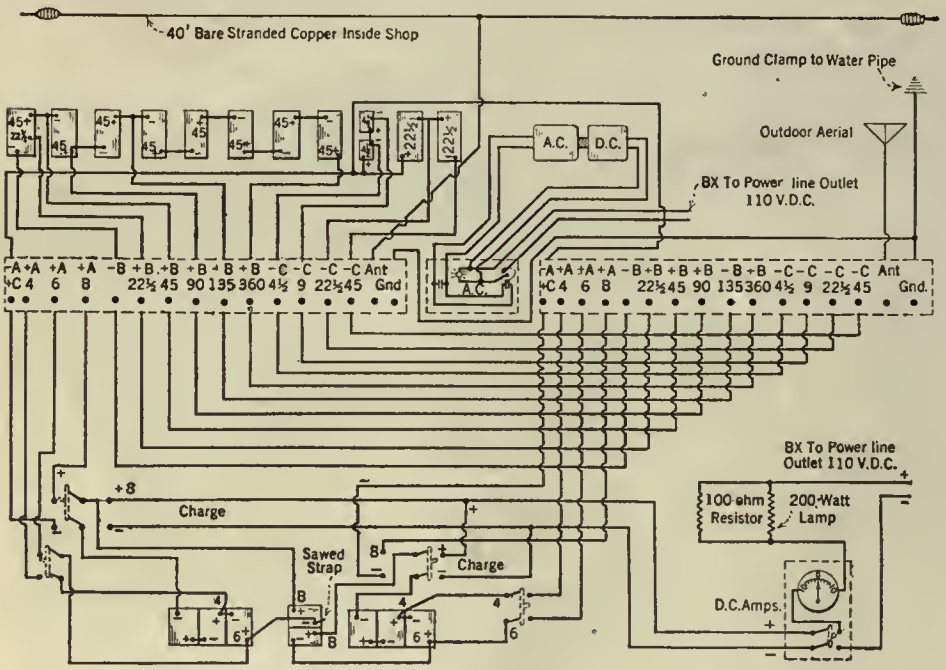


Fig. 1—Wiring diagram of the test bench pictured on page 87

keeps no-charge service calls at a minimum and develops confidence for the shop and men employed by it.

While individual cases frequently arise, calling for ordinary common sense in the handling, the following list of troubles and probable causes may be considered a general guide:

No E_p: Bad B batteries, bad power pack, open plate circuit. The latter may be due to a burned-out plate resistor, a burned-out transformer coil, or a poor or broken connection. A shorted by-pass condenser, or bad rectifier tube, in case of an electric set.

No E_g: Bad C battery, or open grid circuit which may be due to burned-out grid resistor, burned-out transformer coil, or bad connection. In electric sets where I_p through a resistor gives E_g, check plate circuit also.

High I_p: Wrong C bias (too low or reversed), shorted tube, shorted plate resistor, or wrong connection batteries or power pack.

No E_f: Bad filament battery, bad power pack, open rheostat, or bad connection.

Testing Equipment

THE TESTING APPARATUS employed, and the cost of it, is largely a matter of choice with the shop-owner. A large amount of expensive equipment is not actually required in order to conduct a successful servicing business, if such apparatus as is purchased is well chosen. Each outside serviceman must have a neat box with a small number of carefully selected tools. Superfluous tools only get in the worker's way. The kit should contain two styles of pliers, wire-scraping knife, soldering iron, two screw drivers, and a couple of octagonal wrenches.

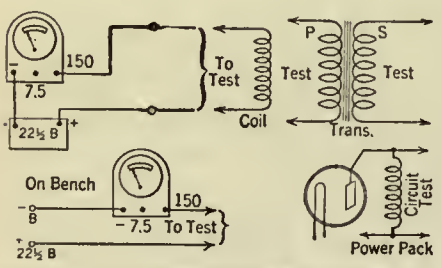


Fig 2—Voltmeter continuity testing.

If one of the screw drivers is magnetized it will be a great help. This is easily accomplished by inserting the blade inside of a coil of about 50 turns of No. 18 insulated wire which is connected across the terminals of a six-volt battery and closing the circuit for a few minutes. It can also be done by holding the screw driver, with a good tight grasp, against the field of a d.c. motor while running. A small mirror, such as carried in women's hand bags is often very useful in looking at crowded wiring and connections under circumstances where it is not desired to dissemble the set, and this is small and of light weight. [A dentist's mirror might prove even more satisfactory—*Editor.*] Besides the tool kit, the outside serviceman should carry an assortment of standard tubes in a separate box, and a

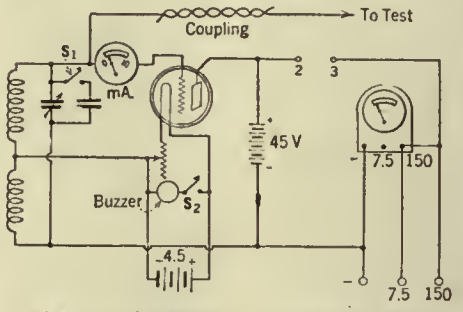


Fig. 3—Oscillator-voltmeter test combinations.

standard tube- and set-tester, or set of testing meters.

Inside the service shop, there should be one completely outfitted work bench for every three or four outside men. In our former article we showed a picture of the actual layout of a service-shop bench which is in continual practical commercial use. The heading picture of this article gives a general idea of the double test bench in use in the Loomis laboratory. This is located in the center of the room in order to permit students to gather around it while trouble-shooting demonstrations are going on. Otherwise it would be much better backed up against windows. A complete wiring diagram of this table is shown in Fig. 1. Batteries and a.c. generator are installed beneath the bench, with wires brought up through drilled holes to conveniently arranged terminals.

If the workers like, a permanently installed arrangement of testing meters may be mounted on a bakelite or metal panel and added to such a work bench. This has some advantages and some disadvantages, depending on individual preference. A few models of complete testing tables, factory built, are on the market. One made by a well-known firm contains seven meters mounted on a steel panel 24 by 42 inches, placed horizontally across two wooden posts 36 inches high. The meters are as follows: 0–7.5 volts d.c.; 0–75 volts d.c.; 0–150–300 volts d.c., 1000 ohms per volt; 0–15–150 d.c. milliamperes; 0–4–8–16 volts a.c.; 0–250–750 volts a.c.; and 0–1.5–15 microfarads. Binding posts and switches are provided so that each meter may be used individually and for all ranges. The panel is wired up with a tube socket and a long cord with a tube-prong plug at the end. By means of these, each circuit in a radio set may be tested with the tube in a socket. Outlets may be connected to a 110-volt 60-cycle line. Voltage may be read and a radio set then plugged into the outlets. The 750-volt a.c. range is for testing the high-voltage secondary winding of a power pack and the capacity meter is useful for determining condenser values and in

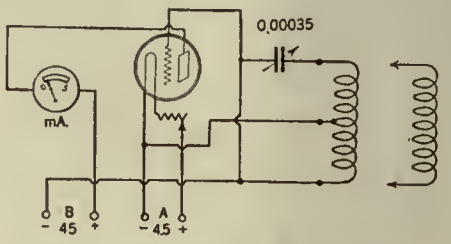


Fig. 4—Diagram of the oscillator tester shown in Fig. 5.

locating condenser shorts. The bench described above is the Jewell radio test bench, No. 580, price $278.50

Standard Testing Methods

IT WOULD BE RATHER out of the question, in an article of this space, to undertake to cover tests on every known make of receiver. Individual tests for various makes of sets, and specific uses of various standard test sets, are at all times available from manufacturers. Each receiver requires its own particular tests, and the makers, in their service manuals, thoroughly explain the correct way of making tests which are best adapted to the characteristics of their machines. In addition to this information some test-set manufacturers supply with their testers complete testing data for every standard receiver.

Certain tests apply in a general way to all sets, regardless of make. These may be set forth as follows: *Test for plate voltage:* Touch leads from a high-voltage voltmeter to the plate and filament prongs of each tube socket, with the set connected to its usual power supply. If no voltage is indicated, there is an open circuit in a transformer coil or a shorted by-pass condenser in the circuit attached to the plate prong of that tube. If several tubes show no plate voltage there may be a broken or loose connection. If a power pack is used, the output voltage of this should be checked, and, if trouble is indicated there, the power pack needs to be overhauled.

Locating open circuit: If the power input to the set is o.k., and a voltmeter gives no reading as referred to above, the same voltmeter may be employed in locating the open which is probably the reason for no voltage on the plate of the tube. The open may be either the primary of an audio-frequency transformer, a coil in the

radio-frequency stage, or a broken lead to coil or tube. To test for an open circuit in any transformer coil, place the voltmeter, in series with a 22½-volt battery, across the section to be tested. No voltage reading indicates an open. If a reading is obtained, this shows that connections or coils are not open. The test tells nothing about shorts.

Locating short-circuit: Any coil or piece of electrical apparatus has some resistance and, therefore, should show a voltage drop. A lower voltage reading will be obtained when testing through a coil than when the ends of the test clips are touched together. When the leads are touched together, the full voltage of the battery is read, but when the leads are placed across a piece of apparatus the battery voltage, less the volt drop across the coil, is read. If *no drop*, not even a small one is shown, a short is indicated. A fairly low resistance voltmeter should be used for this test so that enough current will flow to give a readable drop across apparatus under test.

Testing condensers: In testing condensers for shorts or breakdown, the same test for open circuits will apply. In this case, however, a reading will indicate that the condenser is shorted. A condenser in good condition is an absolute block to direct current. Therefore, if a reading is obtained, the condenser is bad. This test is made best with a high potential, say about 135 volts, as occasionally a condenser will test o.k. on low voltage but will break down when the set-operating potential is applied to it. Bad by-pass condensers will create short-circuits in grid and plate supplies and, therefore, will show up by a zero plate or grid voltage reading.

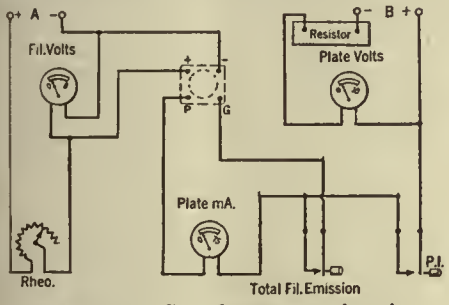


Fig. 6—D. C. tube-tester circuit.

With a double-range portable voltmeter, and the shop work bench wired up as shown in Fig. 1, the voltmeter may be connected to the permanent battery clips for series readings. Or, if the bench is busy, a separate battery and the portable meter may be used at another location.

Tube- and Set-Tester

SEVERAL GOOD tube- and set-testers of standard types are on the market. It is generally safest to purchase such apparatus from one of the well-established concerns. Many testing sets, some standard and others more or less novel, may be made profitably in one's own shop or laboratory. A combination voltmeter and oscillator, as shown in Fig. 3, is a convenient piece of equipment for use in a service shop. Its uses are to test voltages and to provide signals during hours when there is no broadcasting. Only the best materials and meters should be used, and it should be made as small and light as possible. The coil, for the condenser values shown, may consist of No. 30 d.c.c. wire tightly wound on a form 1.75 inches in diameter, to 250 turns and tapped at the center. After being wound, the coil should be coated with collodion to hold the wire in place. Meters and other parts should be arranged to make the leads as short as possible. If a 199 tube is used, the batteries may be placed inside the box. A 4½-volt C battery will suffice for the filament, and a small-sized B battery may be used for the plate. These will last a long time. Note that the B battery functions both as plate power for the oscillator and for operating the voltmeter in making continuity tests. The oscillator must be calibrated from a suitable standard. The following paragraphs describe some tests that can be made with this test-set.

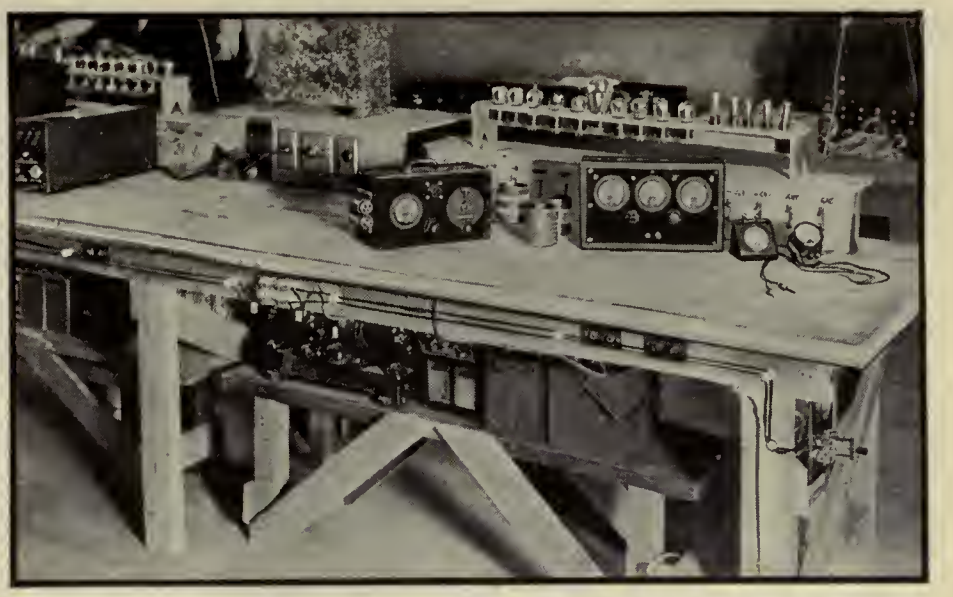


Fig. 5—View of the test bench, oscillator, and tube-tester described in this article.

To use the apparatus as a straight high-frequency oscillator, insert tube, throw switch S_1 to "on" position, and couple test lead to a receiver. Coupling may be increased or decreased by changing the amount of wire twisted together in the lead. At resonance between tester and receiver the greatest "dip" in the grid milliammeter will be noted, but coupling should be loosened enough to prevent the dip from pulling the oscillator off the frequency to which it is set. The oscillator may be modulated for audibility by closing S_2 and causing the buzzer to vibrate.

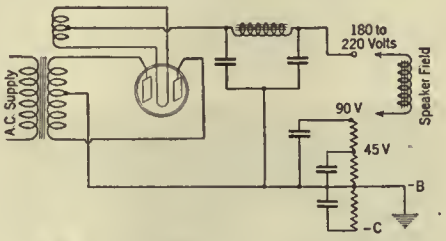


Fig. 7—Typical B and C supply unit of an a.c. receiver.

Continuity and voltage-drop tests may be performed with the oscillator shown in Fig. 3 by connecting the circuit and resistance coil, or other piece of apparatus being tested, to posts 2 and 3. This places the B battery and the high range of the voltmeter scale in series with the circuit or part to be tested. A practical serviceman would gradually discover a number of other ways to employ this set advantageously.

A slightly different oscillating set for testing purposes is seen at the left in Fig. 5. A diagram of this is given in Fig. 4. It is self-explanatory. The milliammeter, in the plate circuit in this set, gives an indication of resonance by dipping. With this apparatus calibrated for standard frequencies, it may be used with a single coil of wire having no center tap for indicating resonance as a pick-up wave-frequency meter. With the center-tapped Hartley coil it is useful as a "driver." For instance, in checking on the coils and condensers of the different stages of a neutrodyne receiver, if the milliammeter dips the same amount for each stage, when tuned to resonance with each tuned circuit, this is an indication of continuity through each coil, the dip being caused by absorption into the coil circuit. If each tuned circuit tests the same, this also shows that they are properly designed to tune to the same frequency. The batteries are mounted inside the oscillator cabinet.

At the right of the oscillator, in Fig. 5, is a tube-tester, made and used by students of the Loomis Radio College. This is a standard arrangement of plate voltmeter, plate milliammeter, and filament voltmeter. Something of the kind is indispensable in every radio service shop. Weston meters, type 301, flush, were used. The resistor is made to be used with the plate voltmeter and is supplied with it by the manufacturer. Some difficulty was encountered in locating suitable jack switches, or push-button jacks, for this set. These were finally devised from parts of telephone jacks, the "push-buttons" consisting of the knobs and brass shafts of Eby binding posts. With the filament rheostat adjusted to show a voltmeter reading of the correct filament voltage, the milliammeter reading of plate current, for various plate voltages, indicates the condition of the tube. If desired, a meter of the same make, showing filament current could be included in such a tester.

The tests described apply to all types of receivers, but, due to the differences in circuit design, as indicated in Figs. 7 and 8, a.c.- operated receivers also require additional tests. However, these are beyond the scope of the present article.

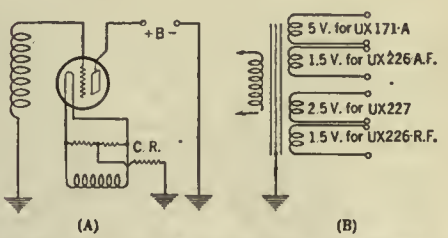


Fig. 8—(A) Method of obtaining negative C bias; (B) usual system of securing filament voltages in an a.c.-operated receiver.

IN THE RADIO MARKETPLACE

News, Useful Data, and Information on the Offerings of the Manufacturer

Personal Notes

J. K. I. Cody, formerly general sales manager of the National Cash Register Company in Japan, has been appointed general sales manager for the Gold Seal Electrical Co., Inc., New York. Edward R. Fiske, formerly assistant general sales manager of the Ceco Mfg. Co., of Providence, R. I., is now general field supervisor of Gold Seal.

Joseph L. Ray, vice-president and general sales manager of the Radio Corporation of America, has been elected to the board of directors of the Victor Talking Machine Company.

Dominic F. Schmit has been appointed chief engineer of E. T. Cunningham, Inc., New York, succeeding Roger M. Wise who is now with Grigsby-Grunow. Before his connection with Cunningham, Mr. Schmit spent three years in the research laboratory of the General Electric Co., at Schenectady, in research and development work on radio receiving tubes. Mr. Schmit was born in Port Washington, Wis., and was graduated with a B. S. in E. E.

Kenneth W. Jarvis, formerly a member of the engineering staff of the Crosley Radio Corporation, at Cincinnati, Ohio, has joined the Sterling Manufacturing Company, of Cleveland, Ohio, as chief engineer of the radio division.

William C. Alley, formerly managing editor of our excellent contemporary, *Radio Retailing*, has joined the staff of R.M.A. as merchandising manager. His headquarters will be in the New York office at 11 West 42nd Street.

Prof. Reginald A. Fessenden, bearer of one of the best-known names in radio, has joined the staff of Grigsby-Grunow, makers of Majestic Radio, as consulting engineer. It was announced that, "while Prof. Fessenden's work will be directed mainly toward developing television apparatus, his experience in radio tube manufacture and set design will be of value."

R. F. Lovelee has been appointed assistant sales manager of the Federal Radio Corporation, Buffalo. Mr. Lovelee has been with the company since its first connection with radio. He is a graduate of the University of Michigan in electrical engineering, worked in the Chicago laboratories of Western Electric and later in the engineering department of Federal at Buffalo.

The Wood Cabinet Corporation, 196 Lexington Avenue, New York, has just been formed by T. J. Molloy to take over the business of the Wood-Molloy Co. A sales force of 50 men will cover the trade with low- and medium-priced cabinets in about 15 models of conventional design, interchangeable for all makes of radio receivers. These cabinets will be sold direct to dealers.

Arthur L. Walsh has been appointed vice-president and general manager of the radio and phonograph division of Thomas A. Edison, Inc. The new Edison radio-phonograph is an important unit in the line and will include provisions for playing the new needle-type Edison record which can be played on any phonograph. Hill-and-dale Edison records will remain in production.

Sparton announces that Frank S. Purviance is now district sales representative in the Michigan-Indiana territory.

D. J. Quinn, formerly Western sales manager for Sonatron, has been appointed vice-president in charge of sales. Other changes in titles have made Nathan Chirelstein, chairman of the board, Harry Chirelstein, president, and R. L. Marshall, in charge of testing and shipping is now secretary of the company.

News of the Industry

Grigsby-Grunow announces the formation of the Majestic Corporation, 120 South LaSalle St., Chicago, to finance the paper of its authorized dealers in connection with time sales of Majestic sets. The office is in charge of H. C. Straus.

Arcturus Radio Tube Company, Newark, N. J., announces an increase in production schedule from 17,500 tubes daily to 45,000 per day. A new factory has been occupied and will add 111,000 square feet of floor space to the 45,000 square feet already in use in other plants.

Stromberg-Carlson, of Rochester, N. Y., has started operations in their new factory which covers 28 acres and provides 360,000 square feet of floor space. Radio sets and telephone equipment will be produced.

The Transformer Corporation of America is now located at 2301 South Kecler Ave., Chicago, Ill.



The new Bosch model 30 radio-phonograph combination.

P. R. Mallory and Co., Inc. announces the purchase of a factory in Indianapolis which is expected to be in complete operation by October 1 and will house the manufacturing activities of Elkon, Inc. and the Knapp Electric Co. The new plant has a floor area of about 200,000 square feet and will house the general sales offices, although a New York sales office will be maintained and complete stocks of Knapp and Elkon radio products kept on hand.

Federal Radio, of Buffalo, announces that the Sanford Motor Supply Co., of Williamsport, Pa., will become exclusive wholesalers for Federal.

The Polymet Mfg. Co., of New York, have purchased the Strand and Sweet Mfg. Co., Winsted, Conn., makers of fine copper magnet wires. Polymet purchased recently the Coilton Mfg. Co.

Expansion in the Crosley manufacturing facilities is reported from Cincinnati where an additional plant to cost $750,000 is expected to double the present production of receivers. At present 3800 people are employed in the plant.

The Acme Electric and Mfg. Co., of Cleveland, has increased its capital stock and changed its name to Acme Radio & Electric, Inc. In 1928, the company began producing a.c. receivers and now has 1700 dealers, an increase of 1200 over a year ago, according to an announcement.

The Raytheon Manufacturing Company, of Cambridge, who manufactures a complete line of radio receiving tubes and rectifiers, is soon to take over a new factory in Watertown, Mass., with about 160,000 square feet of floor space. When fully equipped this factory will turn out about 30,000 tubes per day.

New Receivers Announced

The Radio Corporation of America announces a new six-tube a.c. receiver, the Model 33. It utilizes four 226-, one 227-, and one 171A-type tubes and a 280-type rectifier. A new R.C.A. loud speaker, the 100-B, is used. This loud speaker is of the magnetic type and it fits into a border groove on top of the radio set. The list price of the Model 33 is $77.50 and the list price of the 100-B is $22.00.

The Graybar Model 311 is the latest receiver of the Graybar Electric Company. The list price is $77.50. The Graybar loud speaker lists at $22.00. The circuit uses six tubes in a tuned r.f. arrangement.

The new Eveready receivers were announced recently by the National Carbon Company. Model 31 is a table type listing at $115; model 33 at $210; model 32 at $175, and model 34 at $225. All of the receivers use the same chassis which is a seven-tube set plus a rectifier.

The Earl radio receivers are a product of the Chas. Freshman Company, Inc. The Model 22 Earl lists at $99.50 less tubes. It is an eight-tube set of the neutrodyne type with four tuned circuits, push-

pull amplification, and an inductor loud speaker. The Model 32 lists at $169.00 and is similar to the 22 except for the loud speaker which is of the moving-coil type.

The new Stewart-Warner Series 900 Consolette, consisting of a table-type receiver and a Stewart-Warner Dyphonic loud speaker, lists at $113. With an electrodynamic loud speaker the combination sells for $123.25. The set utilizes seven tubes plus a rectifier. In the output stage two 245-type tubes are connected in push-pull.

The American Bosch Magneto Corporation has announced their new Bosch radio-phonograph combination, Model 30. The new combination uses nine tubes and lists for $475.00. The cabinet is 47½ inches high, 36 inches wide, and 9¼ inches deep and contains two record racks. The turn table is operated by a General Electric induction motor equipped with an automatic stop. Contained in the cabinet is a Bosch super-dynamic loud speaker.

The Simplex Radio Company announces a new eight-tube receiver. The set uses five 227-, two 245-, and one 280-type tubes. The illuminated dial is calibrated in kilocycles. The set contains a phonograph jack and a built-in light-socket antenna. The console model complete with dynamic loud speaker lists at $150.50 less tubes.

Miscellaneous New Apparatus

The Stevens Manufacturing Corporation announces the design of a new diaphragm utilizing a special shape which is said to decrease distortion produced by ordinary cone diaphragms. The new diaphragm is made of Burtex, which is a special diaphragm material manufactured by this corporation.

The Pooley Company, cabinet manufacturers, have designed two special cabinets, models 8200 and 8400, for use with the Atwater Kent Model 46 receiver and the Atwater Kent electrodynamic loud speaker, Model F-2-C.

The Thordarson Manufacturing Company manufactures a special transformer, type T-2903, designed for use in conjunction with the moving-coil loud speakers to replace transformers supplied with these units.

The Clarostat Manufacturing Company, Inc. manufactures a complete line of wire-wound resistors. Fixed resistors are available in sizes from 1 to 3000 ohms. Center-tapped resistors designed for use across the filament circuits of a.c. tubes are available in either fixed or adjustable types in sizes from 6 to 500 ohms.

The Potter Company manufactures a dynamic loud speaker filter, a device designed for use with a.c.-type loud speakers to decrease the hum. The filter is connected directly across the field winding. The price is $4.75.

The Jensen Radio Manufacturing Company announces a new Imperial model loud speaker, consisting of a Jensen auditorium-type dynamic loud speaker mounted in a special cabinet which acts as a baffle. The cabinet was designed by Everett Worthington. Models for operation on either 110 volts a.c. or d.c. can be obtained. The a.c. Imperial model lists at $100.



Louise Homer, Metropolitan Opera Star, listening to the new Victor Radio with Electrola, Model R. E. 45.

The Jewell Electrical Instrument Company's new a.c. tube-checker, type 210, operates from the a.c. lines and will check all types of tubes including rectifiers. The panel of the tester carries an a.c. voltmeter, a d.c. milliammeter, and a selector switch to give a.c. potentials of 1.1, 1.5, 2.5, 3.5, and 7.5 volts.

Insulated test handles useful to servicemen or in radio laboratories are manufactured by the Metropolitan Mfg. and Electric Company, Chicago. The test handles complete with leads list for $1.25.

A new phonograph pick-up has been announced recently by the Best Manufacturing Company. The Best theatre pick-up is counterbalanced so that just enough weight bears on the record for the needle to track perfectly. It is packed in a three-color display box with volume control and a universal adaptor for use with sets not having a phonograph jack. Price, $17.50.

The Hoyt Radio Servicer, Model 600, is a compact portable set-tester for making tests on all modern radio receivers. It contains a high-resistance voltmeter for measuring d.c. potentials with voltage scales of 12, 120, and 600 volts. The milliammeter in the instrument has two scales, one of 30 and the other of 120 milliamperes. The a.c. voltmeter has three scales, 3, 9, and 150 volts. Provision is made for testing all types of tubes, including rectifiers.

A new dynamic loud speaker, Model SP-29, is announced by the Stevens Manufacturing Corporation. To supply field current, a 280-type rectifier tube is used in conjunction with a filter system consisting of 5-mfd. condensers and a 30-henry choke coil. The input transformer is arranged so that the loud speaker may be used with all types of power tubes, either singly or in push-pull.



New Atwater Kent radio cabinet by Pooley.

Items of Interest

The Amrad Corporation manufactures Mershon condensers which are at present being used in the power units of a considerable number of well-known receivers. Mershon condensers consist of rolled aluminum electrodes in a copper case, these electrodes being covered by an oxide film. These condensers have the advantages that they provide a large capacity in a small space and they are also self-healing; that is, if they break down due to the application of excessive voltage, they immediately rehcal and are not affected permanently by the break down.

Mershon condensers are now being used by the following manufacturers:

Automatic Radio Mfg. Co., Boston, Mass.
Balkeit Radio Co., North Chicago, Ill.
Browning-Drake Co., 110 Brookline St., Cambridge Mass.
Colonial Radio Corp., Long Island City, N. Y.
Crescent Radio Mfg. Co., Minneapolis, Minn.
Crosley Radio Corp., Cincinnati, Ohio
DeForest Radio Corp., Toronto, Canada
France Mfg. Co., Cleveland, Ohio
High Frequency Laboratories, Chicago, Ill.
Howard Radio Co., South Haven, Mich.
Jordan Elec. Mfg. Co., Minneapolis, Minn.
National Company, Malden, Mass.
H. J. Power Radio Corp., Medford, Mnss.
Sleeper Radio & Mfg. Co., Long Island City, N. Y.
Sparks-Withington Co., Jackson, Mich.
Sterling Mfg. Co., Cleveland, Ohio
A. C. Dayton, Dayton, Ohio

Luminator, Inc., 1730 South Michigan Ave., Chicago, has issued an interesting catalog describing a portable standing lamp made by them which provides strong indirect illumination for rooms. Irving Davis, of their sales department says many radio dealers are handling this item, selling the product as a sideline.

It was announced by Atwater Kent that representatives of 22 radio cabinet makers have arranged to supply a complete line of cabinets for Atwater Kent sets and loud speakers this year, giving a range of more than 30 different types from the popular priced models to the most elaborate. These cabinet makers expect to furnish their product for more than one million A-K sets during the year, i.e., from May, 1929, to May, 1930.

The Charles Freshman Company, Inc., has applied for two television broadcast channels for experimental purposes. The transmitters will be located at the company's new plant at Clifton, New Jersey.

The Engineering Division of R. M. A. recommends that, for the convenience of the buyer, the tubes in a receiver be designated to indicate which are strictly "radio" tubes and which are accessory to the performance of the set. Thus, the tubes in an average a.c. set would be indicated 6-1. The first six tubes indicate the measure of performance of the set and the number separated by a dash shows how many rectifier tubes and those used similarly are

employed. By totalling the two figures the entire number of tubes employed is apparent.

The General Electric Company has sold to the Russian government the world's largest high-voltage rectifier. This giant rectifier is of the mercury-vapor type and supplies an output of 758 kilowatts at 15,000 volts. Eighteen mercury-vapor rectifier tubes are used. The sale was negotiated under a contract calling for several items of radio apparatus including a 20-kilowatt short-wave transmitter.

Dudley Wilcox, teasurer of the Ajax Electrothermic Corp., Trenton, N. J., advises us that he has available for presentation before engineers' clubs or societies copies of a film dealing with high-frequency electric furnaces. The film shows the melting and pouring of metals in charges of from one ounce to several pounds, clearly indicating the method of operation and the way in which electricity is applied in the furnace charge.

Effective April 1, the Radio Corporation announces, loud speaker No. 103 is reduced in price to $30 and No. 106 to $65. This is a reduction of $7.50 and $23.00, respectively.

Of Enginering Interest

The E. F. Johnson Company, of Waseca, Minnesota, sells a complete line of microphones and accessories, transmitting tubes, inductances, insulators, and filter condensers. The microphone is of the stretched-diaphragm, two-button, carbon type and lists at $67.50.

The Silver-Marshall Company's public-address amplifier, type 690, is designed to supply sufficient power, when fed by a microphone, a radio set, or phonograph pick-up, to operate up to twelve dynamic loud speakers, according to the manufacturer. The amplifier employs three a.f. stages. The first audio amplifier tube is a type 227, in the second stage 226-type tubes are used in push-pull, and in the output stage are two 250-type tubes in push-pull. The amplifier is stated to have a comparatively flat characteristic from 50 to 5000 cycles. Price, completely wired, $245.00.

A calibrated level indicator panel has been designed by J. E. Jenkins and S. E. Adair. The net price, complete except for tubes and batteries, is $250.00 f.o.b. Chicago. The panel gives a wide range of level readings from —10 db to +20 db in steps 2 db deep. The panel is exceedingly useful in determining the output of an amplifier or in making a frequency characteristic run. The input transformer in the device has a flat characteristic up to 6000 cycles. It has the advantage over other level indicating systems that it is direct reading and that it produces practically no change in load when its own settings are altered.



Joseph L. Ray, vice president and general sales manager, R. C. A.

data on interference prevention

Circular letter No. 182 issued by the Bureau of Standards, Department of Commerce, Washington, deals with elimination of certain types of interference with radio reception which have been found serious in some areas. Some subjects covered are power line induction, sparking apparatus, location of interference sources, commutators, bell ringers, and smoke precipitators.

new stromberg-carlson set

The Stromberg-Carlson Company's new receiver, No. 641, contains several improvements in design that result in better detection and audio reproduction. Three stages of r.f. amplification using the new a.c. screen-grid tubes are used. From these tubes tremendous amplification is obtained and there is impressed on the input to the power detector an r.f. voltage at least thirty times greater than would be obtained from an r.f. amplifier using three 227-type tubes. The power detector has a linear characteristic which eliminates distortion obtained from ordinary "square-law" detectors. The output of the detector feeds into a 245-type power tube. The use of only one a.f. stage not only improves the quality by eliminating some possible distortion in the audio amplifier but also results in less a.c. hum. The receiver is single controlled and is equipped with a phonograph pick-up jack.

brunswick buys bremer-tully

The Bremer-Tully Company, of Chicago, has been purchased by the Brunswick-Balke-Collender Company. This brings to Brunswick licenses to use patents controlled by RCA, Meissner, Hazeltine, and Latour. The new line of Brunswick radio sets and Brunswick radiopanatropes will "establish price levels to insure Brunswick dealers a mass market opportunity so essential to successful merchandising," it was announced.

hiler audio system licensees

The Zenith Radio Corporation, of Chicago, is the only receiver manufacturer licensed to use the Hiler audio system. Parts and accessory manufacturers who are now licensed are: General Radio Company, Ford Radio and Mica Corporation, American Specialty Company, Leslie F. Muter Company, and Kenneth Harkness, Inc.



The winner in the Ludlow Radio Company's "Oldest Set Contest."

price of ux-245 reduced

Effective April 15, the price of the new power-amplifier Radiotron, the ux-245, was reduced from $4.25 to $3.50, the Radio Corporation announced. "Although this tube was announced during the early part of March," officials of the Radio Corporation state, "it has already created a demand in excess of preliminary production estimates. The resultant increase in the production schedule has effected a corresponding reduction in cost of manufacture, making the new price possible."

a wisconsin dealer's novel contest

An interesting contest was held recently in Madison, Wis., by the Ludlow Radio Company. M. H. Ludlow, president, called for the registry of the oldest set in town. The first prize was a complete a.c. receiver. "The prize-winning set will be kept as a curiosity," said Mr. Ludlow, "and through the contest we gained a number of prospects for new sets." Some of the old-timer sets which were registered in the contest were Radiola 3, Clapp-Eastham C-23, Grebe CR-9, deForest, Custer Airbug, and A. C. Gilbert. Radio Broadcast was asked to act as adviser in deciding the contest.

We should be interested to hear from other dealers who have successfully carried out similar contests with details of the re-



This attractive window display was employed by the Ludlow Radio Company to create interest in their "Oldest Set Contest."

sults and, if possible, pictures of the displays which they employed in connection with the stunt.

NEW BALKEIT SALES POLICY

THE NEW PRESIDENT of the Balkeit Radio Company, North Chicago, Illinois, is Glenn L. Alspach. Mr. Alspach comes to Balkeit from the Gilfillian Radio Company of Los Angeles where he was treasurer and general manager. The Board of Directors of the Balkeit Company now includes: J. M. Troxel, E. F. Radke, J. C. Baker, W. A. Strong, E. G. Booz, and B. V. Becker. The entire capital stock of the company is owned by the Fansteel Products Company.

Balkeit announces a direct-to-dealer distribution policy. "The groundwork of the new Balkeit sales policy has been laid," said Mr. Alspach, "and among the field sales representatives are Harold W. Goldstein, western Pennsylvania, West Virginia, and part of Ohio; M. C. Curtis, Chicago and northern Illinois; Herman Hollander, Missouri and eastern Kansas; and Gifford Horenstein, Connecticut." Signed contracts for more than 50,000 receivers are now in hand, it was announced, and the minimum production for the year is expected to be 100,000 sets.

NEW TECHNIDYNE LICENSEE

THE NEW A.C. DAYTON SETS, demonstrated at a recent meeting for sales managers of distributing branches at the Dayton factory, will be made under the Technidyne patents, it was announced by Ford Studebaker, chief engineer. The new set, known as the "Navigator," will em-



Arthur L. Walsh, vice president and general manager, Radio and Phonograph Division, Thomas A. Edison, Inc.

ploy only one stage of a.f. which is a push-pull circuit with two 245-type tubes.

R. F. L. LICENSEES

THE RADIO FREQUENCY LABORATORIES, Boonton, N. J., have licensed the following radio set companies under their patents, according to R. W. Seabury, president of the Laboratories:

American Bosch Magneto Corp.
Grigsby-Grunow Co.
Kellogg Switchboard and Supply Co.
National Carbon Company
Stromberg-Carlson Telephone Mfg. Co.
Standard Radio Mfg. Corp., Ltd., Toronto

LICENSEES OF THE HAZELTINE CORP

FROM JACK BINNS, treasurer of the Hazletine Corporation, 42 Broadway, New York, we have secured the following list of the licensees of that organization:

All-American Mohawk Corporation
Amrad Corporation
American Telephone and Telegraph Co.
F. A. D. Andrea, Inc.
Breuer-Tully Mfg. Co.
Crosley Radio Corp.
Chas. Freshman Co., Inc.
Freed-Eisemann Radio Corp.
Gilfillan Bros., Inc.
A. H. Grebe and Co., Inc.
Howard Radio Company
King-Hinners Radio Co.
Philadelphia Storage Battery Co.
Stromberg-Carlson Tel. Mfg. Co.
United States Radio and Television Co.
Western Electric Co.
deForest-Crosley, Ltd., Toronto.
King Quality Products, Ltd., Bridghurg, Ont.
Workrite Radio Ltd., Brantford, Can.
Louis Coen, Wireless Pty., Ltd., Australia
Suttons, Ltd., Australia
Melbatone Radio Co., Ltd., Australia
Werring Radio Co., Ltd., Australia
Metropolitan Elec. Co., Ltd., Australia
Marconi's Wireless Telegraph Co., Ltd., Londou

The Radio Dealer's Note Book

NO. 4. PHONOGRAPH PICK-UP UNITS

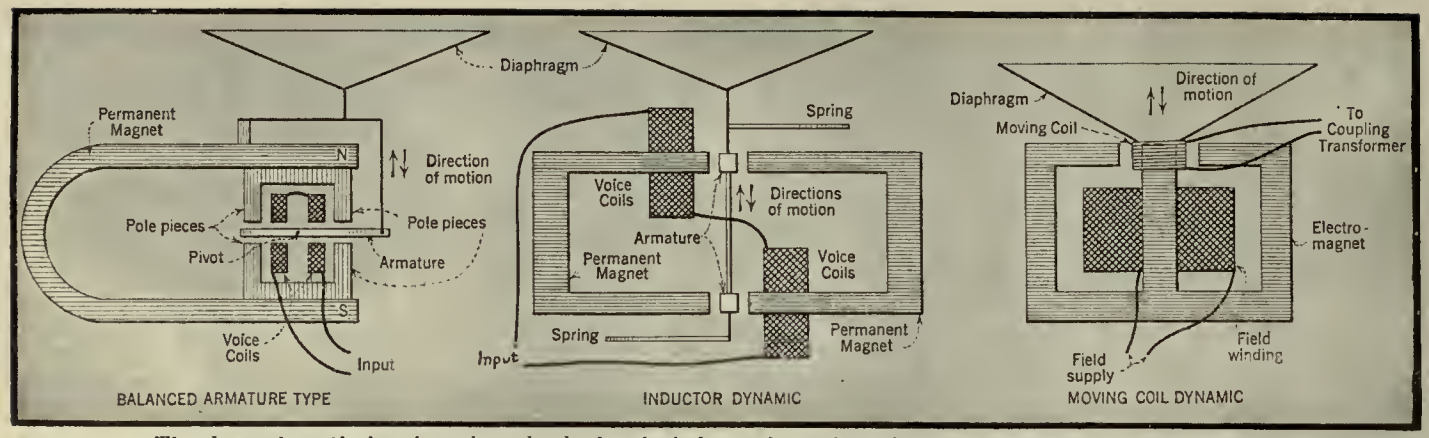
*Free—Complete Information**

ACCURATE summaries of useful information are constantly of value to those radio folk who deal with the public. This sheet, one of many on various subjects to follow, sets down collected information on phonograph pick-up units. The dealer or serviceman can remove this part of the page for his notebook or he can have it photostated.

This month's "Notebook" contains a list of manufacturers of phonograph pick-up units together with the list price and data on accessories. When a phonograph pick-up unit is used to play phonograph records in conjunction with a radio receiver, a volume control separate from that on the receiver is usually required. This device is generally a variable resistor connected across the pick-up unit. Some pick-up units are supplied with a volume control and in other cases, as indicated in the table, the volume control must be purchased separately. The simplest way to connect a phonograph pick-up to a radio receiver is by means of an adapter, the detector tube being removed from the set and the adapter plugged into the detector socket. An arrangement which is perhaps somewhat better is to connect a jack across the primary of the first a.f. transformer and the leads from the pick-up unit are connected to a plug which is pushed into the jack when one desires to play phonograph records. If the customer has available an old phonograph, he can frequently attach the pick-up unit to the existing tone arm. If a phonograph with a tone arm is not available, however, it is necessary to purchase a pick-up unit that is supplied complete with a tone arm.

**As a service to readers, the Editors have arranged that dealers may obtain complete information on all the devices listed in the table by writing to the Service Department of* RADIO BROADCAST *and asking for data on phonograph pick-up units. All requests must be written on a business letterhead or a card must be enclosed to identify the writer as a dealer or serviceman.*

Name of Manufacturer	Price	Specifications
Alden Mfg. Co.	$ 5.00	Complete with adapters but without volume control or tone arm.
Allen-Hough Mfg. Co.	$ 7.50 $ 8.50	Available in nickel-plated and gold-plated models. Complete with adapters and volume control but without tone arm.
Amplion Corp. of America	$16.50	Complete with adapters, volume control, and tone arm.
Audak Co.	$15.00	Complete with adapters and volume control, but no tone arm.
Best Mfg. Co.	$17.50	Complete with adapters, volume control, and tone arm.
Brooklyn Metal Stamping Co.	$10.00	Complete with adapters and volume control, but no tone arm.
Buckingham Radio Corp.	$10.00 to $19.00	Available in many different models with and without accessories. Special manufacturer's models can be obtained.
Carryola Co.	$ 7.50	Complete with adapters and volume control, but no tone arm.
Crosley Radio Corp.	$15.00	Complete with adapters, volume control, and tone arm.
Electrical Research Labs. (Erla)	$13.00	Complete with volume control and balanced tone arm. Adapter $2.00 extra.
Gordon Co.	$11.50 $12.50	Available in two models, with or without accessories.
Nathaniel Baldwin, Inc.	$11.50	With tone arm but no adapter. Volume control $2.50 extra.
Signal Electric Mfg. Co.	$13.00	Complete with adapters, volume control, and tone arm.
Stromberg-Carlson Telephone Mfg. Co.	$25.00	Complete with adapters, volume control, and tone arm.
United Air Cleaner Co.	$10.00	Complete with adapters, volume control, and tone arm.
Utah Radio Products Co.		Complete with adapters, volume control, and tone arm.
Webster Electric Co.	$12.50 $17.50	Complete with adapters and volume control, but no tone arm. $17.50 model includes tone arm.
Pacent Electric Co.	$12.00 $15.00	Complete with volume control, a.c. and d.c. adapters, but no tone arm. Complete with volume control, a.c. and d.c. adapters, and counterbalanced tone arm.



The above schematic drawings show clearly that the inductor-dynamic loud speaker motor differs both in construction and principle of operation from the balanced-armature and moving-coil types of loud speaker driving units.

A New Trend in Reproducer Design

THE INDUCTOR DYNAMIC LOUD SPEAKER

By R. H. DREISBACH

Farrand Manufacturing Company

A NEW DYNAMIC loud speaker, the "Inductor Dynamic," has recently made its appearance in the radio field. This is the result of some three years work by C. L. Farrand and has now been perfected to such a degree that it has surpassed the previous hopes of the inventor.

This loud speaker, in the author's opinion, has several decided advantages over the moving-coil dynamic; it requires no d.c. excitation for its field and experiments indicate that it is more sensitive and more efficient at the lower frequencies.

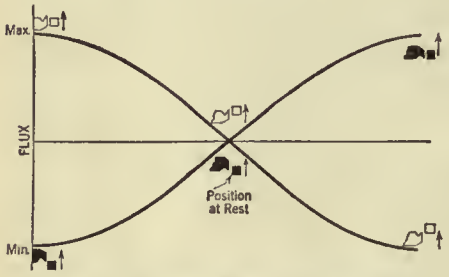
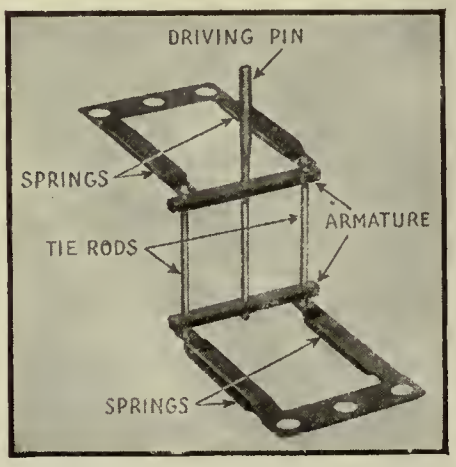


Fig. 1—If the flux in the two magnetic circuits were 180 degrees out of phase there would be no restoring force.

As its name may imply, the construction and principle of operation of the inductor loud speaker is a new departure from the dynamic loud speaker as known up to the present time. [The term "dynamic" is here used by the author to denote force or motion. Dynamic is usually associated with moving-coil loud speakers but in its general meaning it is equally applicable to all types of loud speakers.—*Editor.*] Unlike the moving-coil dynamics, the inductor utilizes two U-shaped permanent magnets to supply its fixed magnetic field instead of requiring some external source of energy to supply this field. Instead of the usual moving coil, the armature is of moving iron and is composed of two separate bars connected by tie rods, each bar working between its respective pole faces. Because the armature is of moving iron the reader may be prone to confuse the operation of this loud speaker with that of the balanced-armature type. To alleviate the possibility of this mistake it may be well to point out the disadvantages of the balanced-armature type which are not present in this new loud speaker.

In the case of the balanced-armature type, the distance between the armature and the pole face is varied. The magnetic force exerted on the armature varies inversely as the square of this distance and the force exerted on the armature by its spring support varies inversely as this distance. From this we see that an element of distortion has entered into the operation of this type of motor. For the balanced-armature motor to be comparatively sensitive this gap between the armature and pole face must be quite small, but then the spring supporting the armature must be made quite stiff to prevent the armature from "flopping" against the pole face. This necessary stiffness impairs the operation of the motor at the lower frequencies; consequently, the design of a balanced-armature motor is a compromise between these two evils. The other obstacles found in the design of balanced-armature units concern spring resonances and the fact that the apex of the cone does not move in a straight line but follows an arc.



The construction of the armature assembly of the inductor loud speaker is clearly illustrated above.

Features of Inductor Type

ALL OF THESE undesirable features are absent in the inductor dynamic. In this new loud speaker the gaps between the armature and the pole faces remain constant and the area by which they overlap is varied. The restorative force in an inductor loud speaker is magnetic and is a restorative force rather than a restraining force, the latter being the case with the spring of a balanced-armature motor. The inductor unit must necessarily have a spring support for the armature but the primary function of this spring is to hold the gap constant, and *not* to supply the restorative force but to leave that function to the magnetic force.

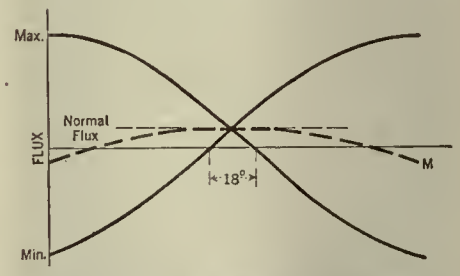
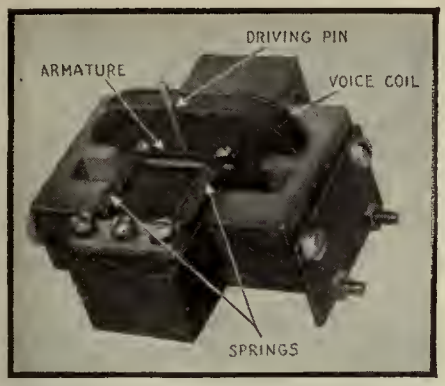


Fig. 2—In practice, a restoring force (see dotted line) is created by shifting the phase of the fluxes 18 degrees.

The driving motor is an induction motor with reciprocating action instead of rotary action. Consider Fig. 3. The armature assembly rides freely between the pole pieces, P_1 and P_2. The coils, C_1 and C_2, are connected in series. A current flowing through the windings in the direction indicated will increase the flux through the pole legs P_1 and decrease the flux through the pole legs P_2. The flux, seeking the path of least reluctance, exerts a greater force on the armature bar A_1



View of the inductor loud speaker motor with the permanent magnets removed.

than on the armature bar A_2, thus moving the armature in the direction indicated. On the reverse of the cycle the armature moves in the opposite direction in the same manner. The pole legs are cut to the shape indicated to reduce the leakage flux and to bring the greatest flux density to the most desired point.

If the inside spacing between the armature bars is equal to the center to center spacing of the pole faces, the flux in the magnetic circuit $P_1A_1P_1$ varies 180° out of phase with the flux in the circuit $P_2A_2P_2$ as the armature is moved to its two extremes. This is shown in Fig. 1, where the flux in the two paths is plotted against the displacement of the armature. The sum of these two curves is a straight line. This would give extreme sensitivity but there would then be no magnetic restoring force. If the armature bars are brought slightly closer together, a distance corresponding to 18 electrical degrees, the resulting curves will be those shown in Fig. 2. The sum of these two curves is the curve M, representing the change in total flux. This shows that the total flux is greatest when the armature is in its "at rest" position and represents the magnetic restoring force, or, if you will, the "magnetic stiffness." This is the design used in practice.

Another explanation of the action in fewer words is that the opposite forces on the two armature bars cause the armature to rest at a middle position which we might call its "magnetic center." The flow of voice currents in the coils causes this "magnetic center" to shift and the armature moves along with the "magnetic center."

It is now apparent that any d.c. component flowing in the windings would change the position of the armature by moving it to one side or the other, thus reducing its limit of motion in one direction. For this reason there must be no d.c. flowing through the windings, thus making it necessary to use an output transformer or a choke and condenser. However, if the loud speaker is to be used on a push-pull amplifier, a third lead may be taken from the windings at the point where the two coils are connected together and used as the mid-tap of the windings. This corresponds to the mid-tap on the primary of the usual output transformer. The d.c. which flows through the windings in this manner does not upset the "magnetic center." On the contrary it should be in such a direction as to aid the permanent flux through the poles. Doing away with the output transformer in this manner does away with its attendant losses and the gain is readily noticed by the ear.

Operating Data

IT HAS BEEN found that matching the impedance of the inductor dynamic to that of the amplifier with which it is to be used is of greater importance than it was with the moving-coil dynamic. The impedance of the moving-coil dynamic may be varied over quite a wide range before the ear will detect any great change in operation. However, this is not the case with the inductor dynamic. If the loud speaker has too high an impedance for that of the amplifier with which it is used, the efficiency is lowered at the higher frequencies and increased at the lower frequencies. Since the loud speakers are made in four different models, each having a different impedance, this feature affords the listener the chance to pick a loud speaker which will give the balance of high and low frequencies which is most pleasing to him.

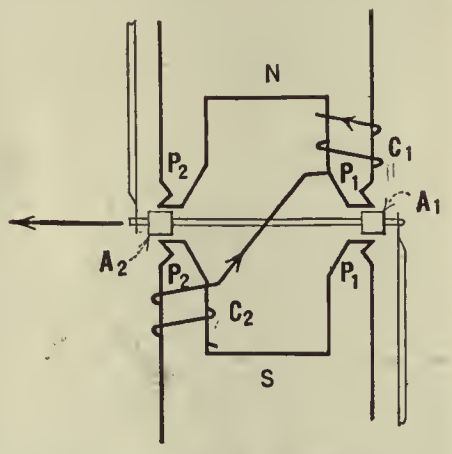
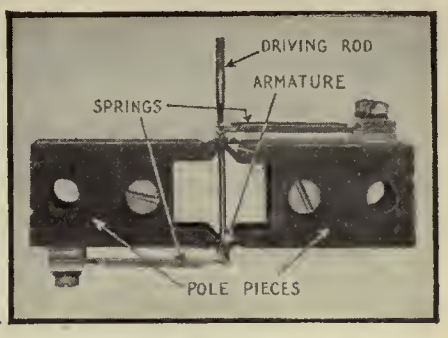


Fig. 3—Schematic diagram explaining the principle of operation of the inductor loud speaker.



View of an inductor loud speaker motor with a paper cone attached. This loud speaker, of course, must be placed behind a baffleboard for best results.



Cutaway picture showing the placement of the armature between the pole faces of the magnet.

Many moving-coil dynamics rely upon a mechanical resonance to give the impression that the loud speaker is reproducing the lower frequencies. The high efficiency of the inductor dynamic at these frequencies makes it unnecessary to depend upon any such "false bass." In fact, the resonance has been placed below sixty cycles. The springs supporting the armature are of very thin stock (0.008") and the entire armature assembly including springs, weighs but 4.5 grams as compared to 8 to 15 grams for the usual moving-coil dynamic. It is at the lower frequencies that the greatest difference is found between the two types of loud speakers. With an input of 15 DB at 30 cycles the inductor motor moves a ten-inch cone one-eighth inch.

The moving-coil dynamic is so inefficient from a standpoint of field excitation that it requires a heavy field structure of a coil and magnet whereas the inductor dynamic is so much more efficient that with two permanent magnets it will give the same output that may be obtained from a moving-coil dynamic using from ten to fifteen watts in the field. It would have been highly desirable before the advent of the inductor dynamic, if it were possible, to build a moving-coil dynamic loud speaker with permanent magnets. This was tried here and abroad unsuccessfully, as, due to the inefficiency of the field system, between 20 and 35 pounds of permanent magnets were necessary. To supply the power to the field of a moving-coil dynamic it has been common practice to use a rectifier which has introduced an objectionable hum in the loud speaker. The inductor dynamic does not add any additional hum to that of the set.

ROUTINE PLATE CIRCUIT TESTING

By JOHN S. DUNHAM

QRV Radio Service, Inc.

FROM THE standpoint of the amount of service required, the plate circuits of a radio receiver are more important than the filament and grid circuits. That is so because more apparatus is associated with the plate circuits than with the other circuits. We have the primaries of a.f. and r.f. transformers, a.f. and r.f. chokes and by-pass condensers, interstage and output jacks, and a loud speaker. With battery-operated sets we have B batteries. In socket-powered receivers we have voltage dividers, variable resistors if the power supply is an external B-power unit, filter chokes, by-pass and filter condensers, rectifier tubes, buffer condensers if the rectifier is of the gaseous type, and the high-voltage secondary winding and primary winding of a power transformer.

Plate circuits are also of greater importance to the serviceman because the voltages employed are of a higher order than those in the filament and grid circuits. The comparatively high potentials are the active cause of open audio transformers, loud speaker coils, and filter chokes. They are responsible for the breaking down of by-pass and filter condensers. They cause shorts and leakage paths through insulation. Because of all that, the serviceman must spend a great deal more time studying plate circuits and the functions and behavior of the included apparatus than it is necessary for him to spend studying the comparatively simple and abbreviated filament and grid circuits.



The Arrow Electric Company, Jersey City, N. J., make a feature of their completely equipped service laboratory. This view of the showroom shows the neat test panel of the laboratory in the background.

Routine Tests

WE HAVE mentioned before the value of routine in circuit testing, and the following of a routine when testing plate circuits is exactly as important as its application to other circuits or other work of any kind. Tests should start at the sockets, with very few exceptions. Continuity, as well as voltage tests which can be made from the sockets should be made under the load of the tube which belongs in the particular socket, *and* with all the other tubes in their respective sockets. In socket-powered receivers, and in battery-operated receivers when the B batteries are partially exhausted, the voltage across any tube rises as the remainder of the load is removed by taking other tubes out, an effect which is especially pronounced in modern socket-powered receivers using the series system of voltage division. What we desire to determine by a voltage test is not the no-load voltage, but the voltage under the normal working load of all the tubes. In past years, before the general advent of the high-resistance meter for service work, the meters used constituted a load greater than the normal load of any one tube and some times greater than the total tube load. The high-resistance meter, either as a single unit or incorporated in a test set, usually requires one milliampere for full-scale deflection, which constitutes a load that is negligible in comparison with the load of the tubes. Therefore, the meter has a negligible effect on the voltage across the tubes or across any one tube.

There are some troubles in radio receivers that do not show up under no-load conditions, but do show up plainly under the normal load. Intermittent opens sometimes fall into that class, and high-resistance joints, such as one where rosin has gotten under a large proportion of the solder at a soldered joint, are practically always in that class. In some cases high-resistance shorts also act the same way. For example, assume that a by-pass condenser across a load has broken down in such manner that its d.c. resistance remains high. Suppose the load which that condenser constitutes is about equal to the load of a 171A tube across whose supply it is connected. In that case a voltage test at the tube socket with the tube removed would show normal voltage. With the tube in, however, the total load on the supply circuit would be twice that for which it was designed, and a voltage test across it at the socket would show a voltage considerably below normal. Whenever you can do so, *make your voltage and continuity tests under normal load conditions.*

Many of the troubles in a receiver can be determined definitely without testing further than the sockets, by the employment of general knowledge of circuits and their behavior under given conditions, in conjunction with a clear analysis of the various items of evidence presented by the tests at the sockets. If, after each separate test is made, the serviceman will stop before going on to the next, and think out exactly what the result of that one test means in relation to the problem he is attacking, he will in most cases save himself a lot of unnecessary testing, and a lot of valuable time.

For example, if an E_p test at a detector socket shows no voltage, or fluctuating voltage, but the same test at the first a.f. socket shows normal steady voltage, the trouble is obviously not a general one having to do with the whole plate supply, but is confined solely to the detector supply circuit. If, however, an E_p test at the first a.f. socket does not show voltage, but a test at the detector socket does, the trouble is not thereby confined to the first a.f. local supply, because in most sets, regardless of type of power supply, the plate supply to the first a.f. and all the r.f. tubes is a common one. In that case it becomes necessary to test at one of the r.f. sockets to determine whether the trouble has to do with that common supply, or is confined to the branch of that common supply which goes to the first a.f. tube.

If tests show lack of E_p at two sockets whose plate supply is common, and normal or slightly high voltage is found at other tubes whose supply is not common to those two, those facts are very definite evidence. If the set is a battery operated one, the trouble must exist between the battery and the point where the common lead branches to the several tubes supplied. If the set is socket powered, the trouble must exist between the voltage divider and the branching point.

Open Circuits

WHEN E_p does not appear at the socket or sockets of one of the usual three branches of the total plate supply, and the cause is an open, part of the load

on the supply has been removed. The effect on the voltage at the remaining tubes is the same as that which would be obtained if part of the total load were removed by taking tubes out, or by any other means. The voltage rises, to a degree that depends upon the percentage of load removed and the regulating effect of the various drops in the supply system. In battery-operated sets, the rise will be very slight when the B batteries are fresh, but may be noticable if they are old. The degree of rise in voltage which occurs in socket-powered receivers is roughly a function of the cost of the supply system. The cheaper it is the higher will the voltage rise. When the thoughtful serviceman finds the condition described, he knows that the *only* trouble he has to find is an open.

When more load is added to the normal load of a supply, the terminal voltage at the load is lowered. If a test for E_p at one branch of the total load does not show voltage, but the voltages at other sockets are *lower* than normal, there are just two possible causes of that lowered voltage. The most probable one is that the load on the supply has been increased, by the breaking down of the by-pass condenser across the section of the supply which does not show voltage. The other possible cause is partial failure of supply, which, in socket-powered receivers, would mean failure of the rectifier tube in ninety-nine out of a hundred cases. If that were the cause, lack of any voltage at the socket or sockets of one branch of the load would mean a coincidental open in that branch, having no bearing on the rectifier trouble. If the rectifier is thermionic, serious overloading will often—but not always—be visually evident by the fact that the plate is red. Gaseous rectifier tubes do not show that evidence, and as the overload caused by a broken down by-pass condenser may not be sufficient to redden the plate of a thermionic tube, the best way to be sure about it is to disconnect one side of the suspected condenser. If the trouble were there, voltage conditions would then return to normal. If the by-pass condenser is connected within the set proper, instead of directly across the voltage divider within the power pack, overload caused by its breaking down can be determined by measuring the total plate current with a milliameter in the minus-B lead between the set and power pack. The point to be emphasized, however, is that the evidence gained at the sockets themselves, without going further, is ample justification for the assumption that the sole trouble is the breaking down of that particular by-pass condenser. The alternative of an open in the part of the load circuit which shows no voltage, and a poor rectifier tube at the same time, is a rare coincidence in actual practice.

Assume that E_p tests at the sockets do not show voltage at any of them. In a battery-operated set it can mean only one of two things. The most probable one of those two is an open in the minus-B lead. The other, which occurs rarely, is totally dead B batteries. In his sixteen years of experience with them, the author has not seen more than a dozen times three, or even two, *totally* dead B batteries connected to a radio receiver. In a socket-powered receiver, the condition can mean an open in the minus-B lead, in the plus-B lead somewhere between the rectifier and the voltage divider, in the rectifier or the transformer secondary winding, or it can mean a broken-down filter condenser. The latter is far more frequent. The question of whether the trouble is an open or a short across the filter system through one of the condensers, can be determined often without further tests. Sometimes the shorting path does not immediately become a continuous metallic one, but is a practically continuous flash-over between plates within the condenser, which is clearly audible as a crackling noise. If the rectifier is thermionic its plate or plates will usually become red, when a dead short exists. If the tube is the gaseous type, a short across its output will sometimes be evident by accentuated humming of the transformer and also noticeable humming of the tube itself. The plates of a gaseous type rectifier tube do not get red hot even with the tube passing as much as an ampere of current.

Tests for Short Circuits

If none of those evidences of a short exists, then actual circuit testing becomes necessary. The easiest and quickest way to decide the question is to put a 4.5-volt C battery in series with a voltmeter across the output of the filter, from the negative to the positive side, *with the power off*. If a full or practically full reading is obtained, a short must exist. If a low reading is obtained it means that the circuit is completed only through the resistance of the divider. If no short exists, the trouble must be an open.

If the C-battery test shows the shorted condition, then each condenser must be tested individually to determine which one is the offender. That may be done by disconnecting one side of each in turn. When one has been disconnected, turn on the power and test for voltage at the filter output. If approximately normal voltage appears, the disconnected condenser is obviously the bad one. The condensers may be further tested by subjecting them momentarily to the voltage supplied at the place in the filter where they are normally connected, and then shorting them with pliers or screwdriver. If a good fat spark occurs, the condenser is not broken down. If it is suspected that the condenser is leaky although not entirely broken down, charging it and letting it stand for ten minutes or more before shorting it will answer that question. If the average filter condenser holds practically its full charge that long, it is in good condition. If it does not hold its charge that long, it should be replaced.

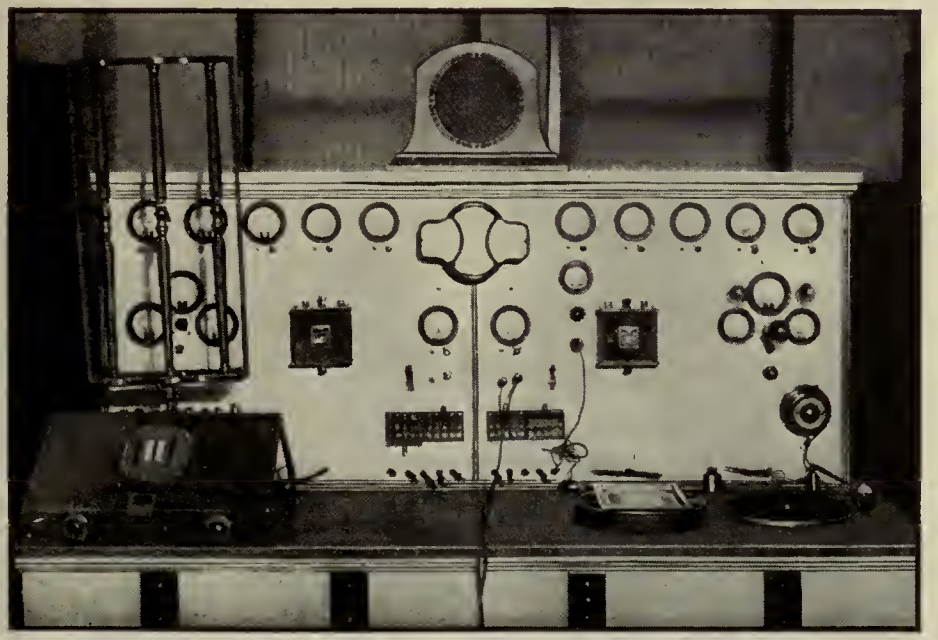
Abnormal I_p through any tube, with normal or low E_p and normal filament voltage, is a plate-circuit manifestation of trouble which may, or may not be an actual plate circuit trouble. In any set, it means insufficient C bias. In battery-operated sets, and practically all sets using external B-power units, the trouble is exclusively a grid circuit one. But in all socket-powered receivers—with the exception of series-filament jobs and a very few others—the C-bias resistor is actually in the plate circuit in addition to being in the grid circuit. If that resistor is shorted there will be no C bias and the I_p will go up. If it is open there will be no I_p at all, a case which we shall discuss further, later in this article.

In battery-operated sets, if E_p tests at all sockets show slight but irregular fluctuation accompanied by hissing and frying noises from the loud speaker, and the voltages are low, it is conclusive evidence, in most cases, that the batteries have outlived their useful span and must be replaced. If the same fluctuation and noise occurs when the voltage shows the batteries to be fresh, then the evidence points either to a varying resistive joint in the minus-B lead, *or* a defective B battery. It is fairly common to find brand new B batteries that are noisy, or have open sections, among the very cheap makes, but rare among the good makes. It *never* is economy to buy or use anything but the best batteries obtainable.

If E_p fluctuation is observed at one socket, but the voltage at others is steady, that set of conditions is valuable evidence. If the fluctuation is at an r.f. tube socket, it points to a resistive joint as the most probable trouble. It rarely means trouble in the primary of the following r.f. transformer. If the fluctuation is at the detector socket or an a.f. socket, or an i.f. socket of a "super" with iron-core transformers, it points to the primary winding of the following transformer, or in rare cases to the loud speaker coils if no output transformer is used. In most cases loud speaker coils open completely when they do go, without any interval of intermittency.

Transformer Breakdowns

The study of the causes of breakdown in iron-core i.f. and all a.f. transformers is an interesting one. It is too lengthy to discuss in this article, but an excellent



The up-to-date radio test panel and work bench pictured above was designed and constructed by G. R. Prell, service manager for the Southern General Electric Supply Company, Oklahoma City, Radiola distributers.

discussion of the subject, by Herbert M. Isaacson, is scheduled to appear soon in RADIO BROADCAST. Suffice it to say here that the conditions which cause trouble in iron-core transformers are so different in air-core transformers as to practically exempt them from that sort of trouble, and consequently they have an indefinitely long life. Iron-core transformers, on the other hand, have a relatively short life. In its relation to practical servicing, the trouble in iron-core transformers is such that, when a transformer starts to become noisy, we know definitely that it will become progressively noisier and will finally open. Sometimes, when the noise has just started, it will be very intermittent and may occur only at intervals of hours or even days. Sometimes fairly high voltage impressed directly across the terminals of such a transformer will not open the winding, and will sometimes apparently clear up the trouble. But because of the nature of the cause of that trouble, it will *always* recur, and transformers which have shown any evidence of that condition always ought to be replaced immediately.

In socket-powered receivers, other than those operated from external B-power units (sets originally designed for battery operation) and those having series filaments, the grid-bias resistor of a particular tube, or a group of tubes whose plate supply is common, is in the plate circuit. It is not part of the supply system, but is part of the load on the supply, as it is between the most negative end of the supply and the filament. The filament is positive with respect to the negative end of the supply by the amount of drop across that resistor. If the resistor is open, a test at the socket from plate to filament will not show any voltage, but a test from grid to filament will show the voltage that is the *IR* drop across the meter itself. The meter is then acting as a substitute for the bias resistor. On the other hand, if there is an open at *any* other point in the plate circuit, no voltage will be obtained testing from the filament to either plate or grid, because there can be no drop across the C-bias resistor unless plate current is flowing. All that makes it important to remember three things when servicing that predominant type of a.c.-operated set. First, that normal C-bias voltage can be obtained *only* when a *good* tube is in the socket, and that no grid voltage at all will be registered if there is no tube in the socket. Second, that if no voltage is obtained from plate to filament, but voltage *is* secured from grid to filament, the trouble can only be an open grid-bias resistor. Third, that if voltage is absent across both plate to filament and grid to filament paths, the trouble is not in the grid resistor, but is elsewhere in the plate circuit, except in extremely rare cases when opens might appear in two parts of the circuit simultaneously.

If any of the foregoing is not quite clear to any serviceman who has read it, the way to make it clear and to make it a useful part of his working knowledge is to draw a diagram of the circuits involved, represent the conditions graphically, and study it until he is thoroughly familiar with the possibilities described. Then he will know a great deal more about it than he would if such a diagram were reproduced with this article. That is an observation that holds true for the study of any problem in any circuit. When one doesn't clearly understand a set of conditions that are found in a receiver, draw a diagram of the circuits involved and study the possibilities as they are governed by the circuit arrangement and the effects which have been observed. Drawing diagrams for the purpose of studying a particular problem, or as an exercise in learning the circuits of a receiver, is a very profitable pursuit.

SYMBOLS IN COMMON USE

The following is a list of radio abbreviations most frequently used as a kind of technical shorthand. It should be posted for convenient reference in every serviceman's shop.

SYMBOL	MEANING
E_B	B supply voltage
E_p	Voltage at plate of tube
E_c or E_g	Grid-bias voltage
E_f	Filament terminal voltage
I_p	Plate current
I_g	Grid current
I_f	Filament current
R_p	Plate resistance of tube
MU (μ)	Amplification constant of tube
G_m	Mutual conductance of tube
R_L	Load resistance in plate circuit of tube
DB	Transmission unit
IR	Current times resistance

RADIO SET ANALYSIS

OWNER K. J. Marshall DATE Aug. 15 '27

ADDRESS 1015 Prairie Ave, City

NAME OF SET 6 tube tuned R.F., with Eliminator

TUBE NO. IN ORDER	TYPE OF TUBE	POSITION OF TUBE (1 ST. R.F., DET., ETC.)	READINGS, PLUG IN SOCKET OF SET: TUBE OUT OF TESTER A VOLTS	TUBE OUT OF TESTER B VOLTS	TUBE IN TESTER A VOLTS	TUBE IN TESTER B VOLTS	TUBE IN TESTER C VOLTS	NORMAL PLATE M A.	PLATE M A GRID TEST
1	201-A	1st R.F.	5.2	95	5.0	90	0	5.3	11.1
2	201-A	2nd R.F.	5.2	95	5.0	93	0	0.2	0.3
3	201-A	3rd R.F.	5.2	95	5.0	90	0	5.2	10.8
4	201-A	Detector	5.6	95	5.0	45	0	1.7	5.5
5	201-A	1st audio	5.4	0	5.0	0	4.5	0	0
6	171	2nd audio	5.2	157	5.0	150	41.0	5.0	off scale
7									
8									
9									
10									

SUGGESTIONS OR CHANGES MADE New tube in socket #2. Repaired break to plate of 1st audio tube socket. Boosted B voltage on last tube.

BY Smith Radio Shop — A. R. West

After servicing a receiver the wise serviceman fills out a chart of the type illustrated above. This saves considerable time on the next call. This form is supplied by Jewell.

Servicing B-Power Units

THE problem of finding opens in a B-supply unit of any kind is not a tremendously difficult one. It means simply going from one point to the next, eliminating sections of the circuit until the right one has been located. In the voltage divider itself, one must have some knowledge of how the circuit works. For example, in the commonly used parallel type of divider, if detector voltage is not obtained, but the other voltages are normal or high, so that we know the trouble is not due to the additional load caused by the breaking down of the by-pass condenser connected from the detector tap to minus B, the open must be between the detector tap and the next higher voltage tap, for the detector voltage does not depend on a drop between its tap and minus B, but on the difference between the drop from that tap to maximum plus B and the drop across the whole supply from minus to maximum plus B. Most dividers have a section from the detector tap to minus B, but for a purpose other than that of furnishing drop for the detector voltage. If voltage is not obtained from minus B to the tap which is next to the detector tap, towards the plus end, and we know from other evidence that the voltage at the next higher tap (usually maximum B plus) is high, then the open must be in the section between the intermediate tap and the maximum. If the open does exist there, then both the intermediate and detector taps will show open. That particular open is another trouble which may be determined definitely, in the vast majority of cases, by *thoughtful* testing at the sockets.

The section of the divider between the detector tap and minus B is added so that there will be a continuous path for current through the divider from plus to minus, thus providing a slight load on the supply system even when the set itself is not drawing any current, as would be the case with all the tubes removed, or if the set were entirely disconnected. If there is no load across the supply system, no current is being drawn from the system and the *IR* drops across the rectifier tube and transformer secondary are negligible, with the result that the peaks of the a.c. voltage at the terminals of the secondary of the supply transformer are impressed across the filter condensers. The peaks of sine wave a.c. voltage have an amplitude of roughly 1.4 times the average or r.m.s. value. If the no-load terminal voltage of the transformer secondary is, for example, 400 volts to supply 180 volts from plate to filament of a 171 after the drops in the rectifier tube, chokes, output transformer, C-bias resistor, and the transformer itself have been subtracted, the peak voltage impressed across the filter condensers when no load exists across the filter output will be approximately 400 times 1.4, or 560 volts. If even a light load of the order of 5 or 10 milliamperes is across the output of the filter system, the *IR* drops across the tube and transformer secondary increase, the voltage impressed on the first filter condenser will be much less than the maximum peak voltage, and that on the succeeding condenser or condensers will be still less by the amount of drop across the chokes preceding them, which means that with a minimum load provided the condensers need not be constructed to withstand as high a voltage as they would were a no-load condition possible.

No. 25 *Radio Broadcast's Set Data Sheets* June, 1929

THE SPARTON RECEIVERS

THE SPARTON EQUASONNE RECEIVERS are especially interesting for they use two devices—a band-pass selector in combination with an untuned radio-frequency amplifier—which are to be found in few other radio receivers.

A Sparton Equasonne receiver contains three separate sections, a "selector unit," an "amplifier unit" and the "power converter." The selector unit picks out the signals from the station to which the user desires to listen, the amplifier unit amplifies and detects these signals, and the power converter amplifies the detected signal sufficiently so that satisfactory volume may be obtained from a loud speaker connected to the output of the power converter. This briefly is the way this set works. It differs from ordinary tuned r.f. receivers in the several ways.

In a tuned r.f. set the incoming signals are amplified by the r.f. amplifier tubes and the selecting is accomplished by the r.f. transformers connected between the successive r.f. amplifier tubes. The desired signal is, therefore, selected *as it passes through the r.f. amplifying system.* In the Sparton circuit all the selecting is done *at one point* and then, *after* the desired signal is completely separated from all the undesired signals, it passes to the r.f. amplifier unit to be amplified.

The r.f. system in an ordinary tuned r.f. set will fail to amplify unless all the stages are tuned to the desired signal. In the Sparton set it is not necessary to tune the r.f. amplifier, for without adjustment it is capable of amplifying any signals (in the broadcast band) that may be impressed on its input. In the Sparton sets one simply tunes the selector to the desired signal and then the amplifier unit automatically does its work of intensifying the particular signal that has been selected.

The last tube in the amplifier unit is the detector. It is of the plate-detection type and is provided with sufficient plate and grid voltage so that it may supply, without overloading, 20 volts or more at audio frequency to the transformer in its plate circuit. The a.f. output from the detector passes into the primary of the audio transformer, and the secondary of this transformer feeds the grid circuit of the power tubes, which, in many of the models, are connected in push pull. This Sparton receiver, therefore, contains only one stage of audio-frequency amplification in contrast with the two stages ordinarily used in broadcast receivers. It is possible to use one stage instead of two because the r.f. amplifier unit has sufficient gain and the detector has sufficient load capacity so that a single transformer is all that is required to step up the a.f. voltage to a value sufficient to operate the power tubes at their maximum output.

The plate circuits of the power tubes contain an output transformer and the secondary of this transformer feeds the moving coil of the dynamic loud speaker used in some of the models. The plate current of the tubes also passes through the field coil of the dynamic loud speaker and the 40 or 50 mA. obtained in this way is sufficient to excite the winding.

The preceding paragraphs have described in a general way the operation of these excellent receivers. Let us now examine in more detail the operation of the selector and amplifier units.

Before entering a detailed discussion of the selector unit, it is advisable to consider, in a general way, the intimate relation between selectivity and fidelity. The perfect radio receiver would be capable of tuning-in any station without interference from any other stations. This is the ideal condition at which set designers aim. Unfortunately, however, as the selectivity of an ordinary tuned r.f. receiver is increased the fidelity tends to decrease, because the selectivity of the r.f. amplifier tends to suppress partially certain essential parts of the receiver signal. When this occurs the fidelity of the output is effected adversely, being apparent by an absence of high frequencies. The problem has been to design an r.f. selecting system that will give adequate selectivity but which will not suppress any essential parts of the incoming signal. In the Sparton receivers this has been accomplished by the use of a "band-pass" filter. The term band-pass is applied to the selector unit because its characteristics are such that it passes a band of frequencies just wide enough to contain all the essential components of the audio signal.



Two new cabinet models used for housing Sparton receivers.

The band-pass selector in the Sparton sets is responsible in no small degree for the good quality which may be obtained from the set.

The selector unit consists of four tuned circuits. If the connections to these tuned circuits were traced it would be noted that a small coil, is connected in series with two of the tuned circuits. Now it is a characteristic of two circuits each tuned to exactly the same frequency that, when they are coupled together by any means (as for example a small coil), the response curve of the two circuits together is quite different from either circuit alone. Either circuit alone would give an ordinary resonance curve—a sharply peaked curve that cuts sidebands resulting in the loss of some of the higher audio frequencies. Both circuits together, however, produce a curve with a flat top and very steep sides. The flat top effect prevents sideband cutting and the steep sides provide excellent selectivity. Such a characteristic—flat top and steep sides—results, however, only when the circuits are tuned accurately to the same frequency. With these circuits it is, therefore, quite important that the coils be matched carefully and the tuning condensers be ganged accurately.

The entire selector section is contained in a single metal box and if any part of it becomes defective the unit may be removed from the set and replaced by another selector unit, the job of removing the defective unit and substituting a good unit taking not more than fifteen minutes.

The amplifier unit which contains five r.f. amplifier tubes and a detector has an overall gain which is considerably more than that of many ordinary tuned r.f. receivers. The circuit of the amplifier is very unusual but no details regarding its operation are available at this time. The amplifier unit like the selector unit can, when defective, be removed from the set and replaced by another amplifier unit.

The fact that any of the three sections of the set may be removed quickly and replaced by a good unit makes the servicing of the set a very simple matter. When a dealer gets a call to service a Sparton receiver, the serviceman sent on the job merely needs to determine which of the three units is defective. He then replaces it with a good unit and takes the defective unit back to the store to repair it at the first opportunity. By means of a simple series of tests it is possible to determine quickly which unit is defective. For example, to detect a defect in the selector unit it is simply necessary to remove the antenna wire from its usual location and connect it instead to the connection between the selector and the amplifier units. With the antenna in this position, signals from all the local broadcasting stations will be heard in a jumble provided the amplifier and the power convertor are in good condition. When signals cannot be heard with the antenna connected to its usual position ahead of the selector the serviceman has a definite indication that the selector is at fault. He then proceeds to remove it and replace it with a good unit. In this way the customer is not deprived of the use of his set while the selector unit is being repaired.

It is seldom that one finds in a single receiver as many unusual characteristics as are contained in the Sparton sets. In the preceding paragraphs several of these features have been described in detail. The following is a rather complete list of all the special characteristics of Sparton sets:

(a) Sparton receivers contain a band-pass selector

(b) An untuned r.f. amplifier

(c) A power detector which gives much less distortion than is obtained from the usual type of weak-signal detectors.

(d) A single stage of a.f. amplification rather than two stages as used in the conventional receivers

(e) A phonograph pick-up jack so that the set may be used in conjunction with a phonograph pick-up unit to permit the electrical reproduction of phonograph records

(f) A dynamic loud speaker supplied from tubes with sufficient output to insure high-quality reproduction.

(g) A tapped power transformer so that adjustment may be made to compensate differences in line voltage, an arrangement permitting the operation of all the tubes at maximum efficiency.

DO YOU KNOW— ?

What the important features of the new radio receivers are? See page 74.

How you can increase profits by selling phonograph pick-up units? See page 77.

That you will sell many more tubes during 1929 than you did during 1928? See page 85.

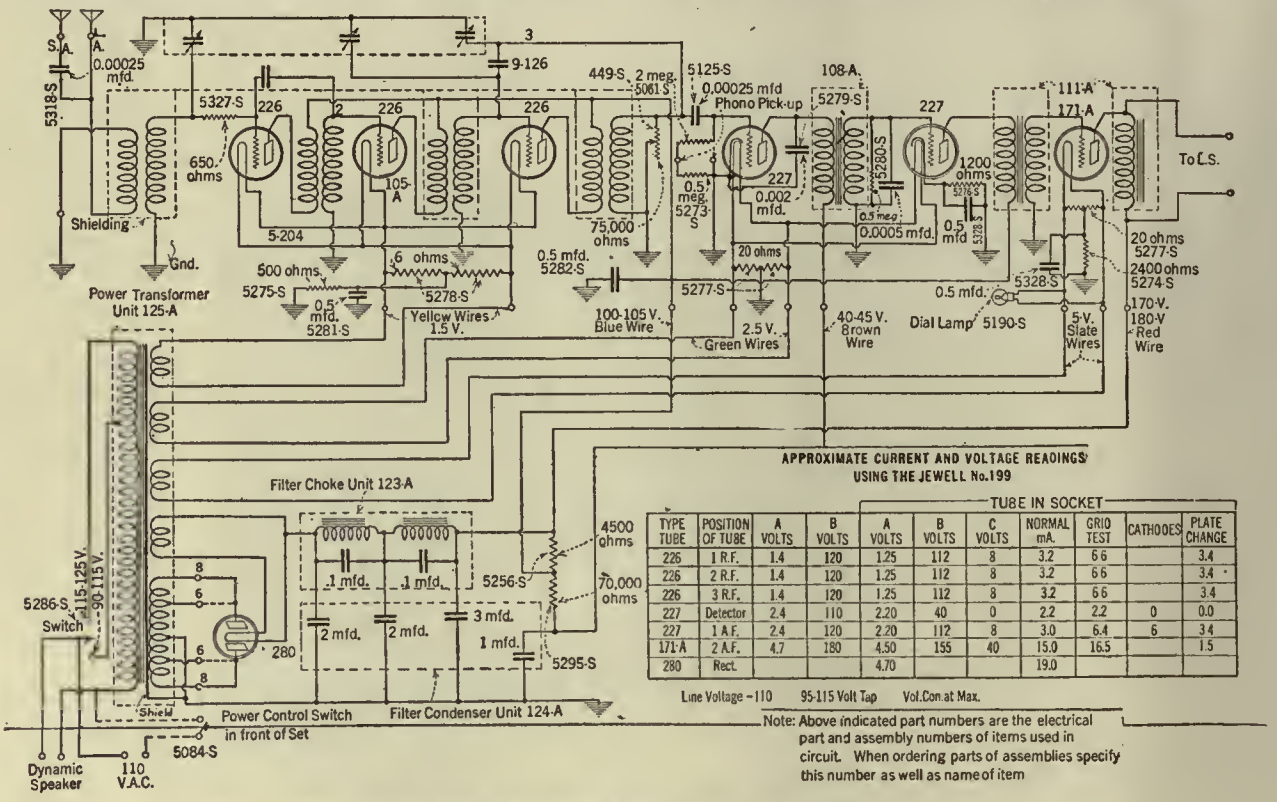
What the trends are in radio cabinet design? See page 69.

How to arrange most efficiently your service department? See page 87.

The important facts about Sparton radio receivers?

ALL AMERICAN-MOHAWK RECEIVER, MODELS 60-61-62-65-66

This all-electric receiver uses six tubes with a 171A-type tube in the output circuit. The volume control is a 75,000-ohm variable resistor connected across the tuned circuit feeding the detector tube. The circuit consists essentially of three stages of r.f., one stage of which is untuned, a detector, and two stages of a.f. amplification. It should be noted that the power transformer is equipped with an extra socket for a dynamic loud speaker and that the primary is tapped for high and low line voltages.



APPROXIMATE CURRENT AND VOLTAGE READINGS USING THE JEWELL No. 199

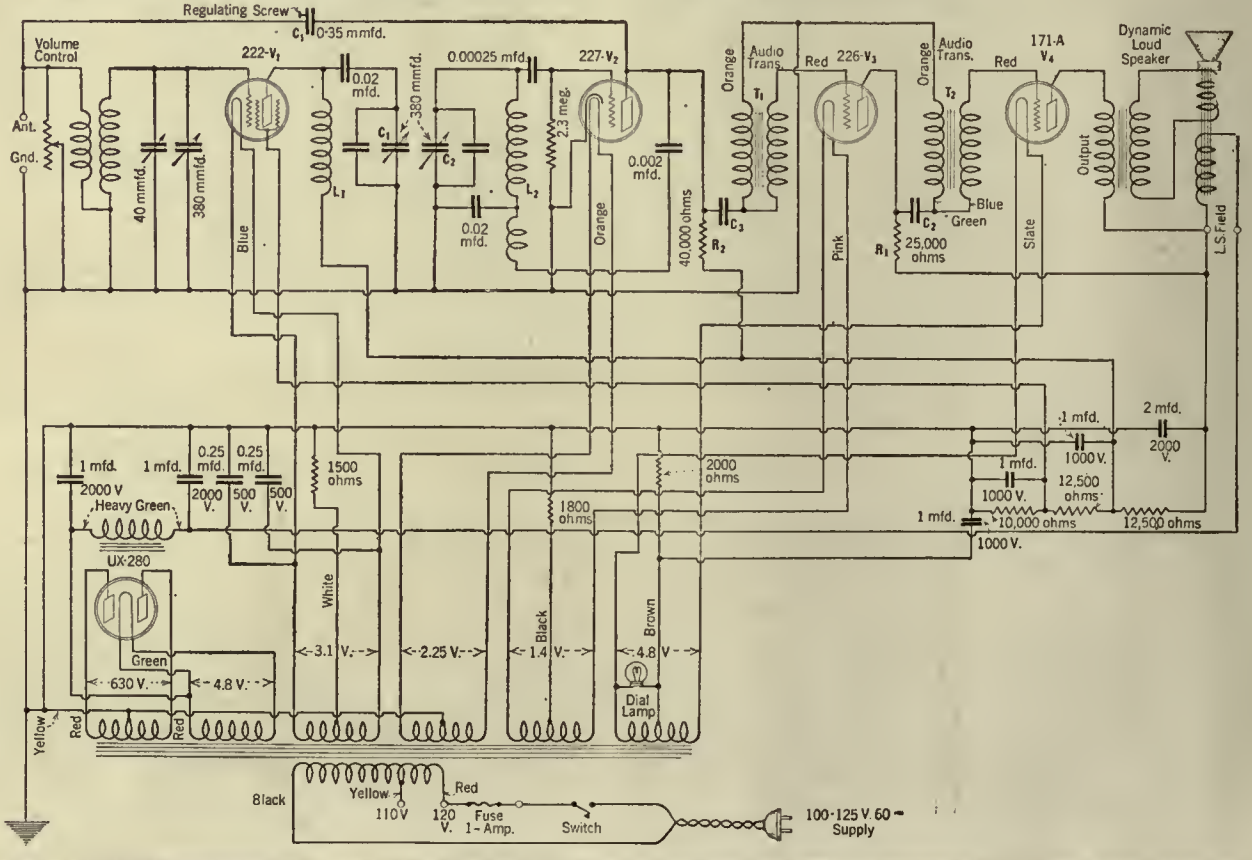
TYPE TUBE	POSITION OF TUBE	TUBE IN SOCKET: A VOLTS	B VOLTS	A VOLTS	B VOLTS	C VOLTS	NORMAL mA.	GRID TEST	CATHODES	PLATE CHANGE
226	1 R.F.	1.4	120	1.25	112	8	3.2	6 6		3.4
226	2 R.F.	1.4	120	1.25	112	8	3.2	6 6		3.4
226	3 R.F.	1.4	120	1.25	112	8	3.2	6 6		3.4
227	Detector	2.4	110	2.20	40	0	2.2	2.2	0	0.0
227	1 A.F.	2.4	120	2.20	112	8	3.0	6.4	6	3.4
171-A	2 A.F.	4.7	180	4.50	155	40	15.0	16.5		1.5
280	Rect.			4.70			19.0			

Line Voltage – 110 95-115 Volt Tap Vol.Con.at Max.

Note: Above indicated part numbers are the electrical part and assembly numbers of items used in circuit. When ordering parts of assemblies specify this number as well as name of item

FRESHMAN MODEL QD-16-S

This receiver consists of a stage of screen-grid amplification using a 222-type tube, a grid leak and condenser type detector, and a two-stage transformer-coupled audio amplifier, the output of which feeds into a dynamic loud speaker. Some regeneration is introduced into the circuit by the small variable condenser C_1. Two tuned circuits are used between the output of the screen-grid tube and the input to the detector circuit. The set, therefore, contains three main variable condensers, and a 40-mmfd. midget condenser is connected across the first tuned circuit to permit accurate tuning for the reception of distant stations.





STRAYS *from* THE LABORATORY

Trends in 1929 Receiver Design

WHETHER OR NOT the majority of receivers sold during 1929 will be engineered for screen-grid tubes is a question that only time can answer. The attitude among some manufacturers is as prevailed at the time the a.c. tubes were first announced, "Let George do it." When several manufacturers merchandise a screen-grid receiver that stays sold, the others will no doubt scramble to get their own screen-grid sets out of the laboratory and on to the dealers' shelves.

It is certain that 1929 will see the general adoption of the 245-type power tube, and indications are that most up-to-date receivers will use two of them in push-pull. Many receivers seem to be including some sort of band-pass tuning, some as preselectors and some between tubes as coupling circuits. Many receivers will have but one stage of audio, and of those which use screen-grid tubes, the majority will require but a very small antenna for loud speaker operation from distant stations.

The average sensitivity of receivers built in 1928 was of the order of 50 microvolts per meter; those built in 1929 will probably be ten times as sensitive, 5 mv/m.

The advantage of uniform sensitivity over the broadcast band is a talking point (and a good one, we believe) of several manufacturers. Whether or not this uniform sensitivity means uniform selectivity, we do not know. This would be more of an advantage than uniform sensitivity, in our opinion.

Some receiver manufacturers feel that the problem of getting a.c. screen-grid tubes in sufficient quantities and of sufficient uniformity will militate against the widespread use of this new addition to the tube line. Tube manufacturers, on the other hand, see no great difficulties in the way of building these more complicated structures. They feel that the experience gained in the production of the heater-type tube will cut down the time of experiment on the newer tube, and, that when manufacturers are ready for the tubes with the additional grid, they will be ready.

Some manufacturers have discovered that they will require the same number of tubes when the screen-grid type are used, as in 1928, and, therefore, that the advantage in making a screen-grid-tube set is only one of sales appeal. On the other hand, at least one manufacturer is ready to advertise that his receivers will not be screen-grid-tube equipped, and others have discovered that the same performance can be secured from a four-tube set using the a.c. screen-grid tubes as is now possible from six tubes. Such a receiver will have two screen-grid r.f. amplifiers, a 227-type power detector, or a screen-grid detector, and one stage of a.f. amplification. Will such a receiver have sufficient selectivity? That is the question everyone asks.

With an equal number of tubes it ought to be possible to design a receiver that, with a small antenna or loop, would bring in as much program enjoyment as an older set with a large outside antenna. We hope the advertising departments will not offer the screen-grid receivers as being more free from static and other unwanted racket. If they are loop operated, considerable discrimination against unwanted signals, broadcasting, or static may be secured. A blanket statement, however, that the screen-grid tube will make a set freer from undesired noise is too good to be true.

The following are among the subjects discussed in "*Strays*" this month:

Trends in 1929 Receiver Design
Data on Electrostatic Speakers
How much is an Engineer Worth?
Power Requirements in England
Humps in Audio Transformers
Short-Wave Schedules
Resourcefulness of an Engineer
Dr. Goldsmith Resigns as Editor

Gossip About Electrostatic Loud Speakers

AS IN THE CASE WITH the a.c. screen-grid tube, some manufacturers will and others will not use the newest type of loud speaker, the electrostatic type. Some observers claim it is more sensitive; others say it is "down." It is generally agreed that its space requirements cannot be made much less than a dynamic from an equal performance criterion, and that the chief cause for worry is how long it will stand up in service. The fact that rubber, or some other insulating material, must be subjected to atmospheric changes, to the continuous static field across it, etc., means that it is difficult to get up accelerated life tests in order to find out how long the device will stand up.

If the condenser-type loud speaker were cheaper, or more sensitive, or better looking, or more durable, or if it had a better frequency characteristic, the technical part of the trade would be interested. If the condenser-type loud speaker proves to be merely a good sales argument, the technical people will pass it by. It is difficult to believe, however, that some good will not come from the work that has gone into its development. We have the highest regard for the engineers and physicists at the Riverbank Laboratories.

How Much is a Chief Engineer Worth?

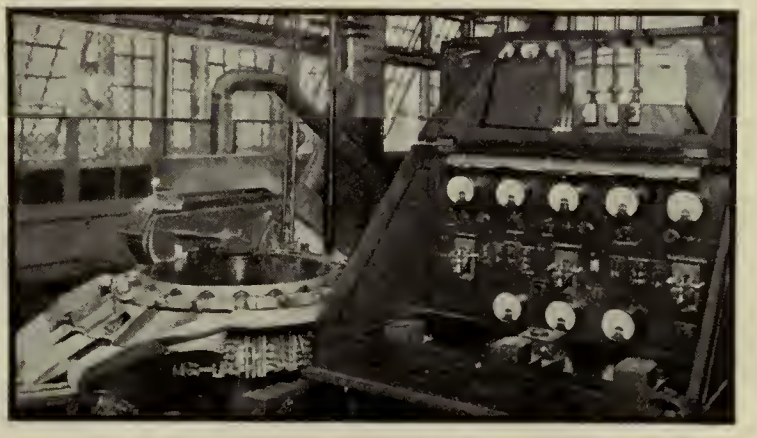
HOW MUCH IS A chief engineer worth? Let us suppose a manufacturer pays his chief engineer $10,000 a year and that he makes 100,000 receivers. This engineer is responsible, more or less, for the expenditure of money for the raw materials, for the design, and for the production of these sets. Thus, he gets about ten cents per set for his work. Now, if the receiver is made under a license agreement, it pays not less than 7½ per cent. ($7.50 on each $100 set), and, if it goes into a big cabinet which brings the price to $200, the licensor gets $15.00 although the chief engineer still receives only ten cents. What is the moral of this story? We don't know.

Power Required by English Loud Speakers

AN EXTRACT FROM A letter from C. L. LYONS, of Claude Lyons, Ltd., Liverpool, radio and electrical distributors, casts some light on the power requirements for various types of loud speakers used in England at the present time. According to Mr. Lyons, who has conducted many tests to determine what his clients desire in the way of volume:

1. Dynamic loud speakers require about 750 milliwatts,
2. Large cone loud speakers, 15 inches in diameter, require 350 milliwatts,
3. Diaphragm-driven horn loud speakers, more or less obsolete, 250 milliwatts,
4. Small cone loud speakers, 7 to 15 inches in diameter, need about 250 milliwatts.

Mr. Lyons expressed surprise at the fact that many American technical articles mention power outputs as



View of an automatic tube-testing apparatus used by Westinghouse. At the right is shown the control cabinet panel and at the left the automatic feeding system

low as 50 and 100 milliwatts as standard volume levels. He does not take into account the fact that these are levels desirable for laboratory measurement and that people in general in this country desire much more power output than these figures. The tendency, if anything, is to about double the power requirements that he mentions as desirable in England. At least 1.5 watts is now considered as necessary for average homes.

Humps in a.f. Transformer Characteristics

ANYONE WHO HAS MEASURED the voltage across a good a.f. transformer when various input frequencies at the same voltage are put into its primary winding will remember the hump that occasionally takes place somewhere between 4000 and 10,000 cycles. Why is this hump?

A transformer may be considered as Fig. 1, in which the primary and secondary leakage inductances are represented in series with the primary and secondary resistances and the previous tube resistance, and across this circuit is the mutual inductance between primary and secondary—which should be high—shunted by the capacity of the windings, the leads, and the tube input, and followed by a perfect transformer. Now all of this is a series circuit which may become resonant to some audio frequency. If so, the voltage across C will rise, and the transformer characteristic will show a hump in the neighborhood of this resonant frequency. If the "Q", $L\omega/R$, of the circuit is high the hump may become high enough for the entire system to sing. If the Q is low, which may be due to high-resistance windings or a high-resistance tube, the hump may be quite small. Thus, a good transformer, which will be stable when worked out of a 201A-type tube, may sing when worked out of a 112-type tube.

Increasing the plate resistance, then, cuts down the peak. Putting an inductance in series with the primary lowers the frequency of the peak. Increasing the capacity across the secondary lowers the frequency of the peak. Putting a resistance in series with the grid lead cuts down the hump.

At low frequencies this series leakage reactance is small compared to the mutual reactance. The response at low frequencies, then, is a function of how great this impedance is compared to the tube resistance. (See Fig. 2) If the mutual inductance of the transformer is high compared to the plate resistance of the tube, the low-frequency response will be good. If a poor transformer with low mutual is used, or if the tube resistance is high, the response at low frequencies may become quite bad, and, in fact, may become markedly peaked in the neighborhood of 1000 cycles. If a good transformer, the Samson Symphonic for example, is worked out of a screen-grid tube some such curve as that in Fig. 4 will result.

The series resonance hump at high frequencies can be cut down by a resistance near the grid of the tube. If carried far enough, the high-frequency response will begin to droop. If the resistance is in the filament side, as for C-bias purposes, the high frequencies will be reduced because the capacity current, Fig. 3, must flow through this resistance and sets up a voltage across it which is out of phase with the desired voltage across the grid-filament input.

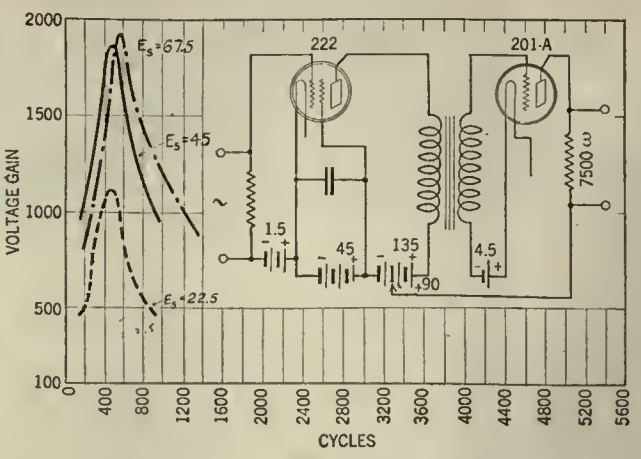


Fig. 4

Short Wave Transmitting Schedules

WELLINGTON W. MUIR, of Lockport, N.Y., who probably has more "DX" records than any other consistent listener in this country, submits the following data on short-wave broadcasting.

The Chief Engineer at Bandoeng, Java, will be pleased to receive reports from those hearing the following phone transmitters: PLE, 15.74 meters, PLF, 17.40 meters, and PLG, 18.88 meters, daily from 7 to 11 A.M. (E.S.T.); PLR, 27.80 meters, daily from 11 A.M. to 2 P. M.; PLG and PLE, Wednesdays from 5:30 to 7:00 A. M. The Société Française Radio-Electrique, 79 Boulevard Haussmann, Paris, will be pleased to receive reports from those hearing the following phone transmitters: FW4, 24.50 meters; FW, 15.55 meters; and Buenos Aires, 15.02 meters. The radio station at Matala, Sweden, will be pleased to receive reports from those hearing their short-wave station on 98.90 meters, daily from 11 A. M. to 5 P. M. PCJJ, 31.30 meters, Eindhoven, Holland, will be pleased to receive reports. This station operates on the following schedule: Thursday 1 to 3 P. M. and 6 to 10 P. M., Friday 1 to 3 P. M. and 8 to 12 P. M., and Saturday 12:01 to 1 A. M. All of the hours given above are in Eastern Standard Time."

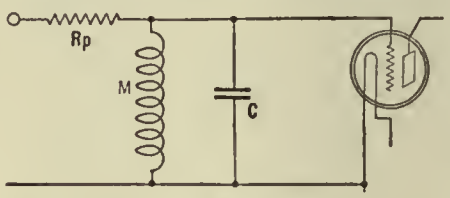


Fig. 2

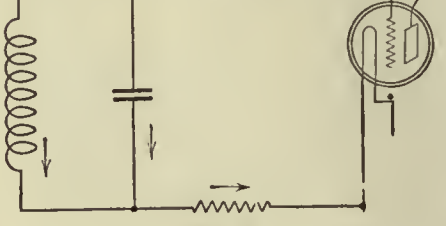


Fig. 3

Resourcefulness of a Consulting Radio Engineer.

A WELL-KNOWN RECEIVER manufacturer in the Middle West decided to go in for the 250-type of amplifier tube but discovered that no greater volume could be obtained from the set than with a 171-type power tube. The trouble was lack of plate voltage. The manufacturer called in a consulting radio engineer and the following is the result. The receiver had eight tubes. The engineer went over the entire receiver and finally secured better results from seven tubes. This left one extra socket on the chassis. He put a 226-type tube in this socket, made it into a two-element rectifier, and supplied the bias for the 250 from it. This added 60 volts to the plate of the 250. The result was a seven-tube receiver with the performance of the eight-tube set, a 250-type tube with 300 volts on its plate, and plenty of volume.

Dr. Goldsmith Resigns as I. R. E. Editor

THE INABILITY of Dr. Alfred N. Goldsmith to serve longer as Editor of the *Proceedings of the Institute of Radio Engineers* is a matter of regret which all members of the Institute share. Despite the difficulty of obtaining a constant supply of good material in the midst of intense rivalry, and considerable secrecy, among radio laboratories and manufacturers, and the labor involved in presenting this material in the proper form, Dr. Goldsmith has served for sixteen years as Editor of the *Proceedings*.

A cursory glance through papers presented during those sixteen years indicates why the bound copies of the *Proceedings* have come to be the cover and contents of every radio engineer's library. These papers are signed by such names as Marconi, Armstrong, Poulson, Hazeltine, Pickard, Cohn, Stone, Zenneck, Austin, Morecroft, Pierce, and others, including Dr. Goldsmith.

Empirical Coil Formulas

IN JANUARY "Strays" we gave some empirical formulas whereby the inductance of multilayered coils, solenoids, and helical coils could be calculated. The dimensions were given in inches. When the dimensions are given in centimeters the following formulas will give the inductance. We are indebted to HAROLD F. SCHWEDE, of Chicago for them:

$$L_m = \frac{0.315\ a^2n^2}{6a + 9b + 10c}\ \mu h;\quad L_s = \frac{0.394\ a^2n^2}{9a + 10b}\ \mu ah;$$

$$L_h = \frac{0.394\ a^2n^2}{8a + 11c}\ \mu h$$

Where L_m = Inductance of multilayer coil
L_s = " " solenoid "
L_h = " " helical "

In the above formulas a, b, c, and N are as shown on page 170, January RADIO BROADCAST.

—KEITH HENNEY

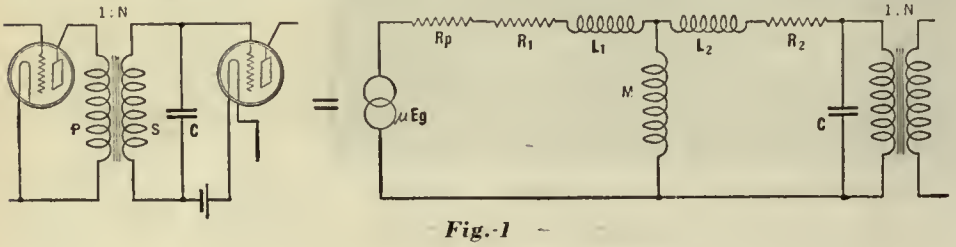


Fig. 1

THE EXPERIMENTER'S ARMCHAIR

By ROBERT S. KRUSE

BY WAY OF departing a bit from the discussion of our own affairs, let us take a look at the German portable broadcast receiver called the "Radio-Baron." It is made by Lorenz who innocently was the cause of our great crop of "wiggle-wound" coils of a few years ago.

The "Radio-Baron" normally lives in a carrying case and is self contained. A multiplicity of adjustments is provided unlike our American practice. First of all the loop is wound around the frame in two layers separated by half an inch. The high inductance thus provided is necessary for the upper wavelength range of the set, which tunes-in the long-wave European broadcasting stations. A tap switch on the panel permits dropping down to the usual range. The circuit is a double-detection one (super-heterodyne) and the two tuning controls are operated by a double drum dial of standard design. Filament power is supplied by a small "dry" storage battery and controlled by the usual rheostat and switch, the latter being on the panel and the former at the back of the set. Grid and plate voltages are supplied by a combined dry-cell B and C battery. Since the highest potential available with a new battery is 90 volts, the last audio tube is special, having an additional grid. It is not a screen-grid tube but is, I believe, a pentode which provides a moderate amount of power output without resorting to a power plant in our customary fashion. The highest potential ordinarily used by the Baron is 60 volts. Circuit variations in plenty are provided for; in addition to the range-change switch there is a lever for altering the coupling to the oscillator, a control for adjusting regeneration in the i.f. system, and provision for operating the set with 4, 5, or 6 tubes! Just what the last device does to the circuit cannot be discovered without wrecking the set. The empty sockets are jumpered by means of a double-ended plug cord. Presumably, the purpose is to save tubes and batteries on local reception.

The loud speaker is peculiar. The rather large diaphragm is of something resembling celluloid and is driven from the center. It is, however, neither flat nor conical but of some curved form, possibly logarithmic.



The "Radio Baron," a self-contained loop-operated portable receiver of German manufacture.

An Improved Oscillator

SO MUCH FOR European practice. Let us now return to the United States; in fact, to a point just a bit north of the center thereof. This must serve as an introduction for LOUIS F. LEUCK, of Lincoln, Nebraska, who describes for us a general-purpose oscillator of more than usual merit. It *holds calibration*, may be used as a mere "driver," as an "oscillating wavemeter," as a transmitter "tone checker," as a "tuning meter," or as a receiving heterodyne. Furthermore, it is very simple, easy to construct, and inexpensive.

Mr. Kruse's "Armchair Chats" this month include the following:

A German Portable Set
An Improved Oscillator
Miniature Current Transformer
A 110-volt Potentiometer
The I. R. E. Patent-Digest
Letters are Welcome

The device with all these virtues is simply a self-contained battery-driven oscillator with circuit precautions against the effects which usually produce the worst changes in calibration. The following description is quoted in part from a longer description which unfortunately cannot be given in full.

The circuit is the balanced-bridge version of the Colpitts circuit, and was developed by Willis Hoffman of the Burgess laboratories. Examination of Fig. 2 will show that if the coils L_1 and L_2 are alike we will have a balanced bridge whenever capacities C_1 and C_2 are equal. There will, accordingly, be no tendency for radio-frequency current to flow from point A to point B and very little tendency for it to flow by way of the plate supply from point C to point B. The choke, L_3, can usually be short circuited without producing any effect. To obtain this condition approximately in transmitting or receiving practice is entirely possible by simple mechanical precautions.

In Mr. Leuck's oscillator, C_1 and C_2 are the halves of a reconstructed receiving condenser which, in its new form, has two rotor sections connected together by the common shaft and meshing into separately insulated stator sections. The spacing has been doubled to improve stability of calibration. L_1 and L_2 are halves of the same split coil wound on a UX tube base whose prongs act as terminals. The by-pass condenser, C_3, and the vacuum-tube socket are connected directly to the coil socket without any intervening wires whatever. As long as the coil is pushed clear down in the socket and the tube is not changed, the tuned system, therefore, remains stable and unchanged. In support of this point, Mr. Leuck says. . . . "To get an idea of the meter's ability to retain its calibration the wavemeter was calibrated from 9XL. A month later the receiver was set on the wavelengths at which 9XL was about to transmit according to its published schedule. This was done by means of the wavemeter (i.e., the oscillator here discussed.) The signals from 9XL came in without retuning the receiver on fully half the points. This was better than could rightfully be expected, since 9XL maintains an accuracy of only $\frac{1}{10}$ of 1 per cent." (This is the guaranteed accuracy but 9XL actually does better on much of its work.)

The bridge circuit, together with the small size of the coils and other parts, makes the meter as free from hand-capacity effects as one could wish. Shielding is entirely unnecessary and useless. The device was accordingly mounted in an old Crosley receiver case. The front of the panel has but three objects mounted on it, a good vernier dial, the filament switch, and a pilot light. The pilot light has but one object in life; when it is included even the most absent-minded person can hardly forget to turn off the filament switch.

Running down of the A battery has very little effect on the frequency of the meter. This has been tested by exchanging a new and an old battery while listening to a beat note produced by the wavemeter and a crystal-controlled oscillator. Running down of the plate battery need hardly be considered as the load on it is almost nil.

RANGE COVERED

"The meter described was intended to cover the amateur bands with generous margin above and below. Its fundamental range is 32 to 50 meters. Since the oscillating receiver and this wavemeter both produce harmonics, the wavemeter is readily usable to determine wavelengths from 16 to 25 meters and from 64 to 100 meters. A 12-volt plate battery (several



This new miniature current transformer has been developed by Weston, seemingly for the experimenter.

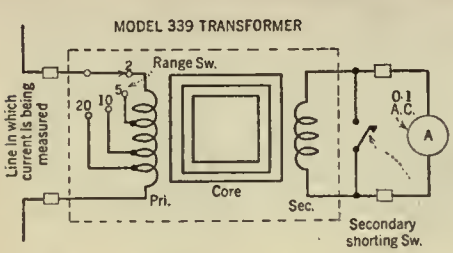


Fig. 1—Schematic diagram showing method of connecting the miniature current transformer.

C batteries or one 22-volt tapped C battery) gives plenty of "poke" to make the last named range useful. The fundamental wave is then almost too strong. Oscillations will occur when only 6 or 9 volts are used on the plate. Too much plate battery brings out the unwanted odd harmonics. A battery potential of 22.5 volts is more than should be used. Harmonics more remote than those named can be used but they are rather weak."

CURVE SHEET

When using a variable condenser having two rotor sections and two stator sections, each of 4 plates and double-spaced, the tuning range shown on the curve sheet is obtained with a 23-turn coil of No. 28 wire space-wound on a UX tube base. The coil is split, hence each section has $11\frac{1}{2}$ turns. In case the meter is to cover a higher band of wavelengths the UX base will prove too small. Its size can be increased by means of a tube that will just slip over the base, and such a tube may be secured with small screws. However, ready-made forms of sufficient size are now obtainable.

By plotting the dial readings against both wavelength and frequency we have a combination wavemeter and frequency meter. The curve chart is also an instrument for converting wavelengths to frequencies, and *vica versa*. For example, suppose we wish to know the frequency corresponding to a wavelength of 43 meters. We find (wavelength) 43 meters on the left of the chart, follow the ordinate to the right until it intersects the wavelength curve, then follow *downward* until we intersect the frequency curve, then to the right again, and read off the frequency —7000 kilocycles. For such conversions the dial reading does not concern us.

The curve sheet shown is for a particular meter. It covers only the one band since, when the meter is used in the band above or below, it is only necessary to multiply or divide the reading by 2.

CALIBRATION

To calibrate such a meter it is necessary to secure a sufficient number of points from the transmissions of standard-frequency stations such as 9XL and WWV. Commercial stations whose wavelengths are known may also be used. The method is as follows: first tune-in the standard signal on an oscillating receiver and adjust the tuning controls to zero beat. Then (without touching the receiver) tune the oscillator until it produces zero beat with the receiver and standard signal. Record the wavelength and oscillator setting and proceed to the next point. Since the second harmonic of both receiver and oscillator is easily distinguished by its strength, points may be obtained also from signals of half or twice the wavelength at which calibration is desired. The receiver, of course, is tuned to the signal and the oscillator to half or twice the wavelength so that the fundamental of one beats with the second harmonic of the other.

USES OF THIS METER

Besides serving most of the ordinary purposes of an oscillator, the meter is of aid in locating stations whose wavelengths

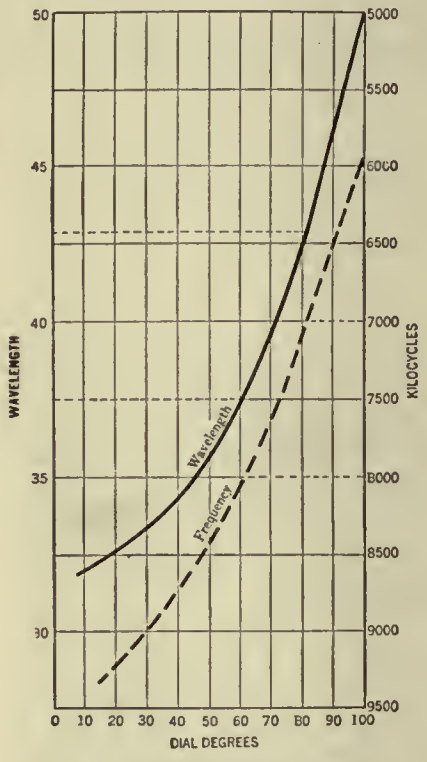


Fig. 3—Calibration curves of Mr. Leuck's oscillator.

are known, it comes in handy when building or altering a short-wave receiver, and is useful in adjusting the wavelength and tone of a transmitter carrier. In doing the latter it is useful to listen to a harmonic of the transmitter while beating it against the receiver and one of the frequencies of the meter. Mr. Leuck suggests, however, that "if one feels it imperative to listen on the transmitter fundamental, this may be done after the oscillator has been equipped with a pair of phones and the sensitivity sufficiently reduced by enclosing the oscillator bodily in a metal shield such as a tin bucket. The phone cord may emerge through a hole in the bucket lid and," Mr. Leuck dryly adds, "it is necessary to devise an extension to the tuning knob to reach outside the pail or else put an assistant inside to do the tuning."

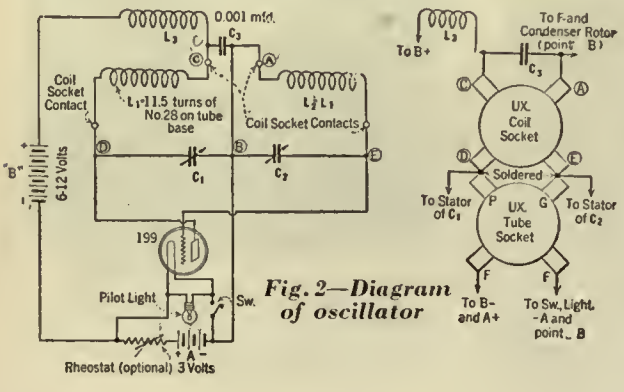


Fig. 2—Diagram of oscillator



A convenient wire-wound potentiometer for 110-volt circuits.

Miniature Current Transformer

For the particular use of the experimenter, seemingly, Weston has just offered a miniature current transformer (type 539). With a single one-ampere a.c. ammeter, such as the type 528, it makes possible measurement of any current from 0.2 to 200 amperes. For currents below 1 ampere the meter is used alone. For currents from 1 to 20 amperes the meter is connected as shown in Fig. 1 and the primary switch is set to the proper range. For larger currents—up to 200 amps.—the line itself is treaded through the "window" of the core.

If the line is put through once the maximum of the meter range represents 200 amperes, if twice—100 amps., and if 4 times—50 amps. Even if we assume that we will use only the upper $\frac{4}{5}$ of the meter scale we can obtain the following ranges, which have liberal overlaps. 0.2–1, 0.4–2, 1–5, 4–20, 10–50, 20–100, 40–200. The rather awkward range of 13.3–66.6 amps. (obtained with three conductors through the window) may be omitted.

Most current transformers have their ranges disturbed and their insulation burned if the secondary is left unloaded (meter off) while current flows through the primary. The size and design of the 539 largely prevents this but a shorting switch (See Fig. 1) has been provided as a precaution.

A 110-Volt Potentiometer

There is much peace of mind in being able to apply voltage gradually instead of "slamming it on." A recent temporary need for a variable a. c. voltage resulted in the acquisition of a Ward Leonard "Vitrohm" potentiometer of a pattern which may be left continuously across a supply potential as high as 125 volts a.c. or d.c. It is known as catalogue No. 64304A and has a resistance of 250 ohms. There are 22 contact points and the slider covers two at a time, thus providing 20 steps with sparkless transfer. Obviously, the device may also be used as a rheostat. It costs less than a single UX-210 and may easily save much more.

The I. R. E. Patent Digest

It is regrettable that the patent digest has gone from the pages of the I. R. E. *Proceedings*. Having asked some dozen or so of the members, I find confirmation of my feeling that the ordinary member read this digest with interest, found it stimulating, and looks forward to the time when it will again be possible for Mr. Brady to furnish this review.

Letters are Welcome

Letters or informal papers to be read or discussed in "The Experimenter's Armchair" are welcome. They should be addressed to Robert S. Kruse, c/o Radio Broadcast, Garden City, N. Y., and should refer to these pages by title.

No. 23 *Radio Broadcast's Home-Study Sheets* June 1929

RADIO-FREQUENCY OSCILLATORS

A VACUUM TUBE will not only amplify and detect radio- and audio-frequency waves but it will also geaerate them. How does a tube oscillate? What are the controlliag factors, how much power can be obtained from it, how can it be adjusted to give maximum power output, maximum efficiency, etc.?

Consider Fig. 1. It represents the apparatus in one of the oldest and most famous experimeats in radio science. It is a condenser which is permitted to discharge through an inductance aad a resistance. Usually the greatest part of the resistance of such a circuit is the resistance of the spark gap. When photographs of such a spark are made on a rotating mirror, it will be seen that the spark does not jump the gap all in one leap, but that it oscillates back and forth, at one iastant goiag through the gap from A to B, and in the next instant going from B to A. The number of times per second these oscillations occur, depends upon the values of L and C, and the totnl number that take place before they eventually die out depends largely upon R. If the resistance is high, only a few oscillations take place, Fig. 2A, and if the resistance is low, many oscillations take place, Fig. 2B. If the resistance could be reduced to zero, continuous oscillations or waves (CW) would take place (see Fig. 2C); there would be no tendency for them to die out, and if a negative resistance could be added, the system would even supply a certain amount of radio-frequency power to an outside circuit without the oscillations dying out.

Consider now an amplifier tube. The tuned circuit is in its plate circuit and it is coupled to the grid circuit through a tickler coil. Suppose the condenser in this tuned circuit is discharged through the coil and the series resistance. This discharge current sets up a voltage across the inductance which induces a voltage on the grid of the tube equal to $M\omega I_L$, where M is the mutual inductance between the two coils, ω is 6.28 times the frequency, and I_L is the current through the coil. This voltage will be amplified and applied to the tuned circuit again. If this amplified voltage is greater than the original discharge voltage

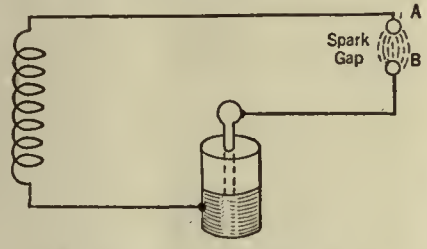


Fig. 1—A coil, a Leyden jar, and spark gap—this was the first transmitter.

across the inductance, oscillations will be built up in this circuit, and will continue at an amplitude depending upon the circuit constants. If the amplified voltage is less than the original discharge voltage, the oscillations in the tuned circuit will be prolonged, but cannot continue forever. If the returned voltage is just equal to the original discharge, the oscillations cannot increase in value, the circuit will be in an unstable condition, and caanot supply any power to aaother circuit.

The plate current of such a tube consists of the average or d.c. value taken from the plate battery plus the a.c. variations just as in an ordinary amplifier tube. In other words, an oscillating tube may be thought of as a self-excited amplifier. The grid voltage depeads upon the strength of the oscillations and the coupliag between tickler and plate coil. This grid voltage drives the plate circuit into producing corresponding plate-current variations. This a.c. plate current produces an a.c. voltage across the tuned circuit, and thereby produces a current that circulates between coil and condenser.

How much can the a.c. plate current be?

Suppose the plate current curve is as shown in Fig. 4. When oscillations start, the a.c. plate current is small. If the operating point is such that the average value of current taken from the plate battery, which is the current read by a d.c. meter, is midway between zero and the saturation current, B, or the maximum permitted by the C bias and a.c. grid voltage, then the maximum variations from this average must be $I_S/2$. Thus we have a plate current varying from twice the d.c. value to zero. This is an a.c. current whose maximum value is equal to the d.c. plate current and whose effective value is $I_{d.c.} \times 0.707$. The plate current is also equal to the grid voltage multiplied by the mutual conductance of the circuit—which we shall assume is the G_m of the tube. Thus,

$$i_p = e_g \times G_m \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$= I_{d.c.} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$\text{or } e_g = \frac{I_{d.c.}}{G_m} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

This is the a.c. grid voltage which is amplified in the tube, and placed across the tuned circuit thereby setting up an oscillatory current in it. Normally this oscillatory current is about 20 times as great as the d.c. plate cur-

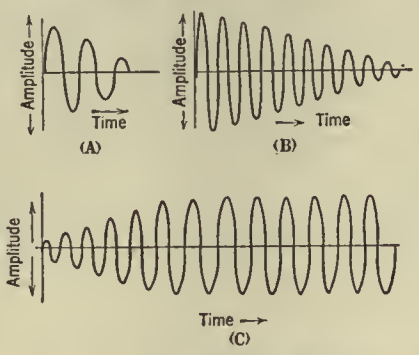


Fig. 2—(A) A highly damped wave; (B) a slightly damped wave; (C) a continuous wave.

rent. This current induces an a.c. grid voltage on the grid coil, and the process goes on ad infinitum. This oscillatory current can be calculated from

$$e_g = I_L \, M\omega \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

$$I_L = \frac{e_g}{M\omega} = \frac{I_{d.c.}}{G_m \times M\omega} \quad . \quad . \quad . \quad . \quad . \quad (5)$$

The power in the oscillatory circuit is equal to

$$P_{osc} = (I_L \times .707)^2 r \quad . \quad . \quad . \quad . \quad (6)$$

where r is the resistance of the tuned circuit.

This power will be a maximum when the effective resistance of the tuned circuit, $L^2\omega^2/r$ or L/Cr is equal to the tube plate resistance. The power into the tube from the B batteries is the product of the d.c. plate current and the d.c. plate voltage. The efficiency of the circuit is the ratio between the power in the oscillatory circuit and the total power taken from the B battery.

$$P_{total} = E_p \, I_p \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

$$\text{Eff} = \frac{P_{osc}}{P_{total}} = \frac{(I_L \times .707)^2 r}{I_p \, E_p} \quad . \quad . \quad . \quad (8)$$

Conditions for Oscillation

If the mutual inductance or coupling between grid and plate coils is varied, it will be found that the tube will oscillate over a certain range in coupling, but not at either greater or less coupling than this range of values. The conditions for oscillations are

$$M \text{ must be greater than } \frac{1}{\mu}(L \times C \times r \times R_p) \quad . \quad (9)$$

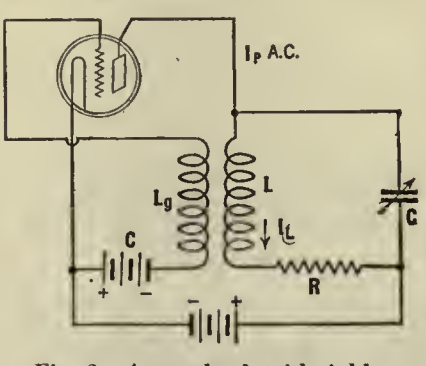


Fig. 3—A standard grid-tickler transmitting circuit.

which may be written approximately as

$$M > \frac{L_l}{\mu} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

Problem: In the Laboratory an inductance of 387 microhenries was tuned by a condenser to 1225 meters, f = 245 kc. A tube with a mu of 8 was coaaected to it in a tuned plate circuit (Fig. 3). Resistances were added to the tuned circuit, and the plate current and oscillating current were read. The values of total circuit resistance, plate current, and oscillating current are given below.

Total resistance	I_p (mA.)	I_{osc} (mA.)	P_{total}	P_{osc}	Eff.
25	9	250			
35	16	230			
38	19	200			
40	22	100			

Procedure

1. Calculate the power taken from the plate battery (E_p = 200) from (7) nt each value of total resistance and fill in the table above.
2. Calculate power in oscillating circuit from (6). Since the meter read the effective value of the current, it will not be necessary to multiply by 0.707 to get the correct value of I_L.
3. Calculate the efficiency of the circuit for each value of total oscillatory circuit resistance.
4. Calculate the effective resistance of the tuned circuit, $L^2\omega^2/r$ or L/cr.
5. Assume that the plate resistance of the tube is equal to the effective resistance of the tuned circuit when the maximum power is transferred to the latter, and therefrom determine what the plate resistance of the tube in this experiment was.
6. From (10) calculate the value of M in microhenries for oscillation.
7. Remembering that G_m equals mu/R_p, calculate the G_m of the tube.
8. From these values of I_p (d.c.), mutual

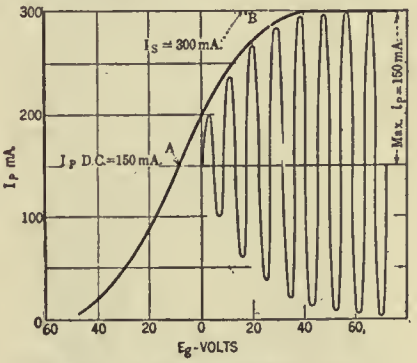


Fig. 4—How oscillations build up in a transmitting tube.

conductance, and mutual inductance, calculate the oscillating current at each value of total resistance and see how it checks the values given in the table above.

9. At each value of resistance, calculate the a.c. grid voltage from (4).
10. From (4) and (1) calculate the a.c. plate current for each resistance value and see how it checks the d.c. plate current.

Note. Do not worry if the values you calculate do not check very closely the values as measured in the Laboratory. The mathematics which you use in the above formulas are only true when the d.c. plate current is adjusted and the feed back is arranged so that a sine wave is generated. In this experiment, it is probable that a very poor wave form was generated, and that with no added resistance the d.c. plate current was equal to the peak value of the a.c. current. It will be most nearly equal to it when the tube is acting nearly 50 per cent. efficient, however.

When a tube has a large C bias and is worked far down on its plate current curve, it cannot generate sine waves. It becomes more efficient, however, and this is why an amateur can push 200 watts into his 50-watt tube without burning holes in the plate. The circuit is more efficient—he is using a large grid leak—and more power goes into the load than is used up on the plate, but he is doing this at the expense of a pure wave form. He is filling the ether with harmonic radiations and he need not be surprised if he gets a card from someone who has identified his call in the 20-meter band, although his wavemeter says his wavelength is 40 meters.

No. 24 *Radio Broadcast's Home-Study Sheets* June 1929

MEASURING CAPACITY

THE ESSENTIAL PARTS of every tuned circuit, of which radio receivers are made, are capacities and inductances. "Home-Study Sheet" No. 20 told how to build a standard inductance for the home laboratory or shop; this "Home-Study Sheet" gives some of the fundamental facts about condensers.

Capacity Measurements

Eliminatiag the slight effect of the edges, the capacity of two opposing conducting surfaces, as in Fig. 1, is given by the simple equation:

$$C = \frac{0.0885\ S}{T} \text{ micromicrofarads}$$

S is the area of one plate, and T the distance apart, both in centimeters. If the dimensions are in inches, the formula is:

$$C = \frac{0.225}{T} S \text{ micromicrofarads}$$

If the space between the plates is occupied by any other insulator (called the dielectric) than air, the above values must be multiplied by the dielectric constant of the material used. For mica this constant may vary from 4 to 8, for glass from 3 to 10, and for waxed paper from 3.5 to 3.75.

For example, the capacity of the condenser in Fig. 1 is 88.5 mmfd.

To the experimenter these formulas have little practical application except to afford some means of estimating capacities. In the usual form of variable air condenser accurate measurements would be extremely difficult, if not impossible. We are, therefore, dependent on some known capacity for a standard. No reliance whatever can be placed in the stated capacities of the many small fixed condensers on the market, the error not infrequently being as great as 50 per cent. Tho G.R. 347 variahlo condenser may be had at a reasonable cost, and carries a scale reading directly in micromicrofarads from zero to 500 or 1000. The upper end of the scale of this condenser could be accepted with assurance of a very fair degree of accuracy, and the instrument is well adapted to laboratory work as it is inclosed in a metal shield. In any case, see to it that the condenser chosen is of the straight-capacity-line type, has a maximum capacity of not less than 500 (preferably 1000) micromicrofarads, hns very durable bearings, has no stop to prevent the plates from revolving completely, and has the dial firmly secured to the shaft. It is also desirable to have a condenser with some sort of fine vernier that can be disconnected, as many times the condenser will be used for approximate determinations when a vernier would be qnite iaconvenient. At other times, when using loose coupling and absolute resonance is necessary, the vernier cannot be too sensitive.

If the experimenter is fortunately in a position to have his chosen condenser calibrated for him at about ten points, his troubles may be ended quickly. A curve should then be laid out on squared paper having ten lines to the inch. The resulting capacity readings may then be tabulated opposite each of the one hundred points of the dial, such a tabulating being much more convenient foi general use than a curve.

Standard Condensers

Standard laboratory condensers of the variable type generally carry a label stating the values at ten different points. If access can be gained to one of these at a near-by college, school, or electrical establishment, the values should be transferred to the new condenser by

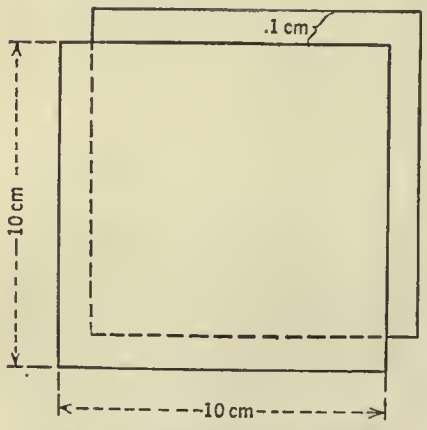


Fig. 1—Schematic drawing of a simple condenser.

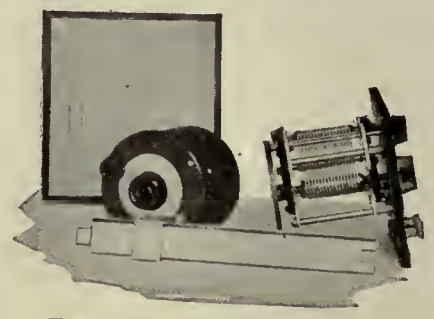


Fig. 2—Two calibrated variable condensers. The ten-inch slide rule shows their comparative size and the chart shows the usual type of calibration curve.

meaas of the substitution method. Set the standard condenser on one of the points at which it has been calibrated. Connect it to terminals "Y" of the bridge ("Home-Study Sheet" No. 21) and then balance it with an extra variable condeaser connected to the "X" terminals at a 1:1 ratio, or, if a third condenser is not available, use a fixed condenser and the slide-wire. When a perfect balance is secured, replace the standard (connected to "Y") with the new condenser, and adjust it carefully until it is in balance; i.e., until its capacity equals the known value of the standard condenser. Have the leads to the coudensers fairly long, and

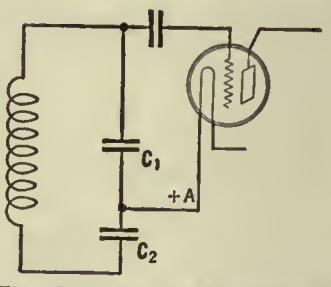


Fig. 3—The circuit used in problem No. 3.

maintain them in the same relation throughout the comparison in order that their capacities will remain constant. The new condenser should be compared at least twice to each of the known values of the standard condenser, using different settings of the slide-wiro nnd capacity. The advantage of this method is that its accuracy is not affected by any errors in the bridge.

When making measurements of capacities on a bridge, the laboratory worker must remember that a condenser has a negative reactance, and so the ratio used in determining the capacity of a condenser in terms of a standard must be reversed. Thus, if resistance or inductances were measured on a bridge, and the two lengths of a slide-wire which gave the ratio between the standard and the unknown resistance or capacity were A/B, when capacities are measnred and the balance is obtained, the proper ratio to use is B/A. Thus, if the lengths of slide-wire to balance two inductances, Lx and Ls, are 4/5,

$$\frac{L_s}{L_x} = \frac{4}{5} \text{ or } L_x = \frac{5}{4} L_s$$

when capacities are balanced by this ratio, the correct value of

$$C_x = \frac{4}{5} C_s$$

At this point it would be appropriate for the experimenter to familiarize himself a little further with his equipment and at the same time experimentally verify the rule for combining two condensers iu parallel or series.

Formulas

In the first case the capacities are merely added, and the demonstration of this fact simply requires the measurement of the two capacities separately and then comparing their addition with the measured capacity of the two connected in parallel.

The resultant capacity of two condensers of capacities A and B in series is the reciprocal of the sum of the reciprocals or

$$\frac{1}{\frac{1}{A}+\frac{1}{B}} \text{ or } \frac{A \times B}{A+B}$$

Thus, if both capacities are 1, then the resultant is obviously ½. To verify this, measure each capacity separately, and then compute the resultant, which may then be compared with the measured value of the two condensers connected in series.

While the expression, the reciprocal of the sum of the reciprocals, souads rather deep, the reason for it is very simple, and requires no mathematical demonstration to show why it should be so. The reactance of a condenser is decreased as the capacity is increased, so that the reciprocal is proportionate to the reactance. The sum of the reciprocals then is, therefore, simply adding two series resistances, as it were, and represents the total reactance. To get this back into terms of capacity again we merely turn the expression upside down.

While a variable condenser of 0.001 mf.l. will generally be found sufficient, it is desirable to calibrate two or three fixed condensers of larger values, for which purpose the usual square mica condensers, securely held together by two eyelets, are satisfactory. In making such determinations do not use the slide-wire at too great a ratio—say not over 5:1. When the measurement of large values is necessary, it is better to measure a condenser of intermediate value, and then proceed from it to the higher value.

For the measurement of a very small capacity, such as the minimum of a variable condenser, it is advisable to connect it in parallel with the calibrated condenser, set at about half capacity. With the bridge, balance this combination against any available condenser, and note the dial reading. Disconnect the small condenser, and balance again. The difference between the two readings will be the desired capacity.

Problems

Problem 1: Two condensers, each of 200 mmfd., are connected in parallel. What is the resultant capacity? If one is 200 and one is 400 mmfd., what is the resultant capacity?

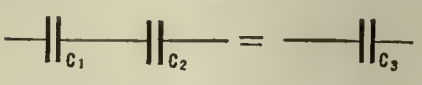
Problem 2: The condensers described above are connected in series. What is the resultant capacity?

Problem 3: In a certain receiver circuit it is necessary to ground the tuning condenser to the filament of the tube but it is not permissible to ground the coil. This can be done by connecting another condenser into the tuned circuit, as in Fig. 3. Must C_2 be large or small compared to C_1, so that the tuning range of the circuit will not be altered appreciably? For example, if C_1 is 500 mmfd., how large should C_2 be?

Problem 4: An antenna has an effective capacity of 0.0002 mfd. How much capacity must be added in series to reduce this capacity to 0.00015 mfd.? If the inductance in the antenna has not been changed, what is its natural wavelength now?

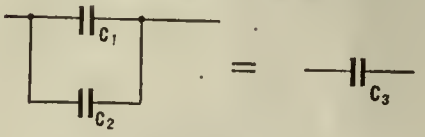
Problem 5: Two plates 10 cm on a side are separated by 3 mm of dry air. What is the capacity of the condenser? Suppose a sheet of mica, dielectric constant = 6, is put between the plates. What is the capacity now?

Problem 6: A fixed condenser across a given inductance has a capacity of 1000 mmfd. and tunes the inductance to 1000 meters. A variable condenser having a maximum capacity of 1000 and a minimum capacity of 25 mmfd. is placed in series with it. Plot the wavelength against added series capacity. (Note. Wavelength in meters = 1.884 LC where L = μh and C = mmfd.)



$$C_3 = \frac{C_1 \times C_2}{C_1 + C_2} = \frac{1}{\frac{1}{C_1}+\frac{1}{C_2}}$$

Fig. 4—Capacity formula for condensers in series.



$$C_3 = C_1 + C_2$$

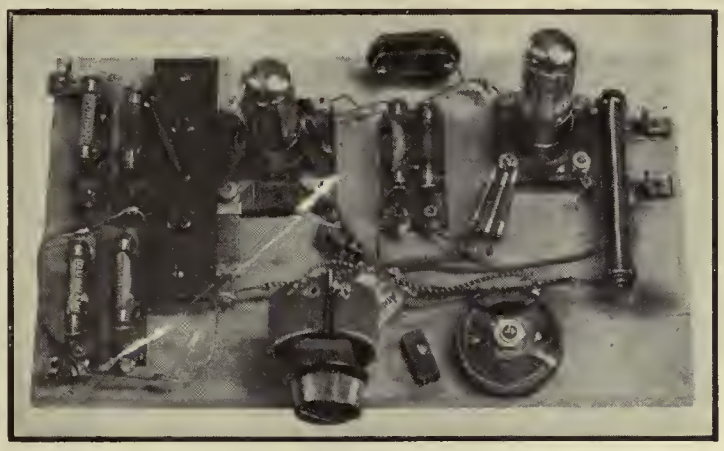
Fig. 5—Capacity formula for condensers in parallel.

A SIMPLE TWO-TUBE V. T. VOLTMETER

By HOWARD E. RHODES

Technical Editor

ONE OF THE most useful instruments to be found in a radio laboratory is the vacuum-tube voltmeter—it is practically an indispensable piece of apparatus in many measurements on circuits and parts used in radio receiving sets. In its simplest form it consists of a tube and meter connected as indicated in Fig. 1A, the B and C potentials being such that the tube is operated on the lower bend of its I_p-E_g characteristic, so that any voltage impressed on the grid produces an increase in plate current. However, unless a very sensitive measuring instrument is used in the plate circuit, this arrangement has the disadvantage that its sensitivity is not very great; with a 200-microampere meter it is generally impossible to read, with good accuracy, any potential below 0.6 volt. A second disadvantage is that the calibration of the instrument is quite sensitive to changes in the A, B, or C battery voltages.



View of the two-tube breadboard-type vacuum-tube voltmeter constructed in the Laboratory.

An unusual form of vacuum-tube voltmeter which does not have these two disadvantages was constructed recently in the Laboratory. This instrument has been used with very satisfactory results for some time and its construction is described in this article. The voltmeter was designed especially for making measurements on phonograph pick-up units, but it is equally suitable for any measurements at frequencies between about 60 and 8000 cycles. However, the usefulness of this meter is limited to audio frequencies because it incorporates a one-stage a.f. amplifier which has a flat characteristic between 60 and 8000 cycles.

Features of Meters

THE CIRCUIT diagram of the voltmeter is given in Fig. 4. It consists essentially of a simple one-tube voltmeter with a stage of audio-frequency amplification ahead of it. From the stage of amplification, a voltage gain of about eight is obtained, and the sensitivity is consequently increased by a factor of eight, so that when using a 200-microampere meter at M we can now read potentials down to about 0.1 volt and, by means of multipliers, up to about 4 volts—a voltage range of 40, corresponding to about 32 DB. By adding a stage of amplification we have, therefore, overcome one of the disadvantages of the simple voltmeter, i.e., lack of sensitivity.

Independence of changes in A, B, and C voltages is obtained by supplying all of these potentials from a single battery.

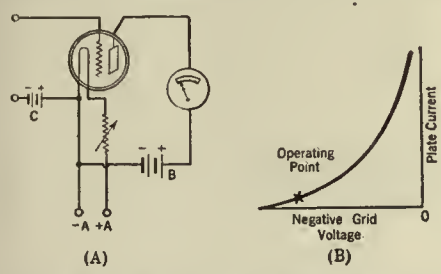


Fig. 1— (A) a simple v.t. voltmeter circuit; (B) I_p-E_g curve of tube showing operating point of meter.

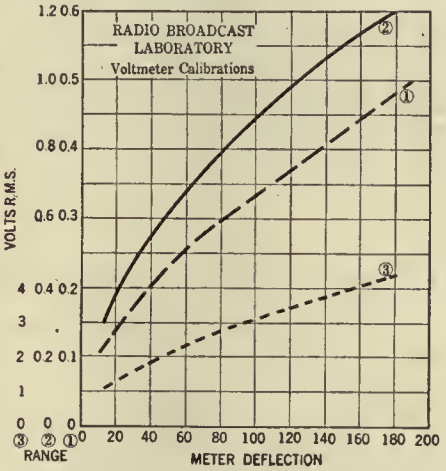


Fig. 2—Calibration curves of the v.t. voltmeter described in this article.

By adjusting a single resistor, R_3, it is always possible to set accurately all the voltages so that a single calibration is correct over a long period of time.

The voltmeter uses two 199-type tubes with their filaments connected in parallel and supplied from a single 45-volt B battery—in the Laboratory a 45-volt storage battery was used. In the plus lead from the battery are connected three resistors, R_1, R_2, and R_3, the total resistance of these three units being such as to permit about 120 mA. to flow through the circuit—each tube filament takes 60 mA. The voltage drop across the 300-ohm resistor, R_1, supplies a plate potential of 300×0.12 or 36 volts to the plates of the tubes. A C-bias potential of 2.4 volts for the grid of the first tube is supplied by R_4, a 20-ohm resistor in the A-minus lead to the tube. A 66-ohm resistor, R_5, supplies a C bias of 8 volts to the grid of the second tube. The tubes are resistance coupled, the plate resistor being R_6, a 50,000-ohm unit, the grid resistance, R_7, 1 megohm, and the coupling condenser, C, with a capacity of 0.01 mfd.

The steady plate current from the last tube is about 150 microamperes, and, in order that the entire scale of the meter may be used, it is necessary that the steady current be balanced out. This is accomplished by connecting a rheostat, R_2, in series with the plus lead and utilizing the voltage drop across it to send a current around through R_8, a 4000-ohm resistor, and the meter, M. The direction of this current is opposite to that of the plate current and, by adjusting the position of the slider on the rheostat R_2, we are able, therefore, to balance out the steady plate current and bring the pointer of the meter back to exactly zero.

In operating the voltmeter it was found that if the resistance of R_3 was slightly reduced, so that more current flowed through the circuit, the reading of M increased; if the resistance was increased the pointer on M moved back passed the zero point. This fact affords a simple and accurate method of adjusting the instrument to the correct operating point. The battery potential may vary from 40 to 50 volts and it will always be possible to adjust the voltmeter correctly by simply adjusting R_3 so that the pointer is at exactly zero. It has been found possible to set up the voltmeter in the Laboratory and, with this single adjustment, exactly to duplicate a calibration made several months ago.

Voltage Range

THE VOLTAGE RANGE of the instrument was increased by connecting several resistances, R_9, R_{10}, and R_{11}, in series across the input terminals. With the lead from the grid connected to terminal No. 1 a calibration corresponding curve 1 in Fig. 2 was obtained. Curves 2 and 3 were obtained by connecting the grid lead to terminals 2 and 3, respectively.

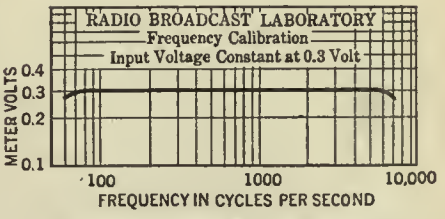


Fig. 3—Frequency characteristics of the v.t. voltmeter designed by the writer.

The frequency calibration curve is given in Fig. 3. It is practically flat from 60 to 8000 cycles—which we considered the useful range of the device.

The fact that a high resistance, R_7, is in the grid circuit of the second tube introduces a rather unusual characteristic. It has been found that as soon as an a.c. voltage, sufficient to swing the grid positive so that grid current flows, is impressed across the grid of the second tube, the reading of the plate meter, M, begins to decrease instead of increase. This characteristic prevents damage to the meter in case excessive a.c. input is applied to the voltmeter—this is certainly an advantage. The disadvantage of this arrangement is that false readings may be obtained unless it is realized that the meter is being overloaded. The decrease in plate current produced by overloading can be prevented by using a choke coil in place of R_7, but the coil must have a very high inductance to prevent a decrease in gain at the low frequencies. A coil with an inductance of between 100 to 200 henries will probably be found satisfactory. The coupling con-

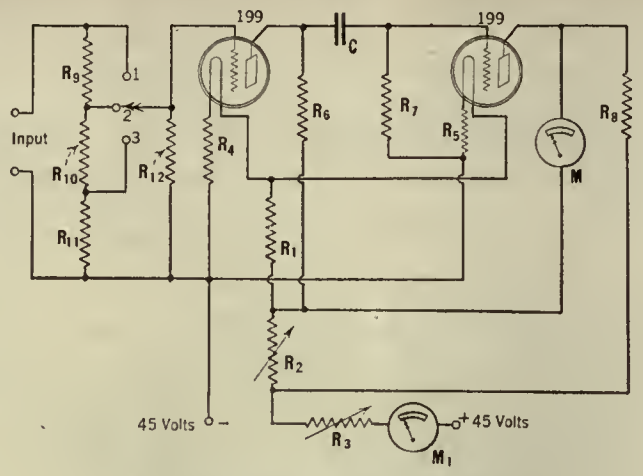


Fig. 4—Schematic diagram of the v.t. voltmeter pictured on page 107.

denser, when using a choke, may have to be increased to about 0.5 or 1 mfd.

The Laboratory's meter has been constructed on a baseboard as indicated in the picture. There is nothing unusual about either the parts or their arrangement on the board—except possibly that we would suggest that a Pacent or G.R. rheostat be used for R_2, since these are the only rheostats we know of that can be fastened directly to the baseboard. A wood screw should also be passed through the center hole which normally holds the shaft. When the correct adjustment of R_2 has been determined, this screw will serve to hold securely the arm of the rheostat at the correct adjustment.

List of Parts

THE FOLLOWING is a complete list of the apparatus selected for the construction of the v.t.voltmeter described in this article:

C_1 One Sangamo fixed condenser, 0.01-mfd.;
R_1 One Ward-Leonard fixed resistor, type 507-93, 300-ohm;
R_2 One rheostat, 2-ohm;
R_3 One Centralab power rheostat, 150-ohm;
R_4 One Frost fixed filament resistor, 20-ohm;
R_5 Three Frost fixed filament resistors connected in parallel, two 20-ohm and one 25-ohm units;
R_6 One Durham Metallized resistor, 50,000-ohm;
R_7 One Durham Metallized resistor, 2-megohm;
R_8 One Ward Leonard fixed resistor, type 507-29, 4000-ohm;
R_9 One Durham Metallized resistor, 0.25-megohm;
R_{10} One Durham Metallized resistor, 0.1 megohm;
R_{11} One Durham Metallized resistor, 50,000 ohm;
R_{12} One Durham Metallized resistor, 1-megohm;
R_{13} Two sockets;
Fahnestock clips, etc.

NEW 227-TYPE TUBE OF IMPROVED CONSTRUCTION

By F. X. RETTENMEYER
Chief Engineer, F. A. D. Andrea, Inc.

DURING THE PAST SEASON dealers may have received quite a few complaints from purchasers of a.c.-operated radio receivers. The owners of these sets state that they frequently hear an annoying hiss and buzzing noise in the loud speaker. The cause of this noise has been traced by tube engineers to the 227-type detector tube. Fortunately, this trouble is not caused by the new tubes which are now available, but many of the old type are still in use.

If a 227-type tube is examined, it will be noticed that the heater and its insulation extends above the cathode by a small amount and it has been found that the noise described above is due to the fact that the exposed portion of the insulating material collects a charge which builds up to a certain potential and then discharges to the cathode. This discharge, which is identical in action to that found in a leaky condenser, causes a buzzing type of interference which may occur at more or less regular intervals and which sounds not unlike radio-telegraph interference. In addition, the exposed portion of the heater sometimes introduces a certain amount of noise into the radio circuits by virtue of its effect on the tube space current. Both of these defects have been eliminated in the 227-type tubes now being manufactured. The cathode has been extended in the new tubes to the end of the insulation on the heater and it acts to shield the entire heater circuit from such interference.

The type of interference mentioned above is, of course, present in all electric receivers but it is much more apparent in those sets which have good a.f. systems. That this must be the case is at once apparent when it is considered that a great many musical instruments produce characteristic tones of the same pitch as the interference (i.e., cymbals, eastinets, bells, triangles, and the overtones of the violin). Further, the s's and th's of speech are hissing sounds which are vitally necessary for good articulation and are very similar in character to the above types of interference. To limit the range of reproduced speech and music so that the crackling and hissing noises would not appear would mean that the quality would be seriously marred, and a receiver is good only when it faithfully reproduces all the audible frequencies broadcast.

COMPLETE LIST OF R.C.A. LICENSEES

THE FOLLOWING is a complete list of the manufacturers licensed to operate under the patents of the Radio Corporation of America.

RECEIVING SET LICENSEES

The manufacturers listed below are licensed under the R.C.A. receiving set patents. Those manufacturers marked with an asterisk (*) are also licensed under the power supply and amplifier licenses, and those marked with a dagger (†) are licensed under the electric phonograph patents.

All-American Mohawk Corp.,*† Chicago, Ill.
American Bosch Magneto Corp., Springfield, Mass.
Amrad Radio Corp.,† Medford Hillside, Mass.
F.A.D. Andrea, Inc., Long Island City, N. Y.
Atwater-Kent Mfg. Co., Philadelphia, Pa.
Bremer-Tully Mfg. Co.,*† Chicago, Ill.
Buckingham Radio Corp.,*† Chicago, Ill.
Colonial Radio Corp.,† Long Island City, N. Y.
Columbia Phonograph Corp., Chicago, Ill.
Consolidated Radio Corp.,*† (two Divisions)
Wells-Gardner & Co., Chicago, Ill.
Arborphone Division, Ann Arbor, Mich.
Crosley Radio Corporation,* Cincinnati, Ohio.
Day-Fan Electric Co., Dayton, Ohio.
Gulbransen Co.,*† Chicago, Ill.
Electrical Research Laboratories, Inc.,*† Chicago, Ill.
Federal Telephone Mfg. Co.,* Buffalo, N. Y.
Freed-Eisemann Radio Corp., Brooklyn, N. Y. and Chas. Freshman, Inc., New York, N. Y.
Gilfillan Bros. Inc.,*† Los Angeles, Cal.
A. H. Grebe & Co. Inc.,* Richmond Hill, N. Y.
Grigsby-Grunow Co.,*† Chicago, Ill.
Howard Radio Co., *† Chicago, Ill.
Kellogg Switchboard & Supply Co., Chicago, Ill.
Colin B. Kennedy Corp.,† Chicago, Ill.
King Manufacturing Corp.,* Buffalo, N. Y.
Kolster Radio Corp.,* Newark, N. J.
Philadelphia Storage Battery Co., *† Philadelphia, Pa.
Silver-Marshall, Inc.,† Chicago, Ill.
Splitdorf Radio Corp., *† Newark, N. J.
Stcinite Manufacturing Co.,* Atchison, Kansas.
Stewart Warner Speedometer Corp.,* Chicago, Ill.
Stromberg Carlson Telephone Mfg. Co.,*† Rochester, N. Y.
Temple Corp.*† Chicago, Ill.
United States Radio & Television Corp.,* Chicago, Ill. (three divisions)
Apex Electric Mfg. Co., Chicago, Ill.
Cnse Electric Company, Marion, Ind.
Continental Radio Corp., Ft. Wayne, Ind.
Walbert Radio Corp.,† Chicago, Ill.
Zenith Radio Corporation,* Chicago, Ill.

POWER SUPPLY AND AMPLIFIER LICENSEES

The following list includes manufacturers licensed under the R.C.A. power supply and amplifier patents. Other manufacturers licensed under these patents are the receiving set licensees (listed above) which have been marked with an asterisk (*).

American Transformer Co., Newark, N. J.
Autorad Electric Corp., Detroit, Mich.
H. H. Eby Mfg. Co., Philadelphia, Pa.
Electrad, Inc., New York City.
Enterprise Mfg. Co. of Pa., Philadelphia, Pa.
Farrand Mfg. Co. Inc., Long Island City, N. Y.
Federal Radio Corporation, Buffalo, N. Y.
Ferranti Inc., New York, N. Y.
General Radio Co., Cambridge, Mass.
Gray Products, Inc., Poughkeepsie, N. Y.
Kingston Products Corporation, Kokomo, Ind.
Martin Copeland Company, Providence, R. I.
National Company, Inc., Malden, Mass.
Radio Receptor Co., New York, N. Y.
Sterling Manufacturing Co., Cleveland, Ohio.
Thordarson Electric Manufacturing Corp., Chicago, Ill.
J. S. Timmons Co. Inc., Philadelphia, Pa.

ELECTRIC PHONOGRAPH LICENSEES

Manufacturers licensed under the electric phonograph patents are those marked with a dagger (†) in the above list of receiving set licensees.

VACUUM-TUBE LICENSEES

The Raytheon Manufacturing Company Cambridge, Mass., is the only tube manufacturer which has thus far been granted a license to operate under the R.C.A. vacuum-tube patents.

BROADCAST ENGINEERING

BY CARL DREHER

Volume Control in Broadcast Transmission

THE PROBLEM of effective amplitude control in broadcast transmission is an old one which has been discussed from the beginning and which has not yet reached a final solution—although a satisfactory answer appears to be in sight. The necessity for it arises through the great range of variation characteristic of acoustic problems, and the fact that electrical machinery and conditions in general are not readily adapted to such a range.

A symphony orchestra which is being broadcast may emit ten million times as much sound energy at one time as another. Even if the range is only one million, it is not readily handled in the transmission chain following the microphone. The maximum amplitude must be set to pass through the various amplifier units without overloading. If, then, the minima are left as they enter the microphone, these portions of the transmission will drop below the inescapable noise level of the equipment itself (tube hiss, etc.), extraneous disturbances in transmission (cross-talk on wire lines, induction, etc.) and noise in reception originating in similar ways. The remedy is to compress the range of variation within such limits that it will fit into the design of the equipment, neither falling to a level where noise becomes objectionable, or overloading any part of the system, while retaining the essential characteristics of the original sound output with its artistic values.

The usual method adopted is the use of a manually operated voltage divider, otherwise known as a "gain control" or "volume control." This is inserted at some point in the transmission chain, as between amplifier stages. The total resistance of the potentiometer is usually 400,000–600,000 ohms, and the taps are so arranged that each step corresponds to a change of 2 DB, sometimes 3 DB. Steps of 2 DB correspond to about 25 per cent. voltage changes. The calibration holds only when no current is drawn by the circuit element ahead of the potentiometer.

VOLUME INDICATORS

Such an amplitude control is usually used in conjunction with a volume indicator. This is simply a tube rectifier acting as a peak voltmeter. It may also be calibrated in DB. The task of the broadcast operator is to watch the indicator and to turn down the gain control when the meter indicates over-shooting, while when the volume drops too low he must raise the level. He is assisted, in some cases, by a view of the action at the pick-up point, while on other jobs he may have to work blind. He may have a musician working with him to indicate what is going to happen, so that the operator may be prepared for changes. Rehearsals, of course, are a great help. The job is well done when changes in volume are confined to an irreducible minimum, effected in advance of the instant when they become necessary, and not made so abruptly that the attention of critical listeners is disturbed. These are difficult requirements.

An automatic volume control in place of the manually operated form, or in conjunction with the latter, was proposed some years ago as a solution, and it is probable that the next few years will witness its adoption in high-grade broadcast operation.

AUTOMATIC CONTROL

The best known form of automatic volume control is the radio-frequency type used to maintain constant output in a radio receiver with varying field intensity, when a relatively distant station is being picked up. Such devices are usually operated by the carrier wave, variations in carrier intensity being compensated for by inverse changes in radio-frequency amplification. The operation of such a system is described by Harold A. Wheeler in a paper on "Automatic Volume Control for Radio Receiving Sets," in the *Proceedings of the Institute of Radio Engineers*, Vol. 16, No. 1, January, 1928. Mr. Wheeler shows a receiver with four neutralized radio-frequency stages, followed by a two-element rectifier with filter circuits arranged to separate the direct and audio-frequency components of the pulsating rectified voltage. The audio components are led through a manually operated gain control to the audio amplifier, which comprises four stages. The direct component of the rectified voltage is led back to the radio-frequency train as an automatic grid bias. Fig. 1, reproduced from Fig. 2 of Mr. Wheeler's paper, shows the circuit. With the circuit constants shown the rectifier reacts on the grids of the radio-frequency tubes in $\frac{1}{10}$ second, so that the system is almost capable of wiping out the inherent audio-frequency variations of sound. This time constant is, of course, controllable.

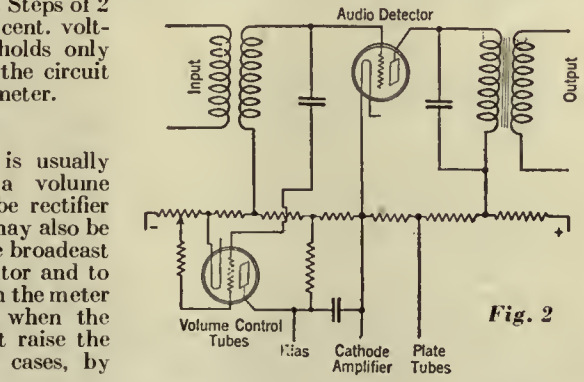


Fig. 2

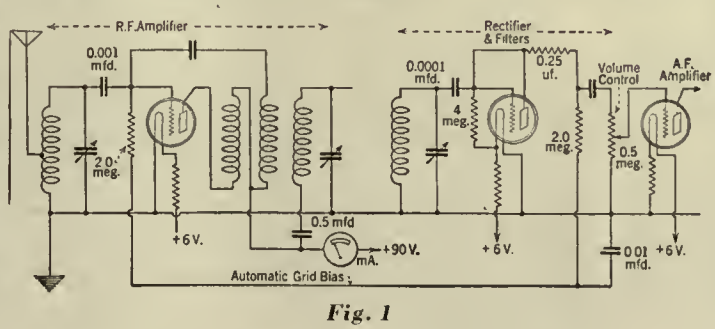


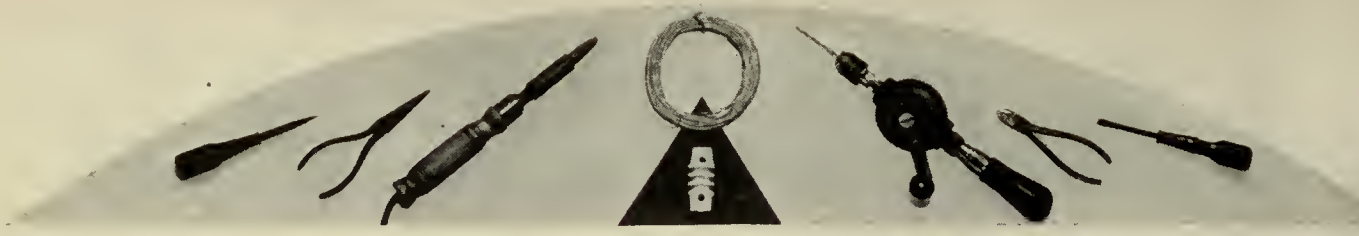
Fig. 1

ANOTHER AUTOMATIC DEVICE

More recently G. L. Beers and W. L. Carson, in a paper on "Developments in Super-heterodyne Receivers," published in the Vol. 17, No. 3, (March, 1929) *Proceedings of the Institute of Radio Engineers*, describe an automatic volume control, the circuit of which is here reproduced in Fig. 2. In this case the grid of the volume control tube is connected in parallel, through a coupling condenser, to the grid of the second detector of the super-heterodyne receiver. The voltage drop across a resistor in the plate circuit of the detector furnishes additional negative bias for the amplifier tubes, reducing the sensitivity of the receiver. The circuit constants are chosen to obtain the desired smoothing out without affecting the audio-frequency quality of reproduction. By means of the manual control on the grid of the volume-adjustment tube the degree of control may be set at any desired value. By increase of the bias on this tube a larger grid swing is permitted in the audio detector before the automatic volume control action comes into play.

The general principle of automatic volume controls for broadcast transmission is similar to that of the radio-frequency devices described, but some modifications are required. The method may utilize part of the input to an amplifier, which, after rectification, yields a d.c. component for control purposes either through grid or plate circuits of the amplifier. By means of a manual adjustment the audio gain control may be set to reduce the intensity range instead of smoothing it out altogether, since in broadcast transmission it is not desired to deliver a constant output with varying input, but merely to bring up the low portions, or reduce the peaks, within certain limits. This may be done by setting the automatic gain control so that it does not function except on peaks above the allowable level, or, alternatively, permitting it to operate at a low level to bring up the amplification as required. In either case the time constants must be chosen to give a rapid response, of the order of a tenth of a second.

It is probable that the automatic volume control for broadcast transmission will be useful only in conjunction with a carefully handled manual control. One reason for this is that announcements, in good broadcast practice, are transmitted well below the level of peaks in the music, a form of discrimination which cannot be expected from anything but a human operator. There is no reason, however, why the operator cannot throw a key, for instance, to lower the over-all gain 4–6 DB for speech, while the advantages of the automatic volume control are utilized during the musical intervals of the broadcast.



THE SERVICEMAN'S CORNER

In "The Serviceman's Corner" for May, we considered the simplest and most inexpensive types of radio testers. We publish below a compromise between these more elementary models and the high-priced commercial instruments. The compromise, however, is merely one of price. The outfit described below is as elaborate and efficient as any portable equipment can well be. The contributor is F. W. Howard, radio electrician, of 444 Lakeview Avenue, Pitman, New Jersey.

A standard service test set: "The following description of a set- and tube-tester constructed by the writer may serve to bring encouragement to some brother serviceman to whom a set-tester and a seat on the Stock Exchange mean the same thing.

"The total cost of this outfit need not exceed $25.00, even if every part of it has to be purchased new, and, as a matter of fact, nearly every serviceman will find a good part of the necessary equipment lying around his shop.

"Reference to the drawing will give the panel layout of the instruments, the dotted rectangle at the bottom representing the C battery, which is placed upside-down under the panel, and held in position by strips of the brass, which are in turn screwed to the brass frame.

"The mounting for the 0.1 meg. resistor is also fastened to the under side of the panel, between the meters and switches, E and F. The writer strapped this mounting between the top screws of the two Weston meters, thus avoiding the necessity of having screw heads showing on the face of the panel, but this is a matter of personal choice.

"The connections are shown in the diagram. Here it will be noted that each of the four switches has the direction of its throw indicated by double-pointed arrows, with an asterisk showing the position given on the panel layout. This might be termed the normal position for tests on d.c.-tube sets.

"In operation, connection is made between the tester and the socket of the set under test by means of a two-foot cord having tips on one end and a plug on the other. Plugs should be made up for all types of tubes. The writer has three plugs, for X base, Y base, and V (standard) base. For testing UV-199 bases, or WD-11 type, use adapters which may be purchased at any parts store. In the case of UV-199, WD-11, and UV-201A tubes, it will also be necessary to use adapters in the sockets on the tester. The writer was unable to purchase one of the latter adapters, so he made one by bolting a standard UV-type socket to the top of a UX-tube base, connecting from prongs to springs with short pieces of wire. This serves to test UV-201A-type tubes. For testing UV-199 and WD-11 tubes, socket adapters were found which fitted into the UV socket of the homemade adapter.

"It is advisable to use different colors for the wires between plugs and tips, having corresponding wires of each cord of the same color. Thus, a solid blue would be —fil., blue with red tracer +fil., yellow grid, red plate, and for UY base, white cathode.

"These cord pins fit into the tip-jacks at the top of the panel, No. 2 being minus fil., No. 3 plus fil., No. 4 grid, No. 5 plate, and No. 6 cathode. Nos. 1 and 4, with switch F thrown to normal (right) position, permit using the C battery as a source of low voltage d.c. for continuity tests, in connection with an external meter, or the same thing may be done using jacks Nos. 1 and 2, with switches D and E in normal (left) position, whereupon pushing button J gives a reading on the d.c. voltmeter if the external circuit is closed.

"It will be noted that switch D is a reversing switch for the d.c. voltmeter, which is very useful in testing certain types of sets, such as Radiola 20 and 25, where every other socket has reversed filament connections.

"Switch E shifts voltmeters, which is about the only necessary change between testing a d.c. and an a.c. set.

"Switch F cuts the local C battery into the grid circuit, thus making it possible to test a tube for "grid swing" in a socket which normally has no bias. This grid-swing test is made by pushing button J with switch G in its normal (right) position, thus connecting the plate circuit through the milliammeter. If it is deemed inadvisable to short the bias in this manner, switch F may be thrown to the center position, opening the grid circuit.



The Modern Radio and Equipment Company, of Buffalo, N. Y., installed a public-address system at the aviation show in exchange for booth space.

"Throwing switch G to the left position makes a high-reading voltmeter out of the milliammeter, with a reading of 100 volts per mA., and an accuracy plenty good enough for most tests. In this test position, button K gives cathode voltage, and button L gives plate voltage.

"Inductance switch H is a multiplier for the d.c. voltmeter, giving 2½, 5, and 10 times normal readings. Inductance switch M is a shunt connector for the milliammeter, giving 2, 5, and 10 times normal. The writer wound these shunts by taking a shield-shaped piece of thin fiber which was anchored under the terminal nuts of the Weston meters. This fiber was pierced with several parallel lines of small holes, and the resistance wire passed in and out of these holes. For the multiplier resistance it is advisable to obtain some very small wire, as considerable resistance is necessary.

"The writer carries his tester in a cash box which measures 13" × 9½" and is 4" deep. The brass supporting frame is therefore made 3½" high, and the full length of the tester, the "runners" having felt strips shellacked to their under sides, to prevent scratching the customer's furniture. The 9½" width of the box allows room to carry a 201A-, a 226-, a 227-, a 171A-, a V-199-, and an X-199-type tube in a line between front of box and side of tester, which serve to keep the tester from rattling around, and also insures a spare of each of the common types of tubes.

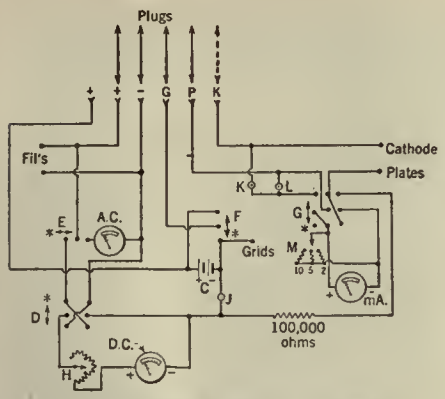
"The list of parts, with designations corresponding to those on the plan of the panel and on the circuit diagram, is as follows:

A—0-7 Beede a.c. voltmeter;
B—0-10 Weston d.c. voltmeter;
C—0-10 Weston milliammeter;
D and G—Yaxley three-pole, double-throw, center position jack switch;
E and F—Yaxley single-pole, double-throw, center position jack switch;
H and M—Yaxley four-point inductance switch;
J, K, and L—Pearl center push button;
S—Eby sub-panel-type four-prong socket;
SS—Eby sub-panel-type five-prong socket;
1-6—Yaxley tip jacks;
7" to 12" hard-rubber panel;
4' of ½" x $\frac{1}{16}$" brass strip;
4½-volt C battery;
100,000-ohm 2-watt Tobe Veritas resistors and mounting;
Resistance wire from old 200-ohm potentiometer or equivalent.

Miscellaneous

Some *helpful information on Zenith Sets:* "When a Zenith model 11-E or 14-E or even a 16-EP gets so that the volume does not remain steady after a station has been tuned-in, it is very often caused by the rotary plates of the gang condenser becoming loose on the shaft.

"I have found a great number of Zeniths with this ailment and I find that a very efficient way of repairing a set of this type



Schematic diagram of Mr. Howard's test set.

is to solder a piece of No. 22 hard-drawn brass wire across all of the rotary plates and ground the wire to the adjustment nut on the left end of the condenser shaft. The wire should be fastened under this adjustment nut first and then wrapped around the shaft once, forming a spiral, or pig-tail, before it is extended across and soldered to each of the rotary plate gangs.

"This will generally improve the operation of the set about 30 or 40 per cent.

"Another thing about the model 11-E and 14-E Zenith that needs a lot of attention is the balancing of the condensers. This, of course, should be done with a good oscillator. I find that the best volume and tone quality may be obtained by setting the second and third r.f. stages approximately two meters lower, and the detector stage approximately three meters higher, (at 300 meters) than the antenna stage. If the four condensers are all set alike it will make the set so sharp that the tone quality will be affected materially."

A. D. Woodyatt, Marshfield, Ore.

An unusual case of distortion: "The writer recently ran into a case of distortion which is, he believes, a bit out of the ordinary. The owner of a Majestic Model 70 receiver complained of oscillation and distortion on all frequencies and a check of the set disclosed the fact that the r.f. plate voltages were too high and the plate voltage at the output was too low. The set was removed from the cabinet, checked carefully, and found o. k. as was the power-pack. The dynamic loud speaker was then checked and it was found that the field winding was shorted. As the field in this particular dynamic acts merely as a choke across the 96-220 volt output of the power-pack it would, of course have produced the above effect."

W. P. Erickson, Omaha, Neb.

Visual checking of resonance in ganged circuits: A visual means of indicating resonance in radio-frequency sets can be arranged simply by placing a low-reading milliammeter in the detector output. The deflection on the meter will be changed by the strength of the carrier wave applied to the grid of the detector tube.

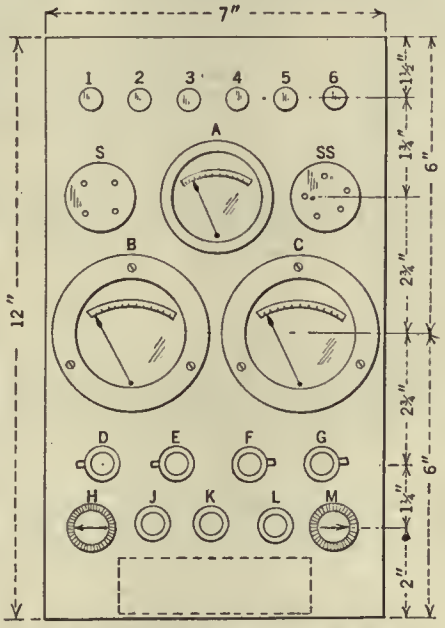
With a given carrier wave, greatest deflection on the meter will denote resonance in the tuning of the set.

In the grid condenser and leak method of detection the deflection on the meter will read downward. In the plate method of detection the deflections will read upward. The meter range should be 0–2 mA.

M. Chernow, Polyphase Radio Laboratories, New York City

Insulating lacquer in an A.-K. set: This was encountered in an Atwater Kent model 30 six-tube single-control receiver. This receiver while playing perfectly would suddenly drop in volume. The A battery and connections, power unit, set, and antenna were found o.k. With the set operating, it was found that by pressing on the condenser associated with the detector tuning coil the above condition would obtain.

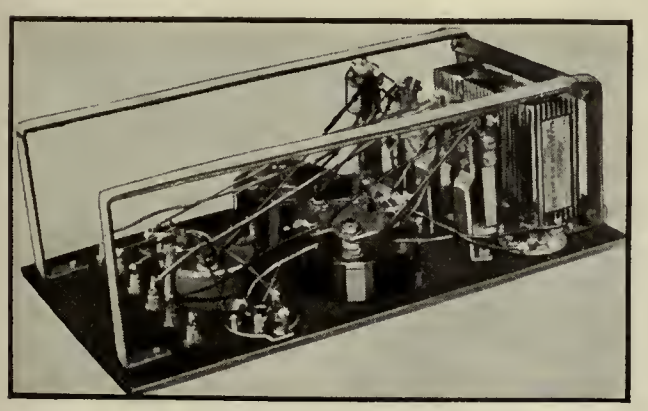
On the condensers in this set there are two screws which go through the bakelite end piece and screw into the stationary plates. From one of these screws the grid



Panel layout of tester showing exact layout of parts.

condenser is connected, and from the other the grid end of the tuning coil is connected. All brass screws in these sets are lacquered and it was found that the screw connection to the grid end of the coil was causing a high-resistance connection due to the lacquer. The lacquer was removed with a file and the set performed as it should.

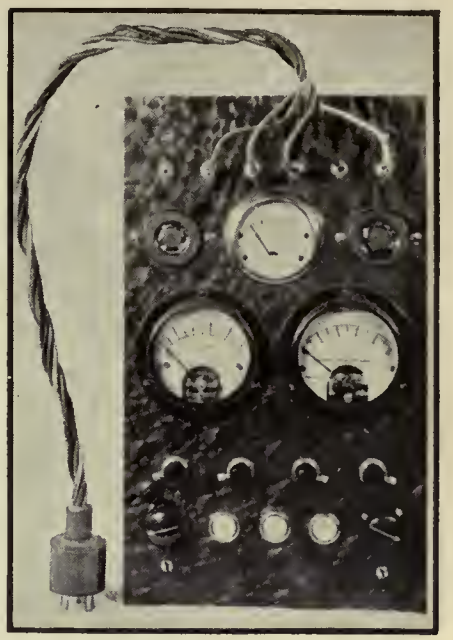
H. Weimer, Finkle Electric Shop, Appleton, Wis.



The arrangement of parts on the rear of the tester panel is shown clearly in this picture.

Accuracy of Small Meters

The accuracy of small meters has often been the subject of service controversy. L. C. Nichols, manager of the New York Weston



Front view of test set showing test plug and cable.

office, writes us in reference to the more popular Weston voltmeters and milliammeters. "Models 528, 476, and 517 are all provided with etched-metal scales and on such instruments, whether d.c. or a.c., it is our custom to state the guarantee as 2 per cent. of full scale to allow for slight discrepancies between instruments which develop in the process of manufacture and assembly. The scale being fixed for any particular range we, of course, cannot calibrate for these slight discrepancies.

"When considering direct-current measurements the Model 433 is correct well within 1½ per cent. of full scale. The other instruments may have errors as high as 4 to 5 per cent., the amount varying to some degree with the scale. Briefly, the low-range instruments are more sensitive to residual magnetism than the higher ranges in any of the models referred to.

"The values given are considerably beyond any errors we have been able to detect, but it is our policy to state these inaccuracies rather high to avoid possible extended correspondence or dissatisfaction on the part of any customer.

Business Kinks

Frank J. Shannon, of Shannon and Wynkoop, radio service and Radiola specialists, of Philadelphia, Pa., gets right down to earth on several vital points of servicing.

"We charge a time rate of two dollars per labor hour on radio service calls. As Philadelphia is so spread out that traveling time and expense mounts up somewhat, we charge traveling time on remote calls—some of our Philadelphia calls are twenty miles by auto from our shop and yet still within city lines. In cases where customer does not care to have us proceed after diagnosis and recommendations we have a minimum charge of two dollars. As to accessories, we charge the current list price—if they want cheap products and prices they can go to 'Radio Row' and take their chances. We, as a rule, always repair a set completely in the customer's home—whoever takes the original phone call requests the name of the radio, trouble as diagnosed by customer, and name and type of accessories. Then the man who makes the call carries accessories to cover probabilities of that particular set or sets.

We put in audio transformers and other such parts right on job, and collect the cash then and there. By the way, getting your cash on the job is an important item. The person taking the job over phone tells new customer our terms—CASH. I learned this important point quickly upon entering repair business, for it's a job in itself to collect a radio repair bill. The excuse is that the radio is unsatisfactory, even if you've left a considerable amount of new accessories. Then too, there's a chance that while you're waiting payment over a long period that these 'tricky' customers will expect you to fix set as a 'reinspection'—don't forget they have yet to pay for the original job. Then, another important feature to the repair service is to have good high-class men out on the job. After all, it's not the name of the repair company that the customer cares about, but it's the high-class work done by the good repairman you send out. Then I find that no matter how many cards I leave on a job the customer will misplace them so as to have difficulty in reaching me in future. I've made up my mind not only to leave a card in the set but also to paste a label under the receiver cover, if possible."

Demonstrating Equipment

I AM ENCLOSING a snap shot of a baffle arrangement I am using in conjunction with an S-M 720 screen-grid six and a phonograph pick-up for demonstrating purposes. An awkward object, but a delight to listen to! I find good demonstrating equipment the best possible sort of publicity and advertising."

H. WILSON, Jamestown, N. Y.

D. C. Installations

HOWARD T. CERVANTES, service manager for Haynes Griffin, New York City, comments interestingly on d.c. installations.

"During the past few years we have installed a great many sets using d.c. A- and B-power units without much success. This was unquestionably due to the poor design of this d.c. equipment. The choke coils and B-power units are, in a great many cases, too small, and in nearly every case there is insufficient bypassing. This, I believe, contributed largely to the resultant poor success.

"For example, it is impossible to substitute a d.c. B-power unit for 90 volts of B battery and get the same results. Our most recent experience with a device of this kind was the Ward Leonard d.c. A, B, C eliminator with which you are probably familiar. This is probably the best outfit that has been developed for this purpose, although the Abox condenser is quite a nuisance, requiring refilling and seemingly not maintaining its capacity for any great period. This change in capacity caused a change in load, either decreasing or increasing the output.

In general, these d.c. outfits have been anything but satisfactory. As you are probably aware, the greater part of our clientele is located in the d.c. district and this season we have had very good success with the d.c. sets that were put on the market last fall. We have had very few complaints of poor quality with these receivers. The better types are using either push-pull or parallel audio systems, and some of the higher priced models employing the dynamic loud speaker are comparable in every way with their corresponding models in a.c.

"I would say that our greatest problem in the installation of these sets has been from line interference. We find that in the majority of installations it is necessary for us to erect an antenna having sufficient proportions to give a pick-up great enough to get good strong signals that will ride over and above the line noises. We find it next to impossible to get good results with an indoor antenna. With elevators, motors, relays, refrigerators, and other such devices, the average apartment house in New York City is a veritable noise factory.

"In some cases we have attempted to clear up this noise by the use of a so-called noise filter at the set, without any success whatever. The only place to tackle this is at the source. Most of the filters on the market are good for small motors and refrigerators but we haven't found anything to eliminate other noises except the erection of a good long antenna."



This picture shows the baffle arrangement which Mr. Wilson uses for demonstrating purposes.



H. Wilson, of Jamestown, N. Y., believes in using high-grade demonstrating equipment.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., required by the Act of Congress of August 24, 1912, of RADIO BROADCAST, published monthly at Garden City, New York for April 1, 1929. State of New York, County of Nassau.

Before me, a Notary Public in and for the State and County aforesaid, personally appeared John J. Hessian, who having been duly sworn according to law, deposes and says that he is the treasurer of Doubleday, Doran & Co., Inc., owners of Radio Broadcast and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: *Publisher*, Doubleday, Doran & Co., Inc., Garden City, N. Y.; *Editor*, Willis Kingsley Wing, Garden City, N. Y.; *Business Managers*, Doubleday, Doran & Co., Inc., Garden City, N. Y.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent. or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.) F. N. Doubleday, Garden City, N. Y.; Nelson Doubleday, Garden City, N. Y.; S. A. Everitt, Garden City, N. Y.; Russell Doubleday, Garden City, N. Y.; George H. Doran, 244 Madison Avenue, N. Y. C.; George H. Doran, Trustee for Mary Noble Doran, 244 Madison Ave., N. Y. C.; John J. Hessian, Garden City, N. Y.; Dorothy D. Babcock, Oyster Bay, N. Y.; Alice De Graff, Oyster Bay, N. Y.; Florence Van Wyck Doubleday, Oyster Bay, N. Y.; F. N. Doubleday or Russell Doubleday, Trustee for Florence Doubleday, Garden City, N. Y.; Janet Doubleday, Glen Cove, N. Y.; W. Herbert Eaton, Garden City, N. Y.; S. A. Everitt or John J. Hessian, Trustee for Josephine Everitt, Garden City, N. Y.; William J. Neal, Garden City, N. Y.; Daniel W. Nye, Garden City, N. Y.; E. French Strother, Garden City, N. Y.; Henry L. Jones, 244 Madison Ave., N. Y. C.; Sanford G. Etherington, 50 East 42nd St., N. Y. C.; Stanley Rinehart, Jr., 1192 Park Ave., N. Y. C.; Donald Macdonald, Garden City, N. Y.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent. or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) NONE.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is ..... (This information is required from daily publications only.)

(*Signed*)

DOUBLEDAY, DORAN & COMPANY, INC.
By John J. Hessian, *Treasurer*.

Sworn to and subscribed before me this 4th day of March, 1929.

[SEAL.] (*Signed*) Frank O'Sullivan
Notary Public Queens County No. 1501
Certificate filed in Nassau County
Term expires March 30, 1930

3 new tubes from the De Forest laboratories



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AUDION 424
The 2½ Volt A. C. Humless Screen-Grid Detector-Amplifier.



AUDION 427
The Humless A. C. Heater Type Detector-Amplifier.



AUDION 445
The 2½ Volt A. C. Power Tube.

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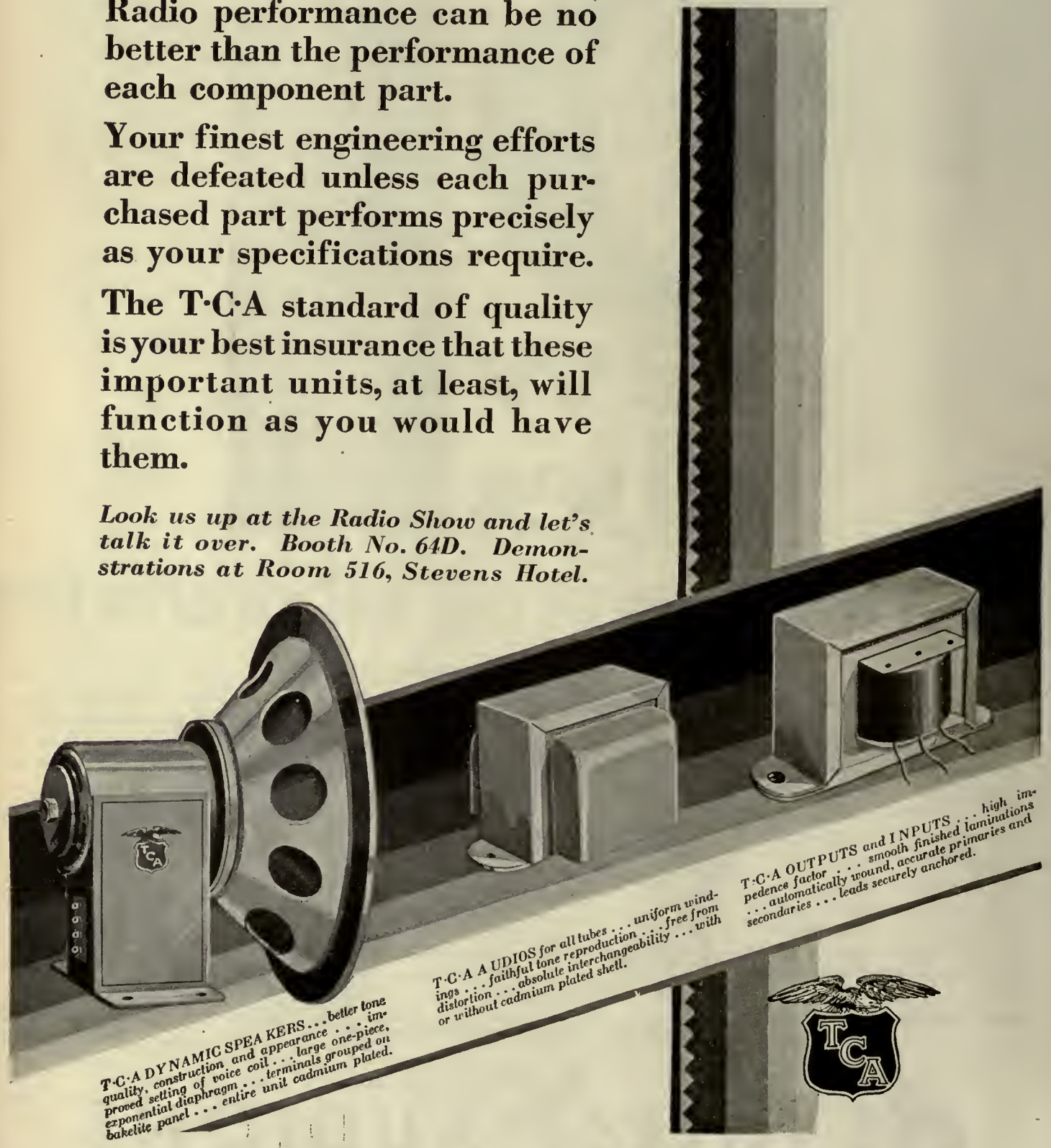
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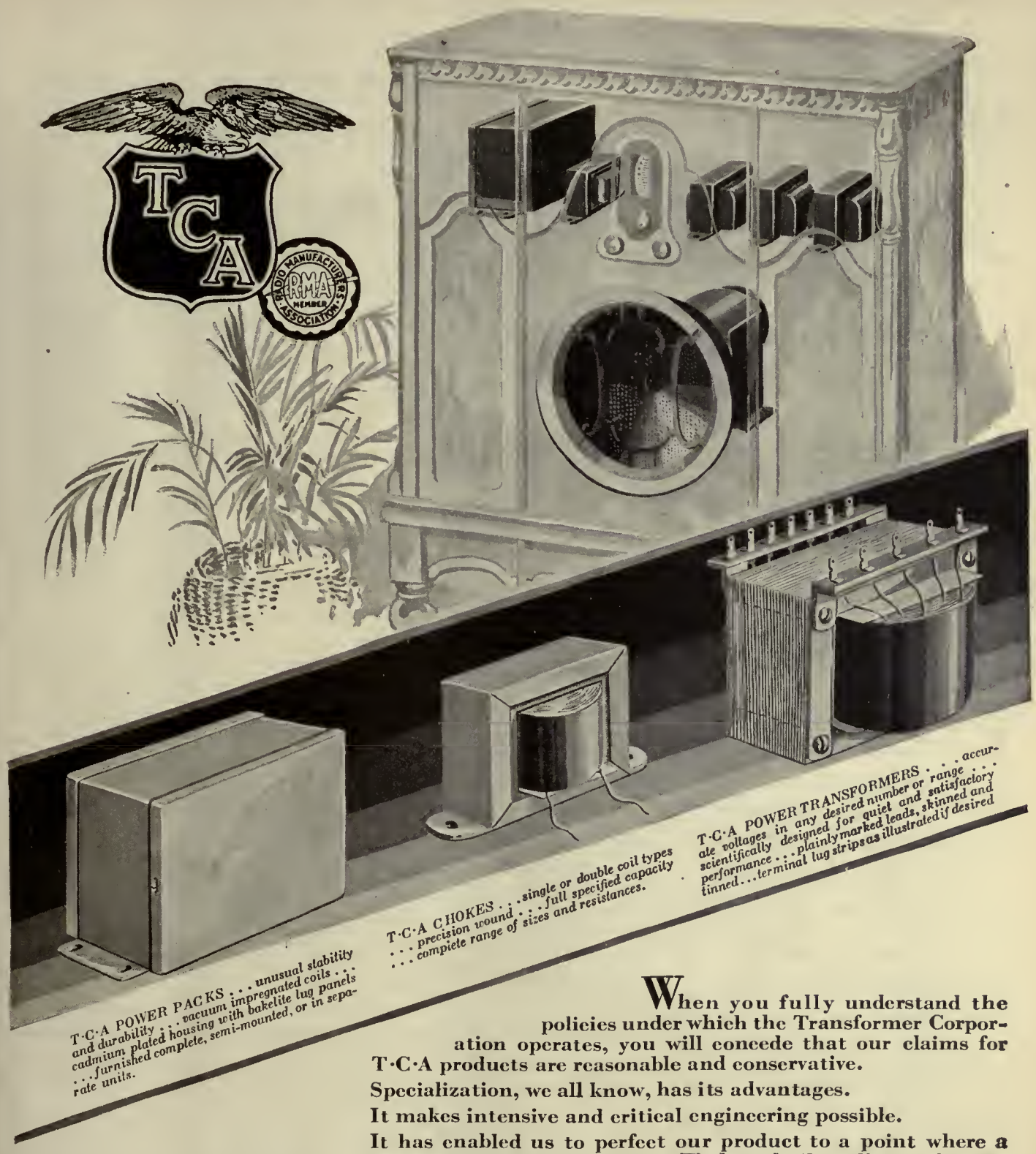
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Your finest engineering efforts are defeated unless each purchased part performs precisely as your specifications require.

The T·C·A standard of quality is your best insurance that these important units, at least, will function as you would have them.

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T·C·A CHOKES . . . single or double coil types . . . precision wound . . . full specified capacity . . . complete range of sizes and resistances.

T·C·A POWER TRANSFORMERS . . . accurate voltages in any desired number or range . . . scientifically designed for quiet and satisfactory performance . . . plainly marked leads, skinned and tinned . . . terminal lug strips as illustrated if desired

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It has enabled us to perfect our product to a point where a large demand has developed. We have built millions of units.

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And the same precision through controlled quantity production that made T·C·A transformers and power packs standard in the country's finest sets, is securing a quality in T·C·A Dynamics that is receiving quick recognition. They are a real contribution to the industry.

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The *Radio Broadcast* LABORATORY INFORMATION SHEETS

By HOWARD E. RHODES

THE aim of the RADIO BROADCAST Laboratory Information Sheets is to present, in a convenient form, concise and accurate information in the field of radio and closely allied sciences. It is not the purpose of the Sheets to include only new information, but to present practical data, whether new or old, that may be of value to the experimenter, engineer, or serviceman. In order to make the Sheets easier to refer to, they are arranged so that they may be cut from the magazine and preserved, either in a blank book or on 4″ x 6″ filing cards. The cards should be arranged in numerical order.

Since they began, in June, 1926, the popularity of the Information Sheets has increased so greatly that it has been decided to reprint the first one hundred and ninety of them (June, 1926-May, 1928) in a single substantially bound volume. This volume, *Radio Broadcast's Data Sheets*, may now be bought on the newsstands, or from the Circulation Department, Doubleday, Doran & Company, Inc., Garden City, New York, for $1.00. Inside each volume is a credit coupon which is worth $1.00 toward the subscription price of this magazine. In other words, a year's subscription to RADIO BROADCAST accompanied by this $1.00 credit coupon, gives you RADIO BROADCAST for one year for $3.00 instead of the usual subscription price of $4.00.

—THE EDITOR.

No. 283 RADIO BROADCAST Laboratory Information Sheet **June, 1929**

Hum-Voltage Characteristics

(226-AND 227-TYPE TUBES)

IT IS becoming increasingly common to find that most recent models of various well-known receivers use 227-type tubes in all the sockets rather than only in the detector socket with 226-type tubes in the r.f. stages and in the first a.f. stage. To explain this trend in receiver design the statement is generally made that 227-type tubes produce less hum than 226-type tubes. This is true—but it isn't an explanation. Why the 227 is a better tube is indicated by the curves on "Laboratory Sheet" No. 284 taken from the *Cunningham Tube Data Book*.

Curve A is for a 226-type tube and shows the relation between the hum voltage in the plate circuit of one of these tubes as a function of the plate current. The minimum hum voltage indicated by this curve is about that obtained from a 226-type tube under normal conditions. If, however, the plate voltage increases or decreases somewhat there is a rapid increase in the amount of hum. If the plate potential were 90 volts and the bias about 6 volts minimum hum would be obtained, but a 10- or 15-volt decrease in plate voltage would double the hum output.

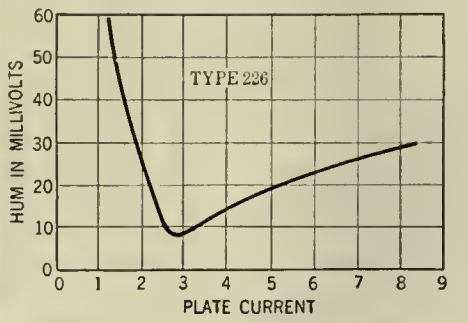
Curve B shows a comparison between the 227- and 226-type tubes with reference to hum. This curve shows hum output as a function of the accuracy of the center-tapped resistor connected across the tube's filament. It should be noted that the 227-type tube is affected only slightly by an unbalance of the center-tapped resistor whereas the 266-type tube necessitates the use of a very accurate center-tapped resistor. Specifically, the curve shows that if the resistor is unbalanced ten per cent. the hum voltage from a 227-type tube is increased very slightly. On the other hand, a ten per cent. unbalance in the resistor across the 226-type tube causes the hum voltage to increase from a minimum of 10 millivolts to about 600 millivolts!

The rather recent improvements in radio receivers—in loud speakers particularly—has made it especially important that everything possible be done to keep the hum output at the lowest possible level. The hum is not only annoying, as of itself, but it also has an apparent effect on the fidelity. When stimulated by a tone such as a hum, it is difficult for the ear to hear other tones of the same or nearly the same frequency and so we get an apparent reduction in low-frequency response. This technically is known as the "masking effect" of one tone on another.

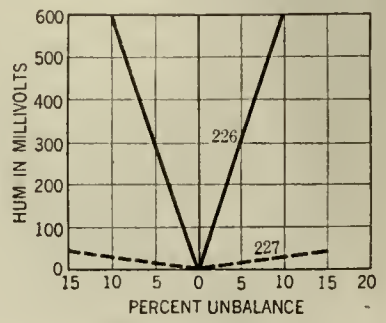
No. 284 RADIO BROADCAST Laboratory Information Sheet **June, 1929**

Hum-Voltage Characteristics

(226-AND 227-TYPE TUBES)



(A)



(B)

PAM Breaks Another Record

All Chicago records for 100% leasing broken by PAM-equipped apartment



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An apartment in the Lake Lane

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DESIGN—INSTALLATION—SERVICE
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ESTIMATES FURNISHED
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February 5, 1929.

Samson Electric Company,
Canton, Massachusetts.

Attention of Mr. R. W. Cotton, Sales Mgr.

Gentlemen:

Enclosed are a few photographs of the radio system which we installed at the new Lake Lane Apartment Hotel at 6214 Winthrop Avenue, here in Chicago, for which we had you build the special power amplifiers.

Everyone who listens to this installation marvels at the perfect tone quality. The reproduction in every apartment is equal to that of a latest model $300 receiving set. What greater tribute can bs paid to the quality of your Samson Amplifiers?

Combined with this tone quality is power. For instance, a few days ago in mid-afternoon we tuned in WLW, Cincinnati, through our barrage of local broadcasters and furnished this program to all the rooms. We are also proud to have completely eliminated cross-talk, usually found on installations with a choice of programs.

Radio was featured in advertising the Laks Lane Apartments, and the speed with which the Hotel was 100% leased, is without precedent.

Thanking you for your co-operation, and with all good wishes, I am

Yours very truly,
RADIO CONTRACTORS
Roy Baumann

RB. AE

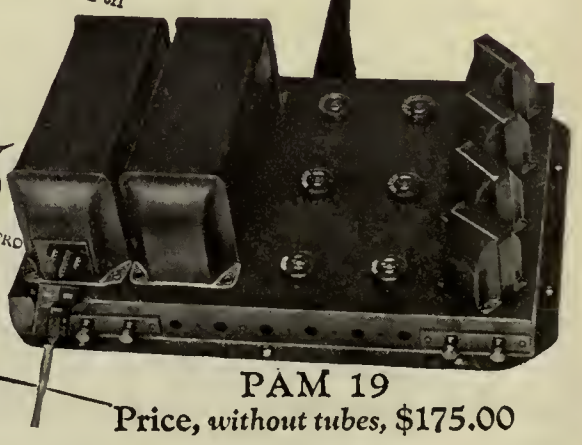
RADIO SERVICE TO EVERY ROOM THRU MASTER CONTROL SET—CHOICE OF PRO
ALSO PUBLIC ADDRESS SYSTEMS

Samson Electric Co.
MEMBER R.M.A.

MANUFACTURERS SINCE 1882

Main Office:
CANTON, MASSACHUSETTS

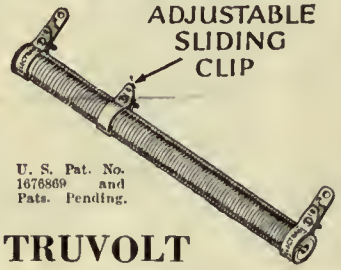
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CANTON & WATERTOWN



PAM 19
Price, *without tubes*, $175.00

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Technical data and fine descriptions may help,—but in the final analysis, nothing counts like—PERFORMANCE!—*And you can rely on Electrad for that.*



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Nothing better for Eliminator or Power-Pack construction. Distinctive design that insures accurate values, cool, safe operation and ENDURANCE that cuts down service and replacement expense. The sliding clip, an exclusive Electrad feature, provides easy, convenient variability. 22 stock sizes. Also Variable Truvolts with same features.



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5-Watt Volume Control

You no longer need compromise on a volume control. You can now plan to use any reasonably high voltage and depend on Electrad's new 5-watt volume control to handle it perfectly without strain. A new principle throughout—smooth as velvet—*and with longer life than you'll ever demand of it.*

Can be made with a varinble or tapered curve with practically nny desired rating.

Sample and laboratory graphs to any established manufacturer. Test it in your own way.

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175 Varick St., New York, N. Y.

Please send me data and sample of —Truvolt Resistance—Super-TONATROL.

Manufacturer.....

Address.....

City.....

State.....

ELECTRAD INC.

No. 285 RADIO BROADCAST Laboratory Information Sheet **June, 1929**

Frequency Vs. Capacity and Inductance

IN "LABORATORY INFORMATION SHEET" No. 286 are given a group of curves indicating what capacity is necessary to tune a circuit to a given frequency when using a coil of known inductance. The curves are applicable to broadcast frequencies and the capacities cover the range of sizes ordinarily used in such receivers.

The curves were calculated by substituting in the formula.

$$f = \frac{159,200}{\sqrt{LC}}$$

where f = frequency in cycles per second
C = capacity in microfarads
L = inductance in microhenries

The curves were calculated for various frequencies between 500 and 1500 kc. A few examples will indicate quite clearly how the curves are used.

Example. What size condenser is necessary to tune to 600-kilocycles with a 200-microhenry coil? To determine this we locate the vertical line corresponding to 200 microhenries and follow it to the 600-kilocycle line and it is found that this point corresponds to 0.00035 mfd. which is the capacity necessary to tune the coils to 500 meters.

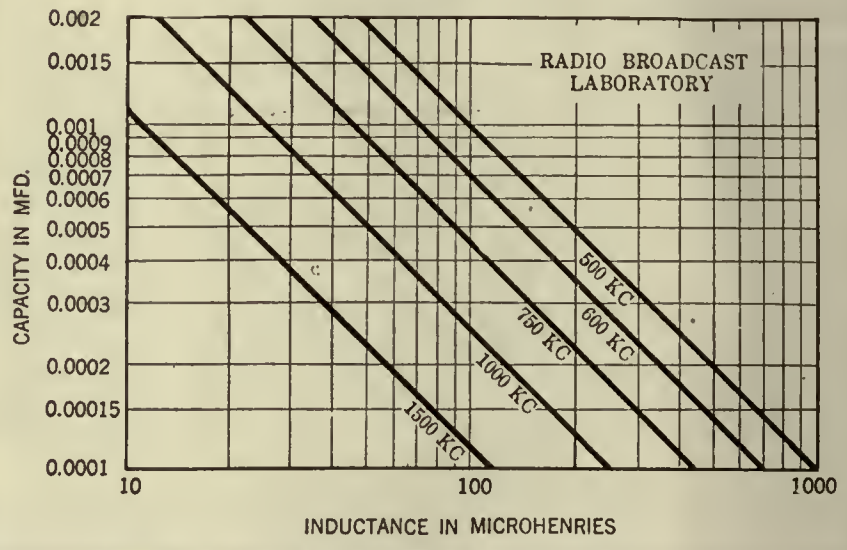
Example. To what frequency will a circuit tune if it consists of a 250-microhenry coil and a 0.0004-mfd. condenser? The unknown frequency in this case is determined by finding the intersection of the vertical line corresponding to 250 microhenries and the horizontal line corresponding to 0.0004 mfd. They intersect at the line corresponding to 500 kilocycles which is the frequency to which they would tune.

Example. How much inductance is required in parallel with a 0.0003-mfd. condenser to tune to 1500 kilocycles? Determine the intersection of the horizontal line corresponding to 0.0003 mfd. with the transverse line corresponding to 1500 kilocycles. The intersection is found to fall on the vertical line corresponding to 38 microhenries which is the required value of the coil's inductance.

If it is desired to make calculations of inductance, capacity, or frequency for values above or below the broadcast bands, the formula given at the beginning of the sheet may be used. It is simply necessary to substitute the known quantities and solve for the unknown.

No. 286 RADIO BROADCAST Laboratory Information Sheet **June, 1929**

Frequency Vs. Capacity and Inductance



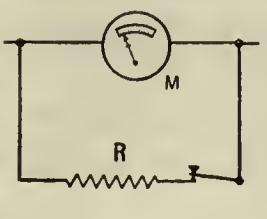
No. 287 RADIO BROADCAST Laboratory Information Sheet **June, 1929**

Protecting Meters

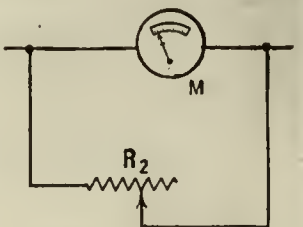
SEVERAL READERS have written us and requested suggestions on how to protect a milliammeter in a set-tester or tube-tester from damage in case there is a defect in the circuit of the device being tested which would permit sufficient current to flow through the meter to damage it.

The simplest way of protecting the meter is by the use of the arrangement indicated in sketch A on this sheet. M is the meter to be protected and it is protected by the shunt circuit consisting of R and the switch S. The switch, S, is the type which is usually used as a voltmeter switch; it normally remains in a closed position and must be held in the open position by hand. The resistance, R, should have a value such that, with the switch closed and maximum rated current of the meter flowing through the circuit, the meter gives a very small deflection. For example, suppose that the meter had a range of 10 milliamperes. The procedure would be to pass 10 mA. through the meter so that the meter read a maximum and then to place across the meter a resistance such that the meter deflection decreased to, say, 0.5 mA. Now when we use the instrument in which the meter is located we first note the reading of the meter with the switch closed (its normal position) and if the meter reads more than 0.5 mA. we will know that excessive current is flowing through the circuit and the meter will be overloaded if the switch, S, is opened. If the meter reads less than 0.5 mA. it will be safe to open the switch.

Another good method of protecting a meter is by the circuit arrangement in B. In this sketch R_2 is a rheostat with a resistance of about 10 ohms. The procedure here is to start with the arm at the right and then to move gradually the arm to the left end. If as this end is approached the meter needle goes off scale it is an indication that current in excess of what the meter can read is flowing through the circuit.



(A)



(B)

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RADIO HANDBOOK
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Director Radio Institute of America

and CHARLES E. DREW
Instructor in Radio and in charge of Electrical Division, Radio Institute of America

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Establish a Brand, New Standard
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Power Tone



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From rasping, indecipherable noise to soft, human reality. Radio critics took a new lease on life; cynics who scoffed at radio became fans overnight; and a few set manufacturers, who were first to grasp the significance of the new Volume Tone standard, became leaders in their industry.

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The Finest Type of Power Amplifier
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No. 994—Power Amplifier Transformer	$12.00
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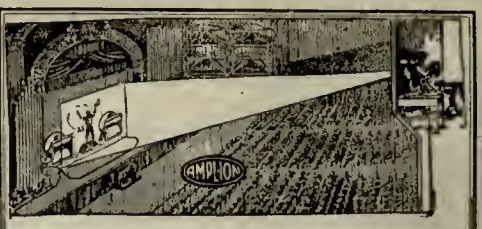
CENTRALAB RADIOHMS
In following resistances: 0-2,000 ohms, 0-50,000 ohms, 0-100,000 ohms, 0-200,000 ohms, 0-500,000 ohms. List price...**$2.00**

The following features distinguish *CENTRALAB* variable resistances of the Graphite Disc type:

Rocking Disc Contact — Noiseless, smooth and easy adjustment
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Complete details and comparative data, showing the results obtained when using these condensers to eliminate hum, will be furnished on request.

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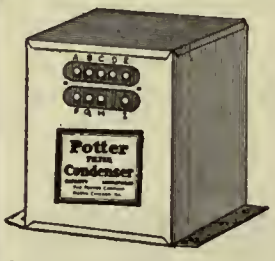
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North Chicago, Illinois
A National Organization at Your Service

Jenkins & Adair

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Type B (Calibrated)



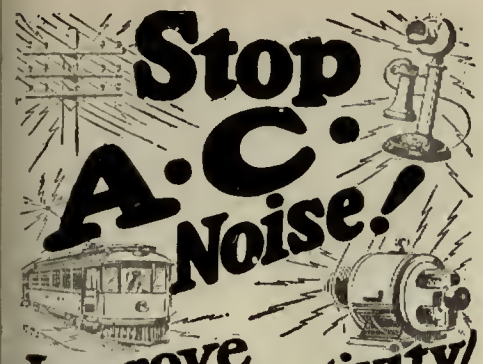
For Broadcasting, Electrical Recording, and Power Speaker Systems

The Type B Level Indicator Panel is designed for direct reading of the voice level on any 500-ohm telephone circuit, the range being from minus 10 TU to plus 20 TU, in steps of 2 TU each. The parts consist of an accurately built input transformer, a specially designed potentiometer, a filter retard and condenser, and direct current galvanometer calibrated for this work.

The use of this panel is essential wherever a specific level must be maintained. The calibration is highly accurate, and cannot alter while the tube constants remain normal. The potentiometer is built up of nichrome wire units, held to an accuracy of 1/10 of 1%. The panel is extremely simple in operation, is direct reading in TU's, and minimizes the change of load on the measured circuit when the level settings are changed. This last feature is a great improvement over present types.

The dimensions of this panel are 19 x 7½ in. It is of 5/16 in. black sanded bakelite and weighs, complete, 18 lbs. It operates on 12 volt A battery and 135 volts B battery, and requires a 102E tube (not furnished by us). The parts of this panel are NOT sold separately. Bulletin 8 gives a more complete description and will be mailed on request. The net price in the United States and Canada is $250.00 f. o. b. Chicago.

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Engineers
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A quality replacement audio transformer for the service man. Possesses the same high degree of performance which characterizes all Thordarson audio units. Provides highest amplification consistent with quality reproduction.

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[*Engineering Facts Have a Utility Significance to the Broadcast Listener*]

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Impress Neat, Clean Letters into your Bases



HAND OPERATED
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Demand this test of the tubes you buy and make it on the tubes you sell.

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In short the Clarostat line is to the radio service man what the first aid kit is to the doctor. Be prepared for all emergencies: include Clarostats in your repair kit!

Write for literature describing the complete line of Clarostats and how the various types are applied to service problems. And if you have any special resistance problems, do not hesitate to call upon our engineering staff for co-operation.

CLAROSTAT MFG. CO., Inc.
Mem. R.M.A. *Specialists in Radio Aids*
284-7 N. 6th St.
Brooklyn, N. Y.

Whatever You're Building...

from a Crystal Set . . to the 17 tube "Hoofus-Doofus"

it'll be that much better for using Polymet Products

and that goes for the man who builds one set for his family or the manufacturer who turns out thousands every day. It all comes down to this—"You can't make a silk purse out of a sow's ear". In the same way, a good radio, to be and to continue to be a good radio, must start with good parts; e. g.—Polymet Products.

We know that you'll find them well-made, uniform, carefully tested, accurately rated and thoroughly dependable, because that's the only way they leave our plants.

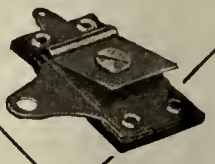
Filter Blocks, By-Pass Condensers . . . Bakelite Mica Condensers . . . Resistances

POLYMET MANUFACTURING CORPORATION

837 E. 134th St.
New York City

"Visit our booth" No. 76, at the R. M. A. Show."

POLYMET PRODUCTS



The Ideal Condenser *for Equalizing*

For balancing the sections of a multiple condenser—for neutralizing oscillations in radio-frequency amplifiers—for antenna coupling to improve selectivity. Ruggedly built with Bakelite base mount, mica dielectric and phosphor bronze spring plate, safe—cannot short. Compact—fits in small spaces. Lug for direct attachment. Two sizes:—35 mmfd. and 70 mmfd.

Write Dept. R B 6 for descriptive folder of Hammarlund Products.

HAMMARLUND MFG. CO.
424-438 W. 33rd St., New York

For Better Radio
Hammarlund
PRECISION
PRODUCTS



$65

NEW GEMBOX AC
ELECTRIC 7 TUBE

GEMBOX

The GEMBOX has three stages of radio frequency amplification, detector, 2 audio with 171-A power tube in last stage and a rectifying tube—7 tubes in all. Shielded—illuminated dial—power output tube—Mershon condenser in power supply—AC electric operation. All modern, up-to-minute quicksale features.

Installed with the Dynacone in the—

GEMCHEST

You have the smartest radio set on the market, and at a price that makes quick sales. The GEMCHEST design is adapted from the Chinese Chippendale—three cxquisite color combinations—Mandarin red with bronze gold hinges and fittings—Nanking green with rose gold—Manchu black with white gold. Stylish—new—individual—perfectly fitting into modern home interiors.

The SHOWCHEST is the same but is equipped with the 8-tube SHOWBOX receiver selling at $109.

Both the GEMCHEST and SHOW-CHEST come equipped with the Improved Dynacone.

The Crosley JEWELBOX selling at $105 is another wonderful value.

The Crosley Radio Corporation
Dept. 20 Cincinnati, Ohio
Powel Crosley, Jr., President
Owners of WLW—The nation's station
Montana, Wyoming, Colorado, New Mexico, and West prices slightly higher.
Prices quoted do not include tubes

The DYNACONE is a different type of power speaker that takes its field current from the set which operates it. This employment of thc armature principle of actuation has improved reproduction to a marked degree. Each tone is true in its relation to every other tone of the audible scale.



$25

IMPROVED
DYNACONE

THE
SMART GEMCHEST



$94

THE·WORLD'S THREE·GREAT RADIO·VALUES

CROSLEY RADIO

A Radiotron for every purpose

RADIOTRON UX-201-A
Detector Amplifier
RADIOTRON UV-199
Detector Amplifier
RADIOTRON UX-199
Detector Amplifier
RADIOTRON WD-11
Detector Amplifier
RADIOTRON WX-12
Detector Amplifier
RADIOTRON UX-200-A
Detector Only
RADIOTRON UX-120
Power Amplifier
RADIOTRON UX-222
Screen Grid Radio Frequency Amplifier
RADIOTRON UX-112-A
Power Amplifier
RADIOTRON UX-171-A
Power Amplifier
RADIOTRON UX-210
Power Amplifier Oscillator
RADIOTRON UX-240
Detector Amplifier for Resistance-coupled Amplification
RADIOTRON UX-245
Power Amplifier
RADIOTRON UX-250
Power Amplifier
RADIOTRON UX-226
Amplifier (A. C. Filament)
RADIOTRON UY-227
Detector Amplifier (A. C. Heater)
RADIOTRON UX-280
Full-Wave Rectifier
RADIOTRON UX-281
Half-Wave Rectifier
RADIOTRON UX-874
Voltage Regulator Tube
RADIOTRON UV-878
Ballast Tube
RADIOTRON UV-886
Ballast Tube

The standard by which other vacuum tubes are rated

RCA

Look for this mark on every Radiotron



RAY H. MANSON
Chief Engineer, Stromberg Carlson Telephone Mfg. Co., says:



"Experiment with every type of vacuum tube has convinced us of the superiority of RCA Radiotrons. We not only use them for testing the performance of Stromberg Carlson instruments, but recommend them for use in all of our sets."

Ray H. Manson

When you purchase a quality receiving set be sure it is equipped with genuine RCA Radiotrons. If you will replace all of the tubes in your set with RCA Radiotrons once a year at least, you will get the finest reception the instrument affords.

RCA RADIOTRON

RADIO CORPORATION OF AMERICA • New York Chicago • Atlanta • Dallas San Francisco

The national magazine advertisement reproduced at the left is one of the 1929 Radiotron series, each of which carries the signature of a leading radio manufacturer.

"Never out of stock on RCA Radiotrons—we carry the complete line." This is the kind of dealer advertising that builds tube business, brings in steady profits, and gives the radio dealer a reputation for dependability. Radio customers choose the stores that are known to carry the full line of RCA Radiotrons—all the time.



Superior resources of research and manufacturing guarantee to RCA Radiotrons the finest possible quality in vacuum tubes. They are the standard of the industry—and so accepted by both the trade and the public.

RADIO CORPORATION OF AMERICA • NEW YORK • CHICAGO ATLANTA • DALLAS • SAN FRANCISCO

RCA RADIOTRON

RADIOTRONS ARE THE HEART OF YOUR RADIO SET

THE COUNTRY LIFE PRESS, GARDEN CITY, NEW YORK

JULY 1929

Desk

RADIO BROADCAST

UBLISHED FOR THE RADIO INDUSTRY



PECIAL FEATURES IN THIS ISSU

The A. C. vs. the Battery Set—A Sales Comparison

New Ideas on Retailing Radio

How One Dealer Solved the Trade-In Problem

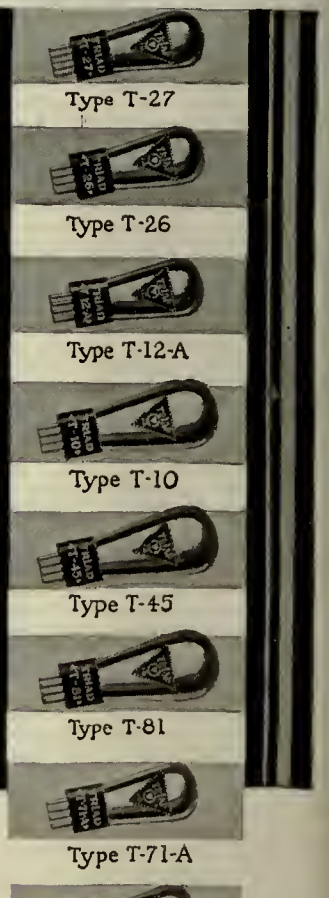
ner Features: The 245-Type Tube · Measuring Loud Speakers · Engineering Descriptions of
sley, Fada, and Silver Sets · The Future of the A.C. Screen-Grid Tube · The Experimenter's Armchair.

THIRTY FIVE CENTS

UBLEDAY, DORAN & CO., INC. ◆ GARDEN CITY, NEW YORK

TRIAD





INSTANT... *nation-wide popularity ....won on quality alone!*

THE demand for TRĪAD is sweeping along to tremendous proportions—and TRĪAD quality has done it! Quality that eliminates all guesswork from tube buying and selling; quality backed by an actual bonafide guarantee of six month's perfect service or a satisfactory adjustment. Every dealer *knows* what that means —*reduced service calls,* easier and quicker sales, greater profits and absolute satisfaction for him and his customer. Here is the greatest achievement in radio tube history—accomplished by a group of nationally-known pioneers in the industry. The TRĪAD Line is complete, including even Television and Photo-Electric Cells. Don't delay — send in your stock order *now.* TRĪAD customers won't accept substitutes.

Call your jobber or write us direct for complete Triad dealer information

TRĪAD MANUFACTURING CO., INC.

Triad Building
Blackstone, Middle and Fountain Sts.
Pawtucket, R. I.



"Ask for the tube in the black and yellow triangular box."



RADIO BROADCAST. July, 1929. Published monthly. Vol. XV, No. 3. Published at Garden City, N. Y. Subscription price $4.00 a year. Entered at the post office at Garden City, N. Y., as second class mail matter. Doubleday, Doran & Company, Inc., Garden City, N. Y.

▶▶▶

A MARVELOUS NEW IMPROVEMENT IN RADIO TUBES

EVEREADY RAYTHEON TUBES GIVE A SUPERLATIVE DEGREE OF PERFORMANCE

INSTALL a set of new Eveready Raytheon Tubes in your radio receiver and note the unusually clear reception, greater volume and sensitivity. Quick heating and quick acting.

Behind all this is a revolutionary improvement in construction. The elements in each Eveready Raytheon Tube are firmly supported by *four strong pillars,* cross-anchored top and bottom. They are accurately spaced within one-thousandth of an inch when they are made. And so rigidly braced that the spacing cannot change with the knocks and jolts of shipment and handling.

In tubes of the 280 type and the 224 screen-grid type, which have heavier elements, this rugged Eveready Raytheon *4-Pillar construction* is of particular importance.

Only with Eveready Raytheon Tubes can you have this improved construction advantage. It is exclusive and patented. Eveready Raytheon Tubes come in every type, including tubes for television transmission and reception.

Eveready Raytheon Tubes are sold by dealers everywhere.

NATIONAL CARBON CO., INC.
New York, N. Y.
Unit of Union Carbide UCC *and Carbon Corporation*



Showing the exclusive patented Eveready Raytheon 4-Pillar *construction. Note the sturdy four-cornered glass stem through which the four heavy wire supports pass, and the rigid mica sheet at the top.*



Eveready Raytheon ER 224 *Screen Grid Tube. The* 4-Pillar *construction permanently holds the four heavy elements of this super-sensitive tube in the perfect relation which assures laboratory performance.*

EVEREADY RAYTHEON

SPECIAL TEST EQUIPMENT



for use in the service laboratory is soon to be announced. This will include an oscillator for measuring the over-all response characteristics of a receiver for the entire broadcast band. It will be inexpensive, compact, and of General Radio quality.

Write for Bulletin G-1

GENERAL RADIO COMPANY

30 State Street
Cambridge, Massachusetts

274 Brannan Street
San Francisco, California



MODEL 489 D. C. PORTABLE THREE-RANGE VOLTMETER

750 - 250 - 10 Volts
1000 Ohms per Volt Resistance

A STURDY, miniature instrument, suitable for home or laboratory use—popular because of its small size and unusual electrical characteristics. A truly professional instrument, with all the niceties of design and construction which make a "Weston" so desirable.

Solid black bakelite case, convenient pin jacks, and test cables equipped with pin terminals for insertion in the jacks. Reasonably priced.

Weston Electrical Instrument Corp.
604 Frelinghuysen Ave., Newark, N. J.

WESTON RADIO INSTRUMENTS

WHY POLYMET-EQUIPPED RADIOS ARE WORTH MORE



Here are some of the advertisements we have been running in the Saturday Evening Post—interesting, instructive messages, that acquaint the non-technical public with the functions of the condensers and resistances we manufacture, and, at the same time, awaken a nation-wide consumer acceptance of, and preference for, sets equipped with well-known Polymet Products. That's why these sets are worth more to radio manufacturer, jobber and dealer.

POLYMET MFG. CORPORATION
837 East 134th St. New York City

POLYMET PRODUCTS



Jensen Patents allowed and pending. Licensed under Lektophone Patents

ANSWERING the demand of an INDUSTRY

the new Jensen CONCERT DYNAMIC

Peter L. Jensen has applied entirely new and original principles in the design of this new dynamic. The cone is 10 inches in diameter. The moving coil represents an innovation in design. The sensitivity is greater than that ever attained in any previous dynamic speaker, and the ability to reproduce enormous volume is exceeded only by the Jensen Auditorium Dynamic.

The Concert Dynamic definitely sets a new standard of excellence. For along with the musical reproduction of bass notes as low as 30 cycles, the higher frequencies are reproduced with extraordinary brilliance. In fact the entire musical scale is reproduced with a brilliance and firmness of quality never acquired before.

There is no need of a "side by side" comparison to appreciate the superiority of this new speaker. Wherever it is heard its performance is both startling and impressive.

Write for complete information and ask for a frequency response curve of this new speaker if you are interested. Ask also about the new Jensen Imperial, a beautiful cabinet equipped with either the Concert or Auditorium Unit.

NEW LOW PRICES

JENSEN CONCERT DYNAMIC
with 10 inch cone
D7AC, $35.00 D7DC, $27.50

JENSEN AUDITORIUM DYNAMIC
with 12 inch cone
DA5AC, $70.00 DA5, $55.00 DA4, $55.00

JENSEN PATENTS ALLOWED AND PENDING
LICENSED UNDER LEKTOPHONE PATENTS

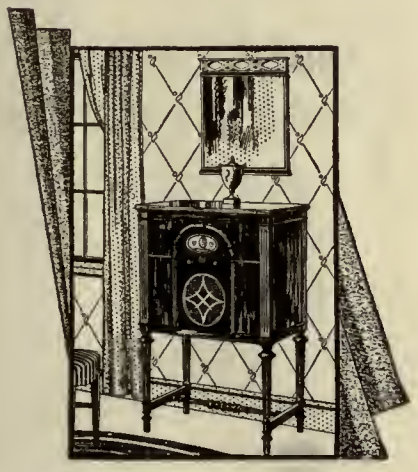
JENSEN RADIO MFG. CO.
6601 S. Laramie Ave., Chicago, Ill.
212 Ninth St., Oakland, Calif.

The Oldest Manufacturer of SCREEN-GRID Receivers Presents



SILVER RADIO

McMurdo Silver.. Designer and Builder of SCREEN-GRID RADIO Since 1927



—the direct descendant of those custom-built screen-grid radios of last season whose remarkable performance has been primarily responsible for the present sharp trend toward the screen-grid principle.

—Silver Radio is the only screen-grid receiver which has back of it 25,000 successful screen-grid sets, and nearly two years of screen-grid manufacturing experience.

—at the R.M.A. Show in Chicago, screen-grid receivers predominated. This proves our prediction that *"1929 will be a screen-grid year."*

—make it your business to HEAR Silver Radio. If you're a dealer, mail the coupon and we'll arrange it with your nearest distributor.

Silver Radio Features

No aerial, no loop, no installation bother. 8-tube, all-electric. 4 screen-grid tubes; two 245 power tubes in push-pull. Screen-grid power detector. Matched impedance dynamic speaker. Overtone switch for static reduction. Sheraton Lowboy, walnut finish as illustrated, **$160** *Less tubes*

Also sliding-door Highboy, $195
(Prices slightly higher west of the Rockies)

SM

Manufactured by

SILVER-MARSHALL, Inc.

6443 West 65th Street Chicago, Illinois, U. S. A.

SILVER-MARSHALL, Inc.
6443 West 65th Street, Chicago, U. S. A.
Please ask our nearest distributor to arrange for a demonstration of SILVER RADIO.

Firm Name .....

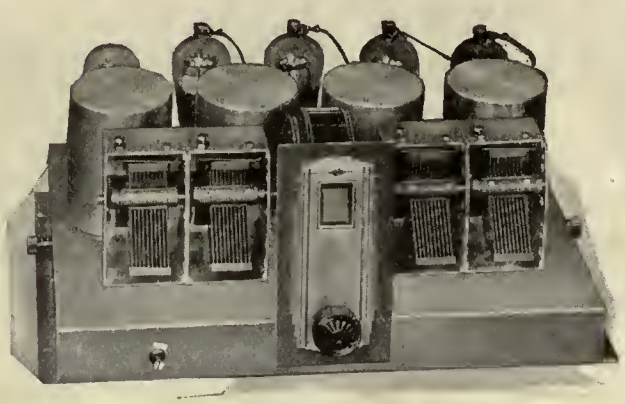
Address .....

.....

Individual .....

A Finer Screen-Grid Instrument

Browning & Millen Designed—NATIONAL Built



The NATIONAL VELVETONE AMPLIFIER-POWER SUPPLY is especially designed for use with the NATIONAL MB-29

The MB-29 with its 4 A. C. Screen-Grid Tubes and 227 detector, with its beautiful shielded aluminum chassis in frosted finish — with the Newest NATIONAL Weld-Built Condensers and the 1930 Model Velvet Vernier *Projector* Dial—offers the Large Scale Custom Set Builder, as well as the Radio owner and the Experimenter, a fine, engineered, R. F. Tuner of enormous gain and selectivity—ready for combination with power supply and audio—especially suited for consoles, and radio-phonograph combinations. Write for Bulletin RB-7, to-day.

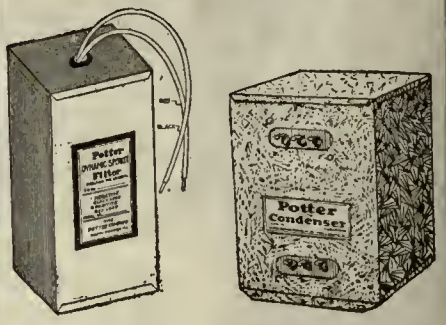
NATIONAL

SCREEN-GRID MB-29 TUNER

NATIONAL CO. INC., Malden, Mass.

Est. 1914

Potter Condensers



Potter Dynamic Speaker Filter . . $4.75

POTTER FILTER BLOCKS

T-2900	Condenser Block for the single 250 type tube amplifier.....	$20.00
T-2950	Condenser for the push-pull 250 type tube amplifier.....	$22.50
T-2098	Condenser Block for single 210 type tube amplifier.....	$20.00
T-280-171	Condenser Block for power pack with 280 type tube rectifier.	$18.00
SM-673	Condenser Block for Silver-Marshall power amplifier and power supply units....	$20.00
RR-245	Condenser Block for single and push-pull 245 type tube amplifier.	$19.75

The Potter Co.

North Chicago, Illinois

A National Organization at Your Service

A Good SUMMER SELLER!

CORWICO VULCAN

Lightning Arrester



List $1.00

The CORWICO VULCAN LIGHTNING ARRESTER not only protects a radio receiver against lightning but it also dissipates accumulated static charges. Corwico Vulcan is the best value lightning arrester on the market. It is big—it is colorful, an attractive dark green shade, and it is packed in an eye-catching, two-color box.

$100 GUARANTEE

Inclosed in every box is a guarantee to repair up to a cost of $100, any radio set protected by a CORWICO VULCAN LIGHTNING ARRESTER that is damaged by lightning. Stock this item now for quick sales and profits.

If Your Jobber Cannot Supply You, Order A Sample Direct.

CORNISH WIRE COMPANY

30 Church Street, New York City

Makers of Corwico BRAIDITE Hook-Up Wire

The HAMMARLUND R. F. CHOKE COIL Is Better Built

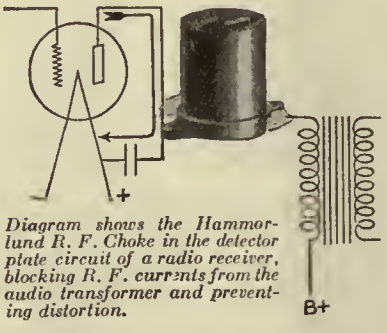


Diagram shows the Hammarlund R. F. Choke in the detector plate circuit of a radio receiver, blocking R. F. currents from the audio transformer and preventing distortion.

A specially developed method of winding and impregnating gives the Hammarlund R. F. Choke an extremely high impedance to all frequencies in the broadcast range. Having no pronounced natural period, its action is uniform throughout the broadcast frequencies.

Compact and completely shielded with a handsome Bakelite case. Current capacity, 60 milliamperes. Two sizes: 85 and 250 millihenries.

Write Dept. RB7 for special R. F. Choke data, showing important uses in modern receivers

HAMMARLUND MANUFACTURING CO.
424-438 W. 33rd St., New York, N. Y.

For Better Radio
Hammarlund
PRECISION
PRODUCTS

---

attention service men



A quality replacement audio transformer for the service man. Possesses the same high degree of performance which characterizes all Thordarson audio units. Provides highest amplification consistent with quality reproduction.

Unique Mounting Feature— The mounting bracket of this transformer is designed to fit all standard mountings without the necessity of drilling additional holes. May be mounted either on end or side or may be used as bracket to support sub-panel.

Remember: Thordarson radio transformers are Supreme in musical performance.

R-100 - - - List Price $2.25

THORDARSON ELECTRIC MFG. CO.
Transformer Specialists Since 1895
Huron, Kingsbury & Larrabee Sts., Chicago

THORDARSON

replacement audio transformer

SM

Is There No Limit To What an S-M Receiver Will Do?

Australia to New York On Six Tubes

MORE and more astounding are the records of long-distance reception with Silver-Marshall screen-grid receivers. First the S-M 710 (Sargent-Rayment Seven) made itself famous as the one set which, in California, could be relied on to bring in Japanese broadcasting stations in any kind of favorable conditions—and often when conditions were otherwise. Later, reports began to be published of reception across the Pacific with the S-M 720 Screen-Grid Six—using only three screen-grid r.f. stages instead of four. Then, in March, came the publication of verified reception in New York City, from 2BL at Sydney, with the 710.

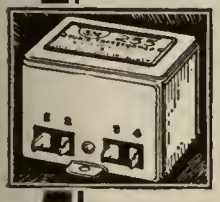
And now the Australia-to-New York record has been duplicated with the 720 Screen-Grid Six.

Not every one, perhaps, has the necessary skill to bring in stations from half way around the globe—but the hard-to-please listener, wherever he may be, soon finds that screen-grid tubes, combined with Silver-Marshall engineering, are the ultimate answer to every demand for superlative radio reception.



(Mr. White states this is his fourth reception from 4QG. Any one wishing to write him is requested to enclose a self-addressed envelope.)

Never-Equalled Tone Fidelity With S-M Audio Transformers



Equally startling records for faithful musical reproduction have been made this season by S-M Clough System audio transformers. These remarkable instruments, practically eliminating hysteretic distortion in all types of radio receivers, are now available in a full line of models. The tremendously popular 255 and 256 straight audio types cost only $3.60 NET, and correspondingly low net prices have been set on all other types, including push-pull and output transformers and chokes.

New List Prices (NET) on S-M Sets That Have Made History

S-M No.	Name	Scr.-Gr. Tubes	Wired Receiver	Component Parts Total
710	Sargent-Rayment Seven..	4	$113.40*	$78.84*
720	Screen-Grid Six.....	3	66.30*	44.79
720AC	Screen-Grid Six (A.C)...	3	70.20*	47.07
730	"Round-the-World" Four.	1	42.90*	31.71*
731	"Round-the-World" Adapter.....	1	30.00*	22.86*
740	"Coast-to-Coast" Four....	1	48.60*	30.96
740AC	"Coast-to-Coast" 4 (A.C.)	1	50.70*	32.97

*Price includes metal shielding cabinet.

Setbuilders who have taken advantage of the unique franchises granted by Silver-Marshall, Inc., to Authorized S-M Service Stations have found that the building of radio sets and amplifiers from S-M standard parts is a highly profitable as well as an interesting business. If you build professionally, and have not investigated the Service Station proposition, ask about it now. And in any case, do not miss the monthly S-M "RADIO-BUILDER"; every issue contains big news for setbuilders. Use the coupon.

SILVER-MARSHALL, Inc.

6403 West 65th St., Chicago, U. S. A.

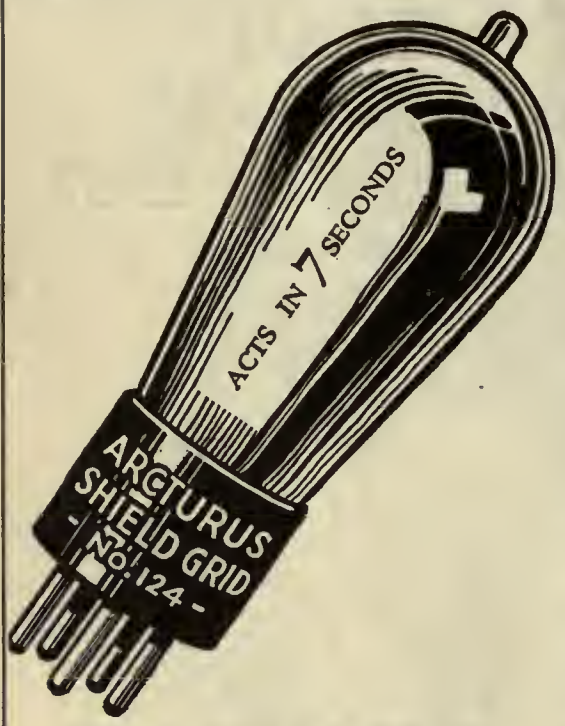
Silver-Marshall, Inc.
6403 W. 65th St., Chicago, U. S. A.

....Please send me, free, the new "NET-PRICE" S-M Catalog; also copy of the RADIOBUILDER.
For enclosed.....in stamps, send me the following:
.... 50c Next 12 issues of The Radiobuilder
.... $1.00 Next 25 issues of The Radiobuilder

S-M DATA SHEETS as follows, at 2c each:
....No. 1 .670B, 670ABC Reservoir Power Units
....No. 2. 685 Public Address Unipac
....No. 3. 730, 731, 732 "Round-the-World" Short Wave Sets
....No. 4. 223, 225, 226, 256, 251 Audio Transformers
....No 5 .720 Screen Grid Six Receiver
....No .6. 740 "Coast-to-Coast" Screen Grid Four
....No. 7 .675ABC High-Voltage Power Supply and 676 Dynamic Speaker Amplifier
....No. 8. Sargent-Rayment Seven
....No. 9. 678PD Phonograph Amplifier
....No. 10. 720AC All-Electric Screen-Grid Six.
....No. 12. 669 Power Unit (for 720AC)

Name.....

Address.....



The PIONEER
of the new
A-C Screen-Grid Tube

A YEAR AGO—the Arcturus A-C Screen-Grid Tube was placed with set manufacturers. TODAY—leading set manufacturers use this new Arcturus A-C Screen-Grid Tube as standard equipment.

Arcturus *pioneered* this latest A-C Radio Tube development and is now building into the No. 124 A-C Screen-Grid Tube *a full year's experience.* Arcturus Tubes act in 7 seconds, give clearer reception as hum is banished, and they hold the world's record for long life.

Insist on Arcturus *Blue* A-C Tubes in your A-C set. Your dealer has an Arcturus A-C Tube for every socket. Try them today—you'll be amazed at the vast improvement.

ARCTURUS RADIO TUBE CO.
220 ELIZABETH AVE. ~ NEWARK, N. J.

ARCTURUS
BLUE A-C LONG-LIFE TUBES

Jenkins & Adair

Level Indicator Panel
Type B (Calibrated)



For Broadcasting, Electrical Recording, and Power Speaker Systems

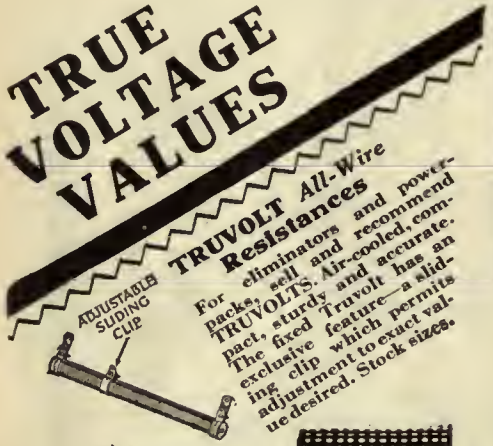
The Type B Level Indicator Panel is designed for direct reading of the voice level on any 500-ohm telephone circuit, the range being from minus 10 TU to plus 20 TU, in steps of 2 TU each. The parts consist of an accurately built input transformer, a specially designed potentiometer, a filter retard and condenser, and direct current galvanometer calibrated for this work.

The use of this panel is essential wherever a specific level must be maintained. The calibration is highly accurate, and cannot alter while the tube constants remain normal. The potentiometer is built up of nichrome wire units, held to an accuracy of 1/10 of 1%. The panel is extremely simple in operation, is direct reading in TU's, and minimizes the change of load on the measured circuit when the level settings are changed. This last feature is a great improvement over present types.

The dimensions of this panel are 19 x 7½ in. It is of 5/16 in. black sanded bakelite and weighs, complete, 18 lbs. It operates on 12 volt A battery and 135 volts B battery, and requires a 102E tube (not furnished by us). The parts of this panel are NOT sold separately. Bulletin 8 gives a more complete description and will be mailed on request. The net price in the United States and Canada is $250.00 f. o. b. Chicago.

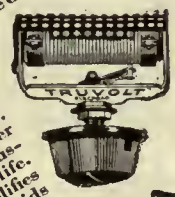
J. E. JENKINS & S. E. ADAIR
Engineers
1500 N. Dearborn Parkway
Chicago U. S. A.
Manufacturers of Recording Amplifiers

TRUE VOLTAGE VALUES



TRUVOLT All-Wire Resistances
For eliminators and power packs, sell and recommend TRUVOLTS. Air-cooled, compact, sturdy and accurate. The fixed Truvolt has an exclusive feature—a sliding clip which permits adjustment to exact value desired. Stock sizes.

U. S. Pat. 1578669 and Pats. Pend.



TRUVOLT Variables
Distinctive Truvolt construction, with a convenient knob for fine adjustment. Contact travels endwise over resistance wire, giving unusual smoothness and longer life. One hole mounting. Simplifies eliminator construction. Avoids complicated calculations. 22 stock sizes.

Electrad, Inc., Dept. R B 7,
175 Varick Street, New York, N. Y.
Please send TRUVOLT literature.
Name
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ELECTRAD INC.

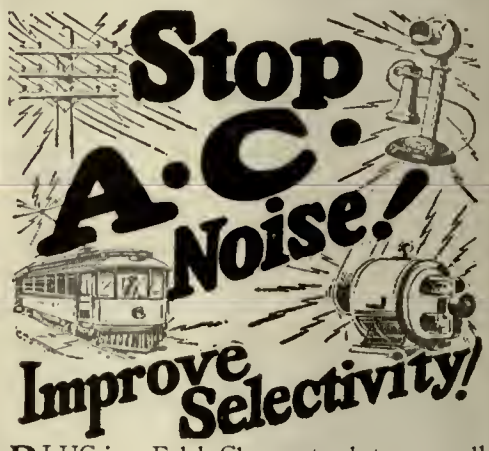
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Let's talk brass tacks on rheostats. You'll agree that the primary requisites in a rheostat are a character of design and a sturdiness of construction that will mean long life and thoroughly satisfactory service. Rheostats must be designed *right* and built *right.* Frost-Radio Rheostats are mechanically and electrically *right.* They are built with the highest grade resistance wire wound on die-cut threaded flexible strips of genuine Bakelite. The German silver contact arm and spring are specially designed to give maximum pressure with minimum wear and absolute smoothness of action. All exposed metal parts are nickel plated and buffed. Arrow pointer knob is genuine Bakelite.

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PLUG in a Falck Claroceptor between wall socket and radio set and eliminate "static" from motors, street cars, telephones and electrical appliances. This new improvement by a pioneer radio parts manufacturer grounds and thus blocks out line interference noise and radio frequency disturbances. *Also improves selectivity and distance.* Requires no changes in set. Measures just 3½ x 5½ x 2½ inches. Thousands now all over America use the Claroceptor for clearer A. C. reception. Get one right away—at radio parts dealers. Write for descriptive folder.

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PAM-5

PAM

PAM-25

Keeps Pace with the Best

PAMs kept thousands along the shore of Biscayne Bay in constant touch with every phase of the International Boat Race pictured above. The voice of the announcer was easily heard above the roar of the giant motors used by Gar Wood and Seagrave.

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Pictured above are two new PAMs, the PAM-5 which uses one 227, one 280 and two 112s, and is designed to work out of the detector tube of a radio set, a magnetic phonograph pickup, or microphone amplifier. Its output is such that it will feed any number of PAM-25s according to power output required for a particular installation. The PAM-25 uses two 281s and two 250s. When used in conjunction with a PAM-5, it has a power output of 14 watts. Multiples of this undistorted output can be had by the addition of each PAM-25.

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RADIO BROADCAST

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. . . *among other things*

THE TRADE SHOW is over. It is of no importance to discuss whether it was "biggest and best" but it was certainly the most business-like of any we have yet attended. The arrangements this year provided for exhibitions and demonstrations in three hotels and, although they are quite close together, we believe it was generally agreed that the arrangement was a mistake. It is hoped that next year a location and city can be chosen where it will be possible to have exhibitions and demonstrations under one roof. We noticed among the dealers present an air of seriousness, a business-like attitude that appeared to have been less apparent in previous years. It seemed to us that those of the selling profession who attended were more interested in the merits of the merchandise shown than in more superficial matters. Dealers appeared more interested in technical features of the various offerings than in discounts. The Show was excellently managed by Clayton Irwin, Jr. and responsibility for the smoothness of the whole affair can largely be laid at his door.

AS FOR TRENDS—that word, we fear is almost becoming a bromide—there were many. These we have summarized on another page. It is without doubt, a screen-grid year. The engineers have seized upon the a.c. screen-grid tube because of its great technical advantages; the merchandisers have seized on the tube as a fine wedge to developing a new public appeal. Consumers everywhere are asking, What is this screen-grid? What does it mean? Dealers must be prepared to answer these questions and in a compelling reply will lie many new set sales. Undoubted public interest has been aroused by the screen-grid tube and it is the dealer who bears the greatest burden of translation. If 1928 showed the rise of the console cabinet, the 1929 show brings the console to its zenith. Table models were literally snowed under. All in all, it looks like a big year for radio.

OUR AUGUST ISSUE will contain the new special section devoted to the tube industry, a second article by our research department on the figures on the radio business, continuing the one in this issue, and a number of especially interesting analyses of business methods of successful dealers. In our engineering section will appear a technical description of the new Stromberg-Carlson set, J. M. Stinchfield of Cunningham writes on detection, and we will present a technical description of the Hazeltine Laboratories' system of uniform amplification.

—WILLIS KINGSLEY WING.

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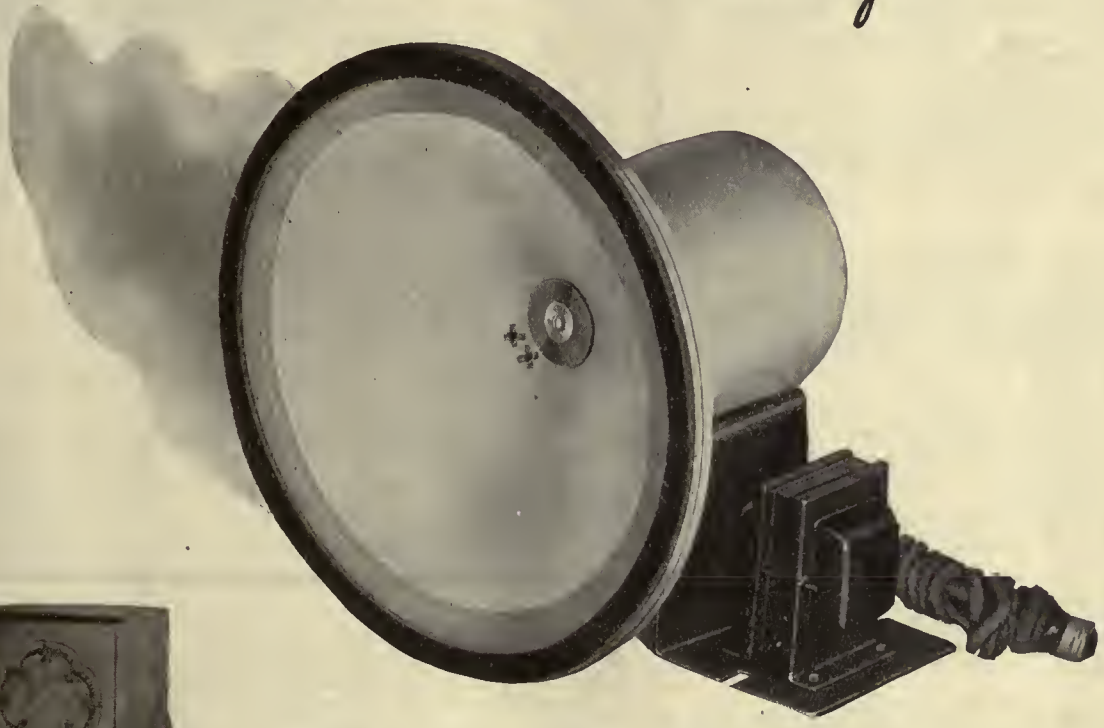
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NO HUM

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"D" Cabinet
Table Model

WRIGHT DECOSTER, INC.

MAIN OFFICE AND FACTORIES

ST. PAUL, MINN.

? Questions the Trade Show Answered

ALL eyes in the industry were turned toward the Trade Show in June and now the question is what did it mean, what are the lessons? A complete canvass of all the showings was made by RADIO BROADCAST in order to determine the trends and a summation of the set manufacturers' offerings. This summary, we present here. This summary is to be taken only for what it is—a tabloid rendering of the June exhibits. Many makers will have new models before September and by that time or before, some of the models involved in this tabulation will be altered in appearance, and design.

Reprinting of any part of this summary must not be made without our written permission.

1. *How many sets are using screen-grid tubes?*
A large number, considering this is the first year that these tubes have been available. Out of the 215 models covered by our survey, 98 sets—45 per cent.—use screen-grid tubes and 117 do not. It looks like a landslide, doesn't it?

2. *What about the 245 power tube?*
Consumers have complained about lack of power but now they will have lots of it. Out of 202 models, 156—77 per cent.—use 245-type tubes in push pull. Such amplifiers are 6.5 times as powerful as last year's sets which used a single 171 tube. The output of two 245's in push pull is 4.5 watts!

Only 8 per cent. of the sets use 250-type tubes, 13 per cent. use the 171-type, and 2 per cent. use the 112 type. The sets using 112-type tubes are battery operated.

3. *Consoles or table models?*
Figures can't lie—only 16 per cent. of the sets at the Show were table models; the rest—84 per cent.—were consoles!

4. *How many tubes per set?*
Of the new sets, 40 per cent. use 8 tubes, 27 per cent. employ 9 tubes, 23 per cent. have 7 tubes, and only 10 per cent. use 6 tubes.

5. *How many tubes will 1929 sets require?*
A total of approximately twenty-four million tubes will be required for initial installations in new sets, figuring a sale of three million receivers averaging eight tubes each.

6. *How many screen-grid tubes will be needed?*
At least half of the sets to be sold this year will use screen-grid tubes, it is estimated, and this will call for between 3 and 4 million of these tubes for initial installations.

7. *How much will sets cost in 1929?*
Out of 212 models, 17 per cent. are priced at $100 or less, 17 per cent. at $100 to $150, 31 per cent. between $150 and $200, 21 per cent. between $200 and $300, and 14 per cent. over $300. Your customers can spend $1000 or more for a receiver.

8. *What about the 226 tube?*
Out of every 100 sets 74 will *not* use 226-type tubes—224- and 227-type tubes are being used almost exclusively.

9. *Push pull versus single amplifier tube?*
Push-pull amplification is being used in 199 out of 202 models. The reasons are: quieter operation, better fidelity, and more power.

10. *Does the dynamic loud speaker hold its own?*
Yes, in 97 per cent. of the models.

11. *How many phonograph radio combinations?*
There are 22 such combination receivers out of the 202 models displayed. Generally speaking, they cost between $300 and $400. A few are lower in price.

12. *How about d.c. sets and receivers requiring batteries?*
The industry has gone a.c.—at the show there were only 9 d.c. sets out of 190 models; these included both battery-operated and d.c. light-socket-operated receivers.

13. *Can chassis be purchased separately?*
Twelve out of 46 set manufacturers will sell the chassis separately. The idea, of course, is for the dealer to install the chassis in a cabinet selected by the customer.

14. *What is the price range of new sets?*
The cheapest set is a small table model for $49.95; the highest priced set, a combination radio-phonograph, lists at $2500. The average price of all sets is $204.

15. *What are the new features?*
Various forms of automatic and semi-automatic *tuning control* were evident. Three manufacturers showed a *remote tuning control* device which allows the user to control one receiver from almost any home location. Eight stations on the average can be tuned-to and the remote control also in each case allows for remote control of volume as well. One maker featured a remote control allowing not only pre-adjustment to eight stations but also provided for remote control of the entire movement of the condenser gang in both directions with provisions for stopping at any point. *Automatic volume control* is evident in the higher-price field, but the trend is not yet general. Some indication that the *local-distance switching arrangement* is returning to popularity was evident and this feature was noted chiefly in screen-grid sets. *Cabinet design* is best described as good, but uneventful. *Ease of servicing* has been considered by the majority of makers and without exception, receiver design is more simple, more sturdy. *Unit construction*, in which the tuning unit is separate from the power-audio units for ease of servicing is a very distinct trend. *Prices* have come down as our summary shows.

TUBES

Type of Tube	*No. of models classified*	*No. of models using tube*	*No. of models not using tube*
Screen-Grid Tube	215	98	117
245 Power Tube	202	156	46
226 A. C. Tube	202	53	149

PRICES OF RECEIVING SETS
(Number of models below)

No. of models classified	*$49.95–$100*	*$100–$150*	*$150–$200*	*$200–$300*	*$300 up*
212	36	36	66	45	29

NUMBER OF TUBES USED IN SETS
(Number of models using)

No. of models classified	*6 tubes*	*7 tubes*	*8 tubes*	*9 or more tubes*
190	18	44	77	51

CABINETS

No. of models classified	*No. of consoles*	*No. of table models*
198	166	32

LOUD SPEAKERS

No. of models classified	*No. using dynamic loud speakers*	*No. not using dynamics*
215	209	6

POWER TUBES

No. of models classified	*No. using 245's*	*No. using 250's*	*No. using 171's*	*No. using 112A's*
202	156	16	26	4

PUSH PULL

No. of models classified	*No. using push pull*	*No. not using push pull*
202	199	3

AVERAGE PRICES OF VARIOUS TYPES

Type of Receiver	*Average Price*
All models	$204.00
All table models	80.60
All console models	240.00
All screen-grid table models	120.00
All screen-grid console models	235.00



HOWARD W. DICKINSON

writes on—

How *the Dealer Can Improve His Point of View*

The author of this article, Howard W. Dickinson, is a merchandiser of the widest experience. For many years he was executive vice-president of the George Batten Company, one of the best known of our advertising agencies. Here, he was in constant touch with business problems in a wide variety of fields, notable among which was radio. While connected with Batten, Mr. Dickinson among others was in charge of the advertising account of the DeForest Radio Company and the Cliquot Club Ginger Ale Company. The famous Cliquot Club "Eskimo" program was begun by him and his experience with radio matters goes back into the early history of the business. Mr. Dickinson is now spending his entire time in writing about his special field of knowledge—merchandising—and his articles appear regularly in *Printers' Ink*, *Advertising and Selling*, and many other general publications. He is the author of two books, *The Primer of Promotion* and *Crying Our Wares*. When Mr. Dickinson writes about radio merchandising, he knows whereof he speaks and we are sure his articles will be read with the widest interest.—THE EDITOR.

SELLING THE ROMANCE OF RADIO

IF I WERE to be asked what one thing the radio retailer needs most of all to help him in his business, I should say a great increase in ability to gloat a bit, nicely of course, over the importance of his business and the charm of the things which he sells.

He is very practical and scientific. It may pay him immensely to learn the art of telling some of the true fairy tales which his industry is full of.

Maybe someone else can tell you the proper relation between inventory and annual sale. I can't, and I am not sure that anyone else can in exact terms.

Somebody else may tell you a whole lot more about window display than I can. I only know when I like to look at a show window. I have found two types of windows that I like to look at. One is the kind that is filled up with tools or other things which interest me. The other kind is where genuinely artistic effects of color and form demand attention and admiration. Beautiful as the second kind may be, I am apt to be just entertained by it, while the display of real things often compels me to go in and buy. A combination of the two is irresistible.

The Average Dealer's Viewpoint

I HAVE BEEN in many a radio shop. I always feel as if the proprietor or even the man behind the counter is my superior in one very important respect. He knows a great deal about a very interesting subject of which I know but little. He is a magician to me. He deals with one of the most fascinating and delightful fruits of scientific magic. What is a mystery to most of us is an open book to him.

He knows the fascinating labyrinth of wires and coils. He knows how the tiniest force imaginable is caught, focussed, and amplified. He knows the multiple function of the vacuum tube. And he calls it all a "Hook-Up."

Respect and admire him as I do, I am a little bit ashamed of him too. I do not dare to voice my enthusiasm to him. He looks so sophisticated and practical. He seems to be selling diamonds by the pound and not by their lustre and quality.

He seems to have left me to pick up the romance of radio wherever I will—if I do pick it up at all; he is willing to sell me *a machine.*

The Radio Dealer's Position

NOW I AM supposed to be an advertising man, a practical chap, and one might wonder why I talk like this. In this article, and the few which may follow it, I want to help make a better salesman out of the radio retailer. So far, it seems to me, he has been pretty much in the position of the coffee and sandwich man just outside the gate through which a hungry crowd is pouring. He hasn't been obliged to sell for he happens to have things which people wish to *buy*. There is a difference. The radio dealer has been a purveyor to actual demand. He hasn't been compelled to stimulate general demand as have merchants in many lines. For example, how many radio dealers make the slightest effort to help sell broadcasting itself or give the slightest thought to the matter of helping people to enjoy radio.

Look in the window of an office for selling transportation over the Great Northern or the Canadian Pacific. Get their folders and you are treated to wonderful views of Glacier Park or the Canadian Rockies—things to see and the fun of seeing them.

Radio broadcasting is full of interesting things and interesting personalities. You are in a fascinating and romantic business. Why not make that fact pay you bigger profits by

learning how to stress it? Radio has developed fast but it is by no means an "old story." The romance of it is still there. Are you so completely scientific that you can talk only in terms of "selectivity," "distance," "elimination of static," "one-dial control," and so on? Are you so completely practical with respect to price, durability, current consumption, and such things that you can't encourage the very practical sales art of sympathizing with the romance that is in the soul of the set buyer just as the romance of lakes and mountains is in the soul of the trans-continental traveller?

Promoting Your Business

AH, I AM really afraid that you have a superiority complex. I come to you about something you know much more about than I do. I show my respect for your knowledge, then you feel that you must be an oracle and in your kindly but positive way talk down to me. You can still show your knowledge, but, if in addition to your superiority in knowledge you have the art of sympathizing with me as a real or possible radio nut, you can make more money out of me. Really, aren't you the least bit inclined to "high-hat" me because I am an ignorant dub about hook-ups and such things in which you are wise?

Can't you realize that if I just have a radio set in the house because every one does, and that I have brought it to you for repair because my daughter said I must, it might pay you to get a bit of enthusiasm pumped into me about radio and the fun I can have with it myself? If you succeed in that I am not going to be satisfied with this old set that needs repair every few months. You must be a salesman to get the most out of your business, and salesmanship is largely a matter of understanding the customer.

Promotion of your business is what I am talking about. If you can in the course of time get fifty of your customers to realize that you are interested in the quality of broadcasting, the fun of listening in, and selectivity with reference to *programs*, then you may make more sales than you now expect to. To you the important thing is the quality and price of instruments, to me the really important thing is radio programs. If you jump that gap yourself and get on my side of the ditch your influence with me will double. I'll still know and admire your scientific qualities and your technical skill. Yes, even more than ever because you sense my need and I recognize that you are a broad man.

A dealer is rather bound by the established routine of buying and selling. Sometimes that is rather drab and uninteresting. Selling easily gets into a stupid rut. Sometimes a single dealer and sometimes a group of dealers make a plunge into a profitable cultivation of the spirit of romance—that imperishable spark which lives in us all, even in this sophisticated age.

Romance in Other Industries

"SAY IT WITH FLOWERS." A great industry has united to spread this romantic touch, and it has done so with enormous profit. Even the old substantial Western Union has branched out into romance, and, strange as it may seem, has made a Cupid out of the messenger boy who delivers thousands of love notes sent by wire. Greeting cards, particularly at Christmas, have offered incense on the altar of romance, good



Following Mr. Dickinson's ideas, the actual show window pictured above has been designed to suggest a radio installed in the home. It causes the observer to consider radio as a practical utility rather than a complicated mechanical device.

wishes for years now—and more than ever will go out next Christmas.

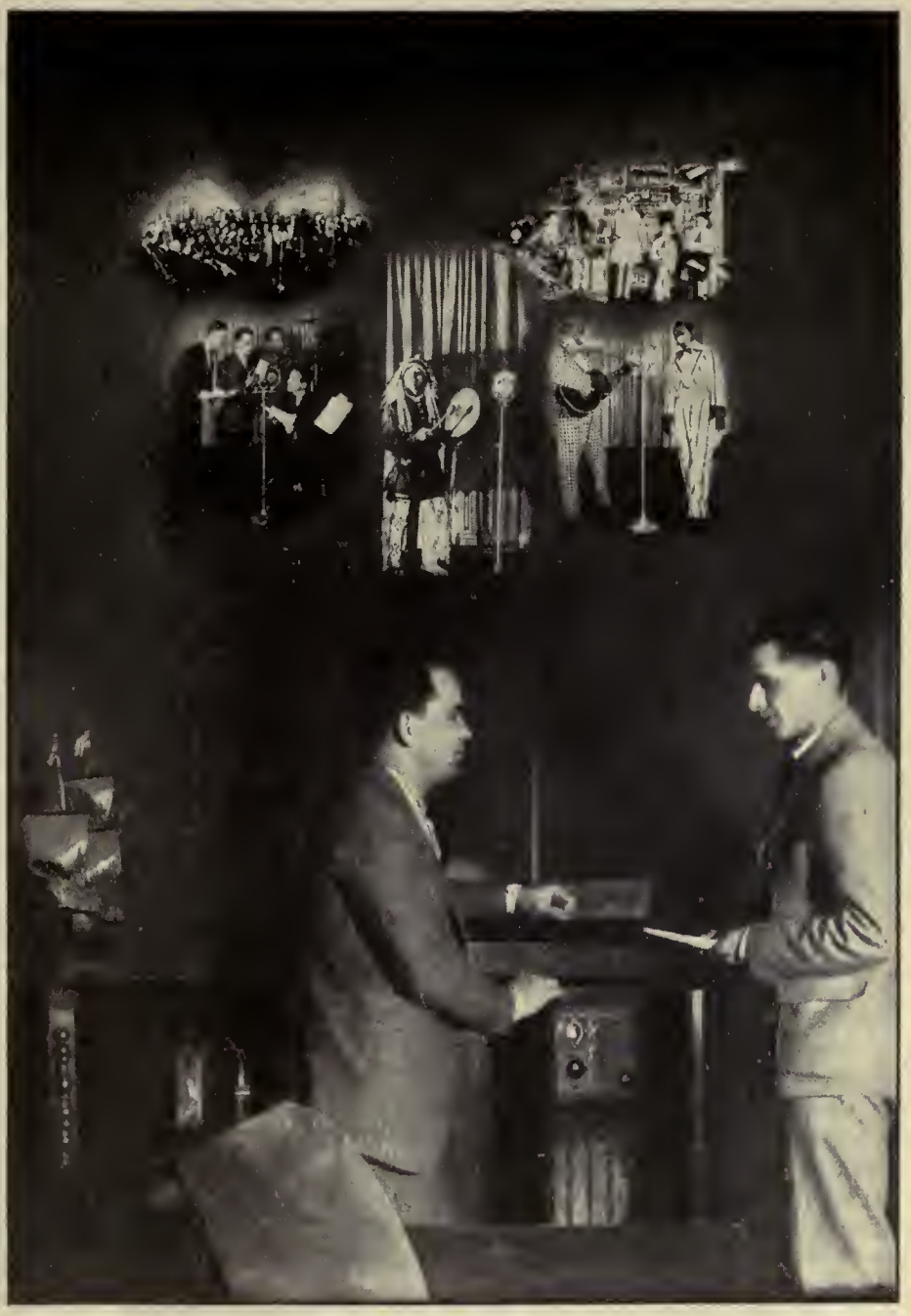
That same chummy, friendly, human element is in radio. Radio is full of it. People like to talk about it. Do you use it for all it is worth? Do you perhaps pride yourself in being *only* on the mechanical side of this industry? Do you fail to interest yourself in the art side? Do you fail to realize that the art of selling canned salmon is a very different art from that of selling flowers, or pearls, or pictures, or radio?

If I Operated a Radio Store

"What would I do about it if I operated a radio shop?" A fair enough question. Specifically, I don't know. Generally speaking, I'd try to get some of the atmosphere of broadcasting into my shop. I doubt if I'd do it by having a loud speaker over my door with its noises mixing with the street noises into a blend of discord. If I fancied the microphone work of Graham MacNamee or some other famous announcer, I think I'd try to have his picture in my shop. I'd expect it to start some conversation which might make a sale. If I had pictures about I'd have some good ones of announcers and artists. I'd make all the "hook-up" I could with the broadcasting side of radio. Separate parts of an industry are very prone to isolate themselves from each other to their mutual detriment.

I believe I would employ a store decorator and tell him or her that I wanted a genuine atmosphere of broadcasting as well as of the mechanics of radio. I'd consult that decorator and try to work out something fine. If a manufacturer who sold me goods should also send me cheap-john lithographs I'd send them back and tell him what was wrong with them. I'd study the problem from all angles, consult authorities if I could find them, and try to work out something which gave to my shop the physical aspects of romance, the existent romance which radio still means. I'd show graphically, in any way I could, the news values and the educational facilities which radio offers as well as the art values.

"Everybody knows all about radio." Guess again. Nobody knows all about radio, and the majority know but very little. It is easy to show most anyone how much more fun and profit he can have from radio.



Your customer's interest is in programs. If you jump the gap and get on his side of the ditch your influence with him will double

Keeping Radio Alive

Don't let *the romance of radio be absent from your shop!* We will keep radio alive and growing by keeping its romance alive. We have to assume that our dealer knows the elements of retailing, knows how and what to buy, and how to mark up to make a profit. What we are concerned about particularly is the extra chance of business, maybe 20 per cent., maybe more, in which profits lie. That extra chance lies in the personality of a business, its artistic and social good will, its ability to be friendly and instructive.

Put an understanding of the fine points in human relationships on top of the knowledge which a radio merchant must have and his selling chances begin to increase rapidly. If I could give the radio man a phrase to remember about his business it would go something like this: "Commonplace and familiar to me, very interesting to others." I think our dealer is apt to know so much about his trade that he forgets the fact that others do not know so much, and that they can be interested easily in anything pertaining to radio. He knows much about it. If he keeps that knowledge all in his head he misses a big chance to use it at a profit. If he makes his shop a fascinating place to visit, more people will visit it. If they are shown things there more people will buy.

Simple? Yes, but easily forgotten, and the radio dealer has this advantage to a greater degree than most others. He has a more interesting product to sell than most others.

The MARCH

New Hope for Clearing the Ether
The Rural Radio Dealer's Problem

Commission's Personnel Completed

WHETHER A MORE forceful policy will be adopted by the Commission, now that its personnel has been completed by the appointment of General Charles McK. Saltzman for the Fourth Zone and William D. L. Starbuck for the First, only experience will determine. We may take slight comfort from the fact that four minor stations have been denied renewal of their licenses and a few others placed on probation. Threats have been made regarding frequency deviations, but we must confess that warnings by the Federal Radio Commission have been issued too frequently in the past without being followed up to warrant taking them seriously.

It is obvious to any unbiased observer with a sensitive receiver that the clear and the better regional channels render such greatly superior service, as compared with that of the local and poorer regional channels, that any move to crowd these channels, further is absolutely contrary to the dictates of common sense. Nevertheless, new licenses continue to be issued and power increases are permitted on the regional channels. We earnestly hope that some of the serious experiments now being conducted in synchronization will help to reduce the number of heterodynes on the shared channels. Apparently it is a vain hope to rely upon the Federal Radio Commission to undertake the prime function for which it was originally organized, namely the drastic reduction of the number of stations operating, and hence synchronization is the only remaining hope for improved conditions.

In dictating strict adherence to frequency stability and staunchly defending the clear channel, the Commission may still serve an important and useful purpose because it is only a matter of time before engineering advances in synchronization will help materially in improving the quality of reception provided on the crowded channels. But even this hope will be destroyed if too many new stations are licensed and too many power increases are allowed on local and regional channels.

Trends in Radio Merchandising

IT IS AS much the concern of the radio receiver manufacturer as of the radio dealer that retail merchandising shall be profitable. Receiver manufacture has proved a profitable and satisfying enterprise for most of those engaged in it with adequate capital and sales and engineering ability. However, if the dealer who retails the receiver does not enjoy this same prosperity, his failure will soon be reflected in the profits of the manufacturer.

With quantity production, drastically lower prices, and a great increase in the number of effective selling outlets, the lot of the smaller dealer in the radio field, particularly in the less-populous communities, has become more and more difficult. The unit of sale grows smaller and, although the turnover is increasing, it is not sufficient to counteract completely the smaller profits per sale now made. The average sale has fallen to about $158. This still leaves an ample margin for efficiently conducted radio businesses. Efficiency implies low overhead per dollar of sale and that, in turn, depends upon a considerable turnover. Where large sales volume is not attainable, the dealer may operate without profit. There is much complaint to this effect at every dealer's meeting. Usually the answer lies in lack of sales ability, poor selection of lines, or excessive competition.



Nevertheless, there are locations where none of these factors account for the dealer's failure to show profit. In such cases, sales are made almost entirely in low-priced merchandise, but population and economic conditions preclude the building up of adequate sales volume.



In the smaller community, the answer to the dealer's problem lies in the development of a more comprehensive business by the sale of allied non-radio products. A manufacturer who would ingratiate himself with dealers serving rural areas could very profitably make a study of the economic position of the rural dealer with a view to point out solutions for his individual problems.

Educational Possibilities of Radio

A BRIEF REVIEW of the British Broadcasting Corporation's latest edition of *Talks and Lectures*, a leaflet issued periodically to assist in taking advantage of its comprehensive educational lecture service, is sufficient to convince any American listener that we are overlooking many of the richest possibilities of radio broadcasting. While no educational lecture is greeted with enthusiasm by a majority of the audience, those whom it does serve are served significantly and the benefit accruing to them is of far greater permanent value than could possibly be derived from the type of program which is the stand-by of American listeners.

We have to blame the economic system upon which our broadcasting is based for its lack of genuine service value. There is no progressive or comprehensive plan to take advantage of the educational opportunities which the microphone offers. Morning talks, presented for women, are little more than blatant and direct advertising of the most forlorn and discouraging type. Since the support for broadcasting is obtained on the strength of the good will accruing to national advertisers, it is natural that features should be presented which attract as broad a cross section of the listening audience as possible. This precludes any serious educational effort and levels all programs to a standard level of appreciation.

Radio is principally a serviceable instrument for securing a background of music in the home with a minimum of effort. There is sufficient variety to appeal to any average musical desire. During political campaigns and outstanding sporting events, radio serves very acceptably as a news reporting device. But this is about as far as it goes and the serious constructive purposes served are highly exaggerated.

There is just as great a field in child and adult education in languages, dramatic, and literary criticism, travel, history,

OF RADIO

Advantages of Dealer Coöperation
American-British Radio Programs

and home economics as there is in broadcasting classical music. This the British Broadcasting Corporation has adequately recognized; in fact, it has probably gone as far in stressing these subjects too much as we have in relegating them to obscure hours. Talks are not compressed into five or eight minutes; they are half-hour lectures, presented by outstanding speakers. They use not only our conventional hour of 10:45 A. M., addressed to women, 3:30 P. M. to women and children, but also such evening hours as 6:00., 6:30, 7:00, 7:25, 8:15, and 9:15 for regularly planned lectures.



The presentation of such programs would not appeal to the national advertiser because there is no educational subject which interests a broad cross section of society, and serving only a part of the audience well does not have the good will value of serving a larger part in an insignificant way.

The broadcasting companies should make some effort in the direction of educational programs as sustaining and good-will features. "Sustaining" programs, however, have begun to designate fill-in periods which cannot be sold commercially rather than any effort to embellish the radio fare.

A close scrutiny of available educational features from all stations serving the more-populous radio areas does indicate that a fairly broad range of subjects is discussed before the microphone, but this is done in such a disorganized manner and at such hours that the listener who concentrates upon two or three stations for his program service hardly has occasion to know that there is anything of an educational nature on the air. The newspapers have taken to publishing programs in a rather sketchy and uninformative manner so that they serve as but little more than a reference guide to those already familiar with the nature of the features offered.

A dealer might serve a useful purpose by sending a regular bulletin to his customers and prospects giving in some detail the educational features which the listener in his territory has available through his radio receiver. This information, conscientiously collected, would have a surprising amount of sales appeal not only among highbrows but among all classes of listeners. The desire for self-education is strongly inherent throughout the American public as anyone familiar with the enormous enrollment of correspondence schools from all classes of society can testify.

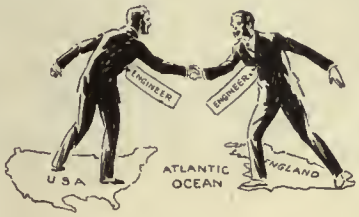
Local Dealer Associations

In most cities of less than a hundred thousand population, the number of dealers is too small to warrant a local dealer's association and the mutual problems which such an association might discuss are hardly suited to coöperative action. But, in larger cities, there are many fields for useful coöperation. Local man-made interference can be tackled effectively by such a body; coöperation with local broadcasting stations effectively maintained, trade abuses corrected, and delegates sent to national conventions of dealers so that the whole community may be benefited by their report. This department would welcome correspondence with successful local dealer associations in order that their experiences may be made of benefit to other communities which have not yet appreciated the potential value of a local dealer organization.



International Program Exchange

The recent trip through Europe, taken by Merlin H. Aylesworth, president of the National Broadcasting Company, can be counted on to produce some significant results in international broadcasting. While the technical problems must first be solved, the value of the impetus given by personal contact of the leaders in broadcasting on both sides of the water is certain to spur on the efforts of the engineers. C. W. Horn, recently appointed general engineer of the N. B. C., is encouraging technical progress in the same manner that Mr. Aylesworth is cementing the executive relations of the two principal broadcasting systems of the world, the N. B. C. and the B. B. C. There is a romantic tinge to international re-broadcasting which is certain to increase the market for radio receivers in both countries.



European Radio Population Grows

Continued increase in the number of licensed listeners in European countries is indicated by statistics for the years of 1927 and 1928. The total number of license holders rose from 5,897,000 to 7,163,000 or 21.4 per cent. The British total, on January 1, 1929, was 2,684,941; the German, 2,635,537. The following is a tabulation of the number of licensed radio receivers per 1000 inhabitants:

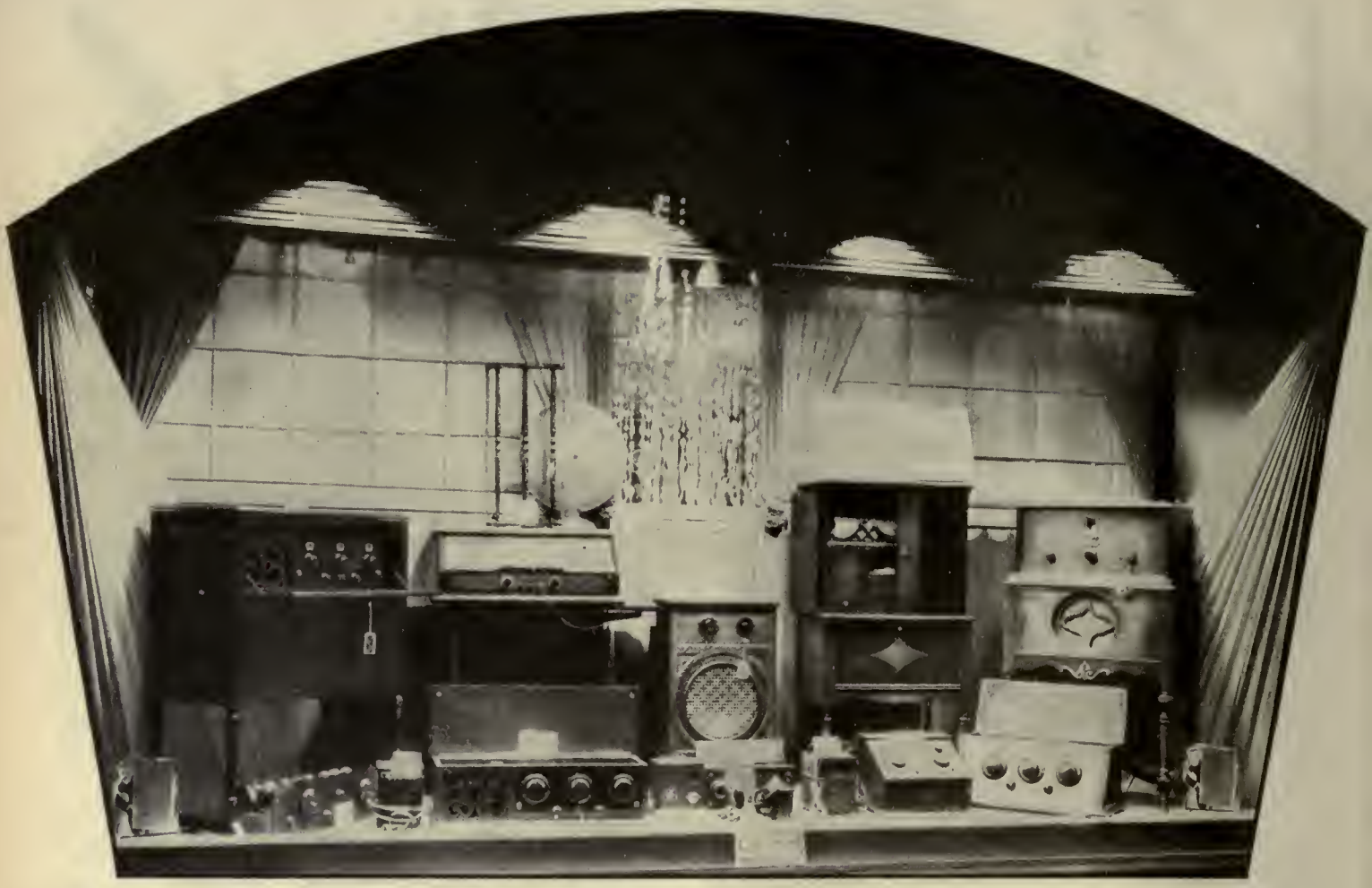
	1927	*1928*
Denmark	57.05	76.42
Sweden	54.68	63.47
Great Britain	56.91	59.48
Austria	47.79	53.31
Germany	33.49	43.92
Norway	22.9	22.9
Hungary	10.41	20.1
U. S. (estimated)		68.1–90.9



New powerful broadcasting stations are likely to make significant changes in several European countries during the next year.

The estimated number of radio receivers per thousand population in the United States lies between 68.1 and 90.9, per thousand, according to the enthusiasm of the statistician. If he is trying to estimate the market for receiving sets, it is the former figure; if he is trying to sell radio advertising, it is the latter. The smaller figure, however, is probably very much closer than the latter.

—E. H. F.



Used set display of the Germantown Radio Co. Note that every set is plainly tagged, the low price at which they are offered being a decided asset in promoting their ready sale.

What to do With Used Sets

RADIO'S TOUGHEST SALES PROBLEM

By HARRY P. BRIDGE, JR.

TO TRADE or not to trade?

This, says H. G. Emsley, of the Germantown Radio Company, 5431 Germantown Avenue, Philadelphia, Penn., is the question. More than that, this matter of aeeepting old sets as partial payment for new ones is his toughest sales problem.

"The trade-in market is a big one," says Mr. Emsley. "That is one reason why it is so hard to find just how to taekle it. The dealer who rushes headlong at it is apt to see only the opportunities and overlook the pitfalls. I've stepped into a few of them and almost stepped into a lot more."

He adds: "Almost every radio set owner, other than those who have sets of the most modern light-socket-operated type, is a good replaeement prospeet. That's one of the good features about the radio business. New developments are eoming along all the time to make repeat buyers out of old eustomers and thus stave off the saturation point in sales that is so much of a worry to a lot of long-established industries. The really big problem in this eonnection is not how to interest present set owners in the latest and best but rather how to make the old sets pay their way. As long as a set works, an owner won't scrap it. Chanees are, he has an exalted idea of its trade-in value. What is more, the dealer who does take it in at a fair price still has a goodly share of his profit on the new set tied up in the old one until it is satisfaetorily moved."

Mr. Emsley is not given to personal publieity and self praise. It was hard to get him to talk about his solution of this problem—not beeause he was loath to pass along any ideas he might have but for the simple reason that he ean see little of an outstanding nature in what he has done in this respeet. Perhaps that is so. The fact remains that he has built up a surprisingly stable year 'round business selling radio alone —also that his ability to handle trade-ins has been responsible for his sueeess in no small part.

This dealer has been in business in this prosperous Quaker City suburb for more than six years. Each year has shown a substantial increase in his business, and the business has been good from the start. Last year showed a 20 per eent. increase over that of the year before and he is planning on a similar growth in 1929. It is not unusual for him to sell as many as 30 or 40 used receivers in a week. Moreover, he does it without any advertising other than that given by frequent window displays. No high-pressure selling is used

to persuade set owners to trade in old sets on new ones, and therein lies the story of Mr. Emsley's solution to the problem. He has found that this is not necessary to get all of this business he can safely handle.

As he has already hinted, one of the greatest difficulties came in knowing where to stop in dealing with the replacement market. Piles of old and hopelessly unsaleable sets on dealers' shelves plus a generally soured outlook on the part of the proprietors concerning trade-ins are mute evidence that many have failed. In going over the new sales they have overestimated their ability to re-sell the old sets and sell them at a profit.

Early in the game, this dealer decided three things: first, that haste must be made "slowly" in the handling of trade-ins —that to tap the market any faster than the old sets could be resold would be both foolish and unprofitable; second, that definite policies with regard to used sets must be formulated in order to take this end of the business out of the hit-or-miss class, and, third, that it is just as important to build consumer confidence in the second-hand outfits as it is in the new ones.

It may seem somewhat paradoxical to say that Mr. Emsley does not aggressively seek trade-in business, yet this is merely a natural development of his policy. He does, however, have a definite and straight-forward proposition to put to every trade-in prospect and he knows exactly what to do with a used set after he gets it. As a consequence, he has become widely known as headquarters for the radio owner who wants to trade in his old set on a new one. More than that, his store is something of a mecca for the man who wants to buy a good reconditioned outfit at a reasonable price and with a reasonable guarantee of satisfactory operation.

At least one prominent radio manufacturer bases his yearly production largely on the number of sets he has made the year before. He knows that a good set is its own best advertisement and feels that one satisfied customer will beget many more.

Fair Deal Brings Trade

So it is with the trade-in business, Mr. Emsley has found. One customer who gets fair value for his old radio is quick to tell a friend who likewise becomes a good prospect. And so it goes. Consequently, by conscientious handling of the business, Mr. Emsley has built a substantial volume—and, by putting something of a curb on his original ambition to cut a wide swath through the used set market, he has avoided the danger point which lies in having more used sets on the shelves than there are buyers to be found. By "making haste slowly" he is progressing steadily year by year, and he learns rapidly as he goes without paying a high price for the experience or jeopardizing his future.

The fact that he has sold as many as five sets to a single customer in a comparatively short space of time is indicative not only of his success but also of the manner in which the market may be made come to the dealer under these methods.

Allowances for used sets represented a ticklish problem.

"There are exceptions to all rules," says Mr. Emsley, "but one of the most rigid rules a dealer should have is that of refusing to accept an old set unless it can be resold. More than that, I have found that it is not safe to base trade-in allowances on the original cost of the set. The one and only thing to be considered is its resale value. If that doesn't amount to a little more than you'll be called on to give for it, then it had best be let alone.

"To take a used set with the idea of discarding it and figuring the allowance as part of the cost of making the new sale is just another way of cutting prices. I never felt it was sound business to cut prices literally and I don't believe it is sound business to do it this way, either. Besides, in the long run, I have found it isn't necessary."

As a consequence, some of the most profitable business, so this dealer says, is the business he doesn't get at all.

If he can't make a sale produce a profit, then he is content to pass up the sale in favor of any other dealer who sees fit to make it. Prospects who insist that they can get a better allowance elsewhere are told politely but convincingly that the company's offer was carefully estimated and is the best that can be made.

"Naturally," says the proprietor, "the best allowance you can possibly make on a set often seems mighty low to a customer who doesn't realize that radio is pretty much in the same class as automobiles in this respect—perhaps more so. Frequently, people of this kind can be made see the 'light' —sometimes not. In a number of cases, I have been successful



An attractive window showing how new sets are displayed by the Germantown Radio Co.

in getting these folks to dispose of the sets themselves. They can do this by advertising them in the classified columns of the local newspapers or giving them to friends or relatives. Many people are susceptible to the latter suggestion, especially when it is put to them that the satisfaction of giving a radio to a deserving party would likely be worth far more than even the best trade-in allowance."

Emphasis is placed on the service on new outfits offered by the Germantown Radio Company and no attempt is made to beat around the bush in showing that this is made possible only by fair profits on every sale. Through the years, Emsley service has become so well known that this argument usually swings the doubtful sale.

Importance of Service

Too much stress cannot be laid on this particular point for Mr. Emsley feels that prompt, efficient service has been the most important factor, not only in building up his business generally but particularly in making it possible for him to gain such a large used set volume. While other dealers were still debating as to the handling of service, and while some were rendering more or less indifferent service only on the sets they had sold, Mr. Emsley had this end of his business unusually well organized.

Whether radio owners who called for assistance were customers of his mattered not at all. All received visits from skilled men in 24 hours or less. A fleet of trucks not only made it possible to extend this work over a large territory but effected worthwhile economies as well. These same trucks are equally useful in facilitating new installations.

Sets sold by this company are serviced for three months without charge while the service cost to others is decidedly moderate. Almost from the start, this department has paid its way directly. Even more important have been the indirect results. People who did not buy their receivers from the Germantown Radio Company originally did come when they were ready to get new ones.

"If there's any one factor that is important in building for success," says Mr. Emsley, "it certainly is the right kind of a service department. It is particularly indispensable if you handle used sets for that is when you reap the full benefits."

No old sets are accepted "sight unseen" nor are allowances based on the prospect's description of them. Estimates are sometimes given in this manner but a definite offer is never made until a serviceman has visited the home and passed expert judgment on the outfit in question.

Particular pains are taken to create a feeling of confidence in the concern's used sets and, consequently, to create a broader market for them. Every old radio that comes in is gone over carefully by the service department and put in the best possible condition. Tubes, batteries, power-supply units, and other accessories are carefully checked and replaced where necessary. Frequently, cabinets are refinished. Dubious trade-ins are never sold for the company will not accept a radio it cannot pass on with a genuine assurance of value received to the customer.

In the isolated instances when complaints do come in, no time is lost in making good providing they are made within a reasonable time and also providing that the fault lies in the set and not in a customer who expects too much of it.

Used sets are sold for just what they are—no more, no less. As with new radios, customers are not led to anticipate the exceptional in distant reception, performance, and the like. They are led to realize that, while no radio is perfect, the right kind of an outfit properly operated and properly serviced offers a truly delightful orchestra seat at the "Theatre of the Air." That, says Mr. Emsley, is the only way to insure lasting and widespread consumer satisfaction.

All used sets are sold for cash only—and they are sold quickly. There is no carrying over of large stocks from month to month, much less from year to year. This dealer has long recognized the importance of prompt turnover and is just as alert in applying this experience to trade-ins as to his general stock. As soon as a supply begins to accumulate, into the window they go. Thanks to the combination of his splendid location on a busy main thorofare plus the enviable reputation he has built through the years, no other sales impetus has been necessary.

Old sets are never displayed in the window for more than a week at a time. The fact is, sets are sold directly from the window and as fast as one is sold another old one is displayed in its place. However, even in this manner used set displays are not kept in the window for more than a week. From ten to fifteen sets (depending upon their size) are kept in the window at a time, all being plainly marked with price tags. During the October season last year Mr. Emsley sold his complete stock of used receivers (about forty sets) in three complete displays within a week.

Resale prices on used sets at the Germantown Radio Company run from $8 to $25 with the average being in the neighborhood of $15. Radios priced at the latter figure are generally the most saleable. Occasionally a used set is sold for as much as $50 but such a case is the exception rather than the rule.

The best seasons for disposing of used sets are during the Fall and immediately after Christmas. Mr. Emsley explains that they sell particularly well at the latter time, either to people who did not receive the radio set they wanted for Christmas or to those who received a little money which was insufficient for the purchase of a new set.

Although he frequently does not make as much on the sale of second-hand equipment as he does on the sale of new, Mr. Emsley sees to it that the resale price allows for a fair margin. Otherwise he figures he would be making two sales to produce a single profit. Once in a while, it is found necessary to reduce the price on a used set to bring about its ready removal in line with the proprietor's ideas on turnover. He realizes that the longer a set remains unsold the greater is its cost to him.

Do not misunderstand the nature of the business of the Germantown Radio Company through a reading of this article. Despite the fact that he regards trade-ins as his toughest problem, Mr. Emsely's aim is first, last, and always the sale of new sets. His is not a business in second-hand material. He has found, however, that the ability to handle trade-ins in a high-grade, strictly ethical manner has greatly increased his market for new sets and consequently enlarged the profits of his store.

Please Note—

What a successful dealer does with trade-in sets. See page 138.
Applying a new idea to retailing radio. See page 133.
Percentages by states of a.c. and battery set sales for 1928. See page 142.
Will the screen-grid a.c. tube displace the 227 type as a general-purpose tube? See page 144.
All the facts about the 245-type tube. See page 167.
How good servicemen have reduced the number of return no-charge calls. See page 145.
Technical data on Crosley, Silver, and Fada receivers. See pages 155, 161, and 171.

what they say



The Trade-In Problem

THE DESIRABILITY *of establishing a workable trade-in mechanism has long been appreciated by leaders of the radio industry. If such a system were developed it would be beneficial to the buyers and sellers of used sets, to radio dealers, and to manufacturers. A study of existing conditions, however, shows that there are many delicate problems which must be solved before the desired result may be obtained. In this connection, Curtiss Abbott, sales manager, Radio Division, National Carbon Company, makes a number of pertinent remarks:*



To the Editor:

Realization of the fact that trade-in value exists in his old set is a decided incentive for the owner to purchase a new and modern receiver. Therefore, a standardized trade-in policy would be of decided benefit to the industry. To this end the most obvious course is to establish a set of valuations for the more recent models of radio receivers.

The value of an old receiver is determined by three major factors: (a) its value in service to the buyer; (b) The degree of technical development involved in its design as compared with current models; and (c) the law of supply and demand.

In establishing trade-in values it is especially important that they be made as fair as possible. If used sets are priced too low it is a reflection on the products of past years and does not encourage trade-ins; excessive valuations are the same as reducing the prices of new receivers.

Giving the trade-in valuation of a receiver on the basis described above may often prove embarrassing to a dealer when faced with a customer to whom he sold the set originally three or four years back. In such cases it must be explained that half of the original investment was represented in the cost of accessories and supplies which are no longer of value, and then the dealer must point out how the improved appearance, selectivity, sensitivity, tone range, and operation of new sets affects the price of old sets. In addition, the improved convenience of new sets, namely, a.c. operation, has placed a very marked handicap on the value of old sets.

From the viewpoint of the dealer, the used set business is dangerous unless it is handled expertly. Giving substantially large allowances provided only a false stimulation of business and in extreme cases result in converting the stock of new models into one consisting of second-hand obsolete sets—and it is not a demonstrated fact that large numbers of used sets may be sold. At present the value of the turned-in product is depressed greatly by the superiority of current models, and great activity in the sale of old sets cannot be expected for two or three years, at which time a.c. sets will be turned in.

A possible solution of the dealer's problem is the establishment of regular channels for the distribution of old sets. At the present time it is customary for each dealer to dispose of his own second-hand stock, which is unsatisfactory in many cases because of the character of his clientele. On the other hand, the situation might be improved by moving these sets to large cities where there are prospects of a type which would be more interested in the opportunity of buying old receivers at a low price.

H. CURTISS ABBOTT.

Interference Hunters

MANY AGGRESSIVE *dealers have found that the best way to create good will in their vicinity is to give complete service and this may be considered to include the elimination of interference throughout the town. This trend has created a demand for data on the design of interference-hunting receivers.* RADIO BROADCAST *has received several letters from dealers on this subject, and the one which follows is especially interesting as it outlines the essential electrical and mechanical characteristics of such a piece of apparatus.*

To the Editor:

While I cannot claim to be an expert in the field of interference hunting, I have done some experimenting—enough so that I know what an interference hunter should do, and how it should be built. Therefore, I am taking the liberty of mentioning a few of the points which I deem desirable:

1. The outfit should be complete with batteries and a self-contained loop, it should weigh not more than 20 pounds, and should be very compact, say, not more than 4 to 5 inches thick, perhaps 12 inches wide, and not exceed 14 to 15 inches in length. It should be carried by means of a shoulder strap, and it should be possible to operate it while it is being carried.

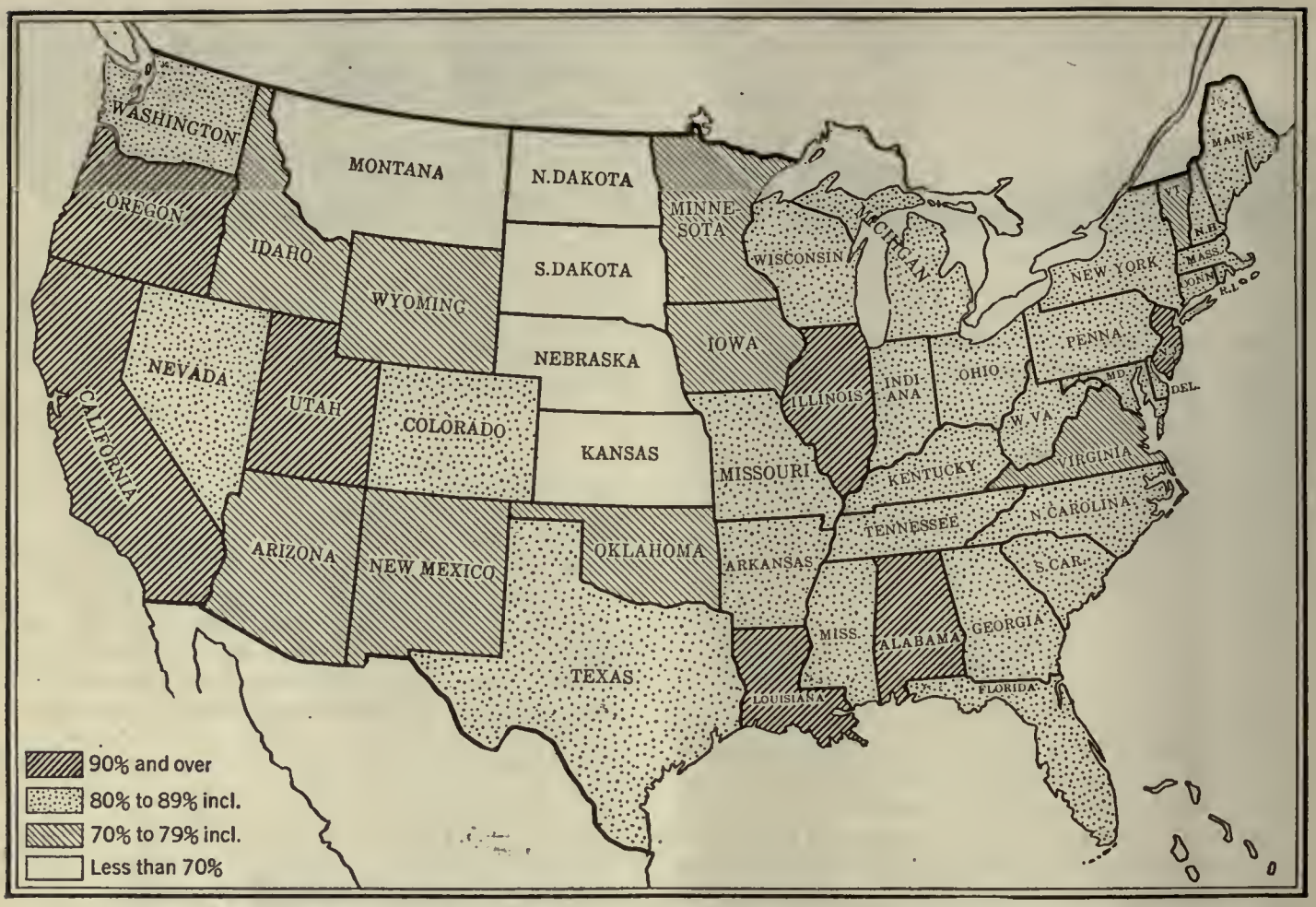
2. Interference hunters should have a minimum number of controls, one tuning dial, a volume knob, and a switch being an ideal combination. The tuning mechanism should offer enough resistance to changes so that its setting is not altered while being carried. The volume control should be across the output so that it may function as an audibility meter. An output meter is desirable for comparing signal intensities and should be included together with a push button for connecting it. A filament voltmeter and rheostat is also desirable in order to insure constant voltage during a test.

3. A set consisting of one stable r.f. stage, a fixed detector, and two a.f. stages is probably best suited for this work as it can be made compact and light in weight. C batteries should be used for the power supply to reduce the weight.



I also wish to point out a few of the disadvantages of the average interference hunter. In the first place, most of them are too heavy and have to be set down, opened, and adjusted before a reading can be taken. Usually the setting has changed or cannot be duplicated and, as a result, it is impossible to obtain an accurate comparison. With the receiver I have in mind, the operator can take a reading in one location, turn off the set, walk a block, and then take another reading without readjusting the dial. The output meter would indicate accurately the relative intensity at each location.

H. J. GODDARD.



This map of the United States shows how the popularity of the a.e. receiver has increased in various sections of the country. The figures give the percentage of the total sales for the year of 1928 which is represented by the a.e.-operated receiver.

How A.C. and Battery Set Sales Compare—I

ANALYZING THE 1928 RADIO SURVEY

By T. A. PHILLIPS

Manager, Research Division. Doubleday, Doran and Co., Inc.

THIS is the first of a series of three articles, analyzing the 1928 radio survey compiled by the Electrical Equipment Division of the Bureau of Foreign and Domestic Commerce. This survey is probably the most complete and important study concerning the radio market made this year. A casual inspection of the report fails to disclose the many significant facts lost in a great mass of detail. This series of articles will analyze the important facts.

A recent study made by the National Carbon Company discloses the fact that there are ten million homes that are not wired for electricity. Of this astounding number very few are not potential customers for radio sets. The following figures taken from the Bureau of Foreign and Domestic Commerce reports show the relative importance of these two types of receivers.

Dealers' Stocks on Hand

	Battery Sets	A. C. Sets
January 1, 1928	72%	28%
January 1, 1929	20%	80%

Number of Sets Sold

	Battery	A. C.
1927	74%	26%
1928	14%	86%
Last quarter 1928	11%	89%

Sales By Population Groups, 1928

Population	Battery	A. C.
Less than 10,000	25%	75%
10,000 to 25,000	16%	84%
25,000 to 50,000	14%	86%
50,000 to 100,000	11%	89%
100,000 to 200,000	8%	92%
200,000 to 300,000	8%	92%
300,000 to 500,000	8%	92%
500,000 to 1,000,000	6%	94%
1,000,000 and over	11.6%	88.4%

Discussion of Figures

THE MAP of the United States on this page presents geographically the relative sales of battery and a.e. sets by states. The figures show that in Kansas, Nebraska, South Dakota, North Dakota, and Montana, battery sales still represent a significant portion of total number of sets sold. New Jersey, Illinois, Alabama, Louisiana, Utah, California, the District of Columbia, and Oregon are mighty poor sales territory for battery sets; more than nine out of every ten are a.c. sets, but even in these territories there are still an important number of homes not equipped with electricity. For example, in the District of Columbia 28,300 homes are unwired.

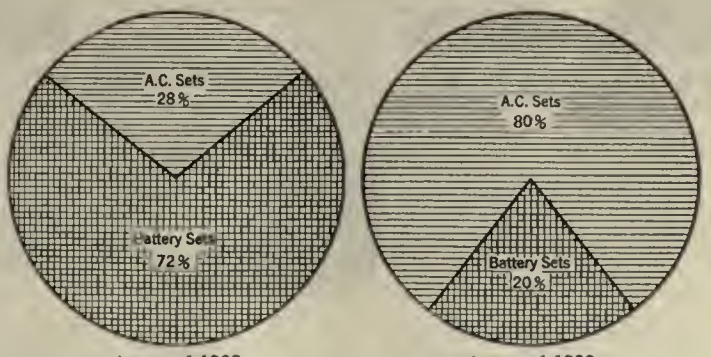
An analysis of the population groups shows that with the increases in population there is a relative decrease in the sale

of battery sets, with one exception. In New York, Philadelphia, Chicago, and the District of Columbia battery sets still find a good market. This may be accounted for by the fact that these cities are the stamping grounds of gyp dealers selling obsolete sets, and also because these large cities contain many homes supplied with direct current and houses in old sections which have never been wired.

A study of the sales for the fourth quarter of 1928 will show sales managers, those states where battery sets are still holding their own as well as the states where they are losing ground. The survey showed an average increase of 3 per cent. in a.c. sets over battery sets for the last quarter compared with the entire year. The following states showed less than a 3 per cent. increase:

Alabama	Louisiana	Oregon
California	Maine	Tennessee
Colorado	Missouri	Texas
District of Columbia	Nevada	Utah
Kentucky	North Carolina	

DEALERS STOCK ON HAND



These charts show the extent to which the a.c.-operated receiver has replaced the battery set on the shelves of the average radio dealer during the year of 1928.

The following states showed the greatest increases:

Arizona	12%
Idaho	7%
Kansas	7%
Maryland	8%
New Mexico	7%
North Dakota	8%
Ohio	7%
Oklahoma	9%
Pennsylvania	8%
Vermont	9%
Virginia	13%
Wyoming	8%

The intelligent progressive dealer will not lose sight of the fact that regardless of his locality he is bound to pass up some good prospects if he does not have a supply of good battery sets. In addition to those radio users who are still unconvinced that the a.c. sets gives them as good, or better reception, there will always be an important number of homes not equipped to use a.c.-operated radio receivers.

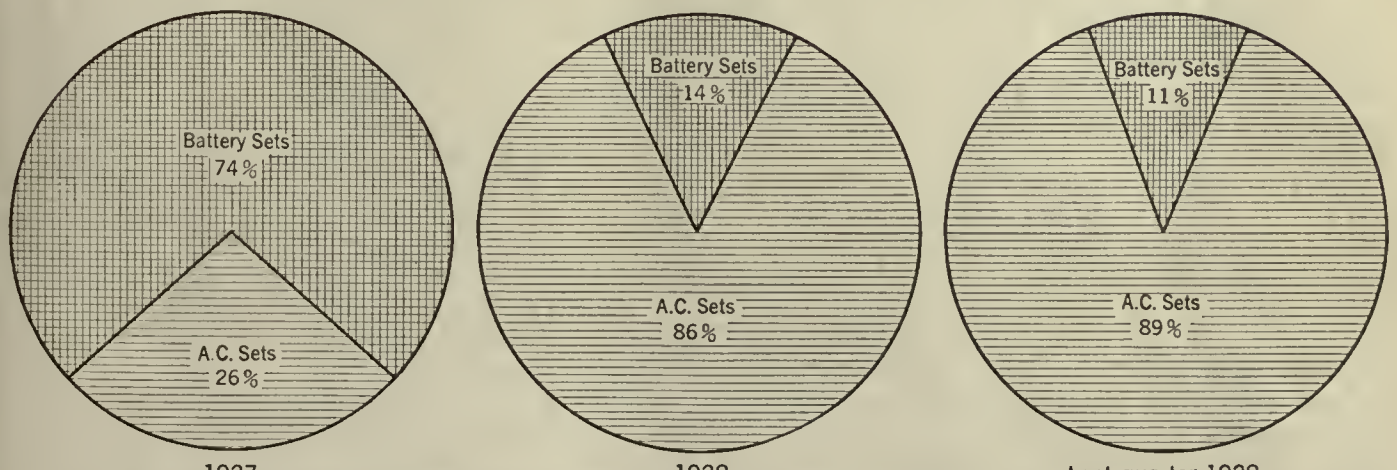
Sales managers, using these figures as a basis, should make careful studies of their territories to determine those localities where battery sets must be sold, if radios are to be sold at all, regardless of the improvements or popularity of a.c. receivers.

Sales By States

(Grouped according to sales for entire year of 1928)

	Entire Year, 1928		4th Quarter, 1928	
	Battery	*A. C.*	*Battery*	*A. C.*
GROUP A—OVER 90% A. C. SETS				
District of Columbia	4%	96%	3%	97%
Utah	4%	96%	3%	97%
California	5%	95%	4%	96%
Louisiana	8%	92%	6%	94%
Alabama	9%	91%	7%	93%
New Jersey	9%	91%	6%	94%
Illinois	10%	90%	8%	92%
Oregon	10%	90%	9%	91%
GROUP B—80% TO 89% A. C. SETS				
Arkansas	11%	89%	5%	95%
Connecticut	11%	89%	8%	92%
Maine	11%	89%	10%	90%
Florida	12%	88%	8%	92%
Massachusetts	12%	88%	8%	92%
Pennsylvania	12%	88%	4%	96%
Rhode Island	12%	88%	3%	97%
Tennessee	12%	88%	12%	88%
Georgia	13%	87%	9%	91%
Texas	13%	87%	12%	88%
Colorado	14%	86%	13%	87%
Indiana	14%	86%	11%	89%
South Carolina	14%	86%	9%	91%
Washington	14%	86%	9%	91%
Nevada	15%	85%	15%	85%
Ohio	15%	85%	8%	92%
West Virginia	15%	85%	12%	88%
Delaware	16%	84%	10%	90%
Mississippi	16%	84%	13%	87%
New Hampshire	16%	84%	13%	87%
New York	16%	84%	12%	88%
Kentucky	17%	83%	15%	85%
Michigan	17%	83%	11%	89%
Maryland	18%	82%	10%	90%
Missouri	18%	82%	17%	83%
North Carolina	19%	81%	17%	83%
Wisconsin	19%	81%	14%	86%
GROUP C—70% TO 79% A. C. SETS				
Vermont	21%	79%	12%	88%
Virginia	23%	77%	10%	90%
Arizona	26%	74%	4%	96%
Idaho	26%	74%	19%	81%
Minnesota	27%	73%	19%	81%
New Mexico	29%	71%	22%	78%
Oklahoma	29%	71%	20%	80%
Iowa	30%	70%	24%	76%
Wyoming	30%	70%	22%	78%
GROUP D—60 TO 69% A. C. SETS				
Nebraska	32%	68%	26%	74%
Montana	34%	66%	28%	72%
Kansas	35%	65%	28%	72%
GROUP E—LESS THAN 60% A. C. SETS				
North Dakota	43%	57%	35%	65%
South Dakota	49%	51%	46%	54%

BATTERY VS. A.C. SET SALES FOR 1927 AND 1928



Of the total radio receivers sold during the years of 1927 and 1928, and during the last quarter of 1928, these charts show what part of that number is represented by the sale of a.c.-operated receivers. It is interesting to note that even in the last quarter of 1928 the sale of a.c. sets is continuing to increase over the sale of battery sets.

PROFESSIONALLY SPEAKING



Needed—a Simple Battery Set for the Farmer

It is said that there is a potential market in this country for nine-million radio receivers for homes in which there are no power wires. These are rural homes, and homes far enough away from power lines to make it uneconomical to extend wires to them. It is in these nine-million homes that we believe a manufacturer with a good three- or four-tube receiver operating entirely from batteries and doing it economically would do not only a remarkable piece of business, but a great public service too. Using one screen-grid tube of the 222 type as r.f. amplifier, another screen-grid tube as detector (which will be about five times as sensitive as the 201A), and a power tube of the 112 type, the total plate current will be of the order of 15 milliamperes and the filament current required would be from 0.4 to 0.5 amperes at 5 volts.

The difficulty is that people have been educated to want greater power output than the 112 tube can deliver. The solution, which has been found in England and on the Continent, is the pentode tube, a tube with five elements instead of three or four as is common practice at present. It is an efficient power tube, consuming less filament power than most of our battery-operated tubes, requiring only moderate plate current at moderate plate voltages, and needing only a small input signal in order to deliver a moderate power output.

Elsewhere in this issue (page 154) will be found some technical data on how much power one can obtain from a tube of this type. These curves and independent measurements in the Laboratory indicate that a pentode will supply a power output equivalent to that obtainable from a 171-type tube at a plate potential of 180 volts—which until a year ago satisfied nearly every one. Furthermore, the plate current drain of a pentode is not over 12 milliamperes.

Now let us see what this means. If the pentode were connected to the detector through a 2:1 transformer the detector would have to put out from 2.5 to 8 volts (depending upon the tube) to load it up. A fully modulated signal of 0.25 volts (r.f.) will produce an audio voltage of 0.5 volts across 50,000 ohms in the plate circuit of a 301A acting as a grid leak and condenser detector. If the 322 is five times as sensitive it will deliver, on the same input, an output of 2.5 volts and will require about 0.75 volts to deliver the required 16 volts.

In a single stage of screen-grid amplification a gain of 50 can be obtained, and if the antenna is series tuned and coupled to the screen-grid amplifier another voltage gain of 15 can be obtained, making the voltage step-up from antenna to grid of detector 50×15 or 750, so that a field strength of approximately 80 microvolts per meter into a 4-meter antenna would deliver 700 milliwatts into the loud speaker. This is the sensitivity of receiving sets of a year ago.

Such a receiver would deliver signals of almost as good fidelity as receivers of a year ago. It would be somewhat deficient in low frequencies, and would not have particularly good discrimination against unwanted stations. It would have, perhaps, 30-kc. selectivity. The entire receiver, including loud speaker—as is conventional practice now—would be provided by the same manufacturer and so the farmer, or dweller far from power lines, could get his economical radio all in one package.

The General-Purpose Tube of the Future—the 224

The fact that the screen-grid tube is the tube par excellence for radio-frequency sockets, and that it can be used as a detector, coupled with the general use of single-stage a.f. amplifiers leads us to wonder if the a.c. screen-grid tube will not become the general-purpose tube of the future.

As a detector of the C-bias type, the 322-type tube is about three times as sensitive as the 327-type tube and the 324 is about ten times as sensitive as the familiar heater-type three-element tubes now employed in the detector socket of all a.c. receivers.

An article is being prepared for Radio Broadcast which will show the characteristics of the new a.c. screen-grid tubes when used as detectors, and data now at hand indicates that an audio-frequency output of sufficient voltage to load up a 171- or 245-type tube may be obtained with an r.f. input of from 2 to 3 volts.

Now let us look at this rather critically. Such a tube will have to be coupled to the grid of the following tube either through a resistance or a choke because of its own very high plate resistance. A 500-henry choke or a 200,000-ohm resistor could be used, but the latter would make it necessary to supply more voltage to the ground end of the coupling resistor than is used in the power tubes—which we shall assume will be the 245 type, for it appears to be the power tube for nearly all home receivers.

It looks, then, as though the screen-grid detector must be coupled to the following power tube through a fairly low-resistance high-inductance choke of low distributed capacity. If shunted by a 250,000-ohm resistor and by a capacity of not over 100 mmfd., a 500-henry choke would provide a characteristic as good as many of the best a.f. amplifiers now being put into commercial radio receivers.

The disadvantage of resistance or choke coupling would be the fact that a push-pull amplifier could not be used, and it seems to be the tendency at the present time to make the final stage push pull. If, then, another a.f. stage were inserted between the screen-grid detector and the power tube, a lot of a.f. gain would have to be thrown away in order to enjoy the advantage of push pull, namely freedom from hum on a.c. operation, cheapness of output transformer, and freedom from overloading difficulties.

With one or two screen-grid tubes as r.f. amplifiers, a screen-grid detector, and a power tube, with pre-selecting ahead of the r.f. amplifier, we ought to have a pretty economical set to build, operate, and keep in order. And there you are. Will the screen-grid tube become the general-purpose tube of the future? Our guess is as good as any one's.

VALUE OF FUNDAMENTAL KNOWLEDGE

By JOHN S. DUNHAM

QRV Radio Service, Inc.

A GREAT DEAL of discussion has arisen about the questionnaire published in the April, 1929, RADIO BROADCAST which is used by the QRV Radio Service, Inc., as an examination of applicants for the position of radio servicemen. Insofar as we have been able to ascertain it, the consensus is that the examination is more difficult than would be necessary to determine the ability of a good serviceman. We have talked with a considerable number of representative service managers and servicemen, most of whom feel that a good serviceman need not know enough to obtain a passing mark on that examination. Some few of the service managers with whom we have talked very heartily approve of the test and there have been a few who thought such an examination might justifiably be made even more difficult; but those who entertained that opinion have been distinctly in the minority.

The purpose of this article is to illustrate the value of the knowledge possessed by a serviceman who could obtain a good mark on that test. We shall attempt to do that by taking each question or group of questions separately and discussing just how the knowledge required to answer that question can be of practical aid in the servicing of broadcast receivers.



This motorcycle service and delivery truck is cutting down service costs for Atchison's Radio Shop, Philadelphia, Pa.

Service Standards

IT IS our opinion that one of the greatest troubles with the service game to-day is lack of realization on the part of the average serviceman that servicing broadcast receivers is a difficult technical pursuit, requiring both general and specialized electrical training. Because the average serviceman does not realize that fact, he is, as a rule, making little effort to provide himself with the technical knowledge pertaining to his work, without which he can never become a thoroughly efficient worker in the field he has chosen. It is our belief that the generally accepted standard of knowledge possessed by men who are considered "good" servicemen has been far too low, simply by virtue of ignorance on the part of the average employer of servicemen that there are men who know a great deal more about their work, and that an intelligent serviceman can be *trained* to know more—and thereby become more efficient—than has been generally thought necessary. It has been our *experience* that a man who cannot make a grade of at least 70 per cent. on our examination has not enough general knowledge of broadcast receivers to be a successful serviceman without a great deal of further training. And by a successful serviceman we mean a man whose work is not followed by a number of return calls, within two weeks, greater than 5 per cent. of the calls made by that man. The return call records of the work of three men employed by QRV, compared with their marks on the test, illustrates the point very clearly. One of these men—who is no longer with us—obtained an examination mark of 60.5 per cent. Over a period of four months, his work was followed by 14.4 per cent. no-charge return calls. The second man had a mark of 81.5 per cent. His work for the same period was followed by 4.3 per cent. return calls. The third man achieved a mark of 96.75 per cent. His work for the period was followed by *0.7 of one per cent.* return calls. Each of the three men made approximately the same number of calls during that period.

Replacing Rheostats

SOME of the servicemen who thought the examination to be of value, taken as a whole, are of the opinion that the portion of it in which we attempt to ascertain the knowledge of simple fundamentals possessed by applicants is an entirely unnecessary requirement. It is our opinion, and it is well borne out by long experience, that a thorough knowledge of the simple d.c. and a.c. circuits is exactly as important a part of the serviceman's working equipment as is his knowledge of how to locate an open in a plate circuit. For example, let us assume the case of a burned-out rheostat in an old set, the manufacturer of which is no longer in existence and for which no parts catalogue is obtainable. In such a case it is extremely rare to find the resistance value of that rheostat marked on it. The serviceman is faced with the problem of determining the proper value of resistance with which the damaged rheostat must be replaced. If he does not possess a working knowledge of Ohm's law, the only method by which he may determine the proper size of rheostat to get is to remove whatever remains of the resistor element of the damaged rheostat and take it with him on a time-wasting search for a new rheostat, the size and length of whose wire appears physically to match that of the old one.

On the other hand, if he is familiar with Ohm's law he will take out his pencil and set down the familiar fact that $R = E/I$. He will then multiply the filament current drawn by one tube by the number of tubes controlled by that rheostat, to get the total amount of current through the rheostat. He

knows that the voltage supplied by the storage battery is 6 volts, that to be supplied at the tubes is 5 volts, and he knows, therefore, that the minimum drop which must be caused across the rheostat by the current taken by those tubes must be one volt. But he knows also that it would be advisable to be able to reduce the voltage at the tubes to about 2 volts so that the maximum drop which will be necessary across the rheostat is 4 volts. Knowing the current through the rheostat and the maximum drop required he can substitute those values in the simple formula and very quickly determine the resistance value of the needed rheostat. Knowing that value and the value of current which the rheostat must carry safely, he can telephone an order to his distributor for a new one and thereby save himself and his organization the time which he would otherwise waste in hunting for a rheostat to match the old one. If the type of replacement which he orders is rated in watts instead of in current carrying capacity, he can calculate the wattage required by substituting the voltage and current values in one of the two simple Ohm's law formulas, $W = EI$, or $W = I^2R$. The time required for those computations should not exceed five minutes, but the time required in searching for a physical mate of the damaged rheostat may very easily extend into hours.

Exactly the same considerations apply in most instances when the replacement of any fixed or variable resistor is necessary in sets for which no parts catalogues are in existence, or, if in existence, are difficult to obtain. The experienced serviceman knows that there are literally hundreds of models of receivers in use to-day for which such parts lists cannot be obtained. He also knows that in most cases neither the resistance, current, nor wattage values are marked on the parts which need replacement. For that reason alone the few hours that it would take the serviceman to learn the fundamental formulas of Ohm's law would, generally speaking, save him at least an equal number of hours *monthly*, and often *weekly*.

Measuring Other Resistors

THERE ARE a good many times when it is impossible to match resistors by their physical appearance. It is usually possible to do so with variable resistors of low value, such as filament rheostats and wire-wound potentiometers of less than 1000 ohms, but it is rarely possible to do so with any other types of resistors, either variable or fixed. Fixed resistors such as those used in voltage-divider systems are usually covered with protective enamel so that the wire itself cannot even be seen. Resistors of higher orders of value than are generally employed in divider systems, such as grid-leaks which run up into the hundreds of thousands and millions of ohms, are usually not wire wound. Even if they were wire wound and the wire exposed, the size of wire used would be so small that it would be impossible to compare its resistance with that of another resistor simply by visual inspection. In any such case the only method by which a new resistor of the proper value can be selected in the absence of a parts list is by arithmetical calculation of the value needed in that particular part of the circuit. The serviceman who is not able to perform the necessary computation can be more hopelessly lost than a child separated from its parents at Coney Island on a hot Sunday, for there may be no kindly policeman around to guide him.

Let us take another example of a service problem that arises frequently with sets supplied from either alternating- or direct-current lighting circuits. In both of those types we have voltage dividers usually consisting of wire-wound resistors upon the value of which and the current through them depend the voltages applied to the plates of the tubes. If the value of one of those resistors changes in use the voltage applied to the tubes will no longer be the correct value. When servicing a set, if the E_p at the tube or group of tubes with common plate supply is incorrect, but the I_p is normal, the voltage supplied to the divider itself is normal, and there are no incorrect conditions elsewhere in the set, it is highly probable that the value of the resistance providing the drop for that tube or group of tubes has changed. There are two ways in which the correctness of that supposition may be determined. One is by substituting a new resistor of known value for the suspected resistor and then determining by test whether the E_p has returned to normal. That method can be used only if the serviceman happens to have with him the proper replacement unit for that particular divider system, which he is unlikely to have in most cases because the values and physical sizes of such resistors vary so widely that it would be necessary for a man who was performing service on all makes of sets to carry an entirely impractical number of such units with him.

The other method is to determine the exact value of the suspected resistor without removing it from the circuit, by the use of Ohm's law. Measuring the current through the resistor by inserting a milliammeter in series with it and measuring the voltage across it *and the milliammeter* at the same time, substituting the values obtained in the Ohm's law formula ($R = E/I$), and solving for the value of R, is an operation which can be accomplished in less time than would be required to remove the resistor and connect a new one in its place. That method not only saves time but it accurately determines the amount of variation from the correct value, and it also may be performed readily without equipment other than the usual good set analyzer. The man equipped with Ohm's law in that case saves time and he obtains definite knowledge which the man who is not so equipped could not obtain. That ability to calculate the value of a resistance is even more important when servicing some of the older socket-powered receivers than it is with the usual modern set, because some manufacturers were guilty of employing voltage-divider resistors which were not wire-wound (of the grid-leak type) which often do not have a sufficiently high wattage rating, with the result that their values are subject to wide changes.

Series and Parallel Resistors

SUPPOSE IN the shop it is found that the value of a divider resistor in a power pack has risen above its correct value to an extent which requires that it be replaced. Suppose also that no new resistor of the proper value is at hand, but there are in the shop a miscellaneous assortment of resistors of suitable wattage rating, which might be used for replacement. If the serviceman does not know how to calculate the value of resistance obtained by connecting resistors of known values in series or in parallel he will be unable to obtain the value he desires to use except by a lengthy and haphazard process of trial. If, on the other hand, he knows the two simple formulas for calculating the resultant value of both series and parallel arrangements, he can quickly, readily, and accurately pick out from his miscellaneous assortment a combination of resistors which not only will give him the desired value for replacement, but will also employ for that purpose the smallest number of those resistors which is necessary. The process of determining whether the miscellaneous resistors in the shop will be suitable and of designing a combination to give the proper value is one which may be performed in a very short time, whereas the trial method without the use of formulas can consume a very *long* time.

Capacity Determinations

THE SAME considerations apply to the value of knowing the formulas for series and parallel capacities. For example, suppose that the familiar ailment of a broken-down filter condenser has occurred and the only capacities which are available for replacement of that condenser are of different values than the one required. Assume that the value of the condenser which has broken down is 4 mfd. and the serviceman has available in his shop, or with him on the job, two capacities of 2 mfd., each of which would be suitable for replacement in the filter in so far as their voltage rating is concerned. If the serviceman does not know the effect on total capacity of either series or parallel connection of capacities, and if he happens to know that connecting two resistances in series increases the total resistance in that circuit—which he might know without being familiar with the formula—it would be logical to assume that he would connect those two capacities in series in the belief that the total capacity obtained would be the sum of their separate capacities, or 4 mfd. Actually, of course, the total capacity obtained would be 1 mfd. and in most cases when the set was con-

FREQUENTLY USED FORMULAS

The formulas given below are those which the serviceman may use daily in his work. Each of these should be memorized so that they become a practical part of his working knowledge of electricity.

Ohm's Law (Three Versions)

Volts (E) = Amperes (I) × Ohms (R)

$$R = \frac{E}{I} \qquad I = \frac{E}{R}$$

Power in Watts (Three Formulas)

$$W = I \times E \qquad W = \frac{E^2}{R} \qquad W = I^2 R$$

Condensers in Parallel

$$C_{TOTAL} = C_1 + C_2$$

Condensers in Series

$$C_{TOTAL} = \frac{C_1 \times C_2}{C_1 + C_2} = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2}}$$

Resistors in Parallel

$$R_{TOTAL} = \frac{R_1 \times R_2}{R_1 + R_2} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}}$$

Resistors in Series

$$R_{TOTAL} = R_1 + R_2$$

neeted up again the 60-cyele hum evident in the loud speaker would be greater than its previous normal value, and in some cases the output voltage of the filter would be lower than normal—depending upon the position of the condenser in the circuit. The serviceman, still assuming that he had replaced the filter condenser with the proper value of capacity, would not know the reason for the increased hum or the lower voltage and might spend fruitless hours in endeavoring to ascertain the cause. On the other hand, if that serviceman were familiar with the two simple formulas for determining the total capacity of series and parallel arrangements, he would have connected the 2-mfd. capacities in parallel, thus obtaining the total capacity of 4 mfd. and when the equipment was connected up again for trial the hum would not be greater than it was before, and the voltages would be correct, assuming all other conditions to be normal.

Assuming the same trouble as that described in the preceding paragraph, suppose that the only capacities available for replacing the 4-mfd. filter condenser were two capacities of 8 mfd. each, but the voltage rating of which was only half that required in the filter system at that point. The same serviceman would assume that the total capacity obtained by connecting those two capacities in series would be 16 mfd. Without even elementary knowledge of fundamental laws he might also assume it to be impossible to use those condensers because of their low voltage break-down rating. The serviceman who was familiar with the series and parallel capacity formulas and who also possessed a general knowledge of a.c. and d.c. phenomena would know, as illustrated in the preceding paragraph, that the sum of the two 8-mfd. capacities in series would be 4 mfd. and he would also know that the voltage drop across each of the two equal capacities would be approximately half of the total voltage across both of them (assuming the resistances of the two capacities to be approximately equal). The latter serviceman would insert those two condensers, knowing that they would meet the requirement, whereas the former serviceman, because of his lack of even elementary fundamental knowledge, would not use those two suitable replacement units and would keep the owner of the set waiting unnecessarily while he obtained a single 4-mfd. unit, and he would unnecessarily continue to carry in stock the two 8-mfd. units which might have been used up. These examples of the value of some knowledge of fundamentals are just a few picked at random for illustration, and enough similar illustrations of different cases where such knowledge is of very real value to the practicing serviceman could be given to fill many pages of this magazine. The money value of the time saved in actual practice by the serviceman possessing such knowledge is so much greater than the money value of the time necessary to acquire that knowledge that the returns on such an investment are well worth while.



A well-equipped service department plus servicemen carefully selected for their ability to create good will is one of the outstanding reasons for the success of Lancaster Radio Sales and Service, Philadelphia, Pa.

A.C. Knowledge Essential

The questions under fundamentals in the examination referred to deal only with d. c. except for the last question on capacities. However, it is important and is becoming increasingly so because of the increasing use of a.c.-powered sets, for the serviceman to have a working knowledge of fundamental a.c. phenomena. In the examination we are now preparing with which to determine the knowledge of applicants who come to us this Fall and which will replace the one under discussion, there will be a number of questions devoted to a.c., under the heading of fundamentals. All signal currents, both radio frequency and audio frequency, are alternating. The filament currents employed to heat the tubes in modern receivers are alternating. It is alternating current which is rectified to direct current for supplying the plate currents used by the tubes. The only direct current used in the modern radio receiver (other than those sets designed for operation from d.c. lighting circuits) is that which supplies power to the plate circuits of the tubes. All the rest is a.c. It would seem logical, even to a layman, that it would be worth while for a man whose vocation is the servicing of such receivers to know something of the fundamental phenomena of the currents with which he is constantly working. If a doctor whose business it is to work on a mechanism of arteries and veins carrying vital blood, which are comparable to the circuits of a radio receiver carrying vital electric currents, knew nothing of the fundamental laws governing the action of those vital currents in the human body, it is obvious that it would be impossible for him to succeed in his profession. Exactly the same conclusion may be drawn about the serviceman who knows nothing of the laws governing the action of the currents in a radio receiver.

A very good example of the value of such knowledge was brought strongly home to us recently. A serviceman of our acquaintance purchased a dynamic loud speaker which did not have an input transformer with it. He connected it to the secondary terminals of an output transformer following the usual 171A-type tube, fully expecting improved results over the cone loud speaker he had been using. Naturally the results were very poor, by virtue of the fact that the impedance of the secondary of the usual output transformer is designed to work into a loud speaker impedance of approximately 4000 ohms at 1000 cycles, whereas the input impedance of the average dynamic speaker is of the order of about 10 ohms. Had that man been possessed of working knowledge of fundamental electrical laws he would have known that maximum transfer of energy is obtained when the impedance of the load matches the output impedance of the transformer or other supply to which the load is connected, and that the transfer of energy falls off badly as the load impedance is decreased. He would also know that there is a modification of that rule which applies to the transfer of energy in the audio circuits of radio receivers. The modification is that the greatest amount of *undistorted* energy is transferred when the load impedance is approximately twice that of the impedance out of which it works. The serviceman described who did not know those things spent a large amount of time trying to discover the cause of his trouble, with the sole result that he became thoroughly disgusted with the dynamic loud speaker and pronounced it to be defective, with no basis for that conclusion other than the fact that it did not work. Had he known those a.c. laws pertaining to the transfer of energy he would have procured, before he attempted to connect the dynamic loud speaker to his set, an output transformer with a sufficiently high step-down turns ratio so that, while its primary impedance would still match the output impedance of the last tube, the impedance of its secondary would be equal to, or less than, the input impedance of the loud speaker at 1000 cycles.

Higher Standards

Standards of service are slowly but surely being raised. Service organizations discovered long ago that there is a very definite relationship between the extent of knowledge, theoretical as well as practical, possessed by a serviceman and the percentage of return calls with which it is necessary to follow that man's work. Dealers who realize the dollar and cents value of giving good service to their customers are discovering that the average servicemen who apply to them for positions in their service departments are not capable of giving their customers really satisfactory service. They are also discovering that the reason the average serviceman cannot perform efficient service is that he has not had adequate training for the work at which he professes to be an expert. A few dealers are learning gradually that there are, among the many servicemen who apply to them for work, a few here and there who have actually *studied* radio, and from their experience with the few men of that type whom they have been able to employ they are waking up to the fact that *only* such men are a profitable investment in service personnel. It behooves the servicemen who desire to continue servicing broadcast receivers as a means of livelihood and who have enough ambition to desire to increase their earnings by means of increasing their efficiency, to see the handwriting on the wall and realize that in order to learn thoroughly the subject of servicing radio receivers it must be studied with the same diligence with which one would study any other highly specialized technical activity.

IN THE RADIO MARKETPLACE

News, Useful Data, and Information on the Offerings of the Manufacturer

New Receivers Announced

THE WARE MANUFACTURING CORPORATION is the maker of a new receiver incorporating a band-pass amplifier to obtain sharp tuning without sacrificing the fidelity. The r.f. amplifier uses screen-grid tubes and the output stage employs a 245-type power tube. The table model lists at $195 and the console, which contains a dynamic loud speaker, retails at $125.

THE C. R. LEUTZ COMPANY has announced the Seven Seas Console Set. The set consists of three stages of tuned r.f., a detector, and one stage of a.f. Screen-grid tubes are used in the r.f. stages and two 210-type tubes in push pull are employed in the output. In the console is incorporated a dynamic loud speaker.

RADIO RECEIVERS for operation on 32-volt farm-lighting plants are being manufactured by the Federal Radio Corporation. The farm-lighting system supplies current for the filament and ordinary B batteries must be used for the plate supply. These sets are completely shielded and use the same circuit as is incorporated in the Federal sets, models E and F, designed for 110-volt a.c. operation. Prices range from $100 to $325.

THE FEDERAL ORTHOSONIC Model M is an all-electric receiver using five 227-, two 245-, and one 280-type tubes. The receiver is shielded thoroughly and each plate lead to the r.f. tubes is filtered hy resistors and by-pass condensers. The set is equipped with a "timher" control which permits the user to vary, to some degree, the characteristics of the audio system.

THE CONTINENTAL RADIO CORPORATION has announced three new designs of "Star-Raider" receivers, models R-20, R-30, and RP-40. The Technidyne circuit is used in a chassis consisting of seven 227-type tubes, two 250-type power tubes, and two 281-type rectifier tubes. An automatic line-voltage regulator is included in the power supply. The set has two dials, one a station selector and the other a volume control. A phonograph pick-up jack is provided. All models use a 14-inch dynamic loud speaker.

THE AMERICAN BOSCH MAGNETO CORPORATION announces three new receivers which have been designed to use the a.c. screen-grid tuhe. All three of the sets will use the same chassis which employs three screen-grid tubes as r.f. amplifiers, one 227-type tuhe as a detector, two 245-type tuhes in push pull, and a 280-type rectifier. The table model is reported to list at $119.50, the comhined set and loud speaker console at $168.50, and the De Luxe highboy at $240.00.

Miscellaneous Apparatus

THE MASTER ENGINEERING COMPANY, of Chicago, is the maker of a complete series of line-voltage control devices. Units with the capacity of either 60 watts or 100 watts may be obtained, the 60-watt size being generally suitable for use in such sets as the Atwater Kent, Radiola 18, Crosley, Philco, etc. The 100-watt size is especially adapted for use with radio sets utilizing dynamic loud speakers such as the Majestic, Radiola 62, Sparton, Zenith, Kolster, Fada, etc. The 60-watt unit sells for $2.50, and the 100-watt unit for $3.00.

A VARIABLE RESISTANCE capable of handling 20 watts and having a range of from about 40 to 10,000,000 ohms is being made by the Pilot Electric Manufacturing Company. This new resistor, known as the "Resistograd," will withstand potentials as high as 500 volts. The retail price is $1.00. Other resistors are made in sizes as follows: 0–50,000 ohms, 0–100,000 ohms, 0–200,000 ohms, and 0–500,000 ohms. These latter resistors will carry 0.125 watts and sell at $1.50.

THE DUBILIER type 688 filter condenser is rated at 2000 volts d.c., 1500 volts a.c., and is designed for use particularly in conjunction with the a.c. mercury-vapor rectifying tube which is frequently used in small transmitters.

ELECTRAD, INCORPORATED announces two new products, a 5-watt high-resistance volume control and a complete line of wire-wound covered resistors. The new volume control measures 2 $\frac{3}{16}$ by 2 $\frac{13}{16}$ by $\frac{5}{8}$ inches deep and is one-hole mounting. It incorporates a graphite resistor element fused to an enamel base. The volume control may be made in any desired range and either of uniform resistance or tapered to meet specifications.

The new Electrad fixed resistors are made in various sizes from 7.5 to 100 watts with various values of resistance up to approximately 175,000 ohms. The nickle-chromium alloy which is used for the resistance wire is wound on a piece of refractory tubing and is covered with an elastic enamel.



The new Bosch console receiver shown above has three screen-grid tubes and a dynamic speaker connected to the output of a push-pull stage. The cabinet has sliding doors.

NEW TYPE volume controls, balancing condensers, and small molded condensers are being made by the Polymet Manufacturing Corporation. The volume controls are made in various values of resistance. The molded condensers contain two insulated mounting holes and measure $\frac{1}{4}$ by $\frac{31}{32}$ by $\frac{1}{2}$ inch.

A UNIQUE "Rainbow" dial is being manufactured by the National Company. As the knob is turned various colors in turn illuminate the face of the dial. Other new products announced by this company are a tuner, type MB-29, which uses four a.c. screen-grid tubes and the new "Velvetone" amplifier. The latter device is completely a.c. operated and uses two 245-type tubes, one 227-type tube, and one 280-type rectifier. Another new product is the National Polarizer, a unit designed to supply voltages to condenser-type loud speakers. It lists at $12.50.

A DYNAMIC LOUD SPEAKER is being made by the Transformer Corporation of America. The diaphragm is one piece of large diameter. Special construction permits the elimination of the suspension spider at the apex of the diaphragm. These loud speakers are furnished to manufacturers with and without rectifiers or transformers. Special field coils are supplied to meet individual requirements.

A NEW DEVICE, the Plugairial, is announced by the Consolidated Corporations of Chicago. The device is designed to plug into a light socket and connection is provided for the antenna. List price: 85¢.

Items of Interest

THE ALUMINUM COMPANY OF AMERICA is prepared to furnish aluminum sheet of high purity, ordinary commercial purity, and in the form of various strong alloys. This material finds frequent use in radio receiving sets. The company also manufactures aluminum foil for use in fixed condensers. Complete data on the products of this company may be ohtained from any of their local sales offices located in the following cities: Albany, N. Y.; Boston, Mass.; Buffalo, N. Y.; Chicago, Ill.; Cincinnati, Ohio; Cleveland, Ohio; Detroit, Mich.; Indian apolis, Indiana; Kansas City, Mo.; Milwaukee, Wis.; Newark, N. J.; New York, N. Y.; Philadelphia, Pa.; Pittsburgh, Pa.; San Francisco, Calif.; St. Louis, Mo.; Toledo, Ohio; and Washington, D. C.

A MICROPHONE for use in broadcast stations is being distributed by the Gotham Engineering and Sales Company. It is of the two-button type with a solid back and uses a stretched duraluminum diaphragm. The unit lists at $75, or complete with ring desk mount, covers, and cord at $98.50.

A RADIO TEST PANEL for jobbers and dealers has been announced by the Jewell Electrical Instrument Company. This new model No. 581 panel makes possible the

rapid checking of both old and new receivers. The panel contains seven instruments as follows; 0–7.5 volts d.c., 0–75 volts d.c., 0–150–300–750 volts d.c., 0–15–150 milliamperes d.c., 0–4–8–16 volts a.c., 0–150–750 volts a.c., and 0–1.5–15 microfarads. The latter instrument measures capacities.

The Sterling Manufacturing Company's new tester, type R-522, makes possible the complete checking of all types of a.c. and d.c. tubes and sets. It contains six meters with no more than two scales on any one meter. Binding posts are provided so that the meters may be used as separate instruments if desired. The entire instrument is supplied with a morocco leather-grained case. The retail price is $40.50.

Personal Notes

H. P. Davis, vice-president of Westinghouse and formerly in charge of manufacturing operations, will devote his entire time to the activities of Westinghouse in the radio field. J. S. Trittle, formerly manager of the merchandising department, at Manfield, Ohio, will succeed Mr. Davis as head of manufacturing operations. Mr. Davis was graduated from Worcester Polytechnic Institute and has been with the company since 1891.

The Board of Directors of Kolster is headed by Rudolph Spreckels, chairman; other members are R. O. Bokee, Frederick Dietrich, Herbert H. Frost, Frank H. Hitchcock, M. C. Rypinski, Robert Hayes Smith, Howard Spreckels, and Ellery W. Stone. Officers of the company are: Ellery W. Stone, president; Frederick Dietrich, vice-president; Herbert H. Frost, vice-president; Howard Spreckels, vice-president; Robert Hayes Smith, vice-president; Augustus Taylor, vice-president; Henry C. Lang, secretary and treasurer. Saint G. Lafitte, who comes from the Spreckels companies in California, was chosen executive vice-president.

A. E. Emerick has been appointed manager of the Edison Distributing Corp., 500 Elm St., Dallas, Texas.

W. C. Evans, formerly assistant manager of radio operations for Westinghouse, has succeeded C. W. Horn as manager. Mr. Evans was formerly manager of KYW in Chicago and began his radio career at the age of 15 as radio operator aboard a Great Lakes ship. Immediately before his new appointment he was working closely with RCA Photophone in the sound motion picture field.

C. W. Horn, formerly manager of radio operations for Westinghouse, has joined the National Broadcasting Company as general engineer. He recently returned from a trip abroad with M. H. Aylesworth, president of N. B. C., where an inspection of foreign broadcasting was made.

Byron B. Minnium is now chief radio engineer with Stewart Warner. Mr. Minnium, a graduate of the engineering school, University of Cincinnati, was, like many others now in various branches of engineering work, formerly a ship radio operator. He pounded brass aboard Great Lakes passenger vessels for many years. He is responsible for the design of the Stewart Warner "balanced bridge" circuit used in their line this season.



The new Eveready Model 32 console receiver. The compact cabinet is made of selected walnut.

The Triad Mfg. Co., Pawtucket, R. I., announce the appointment of V. K. Wilson as assistant sales and advertising manager. Mr. Wilson comes from the Tower Mfg. Co., Boston, where he held a similar position. H. H. Steinle is vice-president and general sales manager of Triad.

Gold Seal, makers of radio tubes under the same name, announce the appointment of Frederick Holborn, Ph. D., as chief engineer. Dr. Holborn studied physics at Frielburg, Goettingen, and Wuerzburg and received his Ph. D. at Jena. He has been with DeForest, Westinghouse, and Kolster in recent years in research work.

Paul J. McGee, formerly of Zenith, is now service manager of Edison Radio. While with Zenith, Mr. McGee accompanied the MacMillan Arctic expedition in 1925 as radio operator.

Two new directors have been added to the board of directors of the Jenkins Television and the DeForest Radio Company. They are Robert A. Gardner of Mitchell, Hutchins & Co., Chicago, and Chas. G. Munn, president, Reynolds Spring Co., Jackson, Mich.



Two views of the new Silver Radio. This model in a sliding-door console cabinet lists for $195.

Dr. Alfred N. Goldsmith is now vice-president and general engineer of the Radio Corporation of America. His former title was vice-president and chief broadcast engineer. As before his office remains at 411 Fifth Ave., New York City.

The Fred G. Smith Company, 1049 Oakdale Ave., Chicago, has been appointed mid-west sales representatives of the General Amplifier Co., Cambridge, Mass. A. R. Wilson, formerly of General Radio, is president of General Amplifier which specializes in the design and manufacture of a complete line of power amplifiers.

Joseph Gershon is director of sales of the Buckingham Radio Corp., Chicago, one of the newest of the R.C.A. receiving set licensees.

Arcturus announces the appointment of John L. Stone as assistant to L. P. Naylor, sales manager. Other appointments include A. S. Van Bochove as western sales representative.

News of the Industry

The Joy-Kelsey Corp., of Chicago, have reorganized and are now known as the Oxford Radio Corporation. The new company is locating in a new Chicago plant at 3200 West Carroll Ave., where dynamic loud speakers will be made exclusively. Frank Reichmann, in charge of sales and engineering, announces that it is planned to build 500,000 units during 1929.

The Transformer Corporation of America, headed by Ross D. Siragusa, president and general manager, has just removed to a new plant at 2301 South Keeler Ave., Chicago. The new equipment will give eight times the capacity of the former factory at 1428 Orleans St. At the new location 25,000 finished units a day can be produced.

The Weber Distributing Corporation, formerly located at 90 West St., New York, is now located at 200 Hudson St., New York. The Weber Company distributed antenna wire, antenna kits, accessories, and replacement parts.

R. E. Smiley, vice-president in charge of sales for Bremer-Tully, Chicago, announces that the purchase of the B.T capital stock by Brunswick in no way affects the sale or production of radio sets under the B-T trademark. Bremer-Tully will continue to operate under its own identity.

The short-wave transmitter of KOIL, owned by the Monamotor Oil Co., Council Bluffs, Ia., went into operation late in April. The call signal is W9XU, and the operating frequency 6060 kc. (49.5 meters). Operating schedule is from 6 A.M. to 10 A.M., 11 A.M. to 2 P.M., and 5 P.M. to midnight, daily, C. S. T. W9XU carries all KOIL programs including those of the Columbia system and local programs from the KOIL's Council Bluffs and Omaha studios.

CLUB ALUMINUM ENTERS RADIO

The Club Aluminum Company and associates will manufacture an electric radio receiving set which will be sold direct to the home through salesmen and not dealers, it was announced by William A.

Burnette, president of the company. This phase of the company's business is termed the Radio Division and Douglas H. Cooke, of New York City, is general manager. All of the preliminary work has been perfected, it is said.

The Club Aluminum line will include three standard nine-tube models. In the manufacture of these sets the company has the use of all important radio and phonograph patents. The sets will retail at $240 complete, with tubes, and installed in the home.

"The same selling policy of Club Aluminum which has brought its products into more than 2,000,000 homes in the United States will be adopted by the Radio Division," Mr. Cooke said. "Our men will take the radio direct to the home and give a demonstration." It is expected that 10,000 salesmen will be qualified to sell the sets in offices in every principle city in the United States by this fall.



B. B. Minnium, radio engineer, Stewart Warner Corporation, Chicago, Ill.

RADIO-VICTOR CORP. OF AMERICA FORMED

THE RADIO-VICTOR CORPORATION OF AMERICA, incorporated under the laws of Delaware, will take over the sales activities of the R.C.A. and Victor. On the board of directors are representatives of General Electric, Westinghouse, and R.C.A. They include H. P. Davis, J. G. Harbord, J. L. Ray, A. W. Robertson, David Sarnoff, E. E. Schumaker, Gerard Swope, and Owen D. Young.

David Sarnoff is chairman of the board; J. L. Ray, president; I. E. Lambert vice-president and general counsel; A. E. Reoch, vice-president in charge of production, service, and traffic; H. C. Grubbs, vice-president Victor Talking Machine Division; Quinton Adams, vice-president Engineering Products Division; Meade Brunet, vice-president Radiotron Division; E. A. Nicholas, vice-president Radiola Division; E. C. Grimley, treasurer and comptroller; Francis S. Kane, secretary.

"The world-wide sales organizations of Victor and R.C.A.," said General Harbord, "will be brought together under one management. The personnel of both will be retained. The unified laboratory, factory, and sales facilities of the new company will make possible a more complete service to the trade and public, according to J. L. Ray, the new president,

Under the new arrangement the Van Courtlandt Park Laboratories of R.C.A. now house only the Research Division. This is headed by Julius Weinberger and his technical staff includes Messrs. Raymond Guy, Irving Wolff, T. A. Smith, Ringel, and Griswold. On April 15 the Technical and Test Divisions, headed by Arthur F. Van Dyck, removed to the Camden Radio-Victor plant. Located in Camden with Mr. Van Dyck are the following engineers: E. T. Dickey, F. H. Engel, E. J. Quinby, Anderson, Howard, and Bunting.

CHANGES IN KELLOGG ORGANIZATION

RECENT CHANGES in the Kellogg organization at Chicago include the appointment of W. J. Leighner as works manager, E. J. Brennan as Chicago District Sales manager, and Fred H. Timperlake, of Chicago, as sales representative in Michigan and Indiana.

Mr. Leighner for the past six years was works manager for Westinghouse plants at South Bend, Milwaukee, St. Louis, and Valdosta, Ga.

Howard F. Curran has been appointed manager of the Kansas City Branch, Edison Distributing Corporation. Mr. Curran was formerly radio department manager of H. L. Spencer Co., Iowa radio distributors.

R.C.A. OPENS TRANSCONTINENTAL CIRCUIT

THE FIRST STEP in an R.C.A. domestic radio system was taken recently, in the opening of a radio telegraph circuit between New York and San Francisco, according to James G. Harbord, president of R.C.A. In experimental operation, speeds as high as 250 and 300 words per minute have been obtained, using the "improved beam-projector" system. It is understood that about 20 kw. is employed in the high-frequency transmission. Interruptions due to static and fading have been minimized through the use of multiple receiving antenna systems. Message transmission is made on high-speed tape transmitters but it is understood that it is not yet possible to employ automatic recorders at the receiving end. Transmission is direct between New York and San Francisco and messages are accepted at the Boston and Washington offices of R.C.A. Communications, Inc., whence they are sent to New York by wire circuits. Rates are the same as those now applying on land wire circuits.

The Radio Dealer's Note Book

NO. 5. VACUUM TUBE MANUFACTURERS

*Free—Complete Information**

ACCURATE summaries of useful information are constantly of value to those radio folk who deal with the public. This sheet, one of many on various subjects to follow, sets down collected information on vacuum tube manufacturers. The dealer or serviceman can remove this part of the page for his notebook or he can have it photostated.

Tubes are certainly the most important item, apart from radio receivers, that a dealer must handle. For this reason considerable thought must be given to the problem of how many makes of tubes he will stock and from what manufacturers he will purchase them. Even though a dealer may have decided these questions to his own satisfaction he should, nevertheless, make certain that he is thoroughly familiar with the products of all the tube manufacturers. Under such conditions the dealer will frequently find it possible to draw helpful comparisons between the tubes he is carrying and those being made by some other manufacturer. The list of manufacturers in this month's "Note Book" is quite complete, representing practically all of the prominent companies.

**As a service to readers, the Editors have arranged that dealers may obtain complete information on the products of all the manufacturers listed in the table by writing to the Service Department of* RADIO BROADCAST *and asking for data on vacuum tube manufacturers. All requests must be written on a business letterhead or a card must be enclosed to identify the writer as a dealer or serviceman.*

MANUFACTURER	TRADE NAME	REMARKS
Allan Mfg. and Electrical Corp.	Vogue	All types
American Bosch Magneto Corp.	Bosch	All types
Arcturus Radio Tube Co.	Arcturus	A. C. tubes and rectifiers
Armstrong Elec. & Mfg. Co.	Armor	All types
Bond Electric Corp.	Bond	All types
Cable Radio Tube Corp.	Speed	All types
CeCo Mfg. Co.	CeCo	All types
Champion Radio Mfg. Co.	Champion	All types
Consolidated Vacuum Tube Co.	Kovac	A. C. tubes and rectifiers
E. T. Cunningham, Inc.	Cunningham	All types
Daven Radio Corp.	Daven	All types
DeForest Radio Co.	Audion	All types
Diamond Battery Company	Diamond	All types
Diamond Vacuum Products Co.	Diatron	All types
Duovac Radio Tube Corp.	Duovac	All types
Duval Radio Corp.	Duval	All types
Emerson Radio & Phonograph Co.	Elektron	All types
French Battery Company	Ray-O-Vac	All types
Gold Seal Electrical Co.	Gold Seal	All types
Grigsby-Grunow Company	Majestic	All types
Hygrade Lamp Co.	Hygrade	All types
Hytron Corp.	Hytron	All types
Hyvac Radio Tube Co.	Hyvac	All types
Kellogg Switchboard & Supply Co.	Kellogg	A. C. tubes only
Ken-Rad Corp.	Ken-Rad	All types
La Salle Radio Corporation	La Salle	All types
Marvin Radio Tube Corp.	Marvin	All types
Munder Electric Company	Vox	All types
National Carbon Co.	Eveready-Raytheon	All types
Neonlite Corp. of America	Neonlite	All types
Northern Mfg. Co.,	Marathon	All types
Perryman Electric Co.	Perryman	All types
Radio Corp. of America	Radiotron	All types
Raytheon Mfg. Co.	Eveready-Raythcon	All types
Schickerling Products Corp.		All types
Sonatron Tube Co.	Sonatron	All types
Sunlight Lamp Co.	Crusader	All types
Sylvania Products Co.	Sylvania	All types
Televocal Corp.	Televocal	All types
The Quinn Radio Tube Co.	Quinn	All types
Triad Mfg. Co.	Triad	All types
Tung Sol Lamp Co.	Tung-Sol	A. C. tubes and rectifiers
Universal Electric Lamp Co.	Buck	All types
Van Horne Tube Co.	Van Horne	All types
Zetka Labs., Inc.	Zetka	A. C. power tubes and rectifiers

THE ALLIED BROADCASTING COMPANIES, INC. are now located at 1780 Broadway, New York City. Allied Broadcasting represents the following west-coast stations: KJR, Seattle; KEX, Portland; KGA, Spokane; KYA, San Francisco; KMTR, Los Angeles; KDYL, Salt Lake City; and ELZ, Denver. The New York Office handles all matters relating to broadcasting on this network from points east of Chicago.

RADIO SET FOR AUTOMOBILES

THE AUTOMOBILE RADIO CORPORATION OF NEW YORK recently showed a receiver called the "Transitone" for installation on motor cars. The controls of the set are located in the dashboard of the car by relocating the instruments there; the antenna is installed in the roof, or, if the car is of the open type, the screen antenna folds down with the top with satisfactory results in either position. A standard tuned r.f. circuit is used and a special filter system to reduce ignition noise is a part of the installation. Offices of the company are at 37-7 Queens Boulevard, Long Island City, New York. Ralph Heina is chief engineer.

ZENITH ENTERS LOW-PRICE FIELD

MODEL 42 IS announced by Zenith, of Chicago, to sell at $175. It uses eight a.c. tubes including rectifier. Screen-grid tubes are employed as well as "automatic" tuning. Unusual sensitivity is obtained, according to the announcement, through the use of a separate control which serves as a combination switch and volume control. Additional selectivity is attained through the use of another control on the right. A patented switch and connection is also provided for a phonograph pick-up unit. The automatic tuning unit is concealed at the upper right of the cabinet, which is a lowboy console. Zenith states that its recent acquisition of a new factory in which all their cabinets are produced enables decreases in list prices. The company now makes all its parts as well as cabinets.

NEW KELLOGG RECEIVERS

THREE NEW SETS are announced by Kellogg, of Chicago, Nos. 523, 524, and 525. Each employs screen-grid a.c. tubes and large power-handling tubes in the last stage. Model 525 is a combination radio-phonograph set. The other two are arranged to permit the use of a phonograph pick-up unit. Each set has three screen-grid tubes in the r.f. system feeding a "power" detector with high plate and grid voltages. The detector output in model 523 feeds a push-pull 245 audio channel, while two 250 tubes in push pull are used in the other models. Each set is equipped with a manual and automatic volume control. Model 523 employs the following tubes: three screen-grid a.c. tubes, three 227-type a.c. tubes, two 245-type power tubes, and one 280-type rectifier. Model 524 and the radio-phonograph, model 525, use the following: three 224's, three 227's, two 250's, and two 281 rectifiers.



The new National "Rainbow" dial is of modern design and construction. As the knob is turned the scale reading is projected in color on the ground-glass screen.



The Transformer Corporation of America has removed to the new plant pictured above. Their new equipment will have eight times the capacity of the former factory.

CONTINENTAL RADIO OFFICERS

OFFICERS AND DIRECTORS of the Continental Radio Corporation, Fort Wayne, Ind., are Charles M. Neizer, chairman of the board; S. Paul Mozeman, vice-president; John A. Thieme, secretary-treasurer; other board members are, Henry J. Miller, W. H. Noll, W. J. Vesey, Max B. Fisher, Carl D. Boyd, W. C. Rastetter, and Joseph Lush (also treasurer, Hammarlund Mfg. Co.). Carl D. Boyd is president of the company, and Henry S. Schryver is chief engineer.

NEW TELEVISION SCHEDULE

IN ORDER TO allow a greater period for study of television reception at various locations, especially during the evening, the daily transmission schedule of the Radio Corporation's experimental television station, w2XBS, has been extended to include the hours of 9–11 P.M. This change took effect May 6th. Beginning April 30th, w2XBS has been operating on Eastern Daylight Saving Time.

Since early in March, when the operating schedule was announced, w2XBS has been transmitting daily from 7–9 P.M. on a frequency of from 2000–2100 kilocycles. Transmitted pictures consist of sixty horizontal lines, each divided into seventy-two elements laterally. Twenty pictures are scanned per second. The new daily schedule will permit experimenters to observe signs, photographs, and views of persons between the hours of 7–11 P.M.

NEW FINANCE PLAN

UNDER THE terms of an arrangement just completed between the Kellogg Switchboard and Supply Company of Chicago, and the General Contract Purchase Corporation of New York, Kellogg dealers may now avail themselves of a convenient and economical method of handling their customer's time payment paper.

A feature of the plan is a copyrighted sales chart furnished to the dealer which eliminates any necessity on the part of the dealer for figuring terms or rates.

With the payment chart the dealer merely asks the customer how much he or she can afford to pay each month on the due balance. The sales chart then gives the exact amount of the contract, the exact amount of the payments, and the number of months the contract runs. Another most desirable feature of the plan is that the customer, seeing the printed figures, does not try to haggle or bargain. He accepts them as they are.

ERLA BUYS CABINET FACTORY

THE CHICAGO PLANT of the Cable Piano Company was bought by the Electrical Research Laboratories. Cabinets, receivers, electromagnetic pick-up units, and dynamic loud speakers will be manufactured. Equipment for manufacturing 1500 cabinets daily was taken over as part of the purchase, and contemplated additions to the equipment are expected to increase cabinet capacity to a maximum of 2500 per day.

Manufacturing operations now conducted at the Erla plant at 2500 Cottage Grove Ave., and at the Greene-Brown plant at 5100 Ravenswood Ave., will be transferred to the Cable plant as rapidly as possible.

THE CHICAGO OFFICE of the DeJur-Amsco Corporation, at 77 West Washington Street, has been removed to larger quarters in the Wrigley Building, Chicago. The change was made May 1st. Mr. William E. Burgoyne is in charge.

SPARTON DEVELOPMENTS

CONTINUING ITS POLICY of manufacturing of every part that goes into Sparton sets the Sparks-Withington Company of Jackson, Michigan, are equipping a new plant for the making of light metal punchings. Machinery is being installed which will be used in the making of a great number of parts for Sparton sets. The new plant will provide space for several hundred additional employees. During the peak of the 1928 season more than 4000 persons were engaged in the making of Sparton sets, and this will be increased greatly during the coming year. The Sparton organization has grown from approximately 500 individuals to more than 4000 within the short space of four years.

LOUD SPEAKER RESPONSE MEASUREMENTS

By P. H. TARTAK

Chief Engineer, Sleeper Radio and Manufacturing Co.

WITH THE ever increasing demand of the public for faithful reproduction and true tonal values from loud speakers it has become necessary for various manufacturers to develop equipment of such a nature that the fidelity of loud speakers may be indicated by some visible means and the results examined at leisure. This article deals with a method for measuring the characteristics of a loud speaker on a comparative basis. It also includes a discussion for making tests on amplifiers and radio sets.

The tests performed are applicable only to a laboratory and were made in a specially constructed sound-proof room. A loud speaker under such conditions would not give the same response to the ear that it would if it were operated in the average home because of the acoustical properties of the room. However, the results are indicative of the performance of one loud speaker in comparison to another subjected to the same test and under the same conditions.

To study the behavior of the loud speaker under test with variation in frequency output, a responsograph and its associated equipment were used. This apparatus consisted of a beat-frequency oscillator having an external variable condenser the shaft of which was coupled to a drum on the responsograph. The output of the oscillator was put through an a.f. amplifier and then to the loud speaker on test in the sound-proof room. A two-button microphone was placed in front of the loud speaker and a shielded cable led from this room to the modulation control box and then to an amplifier, whose output fed into a specially designed vacuum-tube voltmeter. The microammeter, which is a part of the vacuum-tube voltmeter, was mounted inside the responsograph.

The responsograph itself is shown in Fig. 5 and consists of a variable condenser whose rotor is coupled to a paper roller. The frequency of the oscillator is altered by rotating the condenser, which moves the paper strip upon which the graph is made. At the same time the variations of the needle on the microammeter are followed by a lever which is connected to a stylus. The stylus is constructed so that its motion is linear, even though the motion of the needle is circular.

An audio-frequency oscillator of the beat-frequency type was found to work best for making the curves because of the case of varying the frequency from 50 to 5000 cycles. The oscillator produced a very good sine wave as indicated by an oscillograph and its output was very steady over the entire range. The detector output of the oscillator was arranged so that it could be switched to any type of a.f. amplifier, since different types of response curves of loud speakers could be obtained by using different amplifiers and tubes.

The Sound-Proof Room

THE SOUND-PROOF room is of specially constructed sound-absorbing material and its walls are eight inches thick. By placing the microphone at various distances and angles from the loud speaker it was determined that standing waves due to reflection were negligible. The picture in Fig. 2 shows the interior of the sound-proof room with a speaker microphone in test position. It was found by experiment that the best results were obtained when the microphone was placed one foot away from and in line with the center of the loud speaker because the waves were then transmitted directly to the microphone.



Fig. 1—Complete view of the loud speaker measuring apparatus described in this article.

A two-button microphone was used in conjunction with a resistance-coupled amplifier having a straight-line-frequency response. As can be seen from Fig. 3, the amplifier is arranged so that the output may be attenuated by means of varying the resistance in the grid circuit of the last tube.

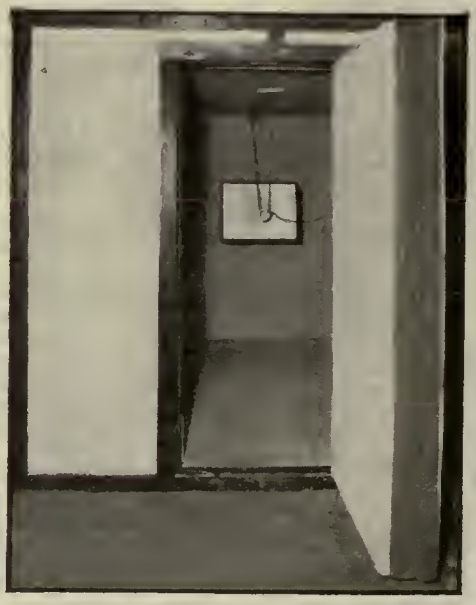


Fig. 2—Interior view of the sound-proof room in which loud speaker measurements are made.

The vacuum-tube voltmeter is of the plate-rectification type and uses the voltage-bucking method of keeping the plate current out of the microammeter. In order to get the complete curve on the paper without changing the scale or attenuating the signal during a single test the vacuum-tube voltmeter was designed so that its voltage variation was not linear. This was accomplished by using the proper shunt across the meter and a resistance in series with it. For convenience in making the test and also for increasing the accuracy of the vacuum-tube voltmeter, a reading of ten microamperes was taken for the zero setting. The d.c. voltmeters are arranged in the circuit so that the correct filament, grid, and plate voltages may be obtained readily, thus maintaining the calibration of the voltmeter.

Figs. 1 and 4 indicate apparatus layout as well as their position with reference to the responsograph.

In order to keep the results consistent from day to day, middle "C" or 256 cycles was chosen as a reference point and the output of the apparatus was adjusted at this frequency. At the beginning and end of each test the output of the oscillator-amplifier combination was thrown to a calibrated vacuum-tube voltmeter used as a volume indicator and the value checked at 256 cycles. By keeping this value constant for all readings and also noting the attenuation on the microphone amplifier all the curves were comparable.

In all loud-speaker response curves, the sound intensity in DB was plotted against frequency. The equipment was adjusted so that the highest peak obtained reached the 100 mark on the microammeter scale. This voltage, E, was taken and the height of the various reference points were calculated in DB on this basis. From the mathematical

formula DB=20 log E, and from the calibration of the vacuum-tube voltmeter, E was obtained for various points. Thus it was possible to measure just how many DB one peak was above another.

Curve A in Fig. 6 shows the response curve for an Airchrome loud speaker; B is the curve of an air-column loud speaker; C is that of a cone loud speaker; D is that of a dynamic loud speaker, and E is that of the same dynamic with the condenser across the loud speaker input. The curves indicate the resonant peaks caused by the component parts of the loud speakers and units. By using filters consisting of condensers and chokes, various peaks can be removed without affecting the response at any other point. The first resonant peak of fair size indicates the fundamental response of the diaphragm.

Value of Curves

INASMUCH AS the microphone was not calibrated with the equipment used, the tests, as previously explained, have been made only on a comparative basis; that is, the performance of a loud speaker and the response in one loud speaker can be compared to another only when the tests are made in the same laboratory. However, by using a condenser microphone and a thermophone, the responsograph can be calibrated easily on an absolute basis, in which case the curves obtained in one laboratory would be comparable with those obtained in another one.

Unless a pure sine wave is impressed at all times, the shape of the curves for any loud speaker would not be the same from time to time and the tests would mean nothing.

All of these tests were made using a sinusoidal input and do not indicate the performance of the loud speaker when music or speech is impressed. This accounts for the fact that, although a loud speaker very often gives a good response throughout the entire range of frequency, it does not perform well on mixed frequencies. This is due to the fact that the lower frequencies carry most of the speech energy while the articulation and intelligibility depend upon the higher frequencies.

In studying the behavior of loud speakers it was observed that changing the shape of the diaphram or its mass affected its response. It was also observed that when a loud speaker had a condenser across its input the high frequencies were cut off. This gave the low frequency or bass notes a predominance and speech then became difficult to understand because the articulation decreased when the high notes were cut off.

Using the responsograph, it was also possible to study the effect of baffling loud speakers, the response varying with the size of the baffle. It was also possible by means of the responsograph to determine the cabinet resonance of any compartment in which the loud speaker was placed. Another interesting experiment consisted of testing the efficiency of various band-pass filters as well as determining how sharp the cut-off's were.

Another use to which the responsograph could be put is to measure the overall characteristics of a radio set and loud speaker combination. For this purpose an r.f. oscillator modulated by means of a beat-frequency oscillator would be used. With this apparatus it would be possible to observe just how cutting off sidebands affects the a.f. system. It would also provide a means of perfecting the radio set so that there is nearly constant frequency response throughout the entire range.

The author wishes to acknowledge the use of apparatus and the assistance which has been rendered by Professor Andres and his staff of engineers at the Temple Laboratory.

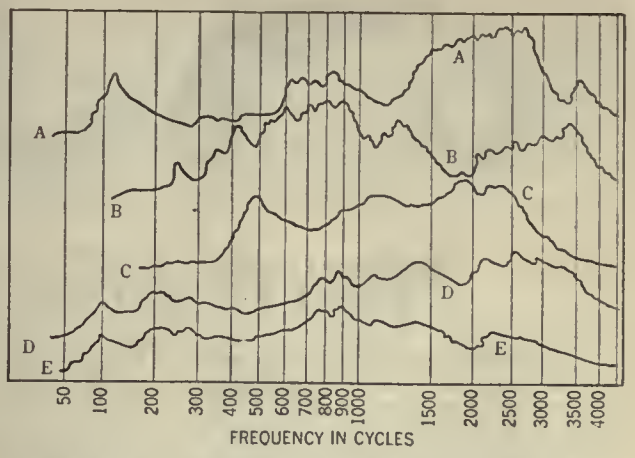


Fig. 6—Sample response curves made with five different types of loud speakers. Note: These curves are not intended to indicate the level at which the speakers are operating but only the relative response at various frequencies.

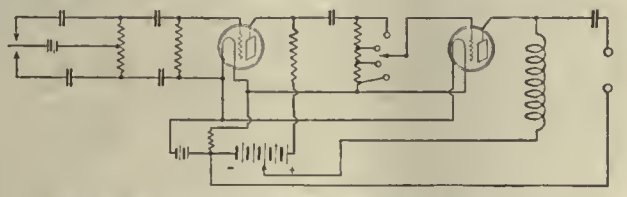


Fig. 3—Schematic diagram of the a.f. amplifier used in making loud speaker response measurements.

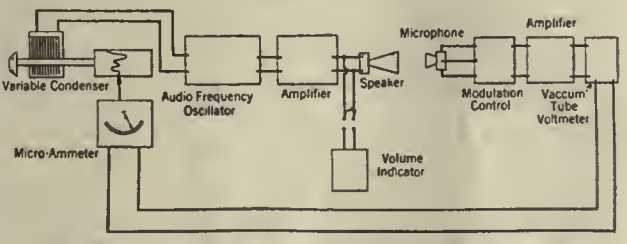


Fig. 4—Schematic diagram showing the set-up of apparatus when making loud speaker comparisons.



Fig. 5—View of a responsograph of the type used for making comparative loud speaker measurements.

BOOK REVIEWS

TELEPHONE AND POWER TRANSMISSION, by R. Bradfield and W. J. John. Published by John Wiley & Sons, Inc., New York City, 234 pages. Price: $5.75.

This new book will take its place in the telephone library along with other standard texts on the theory underlying the transmission of intelligence along wires. It was written by R. Bradfield, late of the engineering department of the British General Post Office, and W. J. John, lecturer in electrical engineering at East London College.

This book is not like that of K. S. Johnson's *Transmission Circuits*, a practical book, but is one dealing with the mathematical theory of the propagation of electric waves on wires. It furnishes its own mathematics but to prevent throwing a scare into any potential reader, let us hasten to set down the aim of the authors, "to write for that vast majority of students and practical engineers who are engineers first and mathematicians only in so far as their profession demands."

The authors realize that hyperbolic functions look more formidable than they really are, and that a telephone engineer has little need for the mathematical concepts on which hyperbolics are based. An engineer wants to know how to solve problems by their use—and to serve that end, examples and problems are included in the text.

There are chapters on general theory of transmission, the application of theory to actual telephone transmission, measurements of line constants, transmission of power on wires, effect of transformers on voltage drop in transmission circuit, traveling waves in transmission lines, etc.

More than half of the book is taken up with the transmission of power on wires, and for anyone contemplating the transmission of radio programs on power wires, this part of the book is useful.

There are a number of tables in the book on such subjects as sizes and resistances of standard-gauge wires, attenuation of various types of lines, mathematical tables of hyperbolic functions, etc. It is interesting to note that the decibel (DB) or the transmission unit does not seem to be mentioned in the book and that losses and attenuation is still spoken of with regard to the mile of standard cable. —K. H.



STRAYS *from* THE LABORATORY

Data on Foreign-Made Pentode Tubes

THE CURVES IN Fig. 1 and Fig. 2 are published through the courtesy of M. E. Bond, engineering department, American Bosch Magneto Company. They show the power output from a Mullard Pentode, and the manner in which it varies with various load resistances. It is interesting to note that with an input of 5 volts on the grid, a power output of 800 milliwatts can be obtained. In the Laboratory it was possible to get this same power from the Philips (Holland) Pentode with a grid voltage of 16, and so the Mullard valve is more sensitive.

Experiments in the Laboratory with Ediswan Pentodes indicate that such a tube with 150 volts on the plate and drawing about 12 milliamperes will deliver power equal to that from a push-pull 171 amplifier with about one third the input voltage.

Listening tests, comparing the Ediswan Pentode working into standard loud speakers through an Ingranic output transformer designed to couple these high-resistance tubes to low-resistance loud speakers, indicate that there is still a lack of low-frequency response compared to the reproduction from the 171 push-pull amplifier using an Amertran transformer. This lack of low frequencies, however, is not as bad as may be noted from some of the newly designed loud speakers sold in this country, and touted as being the last word in "perfect reproduction."

Symbols Used in Technical Radio Writing

IN RADIO LANGUAGE there are many symbols, short-hand expressions, that make it rather picturesque and rather unintelligible for the layman. Some of these symbols have international acceptance, some are used only in this country, and some have not been agreed upon generally even in this country.

For example the Greek letter "*omega*" (ω) is sometimes used to indicate resistance in ohms, and sometimes megohms. Similarly, the large Greek letter "*omega*" (Ω) is used indiscriminately for ohms and millions of ohms.

The Greek letter "*mu*" (μ) is used generally in this country for the amplification factor of a vacuum tube. It is also an abbreviation for "millionths"; thus, microhenry is abbreviated to μh.

The small "*omega*" (ω) is used for the expression $2\pi f$ or $6.28 \times f$ where f is the frequency in cycles. It enters into many electrical calculations. Thus, the reactance of an inductance is ωL or $6.28 \times L \times f$. Strictly speaking, ω is an abbreviation or symbol for the "angular velocity of the vector representing a sine wave of current or voltage, and is expressed in radians." A radian is a measure of the arc through which the end of the vector travels, 6.28 radians constituting an entire circle of 360 degrees.

The Greek letter "*lambda*" (λ) is used for the wavelength in meters. Thus $\lambda = 300$ would be read "wavelength equals 300 meters."

The small or capital letter "r" and "R" is used almost universally for resistance.

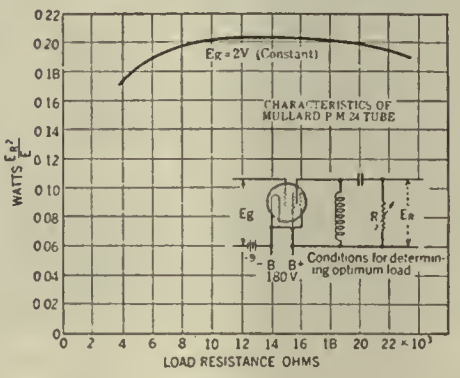


Fig. 1

Thus, R_p indicates the plate resistance of a tube. The letter $_p$ is called a subscript and states that "R" in this case is a particular resistance, that connected with a tube.

In a similar manner, subscripts are used on the letters "E" and "I", denoting voltages and currents to form E_p, E_g, E_f for the plate, grid, and filament voltage of a tube, and I_p, I_g, and I_f to indicate the plate, grid, and filament currents. Generally speaking, large letters denote d.c. values, small letters indicate a.c. values, but here the usage is not universal and some authors use one convention, some another. Thus, I_p may refer to the steady B-battery current in the plate circuit of a tube. This flows whether or not there is any a.c. grid voltage, e_g. When there is an a.c. grid voltage there is an a.c. plate current, i_p, as well as the d.c. plate current.

The letters "DB" are used as an abbreviation for the "decibel," a unit of transmission loss or gain. It has the same value as the TU which it replaces in technical language.

The letter "G" is a symbol for conductance. A conductance is an expression telling how well a certain circuit conducts currents, just as resistance tells how much it impedes the progress of a current. Conductances are measured in mhos (ohm spelled backwards). Thus, the mutual conductance of a tube is its G_m and is usually expressed as micromhos. In England this expression becomes "S," the steepness of the grid voltage-plate current curve.

The Greek letter "*tau*" (τ) is sometimes used for the coefficient of coupling between two coils; sometimes the letter "K" is used for this same expression.

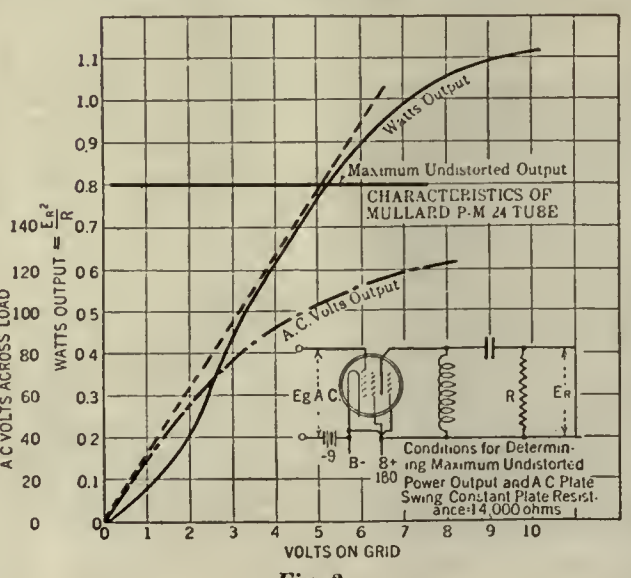


Fig. 2

Fluorescence in Radio Vacuum Tubes

WE NOW HAVE the last word on the strange flickering of light within a vacuum tube when signals are put on its grid. We had laid it to fluorescence, and, following the dictionary, stated that this fluorescence was due to organic material within the tube. This theory was exploded by a reader who wonders how any organic material could survive the heat which the tube undergoes in the manufacturing process. He is correct; no organic matter could. And here is the correct explanation, coming from the engineering department of the General Electric Research Laboratory.

"Fluorescence under electron bombardment is a property possessed by a number of different chemical salts. For X-ray work zinc sulphide is one of the ingredients most commonly used. It is also well known that certain salts of barium and calcium fluoresce when bombarded by electrons under certain conditions.

"It, therefore, seems very probable that the outside of the anode of the tube accumulates a small amount of some salt which shows fluorescence under electron bombardment.

"There may be several sources for such material; notably, from the active filament coating or the getter used. The gas free specially cleaned anode surface is particularly sensitive to receiving such an active material. During operation of the tube there are many stray electrons that have escaped through the end of the grid and plate and these strike the outside of the plate. Variations in grid voltage at an audio rate change the path of the electrons and, therefore, cause different portions of the plate to fluoresce.

"Fluorescence is not associated with organic material, as is well proven by the ordinary X-ray fluorescent screen. Phosphorescence, however, is usually associated with an organic material."

ENGINEERING BEHIND A CROSLEY SET

By KENNETH W. JARVIS



Kenneth W. Jarvis

EVERY SEASON has brought forth upon the market new radio receivers; new in appearance, new in operations, and new in claims as to their great superiority over all previous models. Just what provokes this customary offering on the altar of public service? Technically, it is a result of new inventions or from more intensive engineering development. From the merchandise angle, the public demand for something new and different is an impelling motive. It is the purpose of this article to show how such a recent set (the Crosley Jewelbox) was developed and how its claims to superiority are justified.

The "average" radio receiver of last season comprised an untuned radio-frequency amplifier and two or more tuned stages of radio-frequency amplification. This was followed by a grid-leak-condenser type detector using a heater tube, such as the 227. The first audio stage, as did the radio stages, used a low-voltage filament tube such as the 226. The output system employed one or two low-impedance tubes such as the 171A. The set was transformer coupled throughout, good design insuring a satisfactory fidelity. The volume control was a variable input system to the untuned r.f. stage.

The First Improvement

WITH THIS as a starting point, changes can be suggested and tried out. The first proposal is to change the input system. The advantages of the untuned input system are very real or so many manufacturers would not have used it. Its greatest advantage is in producing a unicontrol set, as the antenna capacity cannot affect any of the tuning units. It is economical and conservative of space and material. A properly designed choke coil can be used to provide a greater amplification on the lower radio frequencies and thereby flatten out the usually sloping sensitivity curve. It provides a convenient place to operate a volume control.

However, in comparison with a tuned input system, the untuned amplifier shows several gross faults. It is relatively insensitive. If the average amplification over the entire broadcast band is greater than one, the designer may consider himself fortunate. The untuned system does not contribute in the least to the selectivity of the receiver, a factor which is requiring major consideration in these days of congested broadcast traffic. Due to the fact that no vacuum-tube amplifier is absolutely linear in characteristics, this untuned stage may produce peculiar effects. The second harmonic of strong local stations may be generated in this tube and then the station may be received at two places on the dial. Obviously, this can occur only with stations operating between 550 and 750 kilocycles. (The second harmonic of 750 kc. is 1500 kc., the limit of the tuning range of the receiver). Due to this same non-linear characteristic, and the lack of selectivity, a strong local station may modulate a weak distant station, and therefore be heard whenever these weak stations are tuned-in.

There is certainly room for improvement here. The tuned stage has major advantages in the increased amplification and selectivity. However, the cost is greater and it adds an extra control to the receiver. Measurement and experiment have shown that the proper utilization of these advantages far outweighs the disadvantages. A comparative idea may be obtained from a study of Fig. 1. The dashed line shown is an amplification curve of a good choke-coupled untuned radio-frequency amplifier. In this, and the other curves in this figure, the amplification is measured from the input voltage in the dummy antenna system to the grid of the first tube.

The respective merits of untuned and tuned antenna systems, "power" detection and conventional detection with the two-stage audio amplifiers, as well as the engineering data behind the Crosley Jewelbox receiver will be found in this article by Mr. Jarvis, formerly of the Crosley Radio Corporation and now Chief Engineer of the Sterling Mfg. Co., of Cleveland, Ohio.

THE EDITOR.

Antenna Input Design

IN THE design finally adopted for the antenna system, a coil with three taps at 3, 15, and 36 turns was used. These are numbered (3), (2), and (1), respectively, in Fig. 1. Tap No. 3 is used with extremely large antennas, or when exceptional selectivity is required. However, even with this small coupling, the average amplification is much better than the untuned stage. Tap No. 2 is used for the average antenna, and in the hands of the average owner is connected once and is never changed. Tap No. 1 is for an extremely small or indoor antenna. On a normal antenna, this tap will give a greater sensitivity to low radio frequencies than Tap No. 2. The relative efficiency of these curves compared with the untuned stage needs no comment. In addition to the great increase in sensitivity, a proportional gain in selectivity is made.

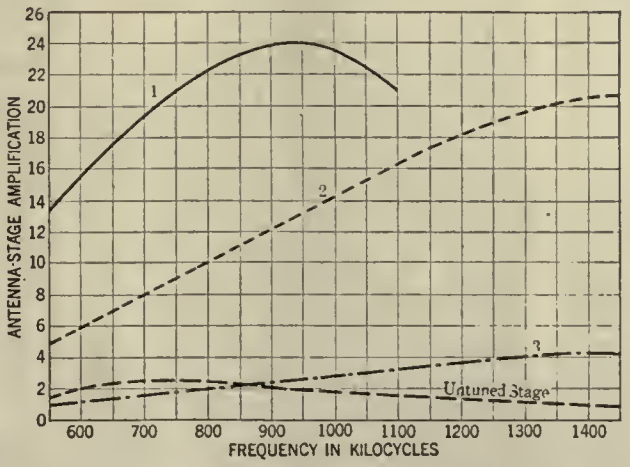


Fig. 1—An idea of the increased amplification and selectivity obtained with a tuned input stage may be gained from a study of this graph.

After determining that the tuned input was desirable, the mechanical problem had to be solved. Due to the antenna capacity, this stage could not be made to rack exactly with the other stages. In the hand of an unskilled operator, it is extremely desirable that the input tuned stage always be tuned approximately, as the great increase in selectivity in this stage results in greatly decreased sensitivity unless the tuning condenser is maintained approximately in resonance. This makes some form of a four-gang condenser (there are four tuned circuits in this receiver) necessary, with the required adjustment on the first tuned circuit to compensate antenna variations. Various combinations were tried to accomplish this compensation, and the simple means of rocking the "stator" was finally adopted as being the best. This rocking movement is obtained by a worm wheel drive on a molded gear segment mounted on the stator of the condenser. The great reduction in gear ratio makes the tuning of this selective circuit very easy. Due to the way the condenser tuned circuits follow each other, only a slight adjustment of this control is necessary to bring the receiver to the peak of its sensitivity and selectivity.

Another change which may be noted here is in the use of beater-type tubes throughout. The a.c. hum voltage is lowered greatly when 227-type tubes are substituted for the 226 type. This is due to decreased modulation of the radio-frequency amplifiers by the filament power-supply voltage, and to the lowered hum voltage in the first a.f. stage. The volume control is arranged by varying the grid bias on the radio-frequency amplifiers This cannot be done on the 226-type tubes due to the resulting hum modulation. In general, a volume control operates more satisfactorily when the sensitivity of the radio-frequency amplifiers is reduced, due to the reduction of the hiss produced in the tubes themselves. Thus, the use of the heater tubes allows this better type of volume control to be used.

New Detector Circuit

BY FAR the biggest change in the new receiver lies in the use of the bias-type detector. As very little data has been pub-

lished on this point, it seems well to discuss it rather thoroughly in connection with this receiver.

As compared with the grid-leak-condenser detector, the bias-type detector is often referred to as a "power" detector. This meaning has come from the fact that by operating with the proper values of grid and plate voltages, a much larger power output can be obtained from the

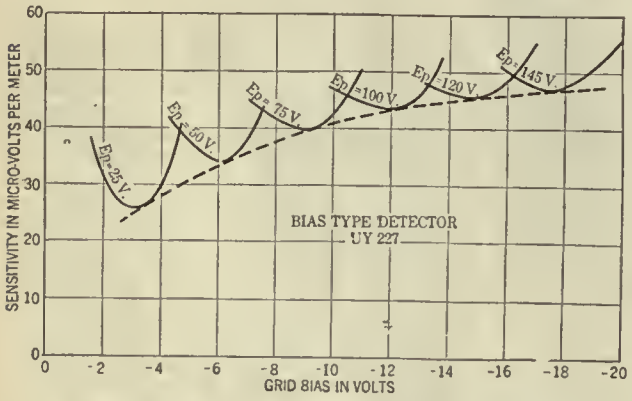


Fig. 2—Sensitivity curves of a power detector.

bias-type detector than from the grid-leak-condenser type of detector. The advantages claimed for this use of the "power" detector lie principally in the dispensation of the first a.f. stage. No a.f. amplifying stage is perfectly linear in frequency characteristics, and the use or two or more stages usually increases the "infidelity." However, this is not all gained without some loss of other characteristics, as will be apparent immediately. The mathematics of the characteristics of vacuum tubes indicates that when voltage is applied to the grid of the tube, plate currents of various frequencies are produced. These are all harmonics of the fundamental applied frequency and represent distortion. The magnitude of these harmonics depends upon the characteristics of the tube used and the value of the voltage corresponding to the order of the harmonic. That is, the second harmonic will vary as a constant times E^2; the third harmonic will vary as another constant times E^3; the fourth harmonic will vary as still another constant times E^4, etc. Thus, in doubling the applied voltage to the grid of the detector tube, the second harmonic is increased 4 times, the third harmonic is increased 8 times, and the fourth harmonic is increased 16 times!

In order to dispense with the first a.f. stage it is necessary to apply a voltage to the detector of approximately five times the value which would be needed if this a.f. stage were present. Under these conditions the fourth harmonic would be increased 625 times! Unless extreme care is taken in design or an unusually large tube (a power transmitter tube?) is used, the resulting distortion would make the gain in fidelity a very dubious advantage!

A view of the curve in Fig. 2 will show another disadvantage toward the use of the "power" detector to eliminate the first a.f. amplifier. In order to obtain the high a.f. voltages from the detector necessary to drive the output power amplifier, it is necessary to use high plate and grid voltages on the detector tube. In Fig. 2 are shown a series of curves of sensitivity of an early experimental model against varying grid and plate voltage. It may be seen that for each plate voltage, there is an optimum grid-bias voltage. The dashed curve is the envelope of these curves, and shows the maximum sensitivity which can be obtained (with this particular model) for any value of grid voltage.

The operating requirements with and without the first stage of audio-frequency amplification are approximately at 4-volt bias and 18-volts bias, respectively. It may be observed that the detector sensitivity is just about twice as great at the low value of grid bias. This two to one difference, plus the gain of the a.f. stage, makes the resulting overall sensitivity of the set so greatly superior to the "power" detector without the first stage of a.f. amplification, that there is no question regarding the use of the conventional two-stage a.f. amplifier.

Justification of Power Detection

THE DEMAND for better fidelity is a justifiable one, however, and some means should be taken to improve this performance characteristic. A view of the reasons why the customary grid-leak-condenser detector contributes to the "infidelity" and distortion of the average set is desirable.

The first point in error is in the use of the grid leak and condenser. Due to the conductance of the grid-coupling condenser at high audio frequencies (2000 and over), the high audio-frequency response is decreased greatly. This point has been discussed in various periodicals and need not be stressed here. The reduction in response due to this cause may be to a value as low as 40 per cent. at 5000 cycles. The use of a bias-type detector automatically cures this fault as the leak and condenser are eliminated.

A second point lies in connection with the distortion previously mentioned, the introduction of harmonic currents not present in the applied voltage. It *is* possible to get more undistorted power from a bias-type detector than from the grid-leak

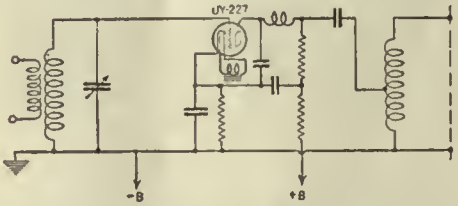


Fig. 3—Schematic diagram of the power detector circuit.

type. This means that in order to drive properly the output tube (or tubes, in push pull) the audio amplifier does not have to amplify so much, and the ratio of the a.f. transformer can be lowered, with a corresponding increase in fidelity.

As an a.f. amplifier, with the customary transformer, the usual detector leaves much to be desired. A flat audio-frequency amplification characteristic is obtained when the load impedance is high with respect to the tube impedance. For an average case, the plate resistance of an a.f. amplifier tube may be 8000 ohms. While the primary impedance of the transformer varies continuously with frequency, the output voltage is approximately constant whenever the primary impedance is above 50,000 ohms. Thus, the primary impedance might increase from 50,000 to 500,000 ohms without changing the output. This is due to the way the voltage divides across the two impedances. In the case of the detector, the plate impedance is usually much higher, say 30,000 to 50,000 ohms. Here the change in transformer primary impedance is of much greater importance in determining the amplification characteristic with respect to frequency. Either the transformer must be correspondingly increased in impedance (size and cost) or some means taken to prevent the usual great change in load impedance. Fortunately this means is simple. A resistance shunted across the primary of the transformer, prevents a great change in impedance, and consequently good fidelity. This is at a slight expense to sensitivity, but, as sufficient sensitivity is gained in the tuned antenna stage, the overall result is ahead both ways. Increasing the resistance increases the sensitivity, but decreases the fidelity. A good compromise gives almost the fidelity of pure resistance and the amplification of the transformer. The transformer is fed through a coupling condenser instead of being connected directly. This enables a saving in cost (no primary, but equivalent to a tapped autotransformer) and slightly increases the response to low audio frequencies due to resonance with the transformer inductance. The circuit is shown in Fig. 3.

Overall Characteristics

WITH THE discussion of the major improvements in this set, in mind, a study of the overall characteristics is apropos.

Fig. 4 shows a type of curve which will be new to almost all readers of this publication. It represents the *percentage of the power* of the harmonics in the output of the radio receiver, plotted against the output voltage, These are true *distortion* curves and show how the percentage of harmonics increases as the output voltage increases.

The curve marked A in Fig. 4 is a most peculiar looking affair but is relatively simple. This represents the distortion present in the Jewelbox at any output voltage. It may be observed that there is a certain minimum distortion, about ½ per cent. This is an inherent property of any receiver, and is properly blamed, not on the receiver, but on the characteristics of broadcasting methods. This minimum power distortion (in any receiver) is equal to $\frac{K^2}{16}$, where K is the percentage of modulation. As these curves were taken at 30 per cent. modulation, the minimum distortion is $\frac{(0.30)^2}{16} = 0.0053 = 0.53$ per cent. From a physical viewpoint, this distortion is all second harmonic, and represents that power obtained at audio frequency due to the "beating" of the sidebands.

Follow along the curve A from left to right. This means an increasing radio frequency applied, (or an increase in the volume control) resulting in an increased audio voltage output. With an output of 65 volts,

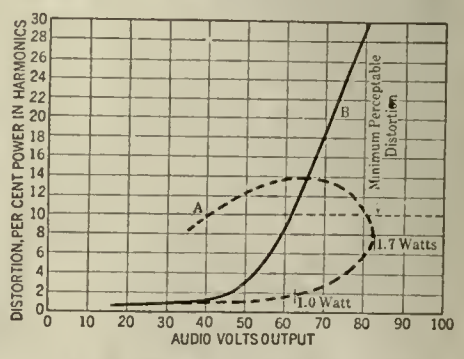
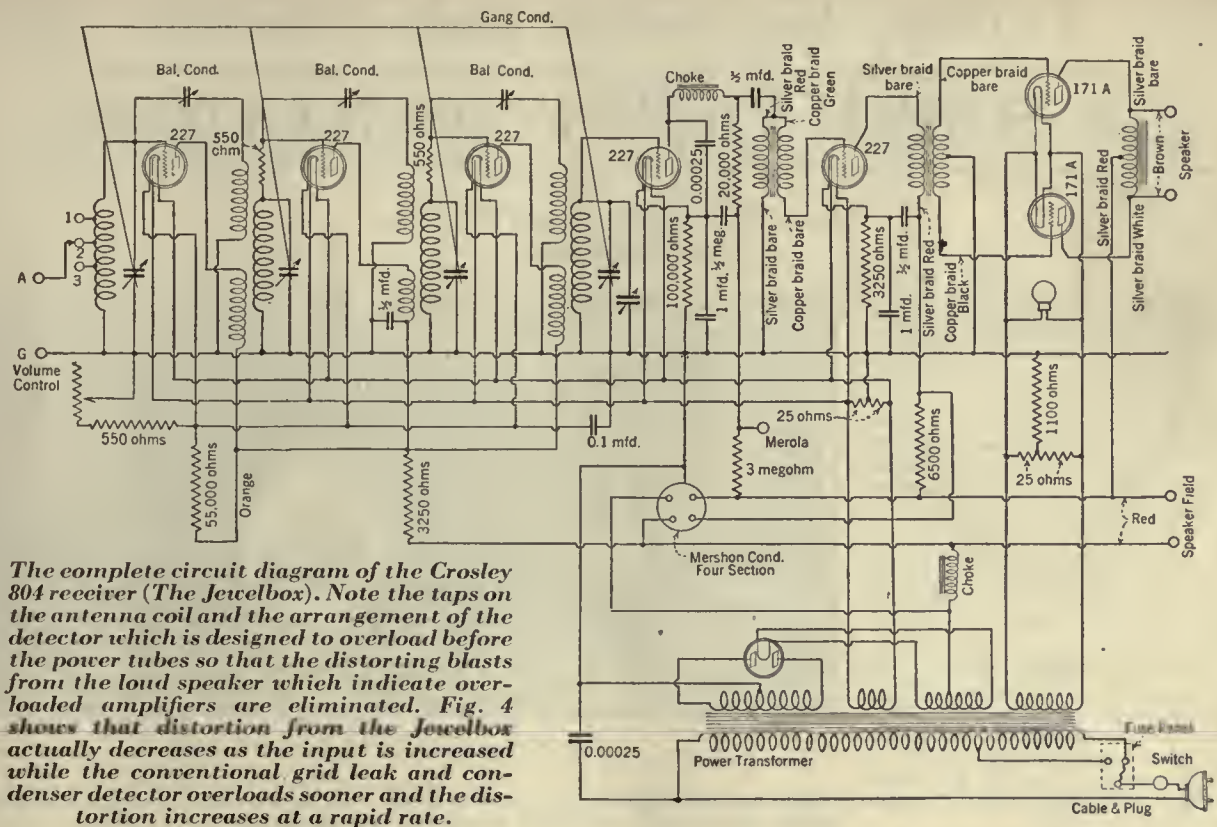


Fig. 4—Curve A shows how distortion in Jewelbox decreases; Curve B shows distortion occuring sooner in grid leak and condenser detector.



The complete circuit diagram of the Crosley 804 receiver (The Jewelbox). Note the taps on the antenna coil and the arrangement of the detector which is designed to overload before the power tubes so that the distorting blasts from the loud speaker which indicate overloaded amplifiers are eliminated. Fig. 4 shows that distortion from the Jewelbox actually decreases as the input is increased while the conventional grid leak and condenser detector overloads sooner and the distortion increases at a rapid rate.

corresponding to about 1-watt output (171's in push-pull with 4000-ohm load), the power distortion is only 1 per cent.! As the radio input is further increased, the output voltage increased to about 82 volts (output 1.7 watts) with a distortion of 9 per cent. If the radio input voltage be further increased, the audio output voltage will decrease as shown by the reversing curve. The percentage of harmonics increases slightly and then decreases as the radio input is continuously increased. This is a new idea in receiver design and one which deserves further comment.

The Output Circuit

THE OUTPUT system of this set consists of two 171A-type tubes in push pull. Singly, these tubes are capable of delivering about 0.7 of a watt. In push pull they will deliver slightly more than twice this value, about 1.5 watts. If the input voltage to such a push pull stage is increased to give a greater power output, the distortion will be enormously increased. In fact, it will sound terrible!

But if some means were provided to prevent a great overload of these output tubes, it is apparent that even in the hands of an inexperienced operator, it would be impossible to overload the output system. The receiver can never be ma e to deliver a signal of poor quality!

This novel effect is obtained by proper adjustment of the detector voltage characteristics, so that as the detector overloads it not only fails to contribute greatly to the distortion, but actually serves to reduce the distortion if the input is sufficiently great.

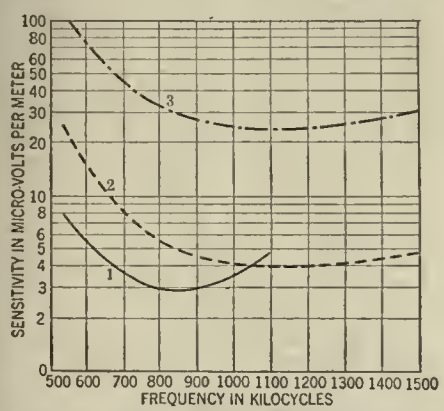


Fig. 5—Sensitivity curves of the Crosley receiver.

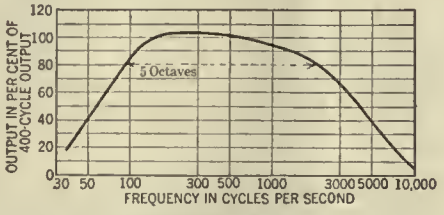


Fig. 6—Overall fidelity curve with the r.f. stages tuned to 1000 kc.

Some idea as to the magnitude of this distortion should be given. A dashed line at 10 per cent. distortion is shown as the "Minimum Perceptible Distortion." This is perhaps a pessimistic viewpoint as many individuals in test have permitted a power distortion as high as 25 or 30 per cent. before *noticing* it. To an untrained ear, this is perhaps excusable. At low percentages, this distortion is apparent only as a change of timbre, or tone quality, and has no characteristics of discord or poor quality. As indicated, this "Minimum Perceptible Distortion" means that point at which a change in timbre becomes apparent. If further comment were needed it would only be necessary to show the great distortion in some receivers whose owners claim them to have the finest quality on earth!

With this idea of what distortion means, the curve B of Fig. 4 may not be judged too harshly. Certainly at low (and probably the normal room volume) there is no choice on a basis of distortion. An output of at least one watt is possible without perceptible distortion. The limit beyond this point is largely a matter of customer discrimination. It can, of course, be pushed until the distortion is apparent to every one, including the neighbors. An automatic overload control such as is shown in curve A is a real contribution toward the improvement of modern radio reception.

Sensitivity of Receiver

THE CURVES shown in Fig. 5 are the usual sensitivity curves plotted in microvolts per meter. The sensitivity on tap (3) was sacrificed to some extent to provide for an extreme selectivity. As shown previously, in the tuned antenna stage discussion, the combination of the characteristics of the three antenna taps makes the receiver adaptable to almost any receiving condition. A comparison of these curves with those shown in a previous article in the January, 1929, RADIO BROADCAST will show what an enormous improvement has been made in this receiver.

In Fig. 6 is shown a fidelity curve taken at 1000 kc. Throughout a range of approximately five octaves there will be no apparent change in sound intensity. This is unusual, and is accounted for only by those factors of design previously discussed. A comparison with those fidelity curves shown in the above mentioned article is invited.

The overall selectivity is such that, except in unusual circumstances, stations on adjacent channels may be received without interference. (And providing they are *on* their adjacent channels). Close to strong local stations, satisfactory reception may be had three channels adjacent.

In considering the development of this receiver and the results obtained, the Crosley engineers feel that they have not merely brought forth another receiver, but one deserving in every particular of the sobriquet of "new."

A SIMPLE LINE-UP OSCILLATOR

By GLENN H. BROWNING

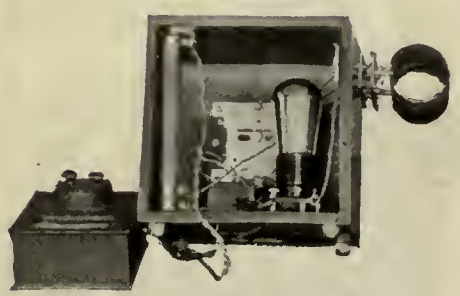
Consulting Engineer

THE AVERAGE serviceman is equiped to take care of the ordinary troubles which are encountered in receivers. However, many times the set simply lacks signal strength on semi-distant stations and a careful check on voltages and tubes shows that as far as they are concerned the set is ok. Usually, in this case, the tuning circuits are not lined up properly and as a consequence signal strength is lost.

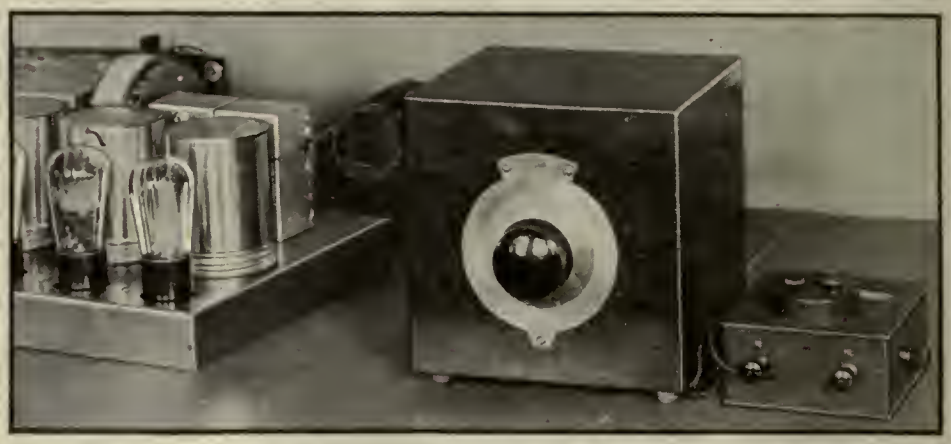
In some single-control receivers there are small compensating condensers which may be adjusted; in other cases the only way to line up the gang of tuning units is to bend slightly the rotor plates of the tuning condensers. In either case it is very difficult to make this adjustment unless there is a station transmitting which is just audible in the loud speaker, and even then, when the set has three or four tuned circuits, it is somewhat of a question as to which of these are off resonance. In fact, this question of alignment in single-control receivers is becoming a problem.

The set manufacturer, of course, does his best to see that the receivers are inspected carefully before they leave the factory, but in mass production there are always slips.

For a number of months the writer has used an oscillator with a grid meter for determining the resonance point of any tuned circuit. This has been found so convenient and accurate that he wishes to pass the idea along. Fig. 1 shows the circuit used. It will be noted that a standard type of oscillator is used and that the design is such that it may be connected to any a.c. or d.c. electric light socket. R is a 440-ohm resistor which will carry a quarter of an ampere for the filament supply of the 201A-type tube. The 110-volt supply is not connected to the plate of the tube as more accurate readings may be obtained when the oscillatory current is low, which will be the case if only about 22 volts is used for the plate supply. C_1 is a variable air condenser whose maximum value is 500 mmfd. L_1 is an inductance which may be made by winding 68 turns of No. 26 wire on a two-inch bakelite form. L_2 is the tickler coil and consists of 18 turns of No. 34 wire wound on the filament end of L_1. C_2 is a small condenser for coupling some of the energy developed in the oscillatory circuit to the circuit in which resonance is to be determined. Usually a two-plate midget neutralizing condenser set at its minimum value is about right. M is a d.c. milliameter reading not more than 2 mA. full scale. (The author used a Rawson meter which cost $15 but a much less expensive meter can be used—a Weston Model 301, for example—*Editor.*)



Interior view of Mr. Browning's oscillator.



The line-up oscillator ready for action.

The apparatus is connected as shown. In connecting the tickler be sure that it is connected so that the circuit will oscillate. This may be determined easily by placing the finger on the grid connection of the tube whereupon the meter will show a small reading if the circuit is oscillating. Now adjust point "A" along the 440-ohm resistor until the milliameter reads about 1.0 mA. and the oscillator is then ready for use.

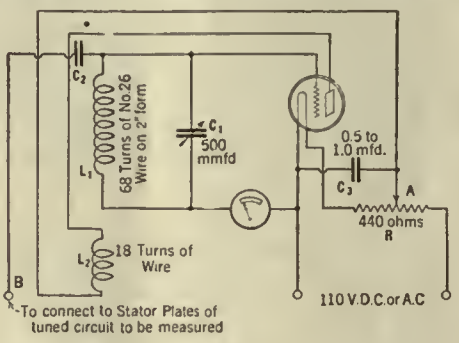


Fig. 1

Operating Data

TO DETERMINE the resonance point of any tuned circuit in a radio set, clip the flexible lead which is connected to the small condenser, C_2, to the stator plates of the circuit under test. Turn the dial on the condenser C_1 until the meter gives a sharp reaction. This reaction is a sharp lowering of the reading of the meter. Now adjust the condenser carefully until the meter is at its lowest reading and any adjustment either way increases its reading. It is necessary for accurate adjustment to have a vernier dial on the oscillator condenser, and at the same time one which may be read accurately. During this process the ground should be connected to the set. If the adjustment of the oscillator condenser is so broad as to cover more than a fraction of one division on the oscillator dial the coupling condenser, C_2, is too large and its size should be reduced.

In a single-control receiver the tuning point of each circuit may be determined as follows. Clip the flexible lead from the coupling condenser of the oscillator onto the stator plates of the first tuning condenser in the radio set. Adjust C_1 on the oscillator for the reaction point and record the reading on the oscillator condenser. Do the same with second, third, etc. tuning condensers in the radio set. During this process the tuning control on the receiver should be left fixed. If the adjustment of the oscillator condenser for each section of the tuning condenser is the same the circuits are properly lined up, if not an adjustment may be made to advantage. In this manner the line up of the tuning condensers in the radio set may be determined for any setting on the dial.

The theory of the line-up oscillator is briefly this: when the circuit L_1C_1 is oscillating, the amount of grid current passing through the meter depends on the intensity of the oscillations. If any energy is taken from the oscillator the reading on the meter decreases. If coupling is obtained by any means to another tuned circuit this circuit will absorb the most energy when it is exactly in tune with the oscillator. Thus a reaction is obtained on the meter only when the two circuits are in tune. The reason for using only a small voltage on the plate of the oscillator tube is so the oscillatory current will be weak and any energy taken from this circuit may be observed easily on the meter.

Incidently, the lower the resistance in the tuned circuit coupled to the oscillator the greater the amount of energy absorbed and the greater the reaction on the meter.

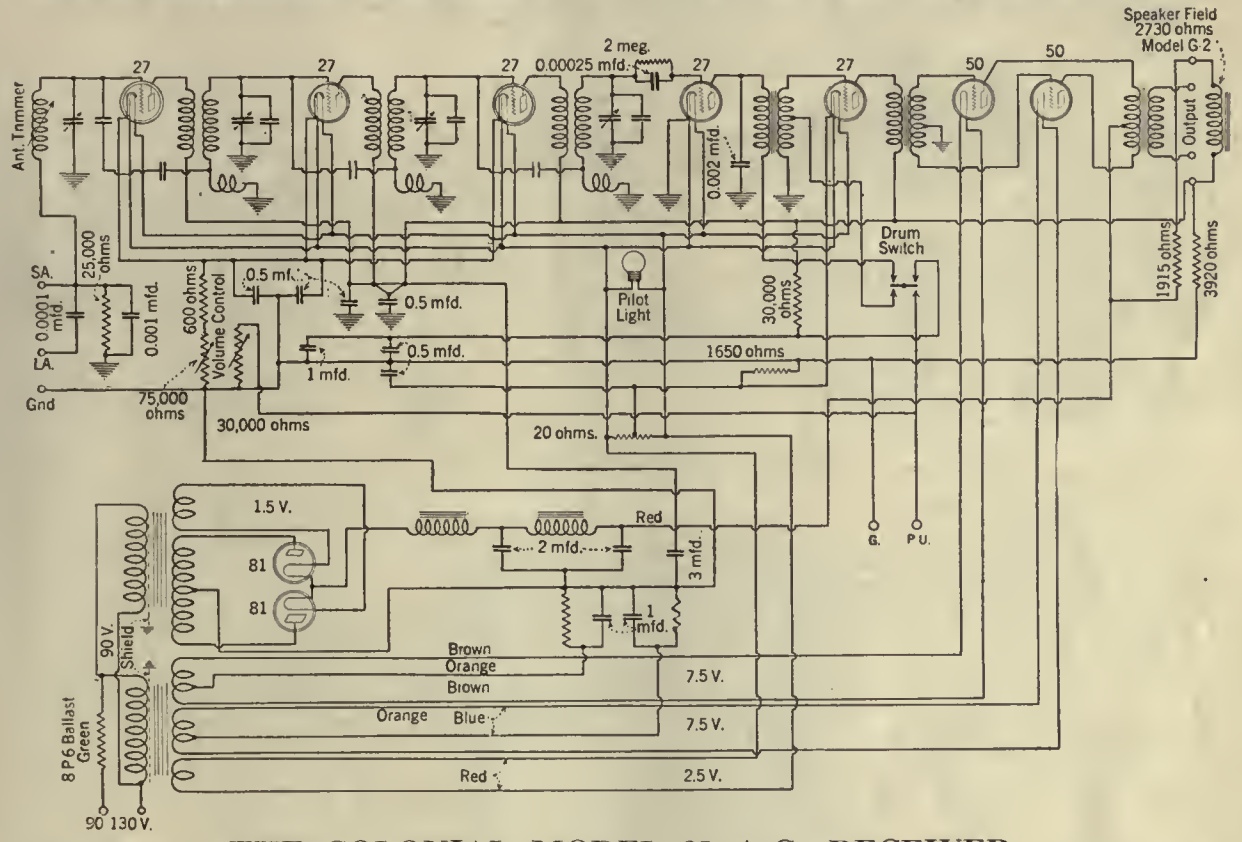
List of Parts

THE following is a list of the apparatus used in the writer's oscillator:

One National Co. precision dial;
One variable tuning condenser 0.0005-mfd (C_1);
One coil wound as per instructions (L_1, L_2);
One tube socket;
One CeCo tube, type A;
One 440-ohm resistor, Electrad (R);
One 0.5-mfd. by-pass condenser, Tobe (C_3);
One Rawson meter, type 507A;
One Two-plate neutralizing condenser (C_2).

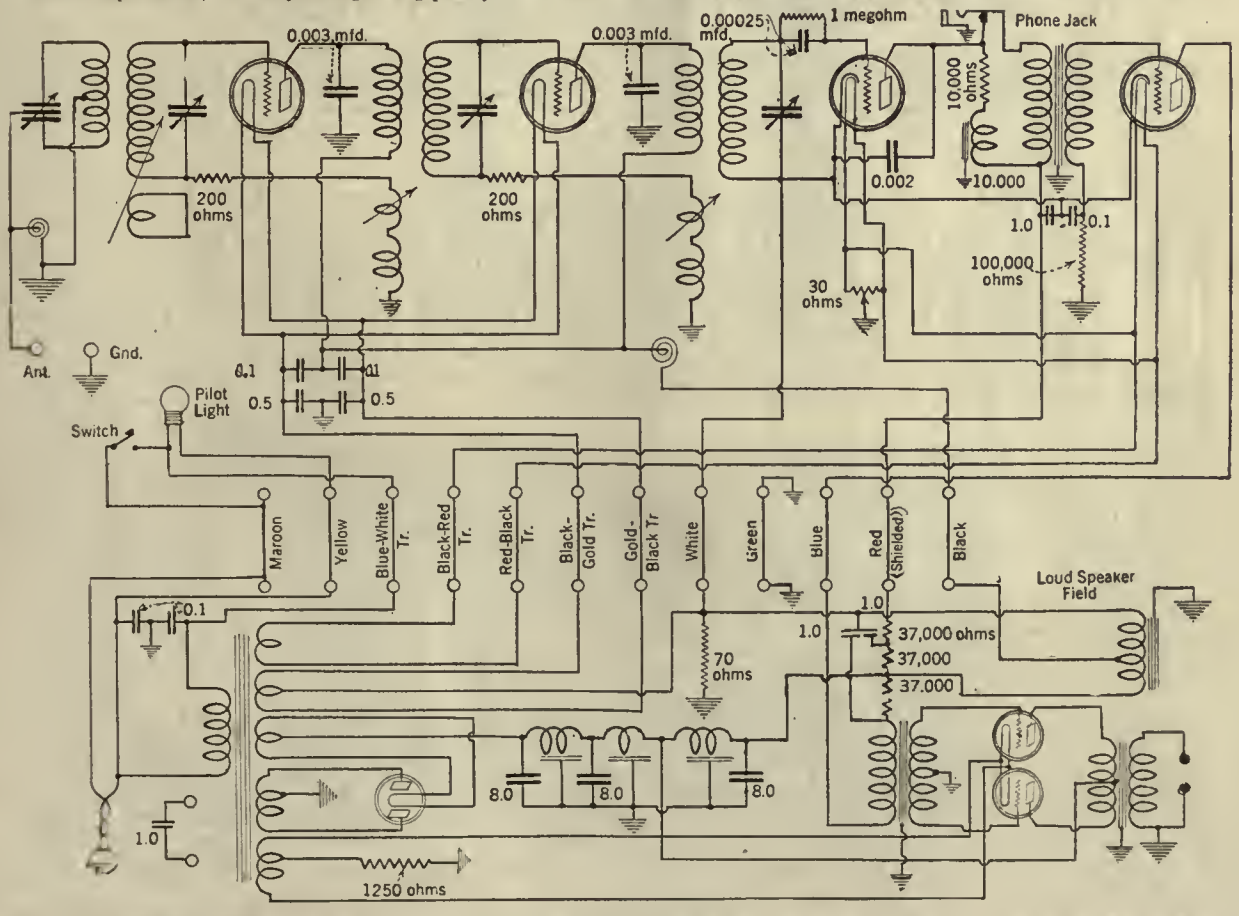
THE MAJESTIC MODEL 180 RECEIVER

Three stages of r.f. amplification are used in this Majestic receiver. The inductance associated with the antenna circuit is arranged so that it can be varied somewhat in order that this circuit may be brought into exact resonance with the other tuned circuits. It should be noted that heater-type tubes are used throughout the set except in the power stage. It is also interesting to note that the phonograph pick-up unit is connected across the small tapped section of the first audio-frequency transformer.



THE COLONIAL MODEL 31 A.C. RECEIVER

This receiver utilizes six a.c. tubes and a 280-type rectifier. It consists of two stages of r.f. amplification, a detector, and two stages of a.f. amplification, the output stage being push pull. Two resistors, not indicated in the diagram but connected in series with the lead to the light socket, function as automatic voltage controls. The 30-ohm variable resistor is a hum adjustment.



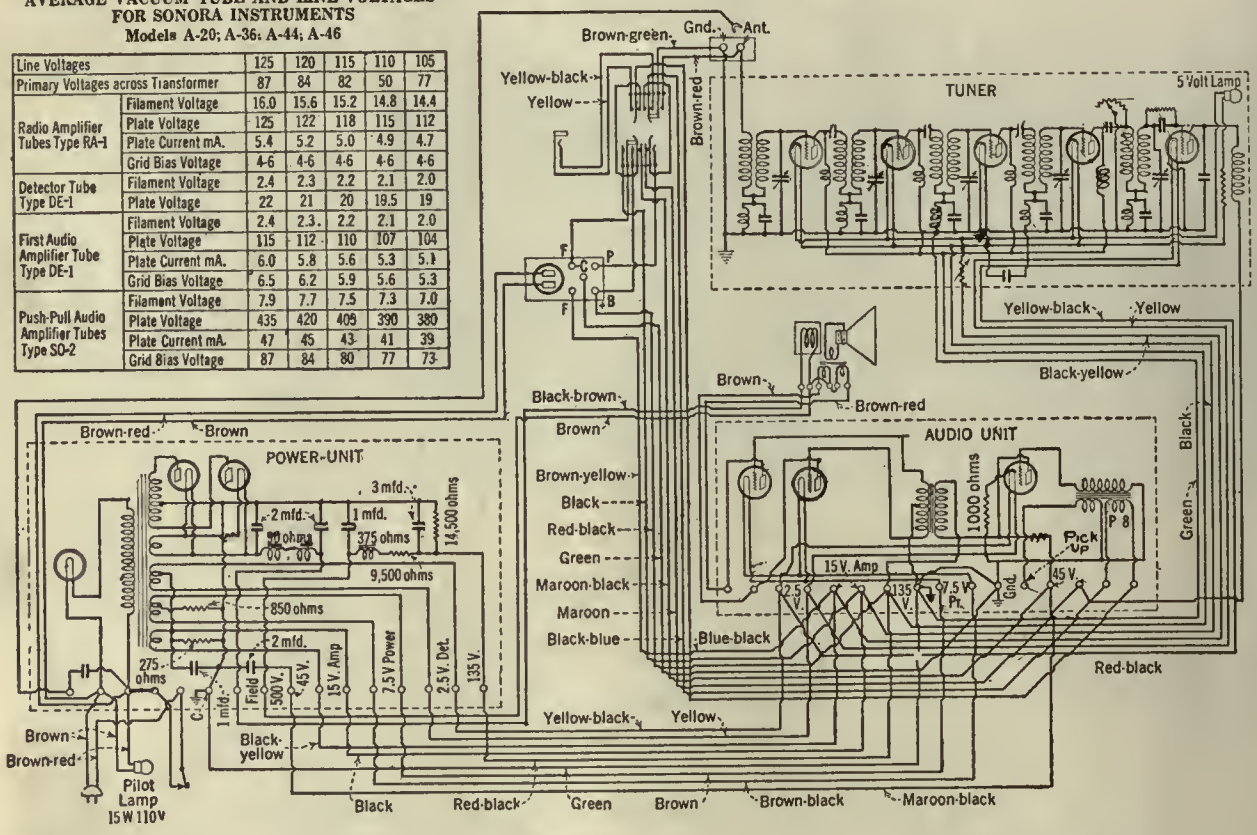
No. 28 *Radio Broadcast's Set Data Sheets* July, 1929

THE SONORA MODEL A-36 RECEIVER

This receiver consists of four stages of tuned r.f. amplification, a grid leak and condenser detector, and a two-stage transformer-coupled audio-frequency amplifier. The set contains the following interesting features: combined electromagnetic and electrostatic coupling in the r.f. amplifier, a special first-stage a.f. transformer phonograph pick-up, a push-pull output stage, an electrodynamic loud speaker, and an automatic control to compensate variations in line voltage.

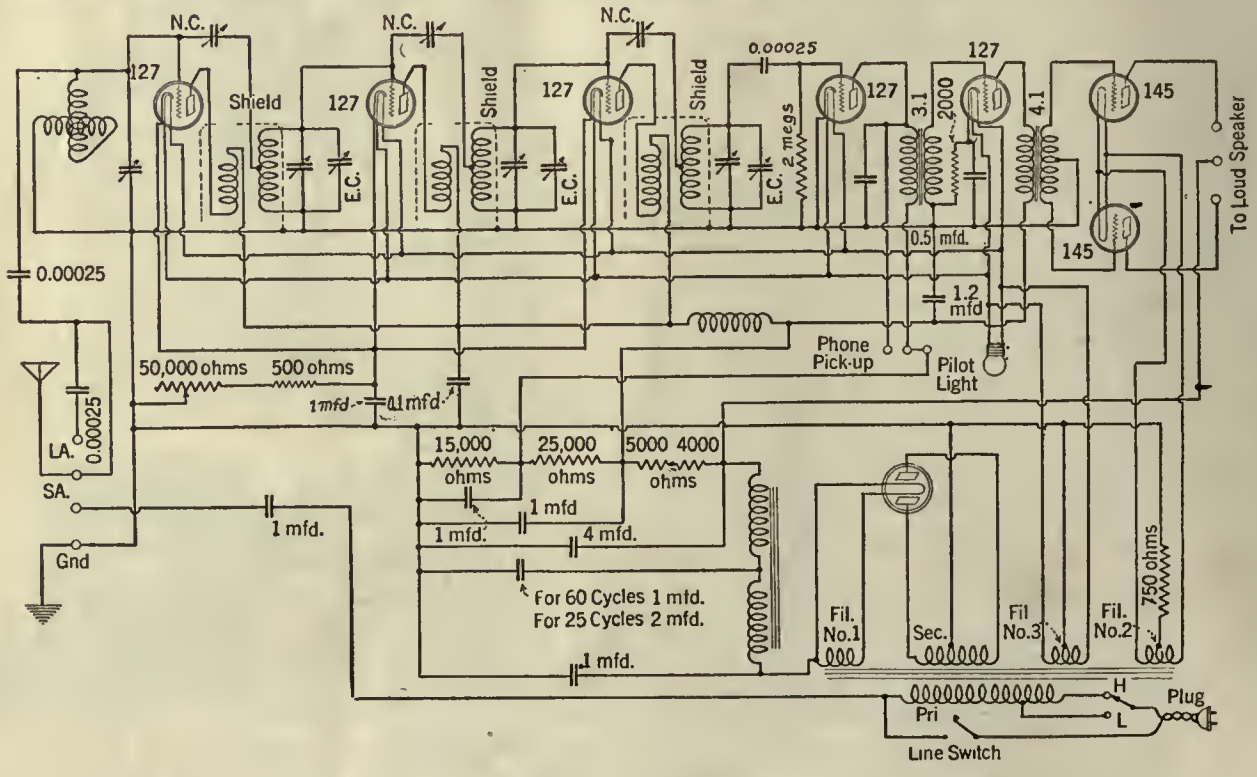
AVERAGE VACUUM TUBE AND LINE VOLTAGES FOR SONORA INSTRUMENTS
Models A-20; A-36; A-44; A-46

Line Voltages		125	120	115	110	105
Primary Voltages across Transformer		87	84	82	50	77
Radio Amplifier Tubes Type RA-1	Filament Voltage	16.0	15.6	15.2	14.8	14.4
	Plate Voltage	125	122	118	115	112
	Plate Current mA.	5.4	5.2	5.0	4.9	4.7
	Grid Bias Voltage	4-6	4-6	4-6	4-6	4-6
Detector Tube Type DE-1	Filament Voltage	2.4	2.3	2.2	2.1	2.0
	Plate Voltage	22	21	20	19.5	19
First Audio Amplifier Tube Type DE-1	Filament Voltage	2.4	2.3.	2.2	2.1	2.0
	Plate Voltage	115	112	110	107	104
	Plate Current mA.	6.0	5.8	5.6	5.3	5.1
	Grid Bias Voltage	6.5	6.2	5.9	5.6	5.3
Push-Pull Audio Amplifier Tubes Type SO-2	Filament Voltage	7.9	7.7	7.5	7.3	7.0
	Plate Voltage	435	420	405	390	380
	Plate Current mA.	47	45	43	41	39
	Grid Bias Voltage	87	84	80	77	73



FREED-EISEMAN RECEIVER MODEL NR-78 A.C.

The NR-78 is a completely a.c.-operated receiver using five heater tubes, two power tubes arranged in push-pull, and a full-wave rectifier. Unlike many other sets, the antenna stage in this receiver is tuned by means of a variometer in conjunction with a variable condenser. Either a long or short antenna may be used. The set also contains a 1-mfd. condenser connected to one side of the power circuit so that the light socket may be used for the antenna by simply connecting together two binding posts.



NEW FEATURES IN THE SILVER RADIO

By McMURDO SILVER

President, Silver-Marshall, Inc.

"WHAT'S NEW in radio?" is the question that is being asked nowadays. Quite a few things are new in broadcast receiver design this year. One good way of answering the question is to review briefly the trends evident at the R. M. A. trade show, and to describe a typical example of a modern radio receiver employing a majority, at least, of these features. Such is the purpose of this paper; the new design trends which should be looked for in the 1929–30 season being listed below, while their application to a practical receiver is well exemplified in the Silver Radio chassis to be described in some detail.

(a) The use of 224-type screen-grid a.c. tubes as both r.f. amplifiers and power detectors, to the probable almost complete exclusion of the 226- and 227-type tubes heretofore popular.

(b) The general use of "band-selector" tuning as an aid in attaining the desirable ideal of a rectangular response curve, with its freedom from sideband cutting (attenuation of high musical frequencies).

(c) The widespread use of 245-type tubes in push pull, feeding a high-grade dynamic loud speaker unit of improved response over the musical range of 50 to 5000 cycles, the amplifier having an undistorted power output of about three watts.

(d) Automatic regulation of fluctuations in a.c. power line voltages.

(e) A tendency to use smaller, or even self-contained, antennas for convenience, when receiver sensitivity permits.

In addition to these general trends in the design of all-electric broadcast receivers, and in addition to the fact that each season prices come down, or actual values given increase (which amounts to the same thing), certain other trends will be evident among a few manufacturers, as follows:

(f) Use of but one a.f. stage following a power detector in sets where the attenuation of high frequencies resulting from the necessary high-ratio a.f. coupling transformer is not considered of as great importance as the cost saving resulting.

(g) A tendency toward condenser loud speakers, not at all general, because of present poor efficiency, high polarizing voltages needed, excessive bulk, and fragility of existing types.

(h) Use of so-called automatic tuning; as, for example, devices for selection of a small pre-selected group of stations by means of a multiplicity of buttons instead of the usual single selector knob.

(i) Extension of the reproduced audio tone range up to 4000 or 5000 cycles to give naturalness and brilliancy, with the addition of an overtone cut-out switch to diminish high-pitched atmospheric noises in bad weather.

Features of Silver Radio

THE RECEIVER here described embodies all of the above features except f, g, and h, which will not be found in wide general application this year.

An article dealing briefly with the one audio stage trend, (f), will be found on page 15 of the May, 1929, RADIO BROADCAST. Another article, upon condenser loud speakers, (g), appears upon page 369 of the April, 1929, RADIO BROADCAST. Automatic tuning, (h), usually accomplished by mechanical selectors, is so simple as to require little special description.

At this stage of the radio art it is unfortunately difficult to make evident the merits of a receiver simply and concisely

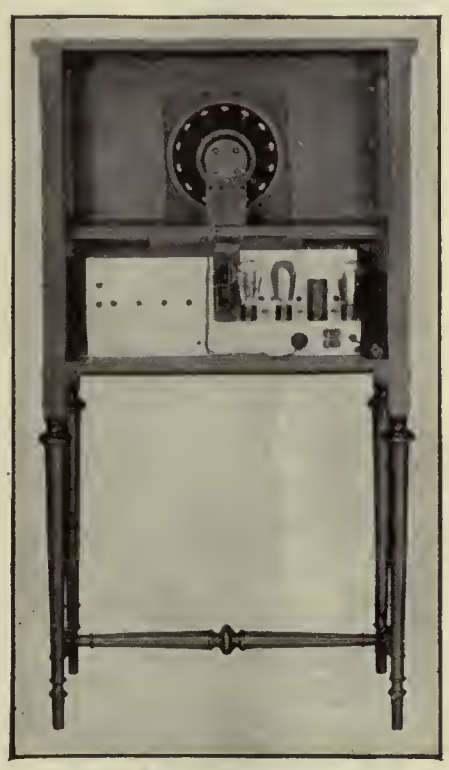


Fig. 1—Rear view of the new Silver Radio showing chassis and dynamic loud speaker.

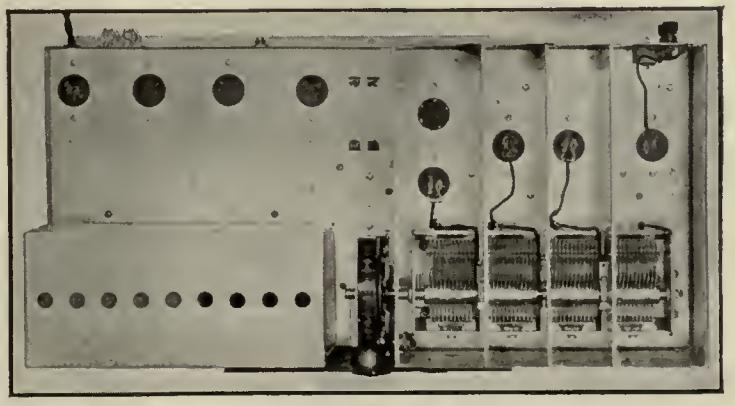


Fig. 2—The chassis of the Silver Radio with shield cover removed.

(as should be the case) by means of quantitative measurements, as few overall receiver measurement curves have been published (due in a large measure to the difficulty of making such measurements, even on older type sets). In presenting Figs. 3, 4, and 5 there is little data to compare them with and the curves must, therefore, be interpreted to be rendered readily comprehensible. Incidentally, it is to be hoped that, as overall measurements are now possible in any well-equipped radio laboratory, manufacturers will have more recourse to facts and less to fanciful "sales talks" for radio receivers in the future.

Fig. 3 illustrates the overall sensitivity of the set of Figs. 1, 2, and 8 under two different antenna conditions. Curve A is for the small self-contained screen antenna (8″x 24″) attached to the bottom of the cabinet, while curve B is for a typical broadcast antenna of characteristics stated on the curve. The order of sensitivity shown is thought to be greater than that of any other receiver offered today. Measurements on typical six-tube, one-dial a.c. sets having three tuned circuits show an average sensitivity of forty to sixty microvolts per meter, and measurements on other sets of the same general type, having four tuned circuits (4 tuned r.f. stages), show about 15 to 20 microvolts per meter sensitivity. Considering curve B of Fig. 3, indicating an average sensitivity of 2 microvolts under standard conditions, the sensitivity of this set is seen to be about seven to ten times that of the typical t.r.f. set of four tuned circuits, and about twenty to thirty times that of the average three-tuned-circuit set. Suffice it to say that a sensitivity of 1.2 to 3.5. microvolts per meter, (the antenna input required to produce 50 milliwatts output, a purely arbitrary measurement standard) is sufficient to bring in almost any station audible above average prevailing noise levels. Comparative tests have furthered the belief that no more sensitive receiver may be used in the average home to-day.

Overall Fidelity

IN FIG. 4 appear two overall fidelity curves for the receiver, taken at the middle of the broadcast band (1000 kc., 300 meters). If the reader unthinkingly compares curve A with typical curves of audio amplifiers such as are often furnished to indicate the audio response characteristic of a radio receiver, this fidelity does not appear to be particularly startling. Here again, the dearth of *overall fidelity* measurements of existing receivers prevents the true excellence indicated by curve A from being appreciated at first glance. Referring again to a previous article in RADIO BROADCAST as one of the few sources of overall measurements that tell any real story of receiver merit, the reader's attention is called to the fidelity curve of Fig. 5, page 16 of the May

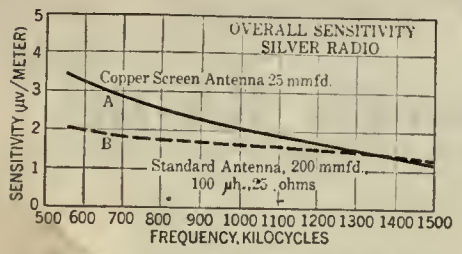


Fig. 3—Overall sensitivity curve of receiver; (A) with self-contained antenna, (B) with outside antenna.

issue. As both the sets to which measurements apply use the band-selector method of tuning for preservation of high tones, some idea can be gained of the terrible extent to which the average, ordinarily selective t.r.f. set (not employing band tuning) cuts sidebands; i.e., suppresses high musical notes. It is the writer's personal opinion that 999 out of every thousand radio listeners have no idea of what faithful reproduction of high audio tones in radio reception is—in other words, that no single receiver available in the past season reproduced tones in the neighborhood of 4000 cycles at even 50 per cent. of the value at which they were transmitted. This opinion is based upon many measurements and practical competitive tests between the set here described and other types. The holding up of the high end of curve A is, it is felt, as good an argument for band-selector tuning as could be asked for, particularly when the high sensitivity and selectivity indicated in Figs. 3 and 5 are considered.

Curve B of Fig. 4 indicates a possible concession to bad radio reception weather or locations. It shows the resulting overall fidelity of the receiver after an "overtone cut-out switch" has been set to cut a 0.001-mfd. condenser into the detector plate circuit to diminish response to high audio frequencies to a level comparable with that of ordinary commercial receivers. This provision is made for two reasons; individual listeners may prefer drummy, bass-accentuated reproduction, and in bad weather static, usually found in the higher audio tone ranges, may be diminished to make reception more enjoyable.

In Fig. 5 appears an overall selectivity curve, taken at 550 kc. It indicates that the frequency band passed is 10 kc. wide, at a level at which an interfering station would have to be ten times as strong as the desired station to produce equal volume (or, at which level the interfering one of two equally powerful stations would be only one tenth as loud as the desired one). At the level at which the interfering station would be reduced to one-one-hundredth of the volume of the desired station, the band width is 24 kc. To the average reader used to tuning sets of claimed "10-kc. selectivity," "knife-like sharpness," etc., such a curve is far from the ideal rectangle 10 kc. wide at its base. Again the dearth of overall measurements is the unfortunate reason for possible hasty misjudgment, for the fact remains that the degree of "apparent" selectivity indicated by Fig. 5 has, in practice, proven considerably greater than that of any commercial receiver so far tested. It should be noticed that the effective selectivity is independent of antenna size; i.e., the set does not "go broad" on a large antenna.

The Silver Chassis

The stock Silver Radio chassis upon which the above measurements were made is illustrated in Fig. 2 and diagrammed in Fig. 8. Mechanically, it consists of a cadmium-plated steel chassis carrying, at the left, an r.f. shielding case, with removable cover, divided into four compartments. In the left compartment is the antenna coupler, first r.f. tube, and first section of the four-gang tuning condenser. The second, third, and detector tubes, with their tuning condensers, are, respectively, in the next three compartments to the right. The detector compartment also houses the first-stage a.f. tube. Beneath the chassis, in four separate sections under the r.f. shielding case, are the coils, condensers, and resistors necessary to the r.f. circuits. At the exact front center of the chassis, is an illuminated vernier drum dial, with translucent scale marked directly in "telephone numbers" (kilocycles) for easy tuning. At the right rear is a steel case housing the power transformer which furnishes all A, B, and C power for the set. In front of this case are, left to right, two 245-type power tubes, a socket for an automatic line-voltage regulator, and the 280-type rectifier tube. On the rear edge of the chassis appear a hum adjuster, a jack for a phonograph pick-up unit, speaker plug socket, and two sets of primary fuse clips. A single fuse, shifted from one set of clips to the other, allows omission or inclusion of the automatic line regulator, if required by power line fluctuations in any given territory. The dynamic loud speaker chassis is a separate unit, connected to the set by means of a cable and a five-pin plug. Provision is made for but three external connections—antenna (if the self-contained screen collector housed in the cabinet is not used), ground, and power cord. The general mechanical construction is of a solid and substantial nature, reducing, and where necessary, simplifying, servicing problems to a minimum.

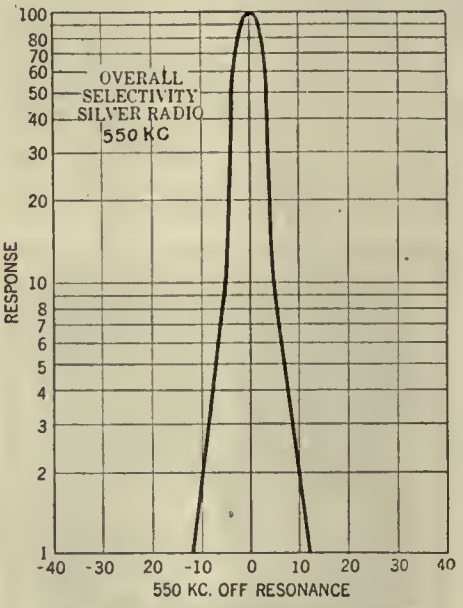


Fig. 5—Overall sensitivity curve taken at 550 kc.

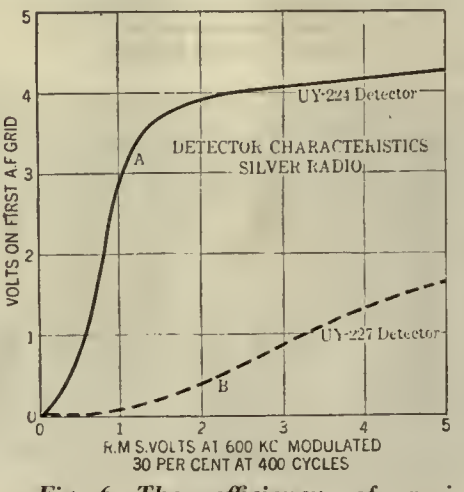


Fig. 6—The efficiency of a screen-grid detector as compared with that of a typical 227-type detector.

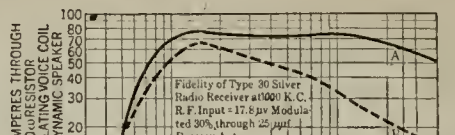


Fig. 4—(A) Overall fidelity curve of the receiver. (B) How the fidelity may be changed with the "overtone cut-out switch."

Electrically, the receiver consists of three stages of tuned radio-frequency amplification, using 224-type a.c. screen-grid tubes, the first and second stages coupled by a band selector. The r.f. amplifier is followed by a screen-grid power detector, resistance coupled to a 227-type first a.f. tube, which feeds a pair of 245-type power tubes in push pull through a 1:1 audio transformer. The power unit supplying all A, B, and C potentials is self-contained with the set and consists of a power transformer, a 280-type rectifier tube, filter choke, condenser bank and voltage-dividing resistors. The more interesting points can be explained most easily in reference to Fig. 8, the schematic diagram.

Uniform Sensitivity

At the left appear the antenna and ground binding posts, and the input coupler. This coupler is a small choke coil, so proportioned as to resonate with the self-contained screen antenna, just above the broadcast band (about 650 meters). This characteristic gives a voltage transfer curve from antenna to the first r.f. tube sloping downward from 550 to 200 meters. This is made much steeper than the gain curves of the following r.f. stages in order to compensate the cumulative steepness of the gain curve of the balance of the r.f. amplifier. This is one method, and the simplest, of evening up gain over the entire broadcast wave band (it is well known that the average t.r.f. amplifier gives greatest gain at the lowest wavelength in its range, and least gain at its highest wavelength). While other systems might have been employed to attain this end, the simplest method is always the most desirable in practice. The efficiency of the method is illustrated by curves A and B of Fig. 3, where the sensitivity is seen to vary in a ratio of less than 2:1 throughout the broadcast band under the most favorable conditions, and less than 3:1 under the most unfavorable—a not serious variation.

The first r.f. tube is coupled to the second through a band selector consisting of two separately tuned circuits so coupled as to produce a "humped" resonance curve of extremely steep sides and broad top. The second r.f. tube is coupled to the third, and the third to the detector, through transformers having untuned primaries and tuned secondaries. The secondaries of these transformers are identical with two band-selector inductances, and all are tuned by a four-gang condenser of extremely wide spacing, having individual compensators. The gain of all r.f. stages has been made equal, so that the curve of Fig. 7 is representative.

While the values of r.f. gain may appear low, as compared to the maximum that may be had from a single stage, they are about as high as may safely be obtained stably in production, and result in an overall gain of as high an order as can be used in practice.

The r.f. circuits are isolated by means of by-pass condensers, resistors, and chokes to a point where the only coupling existing to cause oscillation is the input to output coupling, and this has been effectively eliminated by grounding, not only the set chassis, but the loud speaker frame as well. In isolation, the matter of defining accurately all r.f. current paths, and avoiding the use of the metal chassis as a common path, was found most important. The r.f. tubes are operated at plate potentials of about 170 volts, with screen voltage variable from zero to 67 volts for volume control. C bias is obtained automatically by means of individual resistors common to grid and plate returns. The r.f. amplifier does not oscillate, being completely stable under all conditions of operation.

Power Detection

In the past the 227-type tube operated at a high plate voltage and with a highly negative bias (so-called "power detector") has been considered the most generally satisfactory detector available. In this set, a new detector is used—a screen-grid power detector of such high efficiency that it is probable that within a short time it will replace all other types of detectors. Its conversion efficiency (r.f. signal modulated 30 per cent. at 400 cycles to a.f. signal at first audio grid) is illustrated clearly in Fig. 6 at A as compared against a typical 227-type power detector at B. A comparison of the respective slopes indicates the great superiority of the screen-grid detector, which was operated with a 60,000-ohm bias resistor, a total B potential of 170 volts, and a plate resistor of about 300,000 ohms. A particular point to be noted is the flattening off of the curve at increasing signal voltages. This occurs at such a point as to prevent serious overloading of the audio amplifier, for it has been found that such "distortion" as exists is of a volume limiting nature, and is far less annoying than overloading of the power audio stage—the detector characteristic, therefore, serves as a means

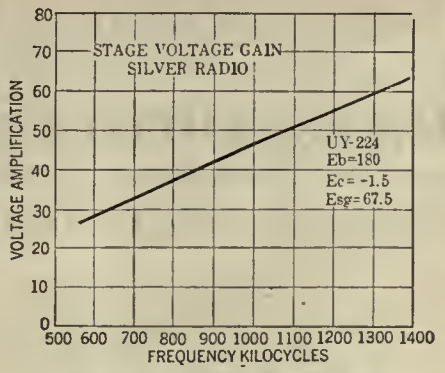


Fig. 7—Curve showing r.f. gain of receiver.

of automatically regulating volume to prevent annoying audio-overload distortion (easily possible, for the sensitivity is so great that a fair signal can easily be built up to far more than the 3-watt undistorted output of the power stage). While the 224-type detector has been used in the power "detector" circuit, no need exists to take advantage of its maximum output because of the use of two a.f. stages. As the detector tube has a very high plate resistance, about the only really practical method of coupling it to the first audio tube is by means of resistance coupling, which is used. The "overtone switch" previously mentioned cuts a 0.001-mfd. condenser into the detector plate circuit to diminish the high tones when desired. As the phonograph pick-up jack is in the first a.f. grid circuit, an external transformer is needed to produce maximum volume.

The push-pull stage is coupled to the dynamic loud speaker through a transformer having an excellent transmission characteristic. The loud speaker head itself shows very uniform conversion from 50 to 5000 cycles. It is baffled in order to avoid cabinet resonances, and likewise to avoid howling due to mechanical vibrations, being coupled to the detector tube.

The Power Supply

The power supply unit employs but one choke, of very high inductance, the dynamic loud speaker field acting as the second choke. The field is connected just after the rectifier tube, at a point where about 100 mA. is flowing through the filter. A portion of this current is bypassed around the field by a 1500-ohm resistor, the actual voltage drop across the field being about 70 volts, a value producing the desired excitation. This allows the second choke to be of unusually high inductance with corresponding filtration. The detector and r.f., first a.f., and second a.f. plate voltages are all taken off the voltage-divider system at different points, in order to provide isolation sufficient to obviate any possibility of the "motor boating" which is apt to occur in audio amplifier circuits showing as good low-frequency transmission as do those of this receiver. For convenience, the filaments of the 245-type tubes are excited from a separate filament winding on the power transformer, which is provided with an electrostatic shield to cut out r.f. noises which might otherwise get into the receiver through the power lines.

RADIO IN N. Y. SCHOOLS

The first demonstration of a new system of "centralized radio" for schools took place recently in the New Utrecht High School of Brooklyn, before 2500 students, music supervisors, educators, architects, and officials of the New York City Board of Education. The demonstration was arranged with Stanley & Patterson, Inc., a sales agent of the Radio-Victor Corporation of America, at the invitation of Stephan A. Thomas, chief of the electrical division of the Board of Education, and with the coöperation of Dr. Harry A. Potter, principal of New Utrecht, to provide educators with an opportunity of observing at first hand, the operation of a radio system especially adapted to school use.

The auditorium of the high school was wired with a single-channel control panel, hooked up to a master receiver combined with an electric phonograph, and an arrangement of ten dynamic loud speakers located in the wall organ recesses. Additional loud speakers were installed in Dr. Potter's office, and in the boy's gymnasium. As many loud speakers as are desired in the various classrooms may be connected to the master control panel, without any mechanical changes in the centralized radio system. A time clock automatically starts and stops the programs.

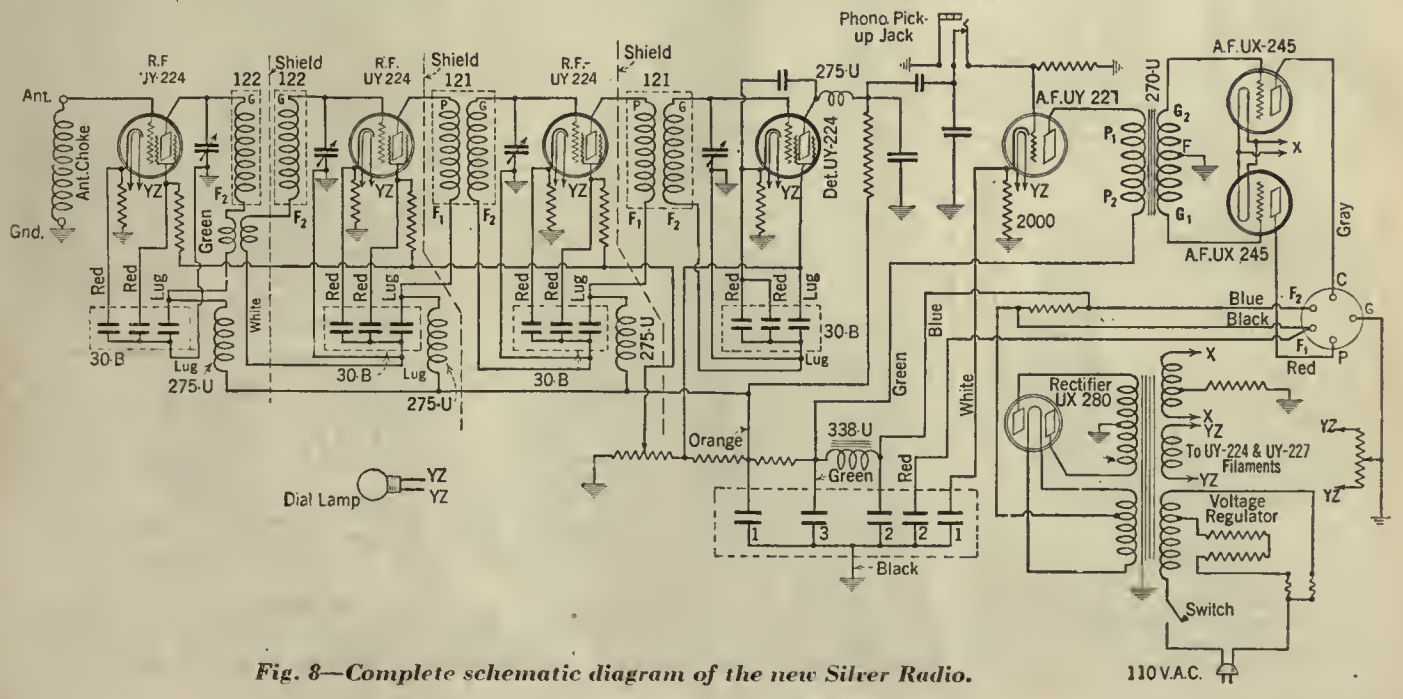


Fig. 8—Complete schematic diagram of the new Silver Radio.

Solving a Sometimes Baffling Problem—

WHY A.F. TRANSFORMERS BURN OUT

By HERBERT M. ISAACSON

PERHAPS THERE are many who have wondered with the writer why transformers "burn out." Why the transformers in one set will stand up indefinitely, and yet transformers of the same make will break down frequently in a different set. That a transformer of "X" make should last longer than one manufactured by "Y" might be accounted for in a number of ways. Fiber is almost always used as the insulating material between the core and the primary, and between the primary and the secondary. In addition, the terminal mounting strip of many transformers is made of fiber; and fiber almost always contains traces of acid. "Y" transformers might invariably break down more frequently than "X" transformers, because the fiber used in them contains more acid, which, of course, eats the fine copper wire away. But, that transformers of "X" make should on the average last five times longer when used in sets made by "A" than they do in sets made by "B", as has been found by the writer, indicates the presence of factors, outside of the transformers, that affect their life.

Some time ago, the writer returned to the manufacturer for replacement, a transformer with an open primary, mentioning that it had been in use in a conventional two-stage amplifier, using double-circuit jacks in both stages. The manufacturer wrote back saying the open was undoubtedly caused by "surges" set up when the plug was removed from one jack and inserted in another; that if automatic filament jacks were not used, then the set should be shut off before plugging from one stage into another, to prevent these surges.

Now, the fusing point of No. 40 wire, the size ordinarily used in a.f. transformers, is 1.85 amperes. The d.c. resistance of the average primary is 2000 ohms. To cause a current of 1.85 amperes to flow through this winding, a terminal voltage of 3700 would be necessary—6845 watts!

[This is an interesting calculation but it neglects the possibility that comparatively high voltages may be developed across an inductance, such as an audio transformer, if the circuit is suddenly opened. These voltages do not depend upon the impressed voltage but are directly a function of the inductance of the circuit and the rate of change of current. If the circuit is opened quickly the rate of change in current will be high and comparatively large voltages will be produced across the transformer. The current would not be greater than the normal plate current of the tube but the voltages will be greater and the transformer might arc over at some point. If this occurred frequently enough the conductor would finally break at the point where the arc takes place. This is undoubtedly the effect which the manufacturer had in mind when he spoke of "surges."—*Editor.*]

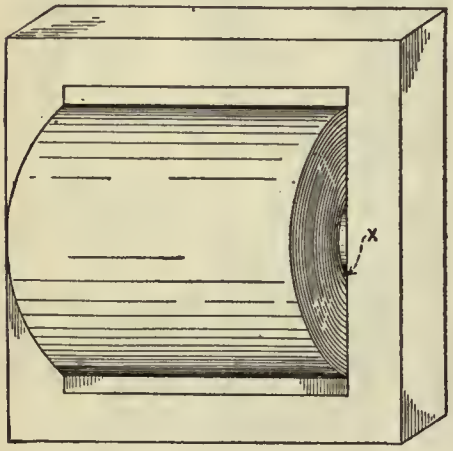


Fig. 1—The point marked "X" in this drawing shows where electrolysis takes place in an a.f. transformer.

Mr. Isaacson, who is a member of the QRV Radio Service in New York City, has discovered a very interesting fact regarding audio transformers; namely, the way in which the unit is connected in the circuit has an important effect on its life. Therefore, the next time one of your transformers "goes west," examine the diagram of the receiver before blaming the manufacturer.
—THE EDITOR.

Recently, the writer took apart a large number of defective transformers of a certain make. About half of them came from sets of one make and the other half from sets of a different make. In "A" sets the cores were grounded. In "B" sets they were not. The transformers in "B" sets had lasted about five times longer than those in "A" sets. In unwinding the primaries, it invariably was found that in those transformers that had their cores grounded, the first few layers of wire nearest the core were eaten away; in those transformers with ungrounded cores, there was no regularity in the position of the lesion. Apparently the grounding of the cores was an important factor in determining the life of the transformer. But why?

If we have two conductors at a potential difference, immersed in a conducting solution known as an electrolyte, electrolysis will take place. The action is, briefly, as follows: The electrolyte is made up of positive and negative ions. Ions are atoms holding charges of electricity. The conductor which is maintained at a positive potential with respect to the other is the anode. The negative terminal is the cathode. Due to the law of attraction of unlike charges, the positive ions are attracted to the cathode. When a positive ion reaches the cathode, its charge is neutralized by it, and it becomes an atom, which in the case of copper is deposited on the cathode. Under certain conditions the positive copper ions of the anode material go into the electrolyte and are carried to the cathode. The effect of all this then is a tearing down, a disintegrating of the anode, the positive conductor, and the building up of the cathode, the negative conductor. The process is electroplating and is also what takes place in our transformer.

The primary of our transformer is the anode. It is connected to the positive post of the B battery. Anything connected to the minus post, very often a metal chassis or metal panel, is the cathode. Moisture constitutes the conducting path, the electrolyte. As has just been shown, under the stimulus of the B voltage, the copper wire of the primary will be disintegrated and deposited on the metal chassis and panel. The rate of electrolysis is proportional to the current flow through the conducting moisture path. The current is inversely proportional to the resistance of the path, which in turn is proportional to its length, assuming that the path is of uniform resistance. And here is where the grounded core enters.

The grounded core is a cathode, separated from the first few layers of the primary, an anode, by a very short distance (see Figs. 1 and 2). Assuming that it is twenty times nearer than any other cathode, electrolysis will then take place twenty times faster, which means that, other factors being the same, the transformer with a grounded core will have a life only $\frac{1}{20}$ as long as one with an ungrounded core. Incidentally this electrolysis goes on all the time the primary is maintained at a positive potential, which, in the case of a battery-operated set, is all the time, whether the set is turned on or not. In the case of sets securing B voltage from the house current, it takes place only while the set is turned on.

Now that the cause of transformers becoming defective is known it is important to discover a satisfactory method of overcoming the trouble. It is well known that in many a.f. amplifier circuits it is essential to ground the cores of the transformers in order to obtain satisfactory operation. However, it will be found that in most cases the same stabilizing effect may be obtained by connecting the core to the positive B wire, and this would place the core at the same potential as the primary (inside) winding, thus effectively preventing electrolysis.

The next time an a.f. transformer in your set "goes west," don't be too quick to blame it on a voltage surge; the trouble probably has been caused by the processions of millions of atoms of copper, each bearing its charge of electricity, hurrying to a "Happy Hunting Ground" called the cathode—minus B in the vernacular—there to give up its charge, its mission having been accomplished.

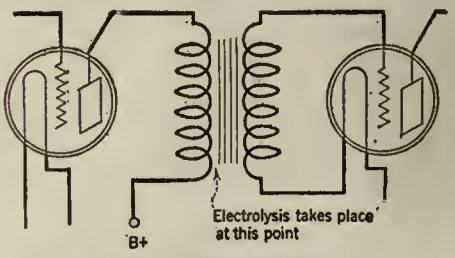


Fig. 2—The arrow in this circuit diagram indicates where transformers are apt to burn out.

THE EXPERIMENTER'S ARMCHAIR

By ROBERT S. KRUSE

BEFORE GETTING down to the main discussion I should like to make a suggestion as to the usefulness of dividing one's wavemeters into two classes. A good example is found in the practice of the Radio Frequency Laboratories, Inc. The precision meters of this establishment are reserved for precision work; during the preliminary adjustments simple and convenient knockabout wavemeters, such as shown in the picture (Fig. 1), are used. If one of these is damaged replacement and recalibration are easy *and prompt*. To save guesses, I will explain that the two large coils are wound on General Radio type 277U forms, the variable condensers are of National Company make, and the two smaller coils are of 3-16th-inch copper tubing. The long baseboard not only carries a calibration chart but also provides room for the long insulating shaft and the National type A vernier dial which materially facilitate readings. The wavelength ranges in meters in this case happen to be 1.85—6.1, 5.5—27.2, 25.0—122.5, and 118.0—565.0. Lamps are placed in the tuned circuit of the two larger wavemeters but are omitted from the smaller ones for the obvious reason that their inductance would be a considerable proportion of the total and would be changed on replacement of the lamps.

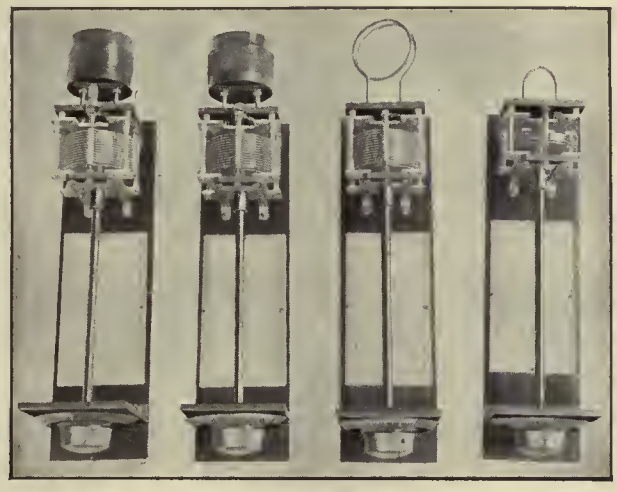


Fig. 1—Knockabout wavemeters are used at the Radio Frequency Laboratories for preliminary adjustments. This picture shows four such instruments of different wavelength ranges.

WAVELENGTH VS. FREQUENCY

The wavemeter charts are in dial setting against wavelength—not frequency. This recalls a discussion held last month. A group of six experimenters agreed thoroughly that frequency was logical as a basis for calculation but was not equally convenient for measurement, and amounted to a positive difficulty during rough preliminary work. The point is, of course, that wavelength is related to the size of things while frequency bears an inverse ratio. During the preliminaries much time is saved if one may estimate the needs without the mental contortion of taking reciprocals of everything. If one insists on talking frequency the only way to avoid such a thing at every turn is to think in reactances instead of inductance and capacities. This in itself involves some detours.

At short waves it is furthermore an infernal nuisance to say "Sixty-thousand kilocycles" when "5 meters" will do just as well. I was quite tickled to find that from the Bell Telephone Laboratories there emerged the same opinion and this was printed in the I. R. E. *proceedings*. I am not quite sure whom the joke is on because one of our I. R. E. Committees has proscribed the meter—and I belong to the Committee!

Incidentally, if frequency is preferred lubberly numbers may be avoided by speaking in megacycles whenever dealing with the territory below (I have fallen back on wavelength again) the ordinary broadcast band. I believe Dr. Pickard is the sponsor of the megacycle terminology. It is in sufficiently general use now so that a complete change-over should be quite painless. What are the opinions of the congregation?

Thirty-Megacycle Reception

LET us get down to the main topic. Our material this month comes from C. A. HART, whose location has been in rapid succession at San Diego, New York, San Pedro, and wherever else the U. S. S. *California* has gone. The correspondence has accordingly taken some time to develop what follows. Let us first look at Mr. Hart's experiments.

A receiver was built up with the conventional oscillating detector and a.f. amplifier for the purpose of going somewhat into the necessities in the region of thirty megacycles. Because such receivers are notoriously weak as to holding calibration, the next step may seems surprising, but this will be explained presently. The curve of Fig. 2 was made by heterodyning the receiver with a crystal-controlled driver. It will be seen that the range of the receiver was from 27.62 megacycles to 45.16 megacycles (10.85 meters to 6.64 meters). For this range the grid coil consisted of one turn and the tickler of $2\frac{1}{2}$ turns of No. 18 enameled wire wound on a standard UX tube base and tuned by a "5-plate" variable condenser. The lengths of connecting leads are shown in the insert diagram of Fig. 2. The ability to take and hold calibration requires the removal of tuning effects from the operator's hands, the antenna, and the regeneration control. If really good permanence of calibration is desired one must also be careful to avoid changes due to shifts of filament and plate voltage, the commonly neglected changes in ordinary r.f. chokes, and, of course, one must keep (and not mistreat) the same tube.

Hand capacity was removed by the use of extension controls rather than shielding. The effect of antenna variations or of changing to another antenna is very large when coupling in the customary amateur manner through a condenser connecting the lower end of the antenna to the upper, or grid, end of the tuned circuit. Therefore, magnetic coupling was used with a primary coil of three times the diameter of the secondary. With a 30-foot antenna adequate coupling is obtained when this coil is placed about $1\frac{1}{2}$" from the secondary, whereby the capacity effect is made sufficiently small so that the differences between various thirty-foot antennas are of no consequence. One accordingly needs to carry only a 30-foot piece of wire and put it up in any convenient manner which will keep it reasonably clear of things. The teeth of the regeneration control were drawn by the simple expedient of cutting and trying until a combination was obtained which permitted leaving this control entirely alone while at the same time giving continued smooth oscillation when tuning across the whole scale. This is in line with the sound amateur tradition of throwing out those things which make trouble. The necessity of doing this while not forcing the tube accounts for the abnormal tickler. The regeneration condenser size is not stated but a small photograph suggests that its capacity runs to several hundred micromicrofarads.

To secure uniform operation across the tuning range the single-layer chokes common to transmission were avoided in favor of a type likely to give a broader response though possibly not of as high an impedance. Three pairs of 1" bakelite squares were strung on a quarter inch bakelite rod. These were located so as to form three slots $\frac{1}{8}$" wide and $\frac{1}{2}$" apart. In the narrow slots were placed scramble-wound, windings consisting of 100 turns each of No. 28 s.c.c. wire, the three windings being connected in series. Smaller wire in the same form proved inferior.

With this combination smoother oscillation was produced than with any combination using higher filament voltages and smaller regeneration capacities in the usual manner. The detector plate voltage had to be kept up to 90 and a 5-megohm grid leak was used. The a.f. stages were run at lower plate voltage than the detector. Concerning this point Mr. Hart says "This may be explained by quoting from Van der Bijl's *Thermionic Vacuum Tubes*, page 214. 'The higher plate potential, of course, gives a higher amplification because the plate resistance of the tube is lower. It is seen also that the amplification at 1000 meters is about 3 times as large as the amplification at 100 meters.' Since without amplification there can be no oscillation, it follows that for 10 meters or less the plate potential must be high."

With this receiver changes of filament voltage such as ordinarily made had very slight effect on the beat frequency, which is unusual for such receivers. The noise level was lower than the other receivers used in the 15–40 meter region, probably because of the loose magnetic primary

coupling. The suggestion made above that magnetic coupling gives a better signal-noise ratio than the usual amateur method of capacity coupling to the end of the antenna was confirmed on some previous experiments on higher wavelengths by enclosing the primary in a metal box with a 2″ hole facing the secondary coil. This permitted magnetic coupling but static coupling was prevented by an ordinary static screen of insulated wire hanging vertically across the hole. The upper end of each wire was secured to the metal box and the lower end hung free. Doubtless the same result would have been secured at 10 meters.

COMMENTARY

It will be seen that Mr. Hart's set departs widely from current short-wave practice of using a large ratio of C/L in the tuned system. For his particular purpose a wide tuning range was desired but the very great merits of a high C/L ratio can be retained while securing a more open tuning scale by merely putting most of the capacity into a fixed form as was suggested in a previous "Armchair" discussion. A 16-megacycle tuning range without variation of the regeneration control is far beyond that ordinarily obtained in short-wave receivers which rarely manage to go a tenth that far and, therefore, rarely are fit for calibration. The signal strength for a well-made oscillating receiver seems (and measures) unchanged by large alterations in C/L. The choke used has undoubtedly a capacity reactance at 10 meters which would be very unfortunate in circuits of conventional proportions but in this case is of distinct advantage.

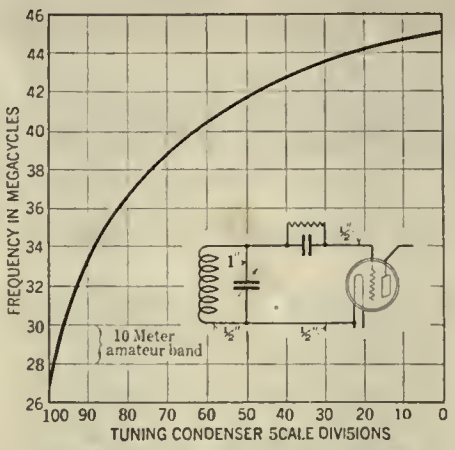


Fig. 2—Calibration curve of Mr. Hart's 30-megacycle receiver. Insert diagram shows lengths of connecting leads.

The absence of shielding is intentional. Since frequent alterations were to be made in the set, a shielding system would have been troublesome during the first stages. Most builders of short-wave receivers entirely fail to appreciate that shielding is useful *only* if there are no circulating r.f. currents in the shield and if the wires emerging from the shield are effectively bypassed and choked. This means that the apparatus inside the shield must connect to the latter at *one point only*, and that much thought must be given to the location of that point, the bypasses, and wires going to it. Frequently the easiest solution is to place a metal sheet inside the shield to which these things are connected and which, in turn, touches the shield at only one point. This is a rudimentary double shield. At very short waves bypasses are not to be judged by their capacity but by their inductive reactance. Paper condensers of 1 microfarad capacity are frequently much less effective than a small mica "postage-stamp" unit of a hundredth the capacity. Chokes, if placed outside the shield, have missed a part of their function and if placed inside may easily reverse it and collect r.f. power which the wire alone would not have intercepted. Again double shielding is indicated as the most desirable solution to the problem.

SKIP-DISTANCE AND RANGE TABLE

For frequencies between 1500 and 30,000 kc.

(This table was prepared especially for RADIO BROADCAST by L. C. Young, Naval Research Laboratory)

Frequency in Kilocycles	Approximate Wavelength in meters	Range of Ground Wave	SKIP DISTANCE				MAXIMUM RELIABLE RANGE				SERVICES (International Radiotelegraph Convention)	REMARKS
			Summer		Winter		Summer		Winter			
			Day	Night	Day	Night	Day	Night	Day	Night		
1500—1575	200—175	100	—	—	—	—	100	100	150	300	Mobile	1604 Experimental—1600–1652–1664–1680–1704–1712 Portable.
1715—2000	175—150	90	—	—	—	—	120	175	170	600	Mobile—Fixed—Amateur	U. S. Entirely Amateur.
2000—2250	150—133	85	—	—	—	—	130	250	200	750	Mobile—Fixed.	U. S. 2002 to 2300 Exp. visual Broadcasting
2250—2750	133—109	80	—	—	—	—	150	350	220	1500	Mobile	2398 Experimental
2750—2850	109—105	70	—	—	—	—	170	500	300	2500	Fixed	2750 to 2950 Exp. Visual Broadcast
2850—3500	105—85	65	—	—	—	—	200	900	350	3000	Mobile—Fixed	3088 Experimental
3500—4000	85—75	60	—	—	—	—	250	1500	400	4500	Mobile—Fixed—Amateur	U. S. Entirely Amateur.
4000—5500	75—54	55	—	—	—	—	300	4000	500	7000	Mobile—Fixed	4795 Experimental.
5500—5700	54.0 —52.7	50	—	—	—	—	400	4000	600	8000	Mobile	
5700—6000	52.7 —50.0	50	50	50	50	60	450	5000	650	8000	Fixed	
6000—6150	50.0 —48.8	50	60	70	60	90	500	5500	700	8000	Broadcast	
6150—6675	48.8 —45.0	45	70	115	80	175	550	6500	750	8000	Mobile	
6675—7000	45.0 —42.8	45	80	185	100	290	650	7000	820	8000	Fixed	
7000—7300	42.8 —41.0	45	90	220	115	360	700	7500	900	8000	Amateurs	
7300—8200	41.0 —36.6	40	140	290	175	465	750	8000	1100	8000	Fixed	
8200—8550	36.6 —35.1	40	160	370	200	570	800	8000	1300	8000	Mobile	
8550—8900	35.1 —33.7	40	170	420	230	630	900	8000	1460	8000	Mobile—Fixed	
8900—9500	33.7 —31.6	40	200	485	270	710	950	8000	1680	8000	Fixed	
9500—9600	31.6 —31.2	40	220	530	280	740	1000	8000	1820	8000	Broadcast	
9600—11000	31.2 —27.3	35	260	625	325	860	1100	8000.	2140	8000	Fixed	
11000—11400	27.3 —26.3	35	300	750	380	1000	1200	8000	2460	8000	Mobile	
11400—11700	26.3 —25.6	35	315	800	400	1080	1300	8000	2700		Broadcast	
11700—11900	25.6 —25.2	35	335	835	420	1120	1500	8000	2800		Fixed	
11900—12300	25.2 —24.4	30	350	870	430	1170	1550	8000	3000		Fixed	
12300—12825	24.4 —23.4	30	370	940	460	1240	1600	8000	3200		Mobile	
12825—13350	23.4 —22.4	30	390	1000	485		1700	8000	3440		Mobile—Fixed	
13350—14000	22.4 —21.4	30	420	1075	510		1800		3660		Fixed	
14000—14400	21.4 —20.8	30	440	1150	545		1950		4060		Amateurs.	
14400—15100	20.80—19.85	30	460	1230	580		2200		4360		Fixed	
15100—15350	19.85—19.55	30	475	1300	610		2300		4640		Broadcast	
15350—16400	19.55—18.30	30	500	1370	640		2500		5060		Fixed	
16400—17100	18.30—17.50	25	550		700		3000		5600		Mobile	
17100—17750	17.50—16.90	25	580		740		3500		6200		Mobile—Fixed	
17750—17800	16.90—16.85	25	600		755		4000		6450		Broadcast	
17800—21450	16.85—14.00	20	660		835		5000		7000		Fixed	
21450—21550	14.00—13.90	20	750		1050		6000		7000		Broadcast	
21550—22300	13.90—13.45	20	780		1090		7000		7000		Mobile	
22300—23000	13.45—13.10	20	835		1130		7000		7000		Mobile—Fixed	
23000—28000	13.10—10.70	15	900		1200		unknown		unknown		Not reserved	Good only for few hours during daylight.
28000—30000	10.70—10.00	10	1000		1400		unknown		unknown		Amateurs	

NOT REFLECTED — NOT REFLECTED

NOT USEFUL — NOT USEFUL

NOTES: Mobile: Ships and Coastal Stations, Aircraft, Railroad Stock, etc.
Fixed: Permanent stations handling point to point traffic.
Skip Distance: Shortest distance beyond the ground wave at which communication is possible, or the point where the sky wave first comes to earth. On certain frequencies and at certain seasons communication is possible within the skip distance due to echoes and around-the-world signals.

The above table was obtained from the general average of a large number of observations. For the night ranges given it is assumed that the greater part of the path between the transmitting and receiving stations is in darkness.

As the distances given in this table are general averages many discrepancies may be found in practice due to seasonal changes, sun spot activities, geographical location, local weather conditions, etc.

ENGINEERING FEATURES OF THE UX-245

By F. H. ENGEL

Technical and Test Department, Radio Victor Corporation



F. H. Engel

THE UX-245 is a power amplifier which has been developed to meet the demand for an output tube which would permit the manufacture of broadcast receivers having good tone quality and reasonable volume at a price well within the reach of the average purchaser. Heretofore, the medium-priced receiver has been limited to the use of the UX-112A and UX-171A types of output tubes, and, while the fidelity of reproduction was satisfactory, the volume obtainable with these types was, in many instances, not considered sufficient for all purposes. Receivers utilizing UX-210 or UX-250 tubes are inherently above the middle-priced range so that a gap has always existed between the medium-priced, good-fidelity, low-volume receivers and the high-priced, good-fidelity, high-volume receiver. The UX-245 tube is intended to fill this gap.

The electrical rating of the UX-245 tube is as follows:

Filament volts	2.5
Filament amperes	1.5
Plate volts	250

Some misunderstanding has existed in the past regarding the voltage ratings of tubes so that a few words in explanation will not be amiss here. The filament voltage rating of a Radiotron, for example, as given in the instruction sheet accompanying each tube, is a normal value, i.e., optimum set performance and life will be obtained when the tube is operated at its rated (normal) value. This means that receiving sets operating on socket power should have transformers or resistors in the filament circuit which are designed to operate the filament or heater at rated value under average line voltage conditions. A reasonable amount of leeway is incorporated in the tube design so that ordinary line fluctuations downward will not cause undue loss of electron emission and appreciable decrease in set performance. In the normal voltage range the filament of the UX-245 tube operates at a dull red color and, with normal plate voltage and grid bias, the sturdy, coated filament gives exceptionally long life performance.

The plate voltage ratings of tubes are maximum values and are so indicated on the instruction sheets. In the case of the UX-245, the 250-volt rating means just what it implies, i.e., the value beyond which it is unsafe to go from the viewpoint of life performance. Several methods of obtaining this voltage regulation are available but their discussion is beyond the scope of this article. In general, however, the amount of voltage fluctuation caused by line-voltage variation, load variation, and manufacturing variations in the apparatus must be determined or estimated and an average design value should then be decided upon so that under the operating variations to be encountered the voltage ratings of the tube will not be exceeded.

Electrical Characteristics

TABLE I gives the electrical characteristics of the UX-245 tube under the two operating conditions which will be used most generally. It should be remembered that the values given are average and that individual tubes may vary somewhat from those stated below.

Table I

AVERAGE CHARACTERISTICS THE UX-245 TUBE

CHARACTERISTIC		
Filament volts	2.5	2.5
Plate volts	250.	180.
Neg. grid volts	50.	33.
Ampl. Factor	3.5	3.5
Plate Resistance (ohms)	1900.	1950.
Mutual Conductance (micromhos)	1850.	1800.
Plate Current (mA.)	32.	26.

In Fig. 2 a family of plate current-plate voltage curves for various grid-bias voltages is shown. These curves are useful in determining the undistorted power output of the UX-245 tube. The method employed has been referred to in an article which appeared on page 329, March, 1929, RADIO BROADCAST ("A High-Power Output Tube—The 250," by K. S. Weaver) and has also been described, among others, by Messrs. J. C. Warner and A. V. Loughren in the I.R.E. *Proceedings*, December, 1926, so that this discussion will not be repeated.

The undistorted output obtainable from UX-245 tube is shown in Table II together with similar data on UX-171A, UX-210, and UX-250 tubes.

Table II

OUTPUT OF VARIOUS POWER RADIOTRONS

	Undistorted power output in milliwatts			
PLATE VOLTAGE	UX-171A	UX-210	UX-245	UX-250
180	720		780	
250		340	1600	900
425		1600		
450				4650

It will be noted that the UX-245 lies between the UX-171A and UX-250 with regard to the undistorted power which it is capable of delivering to a loud speaker, and it has the same output as the UX-210 tube. The advantage of the UX-245 over the UX-210 lies in the fact that the UX-245 delivers the same power as the UX-210 but at about one half the plate voltage required by the latter. This feature is of great importance in connection with set design from the cost standpoint and is one reason for the assured popularity of the new UX-245 tube.

Operation

AS STATED ABOVE, maximum power output from the UX-245 is obtained when it is operated at normal filament potential, 250 volts (maximum) on the plate, and with a negative grid bias of 50 volts.

Filament voltage recommendations for the UX-245 have already been discussed. However, a few remarks concerning the characteristics of this filament may be of interest. The filament of the UX-245 is of the coated-ribbon type and has high thermal inertia which, in addition to the relatively low filament voltage required, insures "humless" operation on alternating current. This type filament is not affected by the presence of small amounts of residual gas and a slight blue glow in the tube is no indication that the tube is defective or that it is improperly operated. The usual midpoint connection to a re-

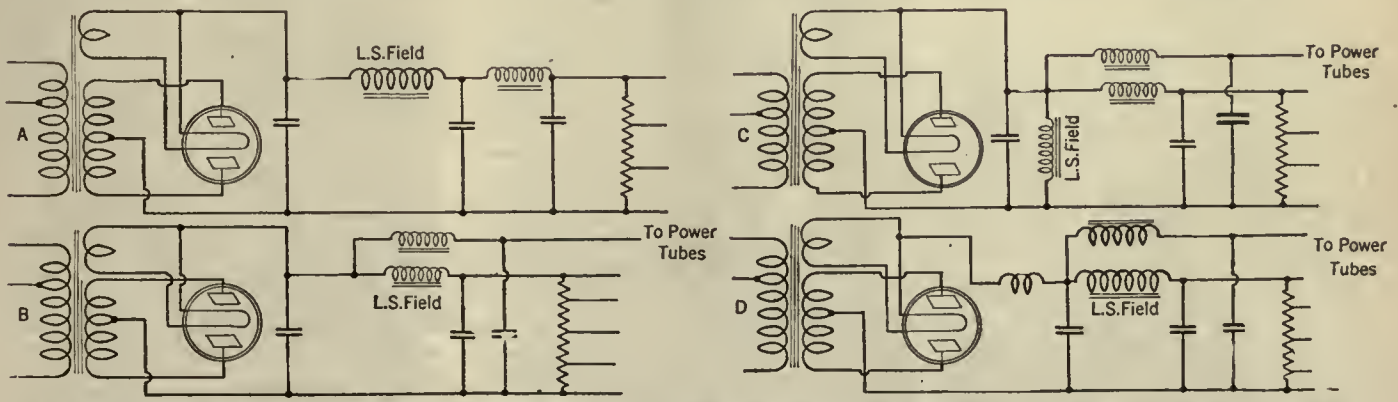


Fig. 1—These diagrams illustrate four methods which may be used for obtaining all potentials required for the operation of a receiver without exceeding the rating of a standard UX-280 full-wave rectifier tube. Each of these power supply systems is designed to supply a receiver of different voltage and current requirements.

sistor placed across the filament terminals or a center-tapped transformer should be used for plate- and grid-circuit return.

The grid swing (50 volts) required to work this tube at its maximum output is easily obtained with sets of present-day sensitivity although when used in "push-pull" circuits the signal input requirement is doubled and this arrangement will call for a set having high over-all gain. When increased power output is desired without increasing the plate voltage supply or grid swing capabilities of the receiver, two UX-245 tubes may be operated in parallel.

The grid-bias voltage for the UX-245 should preferably be obtained by means of a voltage drop across a resistor of proper value placed in the plate-return lead. This is particularly true in resistance-coupled circuits where grid leaks are employed. This "self-biasing" arrangement automatically prevents overloading of the plate and takes care of normal line voltage variation and variations among tubes. When resistance coupling and grid leaks are used it is imperative that the self-biasing connection be used. The grid leak should be made not greater than one megohm so that the grid bias will not be materially reduced in the event that current should flow in the grid circuit.

The plate voltage requirements of the UX-245 are such that the maximum potential (250 volts) may be obtained easily from the type UX-280 rectifier tube. However, the problem of plate voltage supply becomes more involved when two UX-245 tubes are to be supplied in addition to the excitation current for a dynamic loud speaker field and the plate power for the amplifier and detector tubes of the receiver. This condition of use is quite general in this year's receivers and the circuits shown in Fig. 1 will be of interest as they show several methods of obtaining all voltages and currents required without exceeding the rating of the UX-280. This is of particular interest because the use of the UX-280 to supply the plate voltage of a receiver means reduced cost of power pack and reduction in the cost of the receiver.

The rating of UX-280 is as follows:

A.C. volts per anode (r.m.s.) 350 (max.)
D.C. output current 125 mA. (max.)
This gives approximately 350 volts at 125 mA. (d.c.)

Because of the many types of dynamic loud speakers in use no values have been assigned to the various components shown in Fig. 1 since the resistance of the loud-speaker winding and its power consumption determine their values. The following general discussion of the circuits will serve to illustrate the fundamental practice; the set designer can easily fit into his design the constants and select circuit best adapted to this problem.

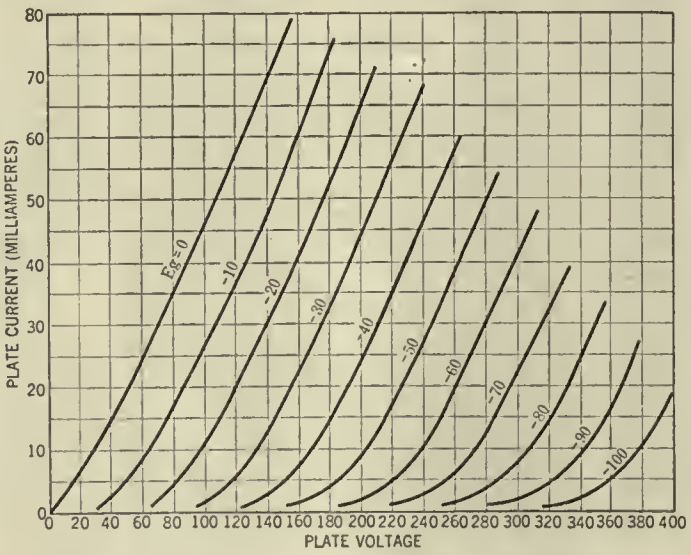


Fig. 2—The undistorted power output available from a UX-245 tube under various operating conditions may be determined easily from the above family of plate current-grid voltage curves.

Four Power Supply Circuits

Circuit A is of use where a considerable voltage drop at a fairly high value of current is permissible; for instance, where the UX-171A, either singly or in push pull, is used as the output tube and UX-226's or UY-227's are used in the rest of the set.

Circuit B is of value where the output power tube requires approximately the full voltage of the rectifier and a considerable voltage drop at a moderate value of rectified current is permissible in supplying the rest of the set. This would be in case the UX-245, either singly or in push pull, is used as the output tube and either UX-226 or UY-227 tubes are used in the rest of the set.

Circuit C is of advantage where the output power tube requires approximately the full voltage output of the rectifier and only a low voltage drop at a low current is permissible in supplying the rest of the set.

Circuit D_e shows a series reactor-type filter circuit for use under circuit conditions similar to those of circuit B. In this connection, the series reactor decreases the instantaneous peak current through the rectifier and thus permits that tube to work under more advantageous conditions. However, in order to get the full value of rectified current from this arrangement, the voltage on the tube must be increased beyond the present maximum value of 350 volts, and this is not recommended.

The arrangement of loud speaker field as shown in circuit C may be used also in connection with circuit D.

Conclusions

In connection with a discussion of plate voltage supply for the UX-245 it might be well to point out that high plate voltage does not of itself produce appreciably higher volume. It does permit greater volume without distortion provided sufficient signal is available to swing the grid with maximum efficiency. In sets which do not have sufficient overall gain to swing the grid of the UX-245 to its full value (50 volts) it is good practice to reduce the plate voltage, as conservative operation of this tube, as well as other types, considerably prolongs its life. Under all recommended conditions of use a transformer or choke and output condenser should be employed to couple this tube to the loud speaker in order to prevent the plate current of the UX-245 from flowing through the windings of the loud speaker.

BOOK REVIEWS

The Radio Amateur's Handbook, The American Radio Relay League, Hartford. Conn., 4th Edition, 200 pages, paper covers. Price: $1.00.

Like its predecessors, the fourth edition of *The Radio Amateur's Handbook* makes no attempt to cover the amateur radio field but confines itself rigidly to telegraphic amateur radio with much stress on message-handling.

The compact first chapter, "What is an Amateur," has been replaced by a longer one on "Amateur Radio." The second chapter remains, as before, a very good introduction to code-learning.

The quite exceptional Chapters 3 and 4 by F. E. Handy have been retained from the original text. They cover the troubled questions of "Fundamentals" and "How Radio Signals are Sent and Received" in a manner that is unusually clear and quite free from the usual semi-correct concessions to brevity.

Chapter 5 on "The Receiver" has chosen to drop the design information of earlier editions and to substitute an array of "how-to-build-it" discussions. Although they are to be classified as amateur-band covering, only two of the designs include the 160-meter band. The three-tube receiver by Westman is unusually well designed and may well serve as a model.

This reviewer must of necessity approve of Chapter 6 since it is written on the text of his own preachings to the amateur transmitter these past years. By this is meant the proper attention to adjustment of transmitters and the use of circuits with a high ratio of C/LR. The chapter presents an array of constructions which crowds out the very good coil-design information of the earlier editions.

Chapter 7 on "Power Supply, Keying, and Interference Elimination" is sound and adequate. Transformer design, rectifier construction, and battery plate supply are discussed. The classic Dellenbaugh filter information has properly been retained.

Chapter 8 does all for transmitting antennas that one may reasonably expect in 10 pages. The 160-meter band again is somewhat lightly touched upon.

Chapter 9 undertakes the impossible by attacking at once "The Frequency Meter" and "Radio Measurements." The discussion of frequency meters and monitoring oscillators is capable but the designs fail to reach the 160-meter band. "Radio Measurements" cannot be treated in 5 pages without references.

Chapters 10 and 11 relate to the mechanism and manners of the message-handling game which is exhaustively discussed in the 26 pages covered by these chapters.

In recognition of the manifest inadequacy of the space Chapter 12 on "The Experimenter" makes no effort at detail but contents itself with a one-page outline and a reference to some prospective activities.

The appendix contains additional information on coded phrases, distance computations, a few formulas, and a good, though short, bibliography.—R. S. K.

No. 25 *Radio Broadcast's Home-Study Sheets* July, 1929

BUZZERS IN RADIO EXPERIMENTS

A GREAT DEAL may be learned from a buzzer, although many never think of it in this connection. There are several ways in which a buzzer may be used to generate radio waves. In Fig. 1, a few turns of wire and a large condenser of one or two microfarads are connected across the contact points. When the contacts are separated, the large condenser is charged by the battery, and when they are closed it suddenly discharges through the few turns of wire. On account of the very high ratio of capacity to inductance, this discharge is highly damped and probably results in only two or three oscillations. This sudden impulse, however, starts oscillations in the secondary circuit, which continue for some time as they are but slightly damped, due to the fact that this circuit has plenty of inductance and very little capacity. The wavelength of the resulting radio currents in the secondary circuit will, accordingly, depend on the values of L and C, and may be determined from the equation wavelength $= 1884\sqrt{L \times C}$ where L = inductance in microhenries and C = capacity in mfd.

Another Method

In Fig. 2 another method of generating radio waves is illustrated. The connections are the same, except that the condenser is smaller and the inductance larger, which reduces the damping effect. High-frequency currents of considerable strength may be generated in this manner by applying several cells to the buzzer, and it has the merit of not seriously affecting other portions of the circuit by inducing stray currents therein.

Probably the most satisfactory circuit for general laboratory work is that shown in Fig. 3. When the contacts are closed, the coil, L, is surrounded by a magnetic field due to the

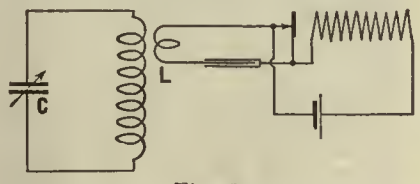


Fig. 1

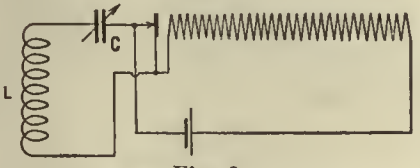


Fig. 2

direct current flowing therein. When the contacts are open, this field collapses rapidly and thereby induces a voltage in the coil, which charges the condenser, C. When the magnetic field has ceased to generate further voltage, the condenser discharges through the coil, and so on until the resistance of the circuit completely dampens the oscillations. At the next movement of the vibrator, the process is repeated.

The buzzer simply functions as an electrical hammer that applies a blow to an electrical weight at regular intervals, the weight continuing to oscillate at its own natural period between the blows. If the value of L and C were such as to have a wavelength of 300 meters, and the buzzer had a pitch of 1000 per second, there would be time for 1000 radio oscillations for each oscillation of the buzzer.

By means of the buzzer and the inductance and capacity standards referred to in "Home-Study Sheets," Nos. 20 and 24, we are now in a position to set up a radio current of any desired wavelength, but before undertaking this it is desirable to consider the mechanical features of buzzers, and also to provide some additional measuring apparatus.

Unsatisfactory Types

There are several high-pitched buzzers on the market that will answer very well in this connection. These are made specially for radio work, such as code instruction and testing crystals. The ordinary house buzzer is of too low a pitch to be satisfactory. Also, the kind that is connected up as indicated in Fig. 4 should be avoided, for the reason that when the contacts are open there is still a fairly large capacity across them due to the fact that one of the binding posts is in contact with the case and the magnet cores, while the other is connected to the surrounding coils. Sometimes buzzers are provided with a resistor across the

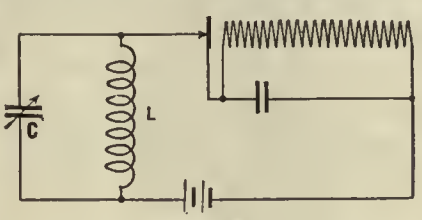


Fig. 3

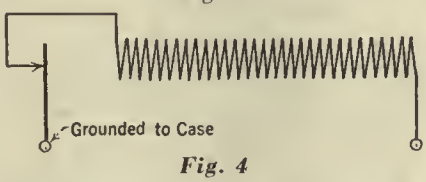


Fig. 4

contacts to prevent sparking. Such a resistor would have to be removed to make the buzzer suitable for radio work.

Making a Buzzer

It is quite surprising to learn what a satisfactory radio current may be generated by a single dry-cell battery and a very small buzzer. Suitable ones of high pitch are not very difficult to make, and they lend themselves admirably to the construction of bridges, wavemeters, etc. Fig. 5 illustrates the general plan of construction, and to what extent the dimensions may be reduced. Buzzers of this type may be made that will vibrate as high as 5000 times a second. The magnet core is simply a piece of soft iron wire about an eighth of an inch in diameter or a bundle of soft iron wire (stove-pipe wire will do) of the same size. In making the hair-pin turn, care will be necessary to keep the two legs straight and parallel. On a straight piece of the same material a thin paper tube is formed by wrapping it with a strip of paper to which glue has been applied. When the tube has hardened, two suitable lengths are cut, and each is wound with number 32 or 34 enameled wire. Shellac must be applied during the winding, and if considerable tension is used in placing the turns, each successive layer may be stepped back half a space, as indicated in the drawing. In this manner the necessity of making two very small bobbins is obviated. When the shellac has hardened thoroughly, the coils are then pushed onto the iron core and the connection between is soldered.

The vibrator is a one-eighth inch strip of the thinnest commercial tin, from which the tin coating has been polished off. While this may be supported by soldering it to one of the magnet poles, it is preferable to provide a separate brass block. This should be heated in a clean flame just enough to permit the tinning of the space where the vibrator is to be applied. The latter may then be coated with flux, and steadily held in position until cool. In this way there should be no danger of drawing the temper of the vibrator.

Considerable care will be necessary in providing the contacts. A small piece of platinum wire should be procured from the jeweler, say about an inch of No. 30 guage. Hammer out one end to form a little spring, not over three-sixteenths of an inch long. Using a piece of heavy tinned copper wire as a soldering iron, attach the platinum to the vibrator with the least amount of solder possible. When the contact screw has been provided, a short length of the platinum wire is soldered on the end, care being taken to remove all surplus solder.

The base should be cut from a piece of panel material, to which the magnet is secured by

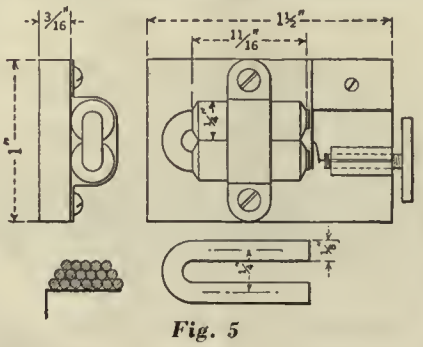


Fig. 5

means of a thin brass yoke held down by two 4-36 screws.

That such a buzzer is working properly cannot be determined by its sound, although it is essential that the note be clear, musical, and steady. It is only when the resulting radio currents are detected with a crystal and are listened to in a telephone receiver that the final result can be ascertained. Not infrequently the strength and quality of the note can be improved materially by placing a rather large fixed condenser across the magnet coils.

Determining Frequency

There is a simple way of determining with a fair degree of accuracy the frequency of high-pitched buzzers. It is also interesting and instructive from the standpoint of radio. In Fig. 6, L is a 1500-turn duo-lateral or honeycomb coil, the inductance and distributed capacity of which we will accept from the manufacturer's statement. L_1 is 8 or 10 turns of wire wound on a wooden core and slipped inside of the large coil, L. C is a calibrated condenser reading up to 0.001 mfd. and to one side is connected a crystal detector with a telephone receiver across it. If the buzzer is now started, the sound should be heard clearly in the receiver, and, as the condenser C is varied, the character and intensity of the note will pass through a series of changes, alternately becoming clear and loud, and then indistinct and confused. The points at which these changes

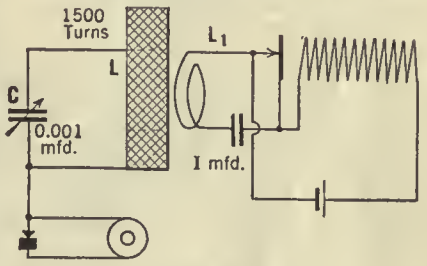


Fig. 6

occur will be found close together at the lower dial readings and further apart toward the upper end of the scale.

In the circuit with which we have been experimenting each impulse of the buzzer starts a series of oscillations in the circuit L C, and the frequency of these oscillations is given by the formula

$$f = \frac{159200}{\sqrt{L\,C}}$$

When the note in the telephone receiver is strong and clear, the frequency of the radio oscillations is an exact multiple of the frequency of the buzzer. To illustrate by figures, assume that at 100 on the condenser dial, C indicates a capacity of 0.001 mfd., and that the lower readings are strictly proportional, as would be the case if the condenser capacity curve were truly a straight line. Let it be further assumed that the coil, L, has an inductance of 175,000 microhenries. With these values a critical point might be noted at, say, number 23.1 on the condenser dial, a second one at 31¼, a third one at 41.1, and so on. The corresponding capacities would be 0.000231, 0.000315, and 0.000411 mfd. Multiplying these by 175,000 we find the value of L C, and the corresponding frequencies may then be found from the formula or by consulting the wavelength and frequency table presented in "Home-Study Sheet" No. 19 (April RADIO BROADCAST). In the present case, these will be found to be frequencies of approximately 12,000, 14,000, and 16,000 cycles per second. The uniform difference of 2000 is the frequency of the buzzer.

In actual practice, depending on the values involved, five or ten critical points may be identified, in which case it is necessary to divide only the difference between the first and last radio frequencies by the number of steps involved, which will, of course, be one less than the number of readings taken. It is also necessary, if accuracy is desired, to add to the capacity of the condenser at each reading the distributed capacity of the coil L, which will be of the order of .00003 mfd.

When a radio-frequency galvanometer, to be described later, has been made, it may be inserted directly in the oscillatory circuit L C, and the crystal and receiver may be dispensed with. The experiment is more striking when carried out in this manner, as the galvanometer shows a marked increase in deflection whenever a critical point is passed.

No. 26 *Radio Broadcast's Home-Study Sheets* July, 1929

COUPLED CIRCUITS

"When two circuits are placed or interconnected so that energy may be transferred from one to the other they are said to be coupled." Morecroft, *Principles of Radio Communication*, p. 95, Second Edition

Kind of Coupling

Circuits may be coupled together by means of resistance, capacity, or inductance. Thus, in Fig. 1, the plate circuits of two radio-frequency amplifier tubes are coupled. These

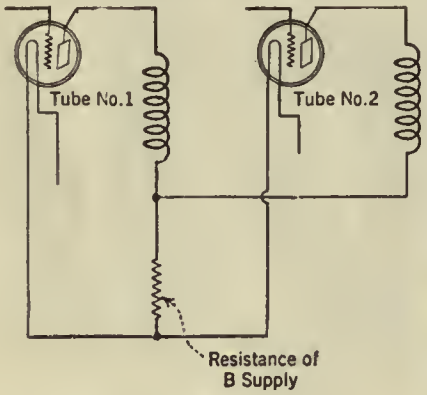


Fig. 1

tubes get plate current through some device that has an internal resistance, the voltage divider of power supply equipment, for example. Now the plate currents of tube No. 1 and tube No. 2 flow through this resistor which is common to both circuits. The voltage that is across this resistor due to the plate current of tube No. 2 is impressed in the plate circuit of tube No. 1. This is our definition of coupling; and so tubes Nos. 1 and 2 are coupled together. This is resistance coupling.

The classic example of undesired coupling due to capacity is that existing within a tube due to grid-plate capacity. Thus, in Fig. 2 is a representation of a tube circuit in which Ri is the input circuit, the voltage across which is amplified by the tube to reappear in the plate circuit as μE_g, R_o is the output resistance which is in series with the plate resistance and μE_g, and C_{gp} is the grid-plate capacity which couples R_o to R_i. If the coupling due to C_{gp} becomes great enough that a voltage is produced across Ri equal to that across Ro divided by the mu of the tube, oscillations occur.

Of course, the most familiar example of coupling is that due the mutual inductance between two coils—a transformer as in Fig. 3. The bracket, marked M, indicates that mutual inductance exists between P and S.

Inductance formulas and laboratory experiments demonstrate that the inductance of a coil varies as the square of the number of turns, so that if one doubles the number of turns on a given coil he will have four times the inductance. Now let us suppose we have two identical coils, L_1 and L_2, as in Fig. 4. If they are connected in series so that the turns are in the same direction the same effect will be produced as if twice as many turns had been wound on a single coil. The inductance will be four times the inductance of a single coil. Now if one of the coils is reversed so that its turns are in the opposite direction to those in the other coil, the inductance will be zero. Actually, however, the inductance will be neither four times that of a single coil in one case nor zero in the other because it is not possible to get perfect coupling between coils.

In the "series-aiding" case where the inductance is increased by adding two coils together, the measured inductance will be made up of the inductance of coil 1, plus the inductance of coil 2, plus the mutual inductance due to the lines of force from coil 1 that go through coil 2,

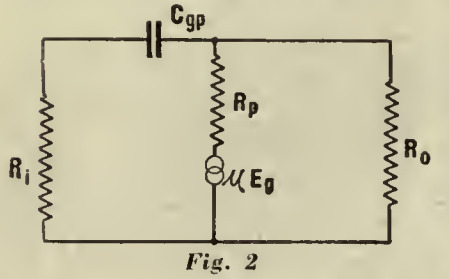


Fig. 2

and plus the mutual inductance due to the lines of force from coil 2 that go through coil 1. Thus:

Series Aiding, $L_a = L_1 + L_2 + 2M$
Series Opposing, $L_o = L_1 + L_2 - 2M$

and if the coupling between coils is perfect and L_1 is equal to L_2, L_a will equal 4 L_1. If the coupling is less than perfect, and in air-core coils it is always much less than perfect, the total inductance will be less than L_o in the series-aiding case and greater than zero in the series-opposing case.

Measuring Mutual Inductance

Let us suppose we have a transformer, as in Fig. 3, and we want to know how much mutual inductance exists between the two coils, P and S. How shall we measure it? Let us connect the two coils in a series-aiding circuit and measure the inductance L_a. Then connect them in a series-opposing circuit and measure the inductance L_o. Then we have two equations given above and if they are subtracted, we shall have $4M = L_a - L_o$. Of course, if we already know L_1 and L_2 we can calculate M from either of the equations above, but when measuring inductance it is just as simple to measure both the series-aiding and series-opposing cases.

Example 1: In the Laboratory it was desirable to know the mutual inductance between the primary and the secondary of an interstage r.f. transformer. The primary and secondary inductances measured 10 and 160 microhenries, respectively, and the total series-aiding inductance was 210 microhenries. The series-opposing inductance was 130 microhenries. What was the mutual?

Solution:

$L_a = 160 + 10 + 2M = 210$
$L_o = 160 + 10 - 2M = 130$
Subtracting $L_a - L_o = 0 + 0 + 4M = 80$
$M = 20$

and thus the mutual inductance was 20 microhenries.

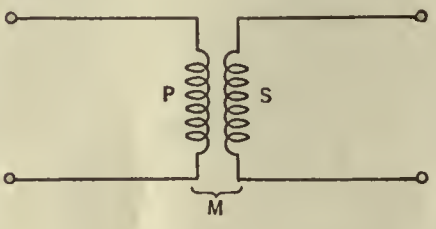


Fig. 3

Coefficient of Coupling

It is desirable to have some expression which tells us how much two circuits are coupled; that is, the expressions "loosely" or "closely" coupled are only relative and really tell us nothing at all about what the mutual inductance is. What would be considered as close coupling in an air-core transformer would be very loose in an iron-core transformer.

The expression "coefficient of coupling" is such a term. It is

$$K = \frac{M}{\sqrt{L_1 L_2}}$$

Perfect coupling gives a coefficient of 1; it is sometimes called "unity coupling." A closely coupled circuit at radio frequencies may give a coupling as high as 70 per cent. (a coefficient of 0.7), but this is higher than obtained in most cases. K can never be greater than 1.

Example 2: In Example 1 what is the coefficient of coupling between primary and secondary?

Solution:

$$K = \frac{20}{\sqrt{160 \times 10}} = \frac{20}{\sqrt{1600}} = \frac{20}{40} = 0.5;$$ or the coupling is 50 per cent.

Fig. 5, taken from Morecroft, p. 33, explains how the coefficient of coupling must be calculated.

When circuits are coupled by a transformer, or by any other kind of coupling, current flowing in one circuit induces a voltage in the other. This voltage forces current to flow through the load in the secondary circuit and thus uses power. The secondary voltage is given by

$$E_s = I_p \times M\omega$$

where I_p is the current in the primary.

Problem 1: If the a.c. current in the primary of the radio-frequency transformer in Example 1 is one microampere what is the secondary voltage? Answer 125.6 microvolts.

The case of the transformer with tuned secondary of the type used in the great majority of modern radio receivers was considered in "Home-Study Sheet" No. 22 (May, 1929, Radio Broadcast). Now what happens if both primary and secondary are tuned?

Such a transformer with both primary and secondary tuned to the same frequency

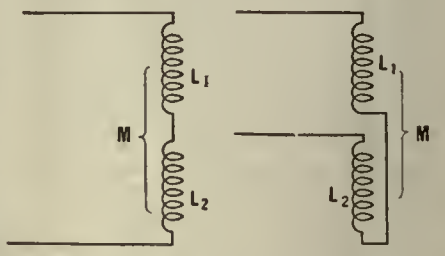


Fig. 4

may be applied to the antenna circuit as a sort of pre-selecting circuit or as a coupling means between tubes. As a pre-selector, the system is used, with certain modifications, in the Sparton receivers as well as the Continental Radio Corporation's "Sky Raider," both built under Technidyne patents. Between stages in an r.f. amplifier the doubly-tuned transformer is used in the "Hi-Q 29" kit receiver, in the Radiola 60 intermediate-frequency amplifier, and in the Freshman Mystery receiver.

If two circuits are tuned independently to the same frequency and then coupled to each other, there will be two frequencies to which the circuit will tune and neither of these frequencies will be the original frequency to which the two circuits were tuned individually. If the coupling is weak, the two frequencies will be close together and give a flat-topped response curve; if the coupling is close the two frequencies will be far apart and give a response curve looking like two peaks widely separated with a deep valley between them.

The two new frequencies to which the circuit will respond are given by

$$f_1 = f_o \sqrt{1 + k}$$

$$f_2 = f_o \sqrt{1 - k}$$

in which f_o is the frequency to which the individual circuits are independently tuned and K is the coefficient of coupling.

Example 3: If the coupling between two such circuits is 10 per cent. (k = 0.1), the two new frequencies will be respectively $f_o \times 1.05$ and $f_o \times 0.95$ and so, if the frequency f_o is 1000 kc. the two frequencies will be 1050 and 950 kc., respectively.

If the two circuits are identical, having the same capacity, inductance, and resistance, and are attached to similar circuits, the two peaks will have the same height.

Problem 2: Assume a fixed degree of coupling, say 1.0 per cent., and calculate the peaks of the two frequencies as f_o is, respectively, 600, 1000, and 1500 kc. As a result of these calculations do you see any reason why the system may fail in radio receivers?

Problem 3: Assume a fixed value of f_o, say 1000 kc., and various values of coupling. Calculate the frequencies of the two peaks as the coupling varies through small values, say 1 per cent. to 10 per cent.

Problem 4: Suppose the frequency f_o is 100 kc., as in a super-heterodyne, and calculate the response frequencies as the coefficient of coupling varies from 0.1 to 0.9.

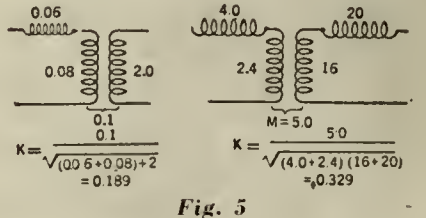


Fig. 5

DESIGN DETAILS OF THE FADA SET

By E. A. UEHLING

Engineering Department, F. A. D. Andrea, Inc.

AMONG THE most important of the recent contributions to radio are the screen-grid tube and the band-pass filter. The first of these permits a flexibility in circuit design that has been possible with no other tube. It makes possible the separation of the function of station selection from the function of amplification.

Separating the functions of amplification and selection is essential if signal selection is to be accomplished in any other way than by the method of single-resonance circuits in cascade, with its attendant frequency distortion. There is another advantage in this separation of functions. If the desired signal is not entirely separated from the undesired signals before being passed on to the first amplifier tube, the latter may modulate the former, because of the non-linear characteristic of the amplifier tube. This modulation is especially noticeable in the neighborhood of a strong broadcast station, which, as a consequence, may be heard over a large portion of the broadcast range whenever another carrier is tuned-in, the frequency of which may be as much as 40 or 50 kilocycles from the fundamental frequency or harmonic frequency of the interfering station.

For the reason described above, if for no other, it is important to precede the amplification in the receiver by adequate signal selection. These functions can be separated by using a band-pass filter to precede the first amplifier tube with the result that very good selectivity can be combined with very slight frequency distortion in the radio-frequency part of the receiver.

The receiver described in this article has a band-pass station selector unit of pre-assigned characteristics followed by two stages of radio-frequency amplification, a detector of the plate-rectification type, and an audio amplifier having in the output stage two 245 tubes in push pull.

Requirements of a Good Set

A GOOD RECEIVER should have a radio-frequency voltage amplification of about 5000. If the amplification is considerably less than this value the receiver may not be capable of distance reception and a detector of the plate-rectification type is not entirely satisfactory. If the amplification is greater than this value, the receiver will, in general, amplify signals that are below the noise level, and it may be unsuited for general use in localities in which there are powerful broadcasting stations in this immediate vicinity.

Before considering the methods by which this value of amplification is to be obtained, let us consider the single stage. The amplification per stage with a screen-grid tube is

$$g = G_m R_L$$

where G_m is the mutual conductance of the tube and R_L is the load resistance.

This relationship holds for the 224-type tube because all values of R_L that can be attained in practice are small compared with r_p.

If R is 10 ohms at 535 meters, L is 200 microhenries, and C is 400 micromicrofarads, R_L is equal to approximately 50,000 ohms. Since the mutual conductance of the 224-type tube is about 1000 micromhos, the total amplification that can be obtained with one stage is equal to the product of 1000×10^{-6} and 50,000 or 50. Two stages will then give an amplification of about 2500, and, with a gain in the antenna and filter circuit of only 2 or 3, we have acquired the required amplification of 5000.

Impedance Coupling

WHEN THE amplification problem was first considered, all methods were subjected to theory and experiment. The final choice of tuned impedance coupling is based on the results of actual experiment, but these results check the theory so well that a description of the advantges of impedance coupling can be illustrated very adequately by considering the actual physical problem involved. Because of the very high plate resistance of the screen-grid tube, the coupling between plate and grid circuits must be very close in order to satisfy the conditions of optimum gain.

As a matter of fact, this condition can be realized only partially in practice. In order to realize this condition with transformer coupling the primary inductance must be very high, that is, equal to or greater than the secondary inductance, and the coefficient of coupling must be as near unity as possible. In general, this design means a transformer of rather high dielectric losses and high mutual capacity. There are other considerations of even greater importance. If the optimum resonance relation is as nearly satisfied with transformer coupling as it would be with impedance coupling, the primary will require a greater number of turns than the secondary even though the coefficient of coupling be very near unity. The effect of the plate resistance on the selectivity of the circuit then begins to assume proportions no longer negligible. The effective resistance due to the internal plate resistance added to the secondary circuit may amount, at 200 meters, to 10 ohms or more. The actual amplification that can be obtained with transformer coupling is approximately equal to that which can be obtained with impedance coupling under the same conditions. The mutual inductance, of course, must be very high, and practical difficulties are encountered that are not met when impedance coupling is used. That the amplification with impedance and transformer coupling is about equal becomes evident when the comparative values of L/R_2C and ω^2M^2/R^2, the load resistance for tuned impedance and transformer coupling, respectively, are considered. The value of the first of these two quantities in a given case we have found to be equal to 50,000 ohms at 535 meters. The value of the second of these two quantities at the

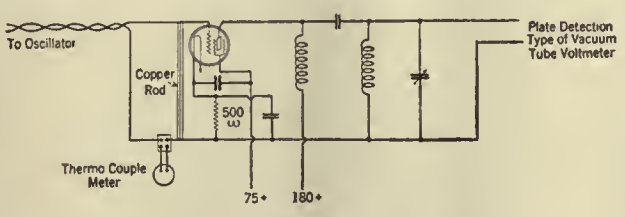


Fig. 1

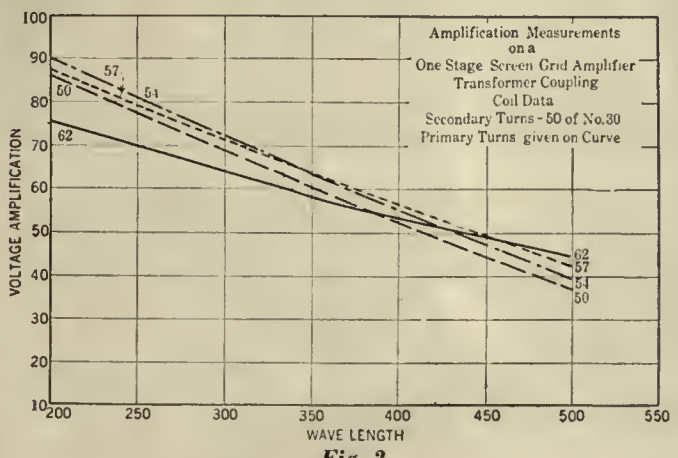


Fig. 2

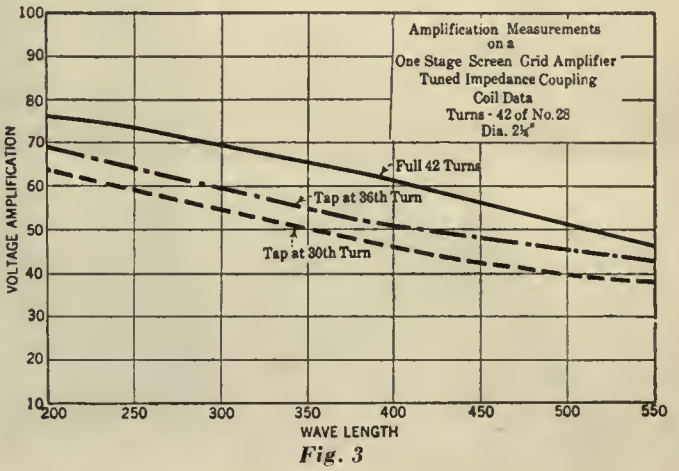


Fig. 3

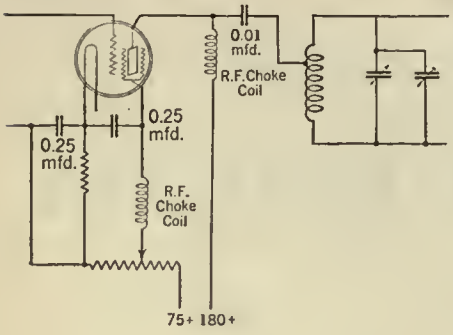


Fig. 4

same wavelength and for a transformer of mutual inductance equal to 200×10^{-6} henries is 51,000 ohms.

Simplified Design

THUS, THE amplification problem has been considered without resort to the more complicated amplification formulas that must be used for other types of tubes. The very high plate resistance of the screen-grid tube makes for simplification in design as well as simplification in mathematical circuit considerations.

In the original experimental work on this receiver, it was necessary to measure the amplification under actual operating conditions in order to check the theoretical results. At that time there was no calibrated oscillator with a calibrated signal output of a wide range of values available and a method of making these measurements had to be developed.

Because of the high amplification of the screen-grid tube the required input voltage had to be so small as to offer considerable difficulty in measurement. Several methods of measuring these small voltages were tried with only partial satisfaction. Finally it was decided to use a method that did not require the measurement of the input voltage. A relatively large signal current that can be measured with a sensitive thermo-couple was made to flow through a definite length of straight copper rod of negligible resistance. The inductance of this short, straight rod of copper could be calculated and thus the reactive voltage drop was known. The circuit used in making of these measurements is illustrated in Fig. 1. The copper rod is 29.2 cm. in length and 0.14 cm. in diameter with a self inductance of 0.341 microhenries at 550 kc. and 0.339 microhenries at 1500 kc.

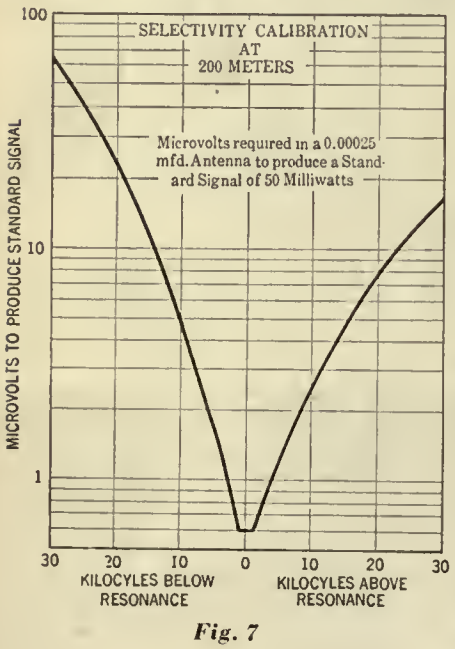


Fig. 7

Its impedance at 545 meters is, therefore, 1.179 ohms and at 200 meters it is 3.197 ohms. With a current of 2 milliamperes flowing through it, the reactive voltage drop is 2.358 millivolts at 545 meters and 6.394 millivolts at 200 meters. This method is not absolutely accurate because of end effects and the mutual reactance between the rod and the rest of the circuit and ground. But with a little care in arrangement of the rod itself, and the lead wires to the rod, errors arising from this source can be reduced to a very small value. Actual amplification measurements as obtained with this apparatus for a few of the more interesting conditions are shown in the graphs (Figs. 2 and 3) on the preceding page.

Amplification per Stage

NOTHING HAS been said up to the present regarding the conditions that affect the actual value of amplification per stage. Regardless of the kind of coupling used, the amplification is inversely proportional to the radio-frequency resistance of the resonance circuit. Low-loss coils of large size wire and good shape factor are very important, and this implies further that the coil shielding itself must be as

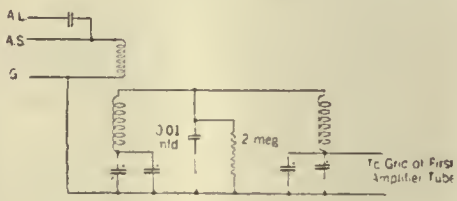


Fig. 5

large as it is practical to make it. As a second condition for good amplification, the ratio of L to C should be large. Making this ratio large also improves the selectivity of the circuit.

There is, however, a very practical upper limit to the value of the ratio of L to C. The larger L is made, the smaller will be the maximum capacity of C necessary to reach the upper limit of the broadcast range. There are, however, fixed capacities in the circuit such as the plate-filament capacity of the tube, and capacity of the compensating condenser, and the minimum capacity of the tuning condenser itself, the total value of which fixes the upper limit of L.

Attention may be called to the amplification curves of Figs. 2 and 3 which were made by using the circuit of Fig. 4. It will be seen at once there is a discrepancy between the calculated amplification for impedance coupling and the measured values. It is obvious that the results that can be obtained with impedance coupling are largely dependent on the characteristic of the r.f. choke coil supplying the tube plate voltage. The measurements on impedance coupling already referred to were made before the r.f. choke coil used in this receiver was designed. This choke coil has three sections. It has an impedance at 500 meters of 70,000 ohms which increases gradually as the frequency increases to a value of about 500,000 ohms at 200 meters. The resonance point of this choke coil falls at approximately 200 meters, or a little higher.

Thus far we have considered only the amplification per stage and find that the amplification of two stages on the basis of the results already discussed, is sufficient and all that is desirable in a good receiver. There will, of course, be some regeneration though none has been purposely introduced, and the actual shape of the amplification curve may be modified to some

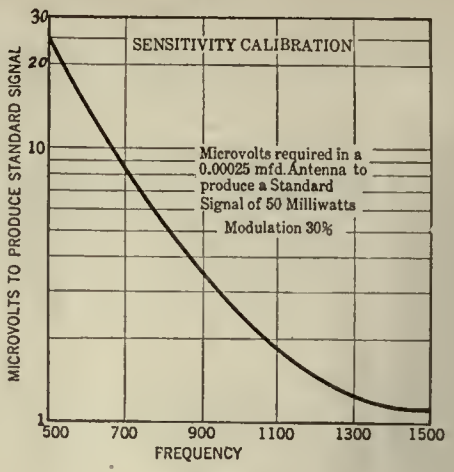


Fig. 6

extent in the completed receiver by the antenna coupling method used and other factors. Actual overall amplification measurements which will be discussed later indicate, however, that these effects are small and need not be considered further.

Detection System

HAVING OBTAINED an overall radio-frequency amplification of approximately 5000, we are at liberty to use plate rectification (C bias) in the detector. It is less efficient than the grid rectification so commonly used up to the present time, but this efficiency is not necessary with the amplification available. It is capable of more faithful reproduction, or, to put it more accurately, the tendency to frequency distortion found in grid circuit rectification with the values of grid leak and condenser generally employed, does not exist in anode detection. A second advantage of plate rectification is the greater audio output power of the anode detector. Detector overloading has been one of the most serious limitations of radio receivers in the past. With the use of plate detection, and the high radio-frequency amplification that makes it possible, a serious defect of past receivers has been eliminated.

As already stated, there is a signal selector of band-pass characteristics preceding the first radio-frequency amplifier tube. There are at the present time many types of band-pass filters, and such filters have been used for a long time in tele-

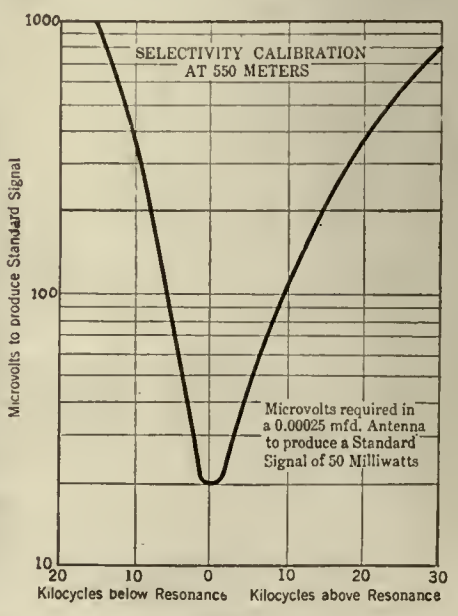


Fig. 8

phone work. But a filter that will meet the requirements for one case may not be at all suitable for another. As a result, it has not been easy to supply a filter of band-pass characteristics for broadcast use.

All filters that are simple enough mechanically and electrically for radio receiver use have the unfortunate characteristic of varying band width for different frequencies in the broadcast range. In most filters already used the band of frequencies transmitted is narrow at the high wavelengths and very wide at the short wavelengths. This condition is an unfortunate one, not only because the width of band varies with wavelength but also because it varies in the way it does. The selectivity at the short wavelengths is usually not very good even in the best receivers because of the increased resistance of the radio-frequency circuits at the higher frequencies. It is obvious that if the width of the band transmitted by a band-pass filter increases as the wavelength decreases, the tendency toward broad tuning at the shorter wavelengths will be even more pronounced.

The Band-Pass Circuit

A SIMPLIFIED CIRCUIT of a band-pass filter having more desirable characteristics is shown in Fig. 5. It will be noted first of all that no magnetic coupling exists between the two circuits. There are two principle advantages of coupling these circuits as shown and these advantages will be described as follows: We are interested in the width of the transmission band which depends on the value of the quantity $\sqrt{R_1/R_2}\,(M^2 - R_1R_2)$ where R_1 and R_2 are the circuit resistances and M^2 is the absolute value of square of the coupling impedance. It will be seen that this coupling impedance should vary as the product R_1R_2 varies with frequency, so that the quantity $(M^2 - R_1\ R_2)$ is as nearly constant with frequency as it can be made. When the coupling between the circuits is magnetic the variation of the mutual reactance is numerically equal to L and when the coupling between the circuits is capacitive, the variation of the mutual reactance with frequency is numerically equal to $1/\omega^2C$

Suppose we decide on 4 per cent. coupling as the value which gives the desired width of band at the longest wavelengths. With 230-microhenry tuning coils the mutual inductance will then have to be 9.6 microhenries and the variation of the mutual reactance with frequency as expressed by the first formula above will be 9.6×10^{-6}. Now, if the coupling between the circuits is capacitive, and a coupling of 4 per cent. is again chosen, the coupling capacity will be about 10,000 micromicrofarads, and at 550 meters the variation of reactance with frequency as determined by the author's mathematical calculations will be 10×10^{-6}. For either type of coupling the variation of reactance with frequency at 550 meters when the coupling percentage is adjusted for the same width of band is the same. But in the case of magnetic coupling this variation is constant regardless of frequency, and in the case of the capacity coupling the variation in reactance with change in frequency decreases

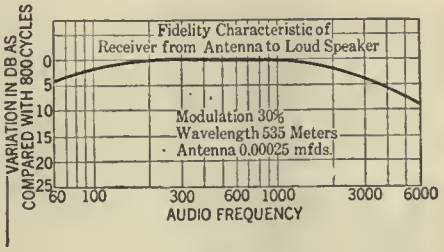


Fig. 9

as the frequency increases. Thus we find at 200 meters the variation of reactance with frequency is equal to only 1×10^{-6} as compared with 10×10^{-6} at the same frequency for magnetic coupling. So in the broadcast range capacity coupling gives a more nearly uniform width of band than magnetic coupling, provided the width of the band is made the same for both types of coupling at 550 meters. That is, the actual arithmetic variation in band width is less for capacity coupling than for inductive coupling.

The second of the two principle advantages of this type of band-pass filter is that whatever variation in band width there is, is in the most desirable direction as already stated. As the receiver tuning dial is turned to the shorter wavelengths, the coupling percentage is reduced constantly. This reduction in percentage of coupling is slightly more than is required to give constant width of band with the result that there is a slight decrease in band width at the lower wavelengths.

The use of a band-pass filter is not without some loss in voltage amplification as compared with other methods of signal selection. But in this receiver with its two stages of screen-grid amplification, the full voltage step-up usually obtained in the antenna circuit is not only unnecessary but actually undesirable. In another part of this paper it was stated that there is a voltage gain in the antenna circuit of this receiver through the band-pass filter of about 2 at 550 kilocycles and about 4 or 5 at 1500 kilocycles.

Overall Performance

THE OVERALL performance of the receiver is adequately described by four sets of measurements made on the receiver with the aid of a calibrated signal generator. These measurements are illustrated in Figs. 6, 7, 8, and 9. In obtaining the data for all of the curves, the input to the dummy antenna of the receiver was adjusted until a standard signal of 50 millivolts in a resistance connected across the secondary of the output transformer was obtained. In all of these measurements an 0.00025-mfd. antenna was used. In Figs. 7 and 8 the data obtained in making a set of selectivity measurements at high and low wavelengths are plotted as a function of kilocycles below and above resonance. In Fig. 9 we have an overall fidelity curve of the receiver. The absence of sideband cutting is apparent, yet the selectivity measurements just described show that the receiver is unusually selective at both high and low wavelengths. In obtaining the fidelity curve the modulation was held constant at 30 per cent. as the audio frequency was varied. As before, the input was adjusted for a standard signal in the output, and the ratio of the input at various frequencies to that required at 800 cycles was taken as the basis for obtaining the variation in transmission units of the overall radio-frequency characteristic of the receiver.

A circuit diagram of the radio-frequency circuits of the new Fada-35 receiver which embodies the features that have been described is shown in Fig. 10. Provision is made for connecting the output of a phonograph reproducer or a condenser microphone in the detector grid circuit. This provision makes the receiver suitable for certain kinds of public-address work. The output is designed to match a 3-ohm voice coil of a dynamic loud speaker.

The receiver can be used with a short antenna in most localities with good results. In apartment buildings and other localities where an antenna is not available, the link switch can be closed connecting the receiver input to one side of the power line. With this connection no external antenna of any kind is required.

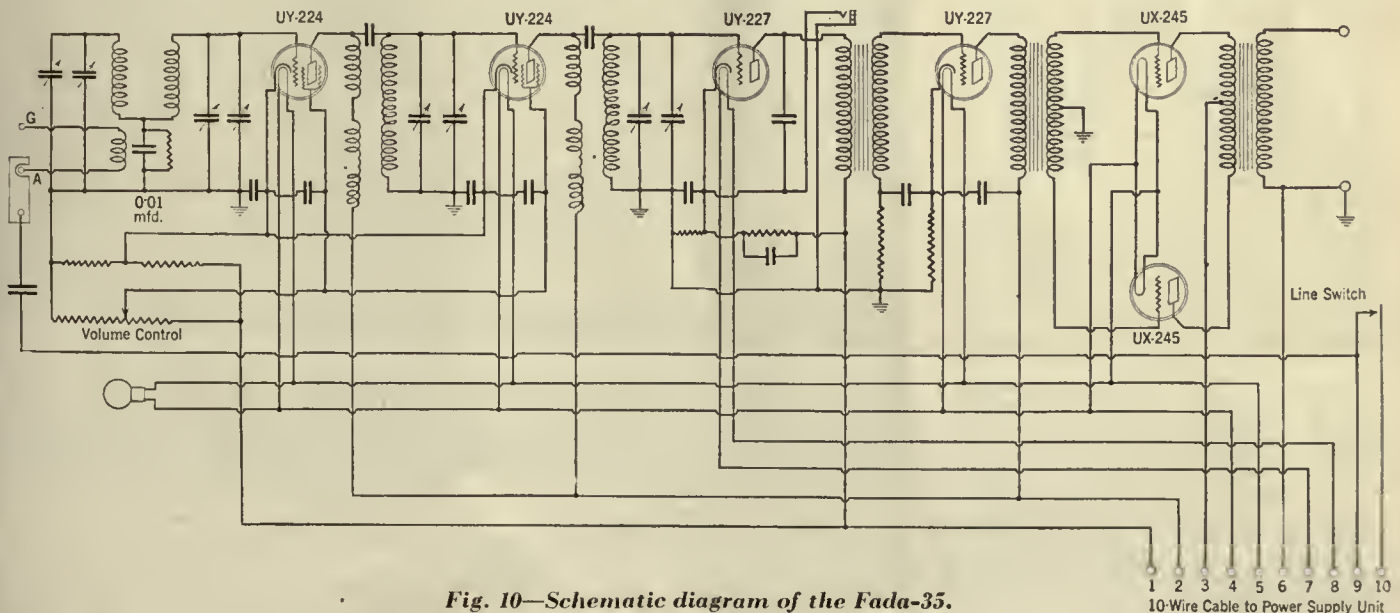
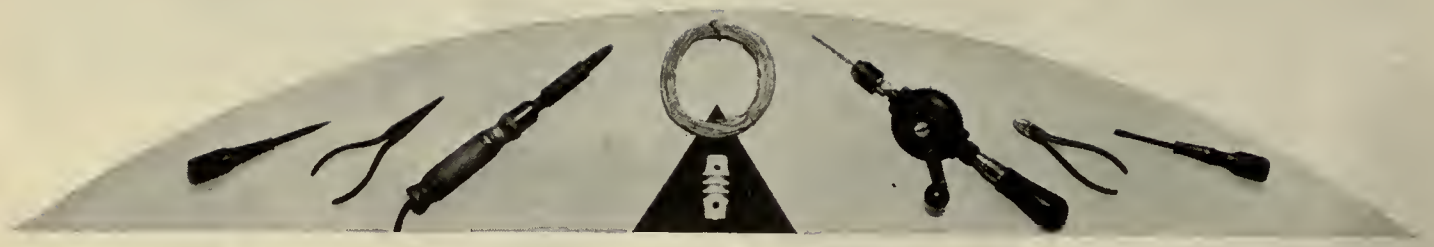


Fig. 10—Schematic diagram of the Fada-35.



THE SERVICEMAN'S CORNER

Hints on Majestic Sets

THE MAJESTIC receiver is one of the season's most popular sets, and the following points on their servicing will be of assistance to many of our professional readers.

Short by-pass condensers: ART HUGHES, of Newark, N. J., writes: "I have been servicing Majestic Sets since they first made their appearance.

"The troubles with Majestics are very few and simple, but for a man who does not understand the set they may appear many and serious.

"When he goes to answer a service call and finds, through his Weston or Jewell, he gets only 50 volts on his r.f. and first a.f. and about 10 volts on his detector plate, first thing he blames is the power pack, takes it out, and puts same on bench for test. He is all wrong, the pack is ok., the trouble is in the chassis.

"The trouble invariably is a shorted twin by-pass condenser in the r.f. B-plus lead located near the volume control. Do not take chassis out, just take a 100-volt a.c. pair, put one wire on the chassis and touch the other on the outside terminals of the loud speaker connections. Before doing this remove the ground wire from the set, also the loud speaker from the terminal strip.

"The result of applying the a.c. is simply this: the short is cleared, due to the heavy current burning the condenser wide enough so that the comparatively low current and voltage used by the set will not jump the punctured section.

"To test a power pack on the bench you have to connect either the loud speaker field or a suitable choke across the 96-volt and 220-volt terminals on the connection block in power pack."

Poor connection through eyelets: "This trouble was encountered in a Majestic set. The set would play satisfactorily and then suddenly cut out. As usual the set would play all right when the serviceman arrived. Continuity test showed all connections apparently ok. It was found that upon pressing the speaker and speaker-field-coil connection strip that the machine would cut out. This strip was removed and to all appearances seemed to be in good condition. However, upon reconnecting, it acted the same as before. The lugs for the connections on this strip are held by eyelets punched through the bakelite. These eyelets are not soldered to the lugs so they form a possible chance for a poor connection. After the lugs were soldered to the eyelets, the receiver performed satisfactorily. This trouble was not due to failure to tighten the binding posts as might be suspected."

H. WEIMAR, Appleton, Wis.

Adjusting gang condensers: ROBERT FREEMAN, dealer in Majestic and Ever-ready receivers, of Adel, Iowa, helps the cause along as follows:

"In servicing Majestic radio receivers we required a method to adjust the gang condensers to resonance. A modulated oscillator and a 0-125 milliammeter across the input to the loud speaker did the trick. Each trimmer screw was adjusted to give a maximum reading on the meter.

"A fraction of a turn made a decided difference in the reading of the meter."



The well-arranged and equipped service department of the Electric Service Company, Inc., of Allston, Mass.

Hum—Its Cause and Cure

IN A GENEROUS response to our request for data on hum, radio servicemen have contributed the following suggestions on this all important subject:

Hum in dynamic speakers: "The use of dry rectifiers in popular-priced dynamic loud speakers has been discovered the source of hum in many instances.

"The hum which is common in a.c. dynamic loud speakers, can be eliminated almost entirely by connecting dry C batteries or flashlight batteries across the rectifier output. The positive terminal of the battery should connect to the positive side of the rectifier. As the voltage supplied to the field coil varies in different types of loud speakers, it should be measured before connecting the batteries. If no voltmeter is available, try various battery voltages, with the current turned on, until no spark is seen when the battery connection is made or broken. It is best to have the battery voltage slightly lower than the rectified output, so that no current will be drawn from the battery. A switch must be used to disconnect the battery when the loud speaker is not in use in order to prevent the battery from discharging into the rectifier. This arrangement makes a very effective filter, and is much cheaper than a low-voltage condenser."

A. H. GOUD, South Portland, Me.

Hum from rectifier discs: "When determining the cause of hum or extraneous noise in an a.c. outfit, if there is a dry disc metallic-type rectifier in the installation it should not be overlooked as a possible offender. The Elkon type as used on some dynamic loud speakers and A-power units seems to radiate, producing a peculiar grind which may be likened to the 'static' created by a large Tungar-type charging unit.

"In a Fada 70 receiver I traced this noise to the Elkon rectifier used on the

We like to think that RADIO BROADCAST *is to the serviceman what the medical journals are to the physician. We endeavor to cover general and specific considerations involved in the servicing of all radio receivers. However, there are additional publications, in the nature of books, radio courses, and special pamphlets issued by manufacturers and other publishing sources that should not be neglected by the efficient serviceman. We review these from time to time in this department, stating specifically where they may be obtained, and the price, if any.*

Fada 14B dynamic chassis. We had one set on the floor which was normal in every respect but terribly noisy, so bad, in fact, that some locals were blanketed. This is a common occurrence in our location, but in this case I 'smelled a rat.' Acting on a hunch gained through experience with Elkon trickle chargers, I disconnected the voice coil leads and plugged in a magnetic loud speaker, leaving the a.c. loud speaker leads in the circuit. The noise persisted but, on pulling out the a.c. plug to the loud speaker, it disappeared. With the dynamic chassis out of the cabinet and field coil energized, if I touched the chassis the interference was increased to a tremendous degree, making any reception impossible. This led me to believe the rectifier was producing some sort of r.f. and the metal chassis was acting as a radiator, because when I touched it, the radiating surface was increased. The remedy was evident: ground the loud speaker case. This may be accomplished with a one- or two-microfarad condenser between the case and one side of the a.c. line."

ELGIN D. MORELL, Service Radio Laboratory, East Orange, New Jersey.

Hum from dynamic loud speaker: "After hooking up a dynamic loud speaker with a 100-volt d.c. field to a high-grade amplifier supplying the current to this field, I was greeted with a loud deep-pitched hum. This hum seemed to be entirely in the field winding.

"After making several unsuccessful attempts to remove this hum, I hit upon a simple remedy that *entirely* eliminated it. This may prove of interest to those who are struggling with this condition, as I understand it as a common fault.

"Simply connect a 200-volt fixed condenser of from one to six microfrads across the loud speaker field. Theoretically the larger the condenser the better results. The writer used a four-microfarad unit which removed the hum to a point where it was inaudible a foot from the loud speaker, whereas without the condenser it could be heard all over the house."

E. R. HATHEWAY, Worchester, Mass.

Mr. Hatheway's experience is along the arguments adduced in the *Aerovox Research Worker*, March, 1929, which can be secured free of charge by writing to the Aerovox Wireless Corporation, 70 Washington Street, Brooklyn, N. Y. An article in this publication shows, by means of interesting curves, how it is possible to eliminate such hum almost entirely by shunting an Aerovox 1500- or 2000-mfd. "A" condenser across the field winding. By use of high-capacity condensers it is possible to reduce the ripple level considerably below the minimum secured by hum coils.

Reducing hum by tube shielding: "A considerable reduction in hum can often be effected by shielding one or more of the tubes in a receiver—generally including the detector tube.

"A good many manufacturers are turning out a.c. sets in which the tubes are placed adjacent to one another in a straight line. If the rectifying tube is close to any other tube, especially the detector tube, it introduces hum in the set. A very simple remedy for this trouble is to take an ordinary cylindrical baking-powder can and solder a lead to the bottom. If the can is then slipped over the rectifying tube and the lead connected to the ground post, the reduction in the hum will be gratifying."

GEORGE EARL SPEIRS, Revere, Mass.



Original and effective! Black type on a yellow card makes this reminder easily located among the contents of the average desk drawer.

Ballast cap reduces hum: "In many of the modern electric sets using a heater-type detector tube (227) a bad hum will sometimes be noticed in the loud speaker. If an ordinary ballast tube cap of the type used for microphonic tubes is placed on the detector tube, and a wire from the ground attached to the cap, the hum will be found to diminish or disappear entirely."

W. GORDEN GENNER, JR., Great Neck, N. Y.

Home-made tube ballast: H. J. GODDARD of Ellendale, N. D., does the same thing a little more economically:

"A bad case of hum in an a.c. set that refused to respond to the usual treatment, was quieted by wrapping the 227-type detector tube with tinfoil and grounding this to the chassis."

Miscellaneous cases of hum: The "April installment of the 'Serviceman's Corner' discussed an interesting case of hum which recalled to my mind a similar trouble which I ran into some months ago. I was called upon to service a newly built power pack. It hummed badly, although it worked well otherwise. Apparently the circuit was connected properly as the plate, grid, and filament voltages checked correctly.

"After increasing the capacity of the detector by-pass condenser, the hum reduced materially, however, not sufficiently. It was apparent at once that something was wrong in the condenser bank. Upon careful inspection I found that the condenser bank consisted of two groups of condensers. The lead from the rectifier tube ran directly to the group of condensers which contained the detector by-pass condenser instead of first going through the choke. Thus, the hum was induced capacitatively into the detector circuit. By simply re-arranging the leads from the choke to the condenser groups the hum was eliminated."

FRED F. OERLEIN, Philadelphia, Pa.

Poor arrangement of parts causes hum: CHARLES H. JENKINS, JR., Radio Service, of Audubon, N. J., is both lyric and effective:

"'Hum'! How often have I heard it and how elusive it is sometimes.

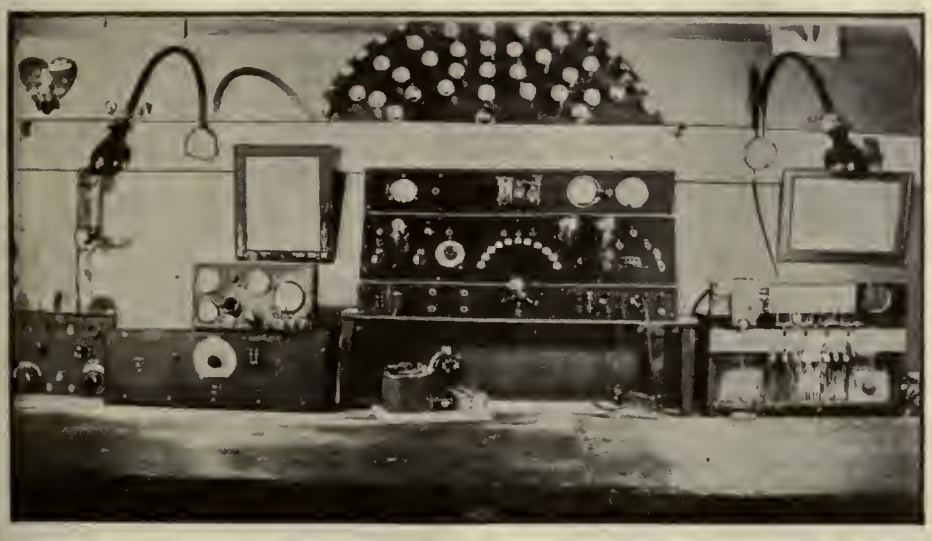
"In power amplifiers where the audio system and the power-supply apparatus are on the one board or very close together you will often have a hum if the audio system is built of good transformers and the loud speaker a good dynamic cone. If the audio transformers are too near the chokes or transformer in the power supply, you will get a hum regardless of the fact that the transformers may be shielded and grounded. The greater the amplification the more likely you will hear the hum. Changing the relative positions does not help a great deal. There is only one sure answer, i.e., allow plenty of room between the power supply and the audio system.

"Another frequent cause of hum from good amplifiers that I have constructed, is the value of the grid leak. Generally speaking, a high-resistance leak in the detector circuit will permit more hum to come through than a low-value unit. Of course, the lower the resistance of the leak the less sensitive is the detector, but with sets having two or more stages of radio-frequency amplification a 1-meg. leak usually holds down the hum and does not impair the operation of the set.

"Another cause of hum is the voltage-divider system. Too low a resistance shunted across the high-voltage output places a load on the rectifying tube and causes hum."

Hum in A-K Sets: "The most common hum trouble that I have experienced in Atwater-Kent electric sets has been traced to a loose nut that makes connection with the common negative return to the transformer and the ground connection.

"This is one of the two screws that hold the bakelite terminal plates down to the ground connection in the transformer, choke, and condenser box, and the trouble seems to be caused by the warmth



Test and service laboratory of E. F. McLaughlin, of Rockland, Mass., dealer in Atwater-Kent, Radiola, Kolster, and Majestic receivers. Prominent portions of this equipment include a modulated oscillator and a tube reactivator.

of the transformer causing the bakelite to contract enough to let the connection get loose and cause a bad hum.

"While I am at these bolts I always tighten all of the screws that hold the terminal plate of the cable down."

A. J. Barron, Shawnee, Okla.

Incorrect C bias: "Just recently I serviced a home-made receiver using all a.c. tubes. When the dial was set to a place where no station could be heard the set showed no sign of any objectional hum, but as soon as a station was tuned-in there was a hum that could be heard all over the room. I happened to be able to correct this condition in a short time, because I had the same trouble on a set which I had constructed myself. The trouble was all in incorrect grid bias. When a tube has the wrong grid bias it is not being worked on the straight part of the curve, and in doing so the tube acts as a detector. This condition may often occur when a different tube is placed in the socket, the reason being that the tube is getting its grid bias by the voltage drop across a resistor, and when the plate current changes the drop across this resistor will also change and cause the wrong bias on the tube. An old tube that is losing its emission will readily show this condition to be true."

George J. Winter, Kearny, N. J.

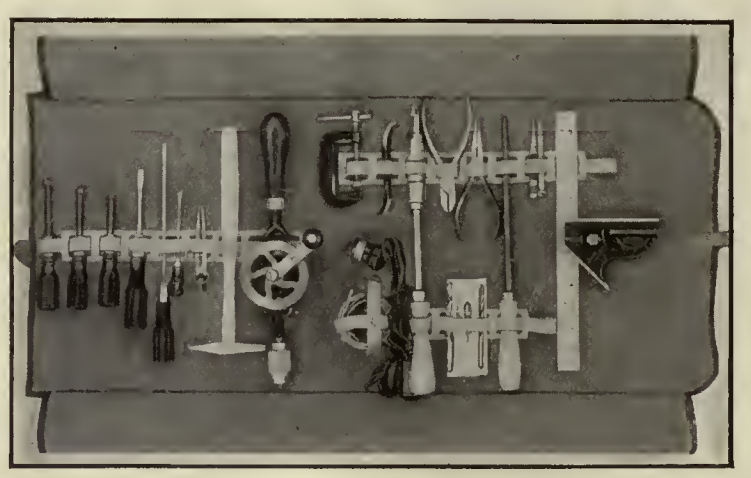
The C bias to all tubes except the power tube, secured by the IR drop method, can be checked with a zero to 1 milliammeter in series with a 10,000-ohm resistor, the voltage being equal to 10 times the fraction of a milliampere indicated. This, of course, is a simple application of Ohm's Law, E = IR.

Identifying distilled water: "Distilled water can be identified from tap water by its conductivity. Use a zero to 5 milliampere meter in series with a 1½-volt dry-cell battery and a 3000-ohm resistor. The resistor may be cut out if an original test indicates a safe deflection without it. The purer the water the higher its resistance. Good battery water should not pass more than 0.1 milliampere."

J. P. Kennedy, South Bend, Ind.

Items of Interest

¶ Hammacher, Schlemmer & Co., Inc., of New York City, have put together an excellent radio tool kit ("Radio Tool Kit Number 1") selling for $20.00. This contains all the tools the serviceman will require on the average call—from an electric soldering iron to socket wrenches—and it packs into a convenient canvas roll.



The "No. 1 Radio Tool Kit" as conceived by Hammacher-Schlemmer. A convenient outfit for the serviceman.

¶ The Kennedy Mfg. Co., of Van Wert, Ohio, are featuring an interesting line of steel tool kits (without tools) several of which adapt themselves to the needs of the radio serviceman. These can be obtained in various combinations of shelves and drawers that will accommodate tools, test equipment, tubes, and spare parts. Their complete catalog can be secured for the asking.

¶ C. Washburn, certified radiotrician, of Jacksonville, Fla., and authorized S-M service station, is a familiar contributor to readers of the "Corner." He refers the radio expert to the Sears Roebuck catalog for a tool container:

"In the search for a suitable carrying case for tools and supplies which a serviceman needs, I ran across a portable tool chest which can be procured from Sears-Roebuck Company at a cost of about $2.75. It measures 20″ × 8″ × 8″ and is made of wood with a thin covering of tin and brass-bound corners. It has a convenient carrying handle on the top and has a strong lock. In appearance it resembles a miniature steamer trunk. It has a sliding tray in which I carry an electric soldering iron, pliers, screw drivers, etc., and in the bottom there is room for new tubes, condensers, head-phones, and meters."

Miscellaneous Data

Run-down *B batteries:* H. B. Moulin, of Gilman City, Mo., says, look for leaking by-pass condensers in all cases of short-lived B batteries, testing preferably with a high-resistance voltmeter. They can also be tested with phones in series with a B Battery. Completing the circuit through the condenser, a second connection, made five seconds later, will give next to no click on a good condenser but a loud click on a poor one.

Original Advertising Cards

Frank J. Shannon, a consistent writer for this department, believes in effective mailing cards. In the following letter he tells us a few things about himself:

"As I have been at service game so long, I advertise 'all makes repaired' but emphasize Radiola Specialists, as I served one year straight as an employee of an exclusive RCA dealer and serviced only RCA models during that one year. It seems that few servicemen thoroughly understand RCA models—I suppose this is because of RCA's methods of 'Dealer-Service,' the closed policy system, and that they closely guard the distribution of their 'service data' so that *none other than their dealers* receive information.

"I have a total radio experience of approximately 15 or 16 years, counting back to amateur transmitting days before war—then to merchant ship operator, U. S. Navy during war, Naval Reserve, public-address work, radio serviceman, radio broadcast operator, etc.

"I am enclosing two additional cards which may interest you. The colored one is for leaving with customers—they lose the ordinary small card so quickly that I thought a contrasting colored card would be found among their papers more easily. This card may also be used as a distribution circular as *it will fit into these new apartment 'locked mail box' slots.* The printed government postal card is for brief communication and it serves also as a 'mail-ad.'



Bridge score pads with your message printed on them constantly bring your name to the attention of customers and their friends.



Making the most of the postcard. An attractive card that suggests wide-awake servicing.

The TUBE Business

THE OPINION of George Lewis, vice-president of the Arcturus Radio Tube Company, the success of the 245-type power tube Arcturus 145) will put a stop to the expensive clamor for higher-powered receivers. The way in which the demand for greater power output changed with time is shown in Fig. 1, and Fig. 2 gives Mr. Lewis' figures which show the relation between power output and cost of home-made B-power units. It is possible to build a 90-volt B-power unit for about $20.00 (retail cost of parts), a 180-volt power unit for $30.00, a 250-volt power unit for about $45.00, and a 450-volt power unit for about $120.00. In other words, a supply device that will furnish enough power for two 145-type power tubes in push-pull can be constructed for less than fifty dollars while a similar device for a single 250-type tube, which would furnish approximately the same undistorted power output, would cost over twice as much. "Proportionate savings will

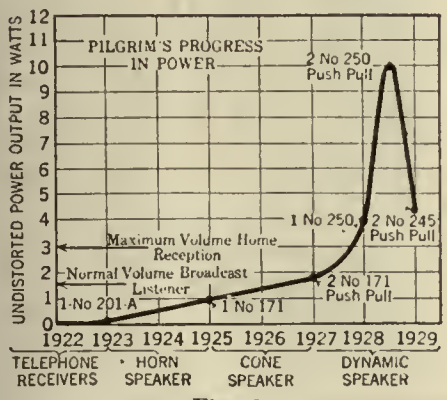


Fig. 1

be experienced by manufacturers," says Mr. Lewis.

Readers of "Strays from the Laboratory" may recall that in that department appeared Mr. Lewis' statement that the usefulness of a tube increases according to some "high-powered" function of the number of elements within the glass bulb. This statement, appearing at a time when many thought the screen-grid tube was a "dud," did not create the impression it should. Those who scoffed at the screen-grid tube will probably change their tune in 1929—this four-element tube will probably he the general-purpose tube of the next few years. Who knows but that the receiver of the future may be a three-tube set with a single stage of screen-grid r.f. amplification, a screen-grid detector, and a pentode power tube?

No Tube Shortage in 1929

EVERYONE KNOWS that 1928 saw an enormous shortage in tubes and nearly everyone is wondering whether or not 1929 will see similar difficulty. After examining many statements from all of the well-known tube manufacturers about their expanding production plans, we believe that there will not be a tube shortage in 1929. According to M. F. Burns, sales manager of E. T. Cunningham, Inc., there will be ample tubes for all present and contemplated receiver sockets in 1929.

"The Cunningham organization will produce as many tubes during the first six months of 1929 as during the entire year of 1928, the banner year in the company's history. Our company delivered 61 per cent. more tubes in 1928 than in 1927, during which time production facilities were increased consistently until we were able to enter the present year with production capable of meeting demand.

"At present our personnel has been increased to 5000 employees, with factory space and equipment added to maintain full schedules. We are providing a tube supply well in excess of the trade's most optimistic estimate of the market's growth," he declared.

Readers may find other signs that there will be no dearth of tubes in the following items gathered from various sources.

A new plant has been projected for the Perryman Electric Company, Inc. It will cost $300,000, will have a capacity of 50,000 radio and electric tubes, and will double the company's output. Unfilled orders (May 13, 1929) amounted to 2,000,000 tubes. Daily production is expected to be at the rate of 25,000 a day by September 1.

The Hygrade Lamp Company, of Salem, Mass., which produced 5000 tubes a day in May, expected to be in daily production of 10,000 tubes by the middle of July and 15,000 tubes by September 1.

Large orders on band and demands from large set manufacturers have forced the Cable Radio Tube Corporation to add to their Brooklyn plant. The new plant is located at 80-90 No. Ninth Street, Brooklyn. The daily capacity of the Cable factories is now 25,000 tubes.

The Schickerling Radio Tube Corporation has been incorporated in Delaware to acquire the business and assets of Conrad Schickerling, Inc. To provide for the expansion of the company's Newark plant, the company will offer 100,000 shares of no-par-value capital stock. The principle

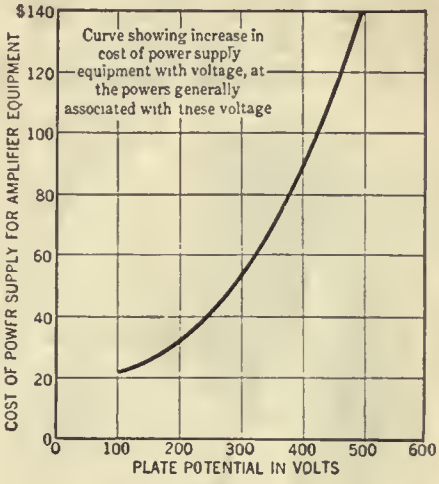


Fig. 2

product of the company is the "Noblow" radio tube.

The CeCo Manufacturing Co., of Providence, R. I., maker of radio tubes, in a balance sheet issued as of March 31 (end of its fiscal year) shows current assets in excess of $600,000. Cash on hand and in banks exceeds one-half million dollars; the remainder is in call loans. The ratio of current assets to current liabilities is as of 6 to 1. Patents, processes, and trademarks are carried at only one dollar.

The CeCo Manufacturing Company has just completed plant improvements costing more than $500,000. Its new factory covering three and one-half acres will be occupied this month. It will have a capacity of 45,000 tubes daily. In addition to the Providence, R. I., plant, CeCo has purchased recently a property at 1312 South Michigan Boulevard, Chicago. It will be used as district headquarters office for the territory surrounding Chicago, and warehouse facilities will be added.

Financial Statements of Tube Manufacturers

The data in this table have been gathered from various sources, chiefly from statements issued by the companies in question and from announcements of new stock issues —of which there are many. These figures have been obtained from sources believed to be reliable, but are not guaranteed.

TUBE MANUFACTURER	SALES	PERIOD	PROFIT	SHARES OUTSTANDING
Ken-Rad Corp, Inc.		1926	$392,380	
		1927	315,213	
		1928	347,010	
		(First Quarter) 1929	138,675	150,000
DeForest Radio Co.	$976,486	6 mos. ending Mar. 31, 1929	176,829	820,543
Northern Mfg. Co.		July 1, 1928 to Jan. 31, 1929	191,072	150,000
				50,000 (pref)
Arcturus Radio Co.	119,670	1927	(77,998)	
	1,096,323	1928	93,909	600,000
Cable Supply Co.		1928	92,829	200,000
Marvin Radio Co.	1,029,624	1928	263,030	146,000
		1928	207,581	250,000
Perryman		3 mos. ending Dec. 31, 1928	177,017	

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Prepared by Official Examining Officer

The author, **G. E. Sterling,** is Radio Inspector and Examining Officer, Radio Division, U. S. Dept. of Commerce. The book has been edited in detail by **Robert S. Kruse** for five years Technical Editor of QST., the Magazine of the Radio Relay League. Many other experts assisted them.

16 Chapters Cover: Elementary Electricity and Magnetism; Motors and Generators; Storage Batteries and Charging Circuits; The Vacuum Tube; Circuits Employed in Vacuum Tube Transmitters; Modulating Systems; Wavemeters; Piezo-Electric Oscillators; Wave Traps; Marine Vacuum Tube Transmitters; Radio Broadcasting Equipment; Arc Transmitters; Spark Transmitters; Commercial Radio Receivers; Radio Beacons and Direction Finders; Radio Laws and Regulations; Handling and Abstracting Traffic.

New Information never before available such as a complete description of the Western Electric 5 Kilowatt Broadcasting Transmitter; description and circuit diagram of Western Electric Superheterodyne Radio Receiving Outfit type 6004-C; Navy Standard 2-Kilowatt Spark Transmitter; etc., etc. Every detail up to the minute.

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By HOWARD E. RHODES

THE aim of the RADIO BROADCAST Laboratory Information Sheets is to present, in a convenient form, concise and accurate information in the field of radio and closely allied sciences. It is not the purpose of the Sheets to include only new information, but to present practical data, whether new or old, that may be of value to the experimenter, engineer, or serviceman. In order to make the Sheets easier to refer to, they are arranged so that they may be cut from the magazine and preserved, either in a blank book or on 4″ x 6″ filing cards. The cards should be arranged in numerical order.

Since they began, in June, 1926, the popularity of the Information Sheets has increased so greatly that it has been decided to reprint the first one hundred and ninety of them (June, 1926-May, 1928) in a single substantially bound volume. This volume, *Radio Broadcast's Data Sheets*, may now be bought on the newsstands, or from the Circulation Department, Doubleday, Doran & Company, Inc., Garden City, New York, for $1.00. Inside each volume is a credit coupon which is worth $1.00 toward the subscription price of this magazine. In other words, a year's subscription to RADIO BROADCAST accompanied by this $1.00 credit coupon, gives you RADIO BROADCAST for one year for $3.00 instead of the usual subscription price of $4.00.

—THE EDITOR.

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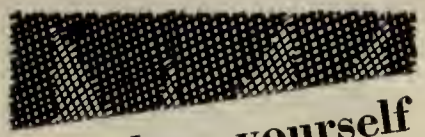
(June 1928 to May 1929)

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Users of CeCo Tubes have learned to expect exceptionally faithful reproduction of tone quality. They also know that it is not necessary to shift tubes from one socket to another in order to obtain the best reproduction their set is capable of giving — the high quality and character of CeCo Tubes are uniform.

There are 64 reasons for this. Every tube that leaves the CeCo factory is thoroughly seasoned and given 64 exacting tests for uniformity of quality and characteristics that affect successful radio reproduction. The result is not only uniformity, but much longer life as well.

If you need just one tube, try a CeCo. As the other tubes wear out, install CeCo's until you have a complete set. Then call in your neighbors and ask them if they ever heard better radio reproduction.

CeCo

Manufacturing Company, Inc.

PROVIDENCE, R. I.

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MILLIONS IN USE

No. 290 RADIO BROADCAST Laboratory Information Sheet **July, 1929**

FILTER CIRCUIT DATA

IN "LABORATORY SHEETS" Nos. 258 and 259 some data were given on filter circuits showing the effect on the regulation, output voltage, and tube load when using and when not using a choke at the input to the filter system. Similar data will be found in Roger Wise's article "Characteristics of Power Rectifiers" in the April, 1929, RADIO BROADCAST. Several readers have written us to the effect that they have not been able to duplicate these curves when using a choke in the input. Some have obtained greater and others less output voltage than was indicated by the curves in "Laboratory Sheet" No. 259.

This discrepancy between the values we gave and that readers have obtained is undoubtedly due to the use of a different size choke coil in the input than was used to obtain the curves on Sheet No. 259. For these curves a standard filter choke of some 30 henries was used. The output voltage, of course, is greatest when there is no choke coil connected in the input and will decrease when a choke is placed at the input. The greater the inductance of the choke, the greater the decrease in output voltage. Those experimenters who obtained greater voltages than the curves indicated probably used an input choke of low inductance and those that obtained smaller voltages used a choke of high inductance.

It could appear from these considerations that a small choke should be used but it should be remembered that the primary reason for the use of choke input circuits is to reduce the instantaneous load on the rectifier tubes so that their life will be a maximum. With chokes of low inductance this desirable effect of reduced load on the tube is not obtained to any considerable degree. In designing such systems a compromise must, therefore, be reached between the use of a large choke giving a good tube load characteristic and a small choke giving a less desirable load characteristic but greater output voltage (assuming that the transformer input voltage is not changed.)

No. 291 RADIO BROADCAST Laboratory Information Sheet **July, 1929**

VOLTAGE-DOUBLING CIRCUITS

IN CASES WHERE there is need of a plate-supply device delivering greater voltages than can ordinarily be obtained from the usual type of rectifier tube, such as the type 281, it is possible to use these tubes in "voltage-doubling" circuits. Two circuits together with their regulation characteristics are given on Laboratory Sheet No. 292. Although the 281-type rectifier in ordinary circuits can supply only about 600 volts to the filter system it should be noted that when using these special circuits it is possible to obtain an input to the filter of approximately 1600 volts.

The circuit shown at A is probably the more familiar type of voltage-doubling connection. As indicated by the curves the voltage regulation is rather poor but, when only small amounts of current are to be drawn from the system, this circuit can be used and has the advantage that it requires but little apparatus.

Improved results can be obtained from the circuit shown at B. With this arrangement four rectifier tubes are used in a full-wave system supplied from a center-tapped transformer having a secondary potential of from 500 to 700 volts a.c. either side of the center tap. Two separate transformers, each supplying from 500 to 700 volts might, of course, be used. The curves for this rectifier system show it to have much better regulation than that obtained from the circuit in Sketch A. With circuit B a maximum current of up to 170 milliamperes can be drawn from the filter system.

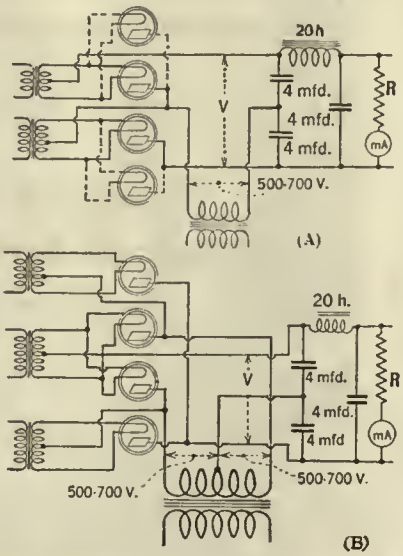
The disadvantage of circuit B over circuit A is that the former requires three separate filament windings each of which must provide the full output voltage.

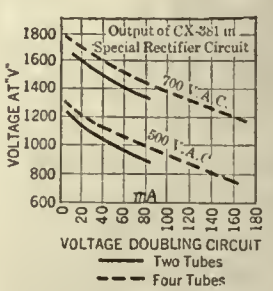
The first filter condensers in these circuits must be capable of withstanding a potential of one half the load voltage. The second condensers must, of course, be able to withstand the full load voltage. The filaments of the tubes should be turned on before the high-voltage winding is closed. If this is not done, the initial charging current may overheat the tubes or cause them to arc over. Across the output of the filter systems resistors should be connected as indicated at R. In general a 100,000-ohm resistor may be used and it should be capable of carrying some 20 milliamperes. This resistor is especially necessary when using circuit A since, with this arrangement, the voltage tends to increase quite rapidly when the load is less than 20 milliamperes.

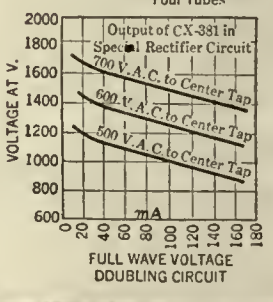
The data for this "Laboratory Sheet" were supplied by E. T. Cunningham, Inc.

No. 292 RADIO BROADCAST Laboratory Information Sheet **July, 1929**

VOLTAGE-DOUBLING CIRCUITS









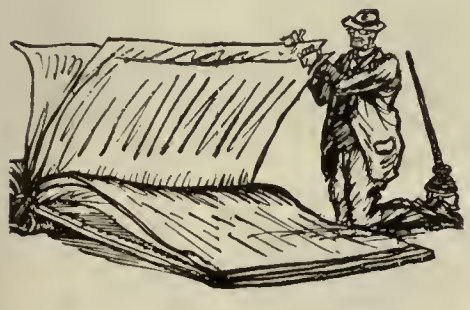
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Christopher Morley

. . . "No one doubts the amazing vivacity and facility of Christopher Morley . . . 'Off The Deep End,' like several of its predecessors is a collection of stray pieces, short stories, brief playlets, humorous squibs and Lambsian essays. The reader saunters, so to speak, through Mr. Morley's engaging purlieus admiring the gusts of the greenery, the sparkling quality of the streamlet of wit and the whimsicality of the curious growths"—*New York Times.*

. . . "Whatever he does will be fascinating talk . . . talk which makes his book of essays a pleasant adventure"— *New York Evening Post.*

. . . Other books by Christopher Morley. THE ROMANY STAIN, WHERE THE BLUE BEGINS, THUNDER ON THE LEFT *and* THE HAUNTED BOOKSHOP.



DOUBLEDAY DORAN & COMPANY, INC.

Garden City, New York

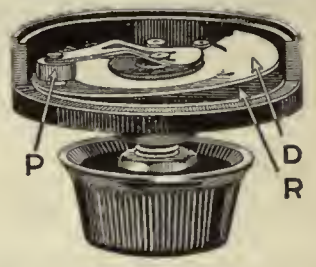
$2.50 at all bookshops

A RADIO RECEIVER IS LIKE A CHAIN. . . .

A CHAIN of parts, if you please . . . transformers, tubes, condensers, resistances and the like as links of the chain. Unless each link performs to perfection the whole receiver is condemned and your name with it.

A lot of grief can be traced to one little part . . . the volume control. Noises are set up . . . uneveness of control develops . . . locals are hard to handle.

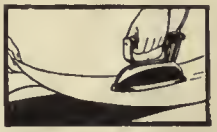
You can save yourself plenty of trouble by seeing that the name "Centralab" is stamped on the volume control. The Centralab exclusive rocking disc construction prevents any change in the resistance or the development of noise. Centralab controls give a perfect control of all stations with an even, "velvety" smooth action.



This shows the exclusive rocking disc construction of Centralab volume control. "R" is the resistance. Contact disc "D" has only a rocking action on the resistance. Pressure arm "P" together with shaft and bushing is fully insulated.



This is the action of the usual wire wound control after it has been in use for some time . . . like dragging a stick over a cobblestone pavement.



The tailor uses the same principle as Centralab. He does not want to ruin the garment by placing the iron on it so he places a cloth in between. Centralab controls cannot ruin the resistance because the rocking disc is in between the pressure arm and the resistance.

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Factory-Built, Ready to Plug Into Any Set

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This amazing instrument now makes it possible to reach 'round the world. Geo. Morcroft of Pa. tuned in England, Australia and Holland on his initial test. Gets stations regular receivers cannot get. No change or wiring required. All complete, ready to operate. Golden brown, compact metal cabinet in crackle finish. Size 9x5½x2½ in. The only converter we know of that really works on all sets. Two models—A.C. and D.C., at $25.00 each. Write for Catalog and literature and dealers' discounts; also give jobbers' name.

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City..... State.....

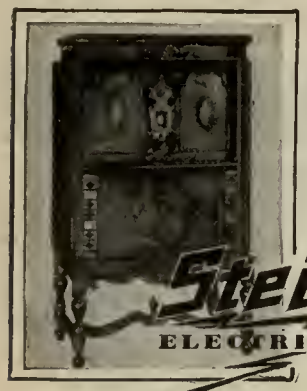
Cunningham RADIO TUBES



14 years of proved reliability

Cunningham Radio Tubes continue to supply the demand for absolute inbuilt integrity and tube quality.

E. T. CUNNINGHAM, Inc.
New York Chicago San Francisco
Dallas Atlanta



Model No. 102
A massive walnut cabinet equipped with automatic phonograph and an improved radio receiver.

Only DURHAMS are good enough for *this Great Receiver!*

ANY manufacturer can cut his parts costs, but it takes leadership to aim at quality reception as a means of winning a quality market, such as Steinite has done in a few short years. Steinite operates on the principle that you can get out of a radio only what you put into it. And so Steinite means a quality circuit embracing every practical modern idea, not the least of which is DURHAM Resistors and Powerohms—the metallized resistances which are endorsed and used by leaders in every division of the industry. Durhams may cost a trifle more than average resistances, but experience has proved that their slight additional cost is cheap insurance against imperfect performance and against dissatisfied purchasers. Ask Steinite! We shall be glad to send engineering data sheets and samples for testing upon request. Please state ratings in which you are interested.

Metallized
DURHAM

DURHAM Metallized RESISTORS and POWEROHMS are available for every practical resistance purpose in radio and television circuits, 500 to 200,000 ohms in power types; 1 to 100 Megohms in resistor types; ratings for all limited power requirements; standard, pigtail, or special tips.

THE LEADERS STANDARDIZE ON

DURHAM METALLIZED
RESISTORS & POWEROHMS

INTERNATIONAL RESISTANCE CO.
2006 Chestnut Street, Philadelphia, Pa.

No. 293 RADIO BROADCAST Laboratory Information Sheet **July, 1929**

REGENERATIVE R. F. AMPLIFIERS

RADIO-FREQUENCY amplification may be obtained by the use of carefully designed r.f. circuits or by the use of carelessly designed circuits with regeneration. Many of the sets made a few seasons ago had considerable inhereat regeneration in them, not because circuits to prevent regeneration were not known, but because the sets were not properly designed. The tendency to-day is to design the set so that without any regeneration the gain and selectivity are satisfactory. If an engineer relies on regeneration in a receiver to give it gain, it is generally found that in the mass production of the set in the factory it is not possible to control the set's characteristics closely enough to give just the right amount of regenerative amplification. As a result in production some of the sets will be found to oscillate while others will not have sufficient regeneration and will be practically dead. This is perhaps one of the major reasons why regeneration is being used less and less in manufactured sets.

There is one time, however, when the use of regeneration to increase the gain and the selectivity might be considered the best thing to do. This case arises in the servicing of an old receiver that has poor gain and poor selectivity. Such a set would be improved greatly by the use of some regeneration, and, since the serviceman who changes the circuit to give it some regeneration can introduce *just* enough in this *particular* set to provide satisfactory performance, there is little difficulty involved in its use.

Regeneration can be added most readily to an existing receiver by the use of one of the circuits indicated on Laboratory Sheet No. 294.

In Sketch A regeneration has been added by winding a coil (No. 32 or smaller wire) around the filament end of the secondary, L_1. The number of turns should be the maximum that can be used without causing the set to oscillate.

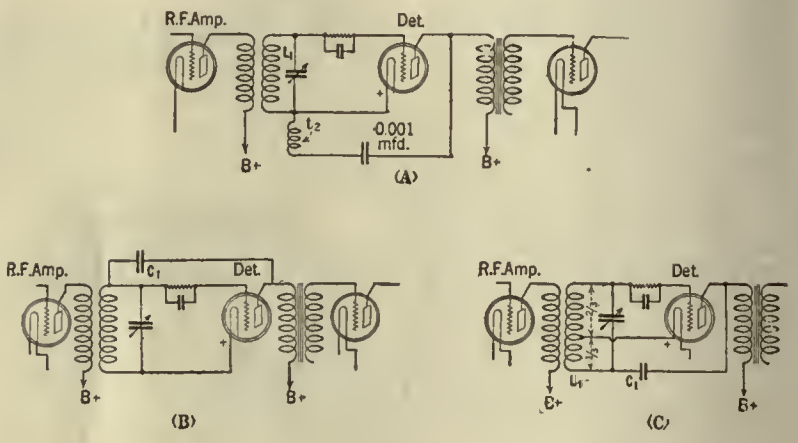
In Sketch B a small variable condenser, C_1—for example, a neutralizing condenser—is connected between the plate of the detector and the plate of the preceding r.f. amplifier tube. The capacity should be adjusted to the maximum possible without making the detector oscillate.

In Sketch C regeneration is secured by tapping the secondary, L_1, as indicated and connecting a small variable condenser (maximum capacity about 0.0001 mfd.) between the lower end of the secondary and the plate of the detector.

Arrangement B is generally the most convenient although in some cases it may be simpler to use the circuits of A or C.

No. 294 RADIO BROADCAST Laboratory Information Sheet **July, 1929**

REGENERATIVE R. F. CIRCUITS



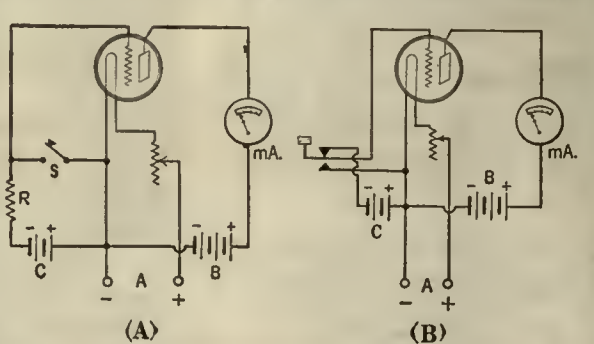
No. 295 RADIO BROADCAST Laboratory Information Sheet **July, 1929**

TUBE-TESTING CIRCUITS

MANY COMMERCIAL tube-testing devices are equipped with a button which is used to determine whether or not the particular tube being tested is up to standard. Generally the procedure is to place the tube in the socket, read the plate current, then press the button, and again read the plate current. Then it is possible to determine from these two readings whether or not the tube is any good.

Just how this circuit functions should be of interest. The arrangement described below may not be the one actually used in some of the testers but the principles are certainly the same. When a tube is placed in the socket (see the sketch A on this sheet) the plate current as read on the plate milliammeter depends upon the plate voltage and upon the C-bias voltage. With the switch, S, which represents the button, in the open position, the bias is equal to the voltage of the C battery. When, however, the button is pressed the bias is reduced to zero. This change in bias, of course, produces a change in plate current and the amount of change determines how good the tube is. What we are actually doing is determining the mutual conductance of the tube by noting the change in plate current obtained from a given change in C bias.

This circuit, it should be pointed out, indicates only one of the many possible arrangements. Another arrangement, for example, would be to make S a single-pole double-circuit switch (sketch B) so that in one position the bias is zero and in the other position it has a value equal to that of the C-battery voltage.



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ADVANCED LABORATORY IMPROVE–MENTS ✣

WE PUT THIS INTO THE TUBE

MODERN ✣✣ FACTORY TECHNIQUE
MONEY ✣✣ TIME ✣✣
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UNIFORM ✣✣ QUALITY ✣✣ TONE ✣
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CONSUMER ✣ YOU GET THIS OUT OF THE TUBE ✣ DEALER

A COMPLETE ✣ ✣ LINE ✣✣✣
A QUALITY LINE ✣
AN ADVERTISED ✣ LINE ✣✣✣
✣ CONSUMER ✣
✣✣✣ DEMAND ✣
QUICK TURNOVER ✣ LIBERAL DISCOUNTS ✣ LARGE PROFITS

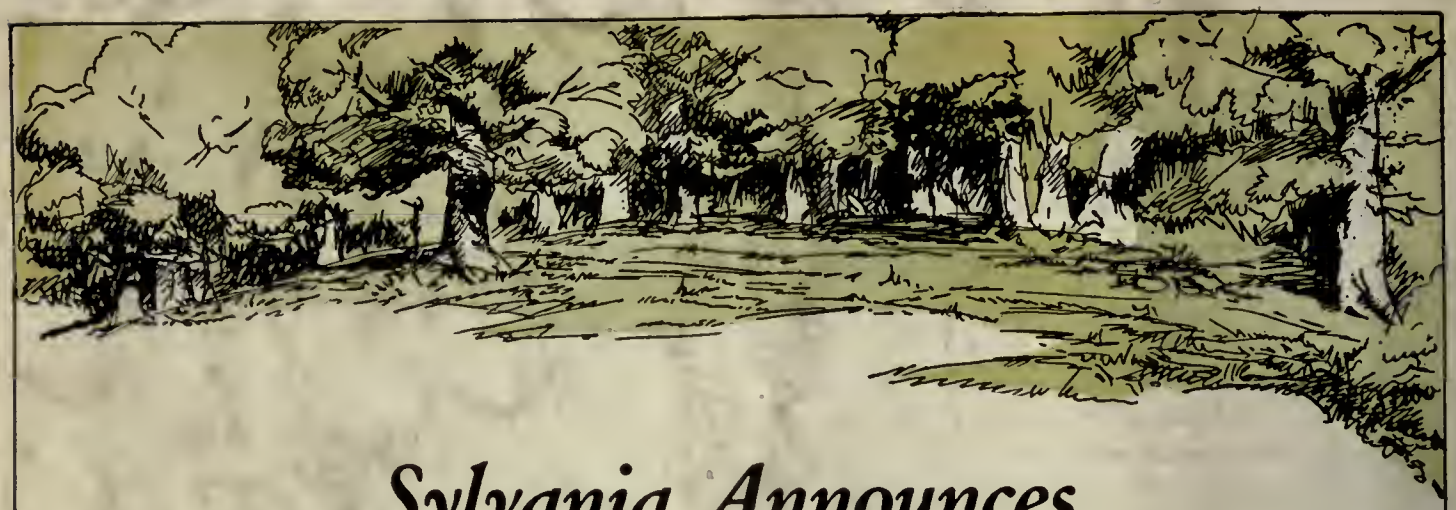
SPEED

CABLE RADIO TUBE CORPORATION

(formerly Cable Supply Co.)
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RMA RADIO MANUFACTURERS ASSOCIATION MEMBER

MAKERS OF RADIO TUBES SINCE 1924



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THE SILENT SLEEVE CATHODE

The pioneering courage and exhaustive experimentation that always have been part of Sylvania development, again bear fruit. This time in the silent sleeve cathode which definitely solves the long baffling problem of crackle and hum in the 227 tube.

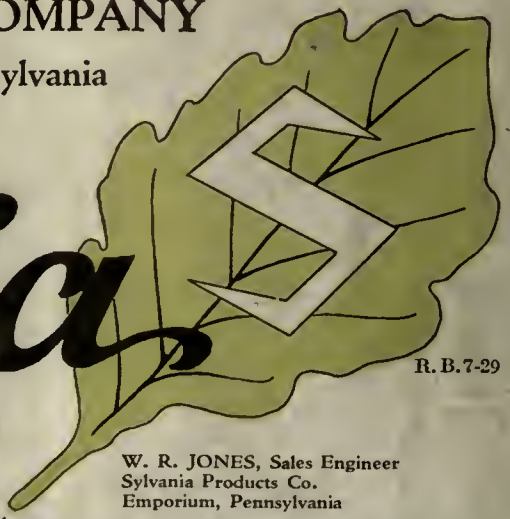
The Sylvania 227 now minimizes hum and further increases amplification as a result of the Sylvania designed sleeve which extends over the entire length of the heating element.

The same kind of diligent research and intelligent application of discoveries account for the superior performance found in all types of Sylvania tubes.

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Sylvania

RADIO TUBES

R. B. 7-29

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YOU'RE WELCOME!

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THE COUNTRY LIFE PRESS, GARDEN CITY, NEW YORK

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AUGUST 1929

710

RADIO BROADCAST

PUBLISHED FOR THE RADIO INDUSTRY



SPECIAL FEATURES IN THIS ISSU

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Detailed Summary of the Season's New Sets

What is Happening to Radio Listening Habits?

Other features: All the Facts About Screen-Grid Circuits · The Stromberg-Carlson Receiver · Set Data Sheet
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Main Office:
Canton, Mass.

Factories at Canton and Watertown, Mass.



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No further proof required!

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No other testing device or equipment on the market approaches the great range and flexibility of this *complete, portable, simplified radio-laboratory* . . . in a carrying case providing compartments for all necessary tools, adapters, tubes and accessories.

The greatest medium available for producing service profits—creating good will—and increasing sales of receiving sets!



Turn Service *Worries* into Sales and Profits

FOLLOWING the enthusiastic reception given SUPREME DIA GNOMETER Model 400-B, at its initial sho wing at the Chicago RMA show, dealers everywhe re nre placing orders in such volume as to prohibit promises of immediate deliveries.

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Please ship ..... SUPREME DIAGNOMETER Model 400-B, on the basis checked below:

☐ Net Cash—$139.50 F.O.B. Greenwood, Miss.

☐ Time-payment Plan
—$33.50 Cash and 8 monthly payments of $15.00 each. F. O. B. Greenwood, Miss.
(No dealers' discounts)

Date of shipment.....

Signed.....

Firm name .....

Street address .....

City.....State.....

References:

Name .....

Address .....

Name .....

Address .....

Name .....

Address .....

Distributor:

Name .....

Address .....

The following is a comparison of the Supreme Diagnometer with the three leading set testers, and the most popular test board on the market, which sells for more than double the price of the Supreme Diagnometer.

"x" indicates YES. Blank space indicates NO.

Tests, Functions and Facilities	Set Tester "A"	Set Tester "B"	Supreme Diagnometer	Set Tester "C"	Test Board
D. C. Filament Voltage Reading	x	x	x	x	x
A. C. Filament Voltage Reading	x	x	x	x	x
Plate Voltage Reading	x	x	x	x	x
Plate Current Reading	x	x	x	x	x
Simultaneous Plate Current and Voltage Reading	x		x	x	x
Grid Voltage Reading	x	x	x	x	x
Cathode Bias Reading	x	x	x	x	x
Screen Grid Voltage	x	x	x	x	x
Control Grid Voltage	x	x	x	x	x
Analysis Without Use of Adapter	x	x	x	x	x
Line Voltage Reading	x	x	x		x
Locate Unbalanced Secondaries	x		x		
Reads Both Positive or Negative Cathode Biasing			x		
Oscillation Test of Tubes			x		
A. C. Line Tube Testing			x		
Bias Emission Tube Tester			x		
Tests 15-Volt Filament Tubes Independent of Radio			x		
Tests Screen Grid Tubes Independent of Radio			x		
Tests Overhead Filament Type Tubes Independent of Radio			x		
Tests Both Plates '80 Type Tubes			x		
Rejuvenates Thoriated Filament Tubes Out of Set Without Removing from Set			x		
D. C. Continuity Tester Without Batteries			x		
Furnishes Modulated Signal for Testing			x		
Syachronizing—					
By Thermal-Meter Method			x		
By A. C. Meter Method			x		
By Audible Method			x		
Neutralizing Signals Provided			x		
Thermo-Couple Movement Meter			x		
Tests Gain of Audio Amplifiers			x		
Measures Up To 250 Mils. A. C. Current			x		
External Use of Meters	x	x	x	x	x
Of 750 D. C. Meter	x		x		x
Of 750 A. C. Meter	x		x		x
Of 2.5 Amps. Milliameter			x		
Measures Capacity of Condensers .01 to 9. Mfd	x		x		x
Tests Charger Output by Meter			x		
Bridges Open Audio Stages for Tests			x		
Positive Milli-Ammeter Protection for Tube Testing			x		
Ammeter Protection			x		
500,000-Ohm Variable Resistor for Testing			x		
30-Ohm Rheostat for Testing			x		
Self Contained Power Plant for All Required Tests			x		
Percentage of EFFICIENCY	38%	26%	100%	25%	36%

SUPREME
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Makes every conceivable test on any Radio Set—

QUALITY **DONGAN** PRODUCTS

Care-Free, Long-Life Reception

—use Dongan Power Parts and get the Best in Radio

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Anything as much demanded and appreciated, a source of never-ending interest and enjoyment, should not be slighted, should not be the victim of petty economy. Today anyone can own the type of radio receiver that will operate hour after hour without attention. Music and speech are resonant and real.

You can have this kind of radio at a moderate cost. The new UX 245 Tube has made possible an even lower gross cost than was necessary with UX 250 Tube.

It will pay you to find out about this new tube and the accompanying Parts.

No. 994 Power Amplifier Transformer	**$12.00**
either	
No. 2189 Push-Pull Output Transformer	**12.00**
with	
No. 2142 Push-Pull Input Transformer	**4.50**
or	
No. 3107 Straight Output Transformer	**12.00**
with	
No. 2158 Audio Transformer	**4.50**

Two Secondary Windings (for either No. 2189 or No. 3107), one for Magnetic type and the other for Dynamic type Speaker.

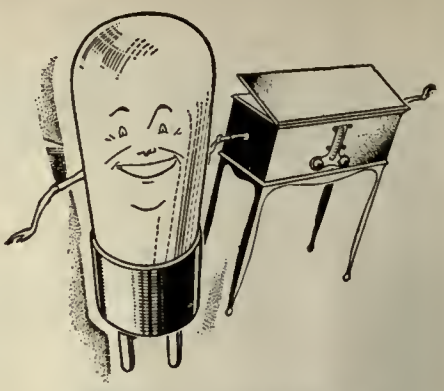
D-946 Standard Condenser Unit	**22.50**

This Condenser Unit is also designed for use with No. 994 Transformer for Power Amplification.

No. 5554 Double Choke, use in Filter Circuit	**11.00**
No. 2124 Transformer	**6.00**

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The child will soon be leading the parent

Here was the split-up of the average radio dollar in 1922:

*10%—$ 6,000,000—spent for tubes
90%— 54,000,000—spent for parts and sets

Between 1922 and 1928 the tube market increased 18-fold—while the market for sets and parts increased only 10-fold—in dollars. Here is the split-up in 1928:

*17%—$110,250,000—spent for tubes
83%—$539,750,000—spent for sets and parts

Your future prosperity depends to a great extent on how well you develop the tube market in your locality.

*Figures courtesy of "Radio Retailing."

The Ce Co Policy

The CeCo Manufacturing Company is embarking on a nation-wide advertising program to help the dealer widen his market for tubes.

The CeCo Couriers broadcast every Monday night at 7:30 Eastern Standard time over the Columbia System.

We have proved the quality of CeCo Tubes by the most severe tests any radio tubes have ever had to stand.

Tests made by independent laboratories have proved that CeCo Tubes have from 30% to 50% longer life than any other tubes tested.

How to increase your tube sales

Send for the dealer book "Tomorrow in the Tube Industry." It contains many helpful suggestions for building up tube sales and shows what progress other dealers are making along this line.



The AC 224 Screen Grid Tube was developed and perfected by CeCo over a year and a half ago.

Licensed under patents and applications of the Radio Corporation of America, the General Electric Company, and the Westinghouse Electric and Manufacturing Company.

Ce Co Manufacturing Company, Inc.
PROVIDENCE, R. I.

CeCo Manufacturing Co., Inc., Dept. 108, 1200 Eddy St., Providence, R. I. Send me a copy of the dealer book on the radio tube market.

Name_____
Company_____
Address_____

Just Off the Press

A NEW **YAXLEY** Catalog



Send for it today for complete listings of Radio Convenience Outlets, Connector Plugs, Rheostats, Fixed and Grid Resistances, Jacks, Jack Switches, Phone Plugs, etc.

YAXLEY MFG. CO.
Dept. B, 9 So. Clinton St., Chicago, Ill.

This is a good time to subscribe for
RADIO BROADCAST
Through your dealer or direct, by the year only $4.00
DOUBLEDAY, DORAN & CO., INC. GARDEN CITY, N. Y.

Prevents Current-WABBLE

$1.10 with mounting (in U. S. A.) at all dealers.

Install Amperite for every tube and smooth out "A" current wahhle that ruins reception. Amperite *adjusts itself* to the exact need of each tube. A type for every tube—A. C. or D. C.

This symbol in a radio diagram means—

Radiall Company
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FREE—"Amperite Blue Book" of modern circuits and valuable construction data. Write Dept. RB 8.

AMPERITE
REG. U.S. PAT. OFF.
The "SELF-ADJUSTING" *Rheostat*

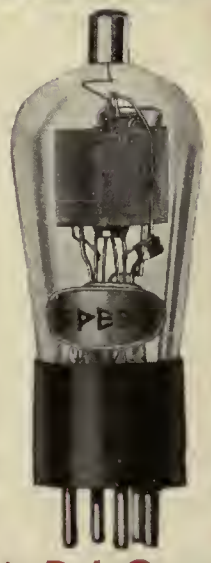


NO TENDERFEET HERE!

The technique of radio tube production is no schoolboy's exercise, to be learned in a day, a week, or a year. ¶It takes the knowledge so painstakingly learned over a period of years from the incandescent lamp, properly attuned to the newer concepts of physics, chemistry and radio science. ¶To this must be added the most modern equipment, the finest obtainable materials, the organization necessary to combine all smoothly. Satisfy all these requirements and you have the **"SPEED"** Radio Tube. ¶**"SPEED"** dealers have the best proposition in the field. The reason—¶They have implicit confidence in the complete line of **"SPEED"** tubes—tests for volume, clarity, long-life, quicker-heating, bear them out. ¶They have implicit confidence in the **"SPEED"** organization—J. J. Steinharter, J. J. Grossman, Fred Guinther,—all pioneers from lamp days and making radio tubes since 1924. ¶And, when the product is right, the sales and resales are right and the profits take care of themselves. ¶Think it over. Write us—It will pay you.

SPEED
CABLE RADIO TUBE CORPORATION
(formerly Cable Supply Co.)
84-90 North Ninth Street
Brooklyn, N. Y.

RMA RADIO MANUFACTURERS ASSOCIATION MEMBER



224 A. C.
Developed by Cable
in 1928

MAKERS OF RADIO TUBES SINCE 1924

KEEP PACE
WITH THE NEWEST!

EVEREADY RAYTHEON TUBES FOR TELEVISION

AND TALKING PICTURES



Eveready Raytheon **Kino-Lamp**



Eveready Raytheon **Foto-Cell**

ARE OF PROVED DEPENDABILITY AND PERFORMANCE

THE Eveready Raytheon Kino-Lamp for television reception is the first tube developed commercially which will work with all systems.

With its uniform glow over the entire plate . . . tested performance . . . long life . . . perfect reproductive qualities . . . the Eveready Raytheon Kino-Lamp is a great step forward in television.

The Eveready Raytheon Foto-Cell is a long-life transmitting tube for television. Used also for talking pictures. Made in two sizes, either hard vacuum or extra-sensitive gas-filled.

Correspondence is invited from everyone interested in television. Foto-Cells to special specifications will be made at reasonable prices.

NATIONAL CARBON CO., INC.
General Offices: New York, N. Y.

Unit of Union Carbide UCC *and Carbon Corporation*

EVEREADY
RAYTHEON

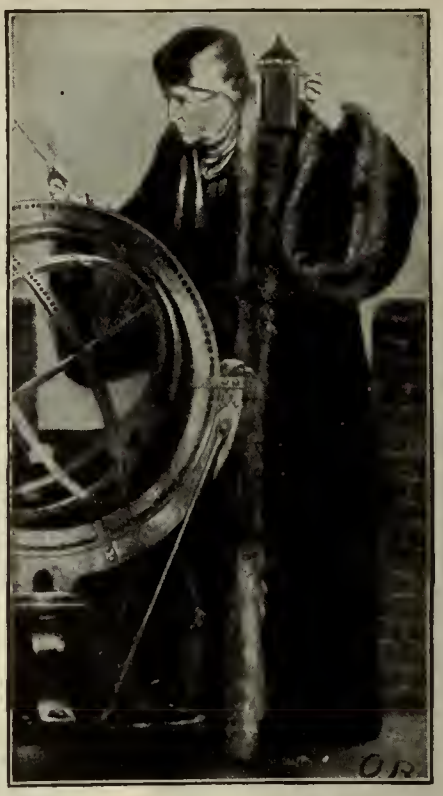
The Spirit of Accuracy

SETTING standards is half the work of science. The standard of length—a platinum-iridium bar; the standard of time—stars passing the hair line on a lens.

And in radio—the standard of reception. This is the ultimate goal of the radio engineer. Progress toward that standard depends upon the uniform excellence of the tubes used for tests.

The Spirit of Accuracy enters into every ARCTURUS Tube and is manifest in each test, check and process of manufacture. Oxides filtered through sieves that hold water... gauges that detect the fraction of a hair's breadth...a vacuum that approaches nothingness—all contribute to the standard the engineer demands.

Radio engineers use ARCTURUS A-C Tubes with the sincere assurance that these tubes are as fine and uniform as it is humanly possible to build them—a new standard in radio tubes.



COPERNICUS
From the Painting by OTTO BRAUSEWETTER

ARCTURUS
BLUE A-C LONG-LIFE TUBES

ARCTURUS RADIO TUBE COMPANY, NEWARK, N. J.

A Complete Line of Quality Volume Controls



U. S. Pats. 1593658, 1034103, 1034104.

Superior workmanship, smooth operation and long life characterize the

ELECTRAD TONATROL

Made in a variety of values suitable for most circuits. One of the most popular of the many Electrad Voltage Control devices with manufacturers, custom-set builders and experimenters. Supplied with or without filament switch. List, $1.50 to $3.00.

The Super-TONATROL—the remarkable new Electrad Volume Control for use in high-voltage receivers. Entirely different in construction and design. Easily dissipates 5-watts. Resistance element fused to an enameled metal base. Pure silver floating contact gives amazing smoothness. Seven types with uniform or tapered curve. List, $2.40 to $3.50

-----COUPON-----

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175 Varick St., New York

Please send TONATROL and Super-TONATROL Literature.

Name .....

Address .....

.....

ELECTRAD INC.

Jenkins & Adair

Level Indicator Panel

Type B (Calibrated)



For Broadcasting, Electrical Recording, and Power Speaker Systems

The Type B Level Indicator Panel is designed for direct reading of the voice level on any 500-ohm telephone circuit, the range being from minus 10 TU to plus 20 TU, in steps of 2 TU each. The parts consist of an accurately built input transformer, a specially designed potentiometer, a filter retard and condenser, and direct current galvanometer calibrated for this work.

The use of this panel is essential wherever a specific level must be maintained. The calibration is highly accurate, and cannot alter while the tube constants remain normal. The potentiometer is built up of nichrome wire units, held to an accuracy of 1/10 of 1%. The panel is extremely simple in operation, is direct reading in TU's, and minimizes the change of load on the measured circuit when the level settings are changed. This last feature is a great improvement over present types.

The dimensions of this panel are 19 x 7½ in. It is of 5/16 in. black sanded bakelite and weighs, complete, 18 lbs. It operates on 12 volt A battery and 135 volts B battery, and requires a 102E tube (not furnished by us). The parts of this panel are NOT sold separately. Bulletin 8 gives a more complete description and will be mailed on request. The net price in the United States and Canada is $250.00 f. o. b. Chicago.

J. E. JENKINS & S. E. ADAIR
Engineers
1500 N. Dearborn Parkway
Chicago U. S. A.
Manufacturers of Recording Amplifiers

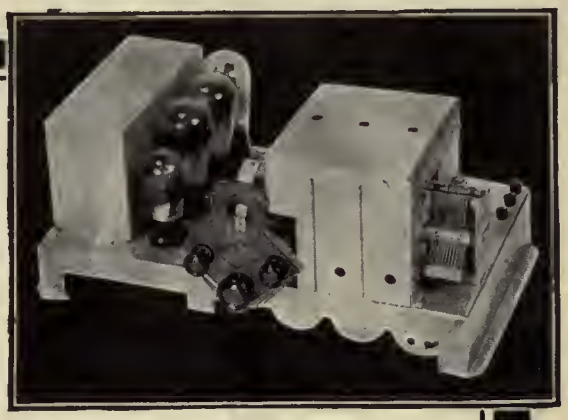
S-M

They said— "S-M will do it this year" —and S-M has done it!

BUILDING upon the experience of last year—when the S-M 720 and 710 Screen-Grid receivers set new high marks of accomplishment, both in extreme distance reception (such as Australia to New York on the broadcast band) and in musical excellence—Silver-Marshall announces a development as important to the 1930 builder as was the 1929 S-M supremacy in screen-grid receiver design.

This year there is an entirely new keynote in designs for the setbuilder: CONVENIENCE. Formerly considered as the one feature monopolized by factory-built sets, *perfect convenience in operation* is now brought within the reach of all—and yet with even *better performance* than the *best* "kit sets" of last year—the S-M 720 and 710.

And this, too, at *lower* cost rather than higher—for the great new S-M factory, five times the size of last year's, and one of the largest in America, is bending its mighty power to bring still lower the cost to the setbuilder of those phenomenal results he feels a right to expect from any S-M receiver.



S-M 722
Band-Selector Seven

Far *better* in actual performance than the famous 720 and 720AC Screen-Grid Sixes, as well as more convenient, the 722 Band-Selector Seven is strictly all-electric, and tuned entirely by a single illuminated drum. It embodies a.c. screen-grid amplification in two r.f. stages, band-selector tuning, screen-grid power detection followed by resistance-coupled first r.f. stage, push-pull 245 output tubes, and provision for dynamic speaker. The 722 makes top-notch 1930 quality no more costly than merely mediocre reception.

And If That Sounds Startling — Read This

The Seven-Twelve Tuner
A Refinement of the Sargent-Rayment

For the setbuilder who wants the best regardless of cost, S-M is able to repeat the promise made *and kept* a year ago. The Sargent-Rayment 710 was acknowledged to stand head-and-shoulders above all other receivers offered at any price—and the same laboratory which perfected it now offers a further refinement in the S-M Seven-Twelve Tuner. Though not high-priced, the Seven-Twelve will this year duplicate the achievement of its illustrious predecessor and will *far surpass* in *performance* anything offered to the setbuilder at *any price whatsoever*. Built to realize every advantage of a precision band selector tuner entirely separate from its audio amplifier, the Seven-Twelve uses 224 a.c. screen-grid tubes in three r.f. stages, band-selector tuning, and power detector. Perfectly adapted to give to the 712 a tone quality in keeping with its own outstanding sensitivity and selectivity is the new 677 two-stage power amplifier (245 push-pull). The 712-677 combination will be the setbuilder's ace for 1930—and at a price that will astonish the most skeptical.

735 Round-the-World Six
All-Electric—Short-Wave and Broadcast-Band

The first completely a.c.-operated short-wave receiver to be offered upon the American market. Built on the same chassis as the 722 illustrated above, the 735 demonstrates in short-wave reception the same mastery of design for the 224 a.c. screen-grid tube which distinguishes the new S-M broadcast receivers. Built into it also is a typical S-M two-stage audio amplifier with push-pull 245 tubes. Plug-in coils give a range of from 17 to 650 meters. Strictly one-dial tuning, full a.c. operation, and provision for dynamic speaker unite to make the 735 a real milestone in short-wave development.

Have you seen the intimate description of these three all-new S-M receivers as first printed in the S-M RADIOBUILDER? If you want to keep up-to-date on the new developments of the S-M laboratories, don't be without the RADIOBUILDER. Use the coupon.

Custom-builders who use S-M parts have profited tremendously throughout the past season through the Authorized S-M Service Station franchise. If you build professionally, let us tell you about it—write now.

Get your order in right away to your S-M parts distributor, for one or more of these 1930 receivers. Net prices will be found in the new S-M fall catalog; see coupon.

SILVER-MARSHALL, Inc.

6403 West 65th St., Chicago, U. S. A.

Silver-Marshall, Inc.
6403 West 65th Street, Chicago, U. S. A.

....Please send me, free, the complete S-M Catalog; also sample copy of The Radiobuilder.

For enclosed.....in stamps, send me the following:

.... 50c Next 12 issues of The Radiobuilder
.... $1.00 Next 25 issues of The Radiobuilder

S-M DATA SHEETS as follows, at 2c each:

....No. 3. 730, 731, 732 Short-Wave Sets
....No. 4. 255, 256, etc., Audio Transformers
....No. 5. 720 Screen Grid Six Receiver
....No. 6. 740 "Coast-to-Coast" Screen Grid Four
....No. 7. 675ABC High-Voltage Power Supply
....No. 8. 710 Sargent-Rayment Seven
....No. 9. 678PD Phonograph-Radio Amplifier
....No. 10. 720AC All-Electric Screen-Grid Six
....No. 12. 669 Power Unit (for 720AC)
....No. 14. 722 Band-Selector Seven
....No. 15. 735 Round-the-World Six
....No. 16. 712 Tuner (Development from the Sargent-Rayment)
....No. 17. 677 Power Amplifier for use with 712

Name.....

Address.....

ILLIS KINGSLEY WING . . . . *Editor*
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RADIO BROADCAST

VOL. XV. NO. 4

PUBLISHED FOR THE RADIO INDUSTRY

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. . . *among other things*

THERE IS no good in reiterating that broadcasting is the one branch of the radio industry on which every other depends. You can't find a soul to dispute it. But the fact is, that with very very few exceptions, the radio industry has rested secure in the belief that the broadcasters were doing pretty well by themselves, thank you, and have not so much as looked up from the press of their immediate problems. Leaders in the industry paused at the Chicago Trade Show to sound a note of warning about the degree to which direct advertising has come to dominate radio broadcasting. To our mind, an unusually interesting discussion of this question appears on page 214, "Curing the Direct Advertising Cancer." Plain speaking is necessary now, but not dismal pessimism, for we believe that far behind the scenes in the councils that rule broadcasting in various sections of the country, the broadcasters themselves are struggling earnestly, if silently, to decrease the hold that direct advertising has gotten on their programs. It is to be hoped that present conditions are only a temporary phase through which broadcasting seems fated to pass.

THE MACKENZIE RADIO CORPORATION, one of Zenith's New York City distributors, has a most interesting junior salesman plan which M. W. Craddick, vice-president of the organization describes on page 193 of this magazine. Mr. Craddick has found the plan eminently workable for his organization; we should like to hear from heads of other organizations who have found success with a plan in any way similar.

A CAREFUL STUDY of the best retail statistics now shows—as detailed at length in Mr. Phillips' article on page 206—that dealers who sell more than $100,000 worth of merchandise per year are still getting the largest share of the total radio sales. But close examination also shows that the smaller dealer in proportion to his sales volume is getting an increasing share of the business. This is a recent trend. Is it permanent?

THE September RADIO BROADCAST will contain a useful study of trends and facts in radio marketing, a description of an unusually successful house-to-house selling campaign, a practical discussion of the dealer relation to finance companies; the engineering section will present for the first time anywhere a discussion of the Technidyne circuits, an engineering discussion of the new Bosch screen-grid receiver, and many other valuable articles.

—WILLIS KINGSLEY WING.

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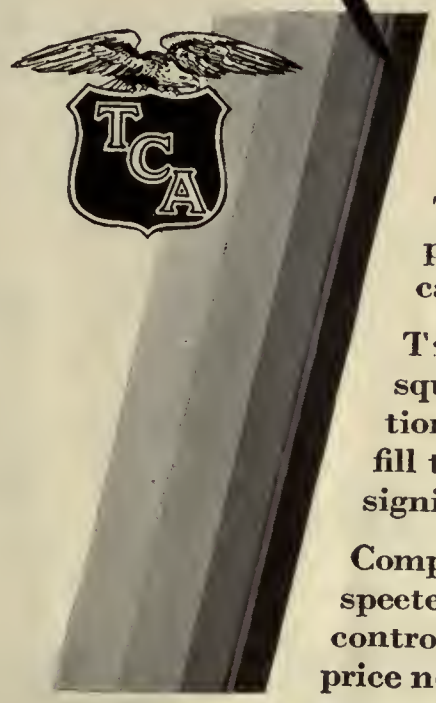
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COUNTRY LIFE . . WORLD'S WORK . . THE AMERICAN HOME . . RADIO BROADCAST . . SHORT STORIES . . LE PETIT JOURNAL . EL ECO . . WEST

BOOK SHOPS (Books of all Publishers) . . .
NEW YORK: <LORD & TAYLOR, JAMES MCCREERY & COMPANY, PENNSYLVANIA TERMINAL, 166 WEST 32ND ST., 848 MADISON AVE., 51 EAST 44TH STREET, 420, 526, and 819 LEXINGTON AVENUE, GRAND CENTRAL TERMINAL, 10 WALL STREET> ATLANTIC CITY: <2807 BOARDWALK> CHICAGO: <75 EAST ADAMS STREET> ST. LOUIS: <223 N. 8TH ST. and 4914 MARYLAND AVE.> CLEVELAND: <HIGBEE COMPANY> SPRINGFIELD, MASS: <MEEKINS, PACKARD & WHEAT.

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What counts like tone quality?

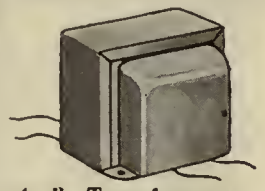


In the last analysis the customer's yardstick is the one by which radio values will be measured. In his judgment tone quality comes first.

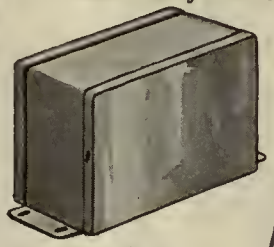
The audio end of the set controls the final performance—so transformers and speakers can make or mar a receiver.

T·C·A products meet their responsibility squarely. They deliver the goods. In perfection of design and construction, they fulfill the most exacting demands of your designing department.

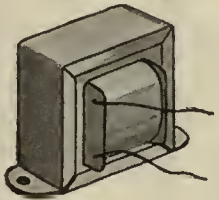
Completely manufactured . . . rigidly inspected . . . carefully tested . . . and through controlled volume production, offered at a price no higher than you pay elsewhere.



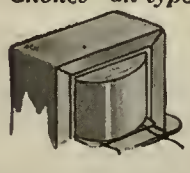
Audio Transformers



Power Packs



Chokes—all types





A Dynamic of exceptional sweetness and volume . . . substantial . . . beautiful . . . possessing many exclusive developments. Write for details.

TRANSFORMER CORP. OF AMERICA, 2301-2319 South Keeler Avenue, CHICAGO

UNIQUE EFFICIENCY

EVEREADY RAYTHEON B-H TUBE



Type B-H—Standard for "B" Power Units. 125 m.a. at 300 volts.

THE ORIGINAL GASEOUS RECTIFYING TUBE FOR "B" ELIMINATOR UNITS

THE Eveready Raytheon B-H Tube uses ionized helium instead of a filament. Not only is it unusually efficient . . . its life is uniformly long and its voltage is sustained.

Unlike a filament, the electron emission of which gradually decreases, ionized helium supplies millions of electrons a second—over and over again.

If you use a "B" eliminator, it was almost certainly designed for the B-H tube. A new tube will probably give you a tremendous increase in power and quality.

If you are experimenting, and require an unfailing source of steady D.C., you can be sure of an efficient heavy-duty rectifying tube in the B-H.

NATIONAL CARBON CO., Inc.
New York, N. Y.
Unit of Union Carbide UCC *and Carbon Corporation*

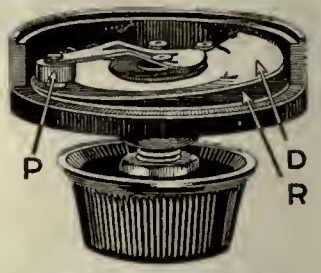
EVEREADY RAYTHEON

FOR WANT OF A NAIL

EVERYBODY remembers the verse about the courier in the battle of Waterloo speeding to get reinforcements for Napoleon. His horse faltered and fell. . . . For want of a nail a shoe was cast . . . and the battle lost.

A radio receiver is very much the same. You may have the "reinforcements" in the form of fine workmanship, good condensers, good transformers and yet there may be a "nail" that causes trouble. Look to the volume control for a great amount of the grief . . . mechanical and electrical noise . . . inadequate and uneven control. Are those the symptoms?

Then turn to Centralab controls whose quality is vouched for by this fact: the great majority of radio manufacturers include them in standard equipment. Be sure the manufacturer of the receiver you sell has done likewise.



This shows the exclusive rocking disc construction of Centralab volume control. "R" is the resistance. Contact disc "D" has only a rocking action on the resistance. Pressure arm "P" together with shaft and bushing is fully insulated.



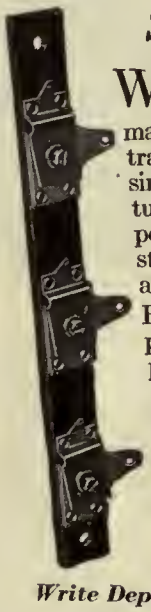
This is the action of the usual wire wound control after it has been in use for some time . . . like dragging a stick over a cobblestone pavement.



The tailor uses the same principle as Centralab. He does not want to ruin the garment by placing the iron on it so he places a cloth in between. Centralab controls cannot ruin the resistance because the rocking disc is in between the pressure arm and the resistance.

Centralab
CENTRAL RADIO LABORATORIES
20 Keefe Ave. Milwaukee, Wis.

According to Your Specifications



WE ARE prepared to make special models of the Hammarlund Equalizing and Neutralizing Condensers, either single or in gang, to manufacturers' specifications. Superbly designed and constructed—compact, accurate, efficient.

Bakelite base; brass stator plate; mica dielectric; phosphor bronze spring plate; convenient adjusting screw and connecting lugs.

The standard models range in capacity value from 2 mmfds. minimum to 70 mmfds. maximum.

Write Dept. RB8 about your needs

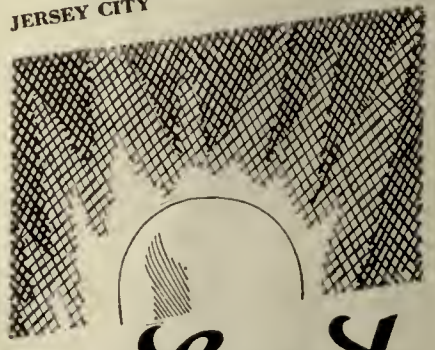
HAMMARLUND MFG. CO.
424-438 W. 33rd St., New York

For Better Radio
Hammarlund
PRECISION
PRODUCTS

Compare Them

The best way to satisfy yourself that Audion 427 is humless is by a direct comparison with the -27 type tubes you now use.

DE FOREST RADIO CO.
JERSEY CITY NEW JERSEY



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AUDIONS



Screen Grid Tubes and Power Detectors

Get the Thordarson August Bulletin

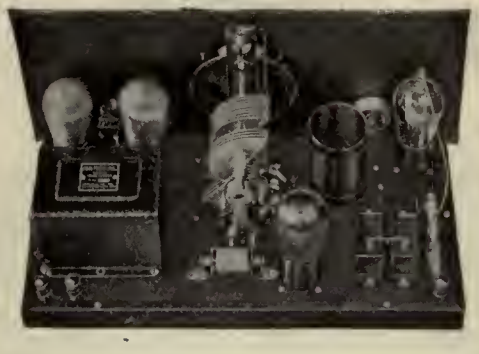
Input Couplings
Speaker Couplings
Filament Supply
Power Compacts

For the new "245" power tubes—single or push-pull—and the new screen grid power detector.

THORDARSON

Transformer Specialists Since 1895
THORDARSON ELECTRIC MFG. CO.
Huron, Kingsbury and Larrabee Streets
Chicago, Ill.

With an Audio-System really Designed for Short-Wave Work



Operates from NATIONAL Velvet-B

Write us today for full details

A special audio system has been built for this Double-Duty National THRILL BOX SW-4. It embodies new improvements on the former NATIONAL Impedaformers, permitting the use of a high-mu audio tube and giving a very high audio-gain. The two audio-units are placed in one case for compactness and to make wiring more simple. And the SW-4 is designed for stable and quiet operation with a 200-A detector—an added and unusual advantage.

Every other detail is just as carefully thought out. The SW-4 is not a copy—it bristles with new and ingenious details for your convenience and pleasure.

NATIONAL

4 Tube THRILL BOX SW-4

NATIONAL CO. INC., Malden, Mass.

Est. 1914

Potter

True-Tone Electrostatic Reproducer

NEW DESIGN
NEW PERFORMANCE
NEW APPEARANCE

Created
Great Sensation
at
R. M. A. Show

Potter

Type "BE" Electrochemical Condenser

Ideal for Filter Blocks

(Edelman Patents)

The Potter Co.
North Chicago, Illinois

A National Organization at Your Service

THREE OF A KIND



NEW YORK PLANT
829-839 E. 134th St.—where Polymet Condensers and Resistances are made.

COILTON DIVISION
Easton, Pa., the home of Poly-Coils.

STRAND & SWEET DIVISION
Winsted, Conn.—where Polymet enameled magnet wire is manufactured.

that beat everything!

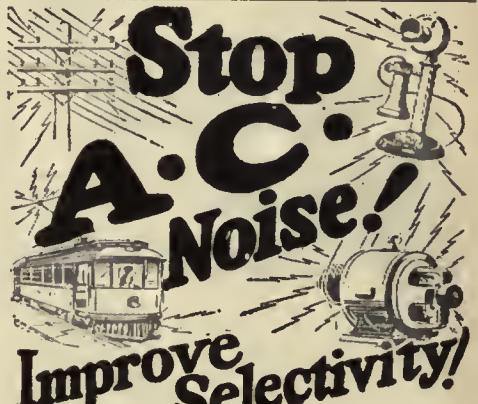
The Three New Plants of

POLYMET

The seal of good radio set essentials

POLYMET MANUFACTURING CORPORATION
837 East 134th Street New York City

POLYMET PRODUCTS



Improve Selectivity!

PLUG in a Falck Claroceptor between wall socket and radio set and eliminate "static" from motors, street cars, telephones and electrical appliances. This new improvement by a pioneer radio parts manufacturer grounds and thus blocks out line interference noise and radio frequency disturbances. *Also improves selectivity and distance.* Requires no changes in set. Measures just 3½ x 5½ x 2½ inches. Thousands now all over America use the Claroceptor for clearer A. C. reception. Get one right away—at radio parts dealers. Write for descriptive folder.



$7.50 complete with cord and plug

Falck

CLAROCEPTOR

Built by ADVANCE ELECTRIC CO.
1260 W. Second St. Los Angeles, Calif.
JOBBERS and DEALERS, GET OUR PROPOSITION

SPECIAL TEST EQUIPMENT



for use in the service laboratory is soon to be announced. This will include an oscillator for measuring the over-all response characteristics of a receiver for the entire broadcast band. It will be inexpensive, compact, and of General Radio quality.

Write for Bulletin G-1

GENERAL RADIO COMPANY

30 State Street
Cambridge, Massachusetts

274 Brannan Street
San Francisco, California

AERO-CALL



Factory-Built, Ready to Plug Into Any Set

Shielded—Filtered No Motorboating

This amazing instrument now makes it possible to reach 'round the world. Geo. Moicroft, of Pa., tuned in England, Australia and Holland on his initial test. Gets stations regular receivers cannot get. No change or wiring required. All complete, ready to operate. Golden brown, compact metal cabinet in crackle finish. Size 9x5¼x2¼ in. The only converter we know of that really works on all sets. Two models—A.C. and D.C., at $25.00 each. Write for Catalog and literature and dealers' discounts; also give jobbers' name.

Send for Aero Short Wave Guide

Gives the very latest details on Aero Coils and Kits, Short Wave Radio, newest broadcast radio receivers, short wave converters, telephone transmitters, coil kits, adapters and a host of new wrinkles for 1929. The kits everyone is talking about are fully described. Chronophase, Metropolitan, Trio, International, Standard, Radiophone—in Shield Grid, A.C. and D.C. models—all good summer sellers.
Be sure to send for your copy—worth $25.00 to anyone who wants to keep up with the latest radio wrinkles. Mail coupon for your copy today—**now!**

AERO PRODUCTS INCORPORATED

4611 E. Ravenswood Ave., Dept. 289, Chicago, Ill.

.....MAIL THIS COUPON NOW.....

AERO PRODUCTS Inc.
4611 E. Ravenswood Ave., Dept. 289, Chicago, Ill.

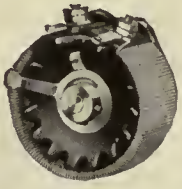
Send me your Short Wave Guide, giving the latest information on what's new in radio, short wave, etc. to help me boost my summer sales.

Name.....

St. & No. .....

City..... State.....

FROST-RADIO Brass Tack Talks on Rheostats



Your experience with rheostats is likely to have convinced you they are made either to *wear* or to *repair*. Frost Rheostats are made to WEAR. And how they do live up to their reputation! There doesn't seem to be any "wear out" to them. Rheostats we made years ago are still giving the same trouble-free service they rendered the first day they were installed. Windings, contact arms, spring tension, knobs, frames—all are designed primarily for SERVICE.

Having made many millions of rheostats of all sizes and types, we have gained a wide experience that is reflected in today's Frost Rheostats—the finest your money can buy.

It may interest you to know that we could save much by making Frost Rheostats not quite so good—but we don't and we won't. The best of everything, tested countless times during manufacture, is combined with our knowledge of rheostat design and construction to give you as close to absolute perfection in a rheostat as modern science can produce.

For your protection, and to insure the best possible reception for your set, insist that only Frost Rheostats be used. Then you will know that their service will equal that of the set itself.

HERBERT H. FROST, Inc.
Elkhart, Indiana
160 North La Salle Street, Chicago, Ill.
The World's Largest Manufacturers of High Grade Rheostats

ROBERT S. KRUSE

Consultant and Technical Writer

103 Meadowbrook Road, West Hartlord, Conn.
Telephone Hartford 45327



Off the DEEP END

Christopher Morley

. . . "No one doubts the amazing vivacity and facility of Christopher Morley . . . 'Off The Deep End,' like several of its predecessors is a collection of stray pieces, short stories, brief playlets, humorous squibs and Lambsian essays. The reader saunters, so to speak, through Mr. Morley's engaging purlieus admiring the gusts of the greenery, the sparkling quality of the streamlet of wit and the whimsicality of the curious growths"—*New York Times.*

. . . "Whatever he does will be fascinating talk . . . talk which makes his book of essays a pleasant adventure"— *New York Evening Post.*

. . . Other books by Christopher Morley. THE ROMANY STAIN, WHERE THE BLUE BEGINS, THUNDER ON THE LEFT *and* THE HAUNTED BOOKSHOP.



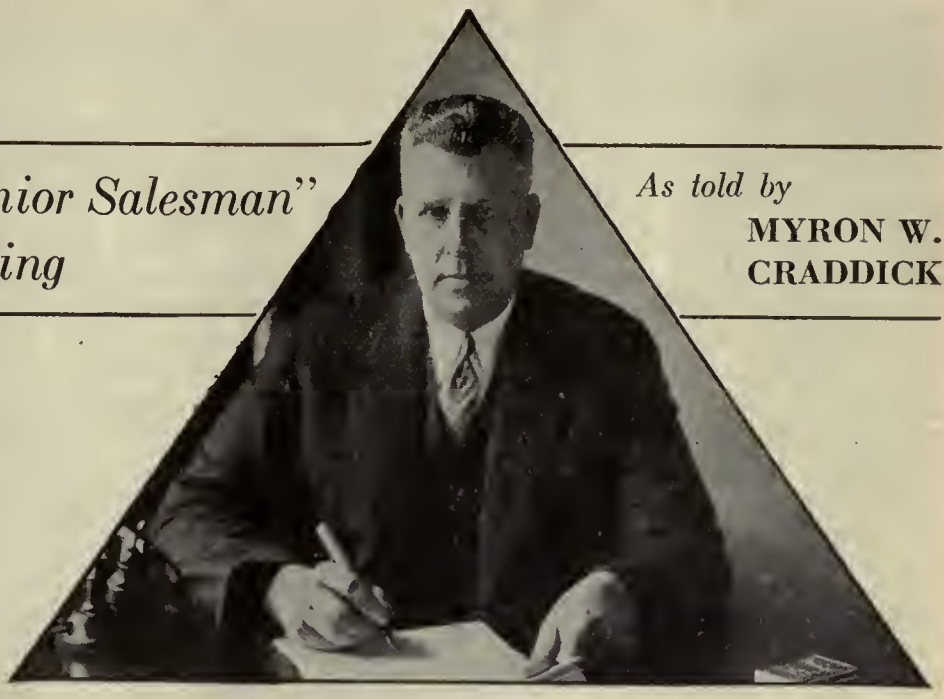
DOUBLEDAY DORAN & COMPANY, INC.

Garden City, New York

$2.50 at all bookshops

Introducing the "Junior Salesman" Plan of Merchandising

As told by
MYRON W. CRADDICK



A JOBBER LOOKS AT HIS DEALERS

THE NEXT few years in radio merchandising will see a rapid development of what can best be described as the "Naborhood Radio Store," a standard-price store carrying recognized lines and giving reliable service to a well-established local clientele, according to Myron W. Craddick, vice-president and general manager of the Mackenzie Radio Corporation.

That propheey, together with an explanation of his novel "Junior Salesman" system for maintaining close jobber-dealer contaet and first-class service for dealer customers, formed the closing part of a recent interview with Mr. Craddick on present merchandising trends and practiees. As managing head of the Zenith distributing organizations in Connecticut, southern New York State, northern New Jersey, Westchester, and the Bronx, Mr. Craddiek has an intimate knowledge of merchandising methods in the entire gamut of markets: metropolitan, urban, suburban, and rural.

In weighing the worth of present trends in radio merchandising, he balanees two sound ones against two unsound ones. The inereasing recognition by individual dealers that a small number of lines ean mean more business than a large number of lines, and the reeent efforts by progressive dealers to build up a permanent clientele, he considers sound. The frenzied price-cutting by some of the chain-stores, and the continued apathy of dealers toward the radio service problem, he terms unhealthy.

The "Junior Salesman" scheme, which will be described in later paragraphs here, was evolved to stimulate dealer-interest in the first two trends, and to offset as much as possible the deleterious effects of the latter two.

A Word of Warning

"BEFORE WE START," Mr. Craddick warned, "remember that while my experienee with dealers gives me intimate views of their problems in practically every type of community and market, what I say about one market doesn't necessarily hold true for another. Some of the policies that my dealers in New Jersey towns have found most profitable, for instance, are not acceptable to d alers in the Bronx. And there can be no attempt to impose a majority precept on the minority dealers; each dealer has his own problems for which there ean be no text-book solution."

More and more dealers in all types of markets, however, are coming to realize that they ean do more business, with greater satisfaction to each customer and a corresponding increase in prospective eustomers, by handling one or two lines of radio receivers than by handling eight lines, according to Craddick.

"A floor salesman can learn all there is to know about a couple of good makes of sets, where he can't hope to grasp more than a superficial knowledge of each of seven or eight makes. And, of course, a floor salesman who knows his sets inside out ean explain and sell any one of them to a customer with conviction and assurance. No eustomer is easily sold when a salesman talks about a set like an advertising pamphlet, but is unable to answer particular questions about its construction or operation.

"Again, no dealer's servieeman can be expeeted to become an expert in each of seven or eight different makes. And a dealer's serviceman who makes a service eall and can only stall around until he admits that he'll have to get hold of a factory serviceman, has done about all he can do to lose for the dealer the prospects that that customer, if pleased, should normally provide."

Radio Vs. Automobile Trade

THERE IS a close analogy between the radio dealer and the automobile dealer, as Mr. Craddick sees it. The day of the general motor agency, where one dealer handled as many different makes of car as he could contract, has long since passed, even in small communities. Automobile dealers now have one or two different lines, and their salesmen are thoroughly familiar with the product they sell. Furthermore, the man who purchases an automobile to-day has absolute confidence in the dealer's service department, since he knows that the garagemen are experts in that particular make of car. In the early days, the automobile purchaser learned by sad experience that the sales agency's service department was only a tinker-shop, no more wise in the ways of his car than

was the "General Repair" garage down by the freight depot, and was in fact often less capable. That feeling exists now about the average radio dealer's service department, and the sooner it is counteracted by the dealers the better for radio merchandising.

The recent revival of the long-condemned practice of price-cutting has had a serious effect upon the radio retail trade. Whether or not the chain-store system is going to prove economically sound in the radio business, Craddick does not attempt to prophesy; but the cut-price policies of some of the metropolitan stores are, to his mind, short-sighted. The manufacturers who permit their lines to be advertised and sold at cut prices, he points out, may be helping themselves out of a temporary over-produced condition, but they are nipping whatever faint buddings of dealer loyalty and confidence they may have raised.

"No dealer who is attempting to build up a stable business in a community can be expected to utter cheers when he finds that list prices on a certain line are made only for some competitor to undersell," he said. "But the question of price-cutting has been argued ever since radio retailing came out of the novelty trades."

Dealer apathy toward the service problem is decreasing at far too slow a pace, Craddick has found. There are, he adds, one or two reasons why that is so, but they are only superficial reasons.

"Very often the dealer gets a call for service from a customer, and sends the serviceman around only to find that there's nothing wrong with the set. The customer isn't satisfied with that report; he still says the set isn't working properly, and back goes the dealer serviceman for a second time. I've known cases where the dealer serviceman has made four calls, each with the report that the set was operating all right. The customer, still dissatisfied, hounds the dealer until the latter asks the distributor's serviceman, or a factory serviceman, to look the set over. The report is still 'O. K.', but the customer believes the factory man where he didn't believe the dealer's man.

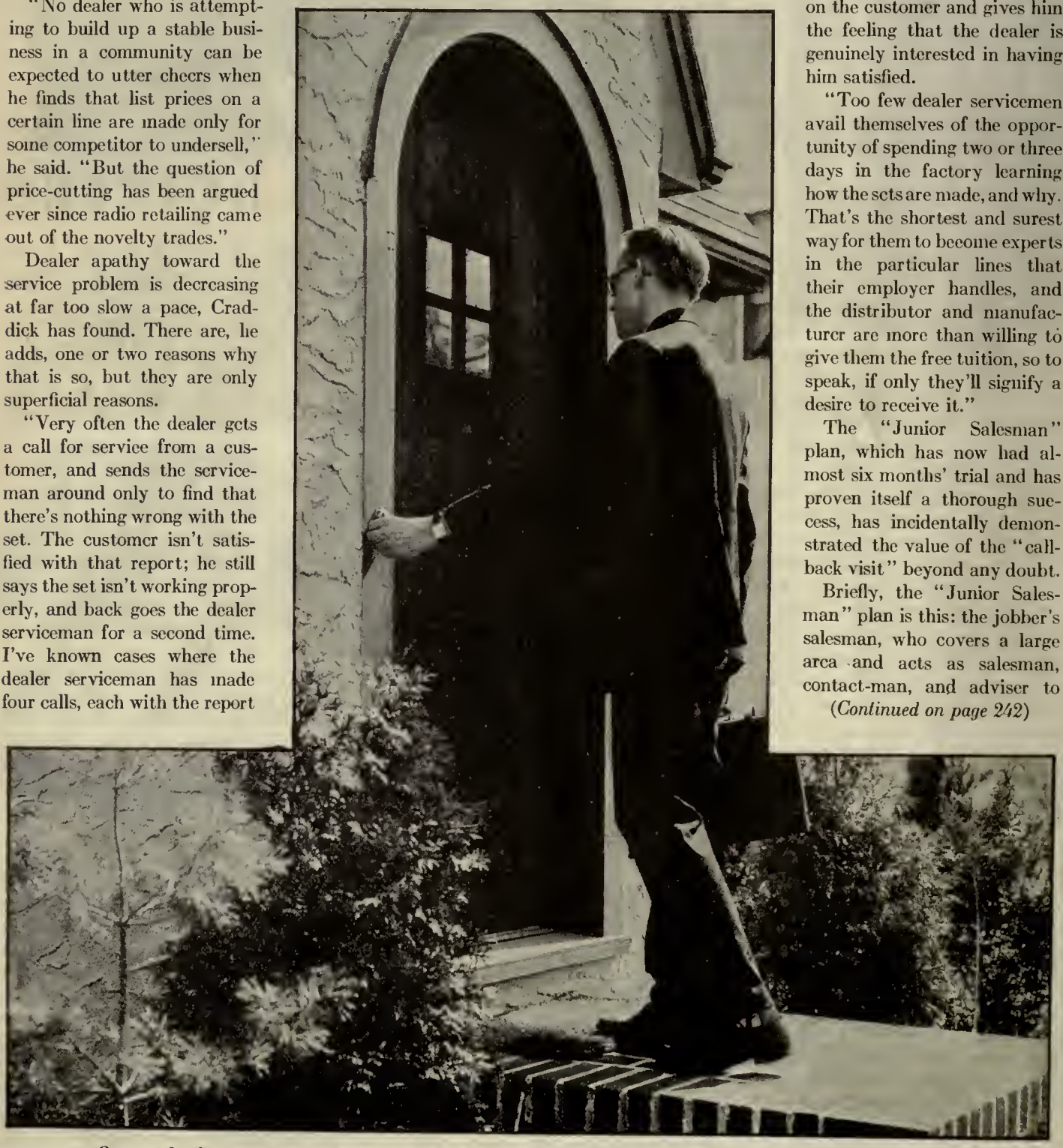
"And the one thing that a dealer's service department should do it doesn't do, in ninety cases out of a hundred. That is, to make an unrequested inspection visit a week or so after a set has been installed in a customer's home. Such a call will often uncover little things that have been bothering the customer; lots of times the customer hasn't learned how to tune the set properly, and doesn't realize that he's not getting the reception he is entitled to have. And, even when that second visit, the 'call-back' trip, as we term it in our organization, doesn't find anything that the serviceman should correct, it makes a splendid impression on the customer and gives him the feeling that the dealer is genuinely interested in having him satisfied.

"Too few dealer servicemen avail themselves of the opportunity of spending two or three days in the factory learning how the sets are made, and why. That's the shortest and surest way for them to become experts in the particular lines that their employer handles, and the distributor and manufacturer are more than willing to give them the free tuition, so to speak, if only they'll signify a desire to receive it."

The "Junior Salesman" plan, which has now had almost six months' trial and has proven itself a thorough success, has incidentally demonstrated the value of the "call-back visit" beyond any doubt.

Briefly, the "Junior Salesman" plan is this: the jobber's salesman, who covers a large area and acts as salesman, contact-man, and adviser to

(*Continued on page 242*)



One week after a new set is installed the junior salesman makes an unrequested inspection visit.

Does ELECTRICAL ADVERTISING Pay?



By F. A. ORTH
Federal Electric Company

NEON!

What is it? Is it a man's name? Will a neon sign help my business? Is a neon tube sign to be preferred over a lamp bulb electric sign? Are there wires in neon tubes? What will it cost?

These and many other questions arise in connection with neon tube signs—the most outstanding development in the history of the electric sign industry. Consequently, there will be answered in this article those questions which are asked most frequently, so that the reader may obtain a general understanding of the very real value of this type of advertising.

It was in 1898—thirty-one years ago—that a new gas was discovered by Sir William Ramsay. He gave to this new element the name "Neon," a Greek word meaning "new." Soon afterward, he discovered that when an electric current is passed through this gas sealed in a tube, a beautiful orange red color results. Realizing the possibilities of his discovery from a commercial standpoint, the following year he asked Georges Claude, a Frenchman, to endeavor to develop his discovery so that it might be utilized in this way. Georges Claude accepted Sir William's proposal and together with J. de Beaufort, worked with this new gas in his Paris laboratory, devising methods and devices for its practical use.

As a result, in 1914, the first neon commercial signs made their appearance in France. To-day, many outstanding examples of the advertising value of neon light mark the thoroughfares of Paris and other European cities, as well as those of this country.

What was, perhaps, the first neon sign erected in this country (United States) was the Packard sign manufactured in Paris and brought to San Francisco by Earl C. Anthony. It was placed on the home of Packard Motors in San Francisco in 1922. It read "PACKARD, EARL C. ANTHONY, INC."

The word "PACKARD" predominated in the sign, while "EARL C. ANTHONY, INC." appeared directly beneath the word "PACKARD," and was, apparently, an enlargement of Mr. Anthony's handwritten signature. The sign was forty feet long and twenty feet high. Considerable interest was created along Van Ness Avenue with the appearance of the Packard sign.

Growth of Electrical Advertising

SINCE THEN, successful business men have been quick to realize the commercial value of neon tube signs as a real asset to business. Many who had not previously entertained the idea of electrical advertising, as embodied in the type of sign which derives its lighting effect from electric lamps, immediately grasped the opportunity afforded by neon. Since the appearance of the first neon sign in the United States, the growth of electrical advertising in the neon field has been phenomenal; in the short period of seven years—1922 to 1929—numerous signs and ornamental designs have been erected throughout the country.

Neon signs and ornaments may be used not only where other electrical display signs are adaptable, but in many other places as well. Trade marks and designs may be reproduced accurately inasmuch as the tubes can be bent to any desired shape. They may be erected where the electric lamp sign cannot be utilized.

For example, the tower of the Coliseum in London is outlined with red neon tubes. At night the tower stands out in

beautiful relief against the black background of the sky and has caused unstinted admiration throughout London. This application of neon light to the Coliseum is typical of the various uses of neon. It may be used on buildings of unique architecture to serve as a border for the windows, doorways, or even the entire building. It takes no stretch of the imagination to visualize the beautiful effects which may be created in this way.

Neon tubes do not have in them any wires of any kind. There is merely an electrode extending into the tube from each end for about two inches. The tube is filled with neon gas and when an electric current is passed into the tube, the gas conducts the electricity, giving off a color of a predetermined hue. Different colored lights—yellow, green, blue, tan, and violet—are obtained by the addition of certain gases or the use of glass tubes of special composition.

particular store, and ascertain whether or not an electric sign influenced him in any way.

"By George, you're right," he replied almost before I had finished. "I went out to buy some flowers the other day to send to a friend of mine who is in the hospital. I looked around for a sign, subconsciously. I now realize I saw one erected over a florist's place of business, and went there to buy those flowers."

And so it is. Consciously or subconsciously, in the prospect's mind, an electrical advertising display sign plays an important part in determining for the prospect where he will buy. It reminds him of his needs and wants while he is on the buying path.

During the day, your sign's distinctive lettering, background, and design stand out in sharp contrast to the surroundings, compelling attention and action and bring people

DATA ON A TYPICAL SMALL SIZE DOUBLE-FACED DEALER'S SIGN

COST OF VARIOUS TYPES

(1) Radio in 12-inch Neon letters and company name in 4-inch Silveray letters. Price: $290.

(2) All reading matter in Silveray letters. Price: $200.

(3) Radio in lamp illuminated letters and company name in Silveray letters. Price: $235.

Size of sign 2½ x 5 feet



OPERATING COSTS

(1) Initial installation all types $18.00

(2) Cost of current.
Sign No. 1 $4.95 per month
Sign No. 2 $9.90 per month
Sign No. 3 $14.88 per month
(See column on left)

(3) Replacement Neon tubes $7.50 per letter. Average life 5000 to 12,000 hours.

Neon signs or ornamental writing are effective twenty-four hours a day. They may be illuminated with almost equal effect both day and night, regardless of climatic conditions. Sunshine has little effect on their brilliancy or legibility.

"But," you ask, "will a neon electrical advertising display sign help my business? Will it pay?" And those are fair questions. In answer, it is interesting to observe that there are over a quarter of a million electric display signs burning every night in this country, and that millions of dollars are spent each year by progressive merchants and manufacturers on electrical advertising display signs. Hard-headed business men who insist that proof of forthcoming results be given with each item calling for an appropriation in the annual budget seem to agree that electrical advertising does pay.

Proof of Sign's Value

AN INTERESTING example of the effectiveness of electrical advertising came to my attention only a few days ago. I was talking to one of my business associates, when he asked me, "How can you prove, without a doubt, that electrical advertising pays? Of course, you can tell me that millions of dollars are invested annually in electrical advertising and that an electric sign guides people into the store over which it is erected, but how can you prove that those people who go into a store having an electric sign would not go into that same store were there no sign erected there?"

In reply, I asked him to see whether or not he could answer that question for himself—to prove from his own experiences, that electrical advertising does pay. To help him along, I asked him to think back over his purchases during the last few days, determine what prompted him to buy in this or that

into your store to buy. At night it blazes your message to passers-by and tells them who you are, where you are, and what you sell. In addition, week after week, month after month, people see your sign and become more and more conscious of your store and what it sells. Then, when they are in need of a radio, your sign's message comes to mind and their wants are satisfied at your place of business.

Tying in on Advertising

A POINT QUITE often overlooked by many radio retailers is that the electric sign enables them to cash in on local or national advertising done by radio manufacturers. It is the connecting link between local or national advertising and the retailer's place of business. Magazine, newspaper, car-card, and billboard advertising create in people the desire to buy, whereas *electrical advertising tells them exactly where to buy the article they want.*

The value of electrical advertising to the retailer under these circumstances becomes at once apparent. Thousands of dollars are spent annually by radio manufacturers to advertise their product—to create in people the desire to buy the particular radio they manufacture. People read these advertisements, decide to purchase the radio advertised, and start out on the buying path. The retailer, having a sign erected over his place of business, indicating that the radio which that person is looking for may be found there, is the one who makes the sale.

Many manufacturers, realizing the value of electrical advertising as a medium which enables them to enjoy greater returns on their national advertising, go to retailers with a proposition like this:

"Mr. Retailer, you agree to handle our radio for a certain number of years and we will pay part of the purchase price of an electric sign to be erected over your place of business. You may suggest the reading matter for the body of the sign. All that we ask is that you include on the sign the trade name of our radio."

Because painted signs peel in hot weather and need repainting at least once every six months to keep them attractive in appearance, users of electrical advertising display signs are turning more and more each day to the vitreous-enameled iron sign. This type of sign needs only an occasional washing with soap and water to keep it always as new in appearance as it is on the day it leaves the factory; it does not fade or peel in hot weather; it is impervious to heat, cold, rain, and snow, and it never requires repainting of its faces. It is manufactured by all reputable sign manufacturers and is invariably recommended by them because of its outstanding advantages over the painted type of sign.

The purchase price of a vitreous-enameled iron sign is slightly greater than that of a painted sign, but, when the cost of repainting a painted sign every six months is added to a painted sign's original cost, the vitreous-enameled iron sign is found to be cheaper in price in the long run. In addition, it is more attractive and, when properly designed and erected, adds considerable attractiveness to the building on which it is erected and to the district in which it appears.

Two Types of Signs

And now for the question, "What should an electric sign say?" The answer is that the sign should say, in effect, either "buy me," "buy here," or both.

A "buy me" sign has on it words such as radio, drugs, or hardware. It tells prospects what they can buy in the store it advertises. It is specific.

A "buy here" sign has on it the name of a company, a trade name, or a trade mark. It, too, tells prospects what they can buy in a store, but does it by carrying a name which, in the prospect's mind, is associated with specific merchandise. It is not specific.

A sign which is specific—which has on it the name of merchandise being sold in a particular store—is usually more effective than a sign that carries only a company name or trade mark.

Of course, if a company name or trade mark is so well known that it is instantly associated in the prospect's mind with a specific product, then it is just as effective as a "buy me" sign.

If the size of the sign permits, it is well to show on it both the type of product which may be bought in the store it advertises and the name of the company. If in doubt as to which type of sign to choose, it is best to purchase a "buy me" sign.

A neon sign costs slightly more than an incandescent lamp sign of the same size, but its current consumption is approximately one third that of the incandescent sign.

Cost of Electric Signs

Information of a definite character regarding the cost of the various types of illuminated signs may be of interest. In this connection a typical double-faced dealer's sign $2\frac{1}{2}$ by 5 feet will be considered as an example.

Assuming that the word "RADIO" is to be in 12″ Neon letters and the words JOHN JONES CO. in 4″ Silveray (raised white glass) letters, and that the sign is to read the same on both sides, the cost would be $290.00. Should all of the reading matter be in Silveray letters, the cost would be $200.00. Should the word "RADIO" consist of lamps on the outside of the sign and the words JOHN JONES CO. be in 4″ Silveray letters, the cost would be $235.00. In each case the installation cost would be approximately $18.00 and the body of the sign would be made of vitreous-enameled iron.

The cost for electricity where the word "RADIO" consists of lamps on the outside of the sign, would be approximately $14.88 per month, while the cost for electricity, should all of the reading matter be in Silveray, would be approximately $9.90 per month. In the case of the word "RADIO" being in Neon and the words JOHN JONES CO. being in Silveray, the cost for electricity would be approximately $4.95 per month. The above estimates are, of course, for average conditions.

It is obvious, therefore, that although a Neon sign costs slightly more than the other types of signs, the difference in cost of current quickly makes up for the difference, at which time the increased value of the Neon sign continues to manifest itself.

The cost of upkeep in the case of Neon means only those costs that are necessary to have the signs washed occasionally with plain soap and water. The tubes burn anywhere from 5000 to 12,000 hours and may be replaced, in this instance, at a cost of about $7.50 per letter. The electric lamps in the sign undergo "casualties" no more than the ordinary lamp in your home.

Vitreous-enameled iron signs never require repainting, therefore the upkeep is confined merely to keeping the sign clean, a cleansing process being necessary not more often than once every three months.





HOWARD W. DICKINSON *says*—

IF I OWNED A RADIO STORE *I'd make it* PAY.

THE ABOVE title comes naturally to one of my breed. Most any advertising man or ex-advertising man is a Mr. Fixit by habit and training.

The idea of my owning a radio shop is not such a far cry, though. I am keen for radio, convinced that it has possibilities much bigger than are being realized. I should enjoy retailing. It is the intimate, human side of business contact which interests me. A retailer of experience is apt to be a good judge of human nature. He may or may not be skilled in catering to human beings—but he generally understands them pretty well.

Why I'd Enjoy Radio Retailing

I LIKE MECHANICS and electricity. I am reasonably handy with tools and I like the adventure that lies in the things a radio set can do. Yes, I'd enjoy the retail radio business.

While the above does not prove that I would be a good radio retailer, I hope it indicates that I would be an enthusiastic one. In fact I have enjoyed thinking about it so keenly that I have pipe-dreamed myself into the business already. I am afraid I have even bothered a few dealers by sticking around and asking questions, disguised as a customer. I really am a customer for a new set but I can't afford to buy one from every dealer I've talked to, so I hope the others will forgive me.

In my pipe-dream radio business I am keen to see how my competitors do it. And I am sorry to say I've seen some poor salesmanship in radio shops. I've been rather high-hatted in a great department store's radio department. The "brilliant" young salesman couldn't see why I wanted to look around and ask questions. He couldn't see why I need do any more than follow his advice. He was very courteous about it all, but to me it seemed like the kind of courtesy which comes out of a can rather than from a chummy heart. Evidently he has been instructed on how to work on *averages* of human beings rather than to try to understand individual human beings. In some of the smaller shops I've found proprietors who seemed so keen on repairs and service that they didn't seem to have any keenness left for making a sale. Give them a pair of pliers and a screw driver and they fairly purr. Give them a cash customer for a new set and they don't act naturally, although they really want to make the sale.

That's where I imagine my pipe dream might make me a living. I'd get a tremendous pleasure out of demonstrating and selling. I'd feel that I was selling daily joy, that I was selling high adventure, and I'd try to make my customers see it.

Oh, I wouldn't gush too much about it, particularly with men. "Not half bad," to a man may mean more than "glorious, gorgeous, simply perfect" might mean to a woman. If I were dealing with a woman I'd not try to imitate her adjectives either, as a woman knows how to interpret men, and senses intuitively whether or not they really believe in the stuff they are trying to sell.

Where I have an idea that I might fall down would be on trade-ins. I am afraid I would allow too much on trade-ins and rob myself of profits. On the other hand, I would need every bit of my profits. I know I should need them to support a good service shop and also to put a little money in the bank, and above all things there is another thing I'd try to do. Even if I had a little eight by twelve hole-in-the-wall store, I'd organize it as a business, pay myself a salary as manager, and expect to make a profit as owner in addition to that. I'd have a good bookkeeper, at least part time, and I'd learn how to use a bank for my own profit and advantage.

Many a small dealer falls down by forgetting or by not learning these things. He thinks all the money in the till and in the bank is his, and forgets that all the bills are his too, also that the kind of troubles which may come from sailing too close to the wind will be his, too. He doesn't figure out whether all the money he takes out is salary or profit or what is the proportion of each, and he lacks the check-up necessary to make him increase his working capital up to the point of safety and progress.

Dividing the Surplus

SUPPOSE HE has made a gross profit of $15,000. If he pays himself a $3500 salary—takes a business profit of $2500—he can put $9000 into surplus and working capital, be in position to expand, open another shop, or take a bigger place and equip himself for a bigger business. If that $15,000 means a new high-priced car and a lot of luxuries—look out!

I have seen businesses successful one year, go broke the next year, even when they didn't need to. Usually it is because they used all the profits and put none into sinking fund or usable surplus.

Two valuable things can be had from that $9000 undivided profits—insurance against a temporary slump and more promotion. I've taken the small shop as an example. A $15,000 gross profit is not a big business. The principle is just the same with $50,000 or $150,000 or $6000 gross profits. I consider

a business profit one of the most important things for a beginner in retailing to look out for—and surely the experieneed dealer should know all about it.

If I eould pay myself a salary as manager of a ousiness and make a profit as *owner*, then my business would be a sueeess and I would only have to hold my extravagant tastes down till the business had grown to sueh a point that I eould afford to gratify some of them.

Another thing I should do is to begin to write off the value of all my equipment, store furniture, and fixings—tools and all. If that equipment eost $5000, I should figure on paying myself for it in five or ten years out of profits. So in my surplus I figure myself as setting aside $1000 eash, or less, for this purpose. Suppose I make it $1000. Then in five years I have made my equipment earn the money to pay for itself. I ean add to it or junk it for what it will bring and have the cash to buy more up-to-date fittings. To get in the position where you are five years ahead of your business furnishings in money instead of five years behind them is to be on the road to worth-while sueeess.

Another thing I'd do with a part of my surplus would be to keep my insuranee up to the minute.

The Bankers Advice

I SPOKE ABOUT using a bank for my own profit and advantage. I'll tell a simple little true story about that. A groeer in Cambridge, Mass., went to his banker to make a loan. He was a bit erowded on some over-due debts to jobbers. The banker was a good friend of his and a eustomer of his store. The grocer wanted a $5000 loan. It was refused. Jones, the groeer, said, "Do you know that this refusal of yours may wreek me?" The banker replied, "Sure I do, that's why I must refuse you. I can't see where we'd get our money baek. However, Jones, let me ask you some questions. How mueh do you take out of your till for your own personal use?"

"Oh I guess about $4000 a year, I don't keep traek of it."

"Second question, how mueh do you take home from your groeery stoek for your family use?"

"Oh, I don't know, not mueh. I don't keep traek of it."

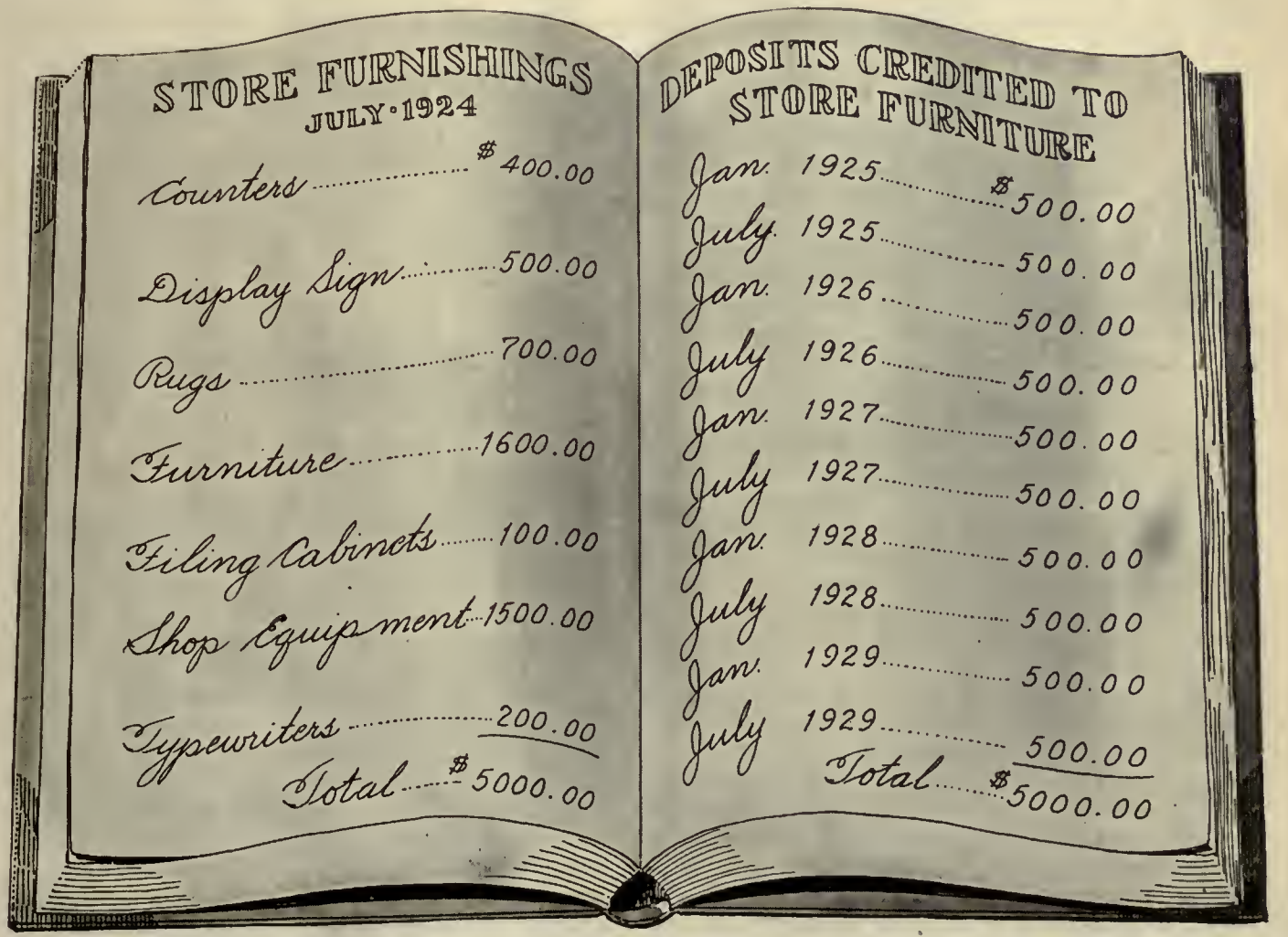
"Jones," said the banker, "if you will do what I tell you to, I'll lend you $10,000 instead of $5000. Here's what I mean. I want your solemn promise to give yourself a salary of $4000 a year, not a eent more. You ean pay yourself by the week or by the month as you ehoose, but never a eent over your salary. Seeond, you must promise to eharge against profits every thing you take home, and keep an exaet account of it. At the end of the year you ean figure out what profits you have left and they will be yours, but even then you should leave a part of them for extra eapital."

Jones agreed. He had to. At the end of a year he had a profit of a little over $5000. He had taken out his salary of $4000 and nothing else, exeept his own groeeries whieh he eharged to himself. He was surprised to see what his own groeeries had amounted to, even at wholesale priees. He found that while spending only $4000, his salary, he had to economize and move earefully to get by, but he did it.

Jones admitted to his banker that previously he had probably been spending about three times as mueh.

"There you are," said the banker. "Your business makes a

(*Continued on page 229*)



Mr. Dickinson says, "To get in the position where you are five years ahead of your business furnishings in money instead of five years behind them is to be on the road to worth-while success."

A Wide-Awake Dealer Solves Some Problems That Every Radio Merchant Meets





General view of Whitaker's service shop



A corner of the display room

B. B. Barber *tells—*

Whitaker, of Bradentown

bases his success on adhering strictly to four business principles:

1. *Prompt and intelligent service.*
2. *Consistent and persistent advertising.*
3. *Outside selling with home demonstrations.*
4. *A simple, complete cost system.*

WHAT A FLORIDA DEALER DID

OPERATING IN a town of 18,000 where radio reception other than that from local stations is limited to about six months of the year, A. K. Whitaker, of Bradentown, Florida, has done a job of radio merchandising which is outstanding. The factors on which Whitaker has built a monument of success are only four. And these four factors, he feels, will serve to spell success for any dealer anywhere who will apply the principles, adapting them to the more or less local conditions with which he may be surrounded.

Whitaker's Four Principles

AS OUTLINED by Whitaker these principles are:

1. Prompt and intelligent service.
2. Consistent and persistent advertising.
3. Outside selling with home demonstrations.
4. A simple, complete cost system.

After the bottom had fallen out of Florida real estate, Whitaker opened his store, June, 1926, with two lines of radio and an electrical refrigerator account. It is interesting to note that none of the original lines is carried to-day; the electrical refrigeration business passed out of the picture completely, while the two former lines of radio have long since been abandoned in favor of other lines, featuring Atwater Kent. A line of talking machines replaced the refrigerators and to-day the business is exclusively musical, being confined to these two lines and their appurtenances.

In launching his radio business, Whitaker determined at once to secure a line on the radio situation as it existed in the homes of the territory he proposed to serve, to learn what sort of radio equipment had been sold prior to his entering the field, how much of it had been sold, and if possible the condition of that equipment.

As the survey progressed, most of it being done over the telephone on a standardized talk, he realized that he was learning exactly who his prospects were, which families owned sets and which did not, and which owners of old sets were about ready to buy new ones. He wound up with a clean list of interested prospects on which he decided to concentrate his selling efforts.

As his sets began to move into Florida homes Whitaker used his telephone again and again. From his satisfied owners he secured the names of friends who had heard the new instruments and had expressed interest in them. Many of these he converted into customers and then he repeated the process, widening his circle of contacts through sets serviced or sold.

The Service System

BUT GETTING back to Whitaker's four principles for conducting a successful radio business and considering them in their proper order, or at least in the order in which he sets them forth, we find first that he is a stickler for having *all* the facts at hand. This is indicated by the "Service Record Card" which is printed on two colors of stock: pink for those sets which he has sold and white for the sets of other makes sold by others. The "work ticket" numbers of all jobs, whether cash or charge, are kept on the individual card with the amount of the purchase. On these cards, in condensed form, is

a complete record of each customer's business. The details of any particular job or purchase can be found at once from the reference numbers. These are kept in an ordinary box file.

In service work there are three separate problems as Whitaker sees it: first, doing satisfactory work; second, being sure that the customer is pleased with the way in which the work is done; third collecting the money. The whole service procedure is cared for on one card—the "work ticket"—from the time the work is requested for until it is billed. The information is filled in when the customer places the call, whereupon it is passed to the service department. The department record is made upon the reverse side of the card giving complete details as to nature of the trouble, materials used, and time consumed, while a general report goes on the front.

The service department places this card on a clip board. Each day the cards are removed by the bookkeeper, who, whenever possible, checks the operation of the set on the telephone. If the work has not been satisfactory the card goes back to the service department for further attention. If sa isfactory it goes to the administrative offices where the labor is priced and the invoicing okayed.

The numbers of these cards are, of course, transferred to the "Service Record Card" of the individual customer and then filed numerically. These service reports are used for work done in the customer's home. Shop work is cared for by a tag which is attached to each article as it is brought in either by the customer or the service department. Information as to the equipment and trouble is filled in on the front and the record of work done by the service department goes on the back.

Advertising Methods

The advertising budget is set at 5 per cent. of the estimated sales. Originally started with newspapers and direct mail it has been expanded to include billboards. Ordinarily the mat service of manufacturers is used but slight changes have been found advisable from time to time because of local conditions. A daily advertisement is changed monthly.

The direct-mail phases of the company's activities are divided into five general classifications:

1. Manufacturers' campaigns (with space for Whitaker's imprint)
2. Store Introductory Series
3. Demonstration Assistances Series.
4. After Trial Series
5. Monthly Series for Customers.

Each of the above fills its own particular place. The first three are in reality part of the sales campaign.

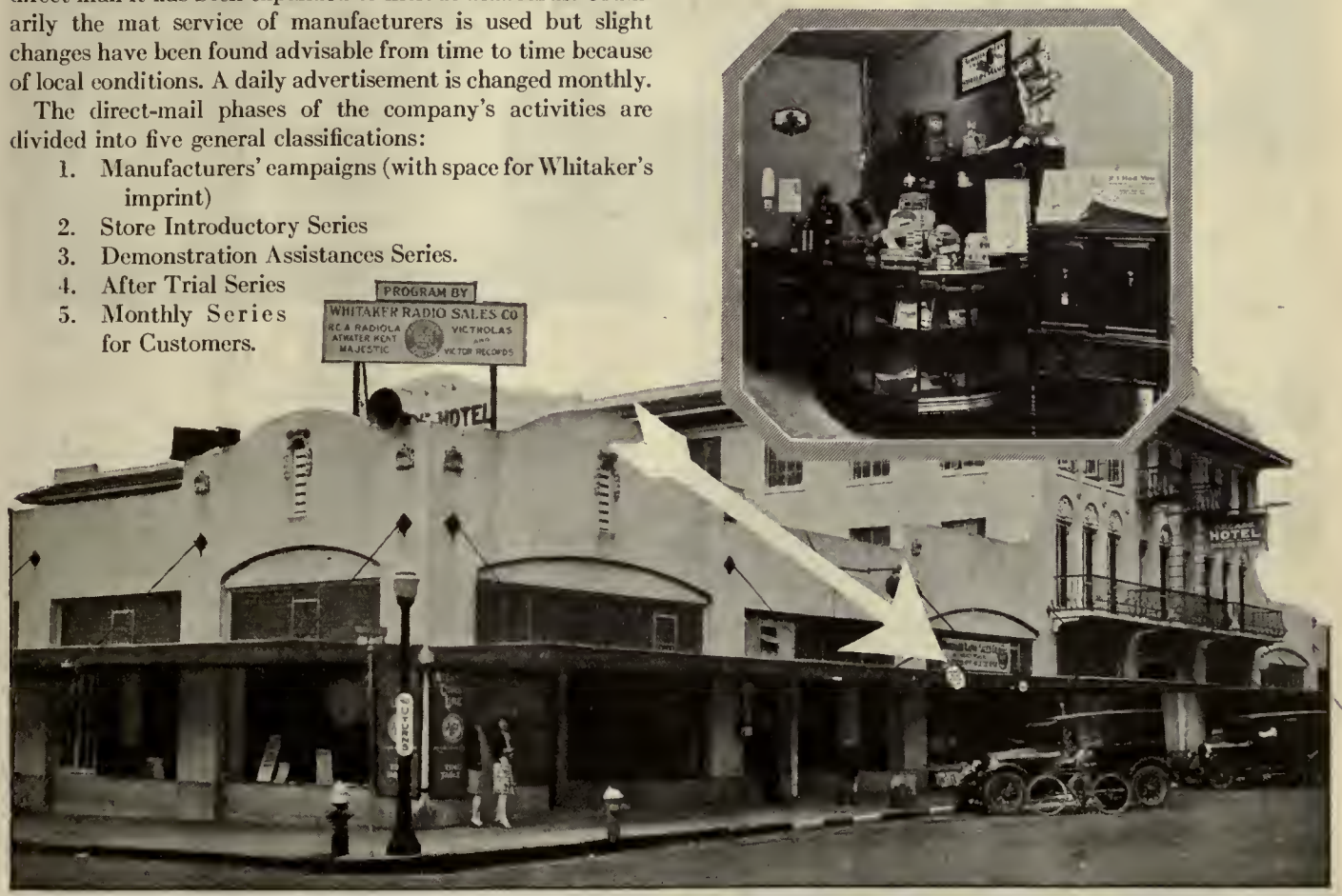
Manufacturer's campaigns are sent to a general list of prospects. These are usually charged with selling copy appropriate for particular seasons such as Easter, Christmas, Inauguration, etc. Whitaker finds them generally effective *if* they are followed up. The store introductory series is sent to active prospects, people whom Whitaker has reason to believe are about ready to buy. There are five letters in this series and they are mailed at three-day intervals. They serve to pave the way for the salesman when he calls.

When a demonstration is secured the Demonstration Assistance Series is brought into play. Again five letters are used, one each day, or until the sale is closed.

When the Sale Is Made

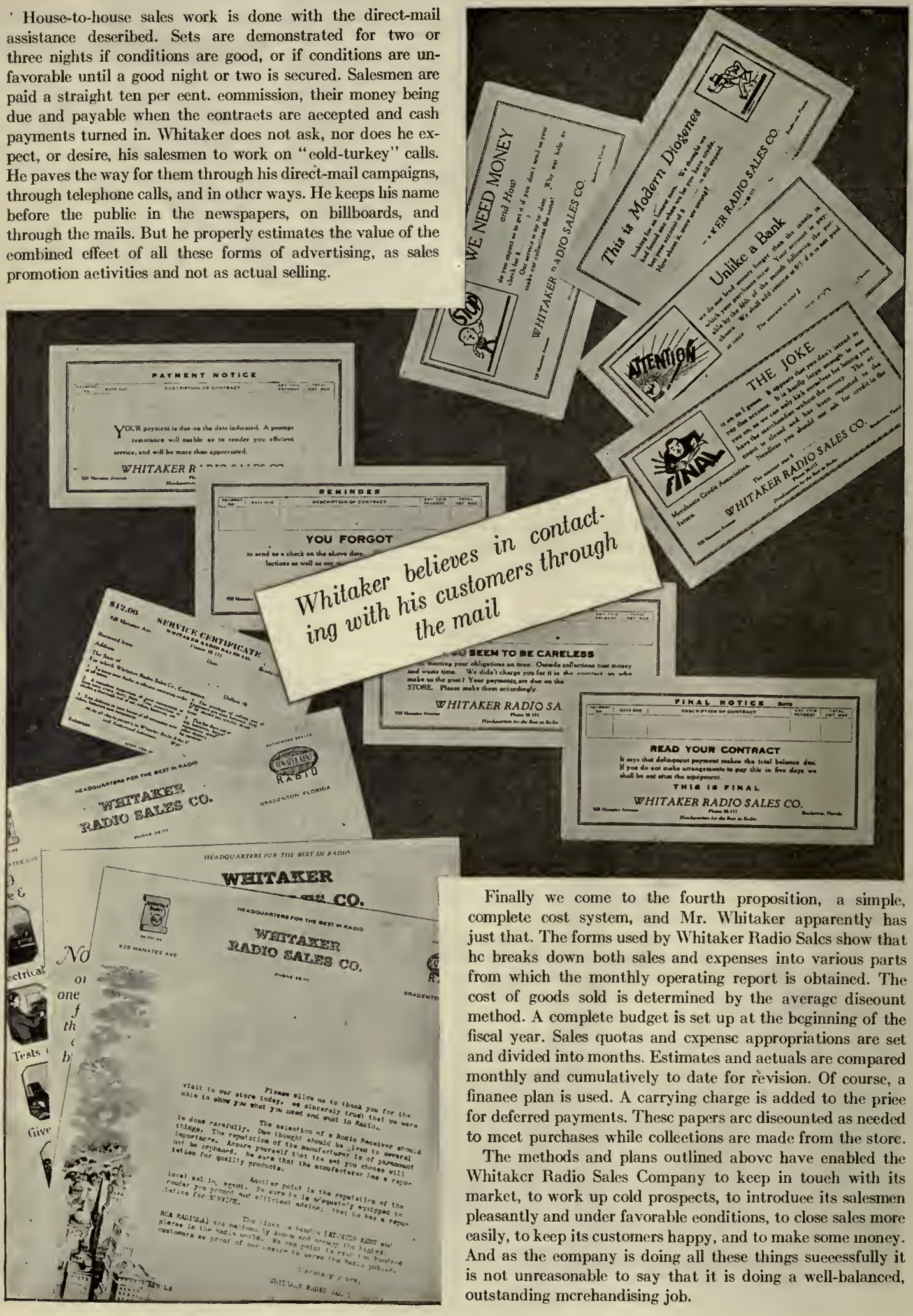
When the sale is finally made the salesman turns in the order, payment-papers, and check for the first payment. The sale is invoiced and confirmation sent to the customer together with the first of the "After Sales Series" of letters. In the case of deferred-payment customers a copy of the contract is attached to a special letter which further impress the necessity of prompt payments.

A week after the set has been installed a letter is sent with a return postal asking for the names of friends who might be interested. Near the end of the sixty-day guarantee period another letter is sent along with two return postals, one for use in case the customer wishes to avail himself of a yearly service contract and the other to permit him to register a complaint in case any trouble has developed with the set. With the advent of the house-current set, which has reduced so greatly the service problem, the yearly service contract is not being stressed as much as it was a year or so ago.



View of Whitaker's store, which is located in the heart of the business district of Bradentown, Fla. Insert shows display counter.

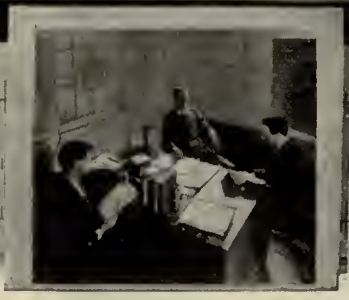
House-to-house sales work is done with the direct-mail assistance described. Sets are demonstrated for two or three nights if conditions are good, or if conditions are unfavorable until a good night or two is secured. Salesmen are paid a straight ten per cent. commission, their money being due and payable when the contracts are accepted and cash payments turned in. Whitaker does not ask, nor does he expect, or desire, his salesmen to work on "cold-turkey" calls. He paves the way for them through his direct-mail campaigns, through telephone calls, and in other ways. He keeps his name before the public in the newspapers, on billboards, and through the mails. But he properly estimates the value of the combined effect of all these forms of advertising, as sales promotion activities and not as actual selling.



Finally we come to the fourth proposition, a simple, complete cost system, and Mr. Whitaker apparently has just that. The forms used by Whitaker Radio Sales show that he breaks down both sales and expenses into various parts from which the monthly operating report is obtained. The cost of goods sold is determined by the average discount method. A complete budget is set up at the beginning of the fiscal year. Sales quotas and expense appropriations are set and divided into months. Estimates and actuals are compared monthly and cumulatively to date for revision. Of course, a finance plan is used. A carrying charge is added to the price for deferred payments. These papers are discounted as needed to meet purchases while collections are made from the store.

The methods and plans outlined above have enabled the Whitaker Radio Sales Company to keep in touch with its market, to work up cold prospects, to introduce its salesmen pleasantly and under favorable conditions, to close sales more easily, to keep its customers happy, and to make some money. And as the company is doing all these things successfully it is not unreasonable to say that it is doing a well-balanced, outstanding merchandising job.

PROFESSIONALLY SPEAKING



MORE TUBE RESEARCH NEEDED

APPARENTLY THERE must always be some weak link in the broadcast chain. Flushed with pride at what radio engineers had done—as evidenced by the Trade Show—we asked a well-known design engineer what he considered the *protem* major technical problem facing the radio industry. He came back with no hesitation, "Tubes!"

According to this engineer, tubes are lamentably short on life, and long on gas. Tube manufacturers are long on self confidence and short on money for research. A tube manufacturer will willingly pay a super salesman ten per cent. to sell the tubes, but will not pay a research department or consulting engineer five per cent. to make better tubes.

It is true that tubes have changed, but these changes are toward new kinds of tubes, or the same tubes at lower prices. What is desired is a better tube at the same price, or one that costs more but lasts longer.

The Western Electric company has developed tubes that last 20,000 hours. It is true that they cost plenty of good money, and that a set that stays in a consumer's house for 20,000 hours is an exception. But it does seem reasonable that tubes could be made for radio reception that would last longer without going gassy or losing emission.

It is true that few tube manufacturers have installed laboratories or research staff, or have been willing to do anything but copy what someone else has developed. This is a rather serious arraignment against the tube industry, and is probably due to the uncertainty of its patent structure, or to the fact that it was easy to make tubes of a sort, or to the fact that tubes of practically any life and characteristics could be sold.

It seems to us that tube manufacturers will have to do some fundamental research into filaments, metals or elements, the glass wall, methods of exhaust, and bombardment—with the thought in mind that, while the electrical characteristics or present tubes are probably as good as necessary, their life is poor.

It reminds us of the story of an automobile manufacturer who made such a cheap car that it failed prematurely—or whatever it is cars do. Sales began to fall off, public enthusiasm began to wane. The solution was to put the profits from the car back into the car itself—not to decrease the price, but to make the car better. Sales began to climb, public confidence came back, proving again that you cannot sell a poor product, no matter how little it costs.

REGARDING HIGH QUALITY

STATEMENTS OF receiving set manufacturers that 1929 receivers will be more selective than those made a year ago, have already stirred up pleasant dreams in the minds of those who play with frequency assignments. If sets are more selective, why not cut down the frequency band each transmitter can occupy—say to 8000 cycles instead of 10,000 cycles—and, with new selectivity, have the situation that we enjoy (?) now?

Rumor has it that suggestions have already been made to reduce the channel width to 4000 cycles each side of the carrier. Now let us look at this suggestion seriously. This would mean that receiving sets would not deliver to a loud speaker any audio tone above 4000 cycles, just as at present they are not expected to transmit anything above 5000 cycles. The disadvantage would be that the user would get poorer fidelity.

But would they? Is it not a fact that the majority of listeners prefer reception with a minimum of noise, and hiss, and other forms of unwanted racket? Is it not a fact that the general public is not at all critical about fidelity so long as there is plenty of bass? Is it not a fact that the majority of receivers have audio-frequency amplifiers or filters which cut off above about 3500 cycles? Is it not a fact that the efforts of a well-known receiver manufacturer to produce the best fidelity possible a year or so ago failed because of too much high-note reception, and that after many sets of this type came back, a filter was put into the audio system that put its audio amplifier back into the class of those a year before?

We believe all of these things are facts, and we deplore them. We believe that the frequency range of receivers should be broadened, not reduced, that the number of stations should be

(*Continued on page 242*)

clippings

A. ATWATER KENT: "I like a game which puts me on my mettle, which makes me keep my wits about me, which forces me to meet and beat new problems. . . . You can't go stale in radio without going bankrupt, because the other fellow will pass you."

D. H. KELLEY, president, U. S. L. Battery Corporation: "If a concern is making a net profit of 10 per cent. it is better for them to lose ten sales than to be stuck with one finished article on hand. This is a case of simple mathematics, but it is overlooked so frequently."

R. H. WOODFORD, radio sales manager, Stewart-Warner: "Radio sales for 1929 will increase 20 to 25 per cent. Our radio production this year will be quadrupled."

GEORGE M. STUDEBAKER, Colin B. Kennedy: "The point of saturation in the radio field is not in sight, radio, to my mind, being in the same position as the automotive industry was fifteen years ago. . . . Radio reaches the popular fancy to an even greater extent than the automobile."

PRINTERS' INK: "There will be a place for the good specialty jobber for some years to come. He still performs economically a service which the usual manufacturer can't perform for himself except at a high cost."

Showing Extent to Which Leading Producers Assemble Sets

WHAT MANUFACTURERS MAKE AND BUY

RADIO RECEIVER manufacturers will make in their own plants approximately 62 per cent. of the parts they require for use in their 1929–30 receivers. The remainder, or 38 per cent. of the parts, will be purchased from outside companies. All the manufacturers will build their own r. f. tuning coils and practically all of them will build or assemble their own audio and power transformers and filter choke coils. The parts which are generally purchased from outside companies are fixed and variable condensers, fixed and variable resistors, and cabinets.

These are some of the conclusions determined from a survey made recently by RADIO BROADCAST among prominent set manufacturers. Requests for the necessary data were sent to a list of 26 of the largest manufacturers, and, at the time of this writing, replies have been received from 14. The manufacturers who have replied are listed in this article. The list includes many of the largest and probably they will account for the sale of at least 75 per cent. of all the sets to be sold during the coming season.

In gathering the data for this survey it was decided to concentrate on 17 different classifications of parts, it having been found that practically every piece of apparatus that is ordinarily employed in radio receiver construction would fall into one of these groups. The various classifications of parts are given in Table 1. The survey indicated wide variations in the practices of different companies. For example, one manufacturer makes 89 per cent. of all his parts and another prominent company makes only 6 per cent. of the parts, purchasing 94 per cent.

It should be understood that the references in the preceding paragraphs to parts "made by the manufacturer" means simply that the manufacturer does not buy the completed device, although he probably does buy the various components used in the particular part. For example, a manufacturer may not buy a complete audio transformer, but will purchase the coils and laminations and then assemble the transformer, from these parts, in his own plant.

Table 1 gives a complete tabulation of the 14 replies received, indicating by an "x" in each case which parts are purchased and which are manufactured. In some cases it will be noted that an "x" appears under both headings, purchased and manufactured. The parts in which this double classification appears most frequently are fixed resistors and cabinets. This probably means that many companies make the various small fixed resistors required in the set but

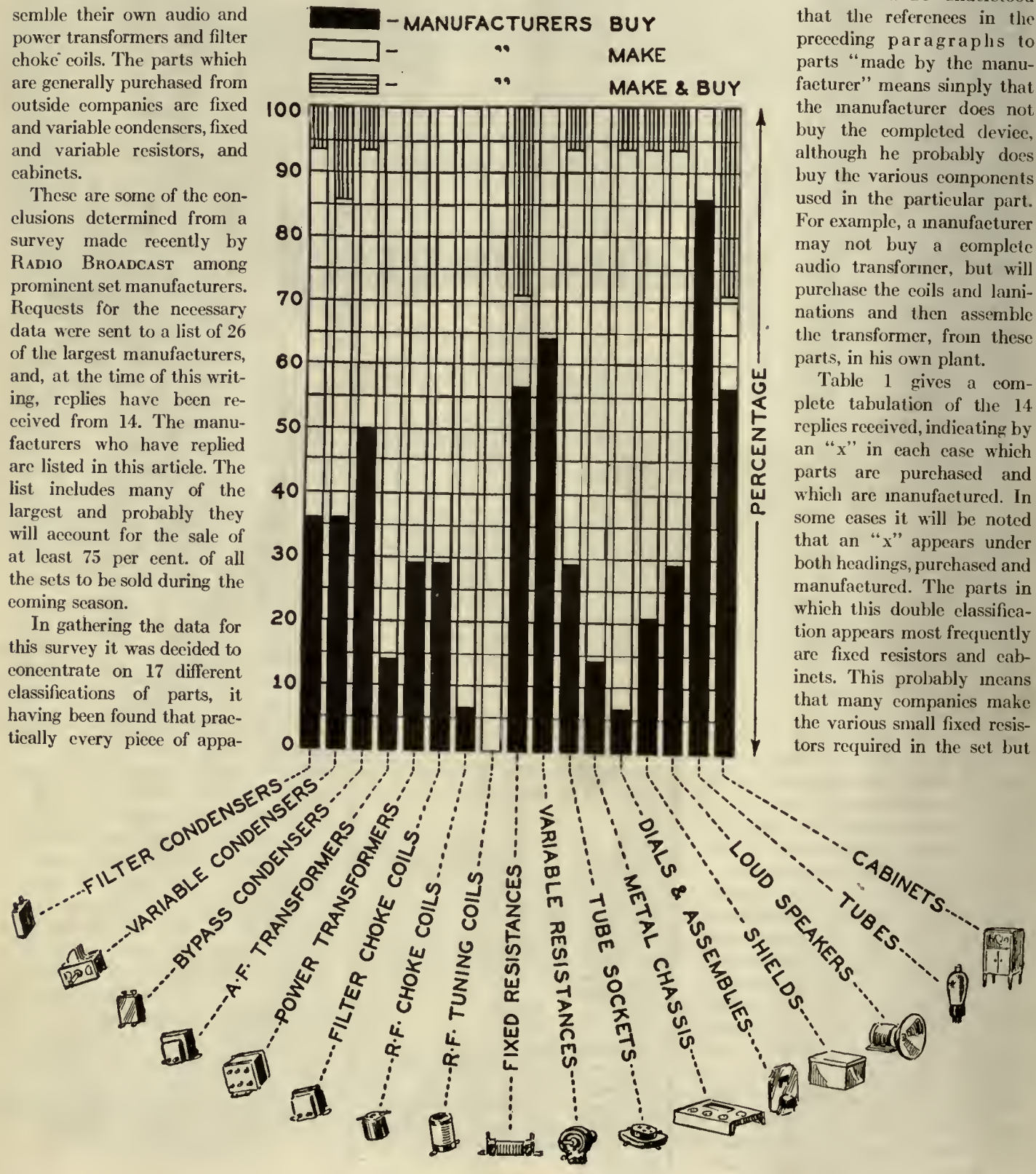


Table I—Tabulation of Parts Made and Purchased by Manufacturers Covered by Survey

Manufacturer →	1		2		3		4		5		6		7		8		9		10		11		12		13		14	
Part ↓	Purchase	Make	Purchase	Make	Purchase	Make	Purchase	Make	Purchase	Make	Purchase	Make	Purchase	Make	Purchase	Make	Purchase	Make	Purchase	Make	Purchase	Make	Purchase	Make	Purchase	Make	Purchase	Make
Filter Condensers	x		x			x	x	x		x		x		x		x	x			x	x			x		x	x	
Variable Condensers	x	x	x			x		x	x	x	x			x	x		x		x			x		x		x		x
By-pass Condensers	x		x		x			x		x		x		x		x	x		x		x			x	x	x	x	
A. F. Transformers		x	x			x		x		x		x	x			x		x		x		x		x		x		x
Power Transformers		x	x			x	x			x		x	x		x			x		x		x		x		x		x
Filter Choke Coils		x	x			x	x			x		x	x			x		x	x			x		x		x		x
R. F. Choke Coils		x	x			x		x		x		x		x		x		x		x		x		x		x		x
R. F. Tuning Coils		x		x		x		x		x		x		x		x		x		x		x		x		x		x
Fixed Resistances	x		x		x	x	x	x	x	x	x		x	x	x		x		x		x			x	x			x
Variable Resistances	x		x		x		x		x			x	x		x			x	x		x			x				x
Tube Sockets	x		x		x			x		x		x		x		x	x			x		x		x	x	x		x
Metal Chassis		x	x			x		x		x		x		x		x		x		x		x		x		x	x	
Dials and Assemblies		x	x			x		x	x	x		x		x		x		x		x		x		x		x		x
Shields		x	x			x		x		x		x	x	x		x		x	x			x		x		x	x	
Loud Speakers		x	x			x	x			x	x	x		x		x	x		x			x		x		x		x
Tubes	x		x			x		x	x		x		x		x		x		x		x		x		x		x	
Cabinets	x		x			x	x		x		x		x	x	x	x	x		x			x	x	x	x		x	x
Total	8	10	16	1	4	14	7	12	6	14	5	13	8	12	6	12	8	9	9	8	5	12	2	16	5	14	6	12

purehase from outside companies the large high-wattage resistors sueh as the output voltage divider in the plate-supply unit. Many manufaeturers evidently make their own metal eabinets but purehase the wooden eabinets.

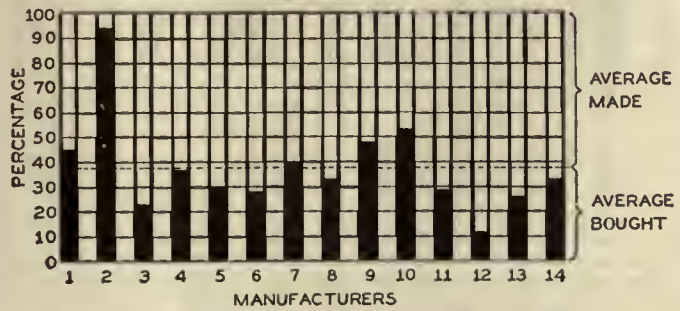
The totals at the bottom of Table I show the number of parts the various companies purehase and make. In Table II these totals have been converted into pereentages. Table II, therefore, shows the pereentage of parts purehased and the pereentage of parts made in the ease of eaeh manufaeturer. From these figures we arrive at the average pereentages given at the bottom of Table II.

Table III gives the pereentage of manufaeturers who either purehase or buy the various parts, indieating thereby whieh parts are most generally made and whieh are generally purehased. For example, filter condensers are purehased by 36 per cent., made by 57 per eent., and partially made and partially purehased by 7 per cent. Dials are made by 86 per eent. of the manufacturers, only 7 per eent. purehased all their requirements of this item from the outside, and 7 per eent. make somc dials and purehase the remainder of their requirements. To indicate in numerieal order those parts most generally made by manufaeturers we

(*Continued on page 238*)

Table II

Manufacturer	Percentage of Parts *Bought*	*Made*
1	45	55
2	94	6
3	22	78
4	37	63
5	30	70
6	28	72
7	40	60
8	33	67
9	47	53
10	53	47
11	29	71
12	11	89
13	26	74
14	33	67
Average	38	62



The data of Table II in graph form. Black bars indicate percentage of parts bought.

Table III

	Percentage of Manufactures who *Purchase the part*	*Make the part*	*Both purchase and make the part*
Filter Condensers	36	57	7
Variable Condensers	36	50	14
By-pass Condensers	50	43	7
A. F. Transformers	14	86	0
Power Transformers	29	71	0
Filter Choke Coils	29	71	0
R. F. Choke Coils	7	93	0
R. F. Tuning Coils	0	100	0
Fixed Resistances	57	14	29
Variable Resistances	64	36	0
Tube Sockets	29	64	7
Metal Chassis	14	86	0
Dials and Assemblies	7	86	7
Shields	21	71	7
Loud Speakers	29	64	7
Tubes	86	14	0
Cabinets	57	14	29

Table IV

Part	*Percentage of Mfrs. who make them*
R. F. Tuning Coils	100
R. F. Choke Coils	93
Metal Chassis	86
Dials and Assemblies	86
A. F. Transformers	86
Power Transformers	71
Filter Chokes	71
Shields	71
Tube Sockets	64
Loud Speakers	64
Filter Condensers	57
Variable Condensers	50
By-pass Condensers	43
Variable Resistors	36
Fixed Resistors	14
Tubes	14
Cabinets	14

ANALYZING THE 1928–29 RADIO SURVEY

By T. A. PHILLIPS

Manager, Research Division, Doubleday, Doran & Co., Inc.



T. A. Phillips

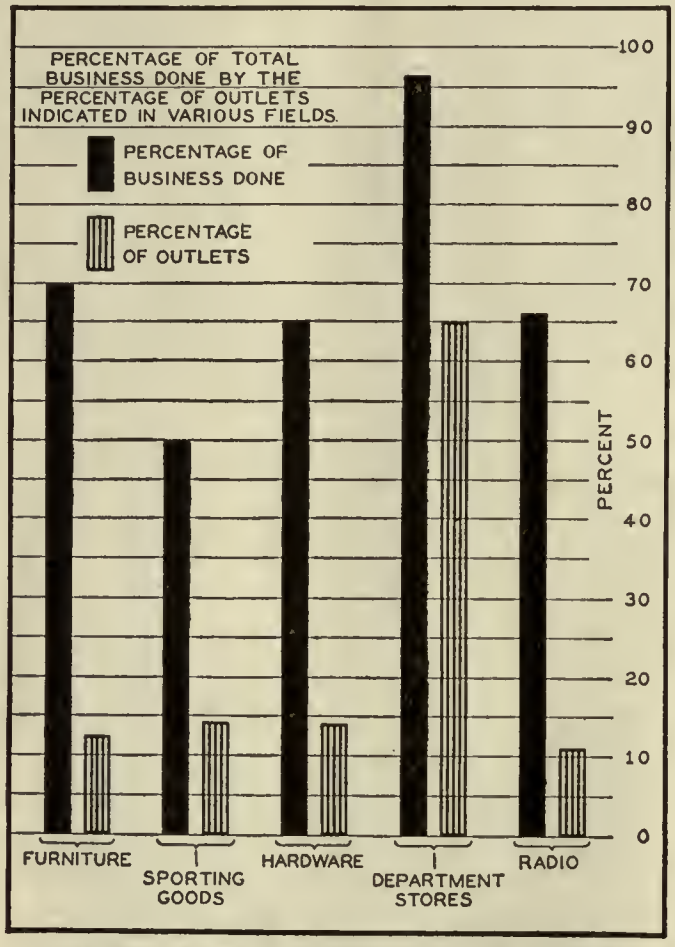
THIS is the second of a series of articles analyzing the quarterly radio surveys made by the Bureau of Foreign and Domestic Commeree with the assistanee and eoöperation of the National Eleetrical Manufacturers Association.

It is an old axiom that the rich get rieher and the poor get poorer. To the casual observers it has seemed that the large radio dealer with his huge yearly volume is eonstantly increasing his sales and forcing his smaller eompetitor to the wall. There is good precedent for this. Twelve per cent. of all furniture dealers do 70 per cent. of the furniture business; 14 per eent of all sporting goods stores do 50 per eent. of the total sporting goods business; 14 per cent. of all hardware stores do 65 per cent. of the hardware business. Department stores having a gross volume in exeess of $1,000,000 a year do 95 per cent. of the department store business.

A elose study of the distribution of business done by radio dealers, as reported by the Department of Commerce, should gladden the hearts of the average radio retailer whose gross sales do not exceed $20,000 a year. It is very apparent that the narrowing of the margin of differenees in merit and prices between the products of various radio manufaeturers has made for a much more general distribution of sales among dealers of all sales volume classifications.

The dealers selling more than $100,000 a year are still obtaining the larger share of total sales. However, the number of dealers doing this volume is deereasing. What is more important is the fact that the smaller dealer in proportion to his sales volume is getting a greater share of the business.

To illustrate with a hypothetical case: there are five dealers in a certain community each having a yearly sales volume of $100,000. One of them drops out, leaving $100,000 in sales for someone. If each of the other four dealers absorbed all the business of the dealer who dropped out, they would each increase their sales $25,000. What is actually happening is that the four large volume dealers are getting only part of the surplus business and that the remainder is being distributed among all the dealers down the line who do not do a business of $100,000 a year.



This chart shows how the retail radio business compares with retailing in other industries. In each case it indicates that a few large dealers handle more than fifty per cent. of the retail business. The department stores indicated are those having a gross volume in excess of $1,000,000 a year.

The lesson to be drawn from this condition of affairs is obvious: Mr. X who has decided to buy a radio set is not influenced nearly as greatly by the size of the radio store he will patronize as he is by the merchandising methods used to sell him. *Good merchandising is not the offspring, but the father of the large volume dealer.*

An examination of the Tables I and II shows definitely the trend toward an increasing number of dealers in the smaller sales volume classifications as well as a smaller percentage of total sales done by the large volume dealers. Naturally the number of dealers doing $100,000 a year is greater than the number doing $100,000 for any particular quarter. In order to determine whether or not sales have been distributed equally in proportion to a dealer's sales volume it becomes necessary to reduce the figures to a common base. We do so by determining the amount of business each individual

TABLE I

PERCENT OF TOTAL NUMBER OF DEALERS IN GROUPS ACCORDING TO LIMITS OF BUSINESS DONE

Limits of Business Done	*1928*	*Last Quarter 1928*	*First Quarter 1929*
Under $1,000	20.82%	30.81%	46.31%
1,000 to 4,999	42.05	45.02	38.05
5,000 to 9,999	16.22	12.34	8.89
10,000 to 19,999	9.57	6.77	4.14
20,000 to 49,999	7.70	3.71	2.00
50,000 to 99,999	2.16	.93	.43
100,000 and up	1.48	.42	.18
	100.00%	100.00%	100.00%

TABLE II

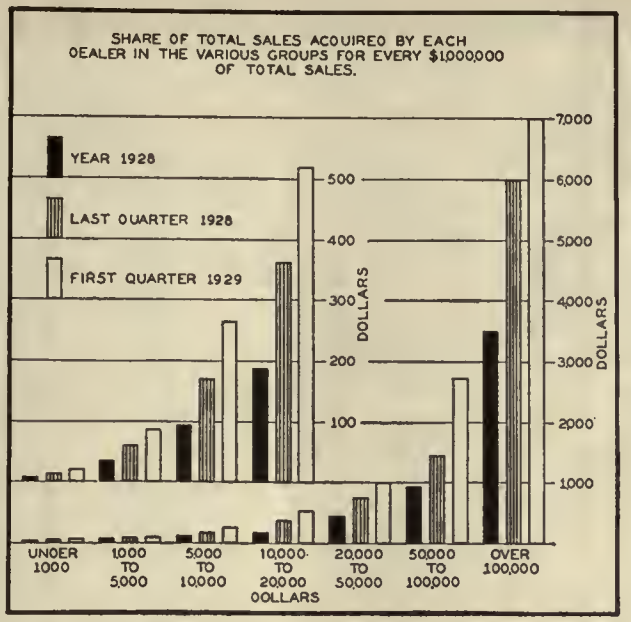
PERCENT OF TOTAL VOLUME DONE BY DEALERS IN EACH GROUP

Limits of Business Done	*1928 per cent.*	*Last quarter 1928*	*First quarter 1929*
Under $1,000	.93%	2.38%	5.61%
1,000 to 4,999	9.90	18.12	24.91
5,000 to 9,999	10.26	14.42	17.90
10,000 to 19,999	11.90	16.06	16.26
20,000 to 49,999	20.95	18.21	16.51
50,000 to 99,999	13.13	11.24	9.01
100,000 and up	32.93	19.57	9.80
	100.00%	100.00%	100.00%

dealer acquired in the various groups, to the total business done. Table III illustrates our point.

TABLE III *reads: 1368 dealers reported a sales volume of $655,308 or an average volume of $479 per dealer. All the dealers reported a total sales volume of $70,877,517.00. Each dealer having a sales volume under $1000 therefore got $6.70 of each million dollars of business reported.*

This analysis shows that the dealers having a volume for the first quarter of 1929 in excess of $100,000 increased their individual proportionate share of business only 98 per cent. over 1928, while the dealers selling from $5000 to $20,000 increased their proportionate share 175 per cent. and 174 per cent., respectively. The slightly above average dealers doing between $50,000 and $100,000 a year show the greatest increase—195 per cent.



The way in which the average dealer of various classifications (grouped according to limits of business done) shares in the total sales of the industry is shown in this chart.

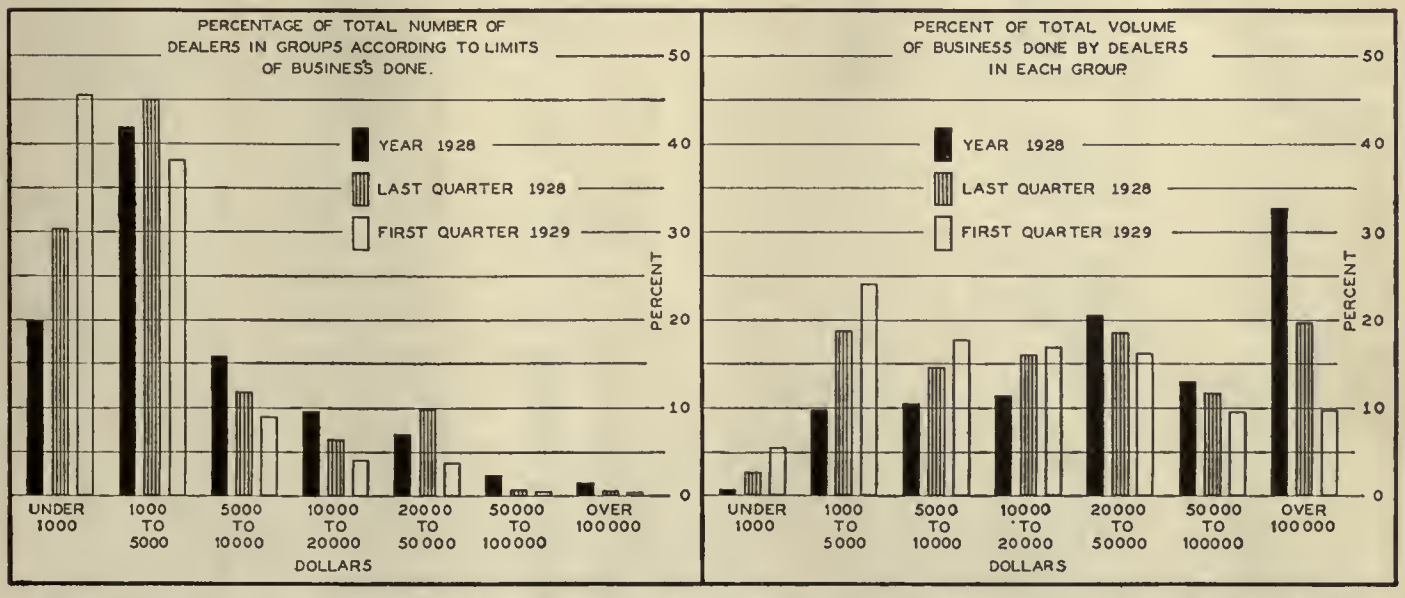
These figures demonstrate, therefore, the soundness of our conclusion at the beginning of this article that the smaller volume dealer is not only increasing in number but is getting a more equitable share of the total business. Sales managers of radio manufacturers should act accordingly.

The smaller radio dealer selling standardized, nationally advertised radio sets is in a position by proper merchandising to compete successfully with his affluent competitor down the street. This survey shows definitely that he is doing just that.

The Bureau of Foreign and Domestic Commerce and National Electrical Manufacturers Association are doing a real service for the radio industry with their quarterly surveys. They deserve the fullest coöperation from every radio retailer receiving a request from them for information. It is well known that government surveys are prepared in such a way that individual firms cannot possibly be identified and radio retailers should not hesitate to coöperate to the fullest extent of their ability.

TABLE III

Limits of Business Done	*No. of Dealers*	*Sales Volume Reported*	*Average Volume per Dealer*	*Each Dealer's share for every $1,000,000 of Sales reported*	*Increase over 1928*
		Year 1928			
Under $1,000	1368	$ 655,308	$ 479	$ 6.70	
1,000 to 5,000	2765	7,009,117	2,534	35.70	
5,000 to 10,000	1066	7,273,779	6,823	96.20	
10,000 to 20,000	629	8,440,406	13,418	189.30	
20,000 to 50,000	506	14,844,306	29,336	413.80	
50,000 to 100,000	142	9,307,050	65,542	9 24.70	
100,000 and over	93	23,347,551	251,048	3,541.90	
TOTAL	6569	$70,877,517	10,800		
		Last Quarter, 1928			
Under $1,000	2023	$ 901,143	$ 445	$ 11.70	74%
1,000 to 5,000	2950	6,877,067	2,331	61.38	71
5000 to 10,000	809	5,478,925	6,772	173.80	81
10,000 to 20,000	445	6,095,173	13,697	360.80	90
20,000 to 50,000	244	6,914,072	28,336	746.10	80
50,000 to 100,000	61	3,270,700	53,618	1,411.90	53
100,000 and over	37	8,437,935	228,051	6,005.20	69
TOTAL	6569	$37,975,015	5,780		
		First Quarter, 1929			
Under $1,000	3511	$ 1,432,029	$ 407	$ 15.90	137%
1,000 to 5,000	2884	6,352,552	2,202	86.20	141
5,000 to 10,000	674	4,563,041	6,770	265.00	175
10,000 to 20,000	314	4,164,852	13,263	519.30	174
20,000 to 50,000	151	4,215,360	27,916	1,010.90	144
50,000 to 100,000	33	2,304,741	69,840	2,734.50	195
100,000 and over	14	2,506,660	179,047	7,010.50	98
TOTAL	7581	$25,539,660	$13,368		



In these charts all radio dealers are grouped according to limits of business done, i.e., under $1000, $1000 to $5000, etc. The chart on the left shows the percentage of the total number of dealers in each of the seven groups and the chart on the right shows how the total business is divided among the dealer groups.

COMPLETE SUMMARY OF NEW RECEIVING SETS

Company	Model	Price	Table or Console	Screen Grid Tubes	Tubes Used
The A-C Dayton Co.	AC-99	$ 98.00	Chassis only	No	
	AC-98	$ 133.00	Table	No	6-227, 2-245, 1-280; Chassis same in all models
	AC-9960	$ 173.50	Console	No	
	AC-9970	$ 190.00	Console	No	
	AC-9980	$ 210.00	Console	No	
	AC-9990	$ 213.00	Console	No	
	AC-99100	$ 292.00	Phonograph-radio	No	
The Aeme Electric & Mfg. Co.	38	$ 139.50	Console	Yes	2-227, 2-245, 1-280, 3-224
	77	$ 99.50	Console	No	5-227, 1-245, 1-280
	79	$ 140.00	Console	Yes	2-224, 2-245, 2-227, 1-280
All-American Mohawk Corp.	93	$ 169.50	Console	No	7-227, 2-245, 1-280
	95	$ 199.50	Console	No	7-227, 2-245, 1-280
	SG-1	$ 184.50	Console	Yes	3-224, 2-227, 2-245, 1-280
American Bosch Magneto Corp.	48	$ 119.50	Table	Yes	
	48-A	$ 168.50	Console	Yes	3-BY 224; 1-BY 227; 2-BX245; 1-BX280 Same in all models
	48-J	$ 240.00	Console	Yes	
	48-17	$ 230.00	Console	Yes	
	48-18	$ 240.00	Console	Yes	
	48-L	$ 230.00	Console	Yes	
	48-R	$ 280.00	Console	Yes	
	48-19	$ 280.00	Console	Yes	
Amrad Corp.	Aria	$ 198.00	Console	Yes	2-227, 3-224, 2-245, 1-280; Same in all models
	Serenata	$ 245.00	Console	Yes	
	Symphony	$ 295.00	Console	Yes	
	Duet	$ 495.00	Phonograph-radio	Yes	
F. A. D. Andrea, Inc.	20	$ 99.50	Table	No	5-227, 2-171A, 1-280
	25	$ 165.00	Console	Yes	4-227, 1-224, 2-245, 1-280
	35	$ 245.00	Console	Yes	2-224, 2-227, 2-245, 1-281
	75	$ 360.00	Console	Yes	3-224, 2-227, 2-210, 1-281
	77	$ 675.00	Phono-radio	Yes	3-224, 2-227, 2-210, 1-281
	18	$ 120.00	Table	No	5-112A, 2-171-A
Associated Radio Mfrs., Inc.	1	$ 165.00	Console	Yes	2-224, 2-227, 2-245, 1-280; Same in all models
	10	$ 149.50	Console	Yes	
	20	$ 137.50	Console	Yes	
	30	$ 126.50	Console	Yes	
	40	$ 99.50	Console	Yes	
Atwater Kent Mfg. Co.	55	$ 88.00	Table	Yes	2-224, 2-227, 2-245, 1-280
	60	$ 100.00	Table	Yes	3-224, 2-227, 2-245, 1-280
	61	$ 88.00	Table	Yes	3-222, 2-112A, 2-271A
	67	$ 77.00	Table	Yes	3-222, 2-112A, 2-271A
Audiola Radio Co.	7330	$ 85.00	Table	Yes	2-224, 2-227, 2-245, 1-280
	8430	$ 95.00	Table	No	5-227, 2-245, 1-280
Balkeit Radio Co.	C	$ 175.00	Console	No	6-227, 2-245, 1-280
Brandes Radio Corp.	B 15	$ 125.50	Console	No	5-227, 2-245, 1-280
	B 16	$ 165.00	Console	No	5-227, 2-245, 1-280
	B 10	$ 85.00	Table	No	5-227, 1-171A, 1-280
Buckingham Radio Corp.	1	$ 119.50	Console	No	5-227; 2-245; 2-280
	2	$ 129.50	Console	No	Same in all models
	3	$ 142.50	Console	No	
	4	$ 69.50	Table	No	
Bush & Lane Piano Co.	30	$ 169.50	Console	Yes	5-227, 2-245, 1-280
	32	$ 179.50	Console	Yes	2-245. 1-280, 1-227, 3-224
	34	$ 187.50	Console	Yes	Either one of above chassis ia all models
	40	$ 179.50	Console	Yes	
	50	$ 197.50	Console	Yes	
	60	$ 199.50	Console	Yes	
	70	$ 207.50	Console	Yes	
	90	$ 217.50	Console	Yes	
	21	$ 169.50	Console	Yes	
	12 C	$ 297.50	Phono-radio	Yes	
	20	$ 125.00	Table	Yes	
Colonial Radio Corp.	32 Cavalier	$ 235.00	Console	Yes	4-224, 1-227, 2-245, 1-280; Same for all models
	32 Picadilly	$ 235.00	Console	Yes	
	32 Modern	$ 270.00	Console	Yes	

Company	Model	Price	Table or Console	Screen Grid Tubes	Tubes Used
Columbia Phonograph Co.	C 11	$ 179.50	Console	No	5-227, 2-245, 1-280; Same for all models
	940	$ 297.50	Phono-radio	No	
Continental Radio Corp.	R 20	$ 435.00	Console	No	7-227, 2-250, 2-281; Same for all models
	R 25	$ 475.00	Console	No	
	R 30	$ 525.00	Console	No	
	RP-40	$ 725.00	Phono-radio	No	
	R 105	$1600.00	Console	No	
	RP 115	$1800.00	Phono-radio	No	
Crosley Radio Corp.	21	$ 49.00	Table	Yes	3-222; 2-201A; 1-171A
	22	$ 88.50	Console	Yes	3-222; 2-201A; 1-171A
	31	$ 55.00	Table	No	4-226; 1-227; 1-171A; 1-280
	32	$ 99.50	Console	No	4-226; 1-227; 1-171A; 1-280
	41	$ 70.00	Console	No	4-226; 1-227; 2-171A; 1-280
	41 A	$ 70.00	Table	No	4-226; 1-227; 1-171A; 1-280
	42	$ 125.00	Console	No	4-226; 1-227; 2-171A; 1-280
	40 S	$ 80.00	Console	Yes	3-224; 2-227; 2-245; 1-280
	41 S	$ 85.00	Table	Yes	3-224; 2-227; 2-245; 1-280
	42 S	$ 140.00	Console	Yes	3-224; 2-227; 2-245; 1-280
	32 S	$ 160.00	Console	Yes	3-224; 2-227; 2-245; 1-280
	82 H	$ 150.00	Console	Yes	3-224; 2-227; 2-245; 1-280
	61	$ 85.00	Table	No	5-201A; 3-171A
	62	$ 135.00	Console	No	5-201A; 3-171A
	83	$ 155.00	Console	No	5-201A; 3-171A
Day-Fan Electric Co.	66	$ 115.00	Table	No	5-226, 2-245, 1-280, 1-227
	68	$ 169.50	Console	No	5-226, 2-245, 1-280, 1-227
	72	$ 175.00	Console	No	5-226, 2-245, 1-280, 1-227
	69	$ 225.00	Console	No	5-226, 2-245, 1-280, 1-227
	73	$ 65.00	Table	No	6-201A, 1-112A
	74	$ 119.50	Console	No	6-201A, 1-112A
Thomas A. Edison Inc.	R 2	$ 225.00	Console	No	1-227, 4-226, 1-250, 1-281
	R 1	$ 260.00	Console	No	1-227, 4-226, 1-250, 1-281
	C 2	$ 395.00	Phono-radio	No	1-227, 4-226, 1-25), 1-281
	C 1	$1100.00	Phono-radio	No	1-227, 4-226, 2-250, 2-281
	R 5	$ 167.50	Console	No	5-227, 2-245, 1-280
	R 4	$ 197.50	Console	No	5-227, 2-245, 1-280
	C 4	$ 295.00	Phono-radio	No	5-227, 2-245, 1-280
Electrical Research Lab.	C 5 F	$ 119.50	Console	No	4-226, 1-227, 2-171, 1-280
	C 4 F	$ 189.50	Phono-radio	No	4-226, 1-227, 2-171, 1-280
	30	$ 165.00	Console	Yes	3-224, 2-227, 2-245, 1-280
	31	$ 147.00	Console	Yes	3-224, 2-227, 2-245, 1-280
	32	$ 165.00	Console	Yes	3-224, 2-227, 2-245, 1-280
	33		Phono-radio	Yes	3-224, 2-227, 2-245, 1-280
Federal Radio Corp.	M 41	$ 295.00	Console	No	5-227, 2-245, 1-280
	M 46	$ 295.00	Console	No	5-227, 2-245, 1-280
	M 10	$ 175.00	Table	No	5-227, 2-245, 1-280
	E 10	$ 95.00	Table	No	4-201A, 1-112A, 171A, Raytheon BA
	M 36	$ 245.00	Console	No	5-227, 2-245, 1-280
	L 36	$ 149.50	Console	Yes	3-224, 2-227, 2-245, 1-280
	L 46	$ 179.50	Console	Yes	3-224, 2-227, 2-245, 1-280
Freed-Eisemann Radio Corp.	55	$ 99.50	Console	No	2-227, 3-226, 2-171A, 1-280
	78	$ 145.00	Console	No	5-227, 2-245, 1-280
	79	$ 172.50	Console	No	5-227, 2-245, 1-280
	95	$ 225.00	Console	No	6-227, 2-245, 1-280
	56	$ 75.00	Table	No	2-227, 3-226, 2-171A, 1-280
	53	$ 55.00	Table	No	5-201A, 2-171A

EXHIBITED AT THE CHICAGO RADIO TRADE SHOW

Company	Model	Price	Table or Console	Screen Grid Tubes	Tubes Used
C. A. Earl Radio a division of Chas. Freshman Co., Inc.	21	$ 92.75	Table	No	2–227, 3–226, 2–271, 1–180
	22	$ 117.25	Console	No	2–227, 3–226, 2–271, 1–180
	31	$ 161.50	Console	No	5–227, 2–245, 1–180
	32	$ 191.50	Console	No	5–227, 2–245, 1–180
	41	$ 250.00	Console	No	6–227, 2–245, 1–180
A. H. Grebe & Co., Inc.	285 A & B	$ 285.00	Console	Yes	3–224, 1–227, 2–245, 1–280;
	270 A, B & C	$ 270.00	Console	Yes	
	219.50 A	$ 219.50	Console	Yes	Same for all models
	450 A	$ 450.00	Phono-radio	Yes	
Grigshy-Grunow Co.	91	$ 137.50	Consnle	No	5-G 27; 2-G 45; 1-G 80
	92	$ 167.50	Console	No	5-G 27; 2-G 45; 1-G 80
	181	$ 265.00	Phono-radio	No	5-G 27; 2-250; 2-281
Gulbransen Co.	291	$ 139.50	Console	Yes	5–226, 1–224, 2–245, 1–280;
	292	$ 149.50	Console	Yes	
	295	$ 159.50	Console	Yes	Same for all models
Howard Radio Co.	Consolette	$ 175.00	Console	No	
	Highboy	$ 199.50	Console	No	5–226, 2–245, 1–227, 1–280;
	Sheraton	$ 235.00	Console	No	
	Hepplewhite	$ 235.00	Console	No	Same for all models
	Louis XVI	$ 255.00	Console	No	
	Florentine	$ 275.00	Console	No	
	Gothic	$ 275.00	Console	No	
Kellogg Switchboard & Supply Co.	523	$ 250.00	Console	Yes	3–224, 3–227, 2–245, 1–280
	524	$ 295.00	Console	Yes	3–224, 3–227, 2–250, 2–281
	525	$ 395.00	Phono-radio	Yes	3–224, 3–227, 2–250, 2–281
Colin B. Kennedy Corp.	210	$ 159.00	Console	No	5–227, 2–245, 1–280
	310	$ 197.00	Console	No	5–227, 2–245, 1–280
	220	$ 159.00	Console	Yes	3–224, 2–227, 1–245, 1–280
	320	$ 197.00	Console	Yes	3–224, 2–227, 1–245, 1–280
King Mfg. Corp.	Imperial	$ 169.50	Console	No	6–227, 2–245, 1–280
	Royal	$ 149.50	Console	No	3–226, 2–227, 2–171, 1–280
Kolster Radio Corp.	K 43	$ 235.00	Console	Yes	3–224, 2–227, 1–280
	K 44	$ 325.00	Console	Yes	2–224, 2–227, 2–281, 2–245
	K 45	$ 500.00	Console	Yes	3–224, 4–227, 2–281, 2–250
	6 D	$ 89.50	Table	No	5–201A, 1–112A
McMillan Radio Corp.	959	$ 159.50	Console	No	5–226, 2–245, 1–227, 1–280;
	965	$ 165.00	Either	No	
	975	$ 175.00	Console	No	Same in all models
	999	$ 199.50	Console	No	
	925	$ 225.00	Console	No	
	935	$ 235.00	Console	No	
	937	$ 237.50	Console	No	
Minerva Radio Co.	1	$ 125.00	Console	No	5–227, 2–245, 1–280; Same in all models
	2	$ 175.00	Console	No	
	3	$ 250.00	Console	No	
	4	$ 350.00	Console	No	
National Carbon Co., Inc.	31	$ 115.00	Table	No	5–227, 2–171, 1–280
	32	$ 175.00	Console	No	5–227, 2–171, 1–280
	33	$ 210.00	Console	No	5–227, 2–171, 1–280
	34	$ 225.00	Console	No	5–227, 2–171, 1–280
	42	$ 180.00	Console	No	5–227, 2–245, 1–280
	43	$ 215.00	Console	No	5–227, 2–245, 1–280
	44	$ 230.00	Console	No	5–227, 2–245, 1–280
	52	$ 185.00	Console	Yes	3–224, 2–227, 1–280
	53	$ 220.00	Console	Yes	3–224, 2–227, 1–280
	54	$ 235.00	Console	Yes	3–224, 2–227, 1–280
Philadelphia Storage Battery Co.	65	$ 67.00	Table	Yes	2–224, 2–245, 1–227, 1–280
	65 Lowboy	$ 119.50	Console	Yes	2–224, 2–245, 1–227, 1–280
	65 Highboy	$ 139.50	Console	Yes	2–224, 2–245, 1–227, 1–280
Philadelphia Storage Battery Co.	65 Highboy DeLuxe	$ 195.00	Console	Yes	2–224, 2–245, 1–227, 1–280
	87 Lowboy	$ 129.50	Console	No	1–227, 1–280, 2–245, 4–226
	87 Highboy	$ 149.50	Console	No	1–227, 1–280, 2–245, 4–226
	87 Highboy DeLuxe	$ 205.00	Console	No	1–227, 1–280, 2–245, 4–226
The Pierson Co.	740	$ 250.00	Cnnsole	Yes	3–224, 2–245, 4–227; Same in all models
	750	$ 300.00	Phono-radio	Yes	
	780	$ 600.00	Console	Yes	
Pioneer Radio Corp.	66	$ 99.50	Console	Yes	
	68	$ 125.00	Console	Yes	1–224, 2–245, 1–227, 3–226, 1–280; Same in all models
	70	$ 135.00	Console	Yes	
	72	$ 150.00	Console	Yes	
	62	$ 77.50	Table	Yes	
Radio-Victor Corp. of Ameriea	33	$ 69.50	Table	No	4–226, 1–227, 1–171A, 1–280
	33	$ 77.50	Console	No	4–226, 1–227, 1–171A, 1–280
	18	$ 95.00	Table	No	4–226, 1–227, 1–171A, 1–280
	44	$ 110.00	Table	Yes	3–224, 1–245, 1–280
	60	$ 147.00	Table	No	7–227, 1–171A, 1–280
	46	$ 179.00	Console	Yes	3–224, 1–245, 1–280
	62	$ 350.00	Console	No	7–227, 1–171A, 1–280
	64	$ 550.00	Console	No	8–227, 1–250, 2–281
Shamrock Mfg. Co.	Console	$ 139.50	Console	Yes	
Silver-Marsball, Inc.	Highboy	$ 195.00	Console	Yes	4–224, 1–227, 2–245 1–280
	Lowboy	$ 160.00	Console	Yes	4–224, 1–227, 2–245 1–280
Sparks-Withington Co.	930	$ 189.50	Console	No	6–484, 2–182, 1–280
	931	$ 179.50	Console	No	6–484, 2–182B, 1–280
	89 A	$ 375.00	Console	No	6–484, 1–250, 2–281
	109	$ 495.00	Console	No	6–484, 2–250, 2–281
	110	$ 395.00	Console	No	6–484, 2–250, 2–226, 2–281
	301	$ 274.50	Console	No	6–484, 2–250, 2–281
	99	$ 875.00	Phono-radio	No	6–484, 2–250, 2–281, 1–226
	101	$ 795.00	Phono-radio	No	6–484, 2–226, 2–250, 2–281
	49	$ 76.00	Table	No	6–686, 2–301B, 1–182
Steinite Radio Co.	40	$ 135.00	Console	No	5–227, 2–245, 1–280
	45	$ 165.00	Console	No	5–227, 2–245, 1–280
	50	$ 185.00	Console	No	5–227, 2–250, 2–281
	60	$ 169.50	Console	No	5–227, 2–245, 1–280
	102	$ 250.00	Phono-radio	No	5–227, 2–245, 1–280
	80	$ 179.50	Console	Yes	3–224, 1–227, 2–245, 1–280
Sterling Mfg. Co.	A-2–60	$ 129.50	Console	Yes	1–224, 4–227, 2–245, 1–280
	B-1–60	$ 187.50	Console	Yes	3–224, 2–227, 2–245, 1–280
Stewart Warner Corp.	901	$ 89.75	Table	No	5–227, 2–245, 1–280
	911	$ 95.25	Table	No	5–227, 2–245, 1–280
	921	$ 97.25	Table	No	5–112, 2–171
	931	$ 72.50	Table	No	5–201, 2–112
	951		Table	Yes	3–224, 2–227, 2–245, 1–280
Story & Clark Piano Co.	1	$ 199.50	Console	Yes	2–245, 2–227, 3–224, 1–280;
	2	$ 249.50	Console	Yes	
	3	$ 299.50	Cnnsole	Yes	Same for all models
Stromberg-Carlson Telephone Mfg. Co.	641	$ 155.00	Table	Yes	3–224, 1–227, 1–245, 1–280
	642	$ 247.50	Console	Yes	3–224, 1–227, 1–245, 1–280
	846	$ 347.50	Console	Yes	3–224, 3–227, 2–245, 2–280
Temple Corp.	860	$ 149.00	Console	No	6–227, 2–245, 1–280; Same for all models
	880	$ 189.00	Console	No	
	890	$ 289.00	Phono-radio	No	

(*Continued on page 242*)

MERCHANDISING SCREEN-GRID RECEIVERS

AMERICAN BOSCH MAGNETO CORP.



F. Goodman

FRANK W. GOODMAN, General Sales Manager, Radio Division: The merchandising of screen-grid radio receivers will largely take care of itself. Like any other major improvement in any commodity, the public becomes conscious of it almost as quickly as the trade. The introduction of screen-grid sets may be compared readily to the introduction of balloon tires on automobiles. It took no particular effort on the part of the automobile dealer to merchandise balloon-tired cars; the public was eager for them and recognized the advantages almost instantly. In the same manner, the public will recognize the advantages of screen-grid radio receivers, and will buy more readily because a lower investment is necessary.

The most important factor in merchandising screen-grid radio receivers is, from the viewpoint of the dealer, "which screen-grid set shall I sell"—and from the customer's viewpoint, "which screen-grid receiver is best for me to buy."

There will be a large number of screen-grid receivers available this year. However, any well-versed radio engineer will explain without hesitancy that the screen-grid tube is ticklish until properly mastered. The introduction of one or two screen-grid tubes in a radio set is not the answer to this year's problem. A radio receiver must be engineered carefully from the ground up in order to obtain all the advantages of the screen-grid tube and at the same time avoid the pitfalls.



F. A. D. Andrea

To turn again to the automobile industry, in the first season of balloon tires, many manufacturers placed these tires on cars then in production in order to meet quickly the public's demand. As a result many disadvantages were evident because proper clearances were not available in existing models, turning radii were too great, etc. On the other hand, those manufacturers who properly designed their models to secure the full advantage of balloon tires were successful, their dealers made money, and the public was satisfied. Those manufacturers who have carefully engineered their screen-grid receivers this year will also be successful, their dealers will have a profitable business, and the customers will be well pleased. The public will quickly seek out the well-designed receivers and will obtain performance such as they have never had before.

F. A. D. ANDREA, INC. (FADA)

FRANK A. D. ANDREA, President: Radio receivers using screen-grid tubes really speak for themselves. Therefore, merchandising is best linked up with actual demonstrations. No dealer can fail to become personally enthusiastic over the performance of the best new receivers, and he should pass that enthusiasm along. It is more of a paramount factor in sales success than ever before—in overcoming competitive pleas and promises.

Dealers should precede the demonstration of a receiver with an analysis of the advantages accruing from the use of these tubes. To do that the dealer must study the information concerning the 224-type tubes which is readily available to him from the manufacturers of sets and tubes. He should absorb this information so that he is able to translate it into simple terms for the benefit of customers who know little about radio receivers other than that they bring in the desired programs. Not all dealers are technical experts, but there are a few who do not have a basic conception of a set and its operation and who do not have a trained serviceman at their beck and call. Such dealers should make an effort to improve their knowledge if they wish to compete in the 1929 market.

At the present time the conception of the screen-grid receivers by those who have not seen them (meaning the majority of our population) is that they are better—"in some way." Telling what that "some way" is forms the first job of the radio dealer. And he must not neglect to emphasize that with the screen-grid tube it is necessary to use specially designed circuits, differing considerably from those employed in previous years and which used lower "mu" tubes like the 227's.

The dealer should make it clear that the screen-grid tube receiver is not an experiment—that it need not be regarded with suspicion, but that it represents long-term development in the radio art. Only after months of intensive laboratory experimenting have the a. c. screen-grid tubes been released.

In addition to technical facts the dealer should know that the screen-grid tube is not new, although it was not used generally in broadcast receivers until this year. The great possibilities of this tube were disclosed by engineers of the General Electric Company in 1919 when laboratory models were perfected and used in a four-stage r.f. amplifier which gave an unusual amount of amplification without any tendency toward oscillation.

It has required most of the interval of ten years that has elapsed between the time the first laboratory models were made and the present date to perfect the tube for general use.

FEDERAL RADIO CORPORATION

EDWARD C. HILL, Sales Promotion Manager: There is always an important factor in the merchandising of any product, and that is knowing that product. This is especially true in selling screen-grid radio receivers.

The all-electric set of last season using a.c. 227-type heater tubes, push-pull amplification, and a dynamic loud speaker left little to improve, but, although there were signs of stability in the radio industry, every manufacturer has been striving to produce better apparatus at lower cost. This has been accomplished this year in the better makes of screen-grid sets.

In the mind of the radio retailer there is no question that performance is the outstanding feature in selling radio apparatus; tone quality, selectivity, distance, and reliability are still considered the chief selling points of a radio set. With the advent of the new screen-grid tube, which has created such wide-spread interest through the publicity given to it by trade journals and newspapers throughout the country, the dealer and the public look to this development to give them the utmost in



E. C. Hill

radio performance. We believe that the dealer should know the fundamental features of this tube as an amplifier in a radio receiver with a properly designed circuit. With this information the dealer can build up a splendid sales talk that will be of great interest to his customer.

Aside from technical advantages, which are many, the greatest consideration from both the manufacturers' and dealers' point of view is that the screen-grid tube marks the advent of quality receiving apparatus at a price that will enlarge the replacement market and attract the new set buyer who has remained out of the market because the price of real performance was not obtainable for the amount he was able and willing to invest. In other words, the screen-grid tube by permitting simplification of circuit design makes it possible to offer outstanding performance at a relatively low price. A properly designed screen-grid receiver represents not only an initial saving but also a substantial saving in the matter of tube replacements, etc., when compared on a basis of performance with sets employing the older types of tubes in the radio-frequency stages. Hence, Federal's message to dealers will be: wider markets to tap, increased stock turn over, and decreased service expense.



H. C. Bodman

SILVER-MARSHALL, INC.

Harold C. Bodman, Sales Manager: We are on the threshold of a new era in radio receivers and with a greatly improved product—the screen-grid set—we are destined to see greatly improved methods of merchandising. Just as the a.c. receiver, two years ago, opened up a vastly broader market for radio receivers by rendering them more convenient to install and to operate in the home—so the screen-grid tube opens up new markets for screen-grid radio receivers, and new methods of merchandising them.

A well-designed screen-grid receiver allows certain feats to be accomplished that were never before practical or possible. For instance, the sensitivity is so high that all local stations and many distant ones may be received with a finger touching the antenna post serving as the only antenna. Then also, it possesses selectivity such as is found in none of the previously known receivers without sacrifice of tone quality. These two advantages alone offer the radio dealer such tremendous opportunities for effective home demonstrations that it would be almost a miracle if screen-grid receivers did not revolutionize radio merchandising in 1929.

Radio "retailing" is fast changing to radio "merchandising." The dealer who waits for customers to come to his store to buy is fast being supplanted by the "merchandiser" who extends the four walls of his store to embrace his entire trading area. And no development that engineering genius has provided since light-socket operation has been so vitally important to the dealer as to-day's well-designed screen-grid set.

In selling screen-grid receivers, a dealer can arrange three or four demonstrations in a single evening due to the fact that such sets may be installed as quickly as a floor lamp. And, when he can use a lead pencil a pen knife, or even an ice pick as an antenna, and bring in stations that are inaudible on previously known types of sets, is it conceivable that he would not take fullest advantage of the home-demonstration method of selling? This year it is expected that at least 70 per cent. of all radio sets sold will be sold in the homes of the prospects, and not on the floor!

From the dealer's viewpoint, the particular screen-grid receiver which he plans to merchandise makes all the difference in the world. Screen-grid tubes don't make a screen-grid receiver any more than "clothes make the man." The most important thing for the dealer to consider is: "What make of screen-grid receiver best lends itself to the home-demonstration method of selling. When a screen-grid receiver has been selected which has a reputation back of it, which performs as a real screen-grid receiver should perform, and which is confidently and aggressively pushed by the manufacturer, half the battle is won.

The other half of the battle is to train salesmen, establish a trade-in policy, follow a safe financing plan, advertise effectively, and watch administrative expenses.

In connection with the actual selling of these receivers it should be pointed out that the most successful and most profitable method of making home demonstrations is not by "cold-turkey canvassing" but by being *invited* by the prospect to demonstrate. Door-to-door canvassing does not build prestige for the store nor customer good will. On the other hand, the most advisable method of securing customers is to reach out for prospects by means of well-aimed letters to the householders of your community, asking for an opportunity to demonstrate your screen-grid radio receiver. Your telephone, too, provides an effective means of introducing yourself and your product to picked prospects. Advertising in your local paper will also cultivate the families of your community and establish your identity, bringing inquiries and prospects and making your selling job easier and quicker.

These are days of great opportunity and strenuous competition for the customer's dollar. While the old time retailer is "watching and waiting" for customers, the "merchandiser" of 1929 is going out after them, building a reputation for being alive and building up his bank account as well.

STROMBERG-CARLSON TEL. MFG. CO.

George A. Scoville, Vice-President and Sales Manager: Merchandising of the new screen-grid receivers on the part of the dealer need differ in no way from merchandising any new and better product. It is true that screen-grid receivers represent a very important step forward in radio; it is unquestionably the most noteworthy advance since "total shielding" of receivers and the introduction of house-current operation. Screen-grid receivers, which are *really* screen-grid receivers—not simply a screen-grid tube or two stuck into an ordinary circuit—offer to the customer something better in radio than anything that has been on the market heretofore, and it naturally presents something of a problem to dealers in connection with present stocks.

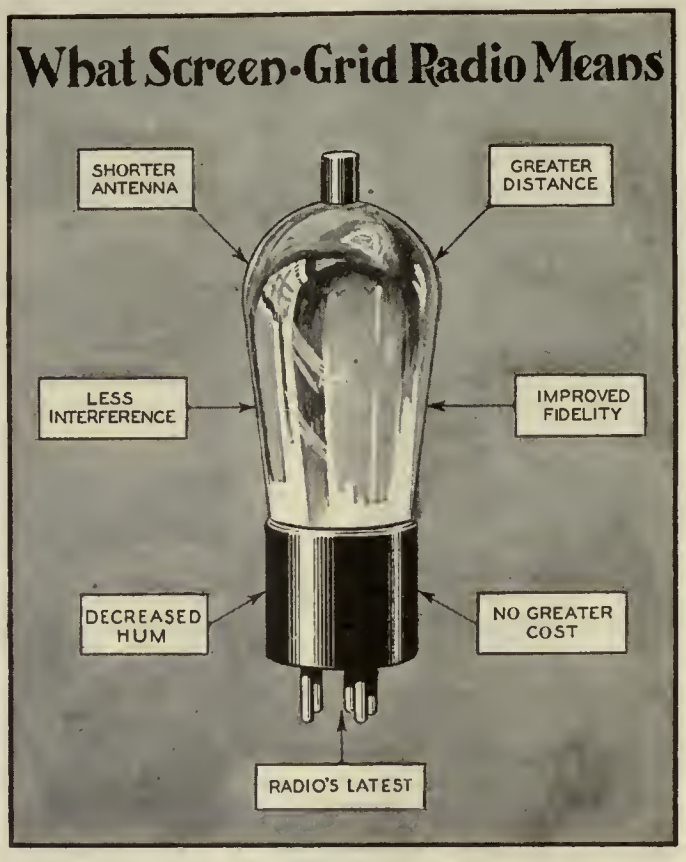
Yet, the problem will right itself quickly if the dealers, and manufacturers as well, will use discretion. The foregoing statement is made with facts behind it, for, when a.c. tubes were introduced, which was a more abrupt change than the screen-grid tube presents, our company produced nothing but receivers with direct-current tubes for a full year afterwards. We were probably affected by the advent of a.c. tubes, yet our sales actually did increase during that period.

Automobile dealers have been confronted with the same situation which screen-grid tubes have created in radio to-day, and a good many times in the history of their industry, and so have the typewriter people, and many others. Advancement in product, the bringing out of goods radically better than anything before, is what gives zest to an industry. It stimulates sales. It is the life of trade.



G. A. Scoville

WHAT THE SCREEN-GRID SET DOES



MANY ARGUMENTS pro and con on screen-grid receivers are taking place behind and in front of counters where sets are sold, and it is no secret that such arguments have occurred in the offices of large set manufacturers, or that these manufacturers are divided into two general groups, those who do and those who don't believe that screen-grid radio is 1929's panacea.

What are the facts about screen-grid radios? In the following paragraphs some of the advances that are possible in receiver design because of the advent of this new tube are pointed out. It must not be assumed merely because such advances are possible, that they already exist. Nor must it be assumed that the screen-grid radio will displace other types of sets. In the words of several large set engineers, the screen-grid tube is another tool; a useful one, but one which must not be taken as the cure-all for every radio ill.

Some of 1929's receivers using screen-grid tubes will be superior to sets made a year ago without the advantage of the new tube; it is equally true that a general advancement has taken place in the year and that sets using three-element tubes throughout have progressed toward the goal of better selectivity, better sensitivity, and improved fidelity.

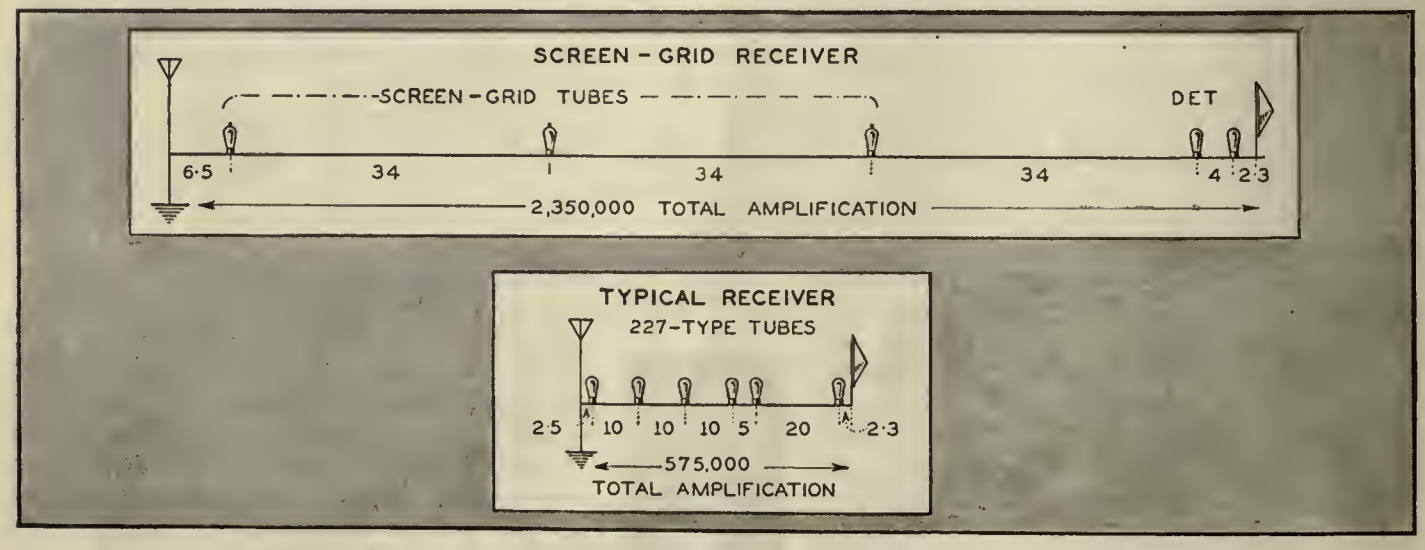
Screen-grid tubes make possible a more sensitive, and more selective receiver than was possible a year ago, and one in which the fidelity of reproduction may be improved over that obtainable in 1928.

Let us look at the sensitivity angle. Last year (1928) receivers were about ten times as sensitive as those of a year or two previous. And many sets of 1929 are ten times as sensitive as those of 1928!

What does this mean? It means that one can receive more distant stations, or a given station louder, or a given station from a greater distance, or lower-powered transmitters, or he can attain all of last year's results on a smaller antenna.

On page 213 will be found a drawing showing the effect of increasing the sensitivity of a receiver by ten times. If an antenna 12 feet high was required in 1928 to deliver a given loud speaker signal from a given station, an antenna only 1.2 feet high will be necessary in 1929. Well-designed screen-grid receivers can get along with only a very small wire or a metal screen as an antenna. For apartment dwellers, this means the complete elimination of the unsightly and dangerous antenna erected on the roof far from the receiver.

In another illustration an attempt s made to show how the receiving range of a receiver may be increased by the use of screen-grid tubes. If the sensitivity of a receiver is increased ten times, the receiver can be placed ten times the distance from a given station and still deliver the same loud speaker



A screen-grid receiver using five tubes compared in overall amplification with a six-tube receiver using three-element tubes

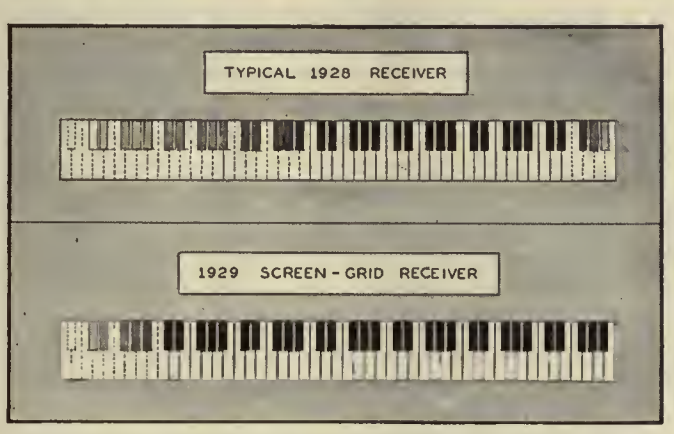
signal. This implies that the set is located in a quiet place which is free from local noise.

So much for the sensitivity of the 1929 screen-grid sets.

In proper designs, the new tube makes possible a more selective receiver. The difference between the selectivity of receivers built in 1928 and those of 1929 may be somewhat difficult to determine because some of the sets of a year ago were so selective, due to regeneration, that high audio notes were badly chopped off. Because of reasons inherent in the screen-grid tube itself, somewhat greater selectivity is possible.

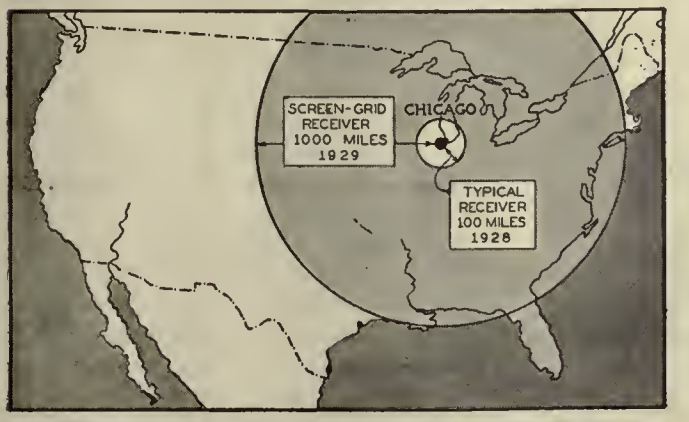
Previous to the present season, receivers had to depend upon a sensitive detector of the grid leak and condenser type for a considerable part of their sensitivity. This kind of detector is a notorious offender when considered from the viewpoint of fidelity. In some receivers using this type of detector, the distortion occurring in the detector circuit alone amounts to 25 per cent. of the desired signal. This much distortion is audible to the most hardened listener. At the same time high audio tones have been reduced by the old-type detectors. With high gain r.f. amplifiers C-bias detection can be used and this type of detector does not discriminate against the high audio frequencies.

The picture diagram accompanying this article shows how the amplification available from new sets compares with those of 1928. A considerable part of the amplification that existed after the detector, in 1928, now comes before the detector. This means that the detector input signal has been increased over that of last year. And so, the "power" detector comes into the radio picture. It is a detector that will handle large input signals without overloading. Also the detector circuit can be designed to have a linear characteristic so that it will put out large signals without the 25 per cent. addition of distorting harmonies. At the same time it need not discriminate against high audio tones as does the older type of detector.



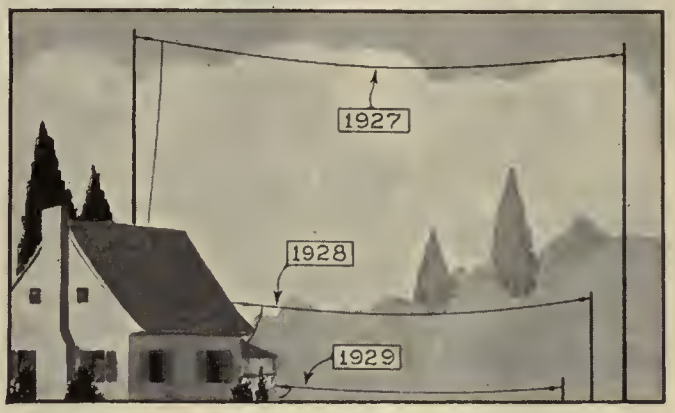
This drawing indicates how the fidelity of response may be improved at both ends of the musical scale with screen-grid tubes.

In well-designed circuits the tube not only increases the musical range over which a receiver may respond, but at the same time permits a clearer reception of this range. In the picture of the piano keyboard, the hazy keys indicate the frequencies which are not clearly received by the average set.



A receiver in a quiet locality has its range increased materially by the use of screen-grid tubes.

At the same time the major qualities of a radio receiver have been improved, certain other electrical and mechanical improvements and simplicities may be effected by the use of the screen-grid tube.



1928 results may be obtained with a 1929 screen-grid receiver with a smaller antenna.

The high gain in the r.f. amplifier makes it possible to eliminate one stage of audio-frequency amplification so that the power tube follows directly after the detector. With one stage of audio there will be less hum and less tube noise and sets will be less microphonic. The elimination of one stage may reduce the manufacturing cost so that the purchaser gets equivalent or better performance for the same money.

Because the screen-grid tube makes possible such a sensitive receiver, it must be engineered more carefully than a set of less amplification. This means that a purchaser in 1929 should get a set engineered and equipped with more care than a similar set of two years ago. The mere matter of having each tuned stage lined up properly assumes much greater proportions in a screen-grid set. The problem of shielding is one which must be looked at more carefully in 1929 than in 1928.

All in all, a well-designed 1929 screen-grid set should give a customer a better radio than he could buy in 1928, at a price no greater than he would have to pay for a receiver a year ago. It is a set that will get more stations, stations farther away, and stations that now seem a bit too close to others in frequency for happy results. Signals ought to sound better. And all of these results may be obtained with a smaller antenna!

NEW MARINE REGULATIONS

THE CONFERENCE on Safety of Life at Sea, which met in London during April and May, adopted regulations respecting radio telegraphy aboard vessels, requiring transmitting and receiving equipment on all passenger ships and all cargo vessels over 1600 tons. This agreement, if adopted by our Government, will require many new radio installations, since our radio law now prescribes only that all steam vessels carrying 50 or more persons shall have radio equipment, thereby exempting small cargo steamers, motor ships, and sailing vessels.

The MARCH

The R. M. A. Elects New Officers
Improvement In Radio Programs Needed

Curing the Direct Advertising Cancer

WHILE GRATIFYING progress has been made in the technical improvement of broadcast transmission and reception, the fundamental concern of the radio industry—the broadcast program reproduced in the listener's home—is suffering dangerously from an insiduous "cancer." Little by little, the incubus of commercialism, at first welcomed because it brought economic independence to broadcast station operation, is now threatening radio broadcasting with paralysis. The commercial announcement has evolved from a courteous and restrained good-will appeal to a



knockout dose of advertising, so potent that one can no longer enjoy a radio program without a feeling of apprehension.

For several years, while it was owned and operated by the American Telephone and Telegraph Company, WEAF set unimpeachable standards for commercial broadcasting. The organization which evolved the economic foundation for broadcasting, launched radio advertising upon an indisputably high plane. Its clients fought for concessions, but nothing more than the firm name and slogan at the beginning and end of each program were allowed to get out over the air. Fulsome descriptions of products, testimonials strangely reminiscent of quack medicine advertising and smart-aleck announcement characteristic of to-day's offerings, were simply prohibited. After two or three years of activity, the company withdrew from broadcasting station operation and sold WEAF to the Radio Corporation of America, which, together with Westinghouse and General Electric, formed the National Broadcasting Company.

Three years of operation under these auspices has resulted in an enormous extension of radio advertising and chain broadcasting. Powerful salesmanship was exerted upon the advertisers, with the result that appropriations for radio programs increased enormously. The professional standing of artists appearing before the microphone has been lifted to the highest standards. But broadcasting has receded from its position as a prime interest of the American public. The good-will program has evolved from a courtesy to an annoyance, in spite of its improved artistic standing. The habitual listener is now as grateful for the commercial program as he is for the billboards which grace the principal highways.

To be satisfied with their investment in broadcasting, announcers are compelled by sponsors to launch into detailed descriptions of their products; they must attempt to intrigue their audiences with countless slogans, discuss financial arrangements, detail payment plans, quote prices, enrapture supposedly gullible listeners with high-priced testimonials, and proclaim real or imaginary points of superiority with which the sponsors consider their products to be endowed. How far from the standards originally charted for commercial broadcasting has the art wandered!



In fairness to broadcast managements, it must be said that most of them have attempted to resist misguided attempts to make radio a direct-advertising medium. Many programs are still models of good taste. Having brought prosperity to commercial broadcasting, however, the demands of many affluent advertisers for stronger and stronger doses of advertising are not easily curbed. On the printed page, advertisers may say what they please; why not over the air? They certainly pay enough for the privilege.

No one objects to superlative statements on the printed page because the reader can, by a turn of the page, dismiss the advertisement instantly, without sacrificing the entertainment or educational value for which he purchased the publication. The radio listener, on the other hand, must dismiss not only advertising but entertainment as well. Unless he seats himself at the controls of the receiver, within a few inches of the reproducer, dismissing unwelcome advertising is a considerable inconvenience.

Many in the broadcasting profession accept the advertising announcement as a necessary evil which must be tolerated. But they are traitors to the ideals which ought to animate the broadcasting industry. By their attitude, they acknowledge

The New R.M.A. Leaders

GREAT WISDOM *was shown by the membership of the Radio Manufacturers' Association in choosing the officers who are to guide the destinies of that body for the coming year. H. B. Richmond, the new president, is acclaimed on every side as an able and popular leader. As chairman of the Engineering Committee of R. M. A. for a number of years, Mr. Richmond has demonstrated a wide knowledge of industry problems, a remarkable ability to "get things done," and a diplomacy and kindly suavity that promises much to the radio industry with leadership of this calibre, One of the outstanding elements in the make-up of the new R. M. A. president is a broadness of vision which will keep association activities on the highest of planes, free from petty politics and pointless bickerings.*

Aiding Mr. Richmond is an unusually able and representative group of officers and directors. They are: T. K. Webster, Jr., treasurer; Morris Metcalf (American Bosch), vice-president; Henry C. Forster (Utah Products), vice-president; William Sparks (Sparks-Withington), vice-president. The new directors, elected for three years, are: H. C. Cox (Columbia Phonograph), Henry C. Forster, George C. Furness (National Carbon), B. J. Grigsby (Grigsby-Grunow), Ralph H. Langley (Crosley), A. G. Mesick (U. S. Radio), R. T. Pierson (Bremer-Tully), and H. B. Richmond (General Radio).



H. B. Richmond

—W. K. W.

OF RADIO

Regarding Screen-Grid Receivers
The Listener's Attitude Should be Studied

their failure to make advertisers appreciate the attitude of the listener who finds, at least a dozen times in an evening, that he has invested a hundred dollars or more in a means of inviting poorly disguised canvassers into his home. These apologists for radio advertising have failed to devise a method of capitalizing good will gained through a high-grade program by means of an effective but inoffensive tie-in because their ingenuity is incapable of originating a practical method of enticing audience response. There is no logical user of broadcasting for whom a tie-in cannot be originated, appealing directly to his prospects.



The task of assuring the intelligent and effective utilization of commercial broadcasting would be much easier if accurate investigations of listener attitude were made. The "statistics" distributed by most broadcasting stations as to coverage are of little value. The population and wealth within an arbitrary distance of a broadcasting station gives no indication of a particular station's real audience and almost invariably embraces areas not served by the station involved. Popularity contests mean still less because unrepresentative groups respond to them and questionnaires are subject to the same failing.

The great public utilities have learned accurate methods of measuring public attitude, employing investigations of a comprehensive character and involving highly specialized techniques. No organization in the radio field has gone further than to estimate the total potential audience for all stations in an arbitrary radius. It is entirely within the capabilities of scientific investigation of public attitude to determine the habitual audience of a given station at all hours of the day in its true service area, as indicated by field-strength surveys; to evaluate the good will loss or gain for specific types of announcements and the relation of the good will won through broadcasting upon the effectiveness of printed advertising and upon sales resistance.

Once modern methods, which have been successfully applied in other fields, are used by the broadcasting fraternity, the advertiser will readily appreciate that radio as a good-will medium has tremendous potentialities, fully justifying huge appropriations, and that, employed as an *advertising* medium, it creates more ill will than good will. In the meanwhile, the average listener, because of the increasingly offensive and effusive character of the announcements, becomes less and less responsive to the good-will influence of broadcasting.

Screen-Grid Receivers, Good and Bad

As the forward looking element of the radio industry has anticipated for two years, the appearance of the a. c. screen-grid tube resulted in its instant adoption by practically every manufacturer in the industry. The tube manufacturers had only to produce an alternating current screen-grid tube and its superior amplification possibilities assured its immediate utilization. Here and there, however, we hear rumors that there is to be grief in connection with the screen-grid tube, and that there is still a great deal to be learned before service difficulties are overcome.



Similar rumors floated about when the alternating current tube first appeared and, prior to that, when the a. c. power-supply unit replaced the battery. Grief did accompany these innovations, which was quickly dispelled by engineering and manufacturing experience. But there is no question about the future of the screen-grid tube. If there is to be criticism, the failure will not lie with the tube but with faulty engineering of the receiver to which it is applied unsuccessfully. There are many examples of marvelous engineering design and successful application of the screen-grid tube which will prove to the rest of the industry that competent and forward looking engineering pays. These receivers are the product of months of experimental work with the battery-type screen-grid tube which has long been available to the laboratory.

This is the season when slap-stick designing and engineering by imitation will expose itself. We have tried some screen-grid sets which must have been hurriedly put together in May in order that the manufacturer might be at the trade show in June with a screen-grid receiver. Some of these are merely inefficient so that little of the benefits of screen-grid amplification are obtained; some are regenerative with disastrous results in audio quality, culminating in obvious loss of the higher frequencies so essential to clear articulation of speech and brilliance in music; one or two which we tried actually oscillated at one or two sections of the dial so that we were reminded again of the regenerative receiver days. But the screen-grid tube technique will yield to good engineering and, presumably before large-scale production begins, these deficiencies will be remedied.

To the radio dealer, who must judge numerous offerings made to him, we recommend exhaustive tests and discriminating selection. This is a screen-grid year and the dealer must be ready to meet the demand. It will pay him to use caution and to determine by actual comparison whether he is considering a product of hasty engineering or whether there is a year or two of experimental experience with screen-grid tubes back of the line which he selects.

The Men Who Write Our Radio Laws

The progress of radio seems to be made and unmade by the legislation adopted respecting it. No body is more important in determining the course of that legislation than the Senate Interstate Commerce Committee. For some time, this august body has been taking testimony from hither and yon in order to clarify its views with respect to the Couzens Bill, providing for a combined radio, telephone, and telegraph commission. Apparently the Federal Radio Commission has either discharged its duties to the satisfaction of the Senate or it is considered not to have enough to do. Senator Pittman of Nevada distinguished himself during these sessions by

(*Continued on page 256*)



The TUBE Business







IN JUNE, without doubt, there was a serious shortage of good screen-grid tubes. At that time an estimate was made that the total production of all prominent tube manufacturers was only 15,000 screen-grid tubes a day, althougb tbe demand was for about 75,000.

Everyone believed that the problem of making a good screen-grid tube at the price announced by the Radio Corporation was a major problem indeed, and one which was not at all certain of solution. Several tube manufacturers coincided with the belief that such tubes would cost in the neighborhood of $2.00 to build, and that plant production would be reduced by from 40 to 60 per cent. by tbeir construction. There is no certainty yet that the tubes will stay good in service after they are made.

It is a fact that the more complicated a tube becomes, the shorter its life. The fact that the 226-type tube is going out of the radio picture strikes out one of the easiest tubes to make. The screen-grid tube with its additional material becomes very difficult to make and to keep free from gas.

It is our belief, and one which seems to be shared by some tube manufacturers at least, that more coöperation between tube and set designers would be welcome. If, say a year before any new idea is to be exploited, the tube and set people were to get together and discuss the problems of each, is it not possible that a better set could be engineered, witb the certainty that the tubes would last longer? Or is it a fact, as many have darkly hinted, that the tube people do not want tubes to last very long? We cannot believe that a reputable tube manufacturer wbo refrains from selling seconds and thirds and who is not here to be gone tomorrow, would besitate to increase the life of his tubes.

There is a race among tube manufacturers to determine who can make the most tests and checks on the tubes before releasing them to the trade. The greatest number we have seen is 137 and, according to the engineer who made the statement, it is only by such an array of tests that it is possible to deliver uniform tubes. It seems to us that this is an admission that modern methods of making tubes are somewhat faulty. If any tube manufacturer has more tests than 137, we'd like to hear about it.

EARNINGS OF TUBE COMPANIES

ACCORDING TO NEWSPAPERS, DeForest earned 22 cents a share on its outstanding stock during the first three months of 1929. Cable, it is reported,will institute a dividend of 50 cents a share.

SCREEN-GRID VS. SERVICE

SPECULATION AS to whether the screen-grid tube will increase the service problem of radio set manufacturers seems to disturb many in the industry. It will not according to Paul Ware (now making the Ware Radio), who states that set people who have really engineered a receiver will experience none of the troubles from oscillation, suppression of higher audio tones, and other griefs in which the manufacturer who has merely thrown together a screen-grid set will find himself.

1929 RADIO TUBE SALES

EDWARD T. MAHARIN, vice-president in charge of sales, CeCo, believes the radio industry will absorb seventy-five million tubes in 1929. He thinks at least six million new sets will be sold. Sincc sixty-one million tubes were sold in 1928, Mr. Maharin's estimate seems somewhat conservative. Others have guessed as high as 130 million tubes. The best guess seems to be in the neighborhood of 100 million for new sets and old.

ZETKA CHANGES NAME

ZETKA LABORATORIES, INC., for several years manufacturers of special-purpose tubes and a series of long-life tubes for one of the large communication companies, has become the Radio Utilities Corporation. Its entire effort will be concentrated on the production of power and rectifier tubes.

PERRYMAN'S PRODUCTION

PERRYMAN ANNOUNCED in June that daily production in three plants was 10,000 and that by the end of this summer the production would be increased to 24,000. According to Benjamin S. Katz, president, the company had unfilled orders for 2,000,000 tubes including 600,000 sold at the Chicago show.

CABLE'S UNFILLED ORDERS

THE CABLE RADIO TUBE CORPORATION had unfilled orders of $2,000,000 in June; the daily production of 8000 was soon to be raised to 10,000 and to reach 25,000 by September 1.

CECO RECEIVES LARGE ORDER

A SINGLE ORDER for tubes to the extent of $550,000 was secured by CeCo—the tubes to be furnished to Sears Roebuck. May sales were 217 per cent. ahead of May, 1928.

ARCTURUS TUBE PRODUCTION

AT THE BEGINNING of 1929, Arcturus made 14,000 tubes a day. In June the production had been speeded up to the tune of 23,000 a day.

REGARDING SLOGANS

DEFOREST produces an interesting booklet entitled *Dealer Manual for 1929*. It describes window posters, etc., all of which emphasize the DeForest slogan, "The Father of Radio." This reminds us that few of the tube manufacturers have created slogans, names, or cartons that can be remembered by the layman. Many of them claim to make "high-vacuum" tubes, but this means little to the man who buys the tube. He must have a catch phrase, something that will stick in his mind.

A NEW RECTIFIER TUBE

WITH dynamic loud speakers and push-pull 245's, the 280-type rectifier tube is being called upon to deliver so near its maximum current and voltage that some tube people are working on a new tube which can stand up under this load. Such a new rectifier tube will probably have a heavier filament and a larger plate.

In the meantime it is understood that some set manufacturers place 400 volts per anode on the 280-type tube and that everything works out properly provided the total current taken from the tube does not exceed 110 milliamperes.

A $200,000 ORDER

A SINGLE ORDER for over $200,000 worth of tubes was secured by E. A. Tracey, vice-president of the Northern Manufacturing Company (Marathon), at the Trade Show.

TUNE IN ON TRIADORS

Triad joins the ranks of tube manufacturers who take time on the air. WJZ and associated stations broadcast the Triadors on Friday evenings from 8 to 8.30.

BATTERY MAKERS ENTER TUBE BUSINESS

THE ADVENT OF BATTERY manufacturers into the tube industry is a new and interesting phase of the radio business. The Eveready-Raytheon combination has already been noted. Tubes are also sold under the names of Ray-O-Vac, Bond, and Diamond. Burgess, we understand, has also made some overtures in this direction.

THE TRIAD GUARANTEE

WITH EVERY TRIAD tube is packed an insurance certificate which guarantees the efficient life of the tube for at least six months. Any tube found faulty within that time and returned to the dealer with tbe certificate will be replaccd.

WHY TUBES ARE RETURNED

FOR THE FIRST six months of operation, the return of tubes to DeForest were less tban 1 per cent. This percentage would be reduced, according to A. H. Fajen, engineer in charge of inspection, if the public would be sure to put each tube in the proper socket of the set, and would not remove or replace a tube without turning off the power. Frequently, a tube will be damaged by putting it in a socket with the power on so that the filament and plate terminals make contact before the grid does, with the result that a high plate current flows—corresponding to zero grid bias. Premature failure of power tubes may be traced frequently to such mishandling.

Sixty-five per cent. of all tube burn outs may be traced to placing tubes in the wrong sockets, says Mr. Fajen.

IN THE RADIO MARKETPLACE

News, Useful Data, and Information on the Offerings of the Manufacturer

CONDENSED FACTS REGARDING NEW RECEIVERS

BREMER-TULLY: Three stages of r.f. amplification, a detector, and two stages of audio are used in the new sets of the Bremer-Tully Manufacturing Company. The output tubes are 245's in push pull. The cabinet models use a 10-inch dynamic loud speaker.

ZENITH: Automatic tuning continues to be a feature of the radio receivers manufactured by this company. Model 39A uses ten tubes including rectifier and is designed for operation on a loop antenna. A phonograph pick-up jack permits the set to be used for the playing of phonograph records. Screen-grid tubes are used.

FREED-EISEMANN: The new receivers announced by this company use a neutrodyne circuit in conjunction with an inductor dynamic loud speaker. Two chassis, one eight tube and one nine tube, are being used in these sets.

ATWATER KENT: The new A. K. screen-grid radio receivers use the a.c. screen-grid tube in the r.f. amplifying circuit with two 245-type tubes in push pull in the output circuit.

DAY-FAN: Type 245 tubes in push pull, improved dynamic loud speaker, phonograph pick-up jack, and a shielded detector circuit are among the features of the Day-Fan Electric Company's new sets. The chassis employs nine tubes including five 226's, one 227, two 245's, and one 280.

KOLSTER: Remote control and automatic tuning with screen-grid tubes in the r.f. stages are the features of the new Kolster receivers. Two 250-type tubes are used in the output of the Model K-45. The Models K-43 and 44 use 245-type tubes.

BOSCH: All the new receivers of this company will use screen-grid tubes in the r.f. amplifier circuit. All models are designed for dynamic loud speaker operation, the consoles being supplied with the new Bosch dynamic loud speaker. Bosch tubes will be marketed this year with Bosch sets.

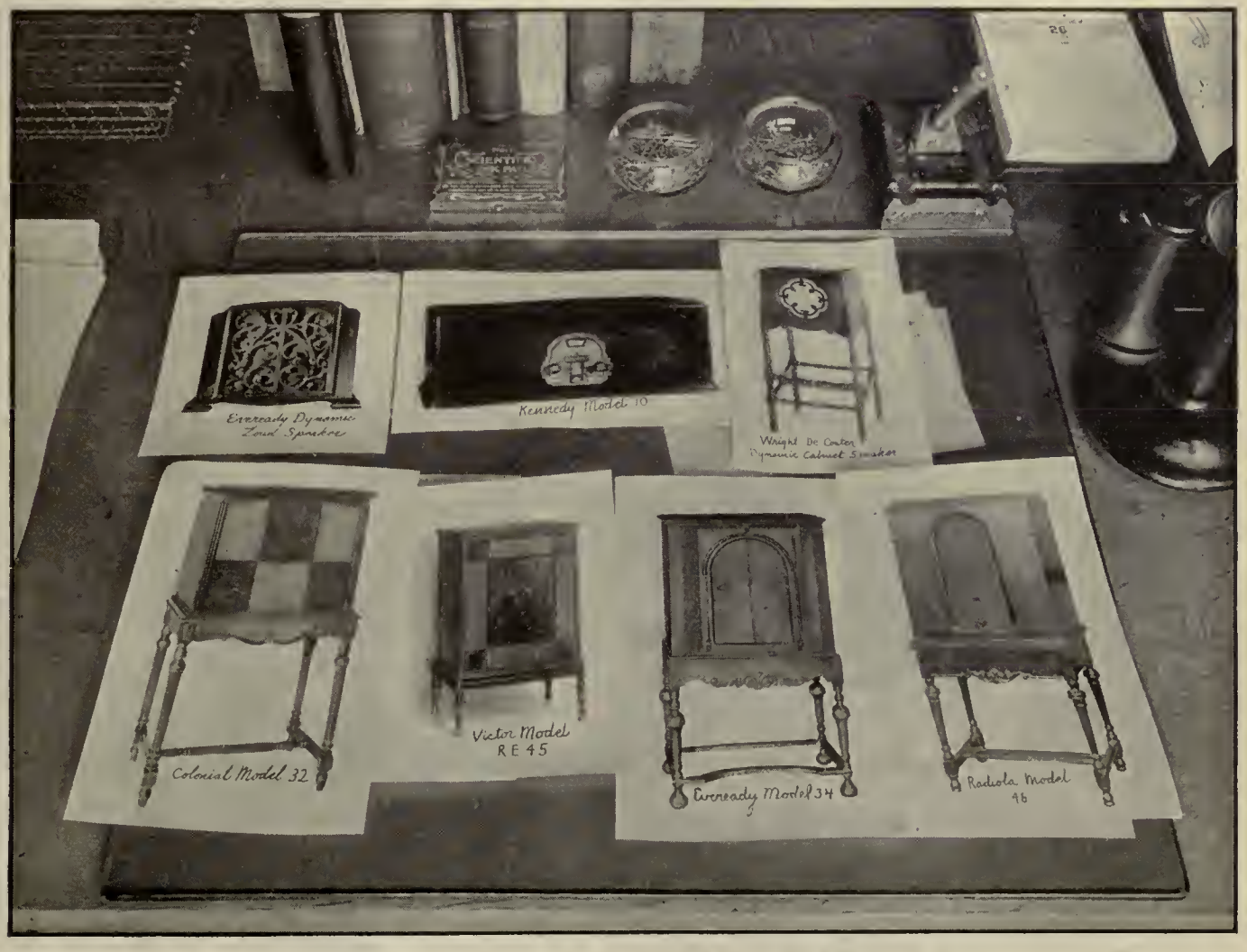
BRANDES: A "selector tuner" is used on the new Brandes receivers. With this tuner there is always in full view on the dial the eight favorite stations of the user.

GREBE: Three screen-grid tubes, band-pass filtering in the r.f. stages, power detection, push-pull amplification, automatic line voltage control, and a dynamic loud speaker are features of the new receivers made by A. H. Grebe and Company.

VICTOR: A "Harmonic Modulator" is used in the new radio receivers manufactured by the Victor Division of the Radio-Victor Corporation of America. The chassis utilizes six 226's, one 227, two 245's, and one 280 tube. Tuning is accomplished by a single leader control which operates over a full-vision scale calibrated in kilocycles with space at the top for marking the names of favorite stations.

KENNEDY: Two new receivers, the Royal Model 310 and Royal Model 210, are being manufactured by the Colin B. Kennedy Corporation.

CONTINENTAL: This corporation manufacture a number of "Star-Raider" receivers. The Technidyne circuit is used. The console models are equipped with phonograph pick-up jacks and the Model RP-40 is a combination radio and phonograph. The dynamic loud speaker used in the console model has a 14-inch cone.



A few of the season's new models viewed from the Editor's desk.

SPARKS-WITHINGTON: The new Sparton receivers continue to use the Equasonne circuit with its automatic-tuned amplifier and band-pass filter which has proven so popular in previous receivers made by this company.

SILVER-MARSHALL: The new Silver radio receivers use screen-grid tubes in the detector circuit and in the r.f. amplifier. The output circuit uses two 245-type tubes in push pull. An automatic line-voltage regulator maintains the voltage supply for the tubes constant even though the supply varies from 90 to 130 volts.

FRESHMAN: The Earl radio receivers of the Charles Freshman Company, Inc. use an eight-tube circuit with 227-type tubes and 245's in push pull in the output. The circuit is of the neutrodyne type.

GRIGSBY GRUNOW: New Majestic receivers incorporate several new features, one of the most interesting of which is an automatic sensitivity control consisting of a device connected to the gang condenser assembly which automatically varies the bias of the r.f. tubes to maintain the sensitivity more nearly constant.

STERLING: This company is building two radio receivers, the Oxford and the Stuart. The former set is a cabinet model using a tuned radio-frequency circuit of three stages and two stages of a.f. with 245-type tubes in the output. The loud speaker is of the dynamic type with a 10-inch cone, the field circuit being supplied with current from the B-power unit. A phonograph pick-up jack is included in the circuit. The Stuart uses three stages of screen-grid r.f. amplification followed by a detector and audio amplifier similar to that used in the Oxford.

COLONIAL: The new Model 32, a receiver using four screen-grid tubes, three of them in the r.f. amplifier and one as a detector, has been announced by the Colonial Radio Corporation. Uniform sensitivity is obtained. The sensitivity as measured on a General Radio signal generator is 5 microvolts per meter. The circuit includes a filter network to prevent the possibility of cross-talk on strong local stations. The detector feeds into two 245's in push pull which, in turn, supply power to a Cutting dynamic loud speaker.

RADIO-VICTOR: Two new receivers, the Radiolas 44 and 46, have been announced by the Radio-Victor Corporation of America. The Radiola 44, a table model, uses three screen-grid tubes, two of them as r.f. amplifiers and one has a detector. The detector is followed by a single stage of audio using one 245-type tube. A rather unusual dial is used on the 44. When the set is in operation the scale markings are projected upon a screen in the center of the escutcheon plate. The set has a local distance switch. The Radiola 46 uses the same circuit as the 44 but is a console model including a dynamic loud speaker of the model 106 type.



F. H. Schnell

KING: The new Royal model, a product of the King Manufacturing Corporation, uses an eight-tube neutrodyne circuit in conjunction with a dynamic loud speaker. The set is contained in a console.

A-C DAYTON: The "Navigator" receivers employ the Technidyne circuit in which all tuning is accomplished before the signal is amplified. Nine tubes are used with 245's in push pull in the output. The set is available in both console and table models.

BUSH AND LANE: A number of receivers are manufactured by the Bush and Lane Piano Company. The company is licensed under RCA and Hazeltine patents. All the receivers use the same chassis with screen-grid tubes in the r.f. amplifier. The console models use dynamic loud speakers.

NATIONAL CARBON: The new series 30 Eveready receivers incorporate several features among which are sturdy mechanical design of the chassis foundation, a variometer tuning of the antenna circuit, and dual loud speaker provision so that either dynamic or magnetic loud speakers may be used. The new sets are very sensitive and the National Carbon Company, manufacturers of these receivers, recommend their use with an indoor antenna or an outdoor antenna of not more than 20 feet. The receivers incorporate three stages of r.f. amplification with 227 tubes, a detector, and two stages of audio with 171A-type tubes in push pull in the output.

KELLOGG: Features of the new receivers of this company are automatic volume control, screen-grid tubes, 250-type tubes in push pull in the output, power detection, and a rugged dynamic loud speaker capable of handling tremendous volume.

EDISON: "Light-O-Matic Tuning" is a feature of the new Edison radio receivers. With this tuning device a red light indicates whenever the user is tuned to one of his favorite stations. The circuit utilizes five 227-type tubes and two 245's in push pull, in some models, and in other models the 245's are replaced by 250's.

FADA: The new receivers of this company use screen-grid tubes, a band-pass filter, power detection, and push-pull amplification. All models can operate on a light-socket antenna thereby requiring no loop, antenna or ground.

RECENT OFFERINGS BY LOUD SPEAKER MANUFACTURERS

AT THE RECENT Chicago Trade Show many of the loud speaker manufacturers showed new models. In the following paragraphs some data is given on some of the more important new improvements.

Jensen Radio Manufacturing Company's newest loud speaker is the "Concert dynamic" loud speaker which uses a ten-inch cone. The other two models in the Jensen line are the "Standard" with an eight-inch cone and the "Auditorium" with a twelve-inch cone. According to Peter L. Jensen, president of the company, the new "Concert" dynamic is unique in that it uses an especially prepared and treated material for the cone and heavy aluminum wire for the moving coil. Both of these factors increase the rigidity and strength of the loud speaker, at the same time increasing the lightness and freedom of motion of the cone so that it gives a better response. Loud speakers are available in various cabinets in both a.c. and d.c. types.



W. Bouck

The *Transformer Corporation of America* has developed a loud speaker incorporating several modifications among which are the use of an unusually large diaphragm made of one piece and the complete elimination of the suspension spider at the apex so that perfect centering of the voice coil is easily obtained. All the connections are grouped at the back on convenient lugs mounted on a bakelite panel. These loud speakers are available with or without rectifiers and transformers.

The *Rola Company* offers both magnetic and dynamic loud speakers in about twelve different models for either a.c. or d.c. operation and either in cabinets or just chassis. Prices vary from about $15 for the magnetic chassis to $60 for a dynamic mounted in a cabinet and completely equipped for light-socket operation.

Four dynamic chassis are being made by the *O'Neil Manufacturing Company*. Two models are for d.c. operation and two models are for a.c. operation. These loud speakers are provided with an adjustment for the moving coil which makes it possible for the most inexperienced person to realign the coil by simply loosening two screws, adjusting the coil, and then tightening the screws. These cones are made with either nine-inch or twelve-and-one-half-inch diaphragms.

The *United Reproducers Corporation* offer a number of Peerless reproducers in three types; magnetic, dynamic, or condenser. The condenser loud speaker known as the "Kylectron" is available in several cabinet models listing at prices up to $600. The magnetic loud speakers in cabinets list at about $25, the chassis being about $14. The dynamic loud speakers in cabinets list at about $50. The dynamic loud speakers use a voice coil consisting of but a single turn of copper wire of sturdy construction so that it is impossible for the coil to get out of alignment.

The *Wright-DeCoster Company* offer new dynamic loud speakers in distinctive cabinets and also a combination phonograph and power radio speaker. This latter unit consists of a phonograph turntable with pick-up unit in conjunction with a Samson amplifier and a dynamic loud speaker. It is priced at $425 less tubes. This company also offer baffles and horns designed for use with their loud speakers in theater installations.

Inductor dynamic, electrodynamic, and magnetic loud speakers are being made by the *Farrand Manufacturing Company*. Prices vary from $12 for the magnetic chassis, $18–$20 for the inductor chassis, $26–$30 for the dynamic chassis, and up to $60 for the dynamic chassis in a cabinet.

A variety of horns designed especially for use in theaters and auditoriums are manufactured by the *Kersten Radio Equipment Company*. For driving the horns this company also make two electrodynamic units priced at from $40 to $75.

The *Utah Radio Products Company* offer a number of dynamic loud speakers in various types of cabinets priced at from $35 to $55. They also have two magnetic loud speakers, one priced at $15 and the other at $19.50.

The *Best Manufacturing Company* offer a new dynamic loud speaker using an unusually large pot magnet, which, according to the manufacturers, gives a flux density of 114,000 lines, much greater than that found in other dynamic loud speakers. The diaphragm has a diameter of approximately 13½ inches. The chassis lists at $95 less tubes.

PERSONAL NOTES OF THE RADIO INDUSTRY

APPOINTED SALES MANAGERS

PAUL HITTINGER has been appointed sales promotion manager of Freed-Eisemann. His task is to sell radio sets to those who have never before owned one. "When we create a new radio fan," he says, "we are enriching the industry far more than when we sell replacement sets."

WILLIAM B. NEVIN has been appointed sales manager of Colin B. Kennedy. He returns to this company after an absence of seven years, having been sales and advertising manager in 1921–22. Kennedy plans to make 150,000 receivers this year and they will be merchandised exclusively through distributors.

RICHARD GNAVER, who answers to the cheerful hail of "Dick" all over this country, has been appointed to the general sales managership of the CeCo Manufacturing Company. His headquarters will be at the home-office in Providence, but like all the rest of the CeCo sales officials he will be a hardy traveler.

WILLIAM C. HEATON has been appointed sales-promotion manager of Fada. He has been with the Welte-Mignon Corporation, manufacturer of reproducing pianos. Frank C. Kenyon, Jr., formerly with Batten, Barton, Durstine & Osborn, Inc., an advertising agency, has been appointed assistant general sales manager. Eric Palmer, widely known radio and publicity man, has resigned from the Allied Broadcasting Companies and will have charge of the new department in the Fada organization designed to coördinate the work of the sales, advertising, and public relations departments.

JULIAN A. GREEN resigned as district manager for Atwater Kent Manufacturing Company on April 15 to accept the position of general sales manager of the Supreme Instruments Corporation, of Greenwood, Miss. Mr. Green is now planning an aggressive merchandising campaign through distributor channels.

NEW DIVISION MANAGERS

AFTER FIVE YEARS with Crosley, R. P. Crawley has rejoined the Kennedy organization. He is in charge, as division manager, of the Kansas City district.

ED LEVY, formerly with Sonatron, is now district manager for Triad in charge of their New York office. Six salesmen will operate under him at 34 West 33rd street, New York.

WITH HIS resignation as sales manager of the Sunset Electric Company, of Seattle, Washington, W. E. Kennard left to enter the services of the Colin B. Kennedy Corporation, of South Bend, Indiana, in the capacity of Pacific Coast division manager.

NEW OFFICIALS ELECTED

LOUIS SISSKIND, until recently president of the Central States Electric Supply Company, has joined the Harrison Wholesale Company, Chicago, as vice-president. Harrison Wholesale handles the Earl line as well as electrical supplies, lighting fixtures, automotive equipment, and sporting goods.

THREE IMPONTANT officials of the CeCo Manufacturing Company, makers of CeCo tubes, have been made vice-presidents of the company. They are N. O. Williams, chief engineer; John E. Ferguson, plant engineer, and Edward T. Maharin, sales director.

WORCESTER BOUCK has resigned from The Equitable Trust Company, of New York, where he served as an official for many years, to become a vice-president, treasurer, and a director of the Arcturus Radio Tube Co., of Newark. Mr. Bouck, who resides at Montclair, N. J., will make his headquarters in the general offices of the Arcturus company at Newark and will have supervision over the company's financial affairs.

OTTO N. FRANKFONT, vice-president in charge of sales of the All-American Mohawk Corporation, of Chicago, manufacturers of Lyric radios, and De Witt L. King, treasurer and factory manager, have been elected to the board of directors of the corporation. Mr. Frankfort and Mr. King replace E. N. Rauland and G. Frankel, who recently left the board.



P. Hittinger

Messrs. Frankfort and King have both been with the All-American Mohawk Corporation since its inception. Mr. King recently completed a reorganization of manufacturing facilities.

HAVE NEW POSITION

ROBERT V. DACOSTA, who for the last twelve years has been in charge of the manufacture of coils and condensers at the Atwater Kent plant, is now the production manager of Atwater Kent's neighbor, in Philadelphia, the H. H. Eby Manufacturing Company, Inc., makers of binding posts, sockets, and tip jacks. Before going to Atwater Kent, he had headed the enamelled wire and winding department of John A. Roebling Sons for seven years, and had been a member of the firm of the Doyle and DaCosta Manufacturing Co., of Easton, Pa., for two years.

LT. COMMANDER F. H. SCHNELL, U. S. Naval Reserves, for six years traffic manager of the American Radio Relay League, and more recently with the Engineering and Research Laboratory of the Burgess Battery Co., has become chief radio engineer of Acro Products, Inc., of Chicago, specialists and manufacturers of short-wave radio equipment.

R. R. KANCH, who has been associated with THOMAS A. EDISON, Inc. for the past eleven years, was recently appointed assistant to A. L. Walsh, vice-president of Thomas A. Edison, Inc. In his new position, Mr. Kaeh's major duties will be to correlate the Edison jobbers' activities with those of the Edison factory and wholesale distributors of Edison radios, phonographs and records.

Practically all of the fourteen branches of the Edison Distributing Corporation were established personally by Mr. Karch.

THE KELLOGG SWITCHBOAND AND SUPPLY COMPANY, of Chicago, has recently appointed Edward J. O'Neil assistant to C. W. Hunter, Kellogg sales representative in the Pacific Coast territory. Mr. O'Neil has been associated with L. G. Reno Company, Oakland, California, distributor, whom he represented until recently.

A. P. SINOIS is now advertising manager of Colin B. Kennedy, South Bend, Ind. Several notable national advertising campaigns are to his credit, among them being those for: Benjamin Electric Company, makers of Crysteel electric ranges and electric refrigerator cabinets, Cle-Ra-Tone radio sockets, industrial illumination; Yaxley Manufacturing Company, radio appliances; Trimm Radio Company, loud speakers and head sets.

SALES REPRESENTATIVES

THE HANDEL-DAVIES COMPANY, 202 Chester-Twelfth Bldg., Cleveland, Ohio, has been appointed district sales representatives for De Forest. Their territory is Ohio and Kentucky.

J. J. BACKEN COMPANY, 2607 Second Avenue, Seattle, Wash., has been chosen district sales representatives for De Forest covering the states of Oregon, Washington, and Montana. This organization also maintains branch offices at Spokane and Portland. The Backer Company at one time handled Raytheon. Now, in addition to De Forest, they handle Audak and Wright-De Coster.

NEWS OF TRADE ASSOCIATIONS

GEORGE H. CURTISS, secretary of the Pacific Radio Trades Association, reports that an East Bay Retailer's Association has been organized and meetings are held regularly from 8 to 9 A. M. once a month at the Leamington Hotel, Oakland, California. An active program of work is in progress, notably with reference to co-operative advertising and radio interference elimination.

HENBERT J. FREEMAN, of the Freeman Radio Shop, Allentown, Pa., was chosen president of the Lehigh Valley Radio Trade Association. Other officers are: Harold Lucky (Lucky Radio Co.) vice-president; Earl Arnold, secretary-treasurer. Retiring officers are Francis J. Hardner, president and Michael McGee, vice-president. The association has been discussing elimination of the "home free trial" of sets without a deposit.

FRIENDS OF J. W. A. Henderson, manager of the Edison Distributing Corporation, Minneapolis Branch, are congratulating him upon his recent election to the Board of Directors of the Northwest Radio Trade Association.

PAUL B. KLUGH, vice-president and general manager of the Zenith Radio Corporation, announces the resignation of Thomas H. Endicott as general sales manager, announcing at the same time, the appointment of Mr. Endicott as Zenith distributor for the entire state of Connecticut.



A. P. Sirois

Mr. Endicott will head a distributing corporation which he is forming. Headquarters will be established in Hartford.

NEW LYRIC DISTRIBUTONS

TEN NEW Lyric distributors in various parts of the country are announced by the All-American Mohawk Corporation, of Chicago, manufacturers of Lyric radios. They are: The Bloomberg-Michael Furniture Co., of Richmond, Va., H. G. Bork & Son, of Watertown, S. D., The Electric

(Continued on page 241)



THE SERVICEMAN'S CORNER

More Information on Hum

HUM, ACCORDING to many servicemen, is still a major consideration in apparatus operated from the house power lines. We shall continue to publish data on its reduction as it comes into "The Corner." Here is a new and logical slant on the subject from BORIS S. NAIMARK, with the Riverside Auto Supply and Radio Company, of 4746 Broadway, New York City, general service and dealers in Colonial and Steinite:

"In my experience as a serviceman I have learned that some of the finest B power packs produce a hum which is quite pronounced during the silent periods of a radio broadcast. If a thorough examination of the operating conditions discloses that such a trouble is caused neither by the electromagnetic coupling between the power unit transformer and the receiver proper nor by an improperly biased last audio stage, the remedy described below will be found effective in reducing the hum.

"It is a well-known fact of electrical engineering that the inductance of a choke (audio) increases with any decrease of direct current flowing through it. Thus, if we could only keep out of the chokes used in the power pack the direct current ordinarily drawn by the power tube in our last audio socket, the filtering action of the remainder of the current supplied by the power pack would be increased.

"A study of the diagrams below will illustrate just how this can be accomplished by taking the high-voltage tap off between the chokes, as shown, instead of from the output side of the second choke. Such an arrangement will reduce the filtering of the current supplied to the power tube, but will improve the filtering of the B current supplied to those portions of the set's circuit that are most susceptible to a.c. hum, i.e., detector and first a.f. tubes."

Center-tapped resistors: FRANK FOLSOM, of the Flint Broadcasting Company, operating station WFDF in Flint, Michigan, and specialist in Radiola service, finds resistor troubles at the bottom of many hum complaints:

"I want to take this opportunity to pass on a few wrinkles that I used recently. One example is the case of an a.c. receiver taken out of a table model cabinet and installed in a console cabinet with dynamic loud speaker. The set was installed in a home but the customer complained of a hum which was very disagreeable. One of the troubles was that the center-tapped resistor across the 1.5-volt line was open. This, of course, was replaced and the set was returned to the home. Still a very bad hum was present. The trouble was located finally in the dynamic loud speaker which was located too close to the detector tube. It was impossible to move either set or loud speaker enough to help, so by shielding the dynamic loud speaker and grounding it all objectionable hum was eliminated. As a safety measure a 1-mfd. condenser in series with the ground lead was used.

In these days of good and inexpensive all-electric radio equipment, it may seem illogical that many receivers, originally designed as battery sets, are in everyday service in thousands of homes throughout the country. The serviceman runs into many of these, and invariably encounters the problem of modernizing this equipment, in reference to the audio channel, and in rearranging it for operation from the house current. How do YOU handle this job? Exactly what equipment do you use, what do you pay for it, and how do you figure your profit? How long does it take you to do the job? We are making an effort to collect information on this subject.
—THE EDITOR.

"I have found that by inserting a 1000-ohm variable resistor from the center-tapped resistor on the 226-type tubes to the negative B wire the hum can be reduced; then by measuring the amount of resistance in the circuit with a bridge the desired value can be obtained by substituting a fixed resistor. This also helps in suppressing oscillation and improves the tone.

"Sometimes you can minimize a persistent hum by shielding the 227-type detector tube and grounding it.

"In my experience as serviceman the customer usually doesn't understand very much about taking care of his set and if you take a little time to explain as fully and as simply as possible what he should do and also what he should not do to his set you will be rewarded with his business again. Try to impress upon him that you want to help him get more service for his money and not that he is not supposed to know anything about such complicated things as a radio.

"Many descriptions of servicemen's kits have been printed. I carry everything I need in a cornet case which has clips to hold screwdrivers, pliers, etc. so they will not juggle around and break my meters. By having a place for everything and keeping everything in its place in your kit you are not so apt to lose or misplace your tools."

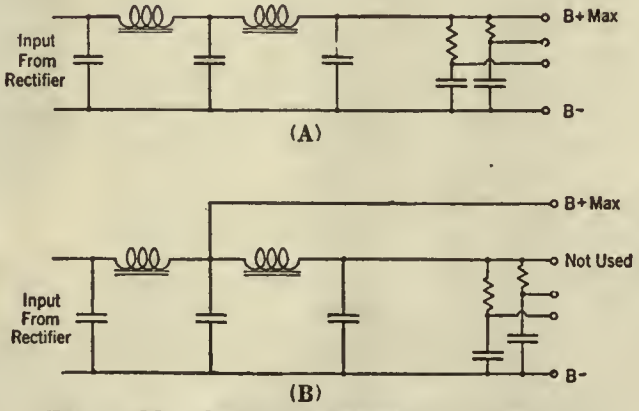


Fig. 1—Mr. Naimark's suggestion (B) for the reduction of hum by eliminating the current to the power tubes through half the chokes; (A) shows the usual circuit arrangement.

Some Cases of Noise

ON A RECENT tour of western New York state, the editor of "The Serviceman's Corner" had the opportunity of talking over service problems with a dozen or so active experts who are servicing in urban and rural districts. It was a general concensus that while noisy reception was directly responsible for only ten per cent. of all service calls, unnecessary noise was present in no less than sixty per cent. of all service cases. Set owners, it appears, often take noise as a necessary concomitant of radio reception, and hesitate to call in a serviceman for this trouble alone. However, clearing up noise, in the course of other service work always results in greater satisfaction to the client. The following contributions on this subject will be of value to all servicemen:

The noisy volume control: "I read the tip regarding noisy volume controls in *Fada Sales*. When it becomes noisy it is all right to shut off the set and turn the knob back and forth a few times, but this will do only temporarily, because it will come in a few days or hours. Here's my idea of cleaning the volume control. Take out the volume control, and with your pen knife scrape off the oxidation. Do this to the arm and element, making a clean line. When the arm is unremovable, as it is in some sets, be careful not to bend the arm too much or it will not run tightly and the trouble will appear again. I don't like to use emery cloth or sand paper because the sand grains will give trouble in a short time. If after many knife scrapings the volume control continues to cause noise then it is best to put in a new control."

WALTER OSTROWSKI, JR., Radio Station W9CMX, Chicago, Illinois.

Queerly enough, some servicemen recommend a touch of grease between the contact arm and the element in a noisy volume control. C. F. REXER, of Grinnell Brothers, Pontiac, Michigan, is among the fraternity in favor of a little judicious oiling.

The lightning arrester: "As I am engaged in the reduction of interference for my company I run into some strange things that may be of help to some of the

others who are employed in the same game. Here's one:

"This trouble was experienced on a Bosch all-electric set and manifest itself as a loud buzz at one spot on the dial. The noise would would rise and fall in volume and would cover the whole dial at times.

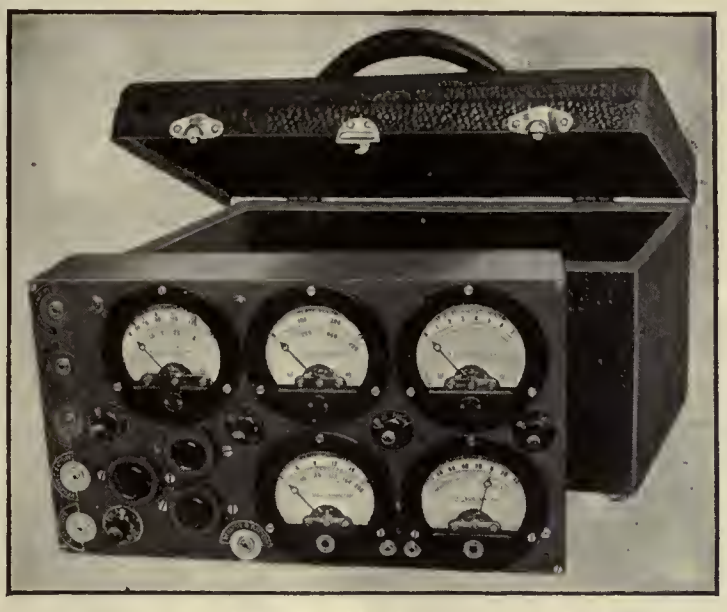
"It could not be heard outside of the house with a portable superheterodyne and disconnecting the antenna and ground stopped the noise. The wiring in the house was inspected but nothing was found. After much scratching of heads we decided to disconnect the lightning arrester. This stopped the noise.

"The arrester was taken into our shop and tested for short circuit, and, with a high-resistance voltmeter and a 110-volt battery, it would show a very irregular swing of from 50 to 100 volts.

"On breaking open the arrester it was found that the brass points were set in the porcelain with melted sulphur which had corroded until it would pass current between the gap.

"It may have been due to moisture as the arrester was mounted in such a way as to let water run down into it if there were a small crack in the sulphur filling."

J. E. Deiners, w9cv, Kansas Power Light Co., Topeka, Kansas.



The Hickok No. 4600 a.c. test set listing at $135.00. This test set contains the necessary shunts and resistors for practically every type and continuity encountered in servicing work.

More trouble with arrestors: J. P. Howard, of the Fayette Tire and Battery Service of Fayette, Mo., dealer in Crosley, Bosch, and Majestic, comes to a similar conclusion.

"As a serviceman I have found a defective lightning arrester causing trouble in several cases. The symptoms in each case were weak distorted signals or none at all.

"The trouble was located by disconnecting the antenna or ground from the arrester while the set was in operation and noting the change in reception.

"In one case the terminals were found to be directly shorted. In several cheaply construeted arresters, moisture was found across the insulation due to defective sealing."

Pilot lamps and noise: "a call for aid in eliminating a noise of this nature, tick, tick, tick, for all the world like an arc light doing its bit, was received recently. The rub was that it was daytime with no lights burning. Investigation failed to located the offending tick and the set was about to be sent back to the shop when it was noticed that the dial light was flickering; and when replaced by another the trouble ended."

Raymond Wafner, Erie, Pa.

Archie Klingbeil, of the thriving metropolis of Ashtabula, Ohio, veteran contributor to "The Corner," ran into pretty much the same thing:

"A source of varied and intermittent crackling noises in an a.c. receiver was accidentally discovered to have been caused through the vibration of the receiver from loud speaker volume on certain tone frequencies, which in turn vibrated the small dial light bulb, making and breaking the bulb circuit rapidly at intervals and causing a short series of occasional craekling. This bulb was only slightly loose, and the vibration was so rapid and intermittent that it was noted mercly as a variation of light intensity through the figure scale when we chanced to be looking at the scale. When the bulb was at rest it was not loose enough to become extinguished."

Noisy Transformers: "Transformers in the audio systems of modern radio sets often become 'noisy,' that is, cause a scratching noise in the output of the set. A good remedy for this, while not always successful in curing a transformer which has become noisy, is to short the highest B-power unit (or battery) voltage across the offending winding. Very often a transformer that has been shorted in this manner will operate satisfactorily for a long period of time."

W. Gordon Genner, Jr., Great Neck, N. Y.

Another case of "static": We have published before something along the complaint recorded by B. F. Steiger (an electrical engineer with a large radio manufacturing company) but as this condition is apparently somewhat prevalent, we feel justified in the repetition.

"A peculiar case of radio interference was encountered recently in connection with a sensitive a.c. receiver. The latter, located in the dining room of a residence, emitted the most ungodly static when anyone walked up or down the cellar stairs. As the receiver was grounded to the steam radiator system, it was at first thought that a loose joint in the steam pipes caused the noise, when vibrated by the passage of a person on the stairs. Rather than attempt to locate the supposed loose joint, the receiver was grounded to the plate of a baseboard a.c. outlet. (Baseboard outlet plates are grounded in many house wiring systems, forming a very convenient ground for a radio set.) However on negotiating the cellar stairs again, the static persisted undiminished. After carefully examining the steam and water pipes under the stairs a place was discovered where the BX conduit of the house wiring, rubbed lightly on a steam pipe. Upon separating the conduit from the pipe, the trouble was cleared up. Since the radiator system and the BX conduit were both grounded, it is not clear why rubbing the two together should cause a noise in the receiver. Possibly, paralleling the two ground systems changed in the ground-antenna constants of the receiver suffieiently to produce the disturbance."

B. F. Steiger, Newark, N. J.

Noisy detector tubes: Mr. Steiger has also run into noisy a.c. detector tubes:

"With the advent of power-operated radio receivers, the question of 'noise' interference has increased in importance. Much of this interference cannot be corrected, but some, however, is curable.

"One cause of curable noise, which is frequently overlooked, is the cathode deteetor tube of the 227 type. Numerous cases have been encountered, in serviee work, where disturbances, having all the ear-marks of line noises, have been traced to this tube. For example, there is the 'snoring' detector, a common trouble maker. This disturbance manifests itself, in the loud speaker as a noise repeating itself at more or less regular intervals and sounding exactly like a person snoring. With some tubes, the snore is loud and annoying, with others, weak, and noticeable only at low volume. Sometimes the snore may vary with a code-like disturbance, or even a scratchy static sound. The noise may start as soon as the tubes are warmed up, or an hour may elapse before it appears.

"The deceiving thing about the 'snorer' is that most 227-type tubes do it to a greater or less degree. Thus changing the detector tube may not locate the trouble unless the replacement tube is free from the disturbance. Tubes which are bad offenders usually show a pronounced flicker in the heater filament.

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"In addition to the above mentioned disturbances, several rarer cases have been encountered, among which two of special interest will be mentioned. In the first case, reception rose to normal volume and then died out, repeating the performance in a regular cycle. In the second case, a slight whistle interfering with reception built up and died down periodically. Both of these troubles were caused by defective heaters which open circuited when the cathode warmed up and closed again when the cathode had cooled off.

"Recently, some experiments were made with the Arcturus 127 tubes. While the few tubes tried were found to be absolutely free from the above-mentioned disturbances, the tests were not exhaustive enough to prove anything conclusive."

A Book for Servicemen

RADIO TROUBLE SHOOTING, by Enno R.Haan, E. E.:

This is a book by an associate editor of *Popular Mechanics Magazine*, and is published by the Goo dheart Willcox Company. It is written as an elementary practical manual for the average serviceman, and as such it fills the bills effectivcly. While I should hesitate to say that no serviceman should be without it, certainly most servicemen, and par ticularly the beginner, will benefit greatly by reading it and then keeping it handy. There are excellent chapters on tools, equipment, service procedure, installati on, and specific and general trouble sh ooting. The book, today, is thoroughly up to date, and should be valuable as a ref erence work for several years to come.



Frank Folsom of WFDF who services Radiolas on the side and gives serious thought to the problems of hum reduction.

Items of Interest

¶WE HAVE commented before on the difficulty experienced by independent servicemen in securing reliable data on different receivers directly from the manufacturers. As a large percentage of all service work must inevitably be carried on by the independent serviceman, and the ultimate reputation of any set manufacturer rests upon the service obtained by the owner, it is obvious that the manufacturer is doing a four-fold injustice to himself, his dealer, the serviceman, and the set-owner in withholding this information from any reliable servicemen regardless of whether or not he retails that particular receiver.

¶MELVIN L. SHOOK, of Shook and Jones, radio maintainance and service, of Akron, Ohio, writes:

"Here is something that may interest you. Needless to say, as soon as I receive the latest edition of RADIO BROADCAST the first articles I read are those on *Service*. Well, a couple of months ago, I happened to read John Dunham's article which said that the wide-awake radio manufacturer would be glad to send service data to service concerns, if said service concern wrote on their business letterhead. I immediately wrote to 28 of the possibly 35 known radio manufacturers. Twenty one sent us their manuals, two others charged fifty cents and one dollar, respectively (We don't mind paying for a manual if it is any good), one never answered, and four refused.

"While we have only 14 makes of the various 28 sent for, represented on our customer file, the manuals have facilitated things considerably, and we have the data for the sets of future customers.

"We find it helpful to examine the circuit diagram of the set to be serviced before starting to service the set, no matter how many times we have serviced that same model before.

"The four manufacturers that refused were: R.C.A., Temple, Bosch, and Stromberg-Carlson. The latter two referred me to local dealers—a futile source of information for independent servicemen."

¶*The I. R. E. 1929 Year Book:* A publication of considerable interest and value to the serious serviceman—the expert verging on the engineering side of his art—is the *1929 Year Book of the Institute of Radio Engineers*. This publication is available to non-members from the Institute at 33 West 39th Street, New York City, for $1.00. Over one hundred pages of the Report of The Committee on Standardization make up a volume of authentic and useful radio information from the definition of radio terms to the description of standard tests on radio receivers. Some of this latter material will be of use to the general serviceman.

Letters from Servicemen

A FEW NOTES on the economics of servicing: "Dear Ed.: Here's my idea of how much a serviceman should charge. This is when service calls are made in the city. I don't know how much to charge the out-of-town service calls because I never had one.

"When I come in a house to service a radio set, the customer does not pay me for the work I do but for how much I know. Here's an example. I walk into the parlor and turn-on the switch for the set. If I find that the set is giving insufficient volume and a tube is the cause of it, I replace the defective tube. My charge is two dollars for the call plus the retail price of the tube. I never give or service a set on trust. This is bad business.

"If I find from routine tests that there is a broken connection or something is burned out then I will most likely take the set to the repair shop. However, if I can fix the set right then and there, I will, so as not to keep the customer waiting and putting a burden on my shoulders. If a transformer or fixed condenser is blown, right to the shop it will go, where I have no interference. This is how I charge on sets brought in. The service call is a standard two dollars. If anything is blown or burned out I charge the retail price for replacement. I also charge two dollars per hour on repairing. Even if I work only a half or three quarters of an hour, I charge two dollars. In this way of charging I am not the loser and no other good radio serviceman should be. When a customer calls on you he expects you to fix up his set properly and he also expects a bill. Some servicemen find that customers will not pay. With my system, if I have the set in my hands, I do not take it back until the bill is paid. If I put the set in the console and make it work and they refuse to pay the full amount, then, after several unsuccessful attempts of collecting, I put his name on my black list which means that no service until the bill is paid."

WALTER OSTROWSKI, JR., Radio Station W9CMX, Chicago, Illinois.

A new phase of real service: "I am in the service business as far as the locating and cure of radio interference is concerned. But after all that is one of the most important branches. This work is not limited to our sets but to everyone that complains of interference to the power company.

"We have a truck equipped for this work—a standard half-ton panel body—and in it there are three sets, a Radiola 26 super, a four-tube radio-frequency set and a three-tube set on loop. All sets are portable. These sets are mounted on spring supports to take the shocks away from the tubes.

"We also carry all kinds of filters, choke coils, and condensers so that most any kind of a cure can be recommended.

"In my work I have found most everything in the catalog that interferes and some that are not in it. Some of these things would no doubt be of interest to others that are in the same game and a help to those that are trying to clear up their town to increase sales."

J. E. DEINES, W9CV, Kansas Power Light Co., Topeka, Kansas.

Telephone Directory Advertising: "Unintentionally we have become specialists in servicing one make of set. In running an advertisement in the classified section of the telephone book, we used a small Fada cut mainly to make the copy more prominent and compelling to one glancing through that section. This has brought in quite some Fada service, and is, in fact, the only advertising that seems to pay for itself. Outside of that we have been taking care of everything that has come along. I think I have run into almost every breed of receiver at one time or another, old ones, new ones, and plenty of trick ones."



Boris S. Naimark who describes himself as a "temperamental debutante."

E. D. MORELL, Service Radio Laboratory, East Orange, N. J.

Messrs. Doubleday, Doran & Co.

announce the selection of Mr. Russell Doubleday *as Editor of* World's Work. *From the conception of the idea of this magazine and from the publication of its first issue,* Mr. Doubleday *has been closely associated with it. His work with this house, including his connection with the management of its periodicals, his authorship of several books and, in recent years, his services as editorial head of its book publishing department, has given him a sympathetic understanding of the aims and purposes of* World's Work; *and so, our loyal friends and readers can confidently be offered the assurance that the highest ideals of the founders and former editors will be upheld.*

On the following page is reproduced a memorandum from the Editor to the Circulation Manager. It is printed here because of its interest to the thousands of men and women who have followed this magazine for nearly thirty years.

May 29th, 1929

Dear Mr. Eaton:

Now that the WORLD'S WORK is about to enter its thirtieth year it seems fitting that its ideals and convictions should be restated and some suggestions made of its history and background. I was fortunate in being present at the modest birthday party of the WORLD'S WORK and took part in many of the discussions in early 1900 when the plan and scope of the magazine were fixed.

Walter Page, in the opening editorial of the first number, forecast the position this country was to occupy in world affairs and with amazing prescience and clearness set forth our national responsibility and our opportunities for usefulness, and the part the magazine hoped to play in these foreseen great events. He ended with this paragraph:

> *It is with the activities of the newly organized world, its problems and even its romance, that this magazine will earnestly concern itself, trying to convey the cheerful spirit of men who do things.*

The founders of the magazine believed very definitely in certain principles. This being a forward-looking country just emerging from its pioneer days the WORLD'S WORK should express that spirit. It was believed that the wrongs, the mistakes, and injustices should not be ignored but the remedies should also be set forth. Great progress in industry, in government, in science, in art, come through the power and genius of man, so, much of the magazine was to be devoted to fact stories of men and women who do things. It was believed that beauty and interest should go hand in hand and that good writing is not incompatible with sound information. I have heard Page say a thousand times: "But the man can't write!" and out would go the article. It was planned to illustrate the magazine with photographs or reproductions of great paintings because it was believed that good photographs carried conviction and could still be beautiful.

The WORLD'S WORK has for more than a quarter of a century been built month by month on these solid foundations and some notable achievements in periodical journalism have been given to the loyal supporters of the magazine during those momentous years.

It is with a mixed feeling of humility and confidence that I take up the work of editing the WORLD'S WORK: humility because I realize the greatness and capacity of Walter Page and his successors and because I

quite understand that comparisons will be made with their work and mine. But I have some confidence also, because I have lived with the magazine since its birth. I have worked for it, had to do with its management, written for it—at times suffered when it did not come up to its best standards, and was cheered when it did its job well, as often happened. If this varied experience is helpful in editing the WORLD'S WORK, I am fortunate. I believe it will be useful in my new job.

Certain of the characteristics (I will not call them features) of the WORLD'S WORK which have been rather lost sight of recently, we shall restore. The March of Events, that summary of important doings here and abroad, will be put back in the front of the magazine. We hope to make it vigorous, interesting, and progressive. The financial articles will resume their rightful place. Authoritative information was never so much needed as today. The flood of new books makes a general survey impossible, but we hope to show their tremendous importance in our daily lives through an account of various human experiences. But of that more later.

All this is general. To be specific: We shall have the biographies of two of our important diplomats:

Myron T. Herrick, so many years ambassador to France, and Henry Morgenthau, who recently accomplished that enormous job of repatriating the Greeks. I wish I had space to tell you how he made the Bank of England turn over to him $50,000,000.

The disregard for law is one of our national sins. A series of articles by various authorities will be published on this subject. And an attempt will be made to lay the situation bare and then remedies will be suggested. An exposure of a sore is useless unless a remedy is suggested.

Much can be done to change and I hope improve the magazine in two or three months but you realize, I am sure, that it will take some time to get articles written and prepared for press.

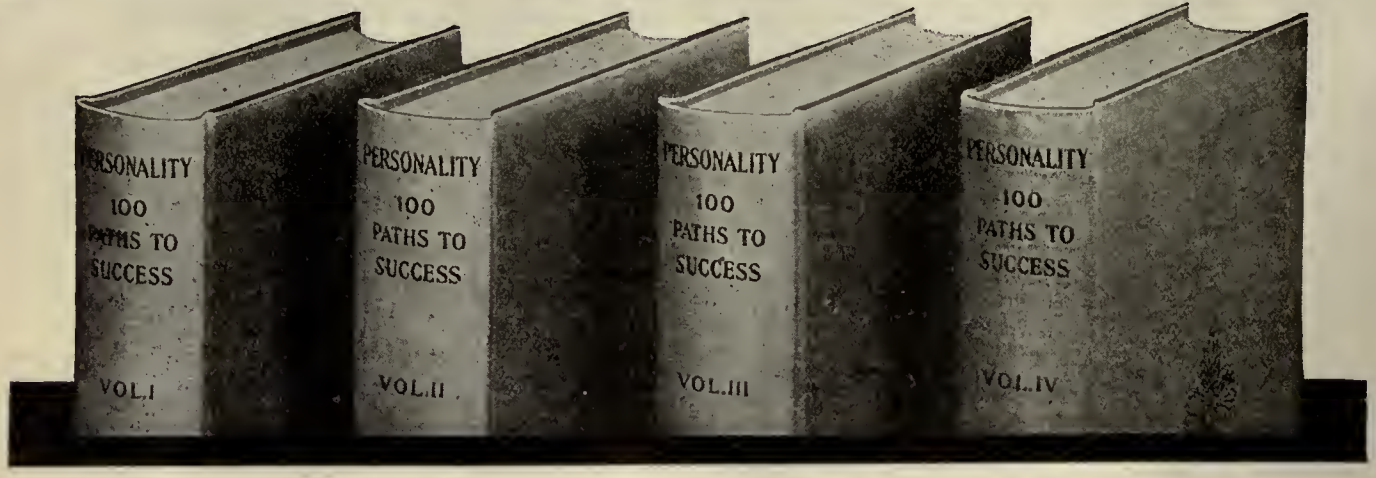
The WORLD'S WORK has a big job to do and I hope that I may count on you and all the able men and women in our business to help me do it.

Let us work together "to convey the cheerful spirit of men who do things."

Heartily yours,

Russell Doubleday

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A SULTRY NIGHT. Boston's waterfront showed but a dim silhouette of steeples, warehouses, and the feathery lacework of spars and rigging. A red-headed immigrant boy, starved and penniless, furtively crept from the steerage hold to the deck and dropped into the murky waters of Boston Harbor.

Desperation alone prompted "Old J.P." to risk being drowned in the dead of night rather than face immigration officials. This was a night on which the fates gave to our country a poor, unfortunate young man who but eighteen years later paid $346,000 for the New York *World!* Immigrant boy, soldier, mule hostler, stevedore—the remarkable life of Joseph Pulitzer truly reads like a chapter from the Arabian Nights!

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STRAYS *from* THE LABORATORY

Free Detector Voltage

A SCHEME FOR using the C bias of a power tube as the plate voltage for a detector is shown in Fig. 1. In this circuit the upper part of the C-bias resistor, which is in the center tap of the filament winding of the power tube, is more positive than the lower part by the voltage drop along the resistor. For example, this resistance is of the order of 2000 ohms with most power tubes and the voltage along it varies from 40 volts for the 171 tube to 80 for the 250 when worked at its maximum voltage. These voltages are of the same order that are required for detector plates. It is only necessary to connect the heater of the detector tube to the point of lowest potential on the C-bias resistor and the plate circuit as shown to apply this voltage to the tube in question.

The only advantage we can see is the decreased cost due to the elimination of one resistance, that used to lower the conventional 90 volts for amplifier tubes down to 45 volts. The disadvantage is that common coupling between two tubes is provided. If the condenser across the resistor is large, so that its reactance at low frequencies is small compared to the resistance of the unit, little a.c. voltage will be developed along the resistor and very little coupling between tubes should occur.

Radio and the Stock Market

THE FOLLOWING story may be interesting to those who either do or do not believe that the Federal Reserve Board should have anything to do with stock market speculation.

The wife of an economics professor in a southern university bought a little battery-operated Radiola—long ago. She was so interested and pleased with the set that she thought thousands of other people would be in the same frame of mind, and had a "hunch." If so many people were liking radio so much, stock of the Radio Corporation ought to be valuable. She learned from her husband exactly what to do and bought some Radio at about $80. After a little her stock went to $140 and taking her husband's advice sold out. Subsequently Radio went sky high as everyone knows.

In the same university a professor of English bought a Victrola and enjoyed it so that he too had a "hunch." He bought all the Victor stock he could on margin, breaking all the rules for conservatism and mortgaging everything he owned. When the Orthophonic came along his stock went up and up and after a little he sold out clearing something like $100,000. This is another one of those stories to which the reader must connect his own moral.

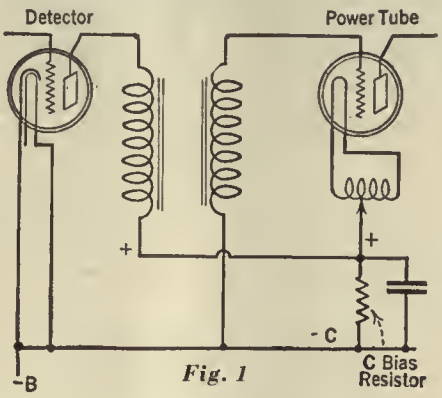


Fig. 1

Graf Zeppelin Transmissions

THOSE WHO listen on frequencies other than broadcast may want to keep an ear open for communications from and to the Graf Zeppelin when—and, if—she turns her nose toward the United States again. Her call letters are "DENNE" and instead of making "V's" she will send "ANNA" as test letters. Her high frequencies are 5677, 8470, 11,990, and 18,170 kc. She calls and answers on 143 kc. and listens on 600 kc. She will have schedules, probably, with Washington who will work on 8030, 12,045, or 16,060 kc.

Output of Rectifiers

IN AN article by R. J. Kryter, Prest-O-lite Storage Battery Company, on a method of using copper-disc rectifiers in connection with milliammeters as a.c. voltmeters, which is now in the editorial office and waiting its turn for publication, we find this interesting statement.

"The d.c. output into a resistance load of a perfect rectifier operating with a pure sine wave on its input is 0.901 times the effective a.c. input. Thus, the output current as read by a d.c. meter would be 90 per cent. of the true a.c. input current to the rectifier."

Measuring Resistance

AN INTERESTING and useful method of measuring resistors follows. It was taken from the service manual of Radiola 44. For resistors of 5000 ohms or less, use a low-resistance voltmeter. For example, the Weston Model 301 and 280 meters have sensitivities of 62 ohms per volt which means that a meter reading 100-volt full scale would have a resistance of 6200 ohms.

Read the voltage of the battery and then put the meter in series with the unknown resistance and put this combination across the battery. Then the resistance desired may be calculated from

$$R=\left(\frac{E}{E'}-1\right)R_M$$

Where E = battery voltage
E' = voltage across battery and resistor
R_M = Meter resistance

For example, a 100-volt Model 301 Weston meter when placed across a battery reads 100 volts and when in series with a resistor indicates 55.25 volts. What is the unknown resistance?

$$R=\left(\frac{100}{55.25}-1\right)6200=(1.81-1)$$
$$6200=0.81\times 6200=5000 \text{ ohms}$$

Intelligent Servicemen

THE SERVICE DEPARTMENT of this magazine received a request for information on how to neutralize receivers. This came from a serviceman. He was told to saw off the filament prongs of a tube which he was to place in the r.f. socket of the particular stage he was to neutralize. Then he wrote back wanting to know if he should saw off the prongs of the power tube too, What's wrong with this story?

Eliminating Interference

THE BUREAU OF STANDARDS has issued a circular letter on "Elimination of Interference to Radio Reception." Such subjects as power noises made by electrical devices (X-ray machines, battery chargers, telephone ringers) power-line induction, electrical smoke precipitators, etc. are discussed. The paper is Circular Letter No. 182.

Short-Wave Schedule

Courtesy W. H. Merriman, *Wireless World*, London

Call Letters	Location	Wavelength & Frequency	Power	Transmissions
AFK	Doberitz, Germany	67.65 meters 4434 kc.	5 kw.	Mon. Wed. Fri. 6:00 A. M. to 7 A. M. 2:00—3:00 A. M.
AFL	Bergedorf, Germany	52 meters 5775 kc.	3 kw.	
EATH	Vienna, Austria	37 meters 8108 kc.		Mon. Thurs. 5:30—7:00 P. M.
FL	Eiffel Tower, Paris	32.5 meters 9231 kc.	20 kw.	Time signals daily 2:56 A. M. and 2:56 P. M.
5SW	Chelmsford, England	25.53 meters 11751 kc.	15 kw.	Daily except Sat. and Sun. 7:30 to 8:30 A. M. 2 P. M. to 7 P. M.
HB 9OC	Berne, Switzerland	32.0 meters 9375 kc.		Mon. Tues. Sat. 3:00—4 P. M.
YR	Lyons, France	40.2 meters 7463 kc.		Daily except Sun. 11:30 A. M. —12:30 P. M.
RFN	Moscow, Russia	50 meters 6000 kc.		Tues. Thurs. Sat. 8:00 A. M. to 9:00 A. M.
PCJ	Hilversum, Holland	31.88 meters 9590 kc.	25 kw.	Thurs. 2—4 P. M. 7—8 P. M. Fri. 8 A. M.—11 A. M. 2—4 P. M. Sat. 8 P. M.—2 A. M.
PCL	Kootwijk, Holland	18.4 meters 16300 kc. 38. 8 meters 7895 kc.	25 kw.	6 A. M.—10 A. M. 10 A. M.—8 P. M.
PHOHI	Huizen, Holland	16.88 meters 17779 kc.	40 kw.	10 A. M.—noon
7LO	Nairobi, Kenya Colony	31 meters 9677 kc.		11 A. M.—2 P. M. 2—3 P. M.
JB	Johannesburg, South Africa	32 meters 9375 kc.	1 kw.	Daily 2—6:45 P. M.

WHAT SERVICEMEN SHOULD KNOW

By JOHN S. DUNHAM

QRV Radio Service Inc.



John S. Dunham

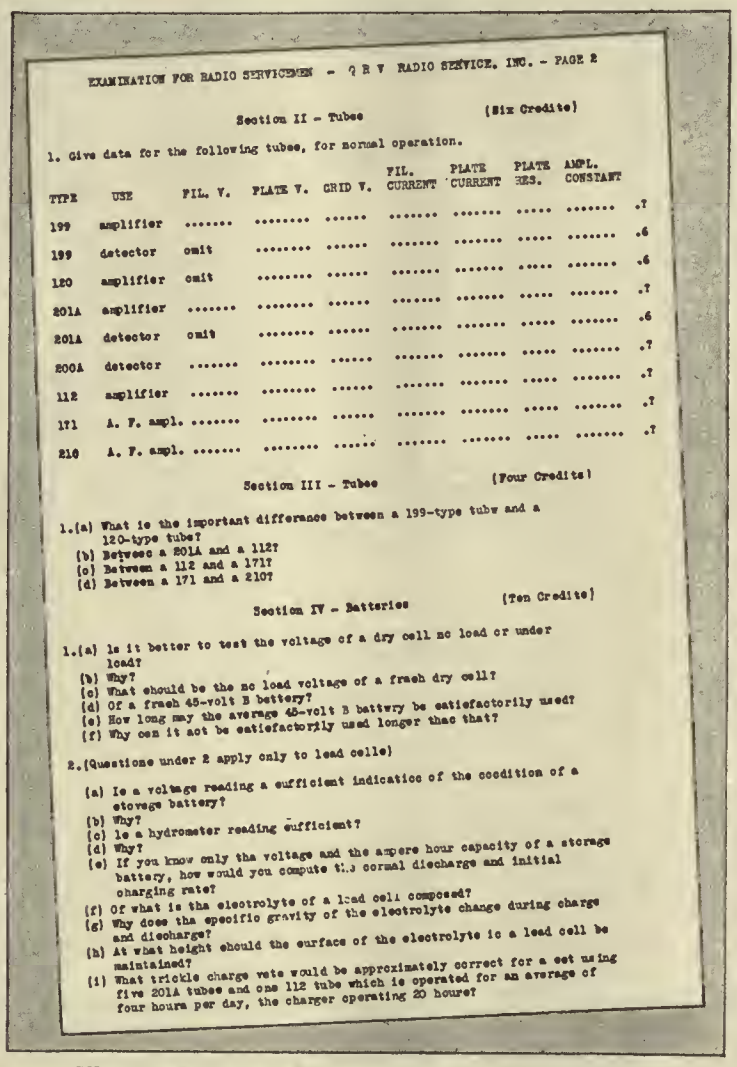
WHAT INFORMATION must a serviceman have about tubes and batteries in order to service properly radio receivers? Of what practical value is a knowledge of the plate, filament, and grid voltages, filament current, plate current, plate resistance, and amplification constant of all the standard tubes in use? When can a serviceman find definite use for information on the life of B batteries under various current drains? Here are certain definite questions—and our answer to them is that such information is almost essential if a man is to service all types of receivers quickly and satisfactorily. That the writer is of the opinion that servicemen must have such knowledge is indicated by the examination (see page 405, August, 1929, RADIO BROADCAST) which is given to all newcomers in his organization. In this organization a serviceman without this knowledge would be

An idle member and good for nothing

—Russus Ephesius.

If there is one characteristic peculiar to the radio industry it is the number and variety of designs which it produces annually. These tricks and changes in circuit arrangements will put any serviceman on his mettle and they will put the serviceman with practical experience only at a distinct disadvantage in comparison with the man who has added to his practical experience the knowledge we have found so essential.

We realize quite fully, however, that many servicemen feel that they can get along satisfactorily without this knowledge—they damn it with the triumphant question, "Of what use is it?" Therefore, we will discuss the subject for the double purpose of showing employers the knowledge which their servicemen should have in order to build up customer satisfaction and of showing servicemen how they may increase their ability.



EXAMINATION FOR RADIO SERVICEMEN - Q R V RADIO SERVICE, INC. - PAGE 2

Section II - Tubes (Six Credits)

1. Give data for the following tubes, for normal operation.

TYPE	USE	FIL. V.	PLATE V.	GRID V.	FIL. CURRENT	PLATE CURRENT	PLATE RES.	AMPL. CONSTANT	
199	amplifier	.....	.....	.....	.....	.....	.....	.....	.?
199	detector	omit	.....	.....	.....	.....	.....	.....	.6
120	amplifier	omit	.....	.....	.....	.....	.....	.....	.?
201A	amplifier	.....	.....	.....	.....	.....	.....	.....	.6
201A	detector	omit	.....	.....	.....	.....	.....	.....	.?
200A	detector	.....	.....	.....	.....	.....	.....	.....	.?
112	amplifier	.....	.....	.....	.....	.....	.....	.....	.?
171	A. F. ampl.	.....	.....	.....	.....	.....	.....	.....	.?
210	A. F. ampl.	.....	.....	.....	.....	.....	.....	.....	.?

Section III - Tubes (Four Credits)

1.(a) What is the important difference between a 199-type tube and a 120-type tube?
(b) Between a 201A and a 112?
(c) Between a 112 and a 171?
(d) Between a 171 and a 210?

Section IV - Batteries (Ten Credits)

1.(a) Is it better to test the voltage of a dry cell no load or under load?
(b) Why?
(c) What should be the no load voltage of a fresh dry cell?
(d) Of a fresh 45-volt B battery?
(e) How long may the average 45-volt B battery be satisfactorily used?
(f) Why can it not be satisfactorily used longer than that?

2.(Questions under 2 apply only to lead cells)

(a) Is a voltage reading a sufficient indication of the condition of a storage battery?
(b) Why?
(c) Is a hydrometer reading sufficient?
(d) Why?
(e) If you know only the voltage and the ampere hour capacity of a storage battery, how would you compute the normal discharge and initial charging rate?
(f) Of what is the electrolyte of a lead cell composed?
(g) Why does the specific gravity of the electrolyte change during charge and discharge?
(h) At what height should the surface of the electrolyte in a lead cell be maintained?
(i) What trickle charge rate would be approximately correct for a set using five 201A tubes and one 112 tube which is operated for an average of four hours per day, the charger operating 20 hours?

This page of the QRV examination for servicemen contains the questions considered in this article.

Value of Tube Knowledge

FIRST LET us talk about tubes and see if we can't give some sound examples to indicate the value of a knowledge of tube characteristics. Probably the most familiar data on tubes is the filament voltage, E_f, required by the various types, but a knowledge of the filament current, I_f, requirements is perhaps not so common—and there are cases where knowing the filament current is essential. Take, for example, the case of a battery-operated radio receiver (there are still many in use) supplied with filament current from a storage battery. The job is to connect a trickle charger to the storage battery and adjust it so that it will keep the battery charged. Unless one is familiar with tube data and can determine the total filament current drain of the tubes in a set, there would be no simple way with the usual field service equipment, which does not contain an ammeter of sufficiently high rating of determining how much current the trickle charger would have to supply to keep the battery charged. On the other hand, if the serviceman has a knowledge of tube data he can calculate that the total current drain of a five-tube set, for example, is 1.25 amperes, since each tube requires $\frac{1}{4}$ amp. Multiplying by the number of hours the set is used per day, for example five, we get the number of ampere hours which in this case is 6.25. Because the battery is only 75 per cent. efficient somewhat more than 6.25 ampere hours must be supplied to keep it fully charged. Therefore, let us say that in the 19 hours (24—5) the trickle charger must supply 7.75 ampere hours. Dividing 7.75 by 19 gives 0.41 ampere as the current required from the trickle charger.

It is equally, if not more important, for the practising serviceman to know the plate voltage, E_p, and the plate current, I_p, requirements of standard tubes. In battery-operated sets, one must know the E_P requirements to determine how many B batteries are required and the I_P requirements to determine whether light- or heavy-duty batteries are necessary. In choosing a B-power unit to be used with a particular set, one must be able to determine whether the current and voltage the unit can supply is sufficient for the receiver. Suppose a particular radio receiver uses a single 171A tube supplied with 180 volts on the plate from a B-power unit and that the owner of the set wants it changed over to 171A's in push pull because the single tube overloads too readily. Will the B-power unit be able to supply sufficient voltage with the additional 171A in use? A knowledge of the plate current requirements of all the tubes in the set to which must be added the additional plate current drain due to the extra 171A tube would enable one to know definitely whether the total plate current consumption would be greater than that which could be supplied by the B-power unit.

Problems in A.C. Sets

THE ABOVE examples have referred particularly to battery sets but the increasing use of a.c. receivers should make it obvious that a knowledge of the E_p and I_p requirements of a.c. tubes is also essential. Sometimes when servicing an a.c. set the serviceman may have on hand the charts supplied by the manufacturer indicating the plate currents and plate voltages, but frequently such information is not available. If the average operating characteristics of the tubes are known, however, the serviceman will be able to know approximately, in most cases, the voltage values he should find applied to the various tubes. Similarly he will be able to judge whether or not the grid voltages are approximately correct. Without this information he can only guess—and guessing is a pretty certain indication of inefficiency.

A knowledge of the plate resistance and

amplification constants of various tubes is not as essential as is a knowledge of the plate, filament, and grid voltages and plate and filament currents, but, nevertheless, it is highly desirable. If one type of tube is to be substituted for another type it is generally advisable that they have about the same plate impedance. If a low-impedance tube is used in an r.f. amplifier in place of a high-impedance tube it is likely that the amplifier will oscillate. If one substitutes a power tube with an amplification constant of about 3, the 171A, for a power tube with an amplification constant of 8, the 112A, he would find that somewhat greater signal voltage would be required on the grid of the 171A tube to deliver the same output as was obtained from a 112A. These voltages might be high enough to overload the preceding audio amplifier tube. Therefore, when using a low-mu power tube in place of a power tube of a higher-mu, it is always advisable for the serviceman to consider the possibility that the preceding audio amplifier stage may be overloaded with a new tube in use.

Such information as this is not only valuable in this very practical manner, but is also useful as stock information to enable the serviceman to answer intelligently the questions of his customers when they ask why a 171A tube should be used in their set in place of a 112A or why the B-power unit they have will not be satisfactory with a new type of tube.

A knowledge of batteries seems perhaps to be a prosaic sort of information and perhaps, in the years to come when all sets are a.c. operated and batteries are simply a curiosity, servicemen will be able to get along without knowing very much about them. Nevertheless, we venture to prophesy that such information will prove of daily value for the next ten years.

Some servicemen feel that the right way to test dry batteries is simply by connecting a high-resistance voltmeter across them. It is not so, however. When batteries that have been in use for some months are to be tested, the set should first be turned on and be permitted to run for several minutes before measuring the voltage of the batteries. Dry-cell batteries recuperate considerably when not in use, and, if their voltage were measured without first turning the set on, it would show up much higher than would be the case with the batteries in service.

Testing Batteries

After much practical experience in measuring batteries we have found that good new dry cells which will have a long life show an initial no-load voltage between 1.55 and 1.6 and that B batteries show between 46 and 48 volts. Supposedly new dry cells or B batteries which show lower voltages under the same conditions are either not fresh or are of inferior construction. This is information which we have obtained after numerous tests and it is well worth while to keep these voltages in mind when installing new batteries. B batteries should be discarded when their terminal voltage under load is less than 37 volts.

In our examination we also test the applicant's knowledge on the care and operation of storage batteries. In this connection it should be pointed out that the method of testing batteries is not always fully understood. A voltage reading, for example, to determine the condition of a storage battery is of very little value and serves only to indicate whether the voltages of the three cells are approximately equal. The state of charge of an ordinary lead-cell storage battery can be determined most accurately by means of a hydrometer. When fully charged the hydrometer will read about 1250 and a battery should never be permitted to discharge below the point where the specific gravity, as indicated by the hydrometer, is less than 1100.

The height at which the electrolyte should be maintained is very important, especially when a rather high trickle charger rate is used. With such an installation there is liable to be considerable gassing and if the electrolyte is too high in the jars some of the acid spray will escape through the vent holes and cause corrosion of the terminals. If the electrolyte does not cover the plates, the uncovered portions will heat excessively and the wooden separators will be damaged. A knowledge of such things is obviously of daily usefulness in insuring the greatest life of the battery.



A view of the test bench installed in the Newark office of the QRV Radio Service, Inc.

Conclusions

We hope we have succeeded to some extent in our endeavor to indicate why we know information of this sort on tubes and batteries is so essential. We don't for a moment believe that the serviceman should be academic—he must be practical. But, figuratively speaking, we don't want to argue whether the horse or the cow is most useful. Both are essential just as practical and theoretical knowledge are essential to good service work.

The road to knowledge—any knowledge—is a difficult one. We can't personally conduct one along the way but have only tried to indicate the path. In a sense, when one takes the path he is a searcher into the unknown, but facts of importance may be in the path of any digger—though he digs only for potatoes.

The prime requisite in increasing one's knowledge is that the added information should be usable. We remember reading a sportsman's recipe for cooking porcupine which included long stewing with many changes of water. The recipe concluded with the advice to throw it all away without serving. Excellent advice under the circumstances, perhaps, but the writer can assure the reader that if he goes to the trouble of getting sound radio knowledge he won't have to throw it away without using.

IF I OWNED A RADIO STORE I'D MAKE IT PAY

(*Continued from page 199*)

profit of between $9000 and $10,000. You are spending $12,000 and going into the hole. Your business was making more than double the profit you thought it was, and you were spending over three times as much as you thought you were. This year you've paid your loan, on the dot, made another and paid that on the dot. You've done other things too. You've looked out for your collections, got your money in; your store looks better and more attractive; you buy your stock less wastefully. Now what are you going to do with your profits?"

"I need $1500 of them. The rest I'm going to keep in the business."

The banker who told me this story also told of doing the same sort of thing for an Italian fruit dealer and several others.

We make a great mistake if we think that the whole function of a bank is just to say, "Yes, you can have this loan," or, "No, you can't have this loan." Bankers themselves recognize their obligations to give advice and the profit there is to them in establishing confidential and advisory relations with their customers. While a banker may not always be able to give important advice on business promotion, he is always able to give the best practical ideas on the financial layout of a business.

Really there isn't an awful lot to learn in order to establish a business on a basis to take care of costs, profits, overhead, promotion, and expansion, but there are altogether too many who neglect these things and who fail where they might succeed if they knew just where they stood financially.

If I could put into my pipe-dream radio business the simple financial organization which I have been talking about and add to my equipment the belief I have in the immediate *possible* development of radio sales which a merchant can stimulate with good promotion material, I have a hunch that I might make a little money.

Personal good-will building, working capital increase, salesmanship, advertising, service—you or I may be better naturally at some of these things than at others, but we've got to have them all well covered to succeed and grow.

A MODERN DESIGN OF RADIO RECEIVER

VIRGIL M. GRAHAM

Radio Engineer, Stromberg-Carlson Telephone Manufacturing Company



Virgil M. Graham

IN DESIGNING modern radio receivers one of the principal problems confronting engineers is that of selecting the vacuum tubes to be used. This selection must not be made haphazardly as a well-engineered job must have a sound reason for everything.

The latest addition to the list of tubes which may be considered by engineers for use in the r.f. stages of broadcast receivers is the 224-type a.c. screen-grid tube. If the receiver designer contemplates using this tube in his radio amplifier stages he must satisfy himself that there are very definite reasons for employing it, other, of course, than the fact that it is new.

The designers of the receiver described in this article—The Stromberg Carlson Receiver, Models 641 and 642—studied the problem carefully and found very good reasons for adopting the a.c. screen-grid tube for radio amplifiers. The first consideration was, of course, the effect on fidelity of reproduction. Investigations showed that a material gain in this characteristic could be obtained when three radio amplifier stages with 224-type tubes were used as this made possible two improvements in the detector-audio system. One of these is the use of the "linear" power detector, which reduces to a negligible value the harmonic distortion common to the ordinary square-law detector; the other, dependent on the first, is the use of a single audio tube, the power output stage being fed from the detector. These advancements are made possible by the greatly increased radio-frequency voltage which can be supplied to the detector by a radio amplifier using 224-type tubes. Both

It is with considerable pleasure that we present this article by Mr. Graham, of the Stromberg-Carlson Telephone Manufacturing Company, for few organizations are as generally held in high esteem as the engineering department of this company. This article on the design of the new Stromberg-Carlson screen-grid receiver, models 641 and 642, will, we are sure, prove especially interesting and helpful to our readers.

—THE EDITOR

the above mentioned improvements depend on this increased radio-frequency voltage. (See "Detection at High Signal Voltages, Part I" by Stuart Ballantine, delivered at U. R. S. I.—I. R. E. Meeting, Washington, May 15, 1929.) A detector having linear characteristics—that is,

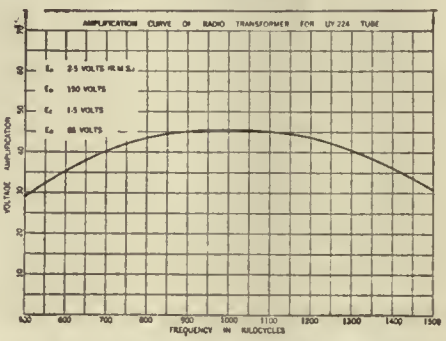


Fig. 1—Amplification curve of a radio transformer used with the 224-type tube.

characteristics which avoid distortion of the audio frequencies in the output when the signal has high modulation—is essentially a device which works on comparatively high voltages. A detector which supplies enough audio voltage in its plate circuit to enable the single stage of audio amplification also requires the high radio voltages whether it be of the "linear" type or not.

Let us now consider the second problem, namely, selectivity. The examination in this case showed that with properly designed radio-frequency transformers the 224-type tubes would enable the selectivity of the receiver to be improved appreciably. The very high plate resistance of this tube working into the proper transformer does not reflect as much loss into the tuning secondary as does the much lower plate resistance of an ordinary three-electrode tube of the 227 type.

The third and last of the main considerations with regard to using the a.c. screen-grid tube was that of sensitivity. Experiments quickly showed that increased sensitivity could be obtained without sacrificing any desirable characteristics of the receiver.

From the above brief analysis it is evident that the three major characteristics of any receiving set, namely the selectivity, sensitivity, and fidelity, may be improved through the use of screen-grid tubes in the r.f. amplifier. Having reached this decision, the next problem was to design circuits for the screen-grid tube. In solving this problem there were many questions for which we had to find the correct answers. Some of the most important problems were, of course, associated with the design of the radio-frequency transformer to be used between the screen-grid stages. Gain and selectivity curves were made on a number of different types, but in this article we will present only the data on the final model.

Description of Curves

FIG. 1 shows the voltage amplification curve of the radio transformer mentioned above, taken with voltage as applied to the 224-type tube that correspond to those used in the receiver.

Fig. 2 shows what is known as the "analysis" of the radio amplifier; that is, a series of curves taken to show the overall sensitivity and the relative amplification of each r.f. stage and the detector. The overall sensitivity is taken with the signal fed to the antenna and ground posts

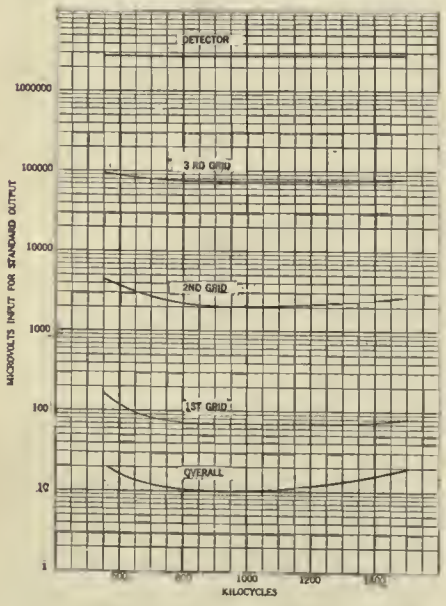


Fig. 2—An "analysis" of the screen-grid r.f. amplifier described by the writer.

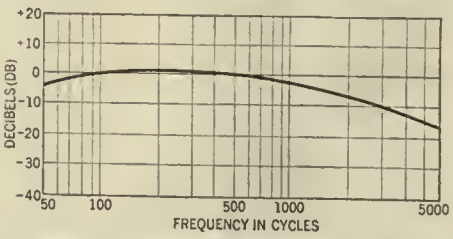


Fig. 3—Fidelity curve of the screen-grid receiver designed by Stromberg-Carlson engineers

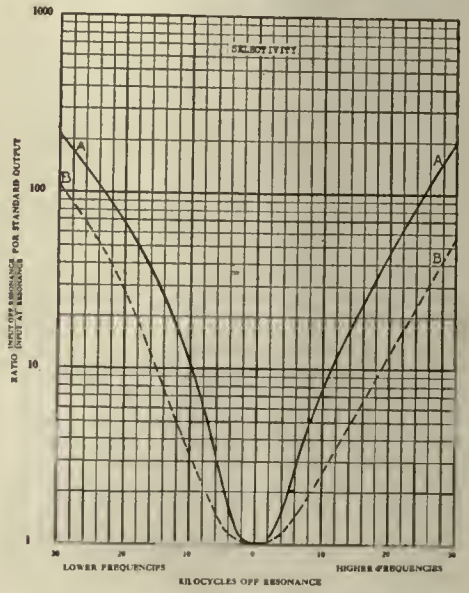


Fig. 4—(A) Selectivity curve of a screen-grid receiver; (B) curve of a standard good receiver.

of the receiver through the standard I. R. E. dummy antenna. The ordinates are plotted in microvolts for convenience and not in "microvolts per meter." The former unit may be converted to the latter by dividing by four (the standard antenna assumes a height of four meters). The curves showing the microvolts necessary at the various control grids to produce a standard output were taken with the signal fed to the control grid through a one-half microfarad capacitor and with the tuning system of that stage realigned to compensate any capacity from the lead wires to ground. Examination of these curves will show that the voltage gain in the antenna transformer is quite appreciable and that the distances between the curves for the successive grids are substantially uniform, allowing, of course, for the usual variation in tube characteristics. It will also be noted that the value of the voltage amplification agrees very well with that shown in Fig. 1, being slightly lower on account of the various leads which are present in the receiver but which are not used in the "ideal" set-up for measuring transformer characteristics only.

Fig. 4 shows the selectivity of the receiver taken at 1000 kc. The dotted line shows the selectivity of a good receiver employing 227-type tubes in the same number of radio amplifying stages. In taking these selectivity curves the interference output is not used, but they are plotted as the "Ratio of Input Voltage off Resonance to Input Voltage at Resonance for Standard Output."

Fig. 3 shows the fidelity curve of this screen-grid tube receiver. The ordinates are in decibels (DB) and show response throughout the range with respect to the standard signal obtained at 400 cycles as "zero level" or reference point.

Complete Shielding Needed

IN DESIGNING a receiver employing a. c. screen-grid tubes for radio amplifiers, as described above, where the radio voltage applied to the detector runs from three to ten volts, great precautions are necessary to insure proper shielding, adequate bypassing, and correct location of wiring. In this receiver the radio transformers are enclosed in seamless copper shields which have tight-fitting overlapping covers. These copper shields are $2\frac{1}{2}$ inches inside diameter and $2\frac{1}{16}$ inches inside length. The transformers are wound on $1\frac{1}{4}$ inch outside diameter formica tubing. The secondary of an interstage transformer is wound with 96 turns of No. 30 B & S enameled wire and the primary is wound over one end of the secondary "turn for turn." The primary consists of 53 turns of No. 39 triple-silk-covered resistance wire, the total resistance of the winding being about 380 ohms.

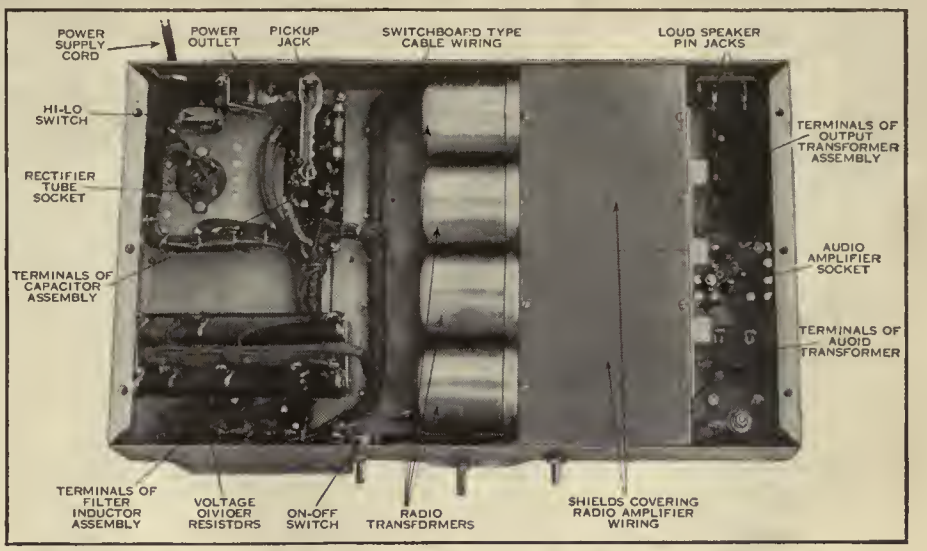


Fig. 5—Bottom view of the screen-grid chassis with all shields in place.

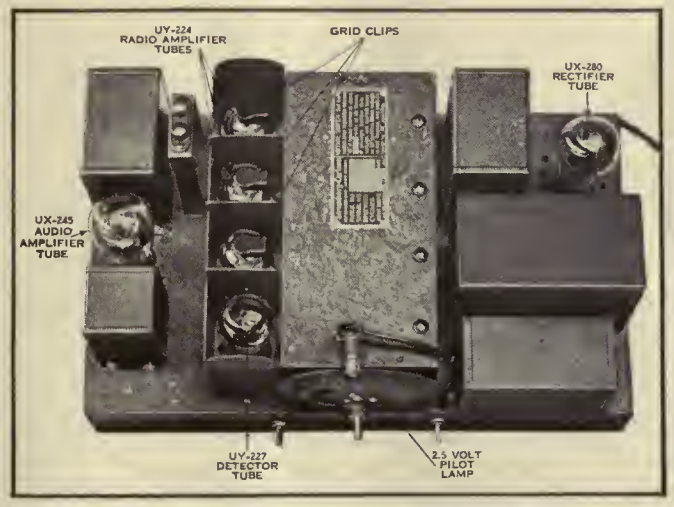


Fig. 6—Top view of the screen-grid chassis with covers over the r.f. and detector tubes removed.

Each unit of the variable gang capacitor is enclosed completely in a metal compartment and special short contact springs are provided to ground the rotors to the partitions between the units. Such short springs are necessary to prevent undesirable effects due to the inductance of longer springs. Fig. 9 shows the construction of the gang capacitor. The radio amplifier and detector tubes are each enclosed in a metal compartment adjacent to the corresponding units of the gang capacitor.

The by-pass capacitors are specially made, low-resistance units and have their lowest impedance at the frequency where maximum gain is obtained in the receiver. A radio-frequency filter in the detector output circuit, located close to the plate terminal, is employed to prevent radio frequency from getting into the audio system. This filter consists of a ten-millihenry choke and two 0.0005-mfd. capacitors in the usual pi arrangement. Fig. 6 shows the top view of the chassis with the tube cover removed and all tubes in place. Fig. 5 shows the bottom view of the chassis with the shields in place and Fig. 7 shows the receiver with the flat shields and the transformer shields removed. It will be noted that the arrangement of apparatus is such as to secure all shielding possible; for instance, the by-pass capacitors serve as shields between the radio amplifier tube sockets.

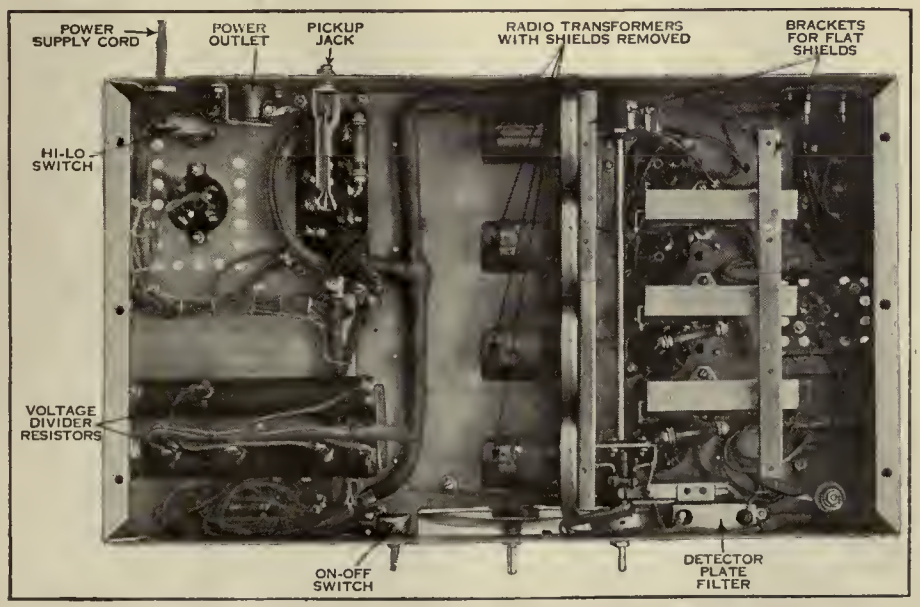


Fig. 7—Bottom view of the screen-grid chassis with all shields removed.

Schematic Diagram

Fig. 8 is the complete schematic circuit of the chassis. The secondary of the output transformer is designed to work into the moving coil of the built-in dynamic loud speaker and the current to energize the field of the loud speaker is obtained from the power outlet shown connected across the output of the rectifier tube.

The 227-type tube is used as a linear detector with automatic bias, the grid bias being adjusted automatically to the proper value for the strength of signal received. This type of detector does not overload

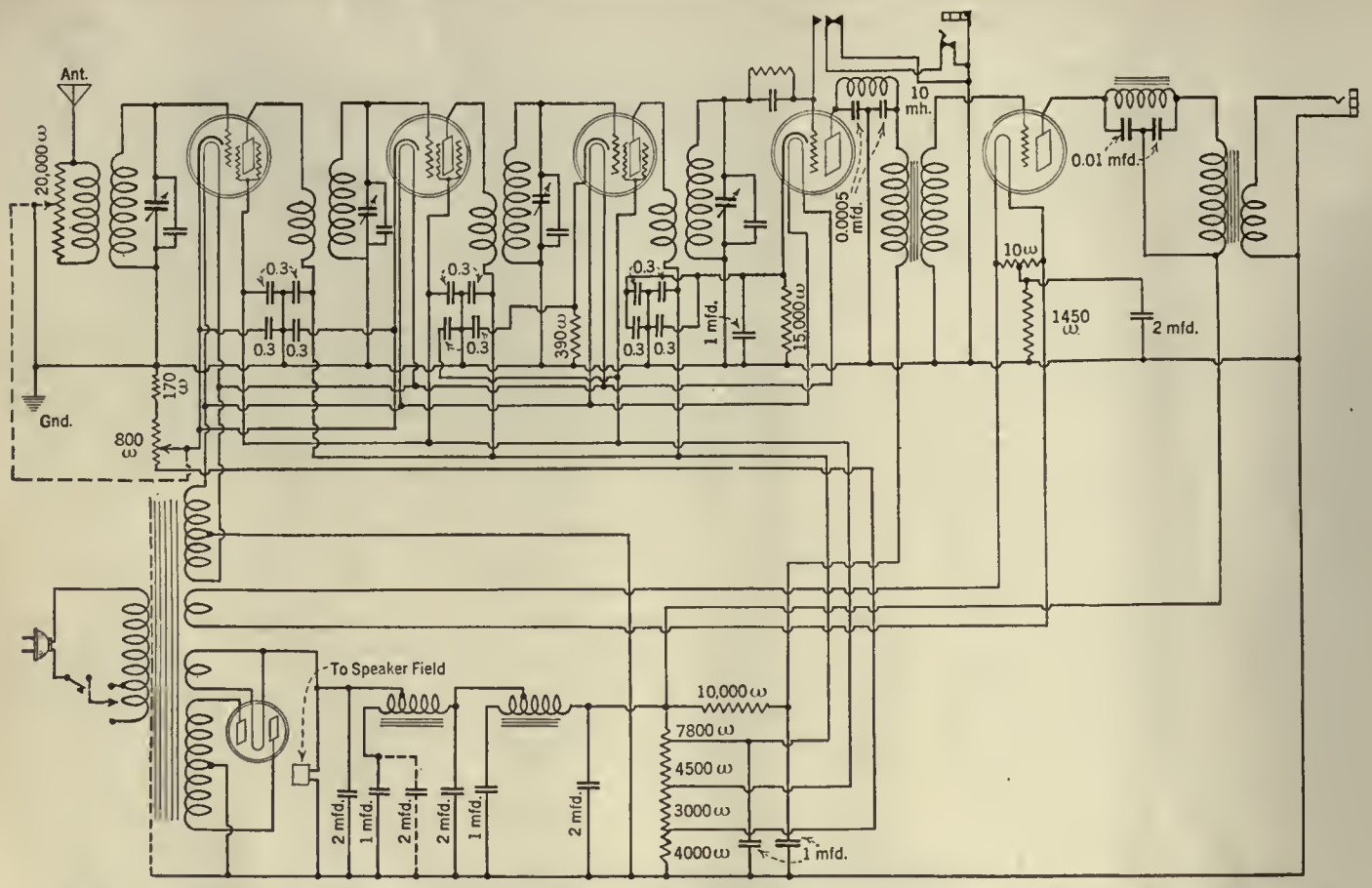


Fig. 8—Complete schematic diagram of the Stromberg-Carlson screen-grid chassis. This receiver is designed to operate in connection with a special built-in dynamic loud speaker.

readily and the output of this set is automatieally prevented from passing the level of serious overload and "blasting" in the power-output stage.

The circuit diagram also shows the double-aeting volume control, functioning to reduce both the voltage supplied from the antenna and the gain of the amplifier, It is arranged, however, so that the biases on the grids of the first two radio amplifiers are not changed until the signal is reduced greatly by the antenna input control, preventing distortion due to overload of the first radio amplifier tube. Such an arrangement is accomplished by operating two potentiometers by a single knob. The first is connected across the antenna primary ("high-impedance" type) with the antenna attached at one junction of coil and resistor unit and the lever or movable contact connected to ground. Thus, as the knob is rotated, varying amounts of signal are admitted to the radio amplifier. The second potentiometer is connected so that the biases of the control grids of the first two radio tubes are inereased as the signal into the radio amplifier is reduced by the first potentiometer. To prevent the overloading effeet mentioned above, this second potentiometer is construeted so that the bias voltages are not changed until the movable contact has traveled about one quarter of a revolution. This insures that the signal applied to the first radio tube is of small enough value to avoid distortion.

It will be noted that while the detector is of the plate-reetification type, there is a grid leak and capacitor shown in the circuit. These have nothing to do with the detector action, but allow the magnetic pick-up unit for phonograph operation to be connected direetly between the detector grid and ground without short eircuiting it through the radio transformer secondary, thus greatly simplifying the switehing arrangement necessary. The 0.00025-mfd grid capacitor also serves as a scrateh filter for the magnetie pick-up unit which is designed to operate with these receivers. The pick-up unit is connected for operation by turning the volume-control knob counter-clockwise.

The audio filter between the power tube and the output transformer is designed to secure the proper eut-off above the useful range of audio frequencies.

The B-Supply Circuit

THE B SUPPLY employs two stages of specially designed filter to secure the extreme filtering action that is necessary. The tapped induetors in the arrangement shown allow much greater filtering action

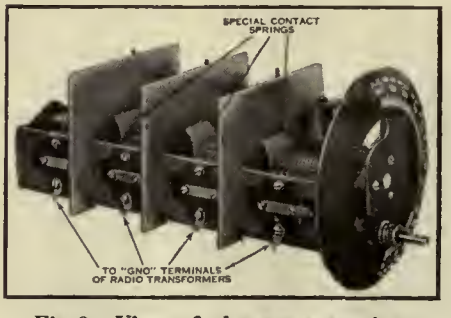


Fig 9—View of the gang tuning condenser unit showing special short contact springs to the rotors.

to be obtained per stage with the same amount of material than is possible otherwise. This additional filtering is aecomplished by a "bucking" action between the fields set up by the current in the two portions of the induetor, one in the main circuit and the other in the branch circuit in series with the capacitor.

There is little else unusual about the B supply. It should be noted that the speaker field circuit is conneeted directly across the output of the reetifier tube as indicated in Fig. 8. Although not so indicated the power transformer is arranged with four taps on the high-voltage secondary. The inside taps are used in the model 641 set which is designed for use with a magnetie loud speaker. Because of the extra load imposed on the filter system by the dynamie loud speaker used in the model 642, somewhat greater voltage must be applied to the reetifier tube and the outer taps are therefore used.

FRESHMAN ORGANIZES CANADIAN COMPANY

CHAS. FRESHMAN CO., INC. in conjunetion with Canadian interests has organized the Freshman-Freed Eisemann Radio Ltd. with headquarters located at 20 Trinity Street, Toronto, Canada.

This recently formed Canadian radio eorporation has issued $400,000 preferred stock and 1000 shares of common stock, all of which has been absorbed by private subscription. C. A. Earl president of the Chas. Freshman Co., Inc., heads the new corporation and George H. Gooderhan, of Toronto, is vice-president. The Board of Direetors includes C. A. Earl, Joseph D. R. Freed, and Warren J. Keyes, representing the Freshman interests and George H. Gooderhan, H. S. Gooderhan, W. S. Turnley, and K. S. MacLaeklan, representing the Canadian interests.

Over half a million dollars worth of business has already been booked by the Canadian Corporation and the new distributors and dealer outlets for both the new Earl and Freed Radio Receivers are being contracted for every day. The sets will be assembled in Canada under special Canadian licenses which have been granted by the Neutrodyne and other patent owners.

No. 29 *Radio Broadcast's Set Data Sheets* August, 1929

THE FEDERAL MODEL "L" RECEIVER

THE MODEL L receiver is not the first Federal set to utilize the new a.c. screen-grid tubes but this new set does constitute a distinct step forward in the design of screen-grid receivers. Because of the use of these particularly effective tubes and the new 245-type power tube, outstanding performance is obtained.

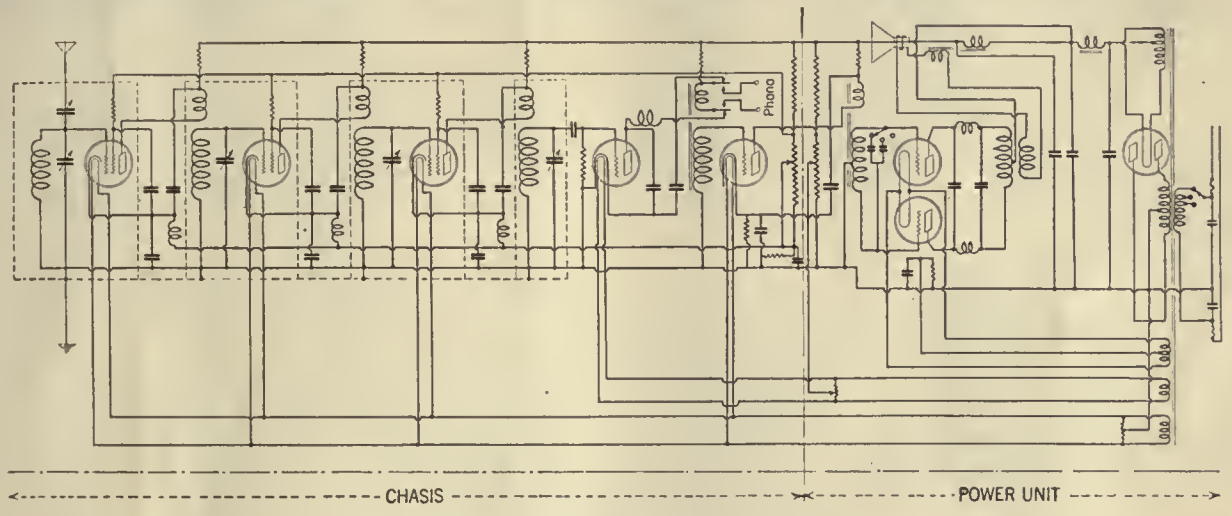
The receivers are housed in conveniently arranged cabinets. In the upper compartment of the cabinet is the radio set proper consisting of three stages of radio-frequency amplification, a detector, and the first audio-frequency stage. In the lower compartment is located a ten-inch dynamic cone, the second-stage audio-frequency amplifier, and the power apparatus. The radio receiver is mounted on a sliding shelf which may be withdrawn completely from the back of the cabinet, the shelf still acting, however, as an extensible support which holds the receiver while tests are being made or the tubes are being replaced.

If the radio receiver housed in the upper compartment were examined carefully it would be found to contain three stages of r.f. amplification with a tuned-coupling transformer between the antenna circuit and the first r.f. amplifier tube, a detector using special circuit arrangements, and the first stage of audio-frequency amplification. The elements of each radio-frequency amplifying stage, namely the tuning condenser, transformer, and a screen-grid tube, are completely shielded. In addition there is a second shield around each of the r.f. transformers and around each tube. All of the power leads to each r.f. stage are filtered thoroughly. This extreme care is used in the design of the set so that maximum gain will be obtained from the screen-grid tubes and so that the complete amplifier will be perfectly stable and free from distortion.

In the design of this receiver the vital dependence of the hum output on the design and circuit arrangement of the detector stage was realized and a dual type of hum eliminator was installed in order to keep the detector hum completely under control. The power amplifier circuit is composed of two high-quality push-pull transformers, a cut-off filter, a timber control, and, of course, the two 245 tubes. The cut-off filter eliminates the very high audio frequencies.

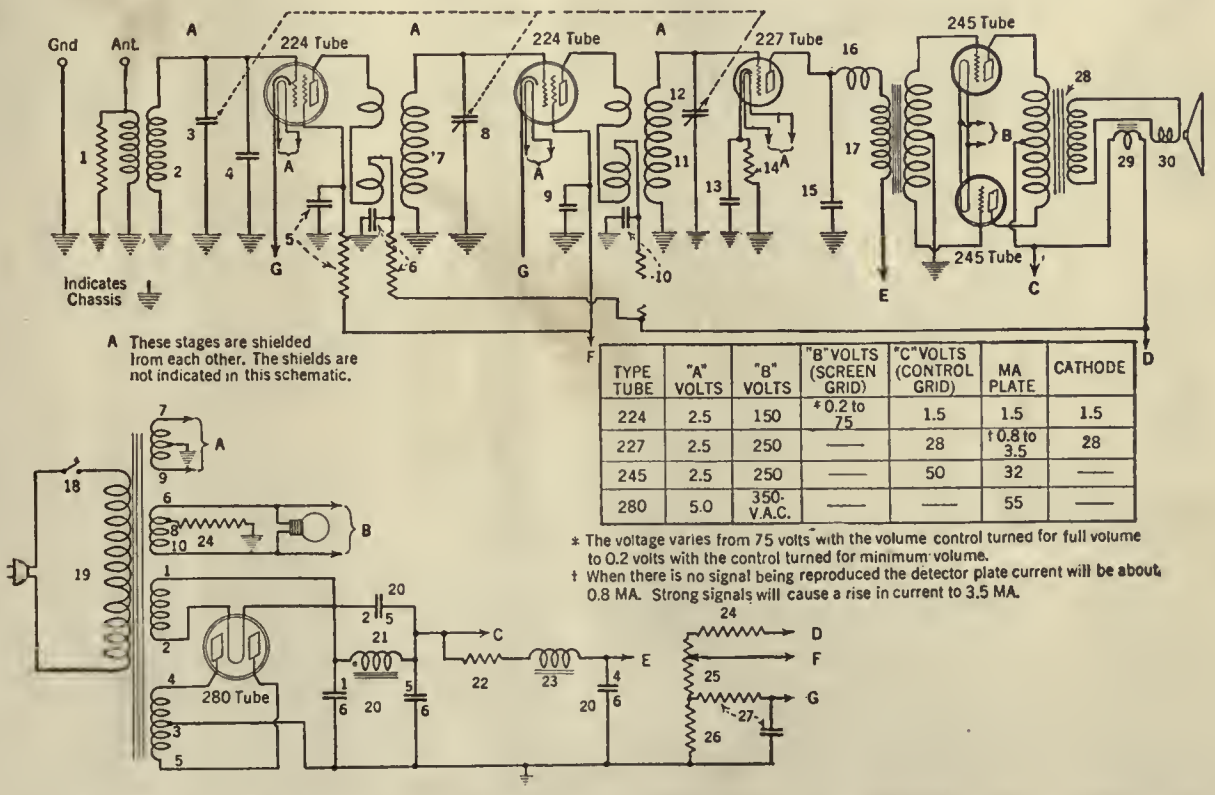
The timber control is an essential part of the receiver. It contains three positions, each having been given a name to indicate the type of reproduction it provides. These three names are utilized in connection with organs to indicate which stop is being used. The first position on the timber control is known as the "Clarion" stop which, as its name implies, gives very brilliant reproduction. It is especially useful in rooms that are acoustically rather "dead." If the set is to be used in more normal surroundings, the "Mezzo" stop should be employed. With this stop some brilliancy is sacrificed to secure somewhat better balance. This is the most useful of the tops and Model L receivers when shipped have the control set on the Mezzo stop. The third position is known as the "Bourdon" stop. With this stop considerable emphasis is given to the extremely low tones.

[Note: We are advised that changes in this circuit are being considered. If necessary, a revised circuit will be published—*Editor.*]



THE PHILCO MODEL 65 RECEIVER

Since the issuance of the circuit below on the Model 65 by the Philadelphia Storage Battery Company, one change has been made in the antenna circuit. The antenna coil shunted by a resistance has been replaced by a tapped coil, the taps making connection to a "local-distance" switch on the panel. Note the use of double primaries on the r.f. transformer to give more uniform gain throughout the band.



TYPE TUBE	"A" VOLTS	"B" VOLTS	"B" VOLTS (SCREEN GRID)	"C" VOLTS (CONTROL GRID)	MA PLATE	CATHODE
224	2.5	150	* 0.2 to 75	1.5	1.5	1.5
227	2.5	250	—	28	† 0.8 to 3.5	28
245	2.5	250	—	50	32	—
280	5.0	350 V.A.C.	—	—	55	—

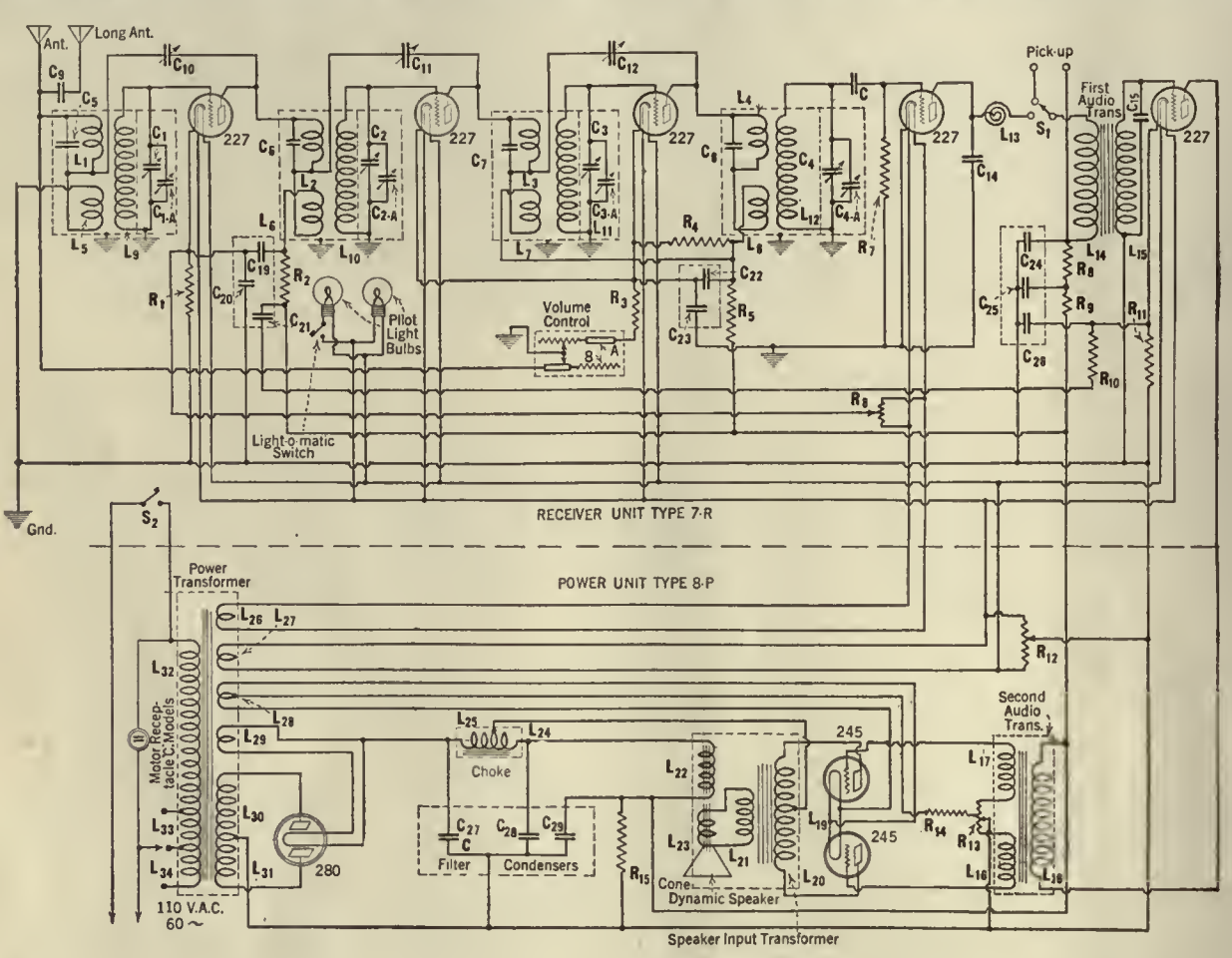
* The voltage varies from 75 volts with the volume control turned for full volume to 0.2 volts with the control turned for minimum volume.

† When there is no signal being reproduced the detector plate current will be about 0.8 MA. Strong signals will cause a rise in current to 3.5 MA.

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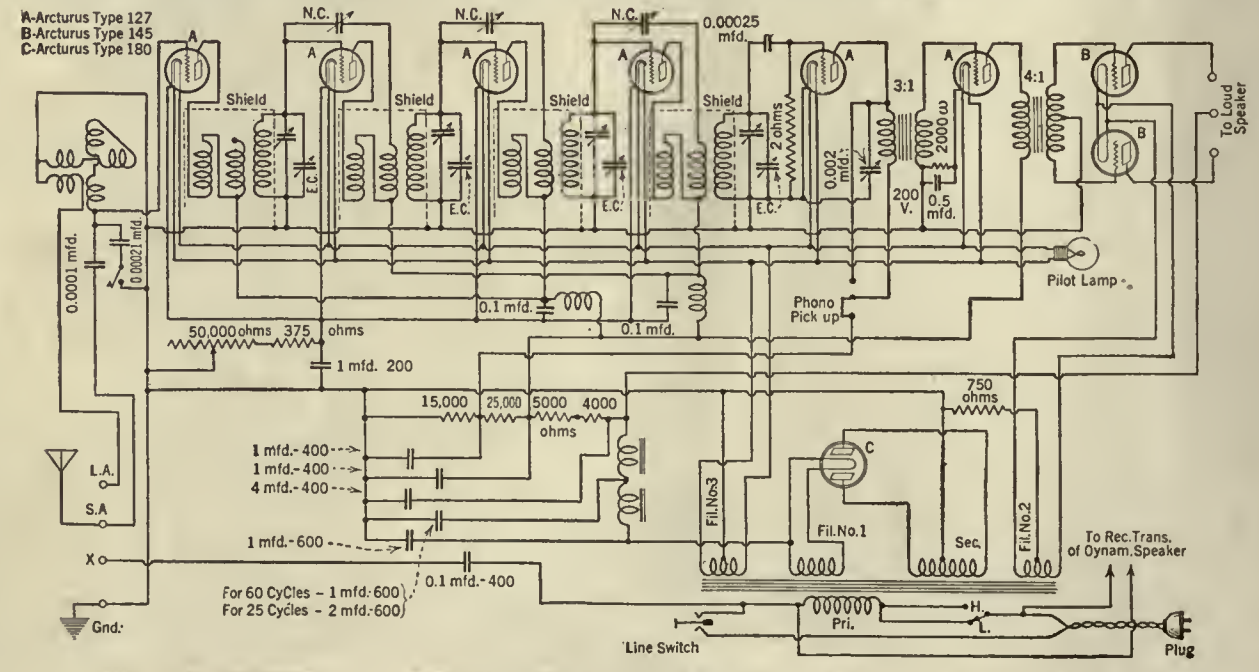
THE EDISON MODELS R-4, R-5 AND C-4 RECEIVER

These receivers incorporate several unusual features among which are an interesting hum adjustor (R-13) connected to the mid point of the push-pull transformer feeding the two power tubes, the double primary windings on each of the r.f. transformers, and the "light-o-matic" switch which automatically indicates when the set is tuned to a favorite station. Type 227 tubes are used throughout except in the output circuit where there are two 245's. The volume control functions to reduce the input from the antenna and also to increase the r.f. bias.



THE FREED-EISEMANN NR-95 A.C. RECEIVER

Four stages of r.f. amplification, a detector and two stages of audio-frequency amplification are used in this receiver. The antenna circuit is tuned by means of a variometer. Each r.f. amplifier stage is neutralized by means of double-wound primaries on the r.f. transformers. In all the stages except the last heater-type tubes are used. The use of heater tubes conforms with a general tendency among set manufacturers to utilize this type of tube rather than the 226 type. A light-socket antenna is provided in this receiver.



A SYSTEM FOR UNIFORM AMPLIFICATION

By W. A. MacDONALD

Chief Engineer, Hazeltine Service Corp. Laboratories

ONE OF THE faults with a radio receiver of the tuned radio-frequency type is that it is not possible to attain uniform amplification over the broadcast band unless certain definite measures are taken. A receiver without these definite measures will have considerable amplification at high frequencies and much less at lower frequencies where the selectivity is somewhat greater. The effect upon the user is a receiver that seems very selective at low frequencies, and rather broad at the high frequencies; or from the standpoint of amplification, the receiver is comparatively insensitive at the longer waves and very sensitive at short waves. This is a disadvantage.

This article is the result of work by engineers of the Hazeltine Service Corp. Laboratories. It describes an antenna coupling system which makes possible an almost uniform voltage step-up over the operating broadcast range or, by slight modification, a greater voltage step-up at the low-frequency (long-wavelength) end of the range than that obtained at the high-frequency or short-wavelength end of the range. In any case, the voltage step-up obtained at low frequencies is a substantial improvement for a given number of tubes, over methods now in use.

Two Systems Now in Use

BEFORE GOING into a detailed description of the arrangement, a better understanding of it may be had by a brief discussion of the two forms of antenna coupling arrangements now commonly used. Fig. 1 consists essentially of coupling the antenna structure to the input of the radio receiver by means of a comparatively small number of primary turns rather closely coupled to the secondary or input tuning of the receiver. Where a separate tuning adjustment is provided for in the input stage, the mutual inductance between

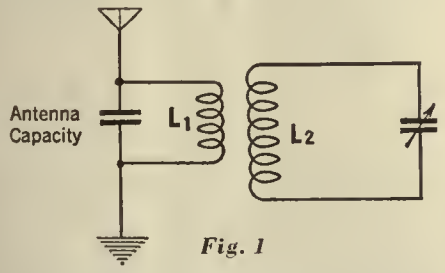


Fig. 1

the primary and secondary of the input transformer may be fairly large. That is, the primary or antenna winding, L_1, may consist of a coil of 15 or 20 turns of wire supported on a 2″ form, having an inductance of possibly 25 microhenries, which is very closely coupled to the secondary winding, consisting of, say, 70 turns of wire, supported on a 2″ form having an inductance of 200 microhenries. When an input transformer of this character is connected to an antenna structure, a certain amount of the antenna capacity will be reflected into the secondary circuit; hence the minimum capacity of the circuit is increased, which in turn requires an increase in the maximum value of the input tuning condenser of approximately nine times the value of the effective minimum increase. With a circuit of this type operating with an average antenna having a capacity of 200 mmfd., the voltage step-up, as measured across the secondary circuit, is approximately 35 or 40 at 1500

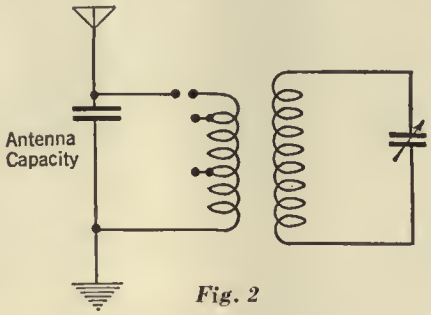


Fig. 2

kc. and 7 or 8 at 550 kc. The amount of detuning of the first circuit as compared with the following circuits is then a function of the size and character of the antenna employed, the detuning being small for a small antenna and increasing as the antenna capacity is increased.

Where a circuit of this nature is employed with a uni-control receiver, it has been found necessary to decrease materially the effect of the antenna upon the secondary circuit of the transformer. A convenient way of accomplishing this is by providing two or three taps on the primary or antenna coil, as in Fig. 2, so that when the receiver is used with a small antenna about 15 or 20 microhenries may be employed in the antenna coil and, as the antenna capacity is increased, a smaller and smaller inductance value may be employed. With such an arrangement it has been found necessary to provide an additional capacity for the remaining stages of the amplifier so that they will "track" properly with the input stage. The value of the capacity is usually in the neighborhood of from 7 to 10 mmfd., which means that the effect of the antenna upon the input circuit may be in the neighborhood of from 7 to 10 mmfd. In this way the various stages of the amplifier are made to track, but at a considerable expense: first, in the form of voltage step-up as determined by the input stage, and second, by increased cost in the tuning condensers, for, as the minimum capacity of all tuning condensers is increased by at least 7 mmfd., it will be necessary to increase the maximum capacity by approximately 60 mmfd. The voltage step-up in a transformer which produces, with an average antenna, an increase in the grid-filament capacity of the first stage of from 7 to 10 mmfd. is approximately 20 at 1500 kc. and 2 at 550 kc.

A Coupling Tube Circuit

CIRCUIT No. 3 employs an antenna-coupling tube or a substantially aperiodic input circuit which links the antenna to the input of the radio receiver. A convenient way of accomplishing this is by employing either a high resistance or high inductance connected between antenna and ground and utilizing the voltage drop to supply signal voltage to the input of the coupling tube. The output of this tube may be coupled to the receiver by one of the conventional coupling transformers. With such an arrangement the antenna constants have little or no effect upon the tuning of the following circuit.

In some cases, it has been possible to secure a small voltage step-up in the coupling tube. This may be obtained most conveniently by utilizing a choke coil connected between antenna and ground which, in conjunction with an average antenna, tunes to approximately 500 or 550 kc., provides a voltage step-up in the neighborhood of 4 at resonance and diminishing to 1 for remote frequencies. It has not been found practicable to employ a greater voltage step-up than this in the coupling stage because of the effect of powerful local stations, which produce an effect termed "cross-talk" in the receiver. That is, even though the radio receiver may be tuned to one station, the large voltage developed in the input coil, as a result of the proximity of another station, tends to modulate the input tube, thereby allowing both signals to be heard.

A New Circuit

THE ARRANGEMENT discussed in the following paragraphs eliminates certain objectionable features of both of the previous arrangements. It consists fundamentally of a rather large inductance which may be coupled to the tuned secondary. The value of the primary or input inductance may be selected to come either just within or somewhat outside of the lowest frequency in the broadcast range when employed with an average size antenna.

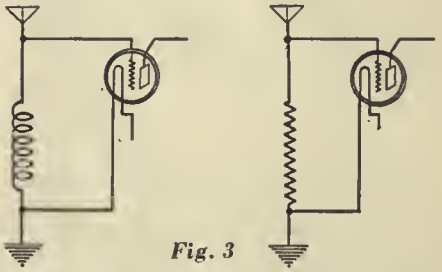


Fig. 3

Assume that a 200-mmfd. antenna is to be employed, then the magnitude of the primary inductance will probably be in the neighborhood of 400 to 600 microhenries. This would produce a circuit resonant to about 560 to 460 kc. which would pass the least current at 1500 kc. and the greatest at resonance. The voltage induced in the secondary circuit by a given primary current, however, is the highest at 1500 kc. and the lowest at 550 kc. The resulting effect of these two conditions produces a substantially uniform voltage step-up over the operating range, with a somewhat higher value at low frequencies. Where antenna capacities in excess of the

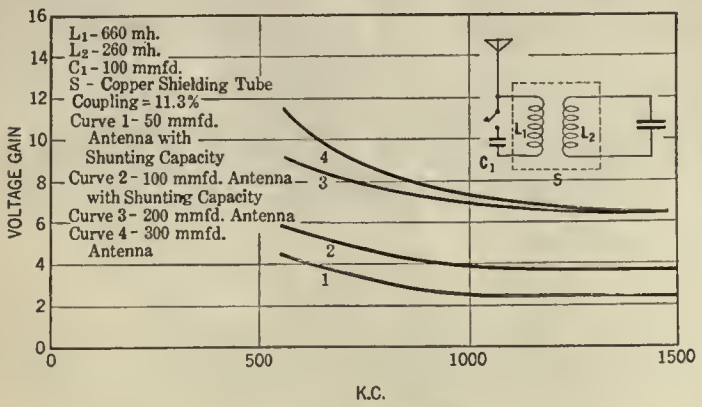


Fig. 4

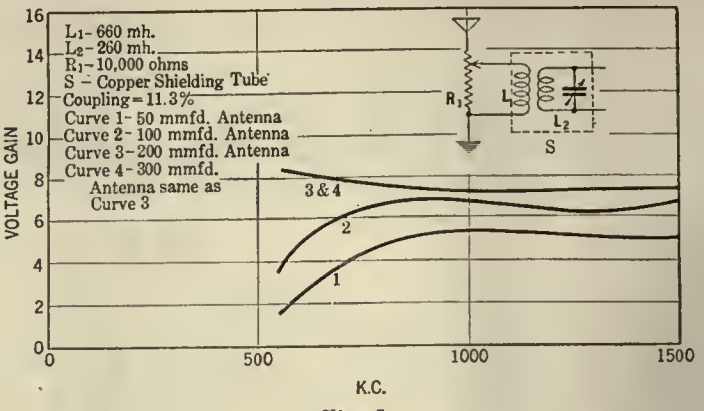


Fig. 5

value mentioned are employed, the effect is to reduce slightly the amplification obtained at the low-frequency end of the range. This is because the resonance of the primary circuit is farther removed with the result that there is less current flowing in that circuit and less voltage developed in the secondary circuit. Where antenna values less than 200 mmfd. are employed, the voltage step-up will increase until the resonant peak of the primary is reached at 550 kc. Where still smaller values of antenna are employed, so that the resonant point of the input circuit comes well within the operating range of the receiver, the effect, as a whole, is rather detrimental but can be minimized by observing special precautions, as explained later.

With the fundamental arrangement as described, the effect of the antenna circuit upon the secondary circuit of the receiver, is exactly the reverse of the arrangement described in paragraph one. Its effect is to decrease the effective inductance of the tuned input circuit. This effect is not very serious and may be compensated by a few added turns on the secondary coil, an increase in inductance of between 1 and 2 per cent. being adequate.

There is some difference in the character of the voltage step-up curve, depending upon whether the capacity coupling between the primary and secondary coils is aiding or opposing the magnetic coupling. If it is aiding, the voltage step-up at 1500 kc. will be considerably higher and the final response curve over the frequency range will be almost a straight line. If the capacity coupling is opposing the magnetic coupling, there will be a decrease in the amplification at 1500 kc. with a gradual rise to maximum at 550 kc.

When the antenna circuit is allowed to become resonant to some frequency within the broadcast range the detuning effect upon the secondary becomes objectionable on the inductive side of resonance unless the input is properly loaded. One method of obviating this condition is in providing a small shunting capacity across the primary (See Fig. 4) for use when an especially small antenna is employed so that the resonant point of the input system will always be outside of the lowest frequency in the broadcast range.

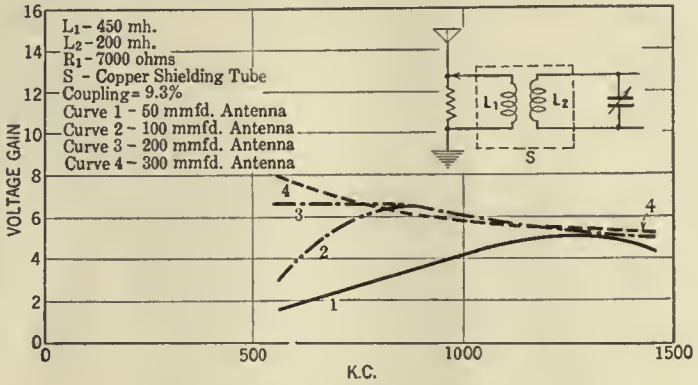


Fig. 6

A preferred arrangement would be to combine the loading means and volume control. This arrangement is obtained by employing a fixed value of resistance permanently connected between antenna and ground with an adjustable arm connecting to the primary coil. (See Fig. 5) When coupling this arrangement it is unnecessary to provide several switch arrangements to accommodate antennas of various sizes, the one connection being sufficient.

A typical series of values that might be employed in designing a circuit of this type, are:

TRANSFORMER NO. 1.
LPri = 650 to 700 microhenries
LSec = 260 " "
Coupling = 12 per cent.
Shunted capacity for very small antenna—100 mmfd.
Voltage step-up 1400 kc. = 7
600 kc. = 11

TRANSFORMER NO. 2.
LPri = 650 to 700 microhenries
LSec = 260 microhenries
Coupling = 10 per cent.
Shunted resistance across primary = 10,000 ohms
Voltage step-up about as No. 1

TRANSFORMER NO. 3.
LPri = 400 microhenries
LSec = 200 " "
Coupling = 10 per cent.
Shunted resistance across primary = 5000 ohms
Amplification values—1400 kc. = 6
600 kc. = 8 to 9

In certain of the experiments the primary coil consisted of a small flat bobbin having a $\frac{1}{2}$" diameter core and a $\frac{3}{16}$" slot wound with approximately 200 turns of No. 36 d.s.c. wire. The secondary consisted of a $1\frac{1}{4}$" supporting form, wound with 100 turns of No. 28 enameled wire. The primary was located at the low-potential end of the secondary and in the same plane as the secondary winding. The entire transformer was enclosed within an open-ended copper can $2\frac{3}{4}$" long and $2\frac{1}{4}$" in diameter.

The accompanying curves (Fig. 6) give a series of absolute values of amplification obtained under various conditions and are complete in themselves.

THE MARCH OF RADIO

(*Continued from page 215*)

remarking, while the testimony of Louis G. Caldwell was being taken, "I think advertising is a fast disappearing part of the radio service." Maybe he was talking about television.

The testimony which attracted the greatest attention was that of Col. J. I. McMullen, of the Office of the Judge Advocate General of the Army, who stated that, in his opinion, the Schloemilch and Von Bronck patents anticipate Alexanderson and that the two Federal District Court opinions, favorable to Alexanderson, were based on evidence which did not adequately set forth the Schloemilch and Von Bronck claims. These cases, he said, were "a rather put-up job by the General Electric Company to have the Alexanderson patents validated over the Von Bronck." Lt. Com. Harold Dodd stated that the Navy paid the Alien Property Custodian about $1690 for the Schloemilch and Von Bronck patents. In Canada, these patents constituted a successful defense against Alexanderson by Fada Radio, Ltd., when it was sued by the Canadian General Electric Company there. The Canadian patent law makes all research work done in Europe relevant in fixing dates; in the United States, however, only foreign *publication* is of weight; hence it does not follow that American and Canadian judges differed on these cases—they each passed judgment on a different case. Col. Manton Davis, with his usual crystal logic and courtesy, called the attention of the Senate Committee by letter to the decisions of Judges Bodine and Thatcher in the Splitdorf and Atwater Kent cases. It must be said that these decisions are only indirect refutation of Col. McMullen's statements because, if what he says is true, the German patents were not adequately presented before the Judges who rendered these decisions.

After all, the argument is quite academic because all the principal radio manufacturers have long ago admitted the validity of the Alexanderson patent and agreed not to contest or to aid anyone in contesting it.

Just what the Senate has to do with this matter, which has been and could again be brought to the courts, is not clear. Delving into such matters is, of course, very interesting, but we suspect some of those who have taken frequent opportunities to address the press through the medium of Senate hearings to be mere busybodies. If the charges they make are true, they should hasten to the courts rather than the Senate and the press.

—E. H. F.

Interesting Data on Their Design and Use

CHARACTERISTICS OF R. F. CHOKE COILS

By ROBERT S. KRUSE
Consulting Engineer



R. S. Kruse

In a recent article in Radio Broadcast, the author made the general statement that it is sometimes quite troublesome to have an r.f. choke present a capacity reactance instead of the inductive reactance that one usually attributes to it. A request has been received for a more specific statement on this point.

Unfortunately it is difficult to make any statement that is both specific and general. More or less qualification is necessary and the reader is asked to keep in mind the necessity of some analysis of his particular circuit before deciding if the remarks apply there.

Rather obviously the choke will act as an inductance at low frequencies, since its distributed capacity is of no importance then. As the frequency is raised one eventually arrives at the point where the choke is in resonance; that is, the inductance and the self-capacity of the choke tune it to the frequency being fed to it. The result is that the choke presents a high impedance to the r.f. (which is desirable), but at the same time tends to develop a large "circulating current" inside the choke itself. This circulating current can be thought of as going in one direction through the inductance of the choke and returning through its self-capacity. Since these constants are distributed it follows that the circuit is not a simple one but instead is capable of showing multiple resonances. On one side of each of these resonances the choke presents (to the external circuit) an inductive reactance; on the other side it presents a capacitive reactance—both being high in normal designs of chokes.

Further general statements become impossible; we must consider the various types.

An Incorrect Assumption

From what has been said one may assume that it is necessary always to operate in the inductive-reactance regions, avoiding the resonant points and those of capacitive reactance. This assumption is not correct. In many cases it is of little consequence whether the reactance is positive or negative, as long as it is high enough—and for some applications it does not even need to be high! Furthermore, the resonance points need not be avoided in the more common cases for reasons that are given in the following paragraphs.

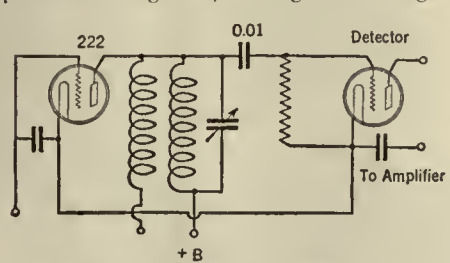


Fig. 2—In this circuit the r.f. tube was fed through the tuned circuit of the following tube. Somewhat higher output was obtained because of the relatively higher load impedance.

Let us first take the case of the simple cylindrical choke, having one layer of wire, the length of the coil being perhaps 4 times the diameter, and the wire size small. Measured alone, this coil will show prominent resonance at a frequency such that a half wave is standing on it (voltage at both ends and none at the center), likewise at 3 times and 5 times this frequency, above which the resonances become less distinct. It will be noted also that the alleged third harmonic is not exactly at 3 times the lowest resonance frequency, likewise the fifth is not at exactly 5 times the fundamental. This is the usual action of a resonant circuit with distributed constants;

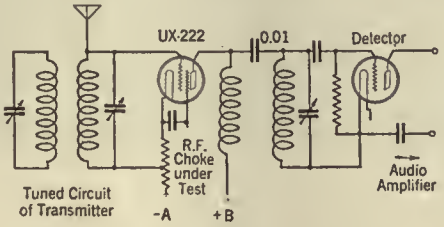


Fig. 1—The effectiveness of the choke between the detector and amplifier was noted by the signal obtained from the two-stage amplifier following the detector.

antennas act similarly. The reason is that at each system of resonance we have a different current distribution which is equivalent to rearranging the current carried by each of the various small portions of the coil's self-capacity. The effect of these self-capacities accordingly varies from that at the fundamental.

So far we have dealt with laboratory conditions—a coil hung out in space and measured by a weak field cautiously coupled into it. This is not the way the equipment will be used. Instead we will connect apparatus to the two ends of the coil and feed r.f. to the coil through this apparatus. This is quite different from the process of magnetically manufacturing the voltage in the coil itself, and again we find the elusive self-capacities shifting about so as to alter the seeming resonance points. It follows that the goodness or badness of a choke depends not only on the choke but also on the suitability of the job for the candidate. This leaves us badly at sea. We have not determined anything and have discovered several new variables. Until one has learned something by trial and error it is usually impossible to generate useful theory. Let us see, therefore, what practice teaches us, then perhaps we can apply the theoretical speculation to step on toward a better type—to be given practical test. Let us leave the single-layer coil for a moment.

We find that where the r.f. voltage across a coil is high, or where a very high impedence is necessary, it is essential that the coil have physical length. If we do not have length—distance between the two terminals—we obviously will have fairly strong electric fields directly between the ends of the coil without much regard to the manner in which the wire wanders about. If the frequency is high there will be entirely too much bypassing due to this end-to-end capacity of the coil, entirely without any reference to the turn-to-turn capacity or the layer-to-layer capacity. Very well—when is this serious and what's to do about it?

The reply to this is that it is serious only for receiving equipment working with shunt-fed screen-grid tubes, short-wave sets working below 50 meters, and for transmitting sets using shunt feed of plate supply or grid bias. The cure depends on which of the cases we consider.

Screen-Grid Circuits

Shunt feeding screen-grid tubes is fairly common practice, frequently with small regard for the effect on the gain of the stage. Unless one knows what the load of the tube looks like it is hard to say if the feed-choke should have a capacity or inductive reactance. One knows with certainty, however, that it should have a very high reactance. Even at broadcast frequencies this means that the inductance must run to many millihenries and the distributed capacity to a very few "micromikes." The average receiving r.f. choke entirely fails to supply such a combination, since it consists of a mere "scramble winding" divided into sections. This sort of choke works well enough when it is required only to keep r.f. out of an audio-transformer primary or to perform some other chore in connection with a 201A or a 227 tube. Inspection of the tube constants suggests that equally good work at the same wavelengths with a 222 or 224 tube will require $\frac{1}{10}$ the self-capacity and 10 times the inductance—or something of that general sort. Such an improvement is hardly to be hoped for, hence we must either put up with the nuisance of feeding through a tuned (tunable) circuit or else do the best we can. The obvious way to improve the choke seems to be that of lengthening it and making it slimmer so as to reduce self-capacity. Unfortunately, one is limited as to space and this process does not help much before the inductance

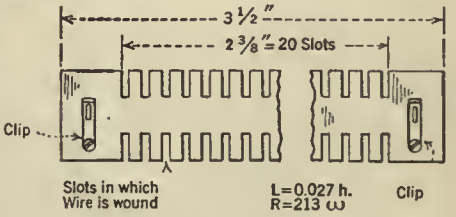


Fig. 3—A common type of multi-section choke. The slots were wound full of No. 38 wire, and when placed near a heterodyne wave meter, resonances were found at or near the following frequencies: 982, 1022, 1620, 1930 kc. Other small resonance peaks were also found.

begins to fall off badly. The next obvious weak spot is the "scramble" winding of the usual choke, since this permits choke-coil turns to slip down inside the winding and come near other turns that should be removed from them. A systematic winding would seem to be of advantage but trial shows that plain layer winding produces so much inter-layer capacity as to ruin the choke rather completely. This leaves the expedient of a winding with narrow layers of the "universal" or "honeycomb" type, or else a winding with layers but one wire wide! This last sounds foolish but is actually done in the Samson choke which consists, in effect, of spirals (one wire wide) laid side to side. Lest this seem to run to hair-splitting let us show a few concrete figures. To secure these a tuned 222 stage was fed from a 1-meter antenna, the driver being a sinusoidally modulated 50-watt transmitter some distance away. The r.f. output of the 222 stage was fed to a detector and two-stage audio amplifier, the a.c. output being measured with an a.c. meter suited to the modulation frequency of 120 cycles. Various chokes were used to shunt-feed the 222 tube whose plate load was the detector-input tuned circuit.

Choke used	Meter Readings (Scale 0–200) 15 meters	80 meters	360 meters
A	1	8	80
B	0	10	50
Samson	5	25	100
C	3	18	90
D	4	6	35
E	6	28	110

The chokes used were as follows:
A Commercial tube using a wooden form with three unequal grooves wound full of No. 38 enamel.
B Same as A except as to proportions. Wire size about 34.
C Three small "Universal" coils 2¼" diameter by 1¼" wide, wound with No. 38 single silk.
D One Universal coil 1 6/16" wide and with outside diameter of 2".
E Feed through tuned circuit

It will be seen that even the best of the chokes drops off in impedance with wavelength. This is *not* altogether the fault of the choke, since the tube falls off also. For comparison there is provided the set of figures obtained with the same tube fed through the tuned circuit, as in Fig. 2. It is only fair to say that the chokes used were considerably better than the average. Some of those sold gave no reading at all at 80 meters and values as low as 10 at 360 meters.

The circuit used here would work well as long as the choke reactance was high *regardless of its sign;* that is, whether it was capacitive, inductive, or resonant. Fortunately, also the lumped types of chokes have so many resonance points that they overlap into a sort of mountain range, giving a fairly uniform high impedance over a wide range and then sinking imperceptibly into the normal X_C and X_L curves. One accordingly has a wide useful range. Though the peaks are not as high as in a simple solenoid, which is very much better *over a small range,* the voltages involved are low and the circulating currents due to resonance are accordingly low also.



Dr. E. F. W. Alexanderson (right), consulting engineer of the General Electric Company, examining the memory meter which he developed for depth sounding from airplanes. The memory meter intercepts the radio echo and records the altitude for the observation of the pilot. With Dr. Alexanderson in the picture is his assistant, S. P. Nixdorff.

The case for the transmitter is different. Here the voltages are materially higher and serious currents will flow through the choke unless its impedence is very high indeed. If we attempt to run the impedence up to the requisite value by using a "tuned trap" (coil shunted by a variable condenser) we will have large circulating currents and large losses in this trap. Fortunately, the transmitter, unlike the receiver, is not required to work at *all* wavelengths and we are enabled to do away with tunable circuits, using instead a coil having small C, large L and ample length so as to cut down the field intensity. In general, this becomes a slim solenoid or else a series of small honeycomb coils strung on a rod with their fields additive. In the latter case the sections may be equal or unequal without marked change in performance. The wire size must be as small as possible—frequently a small wire will heat less than a large one. However, the smaller wire must retain the same thickness of covering to secure this result. The effect is even more noticeable if the spacing in turns per inch is kept constant as the wire size is reduced. This is often difficult without the introduction of grooved forms, whose value is dubious indeed in this work.

It has frequently been denied that working a choke at resonance is a practical operating condition but the writer can find no case where resonant operation is not satisfactory, given a suitable choke design. This statement has not been checked above 3000 volts and the experimenter may get into difficulties higher up on the scale. A distinct exception must be made in the case of regenerative operation—which is to say either in transmission or in receiving with a regenerative stage or one imperfectly neutralized. Here a resonance peak on a choke is a nuisance since a change of tuning may throw the choke reactance positive or negative with an unpleasantly strong effect on the degree of regeneration. In the case of the receiver this may be dodged by using the types of chokes which have multiple resonances in sufficient number to cause the peaks to tie together throughout working range. Abrupt changes of voltage distribution in the choke may be found but these are harmless.

At ultra-high frequencies, corresponding to wavelengths below 20 meters, it is best to arrange circuits so as to minimize the need of r.f. chokes, since it is almost impossible to combine satisfactory choke performance and good mechanical arrangement. Where chokes must be used a special effort must be made to decrease the inter-turn and the end-to-end capacity. Very small "basket weave" or Lorenz coils are fairly satisfactory if the wire is not over number 34 and the leads are continued for several inches with the same wire before reaching larger wire or metal parts. A diameter of ⅜" works out well and may be made on a form consisting of five slim wire nails driven into a board and beheaded.

WHAT MANUFACTURERS MAKE AND BUY

(*Continued from page 205*)

have rearranged these data in Table IV.

In the preceding paragraphs we have pointed out some of the salient facts obtained from the survey. It is hoped the executives of the various set manufacturing companies will be able to obtain some useful information from the various tables. It should be helpful to compare the practices of the various companies who coöperated in this survey with the practices in one's own plant. Whether or not one makes a particular part will depend on the manufacturing facilities available, keeping in mind always that outside manufacturers who make a specialty of a particular item might, in many cases, be able to build it more economically than could an individual set manufacturer. Particularly in the case of the small set manufacturer, the more parts he purchases on the outside, the more space and time can he devote to the making of complete sets. However, among large set companies with adequate manufacturing facilities available, the tendency, as indicated by our survey, is build as many parts as possible in the plant.

The companies from whom data were obtained for the figures in this article are:

All-American Mohawk Corporation
American Bosch Magneto Corporation
Atwater-Kent Mfg. Company
Crosley Mfg. Company
Day-Fan Electric Company
Federal Radio Corporation
Chas. H. Freshman Company
Grigsby-Grunow Company
Kellogg Switchboard & Supply Company
National Carbon Company
Philadelphia Storage Battery Company
Sterling Mfg. Company
Stromberg-Carlson Telephone Mfg. Company
Temple Corporation

MAJESTIC SERVICE FOR DEALERS

GRIGSBY-GRUNOW is now publishing, for dealer distribution, an illustrated rotogravure paper called "The Voice of the Air." It is supplied fortnightly. In addition to many news pictures of general interest, the new publication includes a complete timetable of network programs, pictures of radio stars, and a radio log of all leading stations, divided into four geographical areas. The first issue, it was announced, had an edition of 1,170,000 copies.

CALCULATING DETECTOR OUTPUT

By J. M. STINCHFIELD

Engineering Dept., E. T. Cunningham Inc.

When reduced to its simplest form the detector action of a vacuum tube should be as readily understood as the generally accepted relations for the amplifying properties of a tube. When considering amplification, the tube may be replaced by a generator whose voltage is μe_g, whose internal resistance is r_p, and whose external load impedance is Z_p. The useful part of this voltage, that impressed across the load, is the voltage μe_g multiplied by the ratio between the load impedance to the total impedance in the plate circuit.

In an amplifier tube, plate and grid voltages are chosen which will insure operation over a nearly straight portion of the characteristic. For detection voltages are chosen which place operation on a curved portion of the characteristic. For example, if the bias on an amplifying tube is increased until operation takes place about a point near plate current cut-off, then, in addition to the voltage μe_g appearing in the plate circuit, there will be a rectified voltage, E, due to the curved characteristic. This voltage, E, may be expressed as,

$$E = \left(\tfrac{1}{4}\frac{r_p'}{r_p}\right)\left(\mu E_o\right)^2 \text{ volts D. C.} \qquad (1)$$

Where, E_o (peak) is applied to the grid, for instance a carrier wave, and r_p' is the derivative of r_p with respect to E_p.

Taking small intervals along the characteristic E_p — I_p curve and dividing the E_p intervals by the I_p intervals, we obtain r_p. Plotting r_p against E_p and taking intervals of r_p and E_p, the quotient is r_p'.

Knowing these characteristics of the tube, the rectified voltage is readily calculated. The voltage E is the total internally generated, rectified voltage and is analogous to the voltage μe_g in an amplifier. The portion of this voltage appearing across the load Z_p is,

$$e_{pd} = E\left(\frac{Z_p}{r_p + Z_p}\right) = \left(\tfrac{1}{4}\frac{r_p'}{r_p}\right)\mu^2 E_o^2 \left(\frac{Z_p}{r_p + Z_p}\right) \qquad (2)$$

This is the d.c. voltage appearing across Z_p (where Z_p is the impedance to d.c., i.e., resistance) when a carrier wave of E_o peak volts is applied to the grid. If the carrier

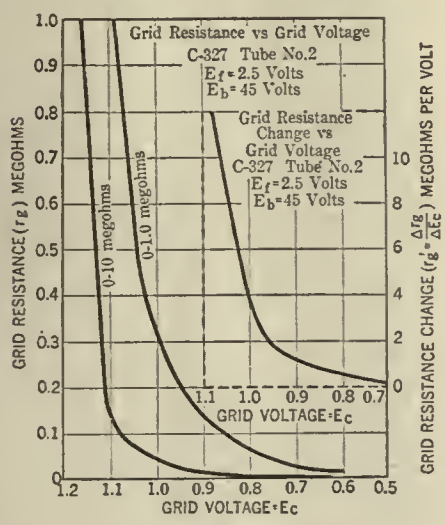


Fig. 2

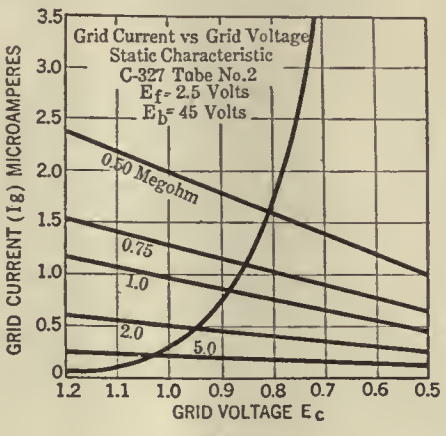


Fig. 1

wave is then modulated M × 100 per cent., the d.c. voltage will be increased by the factor $\left(1 + \frac{M^2}{2}\right)$. A voltage of modulation frequency resulting from the variation in amplitude of the rectified voltage will also appear. Its amplitude will be 2M

TABLE I

A. F. Modulation (M) = 0.20 at 60 cycles
Zp = 50,000-ohm power factor unity
Ec = —4.5 volts
Ep = 45 volts

Carrier Volts r.m.s.	*A.F. Volts r.m.s. (ed ÷ √2)*	*D.C. Plate Current Change △ Ip Microamp.*	*Measured △ Ip Microamp.*	*Equivalent a.f. from Meas. △ Ip*
0.100	0.0027	0.8		
0.200	0.0107	3.3	3.3	0.0107
0.354	0.034	10.4	10.5	0.034
0.707	0.134	41.7	42.00	0.136
1.000	0.269	83.4		
1.500	0.605	187.		

times the internally generated voltage of rectification due to the carrier alone. See equation (1). The internally generated audio voltage analogous to μe_g is then:

$$\left[\left(\tfrac{1}{4}\frac{r_p'}{r_p}\right)\mu^2 E_o^2\, 2\, M\right] \qquad (3)$$

The useful audio output voltage depends upon the impedance of the load Z_p to audio frequencies. The basic relation for plate current detection, when it is entirely due to the curvature of the characteristic and the amplitude of the signal is small, is:

$$e_d = \left[\left(\tfrac{1}{4}\frac{r_p'}{r_p}\right)\mu^2 \left(\frac{Z_p}{r_p + Z_p}\right) 2\, ME_o^2\right] \text{ peak volts} \qquad (4)$$

A brief explanation of the expression for the interally generated voltage, should clear away any vagueness of the physical interpretation.

The term $\left(\tfrac{1}{4}\frac{r_p'}{r_p}\right) E^2$ is the typical expression for the internally generated voltage of rectification due to the curvature of an E-I static characteristic. The same expression is valid whether it is for a plate current-voltage characteristic, or for the grid current-voltage characteristic, or for the current-voltage characteristic of say a crystal when a small voltage, E sin ωt, is applied to its terminals. The r is the slope of the E-I characteristic. The r′ is the slope of the E-r characteristic.

The term μE_o represents the amplitude of the carrier in the plate circuit. If a radio-frequency by-pass condenser is connected between the plate-filament terminals the entire amplitude, μE_o, will be effective on the internal resistance of the tube. The factor 2M is equal to the ratio of the amplitudes of the audio or modulation frequency to the rectified d.c. of the unmodulated carrier.

In many tubes a considerable decrease in mu occurs as the plate current approaches cut-off. With plate current rectification, the point of operation is usually in this region. The mu variation increases the rectified output. Adding a term $\left(\tfrac{1}{2}\frac{\mu'}{\mu}\right)$ to the term $\left(\tfrac{1}{4}\frac{r_p'}{r_p}\right)$ will rather closely account for the detection resulting from the variation of mu. Here μ' is the slope of the μ-E_p curve at the point of operation.

The basic principles of grid-leak detection are similar to those outlined above. The grid is connected through a high-resistance grid leak to some point having a small positive voltage with respect to the negative filament terminal. The small positive voltage brings the grid circuit to a point of operation on the lower bend of the grid current curve. If a small sine wave of radio-frequency voltage is applied through a grid condenser to the grid-filament terminals, a rectified voltage due to the curvature of the Eg-Ig curve will appear in the grid circuit. The portion amplified by the tube appears as:

$$\left[\mu\left(\tfrac{1}{4}\frac{r_g'}{r_g}\right) E_o^2 \left(\frac{R_g}{R_g + r_g}\right)\right] \text{ volts d.c. in the plate circuit} \qquad (5)$$

When the radio-frequency carrier is modulated M × 100 per cent., the amplitude of the internally generated audio voltage is 2M times the internally generated d.c. voltage. The portion developed across the plate load, Z_p, depends upon the ratio between Z_p and $Z_p + r_p$. The detected audio voltage across the load, Z_p, due to the curvature of the grid-current characteristic is

$$e_d = \left[\left(\tfrac{1}{4}\frac{r_g'}{r_g}\right)\mu\left(\frac{R_g}{r_g + R_g}\right)\left(\frac{Z_p}{r_p + Z_p}\right) 2\, ME_o^2\right] \text{ peak volts} \qquad (6)$$

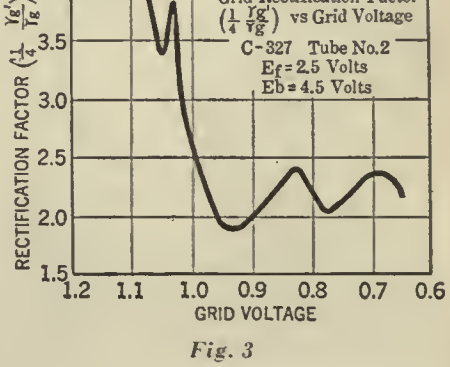


Fig. 3

To illustrate the use of these relations the detector characteristics of a Cunningham type c-327 tube will be calculated. A grid current-grid voltage curve of a typical c-327 tube is shown in Fig. 1. Reading the grid current at intervals of 0.025 volt along this curve, and dividing the current change into the voltage change per interval gives a good approximation to the value of the grid resistance (r_g) at the mid-point of the interval. This data is plotted in Fig. 2. Two scales from zero to one and from zero to ten megohms have been used to extend the accurately readable range. A similar procedure is applied to the r_g curve. Increments of grid resistance are divided by increments of grid voltage and these data are plotted as the r_g' curve shown in the insert graph of Fig. 2. At any given operating point the factor for the internally generated $\left(\frac{1}{4}\frac{r_g'}{r_g}\right)$ voltage of rectification can be evaluated readily from these curves. For convenience this factor is plotted against grid-bias voltage in Fig. 3.

The operating point can be determined by drawing a line with slope equal to the grid-leak resistance and intersecting the

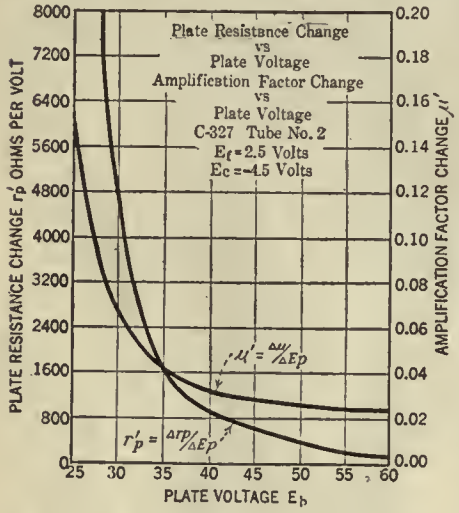


Fig. 5

E_c axis at a voltage equal to the biasing potential. On filament-type tubes the positive filament or A terminal gives a bias of plus 5 or 6 volts. The internal contact potential of the c-327-type tube causes sufficient grid current flow with the connection returned to the cathode. The intersection of the grid-leak line and the grid current curve determines the operating point. In Fig. 1 these points have been located for grid leaks from 0.5 to 5.0 megohms. Referring to the corresponding points in Fig. 2 the grid resistance is found to range from 67,000 to 450,000 ohms. This accounts for the broad tuning in the stage feeding a grid-leak detector. In a later section, it will be shown that the smaller size grid leak is advantageous in reducing the loss of the high audio frequencies in the grid condenser and in maintaining good detection with large signals.

Assuming a grid-leak of one megohm, a load resistance of 50,000 ohms, and 20 per cent. modulation, the detected audio voltage can be calculated from equation (6). The results are shown below.

The last column shows data obtained by actual measurement with a 675-kc. carrier modulated 20 per cent. with 60 cycles. The measured data is about 15 per cent. low due to a loss of radio-frequency voltage in the leads from the signal generator and in the grid condenser. Usually the measured and the calculated data are in close

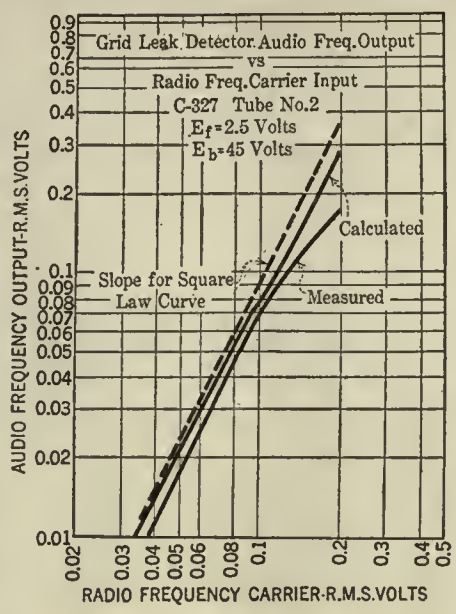


Fig. 4

agreement for small signal voltages. An increasing error is evident with larger signals.

A.F. Modulation = 0.20 at 60 cycles
Rg = 1.0-megohm grid leak
Rp = 50,000-ohm plate load
Eb = + 45 volts

Carrier Volts r.m.s.	*Ec Volts d.c.*	*rg Ohms r.m.s.*	*A.F. Volts r.m.s. (cd÷√2)*	*Measured a.f. Volts r.m.s.*
0.020	—0.88	127000	0.0034	—
0.040	—0.88	127000	0.0134	0.0115
0.060	—0.89	138000	0.0290	0.0255
0.080	—0.89	138000	0.0516	0.0445
0.100	—0.90	150000	0.077	0.067
0.140	—0.93	188000	0.138	0.113
0.170	—0.94	202000	0.202	0.150
0.200	—0.95	218000	0.285	0.175

The data above is plotted on logarithmic coördinate paper in Fig. 4. The dotted line has a slope of 2, representing a true square-law detector. The measured data follows the square law until an amplitude of nearly 0.100 volt is reached when the measured output increases at a lower rate than the square law.

Since equation (6) is the first term of an infinite series resulting from an expansion of a function in the region of a point by Taylor's Theorem, it is only a first order approximation and accurate only for amplitudes over which the slope-derivatives remain constant. If the current characteristic is parabolic over the range of operation the second derivative is a constant and rectification would be proportional to

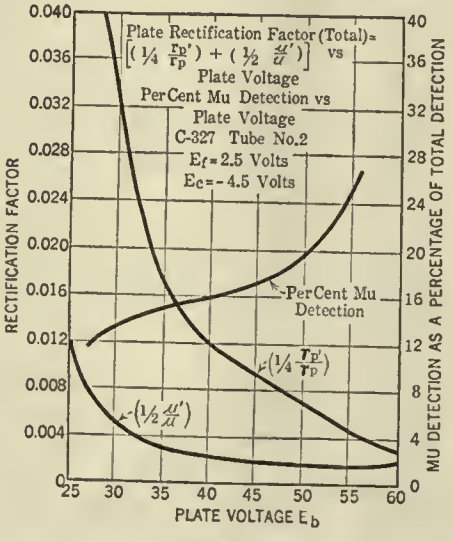


Fig. 7

the square of the signal voltage. In addition to the amplitude limitation on the characteristic of Fig. 3 the d.c. component of the rectification causes an increase in the bias voltage developed across the grid leak. Also a small decrease in mu and increase in plate resistance occur. The plate detection which is approximately in phase opposition to the grid detection may become large enough to cause a small reduction of the detected voltage. All of these factors contribute to the reduction of the detected audio output voltage when the signal is large.

Plate Circuit Detection

Inserting a bias of —4.5 volts between grid leak and cathode would bring the grid circuit to a point of operation well beyond grid current cut-off. Signal amplitudes having a modulated peak from 3.0 to 3.5 volts could be applied without causing any flow of grid current. Assuming 45 volts of plate potential, the plate circuit operating point will be well down on the curved part of the characteristic. Taking increments of current and voltage the plate resistance (r_p) curve

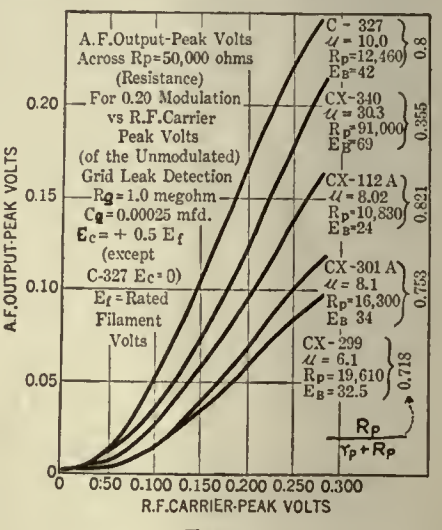


Fig. 6

may be obtained. The mu curve may be read on a Miller bridge. This curve can be obtained very accurately by taking the slopes of plate voltage-grid voltage curves plotted for constant plate current as the parameter. In the usual range of operation these curves are straight lines for many tube types. When this relation holds the mu is a function of plate current only. This relation does not hold with the type c-327 tube though the method is useful for indicating the mu variations.

The curves of Fig. 5 for r_p and μ were obtained by taking increments on the curves. The factors for the plate circuit rectification due to the plate resistance variation and to the mu variation are plotted in Fig. 5.

Assuming a load resistance of 50,000 ohms, an effective plate voltage of 45 volts, —4.5 volts grid bias, and 20 per cent. modulation, the detected audio voltage is calculated from equation (4). The results for several signal amplitudes are shown in Table I. The term $\left(\frac{1}{2}\frac{\mu'}{\mu}\right)$ is added to the term $\left(\frac{1}{4}\frac{r_p'}{r_p}\right)$ of equation (4). The contribution due to mu variation is about 16.7 per cent. of the total detection. The detector output for a signal of 0.2 volts r.m.s. is only 6.1 per cent. the output at this voltage when grid detection

(*Continued on page 242*)

IN THE RADIO MARKETPLACE

(*Continued from page 219*)

Specialty Co., of Dallas, Texas, C. E. Hamlin Sales Co., of Jackson, Mich., National Auto Supply Company, of Independence, Iowa, Michigan Automotive Supply Co., of Detroit, Mich., Radio Supply Co., of Tulsa, Oklahoma, The Royal Furniture Co., of Baltimore, Md., Southern Ohio Radio Corp., of Cincinnati, Ohio, and the Union Tire & Supply Co., of Burlington, Iowa.

It is also announced that the distributorship for Rhode Island has been given to the Plymouth Electric Company, New Haven, Conn., of which R. J. Mailhouse is the head. The company will open offices in Providence.

CAMPBELL & PENFIELD have completed arrangements with the Federal Radio Corporation of Buffalo, whereby they have become distributors in the Detroit area for Federal Orthosonic receiving sets. Showrooms and warehouse have been opened in Convention Hall at 3481 Woodward Ave. where the new Federal "M" and "L" models are now on display.

THE STATE RADIO DISTRIBUTING COMPANY, with headquarters in Newark, N. J., will act as wholesaler for Federal Orthosonic radio in the northern New Jersey territory, operating as far south as Trenton, N. J.

THE FEDERAL RADIO CORPORATION'S distributor for the New York area is the Superior Cabinet Corporation, 206 Broadway, New York City. B. J. Greenbaum is general manager.

A. D. STRATHY, sales manager of Cable Supply, announces the appointment of the following distributors for Speed tubes: The Gardner Radio and Electric Corporation, 2728 Locust Street, St. Louis, Mo., is handling southern Illinois and the state of Missouri exclusive of Kansas City; F. C. Somers, 115 E. 66th Street, Kansas City, Mo., is handling Oklahoma, Kansas, Iowa, and Nebraska; C. M. McIntosh Company, McClintock Building, Denver, Colorado, is handling Colorado, New Mexico, Wyoming, Utah, and Eastern Montana; H. V. Scott & Company 506 S. Canal Street, Chicago, Ill., is handling northern Illinois including the Chicago territory and Wisconsin; J. E. Date, 818 Nicollet Avenue, Minneapolis, Minn., is handling Minnesota and North and South Dakota; S. C. Steinharter, 2353 Greenfield Street, Grand Rapids, Michigan, is handling Michigan and Ohio; Martwell Sales Company, Inc., 1501 Broadway, New York, N. Y., is handling the metropolitan area of New York with a special concession covering furniture, musical, and departmental stores in certain other territories.

SUPREME: A new model of their set tester has been announced by the Supreme Instrument Corp. It will be known as the Model 400-B. This model does not differ fundamentally from the former model, No. 400-A, but there have been incorporated in the new tester certain refinements which will prove advantageous to the serviceman. The model 400-A will be continued so the 400-B constitutes an addition to the line. The new 400-B is designed particularly to take care of all the new receiving sets, many of which will use higher voltages and screen-grid tubes. The 400-B can be used for making all types of tests on all receivers including those using screen-grid tubes. With this instrument it is possible to measure the full output of filament-type rectifier tubes. It is also equipped with a modulated oscillator, a tube rejuvenator for rejuvenating up to 12 tubes, and tube-testing features which make possible measuring the static characteristics of tubes



The Supreme set tester, model 400-B.

as well as testing when they are oscillating. With the instrument it is possible to adjust to exact resonance the various tuned circuits of a receiver. For this test the modulated oscillator is used to supply a signal to the input of the receiver, and the output of the receiver is measured in either one of two ways; one method utilizes the low scale of the a.c. voltmeter which is connected across the output of the set, the other method can be found only in the 400-B which utilizes a thermocouple in conjunction with a d.c. voltmeter to indicate the a.c. output current of a special output transformer, the primary of which is connected across the loud speaker terminals. In adjusting the set, therefore, it is simply necessary to tune-in the signal from the modulated oscillator and then adjust the various condensers until maximum output deflection is obtained. Three meters used in the 400-B are as follows:

D.C. Voltmeter, 4 scales 0–750, 250,100, 10.

A.C. Voltmeter, 4 scales 0–750, 150, 16, 3.

D.C. Milliammeter, 3 scales 0–125, 25, milliamperes and 0–2.5 amperes.

CLAROSTAT: A line ballast Clarostat has just been announced. It is designed for use in the primary circuits of power transformers and maintains the input voltage of the set constant within about 5 per cent.

RADIO PRODUCTS: This company is manufacturing a number of instruments designed for use by dealers and servicemen in making measurements on tubes and receivers. The Flewelling tube-checker, model B, will test all of the following tubes 120, 199, 201A, 112A, 171A, 226, 280, 281, 250, 210,240, 245, 222, 224, Kellogg, and Cardon. The net price of this instrument to dealers is $22.75. The Flewelling Counter-Checker, model C, makes it easy to test all types of radio equipment at the time of sale. Among other things it will test batteries, B-power units, transformers, resistors, and tubes. Price: $26.25. The Flewelling Radio Set Analyzer and Tube Checker is a combination instrument which makes possible the complete testing of receiving sets and tubes. Price: $85.25.

RADIO-VICTOR: Reductions in the list prices of seven types of Radiotrons were announced June 12th by the Radio-Victor Corporation of America. The UY-227 was reduced from $3.00 to $2.50, the UX-226 from $2.00 to $1.75, the UX-222 from $6.50 to $4.50, the UX-280 from $3.50 to $3.00, the UX-112A from $2.50 to $1.25, the UX-201A from $1.40 to $1.25, and the UX-171A from $2.50 to $1.25. Large-scale production and improved tube manufacturing machinery were given by an official of the corporation as the reason why it has been possible to reduce prices.

DETROIT RADIO DEALERS ASSOCIATION: A special radio exposition to be held in the Olympia at Detroit, September 9th to 15th inclusive, is being sponsored by this association. It is the purpose of the Association to direct public interest to the radio industry in advance of the usual peak season. The executive management of the exposition will be in the hands of Corley W. Kirby, managing secretary, and Richard Dunn, general manager of the Olympic.

MEISSNER LICENSEES

B. F. MEISSNER, well-known inventor, has licensed the following companies under his patents:

All-American Mohawk
Bremer-Tully (including sets made for Brunswick)
Crosley Radio Corporation
Consolidated Radio Corporation
(Wells Gardner and Arborphone Divisions)
Electrical Research Laboratories, Inc.
A. H. Grebe & Co., Inc.
Howard Radio Co.
King Manufacturing Corporation
Kolster Radio Corporation
Splitdorf Radio Corporation (including its manufacture for Thomas A. Edison, Inc.)
Stromberg-Carlson Telephone Manufacturing Co.
U. S. Electric Corporation
Walbert Manufacturing Company

The royalty schedules show the cost to the average maker will run in the neighborhood of twenty to twenty-five cents. Mr. Meissner's patents and technical services are largely in relation to design of filters, and in the reduction of a.c. hum. Other patents pending and issued include No. 191,195 with broad claims covering the low-voltage, low-temperature, high-heat-inertia type of filament tube. It is said these claims cover the 226- and 245-type tubes. Patent No. 50,555 is said to cover the use of a tube having a cathode so designed as to generate small hum when energized with alternating current, preceding a tube having a cathode designed to generate large hum, and this, in order that the small hum can be used to neutralize the large hum of the preceding tube. This patent is said to cover any set using the indirectly heated type of cathode or 226 type of filament in the detector and first audio stage in advance of the 171, 245, 210 or 250 in the output stage.

A JOBBER LOOKS AT HIS DEALERS

(*Continued from page 194*)

his dealers, employs a younger assistant. The assistant is an expert servieeman, and incidentally a sales representative. When the salesman makes his weekly visit to a dealer, he asks him for the names and addresses of the dealer's new customers, whose sets have been installed reeently. The junior salesman calls on them, settles any misunderstandings or questions they may have about the operation of the set, ehecks over the installation, and sees to it that they are thoroughly satisfied with their purchase. The practical result of the system is best described in Mr. Craddick's own words.

"Here's a concrete instanee. A salesman and his junior called on a dealer in a New Jersey city and reeeived the names of ten people who had just bought sets from the dealer. The junior made the ten ealls, and brought back to the dealer the names of ten new prospects, given him by the customers. Out of those ten prospects, the dealer sold five within the next few days; the junior salesman made his calls on those five, and from them got the names of two new prospects, both of whom the dealer sold within a week of the junior salesman's first appearance at his store.

"There were seven sets sold as a result of the original ten sales and the junior salesman service. Now take the dollars and cents of it. The salesman has to pay the junior's salary. Suppose that he paid him, in that instanee, sixty dollars a week flat salary. Seven sets were sold, which we'll put at an average price to the dealer of $200. That's $1400; the salesman works on a 5% commission, which brings him $70, or an added income to him of $10 for that week due directly to the hiring of the junior salesman. And that, of course, was just from one of the several dealers on his weekly visit list.

Furthermore, THE dealer is delighted. He's made staunch friends of 17 customers, who will give him, and the partieular set, priceless word-of-mouth advertising in the community. And also, the junior salesman can make the more troublesome of the dealer's ordinary service ealls. Many dealers now greet the junior salesman with a list of serviee calls from their customers, all of which are made by the junior at the regular fee.

"It's a novel scheme, I think. At first my salesmen didn't take to the idea of paying an assistant's salary. In every case, however, a trial has shown them that it means more business and so more money for them, and they're all strong for it now."

In addition, Mr. Craddick eoncluded, the dealers have seen the value of expert service work, of the "call-baek visit after installation, and have been helped in building up their community clientele. Which is just what the junior salesman scheme was designed to do.

PROFESSIONALLY SPEAKING

(*Continued from page 203*)

reduced, not increased, that the publie should be encouraged to listen for high frequencies and to appreciate the improvement in fidelity brought about by the use of better audio systems. We believe that those who talk of increasing the number of stations by reducing the channel width should spend their energy on reducing "man-made static" and thereby permit the full use of high-"quality" amplifiers. We laud the set manufacturer who continues to put the best possible audio system into his set, even though the listener in general is not yet educated to look for real fidelity. Receivers of fidelity of a high order may seem to be more noisy on "DX" but even now, some makers are including filters which can be switched on to cut down high-frequency response when the set is asked to "reach out."

CALCULATING DETECTOR OUTPUT

(*Continued from page 240*)

is employed. The data of Table I] shows the signal must be increased to 0.8 volt r.m.s. to obtain the same output as obtained with grid detection and a 0.20 volt r.m.s. signal. The ratio of signal input for the same output is then four to one.

Columns 3 and 4 of Table I show a comparison of the computed and measured d.c. component of the rectification. The agreement is close up to very large signal amplitudes.

An actual comparison of overall results obtained with grid leak and with plate detection shows less difference in sensitivity than is indicated here. The selectivity and the amplification in the stage feeding the detector are increased considerably by changing to plate detection. Plate detection is particularly advantageous when the signal input is large. Grid-leak detection is not used for inputs greater than a few tenths of a volt. Plate detection may be employed for any signal amplitude by the simple expedient of increasing both grid and plate voltage. It is possible to use inputs of several volts delivering sufficient output to operate the power tube without any intermediate audio stage.

Some data showing the a.f. output of several tubes used as detectors are given in Fig. 6. They show the superiority of the c-327 as a grid-leak detector.

To summarize the preceding, the object has been to illustrate the calculation of detector characteristics from the well-known static characteristics of a tube. It is hoped that the curves and relations given have illustrated the problem adequately so that detector theory will be applied more often to numerical solutions in approximating the performance of that stage. Many factors influencing the quantity and quality of the detector output have not been mentioned here. The discussion of these factors will be reserved for a later article.

SUMMARY OF RECEIVERS EXHIBITED AT THE CHICAGO TRADE SHOW

(*Continued from page 209*)

Company	Model	Price	Table or Console	Screen Grid Tubes	Tubes Used
United Reproducers Corp.	21 Peerless	$ 195.00	Console	Yes	3–224, 3–227, 2–245, 1–280
	22 Peerless	$ 245.00	Console	Yes	3–224, 3–227, 2–245, 1–280
	23 Peerless	$ 245.00	Console	Yes	3–224, 3–227, 2–245, 1–280, 1–201A
	24 Peerless	$ 375.00	Console	Yes	3–224, 3–227, 2–245, 1–280
	25 Peerless	$ 600.00	Phono-radio	Yes	3–224, 3–227, 2–245, 1–280, 1–201A
	65 Courier	$ 85.00	Table	Yes	3–224, 2–227, 2–245, 1–280
	651 Courier	$ 140.00	Console	Yes	3–224, 2–227, 2–245, 1–280
	652 Courier	$ 165.00	Console	Yes	3–224, 2–227, 2–245, 1–280
	653 Courier	$ 165.00	Console	Yes	3–224, 2–227, 2–245, 1–280, 1–199
U. S. Radio & Television Co.	36	$ 39.95	Table	No	4–226, 1–227, 1–171, 1–280
	50	$ 69.95	Console	No	4–226, 1–227, 1–171, 1–280
	55	$ 74.95	Console	No	4–226, 1–227, 1–171, 1–280
	60	$ 79.95	Console	No	4–226, 1–227, 1–171, 1–280
	70	$ 119.95	Console	No	2–171, 5–226, 1–227, 1–280
	89	$ 69.95	Table	No	2–171, 5–226, 1–227, 1–280
	54	$ 67.95	Console	No	5–201A, 1–171A
	22	$ 37.95	Table	No	5–201A, 1–171A
Zenith Radio Corp.	41	$ 100.00	Table	No	1–171, 5–227, 1–280
	42	$ 175.00	Console	Yes	1–224, 4–227, 1–210, 2–281
	39 A	$ 510.00	Console	No	6–227, 1–226, 1–210, 2–281
	40 A	$ 850.00	Phono-radio	No	6–227, 1–226, 1–210, 2–281
	English	$ 800.00	Console	No	2–227, 6–226, 2–210, 2–281
	Spanish	$2500.00	Console	No	2–227, 6–226, 2–210, 2–281
	Special 37 A	$ 625.00	Console Phono-radio	No No	5–227, 1–226, 1–250, 2–281

NOTES

Dynamic type loud speakers are used in all the console models with the exception of certain models made by the Acme Electric and Mfg. Company, Buckingham Radio Corporation, Federal Radio Co., Freed Eiseman Radio Corp., Chas. Freshman Co., and the United Reproducers Corp.

D.C. light socket operated and battery operated models are being made by Atwater Kent Mfg. Co., Day-Fan Electric Co., Freed Eiseman Radio Corp., Kolster Radio Corp., Sparks-Withington Co., Stewart Warner Corp., Radio-Victor Corp. of America, and the Crosley Radio Corp.

Radio-phonograph combinations are made by Radio-Victor Corp. of America, Zenith Radio Corp., United Reproducers Corp., Temple Corp., Steinite Radio Co., Sparks Withington Co., The Pierson Co., Kellogg Switchboard Supply Co., Grigsby-Grunow Co., A. H. Grebe & Co., Electrical Research Labs., Thos. A. Edison, Inc., Continental Radio Corp., Columbia Phonograph Co., Bush & Lane Piano Co., F. A. D. Aadrea, Inc., Amrad Corp., and The A. C. Dayton Co.

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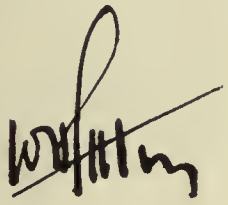
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Unique triangular Triad carton. Builds up into a striking attention-getting display. Use Triad cartons in your windows and on your counter to link up with Triad national magazine, newspaper and radio advertising.

Call your Jobber or write us for complete Triad dealer information

TRIAD MANUFACTURING CO., Inc.
Triad Building Blackstone, Middle and Fountain Sts.
PAWTUCKET, R. I.

THE COUNTRY LIFE PRESS, GARDEN CITY, NEW YORK

SEPTEMBER 1929

RADIO BROADCAST

PUBLISHED FOR THE RADIO INDUSTRY



SPECIAL FEATURES IN THIS ISSU

The Tube Business

House to House Selling—Does It Pay?

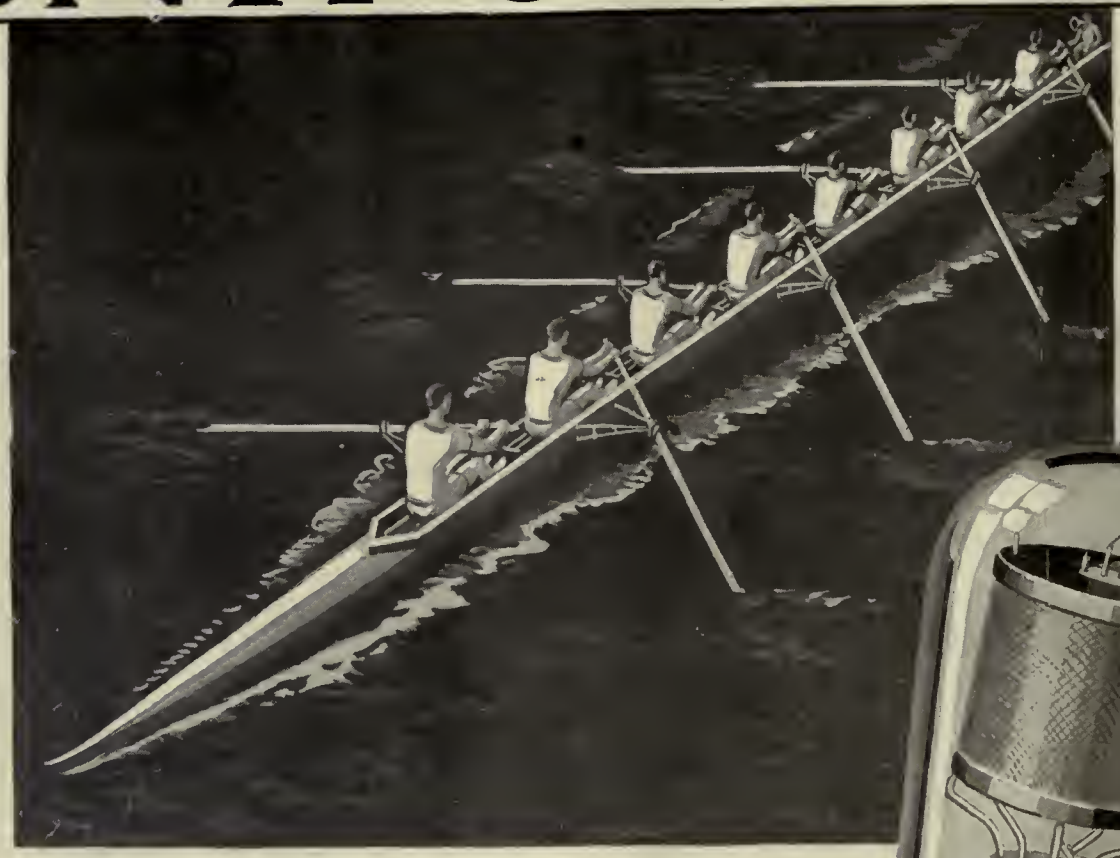
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PAWTUCKET, R. I.

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RADIO TUBES

Above is shown TRĪAD T-24 — Screen Grid Tube for AC use.

▼

Tune in on the "Triadors" — every Friday evening 8 to 8.30 Eastern Daylight Time — on WJZ and associated NBC Stations.

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Accurate screen grid analysis without producing oscillation in the set.

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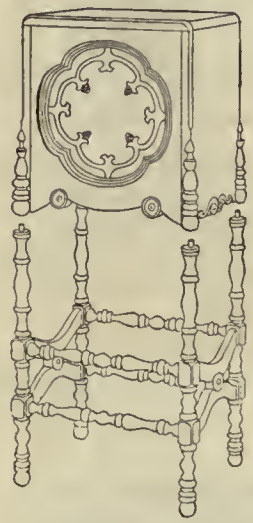
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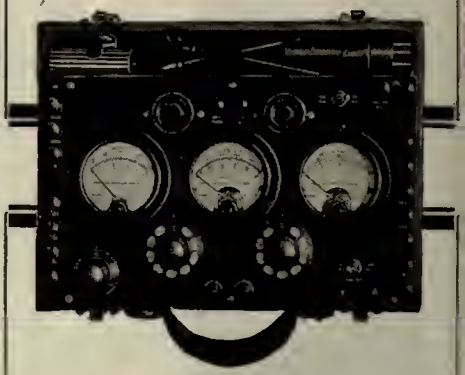
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D.C. Milliameter—double range 100/20 M. A. provides for lower readings with better scale characteristics.

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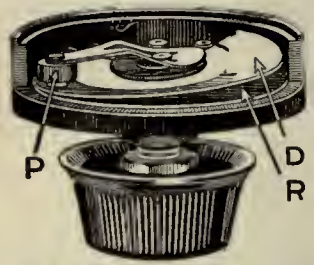
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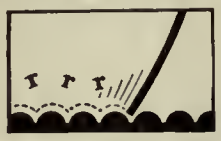
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This shows the exclusive rocking disc construction of Centralab volume control. "R" is the resistance. Contact disc "D" has only a rocking action on the resistance. Pressure arm "P" together with shaft and bushing is fully insulated.



This is the action of the usual wire wound control after it has been in use for some time . . . like dragging a stick over a cobblestone pavement.



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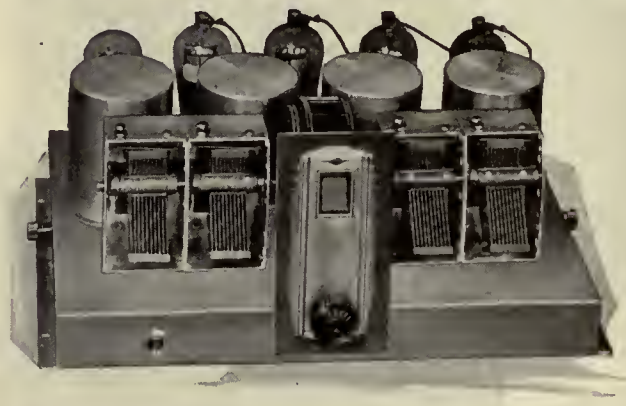
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The NATIONAL Velvetone Amplifier Power Supply is an R C A licensed push-pull power amplifier, sold completely wired, and designed for finest performance with the MB-29. Write today for complete information.

4 SCREEN-GRID Tubes for utmost sensitiveness and distance,—a newly designed system of Power Detection necessary to get the most out of the modern high-percentage-modulation broadcasts; —Band-Pass Tuning for complete separation of stations without any cutting of side-bands,—these are only three of the outstanding features of the new NATIONAL MB-29 Tuner.

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There are available a selection of beautifully finished and specially priced consoles and tables for housing the MB-29, in various popular combinations.

NATIONAL CO. INC., Malden, Mass.

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NATIONAL SCREEN-GRID— MB-29

Screen Grid Tubes and Power Detectors

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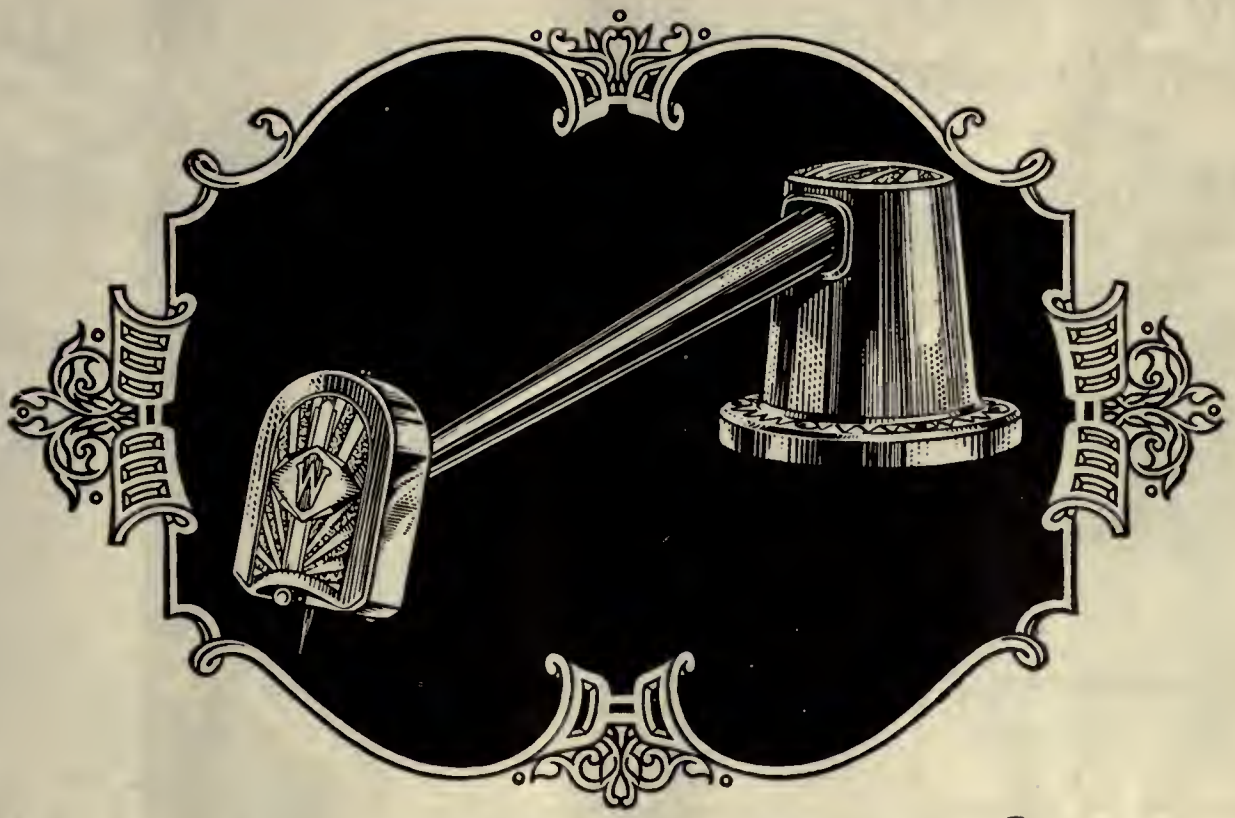
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SALES-PRODUCING features — engineering leadership, correctness of design, precision manufacture, and a resulting magnificance of tone — you get them all in the newest, finest Webster Electric Pick-up!

What a profitable success it has been for dealers everywhere. The few weeks since its introduction have proved this irrefutable fact:

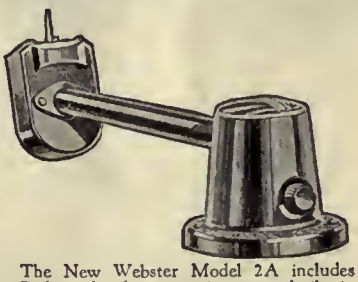
The public wants Webster's product!

They recognize the Webster Electric Pick-up as a perfect medium for the true reproduction of music in any form.

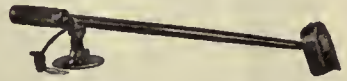
Accurate, life-like interpretation of instrument or voice, in soft whispers or crashing crescendos, determines Webster selection in every comparison.

Webster tone is the logical result of the Webster features listed below. Collectively, they represent the highest pick-up development in the sound-reproduction field.

The new Webster Pick-up is available in two models, each for either battery-operated or A. C. sets. Both models are packed in attractive self-selling cartons—if your jobber has not stocked the Webster, order direct.



The New Webster Model 2A includes Pick-up head, supporting arm, built-in volume control and adapters.



The Webster Electric Theater Pick-up

This special model is offered for use with 16" records operating at 33⅓ R. P. M. An adjustable counterbalance makes it possible to correctly control the weight on the record. Provisions are made for mounting of base with rubber bands to obtain vibration-free mounting. Standard length from needle point to center of base is 12", but shorter length may be specified. Finished in instrument black.

Model 2D—Standard Impedance Head .....List $25.00

Model 2D-1—Low Impedance Head (200 ohm).....List 30.00

Model 2D-1 can also be furnished with an impedance matching transformer at $7.50 extra.

These Features Make the Webster Supreme

1—The famous Webster low-inertia stylus bearing, utilizing an all-metal pivoting action, eliminates necessity for bulky construction. Positively no rubber on bearings. Perfect balance is assured.

2—The Webster Pick-up head is small and compact, perfectly balanced, light in weight. Weight of head on record only 4½ ozs. No counterbalancing or springs necessary.

3—Highest grade Cobalt magnet of greatest possible density is used.

4—Shock-absorbing arm bearing with pivot at base — an exclusive Webster development.

5—Unique method of turning head with arm to conveniently insert playing needle.

6—Volume control incorporated in base—compact and easicst to install — an original Webster feature.

7—Base is weighted. Can be screwed to motor board or merely set in place.

8—Card completely concealed — all bearings free from play and chatter.

9—Construction lends itself easily to use of varied lengths of arm for either standard or talking picture records.



Model 2B includes Pick-up head, separate volume control, and necessary adapters.



Webster

Electric Pick-up

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FREED NR 95 Radio

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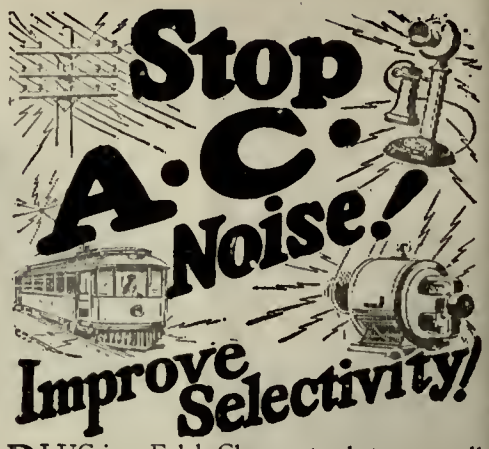
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$7.50 complete with cord and plug

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This is of particular importance in tubes of the 280 rectifier and 224 screen-grid type which have heavier elements, and in tubes used for push-pull audio amplification, where uniform characteristics are most essential. Eveready Raytheon 4-*Pillar* Tubes come in all types. At your dealer's. He also has the famous B-H tube for "B" eliminator units.

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Showing the exclusive, patented Eveready Raytheon 4-Pillar construction. Note the sturdy four-cornered glass stem, the four heavy wire supports, and the bracing by a stiff mica sheet at the top.



Eveready Raytheon Screen-Grid Tube, ER 224. Without Eveready Raytheon's 4-Pillar construction, this type of tube is delicate, liable to severe damage in shipment.

EVEREADY RAYTHEON

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RADIO BROADCAST

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KEITH HENNEY . *Director of the Laboratory*
HOWARD E. RHODES . . *Technical Editor*
EDGAR H. FELIX . . . *Contributing Editor*

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The contents of this magazine is indexed in *The Readers' Guide to Periodical Literature*, which is on file at all public libraries

. . . *among other things*

THE many readers of this magazine who are interested in the selling of radio and all that pertains to it have welcomed the division of our articles into the two distinct sections of the magazine. The Merchandising section of RADIO BROADCAST contains interesting and useful information about selling problems as they are and as we would like them to be. It happened that in our August issue, wholesalers and retailers from many different parts of the country found a number of our articles notable enough to request reprints. These were gladly furnished and it is our hope that they were of help in the merchandising of radio—a continual problem of this industry in which RADIO BROADCAST is primarily interested.

THOSE primarily interested in radio selling will find the issue now before them of more than usual service. A successful house-to-house selling plan is described in the story beginning on page 253; comments on deferred payments selling are helpfully made by G. S. Corpe (page 256) who has been on the firing line for years; Howard Dickinson, a merchandising authority of national reputation, discusses trade gossip and its evils (page 258); the annual behavior of tube sales are detailed on page 260—and interesting information it is too; and B. H. Darrow, who has been associated with schools for many years, outlines the size of the radio school market (page 263).

THE October RADIO BROADCAST will present many short articles on the most useful sales ideas, tested in the furnace of practical experience, a discussion of the best means of advertising a local radio shop, a consideration of the merchandising plans for the current year to meet new problems, and many other articles written from a practical background.

THE technical section will contain a description, published for the first time anywhere, of the new Stromberg-Carlson automatic volume control set, an engineering discussion of the British pentode tube (about which we are going to hear much more in this country as the months roll by), and an unusual article on detection problems by a tube engineer of national repute. These articles are all in addition to the regular features which regularly appear and which have become so popular.

—WILLIS KINGSLEY WING.

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will *you* trust your ears?



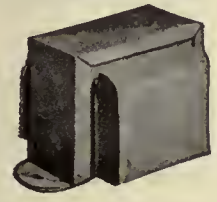
By the only standard which gauges sales success — *the ears of the purchaser* — the T·C·A Dynamic is a better speaker.

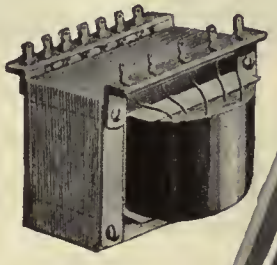
T·C·A's claim for superiority does not hang on the slender thread of a detail here or a detail there. It does not hang on an obscure characteristic of only academic interest.

It hangs on a definite and perfectly apparent *tone value* that impresses itself not only upon the critical ear of the engineer, but upon the unpracticed ear of the ultimate layman who buys the set.

After all, the most important function of a speaker is to *faithfully* reproduce the broadcast program.

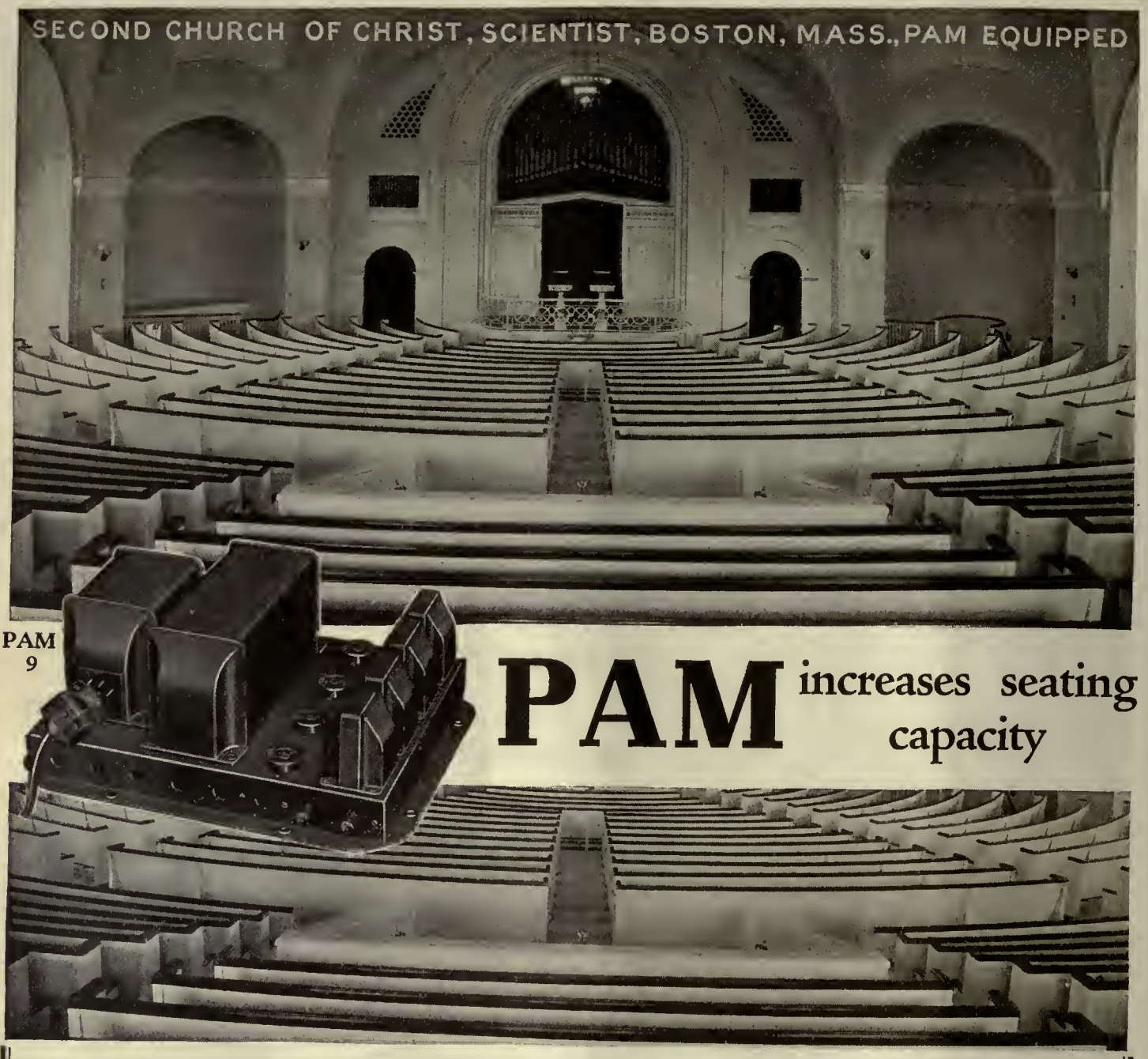
It is this characteristic that sells the set and pays the dividends.





As audio amplification specialists, the T·C·A organization is at your service. The T·C·A Dynamic is, however, only the final step in the audio series. The precision, uniformity and tone quality of the audio transformers and chokes are by no means a secondary consideration. Nor can a noisy, humming power-pack be corrected by any companion parts. Like the links in a chain, each successive unit from the power-pack to the speaker must carry the responsibility for perfect reproduction. T·C·A parts are meeting this responsibility squarely in many of the finest and most popular sets on today's radio market.

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PAM 9

PAM increases seating capacity

BECAUSE of the PAM installation no one need stand or be turned away for lack of seats at the Second Church of Christ, Scientist, Boston, as long as there is a seat available in the Sunday School Room or other parts of the church.

Every word of the speaker is picked up by microphone and PAM amplified for the loud speakers, which deliver it crystal clear to the overflow assemblages.

Every church or parish house is a logical prospect for PAM equipment for this or entertainment purposes, and every radio dealer should see to its installation.

A new 16-page bulletin giving mechanical and electrical characteristics, representative installations and many new PAM amplifiers will be sent upon receipt of 10c in stamps to cover postage. When writing ask for bulletin No. R.B.-10.

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MEMBER R.M.A.

Manufacturers Since 1882

Factories at Canton and Watertown, Mass.



House to House SELLING

How Two Young Men Built Up a Paying Business in New York City

AFTER EIGHTEEN months of experience, a small but active organization in New York City has proved to its own satisfaction that the principle of house-to-house canvassing, so successful in selling washing machines, vacuum cleaners, and other electrical appliances, can be applied to radio receiving sets with profit. Furthermore, the two men behind Reynolds Radio, Inc., of 130 West 42nd Street, New York City, have found that when properly modified and amplified to fit the particular needs of the trade, the house-to-house method of radio sales has produced greater profits than can be expected from the less intricate and supposedly more stable appliance lines.

The two men, K. L. Saunders and Herman Resnick, started on January 1, 1928, with what Mr. Saunders describes as "two salesmen, ourselves, and an idea." The two salesmen were good, Saunders and Resnick had worked successfully together in managing a direct-to-consumer washing-machine business, and the idea seemed to have a few more advantages than disadvantages.

Disadvantages of Plan

The disadvantages which militate against a house-to-house selling business in New York City are more numerous in the radio trade than in any other, especially so since Saunders and Resnick decided to confine their efforts to Manhattan and the Bronx. There are almost as many radio stores in those boroughs as there are drug-stores. The New York newspapers carry more radio advertising of retail shops than do the papers in any other city, and a large proportion of those shops are cut-price stores. Furthermore, house-to-house selling is of necessity a time-payment business, and with one-third of New York's population "transient," and one-quarter of the "permanent" residents addicted to moving to new addresses on every October 1st, the possibilities for lost sets and untraceable debtors are large.

The Advantages

To offset those drawbacks, Saunders and Resnick figured that the all-electric set has a greater appeal to apartment dwellers than it has to house-owners, a greater appeal to the always-busy New Yorker than to the suburbanite who has long evenings in which to tinker over his own concoction or keep his old set in good condition. They balanced the possibilities of absconding debtors against the natural honesty of human nature and the highly developed credit statistics available to all New York merchants through the credit associations. And they knew that a radio set is a luxury, and that people will buy luxuries for the home far more readily than they will buy such efficient labor-saving appliances as washing machines.

At the end of the first year, they had a force of fifteen salesmen, had done a gross business of $157,000, and cleared a net profit of $15,000, or 15 per cent. And they had found some very interesting facts.

"From the beginning, we handled only one line of sets. We have found that our policy has more than justified itself. Our salesman know the set thoroughly, and have confidence in it. The customer feels that if we didn't think it was the best set, we wouldn't be banking on it to the exclusion of others.

And by handling only one line, our service problem is simplified, and we are sure that our servicemen can give expert work and satisfaction. Once the set is installed and has been serviced, subsequent complaints can often be handled over the telephone. At the present time, we are giving service satisfaction by telephone in about 20 per cent. of our complaints, since we can diagnose the trouble from the customer's description."

The average contract has been for $200, and the medium-class market has been the best. Some business has been done in the very wealthy districts, and a little in the very poor, but the people who are buying radio sets are those in the middle level of salary and social position.

The quality of service rendered has been the determining factor in clinching the house-to-house sales, and Saunders and Resnick have built up a service department which few if any retail stores have attempted to equal. The installation problems in New York apartments have made an "interference elimination" department absolutely necessary, and the work of that department has in turn brought increased business to the salesmen.

Sets are never sold at less than list prices, despite the competition of cut-price stores, and with the quality of service which accompanies that higher price, only one customer out of every three hundred has made any complaint regarding the initial cost.



Keith L. Saunders

The policies and practices of the successful house-to-house canvass are best illustrated by taking a theoretical case. The salesman makes his contact, interests the customer, and arranges to have a set installed for demonstration. No sales contracts are signed until after the customer has heard the set in actual operation in his or her home, and is satisfied with its performance. If the delivery-man who makes the installation finds that there is interference or noise, he will not let the customer accept the set until it has been serviced by the interference-elimination department. If the interference-elimination is successful, the customer pays for the cost of the materials (the filter condensers and so on), but pays nothing for the labor involved. If the interference cannot be eliminated, the set is not sold.

One Year Guarantee

All sets are sold with a service guarantee of one year, and a six-months guarantee on tubes. A record card of each set sold, showing the date of sale, with customer's and salesman's name, details of installation work, and individual records of each service call during the year, is kept at the office.

If a set proves faulty, or otherwise in need of repair, it is removed from the customer's home and another one substituted during the time required for repairs.

"We never let a repairman work on the interior of a set in the customer's home, where the customer can see him fiddling around with a soldering iron or puzzling over a diagnosis. We pull the set right out, replacing it with a good set. In many cases, we leave the loaned set there permanently, and, after the other set has been reconditioned to our satisfaction, we treat it as a new set. Our follow-up service system assures us that there will be no dissatisfaction from the purchaser of the set, since if we can't recondition it properly we discard it," Mr. Saunders explained.

The operations of the interference-elimination department can be shown by one incident, where the cost to the customer ran to the unusual total of $127.50. The usual cost varies from $7.50 to $20. The customer was a wealthy man, living in a large coöperative apartment. He had never been able to get a radio set that suited him, because no dealer could eliminate the house interference. The Reynolds man went to work, and before he was through he had to take care of interference from six elevators, five service pumps, and eight electric ice-boxes. The customer was more than pleased, paid the cost of materials gladly, and, as a result of that work, the salesman was able to place two other sets in the same apartment.

In several apartments, where house interference had made radio reception virtually impossible, the salesman have arranged with four, six, or eight prospective customers to share the cost of eliminating the interference, and in every such case each prospective customer signed a sales contract gladly as soon as the interference was removed.

Quoting Prices

The Reynolds salesmen always quote the final price to the prospective customer. They are not permitted to use the "less tubes" or "less speaker" quotations. The price given the customer at first approach is the price he will pay for the set complete, installed, and in actual operation, unless there is an interference-elimination charge.

Frank confession of previous troubles in "bad" areas is also a first tenet of the Reynolds sales policy. No set is sold without actual trial in the location where it will be used, and in some cases sets are removed against the prospective customer's wishes.

"We've found that if the set doesn't function to suit our servicemen's standards, there is no sense in leaving it there, even though the customer says he doesn't mind the interference or the other deficiencies. Sooner or later, the customer will mind them, and then we will be in for more service trouble than the sale is worth. Sometimes, of course, if the customer insists that he wants the set and is willing to forego the guarantee which we won't give him, the set is sold. There was one

ease like that, a man who lived in the same building with a beauty parlor. We couldn't eliminate the interference, we tried three different types of filters without getting results that suited us, and finally we told him we couldn't give him the kind of radio service we insist on giving, so we took the set out. A few weeks later, he came in, said he missed the radio, and bought the set because, even with the poor reception he got, he liked it," Saunders said.

Service within twenty-four hours of every complaint has been a fixed rule of the company ever since it started. That service is possible because of the accessibility of all of the company's customers, the boroughs of Manhattan and the Bronx being easily divided into service districts.

Repossessions, or charge-backs, sets which have had to be removed because the customers failed to pay up their installments, amounted to 2 per cent. of the gross business in 1928, and will be smaller in the future because of added safeguards now taken by the company. One thing that the Reynolds company learned during its first year was never to install sets on trial just before an important prize-fight, election,or other major broadcast attraction. The rule now is that no sets are sent out on trial on the two days preceding such events.

"Ninety-five per cent. of the repossessions were due to outside misfortunes which made it impossible for the customers to continue payments, and are the natural hazards of installment selling. Many of those repossessions, however, were transferred directly to friends of the original customer with the service guarantee still in force," said Mr. Resnick. "Less than one-half of one per cent. of our sets were stolen by customers moving away before their payments were completed."

COST OF OPERATION

Sales Expenses

Service	$5,345.29
Advertising	220.65
Trade-in allowance	1,014.13
Installations	2,588.53
Installation supplies	1,580.75

General Expenses

Office rent	$ 2,250.00
Stationery, printing	766.83
Telegrams	104.09
Telephones	525.54
Office salaries	11,382.00

Income

Gross sales	$157,152.91
Regular sales (cash)	31,724.50
Net profit	15,095.90

In the accompanying table are figures of sales and general expenses for the year 1928. These will make interesting comparison with those of retail store dealers in the same area. The figures are not completely reproduced here, only the more important and unusual items having been selected. Office salaries were about $5,000.00 larger than necessary during the first year of operation (1928), owing to what Mr. Saunders calls "our experiments and inexperience." They will be considerably lower than the 1928 figure this year, despite the expansion of the business.

HOW RETURNS AND ALLOWANCES VARY WITH VOLUME OF BUSINESS

THE PRELIMINARY report on the National Retail Credit Survey, recently released by the Domestic Commerce Division of the Department of Commerce, includes statistics on the percentage of bad debts on open and installment credit sales for department stores, automobile dealers, and independent retail grocery stores reporting by April 13, 1929.

The open credit loss, in the case of both department and grocery stores, was found to vary inversely with the size of establishments, i.e., the larger the store the smaller the proportion of open-credit loss. No such relationship was found between the size of department stores and their installment-credit losses.

The average loss for the 440 department stores reporting, representing the ratio of total bad debts to total open and installment credit sales, was 0.4 per cent. on open-credit accounts and 1.1 per cent. on installment accounts. Chain department stores had an average loss on open-credit sales of 0.8 per cent. and on installment sales of 1.3 per cent. compared with 0.4 per cent. and 1.0 per cent. for other department stores.

The 339 automobile dealers, on the other hand, lost less on their installment accounts than on open-credit sales, bad debts representing 0.4 per cent. of installment credit and 0.9 per cent. of open-credit sales.

The percentage of bad debts on open-credit accounts for the 843 grocery stores doing cash and credit business was 0.6 per cent., the range being from 4.9 per cent. loss for stores with total sales under $9000 to 0.4 per cent. for stores with total sales of $250,000 and over.

VALUE OF CREDIT INFORMATION

THE data collected in the study of credit conditions among Louisville retail grocery stores showed that, as a rule, the credit stores which used a credit bureau had a lower percentage of bad debts than those which did not. The difference is brought out by the following table:

Volume Group of Stores	No. of Stores	Average Bad Debt Losses	
		With Credit Bureau	Without Credit Bureau
Under $5000	10	9.4%	11.6%
$5000 to $9000	9	2.4	5.5
$10,000 to $24,000	59	2.7	3.9
$25,000 to $49,000	52	1.3	1.7
$50,000 to $99,000	25	0.5	1.1
Over $100,000	10	0.4	0.3

Retail radio dealers who are not using credit information available to them through their local Merchant's Association credit bureau should investigate the cost and compare it with the cost of doing without it. It is especially interesting in examining these Louisville figures to note that the most severe losses were not in the largest volume stores but those doing less than $10,000 annually.

THE DEALER and the FINANCE COMPANY



By G. S. CORPE

YOU KNOW, although all of us prefer other parts of our business, the financial side of it just must have at least a small portion of our attention and effort. Whether we like it or not, we have to mix in a little collecting of slow accounts with shooting bugs out of somebody's bum radio; and we are forced to call on our banker once in a while, along with our calling on prospects for a new model radio receiver.

Regardless of how much money a radio dealer may have, it seems to be the consensus that it is best to let a finance company handle and collect time-sale paper. And now-a-days, when 85 per cent. or more of our sets are sold on the monthly payment plan, what dealer has not a connection with some sort of a finance company? That is what we wish to talk about here—your relations, as a dealer, with a finance company.

It doesn't matter much whether the party who handles your paper is a big million-dollar corporation, or just a well-heeled friend; there are certain things in connection with your relationship that deserve the same careful attention that your advertising, servicing, selling, or any other department gets.

Speaking broadly, the good old Golden Rule covers the subject. Don't try any "fast ones" on your bank or finance company that you wouldn't want to have tried on you, were your positions reversed. Handle every transaction with your financier just exactly like you would wish him to do for you.

If he asks that you get one-third down on all sets sold on contract, get one-third down. Don't try to get by with a

Table Shows Cost of Financing Radio Installations of Various Values

(These data were prepared from the rate table of one of the largest finance companies handling radio paper, and are considered representative.)

Unpaid** Balance	Total Cost of Financing Over a Period of*							Cost of Set (Approximate†)	Down Payment (Approximate†)
	4 Mos.	6 Mos.	8 Mos.	10 Mos.	12 Mos.	15 Mos.	18 Mos.		
$ 55	$ 8	$ 8						$ 69	$ 14
60	8	8						75	15
65	8	8						81	16
70	8	8						88	18
75	8	8	$10					94	19
80	8	8	10					100	20
85	8	8	10					106	21
90	8	8	10	$10				112	22
95	8	8	10	10				119	24
100	8	8	10	10				126	26
105	8	8	10	10				132	27
110	8	8	10	10	$12			138	28
115	8	8	10	10	12			144	29
120	8	8	10	10	12			150	30
125	8	8	10	10	12			156	31
130	8	8	10	10	12			163	33
135	8	8	10	10	12			169	34
140	8	8	10	10	12			175	35
145	8	8	10	10.15	12			181	36
150	8	8	10	10.50	12			188	38
155	8	8	10	10.85	12.40			194	39
160	8	8	10	11.20	12.80	$16		200	40
165	8	8.25	10	11.55	13.20	16.50		206	41
170	8	8.50	10.20	11.90	13.60	17.00		213	43
175	8	8.75	10.50	12.25	14.00	17.50		219	44
180	8	9.00	10.80	12.60	14.40	18.00		225	45
185	8	9.25	11.10	12.95	14.80	18.50		231	46
190	8	9.50	11.40	13.30	15.20	19.00		237	47
195	8	9.75	11.70	13.65	15.60	19.50		243	48
200	8	10.00	12.00	14.00	16.00	20.00	$22.00	250	50
205	8.20	10.25	12.30	14.35	16.40	20.50	22.55	256	51
210	8.40	10.50	12.60	14.70	16.80	21.00	23.10	263	53
215	8.60	10.75	12.90	15.05	17.20	21.50	23.65	269	54
220	8.80	11.00	13.20	15.40	17.60	22.00	24.20	275	55
225	9.00	11.25	13.50	15.75	18.00	22.50	24.75	281	56
230	9.20	11.50	13.80	16.10	18.40	23.00	25.30	288	58
235	9.40	11.75	14.10	16.45	18.80	23.50	25.85	294	59
240	9.60	12.00	14.40	16.80	19.20	24.00	26.40	300	60
245	9.80	12.25	14.70	17.15	19.60	24.50	26.95	306	61
250	10.00	12.50	15.00	17.50	20.00	25.00	27.50	313	63
255	10.20	12.75	15.30	17.85	20.40	25.50	28.05	319	64
260	10.40	13.00	15.60	18.20	20.80	26.00	28.60	325	65
265	10.60	13.25	15.90	18.55	21.20	26.50	29.15	331	66
270	10.80	13.50	16.20	18.90	21.60	27.00	29.70	338	68
275	11.00	13.75	16.50	19.25	22.00	27.50	30.25	344	69
$280	$11.20	$14.00	$16.80	$19.60	$22.40	$28.00	$30.80	$350	$ 70
285	11.40	15.25	17.10	19.95	22.80	28.50	31.35	356	71
290	11.60	14.50	17.40	20.30	23.20	29.00	31.90	363	73
295	11.80	14.75	17.70	20.65	23.60	29.50	32.45	369	74
300	12.00	15.00	18.00	21.00	24.00	30.00	33.00	375	75
305	12.20	15.25	18.30	21.35	24.40	30.50	33.55	381	76
310	12.40	15.50	18.60	21.70	24.80	31.00	34.10	388	78
315	12.60	15.75	18.90	22.05	25.20	31.50	34.65	394	79
320	12.80	16.00	19.20	22.40	25.60	32.00	35.30	400	80
325	13.00	16.25	19.50	22.75	26.00	32.50	35.75	406	81
330	13.20	16.50	19.80	23.10	26.40	33.00	36.30	413	83
335	13.40	16.75	20.10	23.45	26.80	33.50	36.85	419	84
340	13.60	17.00	20.40	23.80	27.20	34.00	37.40	425	85
345	13.80	17.25	20.70	24.15	27.60	34.50	37.95	431	86
350	14.00	17.50	21.00	24.50	28.00	35.00	38.50	438	88
355	14.20	17.75	21.30	24.85	28.40	35.50	39.05	444	89
360	14.40	18.00	21.60	25.20	28.80	36.00	39.60	450	90
365	14.60	18.25	21.90	25.55	29.20	36.50	40.15	456	91
370	14.80	18.50	22.20	25.90	29.60	37.00	40.70	463	93
375	15.00	18.75	22.50	26.25	30.00	37.50	41.25	469	94
380	15.20	19.00	22.80	26.60	30.40	38.00	41.80	475	95
385	15.40	19.25	23.10	26.95	30.80	38.50	42.35	481	96
390	15.60	19.50	23.40	27.30	31.20	39.00	42.90	488	98
395	15.80	19.75	23.70	27.65	31.60	39.50	43.45	494	99
400	16.00	20.00	24.00	28.00	32.00	40.00	44.00	500	100
420	16.80	21.00	25.20	29.40	33.60	42.00	46.20	525	105
440	17.60	22.00	26.40	30.80	35.20	44.00	48.40	550	110
445	17.80	22.25	26.70	31.15	35.60	44.50	48.95	556	111
450	18.00	22.50	27.00	31.50	36.00	45.00	49.50	563	113
455	18.20	22.75	27.30	31.85	36.40	45.50	50.05	569	114
460	18.40	23.00	27.60	32.20	36.80	46.00	50.60	575	115
465	18.60	23.25	27.90	32.55	37.20	46.50	51.15	581	116
470	18.80	23.50	28.20	32.90	37.60	47.00	51.70	588	118
475	19.00	23.75	28.50	33.25	38.00	47.50	52.25	594	119
480	19.20	24.00	28.80	33.60	38.40	48.00	52.80	600	120
485	19.40	24.25	29.10	33.95	38.80	48.50	53.35	606	121
490	19.60	24.50	29.40	34.30	39.20	49.00	53.90	613	123
495	19 80	24.75	29.70	34.65	39.60	49.50	54.45	619	124
500	20.00	25.00	30.00	35.00	40.00	50.00	55.00	625	125
505	20.20	25.25	30.30	35.35	40.40	50.50	55.55	631	126
510	20.40	25.50	30.60	35.70	40.80	51.00	56.10	638	128
515	20.60	25.75	30.90	36.05	41.20	51.50	56.65	644	129
520	20.80	26.00	31.20	36.40	41.60	52.00	57.20	650	130
540	21.60	27.00	32.40	37.80	43.20	54.00	59.40	675	135
560	22.40	28.00	33.60	39.20	45.00	56.00	61.60	700	140

*In the computation of these figures it was assumed that the unpaid balance plus the finance charge would be amortized in equal monthly installments.

**On an average the unpaid balance is approximately 80 per cent. of the list price of the receiver, i. e., the usual down payment is 20 per cent.

†Assuming that the customer makes a down payment of 20 per cent., the cost of financing is as indicated in this table. If a larger or smaller down payment is made it is necessary to determine the unpaid balance and then refer to the left-hand column.

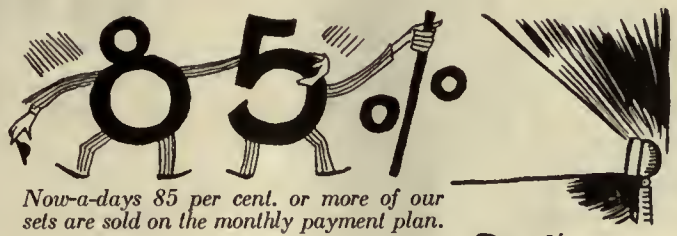
contract with only one-fourth down; and let's not try the old trick of "bubbling" the contract, so that it appears that the total price and the down payment are more than they actually are; finance people make it their business to have full knowledge of prices on all sets they will handle paper on.

If your financier asks that payments do not run longer than 10 months, make all your contracts that way. Don't bother him by asking him to make a special exception and take on a 12-month contract just because you know the buyer is good pay, or because he is a close friend of yours, or for any other reason.

Probably one of the most common causes for a falling-out between a radio dealer and his finance company is the failure to coöperate in making collections. The payments on radio paper are usually of such a small amount that the finance company cannot afford to be sending out a collector, and depends upon the dealer to take care of delinquent payments. The usual procedure is to send a past-due notice when the payment becomes five days delinquent; then another stronger one ten days after the due date; and usually a final notice five days later, or 15 days after the due date. The dealer gets copies of these past-due notices. And if he wants to continue to get along with his financier, he will get busy and find out why the payment has not been made—just as soon as he gets the first notice, and without letting a second notice become necessary. Don't throw that notice in the waste-paper basket and just hope the customer will pay soon; give it honest attention, *right away*. You will find that prompt collecting on any slow accounts will help you in more ways than one. It increases the respect of not only the finance company for you, but actually of the customer, also. And remember that a prompt follow-up may often save you from a serious loss.

Why a customer will sign a contract, setting forth payments on certain dates and then proceed promptly to forget it, is a mystery; but it seems to be human nature, which we cannot change; and the live-wire dealer will be right on the job reminding his customer and getting the money.

Advertising your ability to sell sets on monthly payments in a judicious way will often give you a profit that otherwise might be lost. The angle of this depends upon the community where you do business; study it and work it accordingly. For example, if your business is in a rural community you would hardly advertise that "Sets can be paid for on the budget plan"—most of your customers may not even know what you mean. And likewise, if your business is in a city where industry is the main-stay, tell your customers that payments may be arranged to be met from their salary, each month, and on the date most convenient for them to pay. Or if you are selling to farmers where their money is received only from one or two principal crops a year, go to your bank and arrange to discount that type of paper, and don't be bashful in telling your farmer customer that you can put a radio in his home upon the payment of only one-third down and that you have arranged so that the balance may all be paid in one payment, when his crop is sold.



Now-a-days 85 per cent. or more of our sets are sold on the monthly payment plan.



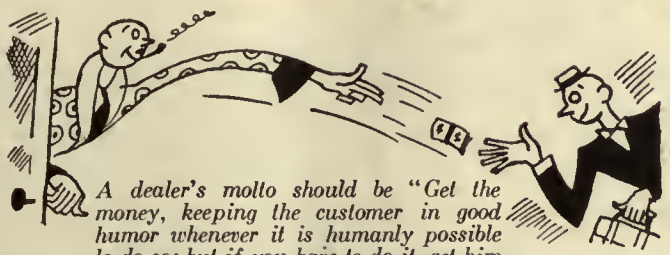
Don't throw that past-due notice in the waste-paper basket and just hope that the customer will pay soon; give it honest attention, right away.



Advertising your ability to sell sets on monthly payments in a judicious way will often give you a profit that otherwise might be lost.



Nearly all finance companies have what is called a "road man" . . . Here is your chance to get some valuable information. Talk over general business conditions with him.



A dealer's motto should be "Get the money, keeping the customer in good humor whenever it is humanly possible to do so; but if you have to do it, get him mad enough to pay."

A successful connection that I have observed between a good dealer and a good finance company resulted in several hundred dollars additional profit each year. The dealer knew the finance company would "go the limit" with him; and in turn, the finance company knew that the dealer was absolutely dependable and that anything or everything he told them would always check up 100 per cent. With that common ground to work from, the dealer proceeded to sell successfully all kinds of radio accessories on small monthly payments; many of them on such small payments that the paper would be hopeless to sell, ordinarily. He sold complete sets of replacement tubes, instead of selling only the one which absolutely needed replacement; and he took as down-payment the price of the one necessary tube; the balance, of course, was covered by a contract and note with monthly installments. He sold dynamic loud speakers to people who had a good set but wanted a modern loud speaker; and he took their old loud speakers at a very low figure for the down-payments and got the balances in such easy installments that the buyers were not hurt at all. One of the most important things he did along this line was getting clear of old sets; all of us know how these will accumulate. But he moved them out at from $10 to $25 each, on mighty easy terms and his finance company handled the paper on them, too—because they knew he would get the money on every contract, promptly. Phonograph pick-ups, short-wave receivers, power amplifiers, and even amateur transmission equipment, were sold on the monthly payment basis. And, at the risk of boring you, let me repeat: the only way he was able to swing all this extra volume of business was through the implicit confidence his finance company had in him. Every dealer should conduct his dealings with his outlet for paper in the same manner, and with the same end in view.

I stated above that it probably is best to let someone else handle time-sale paper, even if you have enough money to

(*Concluded on page 289*)



GOSSIP

THAT TRADE GOSSIP

By
HOWARD W.
DICKINSON

IT IS REALLY a wonder that any industry ever settles into its stride. The men who make their bread and butter through a particular industry seem bound to keep the industry upset and themselves in a perilous state of uncertainty by the recklessness of their gossip. This would be easy to correct if it were not based on human nature. *Gossip is a very human pastime.*

Radio dealers want their business to "stay put" long enough to sell their stocks on hand, at least. But—"I hear that Manufacturer A is coming out with a set which utilizes the wind on the roof for power." Or "They tell me that ABC is about to go broke and their sets will be in job lot sales." Or "The Gyps have all the best of this business. I can't keep prices where there's a living in it." Or "We got stung by XYZ's advertising promises and stocked up and look what happened to XYZ." Or "Wonder how PQ gets away with it, he never made a good set in his life." Or "JZ is playing up to the big dealers and doesn't give the regular radio shop a look in," or worse and worse.

The Dangers of Gossip

Gossip in a new trade presents great dangers and a very difficult problem.

Actual news of the trade is very important. It is very foolish to shut your eyes to the *facts* of your industry. You should know them. And yet unrestrained gossip in an industry is a breeder of many evils. Here are some of them.

Fear or getting the imagination set upon the difficulties of your business. These things grow and grow in the imagination, and soon fear looms bigger than the hope of profit and growth. That is a condition which almost surely dooms a dealer to failure. It has many forms, such as fear to invest in necessary stock, lest it shall go stale; fear that a competitor will allow more on a turn-in and so you will lose the sale; fear that the industry as a whole is on the skids. Fear is not the frame of mind to carry one to success. Careless gossip is its breeder. Fear and Success do not ride in the same car.

Price Cutting. "Everybody's doing it." "Only way to compete with the big people." "This business just won't let you make a good living and get ahead." "So much new stuff on the market, no chance to move it all—then bang! Prices will go right under us and leave us carrying the bag."

There are insidious forms of price cutting, sometimes fostered by the very same manufacturer who should protect you. I have been offered an unbelievable "turn-in" allowance, provided I would buy a certain high-priced set. The offer was $150 on *any* set I might turn in, even an old one-tube set. I was tempted to wrap some wire around a couple of old tin cans and see if I could get $150 allowance for that. I believe it would have been accepted.

How can I ever figure I am getting the bottom price on that expensive set? As a believer in reasonable performance in trade, I wouldn't have that set at any price, even if it were the most perfect reproducer on the market, and no matter how much it is advertised. Until it is priced reasonably, no dealer should be asked to carry it.

Uncontrolled gossip breeds *distrust.* This is shown in an



FEAR

attitude of repulsion to ideas which may be profitable to you, but which you refuse because you think that maybe you are being played for a sucker. "Why is he so anxious to unload this thing on me? He makes it sound good, but how do I know there isn't a nigger in that woodpile?"

A dealer needs to buy well just the same as he needs to sell well. An over-suspicious attitude makes him a poor buyer both selectively and in the quantity he buys. It spoils his trade judgment and dumps him into just the hole he is trying to avoid.

Gossip in the retail trade spreads to the *distributor* and the *manufacturer*. Such gossip upsets them and injures the coöperative friendliness which should extend through all the parts of an industry. A salesman suspicious of the good intent of a dealer, working with a dealer suspicious of the manufacturer whom the salesman represents—that is an all too common picture and does not make a good background for a mutually profitable business. The only man who wins under those conditions is the Gyp, who has learned how to make a



PRICE CUTTING

profit out of being suspicious of everybody, and who has no good will to protect. He doesn't care a hang who is suspicious of him. Extravagant and foolish gossip plays right into his hands. He does not appeal to the quality sense, anyway. The price nerve is all he tries to excite.

Customer Distrust

Worst of all, upsetting gossip works on the *customer* and makes him doubtful about what to buy, makes him wonder if this is the time to buy. If a dealer is in a gossipy condition his customers get reflection of it, shy off from their intentions to buy and wait for things to settle down or until the wild-cat predictions of impossible new inventions shall come true. Those vague predictions come to the customer through customer gossip as well. Customer gossip can be made harmless only through the dealer's calmness and his knowledge of facts.

Everybody in radio knows pretty well that the business has suffered greatly from foolish and uncontrolled gossip ever since it started. How can we keep up to the minute in the real news of the industry and also help kill destructive gossip? The answer is not to keep mum, but to be sensible in what we say.

To go back—

Fear is an imaginative bogie man. He can be killed by realities and by getting the imagination as well as the legs and voice at work doing business and making money. There is plenty of business to be had, even if too little of it comes in



DISTRUST

and begs you to sell to it. Imagination working upward leads to the necessary boldness, taking full profit and letting it be known that you intend to keep on doing it, insuring yourself in credits, and not falling for turn-ins on which you can't make full profit. Allowing $50 on a set that you've got to sell for $7, if you can sell it at all, is ridiculous, and no matter if a million dealers are doing it, it is unnecessary. Customers will admit it, too, if you tell them so frankly. If it is done it is because dealers are weak-kneed—because they follow each other in this thing like a flock of sheep. Some other industries have cleaned their houses of this pest and have standardized profits.

Price Cutting

Losing customers by *price cutting* of competitors is unnecessary to any great extent. Building a reputation for fine service, quality goods, and courteous treatment will absolutely cure it. Price isn't always the customer's first consideration. Competition shopping takes time and most people are busy. Be known as a fine, reliable shop and you can get along without the bargain hunters. In fact, if you have a fine reliable shop you will give many genuine bargains on which you will make your profit.

In a certain great city there are two fine stores, not radio shops, a block apart. They carry similar lines of merchandise. In one store the mark-up is 50 per cent. In the other it is 100 per cent. There is one line—a standard line which they both carry—on which they both *do just about an equal volume* at very different prices.

Distrust is destructive to an open mind. If a mind is not open it is not receptive to new ideas. You need new ideas. You need progressive development of your store display, ideas on demonstration, on new and better merchandise, on how you can advertise at a profit. These things are all upset by uncontrolled and foolish gossip. The wise man realizes that talk is cheap and that there are many cheap talkers. I have lost a little money in the years past by trusting friends. But by *having* friends I have made a hundred dollars for every dollar I have lost. With an attitude of distrust it is hard to have friends. The balance of profit is overwhelmingly in favor of having friends.

Coöperate With Manufacturers

Ever since manufacturers made goods and retailers sold them, these two partners in trade have been suspicious of each other, have made love to each other, have fought each

(*Concluded on page 302*)



The shadow cast by the twelve representative tube cartons in the illustration on the left indicates the way in which the sale of vacuum tubes varies throughout the calendar year. Each tube carton represents a month, starting on the left with January and ending with December on the right.

HOW TUBE SALES GO

By T. A. PHILLIPS

Manager, Research Division, Doubleday Doran, Inc.



T. A. Phillips

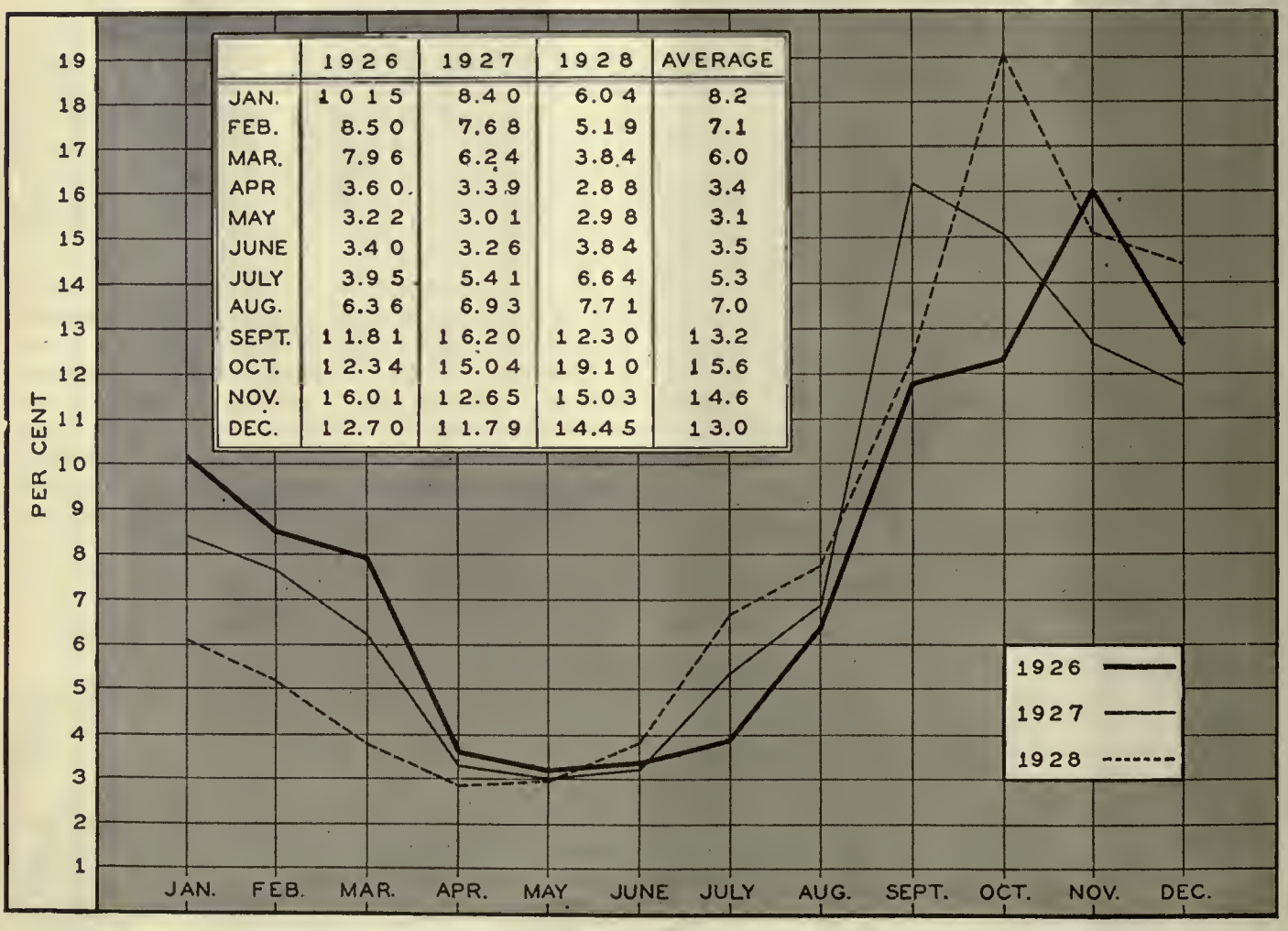
SPORTING EVENTS and other broadcasts which create national interest affect the sale of radio tubes tremendously. A study of the monthly sales of tubes in the past three years demonstrates the influence of such events on tube sales. It was found, for example, that the Tunney-Dempsey fights of 1926 and 1927, and the Presidential Campaign of 1928, made decided changes in the trend of the sales curves for radio tubes for the years in which they occurred.

It was possible also to determine how the demand for tubes varies throughout the average year. In June—the beginning of the radio year—the sale of radio tubes is near its lowest ebb, and from this point business begins to pick up gradually during the months of July and August. Sales take a big jump in September, and, in October, according to the average curve, reach the peak of the year. After October tube sales begin to drop, gradually at first and then more rapidly after the first of March. The lowest point in the sales curve is reached during the month of May.

These facts are illustrated graphically on this page. Below will be found a chart giving tube sales in percentages by

(*Concluded on page 301*)

	1926	1927	1928	AVERAGE
JAN.	10.15	8.40	6.04	8.2
FEB.	8.50	7.68	5.19	7.1
MAR.	7.96	6.24	3.84	6.0
APR	3.60	3.39	2.88	3.4
MAY	3.22	3.01	2.98	3.1
JUNE	3.40	3.26	3.84	3.5
JULY	3.95	5.41	6.64	5.3
AUG.	6.36	6.93	7.71	7.0
SEPT.	11.81	16.20	12.30	13.2
OCT.	12.34	15.04	19.10	15.6
NOV.	16.01	12.65	15.03	14.6
DEC.	12.70	11.79	14.45	13.0



These curves show how the demand for tubes has varied during the last three years.

"THE COURT DECIDES"

Some Decisions of the Higher Courts of the Country Affecting the Daily Interests of Dealers

By LEO T. PARKER
Attorney at Law

THE PRINCIPAL advantage of radio dealers obtaining legal information is the avoidance of litigations. Obviously, a person who understands his obligations is less likely to perform acts that will result in legal liability, when compared with a dealer who is unfamiliar with the law or one who relies upon "hear-say" information which, in the majority of instances, is quite undependable.



Moreover, frequently the records of fresh higher Court cases may be utilized advantageously in defending a suit. Therefore, the purpose of this article is to review several higher Court cases, decided during the past few months, involving radio dealers in which unusually important points of the law are explained.

Purchaser of Defective Radio Sets

The majority of persons are familiar with the established law that the maker of a negotiable note is bound to pay the proceeds to a disinterested and innocent party, who purchased it from the original holder, although the latter defrauded the maker when receiving the note.

In other words, a retail dealer of radio receivers is bound to pay a note given in payment for defective radio equipment, providing the manufacturer of this apparatus sold the note *in good faith* to an innocent purchaser.



On the other hand, it is important to know that this law is not effective under circumstances where the manufacturer sells the note to a person for the purpose of avoiding the responsibilities of the law, which is a rather frequent practice.

For illustration, in Stevens *vs.* Gaude, 120 So. (Louisiana) 79, it was disclosed that a retail radio dealer purchased several radio sets from a manufacturer who guaranteed them to be satisfactory. The manufacturer accepted notes in payment for the equipment and soon thereafter sold the notes to a man named Stevens.

When the radio dealer discovered that the radio sets would not operate satisfactorily he refused to pay the notes and Stevens filed suit, contending that he was a disinterested party.

However, in view of the fact that the manufacturer had agreed to repay Stevens any expenses he incurred in collecting the notes, the Court held the retail dealer not required to pay the same, saying:

"The testimony of the defendant, Gaude (radio dealer), corroborated by his son and two other witnesses, shows that the radio receiving sets were not satisfactory, and that for some reason they would not work in a satisfactory manner.... We therefore find that the notes are and were without consideration at the time they were executed. . . . It is our conclusion that these notes were never negotiated and delivered to Mr. Stevens in the execution and performance of an intent to sell them to him outright, but that the transaction between Mr. Stevens and the manufacturing company was merely a plan whereby the notes were sued on in the name of Mr. Stevens for the purpose of cutting off the equity of the makers."

Contract Held Legally Altered

In many instances, buyers and sellers enter into contracts the terms of which are cancelled or altered by mutual consent of the parties, although no written evidence may be introduced to prove conclusively the facts.

Therefore, it is important to know that the Courts look through obscurities surrounding sale contracts and endeavor to render verdicts in accordance with the true intentions of the parties.

For example, in F. A. D. Andrea, Inc., *vs.* Dodge, 28 F. (2d) 147 (Pennsylvania), it was disclosed that a manufacturer of radio cabinets and a manufacturer of radio receivers entered into a contract by the terms of which the latter agreed to purchase approximately 900 cabinets each month.



Later the buyer required a greater number of cabinets monthly and wrote the seller the following letter:

"Starting December 1, we are willing to allow you a bonus $1.00 per cabinet for each cabinet that you deliver, provided that deliveries of 1100 cabinets per week are sustained throughout the balance of the contracts. We are willing to pay you this bonus at the end of each month if your deliveries throughout that month amount to 1100 or more cabinets each and every week."

Some time after Christmas, the radio manufacturer wrote the seller explaining that he did not require so many cabinets

monthly, and requested the seller to reduce the shipments and revoke the bonus agreement. The seller answered that he had rearranged his production and agreed to supply fewer cabinets each month, but did not agree to reduce the $1.00 bonus per cabinet which the purchaser had agreed to pay in the above quoted letter. However, the seller failed to bill the buyer the $1.00 bonus for the cabinets delivered after agreeing to reduce the monthly shipments.



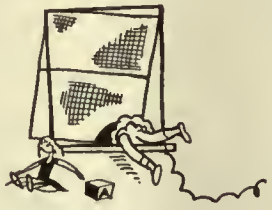
Later, controversy arose between the parties and the seller filed suit against the purchaser to recover $14,571, including $1.00 bonus for all cabinets delivered after the purchaser agreed to pay this additional amount. The seller contended that the purchaser was liable because the offer to pay $1.00 was accepted by both parties and became a part of the contract which neither party had altered after the monthly deliveries were reduced. However, the Court held the buyer *not* liable for payment of the bonus, thus showing that in litigations involving uncertain contracts, the Courts endeavor to interpret the intended meaning of the parties.

Employer's Liability

Since in many instances radio dealers have been held liable for damages caused by employees who install radio sets in purchasers' homes, the recent case of Davis *vs.* Harry B. Loeb Piano Co., Inc., 119 So. 746 (Louisiana), imparts unusually valuable information.

The facts of this case are that an employee, sent by a radio dealer to install a radio set in the purchaser's home, removed a screen and in restoring it he failed to fasten or secure it properly. Subsequently the purchaser's minor child, who was accustomed to play on the window and use the screen as a support, fell through the window by reason of the insecurity of the fastening of the screen, and sustained severe injuries.

The child's parents sued the radio dealer for heavy damages, contending that the employee's neglect to fasten securely the screen in its position was the proximate cause of the injury. However, it is interesting to observe that this Court held the radio dealer not liable and stated important law, as follows:



"In order to be a proximate cause, a cause must be, either in itself or in connection with other causes, in direct and unbroken sequence, an efficient cause of an accident; but where the supervening cause, such as in this case, the permitting of the child to use the screen as a support, was in itself an efficient cause of the accident, the other cause then becomes the remote cause. . . . To hold a person liable under the circumstances set forth in this case would be far-reaching in its effect, because any one who made an installation of any kind would, by virtue thereof, become liable to third persons injured by coming in contact with or through the use or misuse of the particular installation, notwithstanding the damage could not be foreseen, and notwithstanding it was caused by some supervening cause."

Minor Not Required to Pay

Contrary to the opinion of the majority of persons, the law gives to a minor, for his protection against persons taking advantage of his inexperience, the privilege of avoiding contracts which are injurious to him and rescinding all others, whether fair or not, excepting contracts for necessaries, and executed contracts, where he has enjoyed the benefit of them and cannot restore the other party to his original position.

In other words, if an "infant" makes a sale contract for a radio, and receives the radio and disposes of it before his majority, either by losing, expending, or squandering it, *this is nothing more than the law anticipates of him*, and he is not required to pay for it.

For instance, in Shutter *vs.* Fudge, 143 Atl. 896 (Connecticut), a minor seventeen years old purchased $415 worth of radio parts and used them for the purpose of building radio sets which he sold to various purchasers. He refused to pay for the parts and the dealer filed suit. However, the Court held the boy not required to pay the bill, saying:



"It is evident that, if the infant is, in every case, bound to return the consideration which he received, or its equivalent, in order to avoid or rescind his contract, the protection accorded to him, as such infant, is seriously impaired, and may often be destroyed, for it is precisely because he is supposed to be improvident, and likely to misuse and squander what he receives, that his contracts are made voidable. . . . Where he (infant) has exercised his right to repudiate the contract, the infant may be required to return the consideration, or such part thereof received by him, as still remains in his hands and under his control. But if, during his minority, the infant has lost, wasted, or otherwise disposed of the property or other consideration received under the contract, he may, nevertheless, repudiate it without making restitution in order to give effect to his disaffirmance."

Monopoly of Patent Contract

In Radio Corporation of America *vs.* Lord, 28 F. (2d) 257 (Delaware), it was disclosed that the Radio Corporation owned certain patents and made contracts with various firms containing clauses by which the Radio Corporation endeavored to induce the firms licensed to build radio sets under its patents to use in such sets the vacuum tubes manufactured by the former, on which its patents had expired. The Court said:

"A single old element, whose patent monopoly has expired, cannot be put into a new patented combination as a constituent element, and thus have its individual monopoly revived for seventeen years more. This would be a new method of securing a patent, or a means of evading the patent law, by doubling the length of the life of a patent. . . . A patentee may not prevent the individual manufacture, use, and sale of a single unpatented element, which the world is free to make, use, and sell, by simply including it as an element in a new patented combination. To put it differently, the inclusion in a patented combination of an unpatented element does not give the patentee of the combination a monopoly of each element, and the exclusive right to make, use, and sell that element independent of the combination. So long as the patent covering vacuum tubes was in existence, the patentee of this element of the combination was protected, and it could not be included in the combination without a license to do so; but, when the patent on this tube element expired, the rights, which were theretofore vested in the patentee, became the property of the public, and not of the patentee of the combination. . . . A patentee may sell his patented product at any price he desires, to whomsoever he will, and under whatever restrictions he conceives to be advantageous, provided he does not violate the law in doing so."





THE LITTLE RED SCHOOL HOUSE COMES TO MARKET

By B. H. DARROW

AMERICA'S GREATEST INDUSTRY—*Education*—is turning to radio. Here lies a golden opportunity for the radio industry which should receive the careful consideration of every manufacturer, distributor, and dealer. Briefly, it means that the schools in the United States represent a potential market for three hundred thousand radio receivers and for nearly one million loud speakers!

The fact that radio broadcasting has been recognized generally by educators as a medium of instruction in schools is a question which no longer need be debated. Many of the schools which are radio equipped have reported enthusiastically upon the results which have been obtained, and every day word is received that new schools are planning to install radio apparatus. However, there is still much room for development in this field, for only a very small number of the schools—probably not more than one per cent.—have facilities for receiving broacast programs.

Interest on the part of educators in broadcast programs is, of course, a direct result of the effort made by station managements during the last few months to provide educational programs. Whereas until recently practically all daytime radio programs were made up of "talks to the housewife," music, direct advertising, etc., to-day there are many features of interest to schools which are broadcast regularly. Such programs as the Damrosch lessons in music over the WEAF chain, the "Ohio School of the Air" over WLW, the school broadcast by WMAQ, Chicago, the standard educational program of KFI, Los Angeles, etc., provide adequate proof of this trend.

In addition to the deliberately planned educational programs which are regular features of many stations, education by radio has other values which are axiomatic, and which alone are quite sufficient to make it imperative that radio be unleashed and set to work with the childhood of America. For example, an address by the president of the United States or events of current historical interest may be brought directly to the classroom. In this and in many other ways radio makes possible an equality of opportunity never before dreamed of, in which the smallest country school with an inexpensive radio set is on an equal footing with the million-dollar metropolitan school.

Size of the Market

From the viewpoint of those in the radio industry, statistics on the size of the educational market should be of interest. In the opening paragraph of this article it was stated that education is America's greatest industry, and, after analyzing the tables accompanying this article, this fact should not be difficult to appreciate. In this connection the following figures are also rather convincing: the value of school buildings in the United States is over $5,000,000,000; the yearly cost of operating our schools is $2,750,000,000; there are approximately 1,000,000 classrooms in 275,000 school buildings; 978,310 persons are employed as teachers; 29,001,761 persons are enrolled as pupils; and it is forecast that $569,172,000 will be

Number of Elementary, Secondary, and High Schools

State	Elementary and Secondary	Public High Schools	Private High Schools and Academies	State	Elementary and Secondary	Public High Schools	Private High Schools and Academies	State	Elementary and Secondary	Public High Schools	Private High Schools and Academies
Alabama	6,237	220	47	Maine	2,807	212	54	Oklahoma	6,344	519	38
Arizona	525	41	5	Maryland	2,369	157	50	Oregon	2,709	249	21
Arkansas	6,611	255	25	Massachusetts	2,959	347	117	Pennsylvania	12,854	999	145
California	5,348	406	109	Michigan	9,007	567	77	Rhode Island	503	22	17
Colorado	2,888	190	14	Minnesota	9,192	529	52	South Carolina	4,306	224	22
Connecticut	1,496	92	58	Mississippi	6,347	327	33	South Dakota	5,101	287	13
Delaware	444	25	6	Missouri	10,099	725	61	Tennessee	6,488	307	42
District of Columbia	160	15	30	Montana	3,546	191	11	Texas	12,395	722	51
Florida	2,285	177	25	Nebraska	7,653	565	35	Utah	722	71	7
Georgia	6,867	313	36	Nevada	381	23	Not listed	Vermont	1,370	76	18
Idaho	1,694	131	11	New Hampshire	1,073	105	28	Virginia	6,133	353	67
Indiana	5,385	809	36	New Jersey	2,182	174	77	Washington	3,045	313	27
Iowa	11,950	917	102	New Mexico	1,479	92	17	West Virginia	7,116	240	18
Kansas	9,196	722	33	New York	12,101	766	258	Wisconsin	8,280	425	39
Kentucky	7,853	540	74	North Carolina	6,759	567	57	Wyoming	1,491	62	2
Louisiana	3,250	251	50	North Dakota	5,097	355	16	Illinois	14,028	958	113
				Ohio	7,975	1,077	105	*Total*	*256,104*	*17,710*	*2,350*

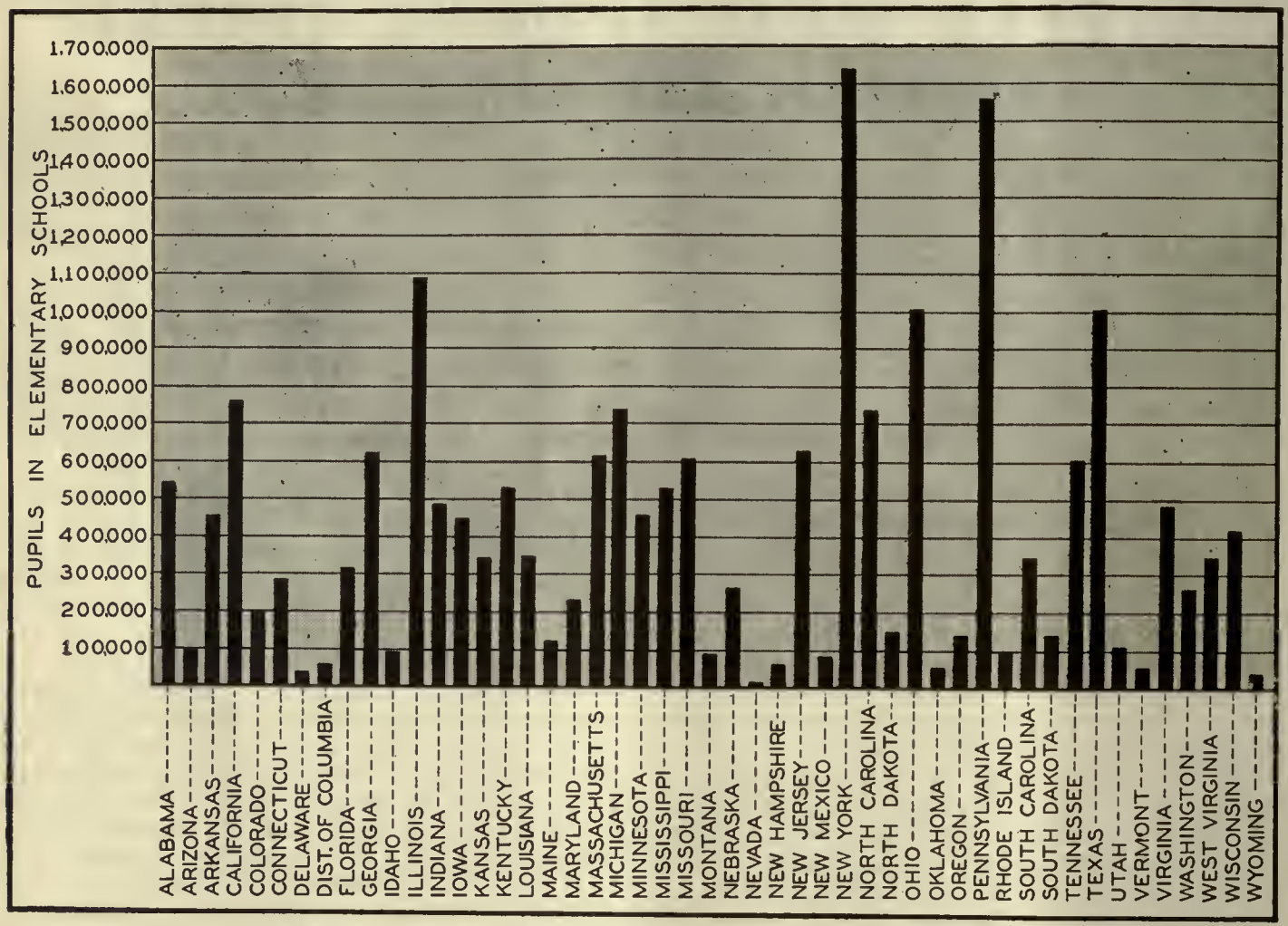
spent for new school building construction during the current year.

The table on page 263 shows the number of schools of various types in the forty-eight states. These figures include schools of all sizes from the one-room country school, of which there are approximately 150,000, to the large city school. However, it must be remembered every school regardless of its size is a sales opportunity, and some of the larger schools may find need for four or more receivers.

The illustrations and tables on pages 264 and 265 give more specific facts which are of definite aid in determining the size of the educational market in the various states. The data below were taken from "Statistics on Public School Systems" prepared by the U. S. Department of the Interior, Bureau of Education. These figures show, for elementary schools, the number of pupils enrolled, the number of teachers, and the value of all property used for school purposes. From these figures it is also possible to estimate the approximate number of classrooms (usually there is one teacher for each classroom) which is useful as it is indicative of the number of loud speakers which would be required in order to equip fully each school.

The way in which the pupils and teachers are divided among the various kinds of schools is shown clearly on the next page. It is important to note that 79.5 per cent. of the total number

How Educational Demands and Facilities Compare in the Forty-Eight States



State	Teachers Employed in Elementary Schools	Pupils Enrolled in Elementary Schools	Value of All Property Used for School Purposes
Alabama	13,237	538,984	$ 43,738,697
Arizona	2,204	70,745	12,131,560
Arkansas	11,078	462,175	28,443,757
California	20,854	759,676	328,428,349
Colorado	7,879	195,101	54,643,686
Connecticut	7,592	279,106	83,352,004
Delaware	1,114	33,590	6,912,068
District of Columbia	1,996	60,027	22,885,000
Florida	9,462	307,603	53,370,802
Georgia	14,548	623,684	40,876,987
Idaho	3,284	95,831	20,897,820
Illinois	34,725	1,095,618	322,871,774
Indiana	14,482	488,780	155,313,649
Iowa	18,179	121,376	129,470,931
Kansas	14,256	340,330	74,382,427
Kentucky	12,937	529,996	35,339,705
Louisiana	9,041	349,488	45,748,847
Maine	5,408	112,534	27,420,035
Maryland	6,913	229,971	38,678,684
Massachusetts	18,333	616,869	182,799,503
Michigan	27,040	744,253	240,017,020
Minnesota	16,668	455,853	136,075,817
Mississippi	12,772	529,881	36,737,629
Missouri	19,911	612,414	128,090,771
Montana	5,172	96,949	27,190,286
Nebraska	11,405	266,828	66,045,345
Nevada	588	12,804	4,664,986
New Hampshire	2,363	59,628	16,217,312
New Jersey	16,707	629,774	212,243,706
New Mexico	2,424	79,529	9,516,286
New York	60,352	1,643,215	625,182,175
North Carolina	20,691	734,170	82,764,628
North Dakota	7,946	149,565	38,052,613
Ohio	30,616	1,031,644	171,083,252
Oklahoma	14,453	565,884	80,857,406
Oregon	5,758	142,711	39,514,790
Pennsylvania	43,103	1,581,767	419,964,289
Rhode Island	2,897	96,486	23,131,959
South Carolina	11,200	435,425	33,911,840
South Dakota	7,103	138,166	26,246,471
Tennessee	14,518	600,584	40,432,610
Texas	26,981	1,015,951	145,543,621
Utah	3,205	110,695	25,018,095
Vermont	2,383	53,551	9,757,365
Virginia	13,704	481,799	54,850,000
Washington	7,526	258,814	68,403,558
West Virginia	12,331	346,716	61,733,333
Wisconsin	14,856	415,888	131,933,085
Wyoming	2,436	40,474	13,717,006
Total	*644,631*	*20,984,902*	*$4,676,603,539*

of pupils and teachers are in elementary schools which compose radio's largest educational market, not only because of the large number of pupils but also because education by radio is best suited to the requirements of this class of school.

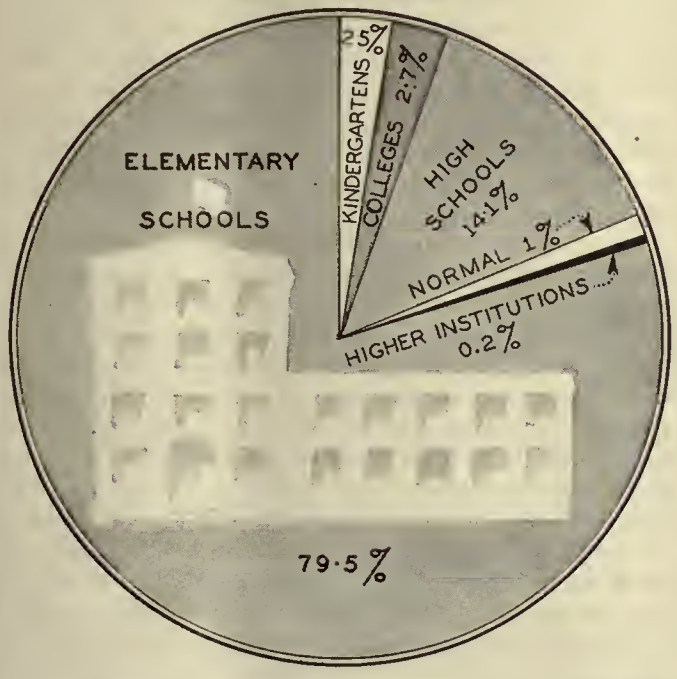
The tremendous growth of education in America is indicated by the figures on the right. These data, which were prepared by the *Architectural Forum*, show the forecast of the money which will be spent for new building construction during the current year. It will be noted that schools hold the third place on the list.

What Has Been Done

It has already been explained that at the present time the installation of radio apparatus in public schools is almost a virgin field, that only a few thousand of the one million classrooms have been equipped for radio reception. However, this condition is changing very rapidly and in some sections of the country as many as 20 per cent. of the schools are able to tune-in on educational broadcasts. This is true of Ohio.

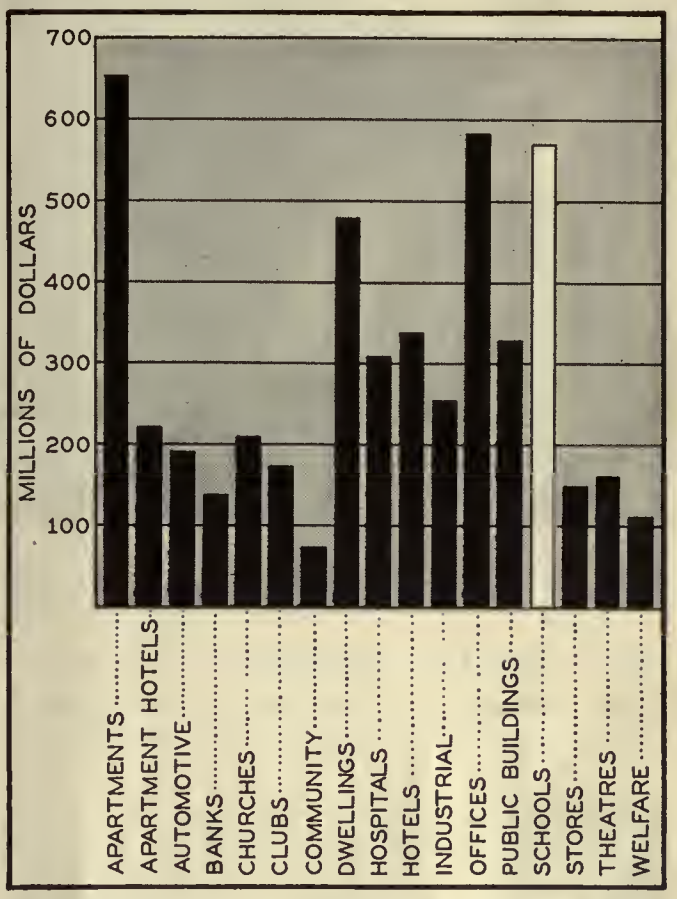
In the state of Ohio there are 240 cities, towns, and villages part or all of whose schools are equipped. Some of the villages have but one school, whereas some of the cities have as many as forty. In the latter class is Dayton which has auditorium or classroom reception for every school. The city of Cincinnati now has thirty-eight schools equipped and several other schools in the city are planning to have receivers installed. Columbus will have 128 classrooms equipped for reception when the schools open next fall. In addition, Cleveland, Youngstown, Sandusky, Elyria, Kent, Barnesville, and many others from modest beginnings are starting on a program which calls for equipping every classroom.

How Pupils Are Divided



Schools		Total Teachers	Pupils	Per Cent. Teachers & Pupils
Kindergarten	Public	10,852	673,231	2.5
	Private	*2,140*	*54,458*	
Elementary	Public	644,631	20,984,902	79.5
	Private	*56,272*	*2,143,100*	
High Schools and Academies	Public	169,538	3,757,466	14.1
	Private	*20,145*	*295,625*	
Preparatory Departments of Higher Institutions	Public	721	10,456	0.2
	Private	*3,196*	*45,176*	
Universities, Colleges and Professional	Public	20,169	280,437	2.7
	Private	*38,138*	486,704	
Teachers' Colleges and Normal	Public	11,216	252,907	
	Private	1,292	*17,299*	1.0
Total	Public	857,127	25,959,399	
	Private	*121,183*	*3,042,362*	
Grand Total		978,310	29,001,761	100

Forecast of New Building Construction



Building Types	Value	Per Cent.
Apartments	$ 652,829,000	13.2
Office Buildings	584,510,000	11.8
Schools	569,172,000	11.5
Dwellings	479,877,000	9.7
Hotels	342,001,000	6.9
Public Buildings	330,801,000	6.7
Hospitals	306,283,000	6.2
Industrial	260,816,000	5.3
Apartment Hotels	217,518,000	4.4
Churches	211,142,000	4.2
Automotive	197,431,000	4.0
Club	175,963,000	3.6
Theaters	161,938,000	3.3
Stores	146,221,000	2.9
Banks	137,394,000	2.7
Welfare	106,574,000	2.1
Community	74,796,000	1.5
Total Value	*$4,955,266,000*	*100%*

Although the cities in the state of Ohio are probably the most progressive from the radio instruction viewpoint, there are several other areas which are rather heavily equipped. In the East there is considerable activity in the vicinity of New York City, Boston, and Hartford; in the South, radio interest is greatest near Atlanta and New Orleans, and the vicinity around Chicago and parts of California also report a considerable number of school radio installations. In each of the cases cited above it is most interesting to note that the equipping of the schools has followed the provision of suitable programs by the broadcasting stations.

The facts given above show that although the addition of radio instruction to the curriculum is not general throughout the entire country, the schools have been quick to take advantage of radio when regular programs of a suitable character have been made available by the stations. This is especially noticeable in Ohio which may be taken as an example of the results which may be accomplished by coöperation between station managements and educators.

It was believed originally that few schools boards would have both the money and the inclination to purchase radio equipment for their schools, but this proved false. In the Ohio

(*Concluded on page 292*)



RADIO VS. AUTO SERVICE

Dealers Who Look into the Service Systems in the Automotive Field May Find Ideas Which Will Aid in Solving Their Problems

By JOHN S. DUNHAM



John S. Dunham

THERE IS no one sure way of getting rich in any line of endeavor, and, in the radio service field, there is no single method which may be followed that will by itself spell success. That magic word "success" must be made up of a large number of well-planned systems for doing everything which needs to be done in any particular business. A group of good servicemen will not make a service business or a service department pay for itself unless the prices are correctly designed, the records are carefully kept and intelligently used, and the costs of giving good service and the overhead costs of doing business are known and closely regulated. We must also know how to secure customers without spending too much money getting them, and, once gained, how to keep them.

In the space of this article we can't discuss all the ways that experience has taught us are conducive to success in the radio service game, but we shall consider briefly a few of them. In this connection a few of the remarks made to the author by H. R. Cobleigh, secretary of the National Automobile Chamber of Commerce in New York, should be of interest, as they considered the solutions to service problems in the automotive industry which might very profitably be applied to problems in the service branch of the radio industry.

Perhaps the most striking thing Mr. Cobleigh pointed out was the difference between the words "maintenance" and "service." Some years ago there was a great deal of discussion among automobile men about the advisability of employing the word "service," he explained. There were many who thought "maintenance" would be a better term because they felt that "service" was firmly fixed in the customer's mind as meaning something that is free, whereas the use of "maintenance" would remove some of the difficulties in collecting for service performed after the end of the free-service period. The answer to the question was that maintenance means keeping a car in proper running order, but that *service means satisfying the customer*, and there is a wide difference between the two.

An actual experience with automobile service illustrates this point very clearly. A car owner went into a repair shop, waited fifteen minutes before anyone paid attention to him, asked for an estimate of the cost of the work he desired done and how long it would take. He was told it would cost somewhere between thirty and forty dollars, and that they would try to have it ready by two o'clock the next afternoon. He returned at the time mentioned the next day, waited an hour to get his car, found that the bill was $45., and noticed as he drove out that his steering wheel was greasy and the windshield had not been wiped off. The repair job by that concern was properly done and the fee charged was a fair one for the time spent and materials used, so that the work could be justly called proper maintenance, but the customer was very far from being satisfied.

The next time that car owner wanted service performed on his car he went to a new service station a block away from the first one. He was greeted promptly and courteously, was given an exact statement of the cost of the needed repairs, and was told definitely when his car would be ready. When he called for the car at the specified time, it was waiting for him, the windshield was cleaned off, the whole car had been dusted, the steering wheel and the seat were clean, and the bill presented to him was exactly the amount he had been told it would be. The radiator was filled with water. The service salesman asked if he might fill the gas tank and check the oil and air in order to replenish them if necessary. That work was *service*. The customer was more than satisfied—he was *pleased*—and he has consistently patronized that service station ever since.

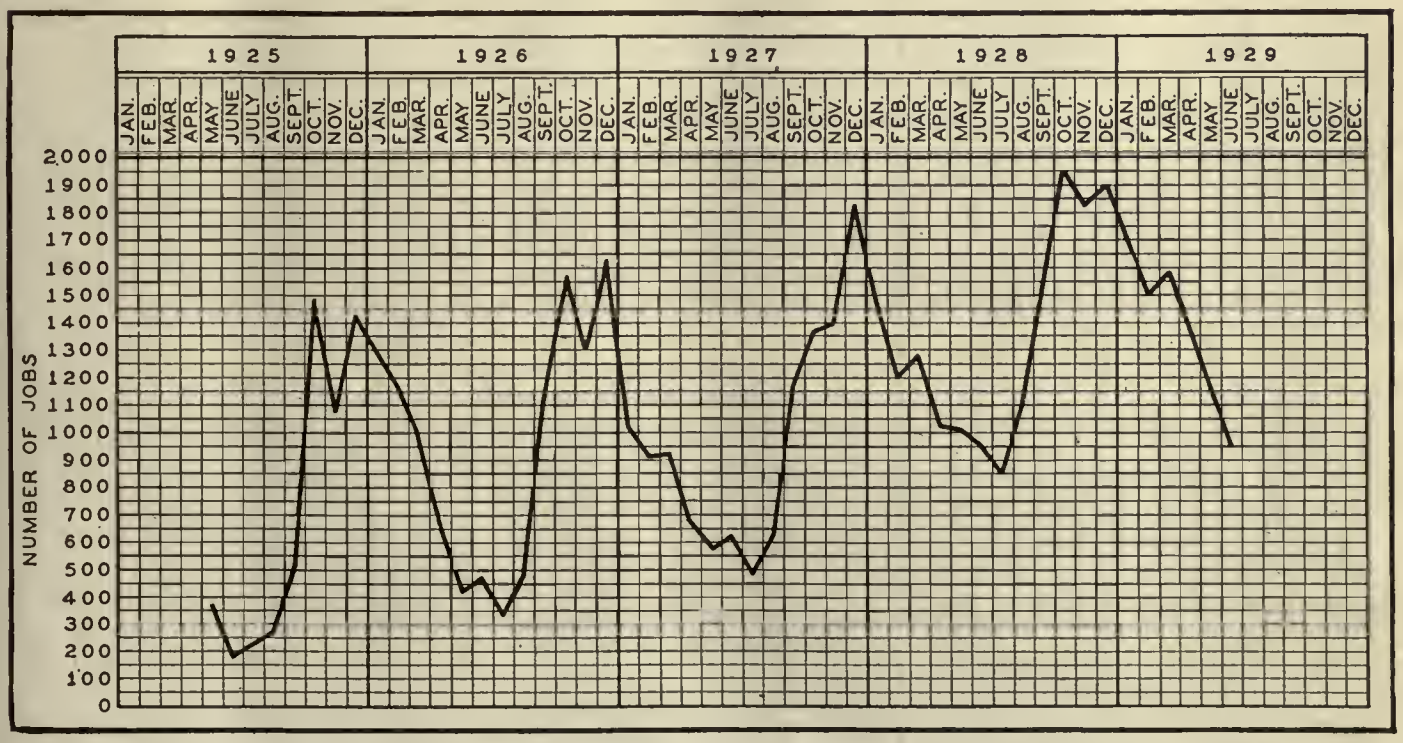
Suppose a radio serviceman went into the home of a customer, looked at the radio without asking what the complaint was, found no trouble in the set other than a dirty volume-control rheostat which he cleaned, and then immediately packed up his kit and left without regard to the question of whether or not the work done would satisfy the customer. If the set was working normally when he left, the work done could be termed proper maintenance. However, suppose the customer's complaint was not about the slight noise experienced when adjusting volume, but that his complaint

was of variation of volume during the course of an evening and of *much* noise which he was experiencing and very naturally blaming on the set. Although such a call would result in the rendering of proper maintenance, it very decidedly would not result in the rendering of *service*. The customer would be dissatisfied, it would be difficult to collect from him, and the next time he wanted service he would go to some other service organization.

Flat rates for all kinds of service work, against the old method of rendering service on a time and material basis, was another subject which Mr. Cobleigh discussed at some length. In the automotive field their experience has been—and it applies to owners of radio receivers just as much as to owners of automobiles, because they usually are the same individuals—that people want to know before they have a job done exactly what the work is going to cost. When they know beforehand that it will cost them $100 to have a car overhauled, or $15 to have their radio overhauled, if they accept that figure and give the order and the work is satisfactorily done, they are invariably satisfied that the money was well spent. On the other hand, if either the automobile or radio service organization cannot give them a definite figure at all, or can give them only the cost of parts and tell them that the labor charge will depend on the time it is found necessary to spend on the job, there will be many cases of dissatisfaction with the amount actually charged, even though the work is properly done. Our own experience of nearly six years with an independent radio service organization has amply proven that the experience of the automotive industry in that respect can be very profitably used as a guide in the radio industry. Before we instituted the flat-rate system we had a great deal of dissatisfaction, not with the work done but with the cost of that work, simply because the customer thought he might have been able to have the same work done much cheaper somewhere else. If he knows just what a service call will cost he can then get estimates from other concerns, and he will be satisfied with the cost of the job because he has found, by comparing estimates and the quality of service rendered by various concerns whose work he has tried, approximately what it will cost to get the kind of work he wants. Since we instituted the flat-rate system some three years ago, we have had practically no complaints or dissatisfaction because of our charges.

The U. S. Chamber of Commerce has stated, as a result of a very comprehensive survey made in all retail fields, that only about fifteen per cent. of the business that is lost by the average individual retailer is lost because the customer considers his prices too high. When we started business in 1923 we charged for labor at the rate of $1.50 an hour. In 1925, in fear and trembling lest we lose too many customers, we raised our rate to $2 an hour, and we were surprised and greatly relieved to find that, so far as we were able to determine, we did not lose *any* customers. About a year ago we realized that our rates were still too low for the service we were rendering and again with a great deal of trepidation we revised our entire schedule of flat rates on the basis of $2.50 per hour, or $20 per man per day. The tabulation of the results of a survey made this past summer showed us that only about two per cent. of the customers we lost following our last raise in rates left us because of that raise. So long as a service department or a service organization in any industry gives the best service that is humanly possible, the customers and prospective customers of that organization will not worry about the cost of service, provided it is not appreciably higher than other service concerns charge for rendering *comparable* service. The average individual is far more concerned about the quality of the service he gets than about the cost of that service, and the dealer's service department or the service organization can safely charge fees which will permit a reasonable net profit over the cost of rendering the best of service, without any fear of losing customers thereby.

In the automotive business, a policy which has grown up out of the flat-rate practice, is the method of paying mechanics, not by the month, week, or hour, but by the job. Approximately two-thirds of the automotive service stations in the New York metropolitan area pay their men on that basis, according to Mr. Cobleigh. The mechanics make more



This curve showing the number of service jobs handled per month during the last four years by a well-known radio firm in New York City indicates a slight tendency to flatten out.

money on an average over the year than they made before on the hourly basis, the employer pays his labor only for work done, and he knows exactly what his labor cost for each job will be. The disadvantage of the system appears to be two-fold: one is that the men work overtime in the busy season and make abnormally high wages, while in the slack season they do not have enough work to do and consequently make less than their average weekly pay over a period of a year. The other disadvantage is that at all times, and especially whenever there is insufficient work, considerable care must be exercised by the service manager to distribute the work equally among his men.

When employed on a piece-work basis, fewer men are required in each shop than were previously needed because each mechanic does more work than he did before and the men in a shop do not want to have additional help taken on, even in the busy season, as long as it is physically possible for them to handle all the work. That has the advantage that less labor turnover is required—less hiring of men at the beginning of a busy season and less firing of men when work slackens. In a certain repair shop which was using the old hourly system of pay, twenty-two men were employed. When the piece-work system was instituted during a somewhat slack period, eleven of those men were discharged. The remaining eleven men were able to handle the work easily and made considerably more money. When the busier season arrived and the work became heavier day by day, the men in the shop went to their employer, asked him to please refrain from hiring any more men, and assured him that they could handle the additional work by staying overtime. The boss consented, as a matter of trial, and the shop went through the busy season without hiring more men. Those mechanics made a great deal more money than they would have made had more men been taken on, the cost to the employer for the work done was no greater than it would have been with twice the number of men employed, and he was relieved of the high cost of hiring and breaking in new men.

Perhaps you are thinking that when a man is paid a flat rate for a certain job his natural tendency will be to hurry that job at the expense of doing it properly, and that much customer dissatisfaction would therefore result from careless work. The way the problem has been solved in the automotive field is by requiring, whenever a job is incorrectly done in any respect, that the serviceman responsible shall do the work over on his own time. The result is that each mechanic is very careful to do the job as it should be done the first time. Whether the piece-work system would work out satisfactorily in the service branch of the radio industry, as it has in the automotive industry, is a question well worth while considering. It seems to the author that the majority of our problems so closely parallel those of automobile service that the method of paying men a definite percentage of the flat labor charge for each job should be tried out. The only way to determine whether it would be better than the present haphazard method of paying for labor is by trial.

We believe that a graph of the amount of radio service performed during the year has higher mountains and lower valleys than a similar graph depicting the work of the average automotive service department or organization, which, under the piece-work system of pay, has the disadvantage that either the pay of a radio serviceman would fluctuate more widely or else that more hiring and firing would be necessary than is the case at present in the older industry. However, progressive automobile shops have done a great deal to fill up the hollows in their yearly volume graph and to straighten out the whole curve by selling combination jobs and general overhaul jobs at much lower than normal rates during their slack periods and by selling an increasingly large proportion of their customers on the benefits and the economy of regular periodic service. If those remedies can be applied successfully to automobile service they certainly can be applied to radio service.

The yearly curve of radio business has straightened itself out gradually during these nine years of broadcasting by reason of better summer features, better quality of transmission and reception, and greater power used by local stations to permit a very high signal to noise ratio even under bad atmospheric conditions. Although there has been gradual improvement, the maximum amplitude of that curve is still a large multiple of its minimum and it will always be so unless the minimum portions are artificially stimulated by intensive sales effort. The fact that an older industry has been successful in artificially raising the low periods of their yearly curve is very hopeful evidence indeed that we can do exactly the same thing if we start employing both mental and physical activity to get that work which *can* be obtained.

clippings

N. P. Bloom (Adler): "The manufacturers of radio have been laying the ground for the interchange of patents within the radio industry, and I believe before the present year is over this will have been achieved."

John W. Van Allen (counsel, R.M.A.): "Radio program sponsors need listeners to be successful. The public has accepted sponsors of programs but has not accepted sales talks as sufficiently entertaining to sustain interest."

Gordon C. Sleeper (Temple): "Radio dealers are increasingly prosperous and daily becoming increasing factors in their communities."

H. B. Richmond (General Radio): "This year we find a large number of manufacturers putting their receivers through a complete performance test. Receiver design has been reduced nearly to a mathematical formula."

Sosthenes Behn (president I. T. & T.): "The engineering development of communications facilities, in respect to cables, wires, and wireless, has outdistanced the adoption of more advanced commercial practices in the use of such services. . . . The new types of cables, carrier current for wire service, and short-wave wireless equipment will have so much greater traffic capacity that new commercial practices and services must be adopted to absorb these capacities."

Alfred Hand (Edison): "The questions before most companies is not whether to advertise; it is how to advertise. Manufacturers, in general, owe a certain obligation to their distributors and should do all they can to build up good will and a buying urge in favor of their product."

Domestic Commerce (Government): "The opinion of 53.3 per cent. of manufacturers definitely answering the question (does dealer-price cutting affect my distribution?) was that when dealers cut the price of a manufacturer's product its distribution is decreased."

PROFESSIONALLY SPEAKING



WHAT COST ENGINEERING?

A FEW YEARS ago there was little demand for high-grade radio engineers. Pseudo-engineers did most of the engineering, chiefly because they were young enough and with so few responsibilities that they did not mind getting small pay for the work they would do at home anyhow at no income. Competition among set manufacturers has put a stop to this business of flirting with the undertaker, technically speaking. At the present time no high-grade set manufacturer can stay in business if he does not possess a laboratory and a staff to work in it.

What does it cost to engineer radio receivers?

In reply to such a question RADIO BROADCAST received some very strange answers. One chief engineer stated that "in our own case, it would be a matter of considerable difficulty and would involve a very considerable expense to give even approximate answers" to the questions we asked on the cost of engineering radio sets made by this well-known company. In other words, the chief engineer did not know how much it cost him to engineer his company's production! Fortunately this answer was not at all characteristic.

For example, the following figures are quoted from a letter from another well-known manufacturer:

1. Total amount charged to radio engineering in 1928:

Production drafting	$10,451.27
Engineering administration	34,797.24
Experimental	12,968.27
Research	1,401.82
Total 1928	$59,618.60

2. The total cost of apparatus (meters, bridges, etc.) utilized by Engineering Department plus the equity in a well-known licensing organization was $75,000. This company employed six engineers and three laboratory assistants. In 1928, the company sold 145,000 sets.

Another company which made approximately 100,000 receivers and 10,000 dynamic loud speakers had a technical staff of five engineers and two electrical mechanics. The laboratory equipment, which represented an investment of about $18,000, was being increased all the time. The engineering costs, exclusive of inspection, ran close to 1½ per cent. of the net selling price. These are comparable figures, certainly. Such figures come from the books of successful manufacturers; they indicate that the manufacturers in question are not content to let amateurs do their engineering. The only conclusion is that such expenditures must pay.

A side light on this subject is the fact that there seems to be a dearth of really high-grade experienced engineers. A licensing organization with home office in New York had two long-distance calls from the Chicago area within an hour recently, both asking for engineers who were equipped so that they could step into positions paying up to $7500 a year. The licensing organization receiving these urgent requests had no engineers in mind; they did know where to look. Consolidations among set manufacturers will release some men of the proper caliber, but there will always be good positions for good men.

One of the manufacturer's best safeguards against decadence must lie in his engineering department. This department will cost about 1½ per cent. for engineering alone; and the manufacturer will have some difficulty in finding and keeping good engineers unless he is willing to pay good money for them.

A WORD TO THE WISE IS SUFFICIENT

THE FOLLOWING quotation from the *Exhibitors' Herald World*—a trade journal of the motion-picture industry—is so succinct and needs so little paraphrasing to make it a shoe for the foot of some manufacturers of radio receivers that we reprint it as it appeared in the May 4, 1929, issue of that journal.

"It would be amusing—if the matter were not one of such vital importance—to see the number of persons connected in one way or another with motion-picture affairs who have suddenly set themselves up as experts on reproducing devices. The intentions of some of these may be worthy enough but the exhibitor who depends upon their guidance is headed for a painful and expensive experience.

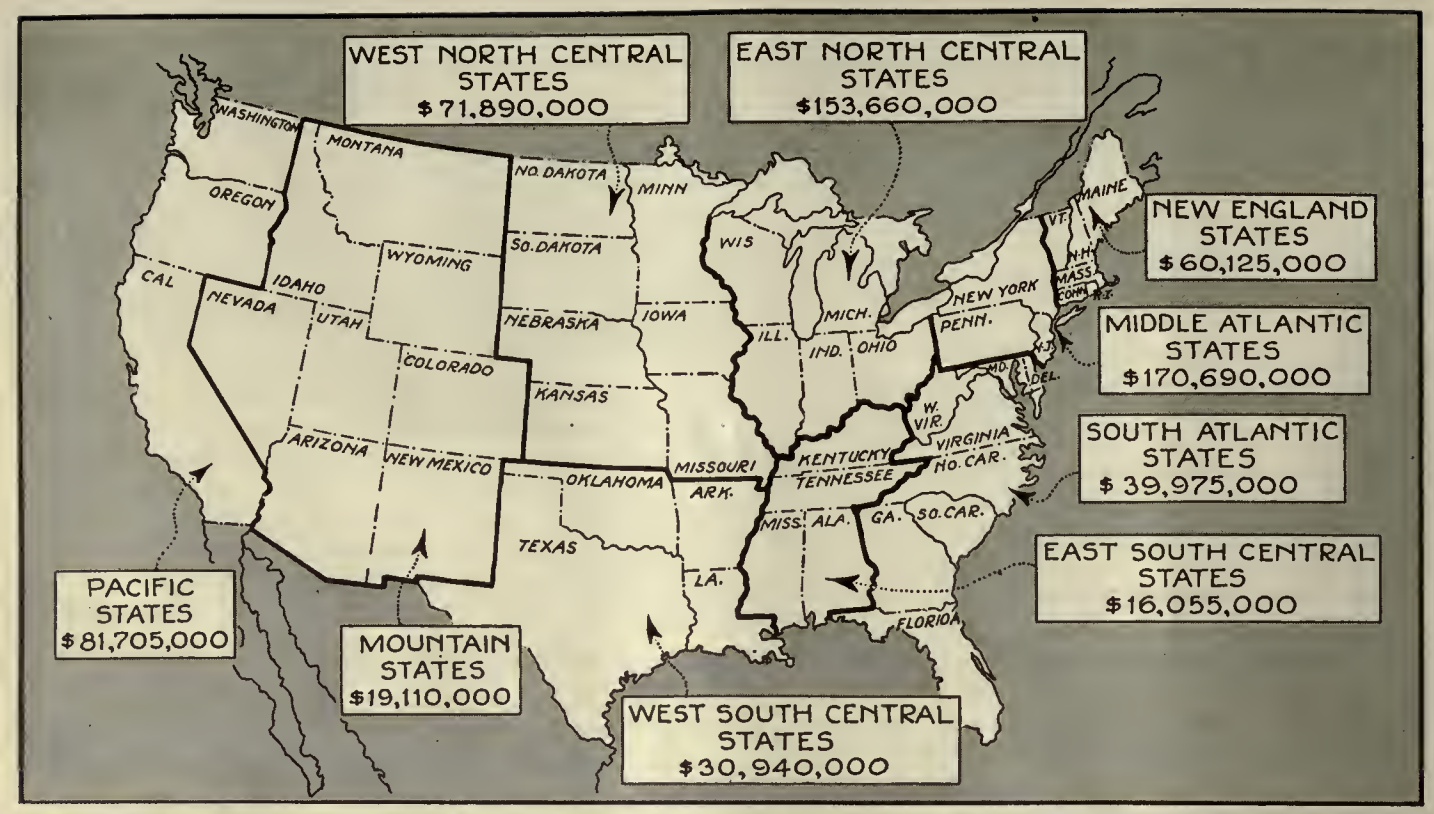
"It seems almost too obvious to state that when a person wants advice on a technical matter he should go to a technician —and not to a banker, baker, or candlestick maker. But this very thing is being done by exhibitors in connection with contracting for reproducing equipment. The theatre man who follows this course will have to be lucky indeed to escape seriously unpleasant results."

UNIFORM SELECTIVITY IN 1930?

ONE OF THE engineering advances which the screen-grid fervor has masked rather thoroughly is that which gives radio-frequency amplifiers a flat frequency characteristic and endows a receiver with uniform r.f. gain. The tuned r.f. set of a year or so ago had a voltage amplification that varied at least three to one over the band and many varied in a much greater ratio than this. At the same time the selectivity of the set varied in at least a three to one ratio. The result was a set which seemed very selective and somewhat dead at 550 kc., and very broad and of proper gain at 1500 kc.

Now what is really desired is an amplifier that has constant gain over the band—disregarding any peculiar method of allotting station frequencies indulged in by the Radio Commission —and in which the percentage selectivity at the high frequencies is three times as great as at 550 kc. For example, at the lower end of the band we desire to pick a 10-kc. channel out of 550 kilocycles, or one in 55. This calls for a frequency separation of 1.82 per cent. Now at 1500 kc. we want the same 10-kc. channel, or one part in 150 or a frequency separation of 0.66 per cent.—three times as great as is required at the other end of the broadcast band.

(*Concluded on page 298*)



*The figures on this map give an estimate of the total radio set sales for the radio year of 1928-29 (**July-June**).*

AN ESTIMATE OF SET SALES

By T. A. PHILLIPS

Manager, Research Division, Doubleday, Doran & Company, Inc.

THIS IS the last and concluding article analyzing the radio survey made by the Bureau of Foreign and Domestic Commerce, electrical equipment division, in coöperation with National Electrical Manufacturers Association. The first two articles discussed the most important phases of the survey. This article reports some of the other items covered that are of general interest.

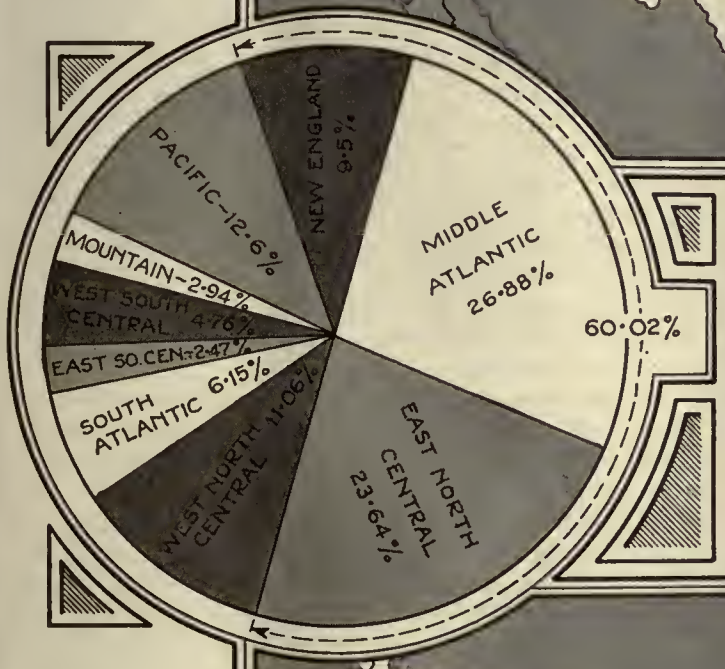
The survey gives radio set sales by states July 1, 1928 to March 31, 1929, which presents the opportunity of making an estimate of total set sales for the radio year (July 1, to June 30) by states. The radio year has passed but it will be many months before the totals are known. In the meantime, these estimates will help in determining the future business in light of past results. The NEMA estimates that set sales will reach a total of $650,000,000. Taking that as a base we have made the estimate given in Table I. Note that New York, New Jersey, and Pennsylvania account for more than one-quarter of the total sales. The territory east of the Mississippi and north of the Ohio River accounts for more than

Table I: Estimate of Total Radio Set Sales for Each State for 1928-1929

State	Percent. of Total Sales	Estimated Total Sales in Dollars. Radio Year 1928-1929.
NEW ENGLAND STATES		
Maine	0.89	5,655,000
New Hampshire	1.00	6,370,000
Vermont	0.36	2,210,000
Massachusetts	4.39	27,690,000
Rhode Island	0.92	5,915,000
Connecticut	1.94	12,285,000
Group Total	9.50	$60,125,000
MIDDLE ATLANTIC STATES		
New York	11.80	74,750,000
New Jersey	4.42	28,600,000
Pennsylvania	10.66	67,340,000
Group Total	26.88	$170,690,000
EAST NORTH CENTRAL STATES		
Ohio	7.75	50,375,000
Indiana	3.16	20,540,000
Illinois	5.90	38,350,000
Michigan	4.39	28,535,000
Wisconsin	2.44	15,860,000
Group Total	23.64	$153,660,000
WEST NORTH CENTRAL STATES		
Minnesota	2.04	13,260,000
Iowa	2.58	16,770,000
Missouri	3.55	23,075,000
North Dakota	0.38	2,470,000
South Dakotn	0.40	2,600,000
Nebraska	0.11	715,000
Kansas	2.00	13,000,000
Group Total	11.06	$71,890,000
SOUTH ATLANTIC STATES		
Delaware	0.28	1,820,000
Maryland	1.20	7,800,000
District of Columbia	0.91	5,915,000
Virginia	1.00	6,500,000
West Virginia	1.22	7,930,000
North Carolina	0.37	2,405,000
South Carolina	0.49	3,185,000
Georgia	0.34	2,210,000
Florida	0.24	2,210,000
Group Total	6.15	$39,975,000
EAST SOUTH CENTRAL STATES		
Kentucky	0.79	5,135,000
Tennessee	0.69	4,485,000
Alabama	0.74	4,810,000
Mississippi	0.25	1,625,000
Group Total	2.47	$16,025,000
WEST SOUTH CENTRAL STATES		
Arkansas	0.59	3,835,000
Louisiana	0.42	2,730,000
Oklahoma	1.15	7,475,000
Texas	2.60	16,900,000
Group Total	4.76	$30,940,000
MOUNTAIN STATES		
Montana	0.25	1,625,000
Idaho	0.30	1,950,000
Wyoming	0.09	585,000
Colorado	1.04	6,760,000
New Mexico	0.04	260,000
Arizona	0.13	845,000
Utah	0.98	6,370,000
Nevada	0.11	715,000
Group Total	2.94	$19,110,000
PACIFIC STATES		
Washington	2.16	13,975,000
Oregon	2.38	15,405,000
California	8.06	52,325,000
Group Total	12.60	81,705,000
Grand Total	100.00	$650,000,000

The figures on this map show the average volume of radio sales per dealer in each state. The data were taken from the radio survey for the first quarter of 1929 which was prepared by the Bureau of Foreign and Domestic Commerce in coöperation with NEMA.





almost 60 per cent. of the total sales. The comprehensiveness of the survey allows for considerable reliance upon the figures showing the percentage of total business done in specific states. Should future estimates of total radio sales for the radio year 1928–29 differ from the NEMA estimate of $650,000,000, the per cent. of sales by states will still, in the main, hold true.

The percentage of the total radio sales handled by dealers in various districts of the United States is shown in the chart on the left. These data are taken from Table I which also gives the percentage of total sales by states.

The average values of radio receivers sold during the first quarter of 1929 in each state are given in the map on the right. These figures vary from $143.50 for Oregon to $191.50 for Nevada. The average for the entire country is $165.00.



The MARCH

Putting Radio on the Front Page
Let Dealers Suggest Advertising Copy

Tying In With Aviation

FIVE YEARS AGO, radio occupied the same public attention and the same liberal space in the press that is to-day accorded to aviation. There was then no item of the broadcast studios or of the industry too insignificant to break into print and one who had a working knowledge of radio became automatically a social lion. The radio industry successfully established itself on a sound footing before its command of the front page wore off.



Radio is remarkably well adapted to associate itself with aviation in the news of the day. By such an alliance, it may share the limelight. Most broadcasting organizations have been too concerned with direct advertising to realize that, in aviation, they have an ally which may bring them once again to the front page of the newspaper and to the forefront of public interest. Consequently, they have made rather limited use of their opportunities restricting themselves to such events as the start of the recent transatlantic flights, the inauguration of the transcontinental air-rail service, and occasional talks by various aviation experts. These features are scheduled during obscure broadcasting hours when audiences are at their minimum.

If the newspapers had as little conception of news interest as the broadcasters, they would still be carrying aviation news in a half column on the fourth page. Why restrict aviation broadcasts to relatively unimportant hours?

Aviation also means opportunity to the dealer. The public is flocking in huge numbers to airports, particularly on Sundays and holidays. During May, 22,072 people paid admissions to visit Roosevelt Field, Long Island. Leisurely crowds at airports can be entertained by radio reception to the advantage of the radio dealer who capitalizes this opportunity. Open air demonstrations show up the capabilities of the modern receiver to the best advantage.

Let Dealers Mould Advertising Policy

RADIO MANUFACTURERS spend tens of millions annually in newspaper and magazine advertising to stimulate sales of radio receivers. The influence of that expenditure depends not only upon its magnitude and the skill used in selecting mediums, but also upon the directness and power of the appeals made in the advertising copy itself. One must go far from radio and the advertising profession to evaluate effectiveness of copy appeal upon those who are neither technically familiar with radio nor sufficiently interested in broadcasting to purchase a receiver. To pass judgment, one must consider advertising copy in the light of the questions asked by the prospects who visit the radio dealer's store for the first time and upon close observation of the influences which attract the new prospect and lead him to buy.



Advertising policies are usually determined by persons who have no real contact with buyers and prospects. They are based more upon theory than upon practice face-to-face with buyers. All sorts of methods are resorted to by the advertising agents to acquaint themselves with the new buyer attitude. But none have the opportunity of the average dealer to secure first-hand information as to the sales appeals arousing the greatest interest in the non-owning group, now by far the largest potential market. The dealer can help to mould advertising policies by practical suggestions made to the manufacturers whose products he handles, based on his selling experiences.

Radio manufacturers' advertising has an unconvincing uniformity to the average non-owner. The claims made by most makers are almost stereotyped, such phrases as "magnificent tone quality," "revolutionary in principle," and "new precision," appearing everywhere. Another favorite advertising technique is to coin an esoteric technical term to lend a veil of mystery to what is usually a perfectly ordinary design feature. This may captivate the dealer who gathers some glimmer of meaning from the verbiage, but it is doubtful whether a new prospect was ever won by the hocus-pocus appeal in advertising.

The disadvantages of being technically expert, when associated in the preparation of advertising, are usually not apparent to those who pay the advertising bills. Dealers use copy sent them by the manufacturer because of its convenient form and the prestige of those who prepare it. But many a dealer is better able to suggest copy themes which will bring people into his store than the manufacturer or his advertising agent. The dealer's idea of copy may violate all the principles of advertising which have been laid down so carefully by armchair experts, but it would be based upon an intimate knowledge of the buyer's attitude when he enters the radio store. For that reason, suggestions and conclusions based on careful observation should be welcomed. A dealer contest for advertising copy suggestions would be a productive source of copy ideas for any manufacturer.

The WCFL Controversy

CONSIDERING THE immense political agitation brought forward in behalf of WCFL, the Chicago Federation of Labor broadcasting station, one would derive the impression that its activities are of vital importance to the well-being of labor. We were, therefore, sufficiently interested to read the brief filed in reply to WCFL's appeal by the Federal Radio Commission with the Court of Appeals of the District of Columbia.

The Commission pointed out that the station, in the long period that it has had full time on its channel, had devoted only 30 to 65 minutes daily to programs of special interest to labor, that it has broadcast patent-medicine advertising and violated the order that phonograph records be identified. The Commission contends that labor unions as



OF RADIO

Paramount Enters Broadcasting
District Judges Become Commissioners

a class are no larger or more important than numerous fraternal and political bodies which could, with equal propriety, claim an exclusive channel on the basis of their numerical strength. By making the fate of WCFL a "cause," politically potent labor may force upon the Commission the necessity of granting it a clear channel. Such a decision would establish precedents which will encourage other groups to make pleas for exclusive channels on the same grounds.



There is no instrumentality which serves the public without discrimination on a broader scale than radio broadcasting. It is unfortunate to attempt to make this the tool of any class or grouping of society. WCFL should base its case on superior service to all the public and prove itself a better station from the program and service standpoint than other Chicago stations assigned clear channels. Dependence on service to labor unions rather than to the general public might indeed be construed as a realization that its case is weak from the public service standpoint. Any group, including organized labor, better able to serve than existing broadcasters, is entitled to the channel facilities of inferior broadcasters, but none deserve consideration on the basis of political threat or influence.

A Fortune for a Feature

"AMOS 'N' ANDY" have captivated the radio public so successfully that numerous stations have been broadcasting special phonograph recordings released them each week. Recently, the services of these artists were purchased by the National Broadcasting Company from Station WMAQ for a sum reputed to be $100,000, apparently the highest price to be paid to date for the release of a single broadcast act. The sum is not verified, but it is quite probably correct.

There is no shortage of good radio talent, but it is a matter of the utmost difficulty to secure real headliners whose merit and distinctiveness establish extensive and enthusiastic followings. It is probable that the National Broadcasting Company will be fully compensated for its purchase. No doubt, there is a great deal of scurrying around to find an advertiser to sponsor these two capable and expensive entertainers. One of these days, they will appear in the name of toothpaste, halitosis, or screen-grid tubes.



In this connection, it is interesting to learn the conclusions of Duane Wanamaker, advertising manager of the Grigsby-Grunow Company, sponsors of the "Majestic Theatre of the Air," after presenting Moran and Mack as a headline feature over the Columbia System. There has been no question about the popularity of this feature, he states in *Broadcast Advertising*, but headline artists win attention to themselves rather than to their sponsors.

This reasoning might justify the conclusion that an ordinarily good broadcast feature, not sufficiently outstanding to arouse great public interest in the artists presenting it, centers good will upon the sponsor and his product most effectively. Therefore, such a program is a better paying broadcasting proposition than a "big-name" feature.

It is doubtful, however, whether an "average" feature can attract as large an audience as outstanding headliners. The average radio advertiser is no longer content to make his advertising secondary to good radio performance. Such reasoning, it seems to us, is fallacious because the first essential to successful radio advertising is to attract the largest possible audience through the program merit of the feature itself. The advertiser may secure the benefits of headliners by identifying them with names suggesting his products.

Paramount in Broadcasting at Last

PARAMOUNT-FAMOUS PLAYERS have purchased a half-interest in the Columbia Broadcasting System, forming a combination somewhat similar to the Radio-Keith-Orpheum. The statement issued at the time of the merger set forth that it was brought about by Paramount's desire to associate itself with radio on account of the coming of practical television. It is our guess that this was simply publicity strategy because television has yet to reach a stage of development of interest to the general public and does not promise to do so in the immediate future. Paramount has been linked with the effort to start broadcasting chains for several years and this merely represents the consummation of their work in this direction.

District Judges Become Commissioners

THE FEDERAL RADIO COMMISSION bids fair to be displaced in its most important functions by the District Court of Appeals of the District of Columbia. All the Commission's major high-frequency allocations in the continental and inter-continental channels have now been brought before that court by appeals. This amounts to placing the decision as to how the high-frequency allocations will be made with that judicial body. Attacks have centered upon the generous allotment of frequencies made to the Universal Wireless Communications Company. The Mackay Radio Corporation, Radio Communications, and Intercity Radio have appealed the Commission's decisions. The latter two fear no comparison with Universal Wireless Communications in experience in practical commercial radio telegraphy, their contender in high frequencies having had none to date.

It is all an extraordinary mess which has not been in the least simplified by the existence of strong prejudices against some of the interests involved. Radio communication is of such importance in national and international relations that it is well to consider decisions not only from the standpoint of how they affect the relative positions of various communication companies and the pet hatreds of some Senators and Congressmen, but primarily how they affect the economic future of the United States and its position in international communication.

—E. H. F.

IN THE RADIO MARKETPLACE

News, Useful Data, and Information on the Offerings of the Manufacturer

New Receivers Announced

KELLOGG SWITCHBOARD AND SUPPLY CO: Three new receivers, especially designed for use in districts supplied with 25-cycle current, have been added to the line of sets manufactured by this company. These new sets, models 526, 527, and 528, will use 224-type screen-grid tubes and an automatic volume control. The 526 and 527 have phonograph pick-up jacks.

STERLING MANUFACTURING COMPANY: This is the first season that this company has manufactured radio receivers although they have been in the electrical business for 23 years. Three sets are being made, the Stuart, the Avon, and the Oxford. The sets use screen-grid tubes and 245-type power tubes. The loud speaker is a 10-inch dynamic.

STEWART WARNER CORPORATION: The series 900 screen-grid receiver and the Stewart-Warner dynamic loud speaker are now available in a new console of 17th century English furniture design.

TEMPLE CORPORATION: The new receivers of this company are arranged so that either screen-grid or ordinary 227-type tubes may be used, the change over from one type to the other requiring about thirty minutes work. All models use the Temple 14-inch dynamic loud speaker. In converting a Temple set from 227 tubes to a screen-grid tube receiver, two radio-frequency transformers and two resistors must be changed. Then two 224-type screen-grid tubes are substituted for the 227 tubes in the r.f. stages and the job is done. The Temple Corp. feels that the possibility of using either 227- or 224-type tubes in their sets is a protection for their dealers in case of a screen-grid tube shortage.

STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY: The model 846 receiver is a screen-grid set with automatic volume control. Two special features provide for quiet reception. One of these is a control which reduces the sensitivity of the set when powerful locals are being received or when there is considerable static. The second feature is the "silent key" operated by a push button, which enables the user to cut out background noises and station signals when tuning from one station to another. The set uses a linear detector and is tuned by means of a single dial in conjunction with a tuning meter. A phonograph pick-up jack is provided.

Miscellaneous New Apparatus

RADIO RECEPTOR COMPANY, INC: Four new power amplifiers have been designed by this company. The PYP-245 is a three-stage amplifier with two 227-type tubes followed by two 245-type tubes in push pull, the PX-245 is a two-stage amplifier with one 245-type tube, the PXP-245 is a two-stage amplifier with 245-type tubes in push pull, and the PXP-250 amplifier contains three stages with 250-type tubes in push pull.

JENKINS TELEVISION CORPORATION: This company recently demonstrated a complete television receiver for home use. The complete receiver was contained in a cabinet measuring 18 by 18 by 24 inches and the apparent size of the image was 6 by 6 inches. The set is operated by first turning on the neon glow tube by means of a snap switch and then tuning in the television signal. A crank on the set is turned to frame the picture properly. The interior mechanism consists of a synchronous motor and the scanning drum. A special distributor serves to flash in succession the four plates contained in the neon lamp. Two transmitters of the company, one at Jersey City, N. J., and the other near Washington D. C., are on a regular schedule transmitting television programs. Both stations are rated at 5 kw. and operate on 140 meters.

JEWELL ELECTRICAL INSTRUMENT COMPANY: The pattern No. 199 Set Analyzer is now available in a portable cabinet provided with a drawer and compartments for tools and tubes.

Personal Notes

C. J. CALLAHAN, has assumed the duties of sales promotion manager of Colin B. Kennedy Corp. Mr. Callahan was for several years promotion manager of the Zenith Radio Corporation, of Chicago.

AT A SPECIAL MEETING of the Midwest Radio Trades Association held at the Electric Club of Chicago, E. J. Brennan was formally elected to the board of directors. Mr. Brennan is Chicago district radio sales manager for the Kellogg Switchboard & Supply Co.

GEORGE MUCHER, of the well-known family of Mucher brothers, who operate in the radio field under the name of the Clarostat Manufacturing Company, of Brooklyn, N. Y., has just joined the Clarostat engineering staff, following his graduation from the Rensselaer Polytechnic Institute.

D. W. MCKINNON has been chosen division manager for the Colin B. Kennedy Corporation, of South Bend. Mr. McKinnon will cover the Mid-West territory.

DAVID GRIMES, radio inventor, has been appointed chief research engineer of the Pilot Radio & Tube Corporation, it was announced by I. Goldberg, president of the firm. He has taken charge of the main Pilot laboratory, 323 Berry St., Brooklyn, New York, where he will conduct investigations along original lines.

EDWARD STRAUSS has joined the Brunswick national organization, and be will be succeeded by Frank S. Horning as the New York district sales manager.

AMONG THE recent additions to the Colin B. Kennedy Corporation executive personnel is G. H. Kratsch, divisional supervisor at the main office.

O. H. ESCHHOLZ has been appointed manager of the patent department of the Westinghouse Electric and Manufacturing Company, succeeding O. S. Schairer, who resigned to accept a similar position with the Radio Corporation of America. Mr. Eschholz's headquarters will be at the company's East Pittsburgh works.

E. W. BUTLER, for the past five years with the sales and engineering department, San Francisco office, E. T. Cunningham, Inc., has been transferred to the New York executive offices of the company, it is announced by C. R. King, vice-president and assistant general manager of the company. Mr. Butler will devote his time in the same capacity at the company executive headquarters.

THE STERLING MANUFACTURING COMPANY, Cleveland, announces the addition to their staff of Geo. J. Eltz, Jr. Mr. Eltz will act in the capacity of manager of the Radio Division.

A. A. TROSTLER has just been made sales manager of the Radio-Panatrope Division of the Brunswick-Balke-Collender Company, of Chicago. This concern recently purchased the Bremer-Tully interests.

KEITH SAUNDERS, well-known figure in the New York radio sales field, has been appointed assistant sales manager for the Freed-Eisemann Radio Corporation. Mr. Saunders will handle all the shipment problems of the Freed concern and will contact with the Freed Radio distributors throughout the nation.

EXECUTIVE PROMOTIONS are announced by E. T. Cunningham, Inc. George K. Throckmorton, formerly vice-president and general manager, to the position of executive vice-president and general manager; C. R. King, formerly assistant general manager to the position of vice-president and assistant general manager; and M. F. Burns, formerly general sales manager, to the position of vice-president and general sales manager.

News from Distributors

W. E. DARDEN has been elected vice-president and Hal Motor has been elected treasurer of Ernest Ingold, Inc., Atwater-Kent distributor of San Francisco.

C. V. CHISHOLM, manager of the Edison Distributing Corporation, of Boston, Mass., New England distributors of Edison radios, phonographs and records, recently announced the appointment of Guy P. Clement as their representative for the state of Maine.

R. B. WOLFE, sales representative of the Atwater-Kent Manufacturing Company assigned to the Sioux City distributing area, has moved to Sioux City and will serve in the territory embraced by the A. A. Schneiderhahn Company.

THE BURR-TRUE CORPORATION, Atwater-Kent distributors in Syracuse, N. Y., devised in connection with their annual Atwater-Kent Dealers Convention, a very novel and arresting announcement and reservation blank in the form of a check, making payable to the invited dealer "One Profit-ful Day and Enjoyable Evening," collectible at par at the Convention Headquarters. The lower part of the perforated double check, to be returned to the Burr-True Corporation, is detachable for the purpose of reservations.

NEW DISTRIBUTORS APPOINTED

THE KELLOGG SWITCHBOARD AND SUPPLY COMPANY has appointed the Em-Roe Sporting Goods Company, 209 West Washington Street, Indianapolis, Indi-



NEW CONSOLES

(A) The new Victor receiver which has attracted considerable attention. The tuning control consist of a transparent indicator which slides over an illuminated dial.

(B) A rather interesting cabinet houses this screen-grid receiver manufactured by the Sterling Manufacturing Company. The dynamic loud speaker is connected to a power stage using two 245-type tubes in push-pull.

(C) This illustration shows the Jensen Imperial Model dynamic loud speaker. This model is available with either the Concert- or Auditorium-type dynamic units.

(D) Automatic volume control and power detection is used in this model (No. 846) Stromberg Carlson receiver. The r.f. amplifier employs three screen-grid tubes.

(E) The Stewart Warner series 900 screen-grid receiver in a 17th Century English Console. The receiver uses eight tubes including the rectifier.

(F) An Atwater-Kent Screen-Grid receiver and dynamic loud speaker in a well-designed console. The receiver uses three screen-grid tubes and two 245-type power tubes.

(G) Here is a picture of the Eveready Model 33 radio receiver. It is one of the ten models included in the Eveready line this year.

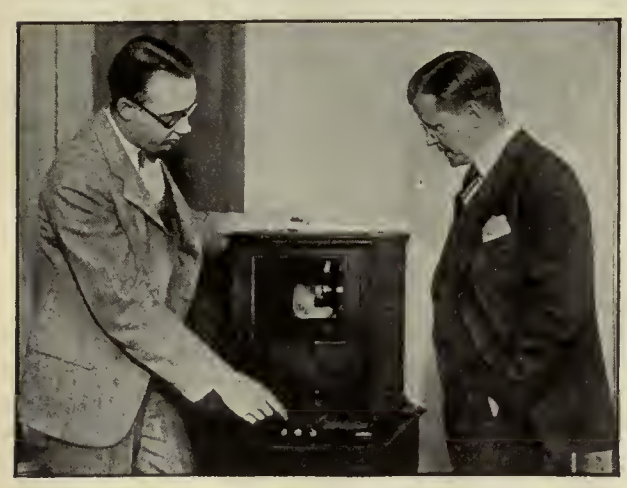
(H) The Bosch Radio De Luxe Highboy. Sliding doors are used in this artistic piece of furniture. The receiver uses screen-grid tubes and a dynamic .oud speaker.

(I) Here is a unique cabinet design. No loud speaker grill is required for the loud speaker plays through an opening in the bottom of the cabinet. It is the Colonial Model 32.

(J) The Radio-Victor Corporation of America makes this receiver, known as the Model 33. The legs are readily detachable making a table model receiver.

ana, distributor for the southern Indiana territory.

Western Missouri and the entire state of Kansas will be served by the Universal Equipment Company, 1201 Winchester Avenue, Kansas City, Missouri. Another distributor recently appointed by the Kellogg Switchboard and Supply Company is the F. D. Lawrence Company, Inc., 219 W. 4th Street, Cincinnati, Ohio, who will serve dealers in eastern Kentucky, southwest Ohio, and the southwestern portion of Indiana.



The television receiver pictured above has been developed for home use by the Jenkins Television Corp.

THE TRIAD MFG. COMPANY has appointed the Northeastern Radio, Inc. and John V. Wilson, of Boston, Triad wholesalers for the New England territory.

THOMAS A. EDISON, INC., maker of the Edison Radio, have completed negotiations with Morley Bros., of Saginaw, Michigan, for the distribution of Edison radios, phonographs, and records in that state, according to an announcement recently made by Roy S. Dunn, western sales manager of Thomas A. Edison, Inc. Michigan Edison dealers will now be served by two Edison distributors, the other distributor being E. A. Bowman, Inc., of Detroit, who is intensifying his Edison activities within the environs of Detroit.

THE COLIN B. KENNEDY CORPORATION, announce the appointment of the following distributors: Belknap Hardware & Manufacturing Company, Louisville, Ky.; Lindsay Electric Company, Rochester, N. Y.; Whiteemore, Bros., Worcester, Mass.; Narrangansett Radio Corporation Providence, R. I.; Tri-State Radio Co., Huntington, West Virginia; Ashton-De-Veer, Inc., Boston, Mass.; J. H. Blimline & Sons, Reading, Pa.; G. S. Means Co., Fort Wayne, Ind.; John Y. Parke Co., Philadelphia; and the Gertler Electric Co., New York City.

W. R. McALLISTER, sales manager of the Federal Radio Corporation, Buffalo, N. Y., announces the appointment of the Haas Electric Sales Company, Cleveland, Ohio, as a Federal wholesaler. The company's territory extends throughout about half of the state of Ohio and the tier counties in the southeastern portion of Michigan. The company contemplates opening a branch in Toledo in the near future, thereby giving immediate service to its trade in its western territory.

JOBBER-DEALER MEETINGS

DEALER MEETINGS during the summer were held by the following Atwater-Kent jobbers: Louis Beuhn Company (Philadelphia); Knerr & Company, (Harrisburg, Pa. territory); D. T. Lansing Company (Scranton, Pa. territory); Southern Wholesalers, Inc. (Washington D. C. territory); E. J. Edmond Company, E. B. Latham, and E. A. Wildermuth (metropolitan New York area); Bertram Motor Supply Company (Boise, Idaho, area); Sunset Electric Company (Washington state territory); Ernest Ingold, Inc. (San Francisco territory); Ray Thomas, Inc. (Los Angeles area); Albany Distributing Corporation (Albany, N. Y. area); Stiefvater Electric Company, Utica N. Y.; Columbus Ignition Company, Columbus, Ohio; C. L. Hartman Corporation, Rochester, N. Y.; Burr-True Corporation, Syracuse, N. Y.; Kurtzmann Company, Buffalo, N. Y.; Strevell-Patterson Hardware Company, Salt Lake City, Utah.

TEMPLE DISTRIBUTORS' dealer meetings were held during the summer by Bihl Brothers, Buffalo, New York, and by the Ackerman Electric Company in Grand Rapids, Michigan. At Pittsburgh, Pa., the Keps Electric Company gathered 315 dealers to hear the Temple story and a similar meeting was held for the West Virginia territory by the Front Company, Temple wholesalers in that territory.

News of the Industry

THE ACTIVE Pacific Radio Trade Association, with George H. Curtiss as secretary, has been sending out dealer window strips during the summer, plugging summer radio entertainment to be had over the West Coast networks. Window strips at other seasons for important broadcast events have also been sent out.

NINETEEN DEALER helps are listed in an illustrated catalogue recently sent to Atwater-Kent dealers. Among the sales helps available are the following: window sign; girl cutout, cardboard musical instrument group, name blocks, humorous cardboard cutouts, organ and disc cutouts, heraldic figures, color shafts, miniature posters, 24-sheet posters, bridge sets valance and window transparencies, cardboard letter, match folders, whistles, and balloons.

PARKS AND HULL, Atwater-Kent distributors in Baltimore, issue each week a folder giving highlights of local broadcast programs. The cover of the printed piece gives program features on the air at the same time every day as well as a list of regular attractive types of programs to be heard. The two inside pages are multigraphed each week and refer especially to local programs of interest. *Highlights of Local Programs*, as Parks & Hull have named the sheet, is available to retail salesmen.

W. S. TAUSSIG, service engineer of Freshman-Freed Eisemann, believes that radio manufacturers should encourage coöperation with manufacturers of electrical and other devices which are, in operation, capable of setting up interference with radio reception. In this way, he thinks, these makers can be induced to cure the trouble at the source and in a great measure, relieve the industry of the onus of curing interference after it is created.

THE FRESHMAN COMPANY have contracted with the makers of electric flasher signs, electric pianos, elevators, telephone apparatus, street cars, electric refrigerators, etc., to furnish information about the parts of their products causing interference and to assist them in ways of removing the causes without altering the operation of the apparatus.



L. T. Breck

WALTHAL'S, New York radio chain, announce the appointment of Miss Nellie Brennan as manager of their New York City store at 142 East 86th Street. It is said she is the first woman radio store manager on record.

Walter Nussbaum, president of Walthal's, announces the opening of the 15th store in the system in Brooklyn. Another store was recently opened in New York City.



Crosley distributors and representatives of seven leading furniture manufacturers met in convention recently at the Crosley factory at Cincinnati, Ohio.

TEMPLE IS having 5000 fect of film takcn whicb shows the process of receiver making. It will be put to good use beginning August 15 when a fleet of Temple sales-promotion autos starts on a tour of the Unitcd Statcs.

There will be six machines, paintcd Temple bluc and cream, in tbe caravan at the start. Each machine will be equipped to show films of the Temple plant and will be prepared to shoot new scenes along the way. A sales-promotion official, a radio enginccr, and a window trimmcr will be in eacb car, and, in addition, eacb auto will carry a Temple receiver.

THE NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION will hold its annual meeting at the Wardman Park Hotel, Washington, D. C., during the week of Octobcr 7. A large attendance, representing the entire electrical manufacturing industry, is anticipated as this is the only mccting attended by all the different product groups in the Association.

A SPECIAL STOCKHOLDERS' mecting has been called for the purpose of changing the name of the Chas. Freshman Co., Inc. to Earl Radio Corporation. The change in name was strongly urged by dealers and distributors who decmcd this advisable, in order to identify more properly the company with the new C. A. Earl Radio which has been so enthusiastically received by the trade and the public.

HAROLD J. WRAPE and his business associates in the Benwood-Linze Company purchased outright the entire interests of the Trav-Ler Mfg. Co. stockholders. Ncw officers of the company are Mr. Wrape, president; C. Hambuechen, vice-president; and C. R. Ogle, sceretary and treasurer. W. A. Butler, formerly merchandising manager of the Benwood-Linzc Company, is general sales manager for the Trav-Ler Mfg. Corp.



George K. Throckmorton

THE NEW *Better Radio Reception Manual*, published by R. M. A., gives detailed information as to the various types of electrical appliances which are liable to cause interference, how the cause of the noisc can be located, and, finally, how the noises can be eliminated through the installation of various types of filters. The price of the Manual is 25 cents and copies can be obtained from the Radio Manufacturers Assocciation, 32 West Randolph Street, Chicago, Ill.

AT A MEETING of the Board of Directors of the Grigsby-Grunow Company, tbe regular quarterly dividend at thc rate of $4.00 pcr share per annum was dcclared. The Company's fiscal year endcd May 31, and total salcs for the fiscal year were $49,275,990.97.

IN THE PRESENCE of more than 100 distributors and guests, the All-American Mohawk Corporation, manufacturers of Lyric radios, in June opened its new cabinet manufacturing plant at North Tonawanda, N. Y. This was one of the featurcs of the fourth annual convention of the corporation's distributors.

Dr. Charles Lauritsen, chief engineer of the Colin B. Kennedy Corporation, has inaugurated a complete system of inspection to maintain production models of the sets equal in every respect to the laboratory models. Thc factory test bench is shown in an illustration on this page.

IN OPENING a new real estate dcvelopment featuring a modernistic home, the Justin Matthews Company, developers, working with 555 Incorporated, Atwater-Kent distributor of Little Rock, Arkansas, equipped the home with a new Atwater-Kent screen-grid electrodynamic radio set.

RADIO AND FURNITURE MEN MEET

SEVEN LEADING manufacturers of fine furniture were asked to display cabinets to the distributors of Croslcy radio receivers at a convention held reccntly in Cincinnati. Distributors from all parts of the country, with the exccption of thc West Coast, attended, while the latter group held a similar meeting at San Francisco at the same time.

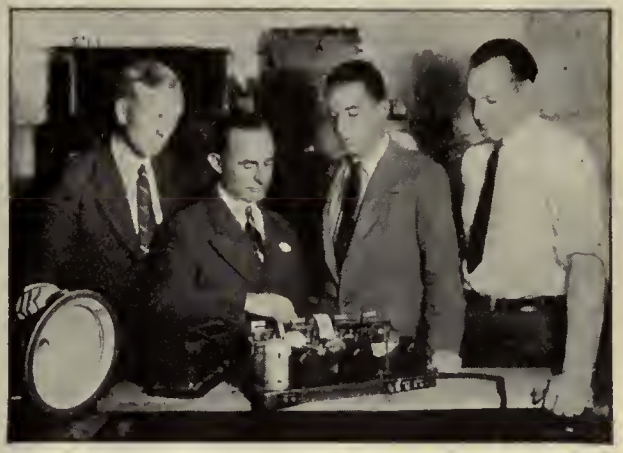
Tbe cabinets displayed by the furniturc companies are designed to take tbe Croslcy cbassis and moving-coil loud speaker. Assembly may be made in a few minutes. Provision bas been made to make permanent installation by placing two screws, one in tbe chassis and one in tbe loud speaker. Steel rails are placed in the cabinets to permit easy placing of the chassis.

The seven furniturc manufacturers who displayed thirty cabinet designs, were: Berkey and Gay, Grand Rapids, Mich.; Sligb Furniture Company, Grand Rapids, Micb.; Sbowers Brothers, Bloomington, Ind.; Thomasville Cbair Company, Thomasville, N. C.; Memphis Furniture Company, Memphis, Tenn.; Rockford Furniture Company, Rockford, Ill.; and Docrnbecker Manufacturing Company, Portland, Ore.

PRODUCTION PLANS FOR 1929

FROM ANNOUNCEMENTS of set manufacturers, referring to production plans for the current radio scason:

Kennedy: 1000 sets per day on the screen-grid chassis. "Estimates from orders on file place our production for 1929-30 at 150,000 sets."—F. W. Wellington, chairman of the board.



F. A. D. Andrea showing A. S. Hunter and J. Sieger, London radio engineers, the new Fada chassis. F. K. Rettenmeyer, chief engineer Fada, is on the right.

Bremer-Tully: 2200 complcte radio sets per week. ("Before winter, the company expects to specd up production to 750 sets per day."—R. E. Smiley)

Majestic: 5100 sets per day.

Temple: 500 sets per day (July 15); production quota for 1929-30: 250,000 sets.

Freshman: 1200 sets a day; 1500 by August 1st.

RADIO ADVERTISING SERVICE

STANDARD RATE AND DATA SERVICE, 536 Lake Shore Drive, Chicago, are issuing a monthly radio supplement to their regular advertising media service. In addition to rate cards and information about each station, the monthly issue provides data on the following broadcast networks: National Broadcasting Company, Columbia Broadcasting system, American Broadcasting Company, and Trans-Canada Broadcasting Company.

KOLSTER ORGANIZES FIELD FORCE

THE KOLSTER RADIO CORPORATION has completed tbe reorganization of its field sales force into five districts covering tbe United States, according to sales manager L. T. Breck. The company has set

(*Coneluded on page 303*)



Dr. Charles Lauritsen, chief engineer, Colin B. Kennedy Corp., tries to keep production models equal in every respect to laboratory models. Above is pictured the elaborate factory test bench.

THE TUBE BUSINESS

HOW TO ADVERTISE TUBES

We have heard the belief expressed a number of times that tube advertising which suggests a test between two makes of tubes to determine which gives better tone quality, distance, etc., is certain of failure. We have heard of several of these tests, conducted according to the modern "blindfolded" fashion, which proved conclusively that one set of tubes in a given receiver was just as good as another set from another manufacturer. It is our belief that any test suggested by advertising which when carried out does not point conclusively to the superiority of the product being advertised is sure to be a boomerang.

Long tube life, uniform construction, freedom from hum, the sound judgment and financial status of the manufacturer, the superior engineering force as evidence of good design—these are the sources of copy which the advertising writer can use to the advantage of his client.

Some manufacturers feel that advertising which claims a tube "heats" instantly may be perfectly true but that it is misleading. No tubes "play" instantly, and even with d.c. tubes there is appreciable time lag between turning on the switch and the advent of sound from the loud speaker. We feel that such advertising harms the tube in question more than other manufacturers, who state plainly that their tubes produce music in from five to ten seconds, and therefore carries its own punishment with it. It is just the difference between a clear-cut statement and one that is cloudy—and it is here that a test will tell the truth. We should like to see and to recommend a tube of the 227 type that "plays" instantly.

FACTS ABOUT SYLVANIA TUBES

In a booklet entitled *Business Facts about Sylvania Radio Tubes*, we find the following four reasons why the tubes identified by the "Flashing S on a Green Oak Leaf" are good tubes.

"First: Sylvania precision operations are handled by men trained for years. And we never rush them, because if you crack a whip over skilled workers they become nothing more than laborers, and the product is bound to suffer.

"Second: We will never let a Sylvania tube leave the factory unless it passes fifteen rigid inspections. That protects the product against rush and hurry because all tubes must pass those tests or go into the junk pile. And junk piles run into money.

"Third: Sylvania has contentment. No slot machines are on Sylvania's payroll. Our hundreds of employees are treated like human beings, given good wages and every consideration, from a completely equipped hospital and nursing staff to buses that take them back and forth.

"Fourth: Sylvania's up-to-the-minute plants at Emporium, Pennsylvania, are in the heart of the Allegheny Mountains—where the air is crisp and healthful, bodies rugged, eyes clear, and minds alert."

TUNG-SOL ENTERS FIELD

Entry of Tung-Sol Lamp Works, Inc., Newark, N. J., into the radio tube industry has been announced. A new factory adjacent to the lamp factory in Newark will be built. It will have an operating space of over 82,200 square feet, a daily capacity of between 25,000 and 30,000 tubes, and will be in operation by January 1, 1930. Tubes will be made under R.C.A. license. The factory is to be built out of company earnings. Harvey W. Harper is president of the company.

NEW TUBE TESTER

The Jewell Electrical Instrument Company announces a new Pattern 199 a.c.-d.c. set analyzer designed to test the new a.c. screen-grid tubes. This instrument tests practically everything about a radio set except the kind of program the user tunes in, and, if there were any way in which the device could be made to censor loquacious announcers, we suppose Jewell would incorporate it into the instrument.

CUNNINGHAM SALES

Cunningham sales for the first five months of 1929 show an increase of more than 35 per cent. over a corresponding period of 1928, according to M. F. Burns, vice-president and general sales manager. It is expected that the figures for the first half year will show a total number of tubes made exceeding the total number built during 1928.

Mr. Burns believes the 1929 tube market will be greater than any other in the history of radio. He believes the total production of tubes for the year will reach 110,000,000.

MARVIN'S RADIO DEBUT

The Marvin Musicians, sponsored by the Marvin Radio Tube Corp., of Irvington, N. J., will make their radio debut over the WJZ network of the National Broadcasting system on Saturday, Aug. 31, at 8:30 P. M., New York Time. The series will continue for a period of 26 weeks.

Hugo Mariani, ace conductor of the NBC studios, assisted by a 25-piece orchestra, comprise the Marvin Musicians. Mariani has evolved a novel "musical-journey" idea which readily adapts itself to a flexibility in programs.

RUMORS OF LARGE MERGER

Rumors of a merger of the manufacturers of Televocal, Magnetron, Sonatron, and Marathon tubes continue to float hither and yon. No one will deny or confirm these rumors which in themselves are a good indication that something is brewing. The latest rumor (July 25), published in New York papers, states that not only has such a merger been completed but that a license bas been granted it by R.C.A. who has loaned the new company $2,000,000 secured by an option on 50,000 shares of stock in the new company.



The New Jewell set analyzer tests a. c. screen-grid tubes.

TUBE SHORTAGE PREDICTED

As late as July 22, William J. Barkley, assistant to the president of the DeForest Radio Company, predicted a severe shortage in tubes of the -24 and -45 types, and encouraged all dealers to stock up on tubes in preparation for the fall trade when this shortage would become evident in the retailer's end of the business.

Certainly there are two serious aspects of any tube shortage. If a dealer cannot supply tubes he cannot sell sets, any more than he could sell an automobile on the promise of getting tires later on. Thus the dealer loses sales. On the other band, a pronounced tube shortage makes it "pie" for inferior products to be dumped on the market and sold. These tubes either work but poorly, or fail prematurely and always breed dissatisfaction. As Mr. Barkley says, "Tubes in stock mean more than money in the bank."

(*Concluded on page 303*)



THE SERVICEMAN'S CORNER

Why Servicemen Go Home

RADIO SERVICING has settled down for the greater part to the detection and solution of a few relatively simple troubles. But every once in a while, just to make life interesting, we run into a stumper, and HERBERT M. ISAACSON, service expert of Brooklyn, N. Y., describes two good ones in the paragraphs that follow:

"If your customer complained that a loud bong came from the loud speaker at every footstep of a person in the room, and that a howl, low in volume at first, but rapidly building up to tremendous loudness, occurred whenever the loud speaker was brought within ten feet of the set, you'd say that undoubtedly there was a very microphonic tube in the detector socket.

"Well, that's what I said, but——

"The set was a Garod electric, model E A. The detector is a 199, and because of the high audio gain, a tube that is only mildly microphonic manages to kick up quite a rumpus. Wherefore, I had selected a number of 199's that tested practically non-microphonic, feeling quite certain that the trouble could be due to nothing but a microphonic tube.

"A terrific howl was my greeting when I switched the set on. We'll fix that in a moment," I murmured confidently to the customer, and I slipped in a new detector tube. To my chagrin it too howled unmercifully. I tried the rest of my tested tubes with no greater success.

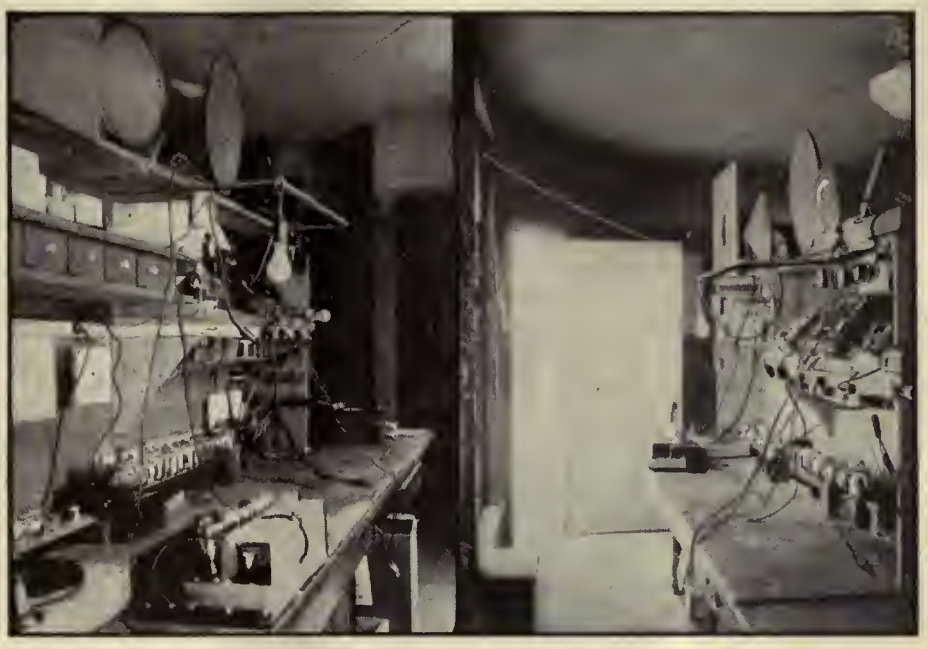
"The loud speaker had a 30-foot cord, so that it was possible to move it into the next room. This stopped the howl which was due, of course, to accoustic coupling between it and the set. However, the scraping of a chair across the floor, walking or the very lightest scratching of the set panel with the fingernail resulted in a noise of considerable volume from the loud speaker. With my mouth held close to the panel, every word I uttered was reproduced, badly garbled but still intelligible and with good volume.

"I tried tapping the set at different places in an attempt to localize the source of the trouble, but the noise in the loud speaker was equally loud wherever I tapped. An examination of the set did not indicate anything that might cause the trouble.

"Finally I sandpapered the brass end caps of the grid leaks and the trouble cleared up. Although the grid leak was held tightly between its mounting clips, tarnish on the end cap evidently caused a highly resistive contact that varied greatly under the stimulus of any slight vibration. The result was to affect grid circuit modulation in the detector.

* * *

"On another occasion, I was called in to correct a trouble that the customer assured me I couldn't correct. 'No one could,' he said. All the local experts had tried to, and had failed. This fellow was fairly bursting with pride at being the owner of a radio that 'no one could fix.'



Two views of the radio service bench at the Bee Automobile Company, of Allentown, Pa.

"This customer had a Garod electric on which reception was perfect except for the annoying fact that all stations would fade in and out. This fading was gradual and very similar to that encountered when listening to a distant station. My first suspicion was that the antenna was at fault. I disconnected it and strung a few feet of magnet wire through the room instead. (The r.f. gain of these sets is quite high so that good volume is obtained with very small antenna.) I disconnected the ground. But WOR faded serenely in and out. My diagnoser showed that the voltages at the tubes remained steady while the fading occurred. A new set of tubes helped not at all. Jarring the set didn't seem to affect the fading.

"Then, during one of the periods when the station stayed 'out' for a few seconds, I found that I could bring it in again with full volume by retuning about 3 degrees. Here was a clew. Whatever was causing the fading was doing so by virtue of a tuning effect. I took off the shield cans—which were of brass and bolted to brass bed plates on which the apparatus is mounted—and inspected the tuning condensers. Seemingly, they were perfect. Careful examination of the r.f. coils showed them to be perfect, too. Everything appeared to be tight. I sandpapered the bed plates where they made contact with the shield cans and secured the cans back in place. The fading was gone.

"In all probability tarnish and dust were causing variable contact between the shields and the grounded bed plates, so that at times the shields were grounded and at other times they were 'floating' with a resultant tuning effect on the coils mounted inside them."

[These are only two of Mr. Isaacson's unusual experiences in servicing radio receivers. We are holding several others in type and they will be published in a future issue—Editor.]

Tube Troubles

"The big joke was found in a brand new Tyrman a.c. Imperial 80 (beautiful job). The trouble: fading signal, no wallop, hum,

We are publishing this month a collection of several contributions on radio service problems caused by faulty tubes. In the past we have given space to articles of a similar nature but these have by no means exhausted the subject, as it has been estimated by service experts that tube trouble is to blame for more service jobs than the failure of any other piece of apparatus or equipment. Fully fifty per cent. of radio difficulties—in many instances fading, distortion, lack of volume, noise, dead set, howling, insensitivity, and almost anything else that can happen to a radio set—can be traced to a tube in the process, past or present, of "going west."

We should like servicemen to tell us of the tube troubles they have run into, simple and complex, the common difficulties and the freaks. The more the merrier!

—THE EDITOR.

and several minor afflictions. I made strict search for all defects possible and then put the little box of tricks to work. Well, the amplifier proved ok., plenty of pep and juice to spare, but when I hooked it all up I lost all plate voltage on the second detector. Well then it was the old process of elimination and the trouble was located as a direct short from the second i.f. transformer space charge to cathode. So watch your a.c.-24, they're tricky."

R. R. Hescock, Manager (Silver-Marshall Service). Associated Radio Engineers, Portland, Oregon.

George W. Brown, radio service manager of the Motor Supply Company, Boston, Mass., reports the following:

"Here is a trouble which I have encountered often enough to deserve a space in the "Corner."

"I have been servicing Eveready sets. This set uses three stages of r.f. with 227 tubes. The detector and 1st audio are also 227's and two 171A's are used in the last audio. The volume control, a resistance in the cathode leads of the r.f. tubes, controls the C bias.

"The set in question after working for a short while suddenly developed full volume and the volume control had no effect on it. After a lot of testing and sweating I found that one of the 227 tubes in the r.f. end had developed a short from cathode to filament, thus shorting out the volume control completely.

"Shortly afterwards I had another set which after playing ok. for a while started to hum in an alarming manner—a regular 60-cycle hum. On testing this set I found there was no C voltage on the r.f. tubes. Here again it was due to a 227 being defective, and I imagine it was also a cathode to filament short."

It is reasonable to suppose that the possible tube troubles will be augmented considerably with the popular use of the a.c. screen-grid 224 tube.

Miscellaneous Kinks

Majestics, Fadas and Radiolas: H. P. Erickson, specialist in Fada, Majestic, and Atwater-Kent service in Ottumwa, Iowa, helps the cause along:

"Majestic 181 Combination: In the installation of a number of these machines, the serviceman will, no doubt, find that some have much more volume on the phonograph pick-up than others. This is usually due to the fact that some 181's have the pick-up unit connected ahead of the detector and some are hooked up ahead of the first audio tube. To ascertain this quickly, it is only necessary to pull out the detector tube and try the phonograph. If it plays with the detector out it is generally advisable to change the wiring.

"To do this, remove the bottom of the chassis and locate the switch which is directly below the tuning drum. Disconnect the two wires leading to the detector plate voltage from the pack and the first audio transformer, solder them together and tape. Clip the third of the three long white wires running to the radio-frequency bypass in such a way that they will reach the switch and solder the ends of the lugs from which you have just removed the other two wires. Next clip the grid lead on the other side of the switch and solder it to the grid side of the detector grid-condenser. A substantial increase in volume will be the result.

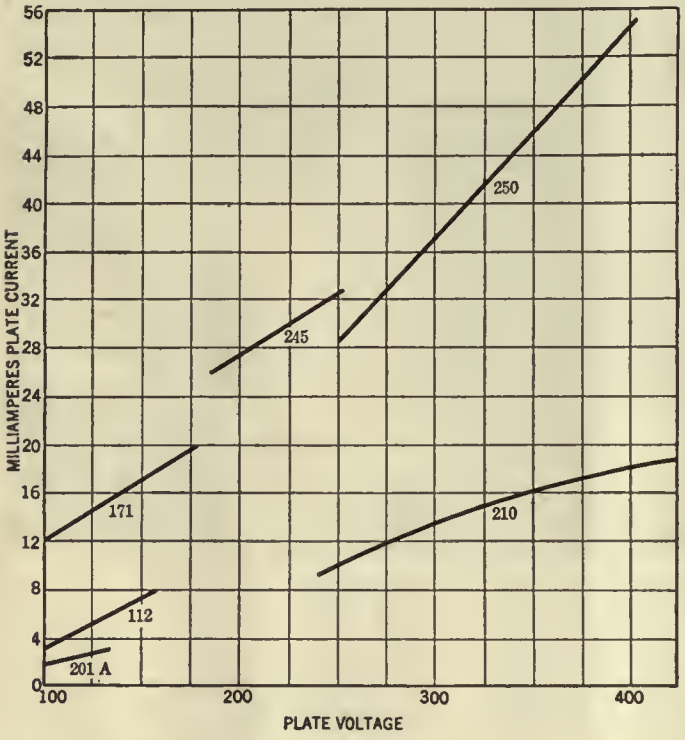
"When a cable breaks on the tuning drum of a Majestic or other receiver, and you find that your stock of cables is completely exhausted, try this one. Get a three-foot cable fish-leader (who laughed?) about the same size as the drum cable. This is almost exactly the same length as is used on the Majestic sets. Remove the eyelets from the old cable and put them on the leader. You now have a cable that is just as strong and just as efficient as a new drum cable, at, incidentally, a fraction of the cost of a new one.

"Fada 'Big Shielded Six' D.C.: Some of these models are equipped with grid leaks and condensers, and some are not. The next one you work on put in an 0.00025-mfd. condenser and a 2-meg. leak. You will notice about a 50 per cent. increase in general efficiency, is most cases.

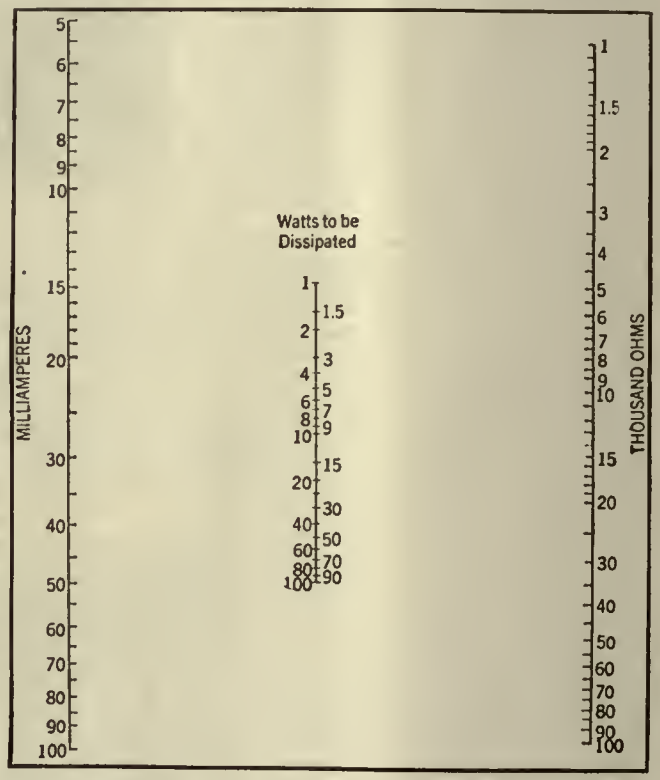
"Fada Seven D.C.: A lot of these sets have been equipped with a dry ABC power unit by Fada. In my past experience I find that the only way in which to avoid trouble caused by excessive filament overload is to put fixed resistors in the filament circuit and use a variable high resistance across the first audio as a volume control.

"Pooley and Red Lion Cabinets: To search an hour in an attempt to locate mysterious noises and vibrations in a machine only to find that a loose board in the cabinet is causing it, is not as much of a novelty as it should be. A hammer and brads are indespensable to the serviceman in his everyday routine.

"Radiola 20 Receivers: If the volume is very poor and nothing but locals are being logged, though the filament, grid, plate voltages at the sockets are perfect, almost invariably you will find that the rotor connections on the condensers are bad. The substitution of some good cable pigtail is recommended. In a case like this the set owner usually complains that the trimmers are not working which is a good indication of this kind of trouble."



This graph indicates the correct plate currents for six popular types of tubes at various plate voltages, assuming a consistently correct C bias. These data should be pasted to the cover of your tube- and set-tester.



With this chart one may determine the relationship between current, resistance, and wattage when two factors are known. A straight edge is laid across the two known factors and extended, if necessary, to include the third. The chart was prepared by R. C. Hitchcock.

Pepping Up the Set: "What causes a set to have 'no volume' when all the circuits test ok., all the parts appear to be, and test, in good mechanical and electrical condition, tubes of known performance are used, and a power supply furnishing standard operating voltage is connected?

"It is the big question in radio service, as it fits those jobs which we often hear described as 'all right, just has no pep.' And the man working at radio service is measured in efficiency by just how many of these sets of reliable manufacture pass by him with no material good being accomplished toward correction. And the manufacturer, jobber, or dealer, as the case may be, suffers the consumer's loss of confidence, and the passing around of

advertising that sells no goods or makes no friends. Most every serviceman has had his share of these cases on sets known to be of reliable manufacture and to have a reputation for a high standard of performance.

"Some RCA 17's suffered from this trouble last summer in the territory along the Eastern coastal states and the cause and correction is now fairly well known over this territory. The forms on which the radio-frequency coils were wound, in some cases absorbed sufficient moisture to cause a high r.f. loss in the amplifier circuit. The popular remedy has been to remove the radio-frequency coil assembly and dry it out thoroughly in a moderately heated oven or to dry it out less quickly by placing the whole set in a warm dry place for a few days. In almost every case the original performance has been obtained after this treatment.

"Another group of 'no-volume' cases was found to exist in the variable tuning condensers of some models of A-K and other make sets using bolted-stator condensers.

"It was found that by loosening up on the bolts and turning the spacing washers a turn or two, a retightening resulted in a marked improvement in reception."

H. J. S. Emmerich, Service Manager, Parks and Hull, Baltimore, Md.

Lack of pep in many single-control jobs is due to the fact that one or more of the condenser units have been thrown too far off resonance in stabilizing the receiver—as often happens with A-K's. The tuning circuits should be lined up until they are closer to the oscillation point.

A Pocket Tool Kit: "To the radio serviceman a few tools close at hand when needed are a great deal more valuable than a shop full of tools lying somewhere else.

"Since he is liable to be called on at any time to go almost anywhere, like a family doctor, he will likely have to go home first for his tools, like a plumber. This is not so good because the sick radio is liable to start playing again while he is gone. On the other hand, if the set starts while he is working at it everything is 'Jake' and he can collect his fee.

"I started early in the game to carry a small pair of pliers and a screw-driver in my coat pocket. This practice day after day soon wore holes in my pockets and coat-lining. Also, I found it necessary to buy tools quite frequently to replace those lost. Therefore, I bought a small leather pouch that was just large enough to hold the following:

One five-inch needle-nose, side-cutting pair of pliers.

One four-inch screw-driver, narrow enough to fit the set screws in radio switch knobs and dials, yet strong enough to loosen most of the screws about a radio set.

One No. 1020 Bonney CV double-end wrench that fits most of the hex nuts.

A few inches of rosin-core solder.

A short piece of insulated copper wire.

"The leather pouch is not cumbersome and can be carried any time unnoticed. The wire is often necessary to make a splice in the case of a broken connection. The rosin core solder needs only the application of heat which the ingenious serviceman will supply with a match, cigar-lighter, or a hot poker.



H. P. Erickson

"I carry the kit with me whether I am on duty or not and it has prevented disappointment in receiving radio programs many times, also possibly a reputation."

Erwin J. Bachman, Bee Automobile Company, Allentown, Pa.

Starting Nuts or Bolts with Rubber Tubing: "The serviceman or set builder often finds times when it is next to impossible to start a nut or a bolt because of the narrow space in which he works. There have been many methods devised for doing this but all are more or less emergency devices and call for as much effort arranging the device as for doing the work. By using several eight- or ten-inch lengths of rubber tubing of varying internal diameters the work can be quickly and easily accomplished.

"Use fairly heavy walled tubing. To start a nut simply push one end of the tube over the nut and then insert that end in the space and give the tube a few twirls with the fingers. The nut will catch on the threads at once. Then pull off the tubing and finish with the necessary wrench. Bolt heads can be inserted in the tubing in the same way and thus started into any otherwise inaccessible threaded hole."

This idea, contributed by L. B. Robbins, veteran supporter of our departments, in Harwich, Mass., will appeal to every serviceman who has rubbed his knuckles against live stuff in trying to start an elusive nut or bolt—which makes it just about unanimous.

The Ohm-Meter as a Service Instrument: Reynolds W. Smith, authorized radiotrician, of Manchester, N. H., recommends the General Radio Company type 287-A portable ohm-meter as a most useful service device. The instrument consists of a 4.5-volt battery and a 7000-ohm meter in series with a variable resistor. The dial of the instrument is calibrated directly in ohms. It is portable, weighing only two and a half pounds, and rugged.

In checking circuits the ohm-meter gives a visual indication of continuity, and shows the resistance of the circuit, which, when compared with a table of standards which are easily prepared, is often significant. The resistance measurements provided by the meter are sufficiently accurate for all service work.

This G. R. ohm-meter sells for $30.00



H. J. S. Emmerich

Reducing Man-Made Static

The Pacific Radio Trade Association makes the following recommendations in reference to reducing artificial static by means of a preferred ground connection:

1. Make the ground wire as short and direct as possible.
2. If a water pipe must be used make the connection to the pipe as near the earth as possible (remember that copper wire will always have a lower resistance than a water pipe).
3. Use only approved ground clamps for connection to water pipe or ground rod.
4. Never connect the ground wire to steam, gas, conduit, hot water or telephone grounds.
5. The ground wire must be insulated and treated in the same manner as the antenna.
6. To prevent ground pick-up keep the wire as far away from power wires and grounded metallic objects as possible.
7. Do not run the ground wire close and parallel to the antenna.
8. Before attaching a ground clamp to pipe or rod clean surface with sandpaper.



The G.R. 287A ohm-meter will give resistance readings directly without an external battery.

9. Wherever ground pick-up is had shield the ground wire.
10. Where an unusually low resistance earth contact is desired, or where the soil is dry and sandy, two or more pipes may be driven not less than six feet apart, nor more than ten feet apart, and the two or more pipes connected in multiple or parallel to form the ground for the receiver.



E. J. Bachman

Service Managers Organize

The Radio Service Managers Association, New York City, was recently organized with the following officers:

John S. Dunham, QRV Radio Service, Inc., president; Howard T. Cervantes, Haynes-Griffin, Inc., vice president; James E. Shannon, Colonial Radio Corporation, corresponding secretary; C. P. Baldwin, The Aeolian Company, recording secretary, and O. Ramberg, R. H. McMann, Inc., treasurer. The three additional directors provided for and elected are: Wm. W. Heller, Gimbel Brothers; Henry C. Struckmann, American Bosch Magneto Corporation; and J. W. Wiegand, Factory Radio Service.

The principal objects of the Association, as set forth in the by-laws are:

1. To act as a forum for the interchange of ideas and experience relating to service.
2. To secure the coöperation of manufacturers and distributors in furnishing service information for dissemination to its members.
3. To provide a central source of service information for the use of its members.
4. To act as a free employment agency for servicemen and service managers.
5. To establish a system of examination and classification of applicants for service and managerial positions.
6. To coöperate with radio service schools or schools having such courses, for the purpose of improving the training available for men who desire to go into the service business.

All those who are interested in applying for membership, or who wish to be informed of future meetings, or desire more information, may address the Radio Service Managers Association at Room 406, 1400 Broadway, New York City.

We are anxious to publish names of local radio service organizations and will appreciate having secretaries send us the name of their organization together with other data, such as the address, number of members, activities, etc.—Editor.



STRAYS from THE LABORATORY

Regarding Cross Talk

The screen-grid receiver has brought into the limelight a problem which has bothered engineers in the past and which assumes a major importance now. This is the problem of "cross talk." It is distinct from lack of selectivity, and, as a matter of fact, may have little to do with the selectivity of a receiver.

The latter is a function of the number of tuned circuits, their alignment, and the selectivity of these circuits. Cross talk occurs in the first tube circuit and is not confined to screen-grid receivers.

Any receiver which is connected to the antenna through an untuned or aperiodic circuit, such as a resistance or choke, may be subject to cross talk if it is in the vicinity of powerful stations. The strange fact is not that the receiver is bothered by local stations when its antenna is floating in the midst of an extremely heterogenous field of signals of all frequencies, powers, and band widths, but that the receiver gets any one signal at all.

Cross talk may take place when there is some non-linearity in grid or plate circuits of the first tube, or it may take place even though the characteristics are essentially linear.

Suppose two voltages of equal amplitude at 600 and 700 kc. are impressed on the antenna and thence to an untuned input of a receiver. These signals may beat and produce a sum frequency of 1300 kc. If the following tuned circuits are tuned to 1300 kc. a signal may be heard in the loud speaker composed of the modulations of both the component station frequencies. It will be a *potpourri*, and undecipherable.

Suppose the receiver is tuned to a rather weak 700-kc. signal and that a strong 600-kc. voltage is impressed on the grid of the first tube. If this signal is great enough to cause the grid to draw current, or to cause any non-linear part of a characteristic to be traversed, demodulation will take place and the resultant audio voltages which will be present in the circuit may modulate the carrier of the desired station. Thus it may be possible to hear the studio program of a local station "riding in" on the carrier of a distant station. This carrier may or may not be completely modulated by the local station's signals.

If the volume control reduces the plate voltage of the r.f. tubes, or increases the grid bias of these tubes, a peculiar form of cross talk may result. If the volume is reduced sufficiently, the r.f. tubes become peak voltmeters and the peaks of strong local signals will "blurb" through the receiver and make intermittent loud speaker squawks and gasps that sound like regurgitations of undesired noise.

All of these evidences of cross talk can occur in screen-grid sets. In fact, they may appear often unless precautions are taken to prevent them. The amplitude of signal that can be applied to the grid of a screen-grid tube is distinctly limited by the curvature of the characteristics and the flow of grid current. A strong local signal may overload the first tube and cause cross talk. If the volume control is on the control or screen grid and must be reduced too far to cut down a local signal to reasonable volume, cross talk may result.

The solution is to use a selective input circuit to the receiver. In some cases this may involve the use of band-pass circuits between antenna and receiver so that desired signals are admitted and passed while undesired voltages are attenuated. It seems almost certain that the volume control of the future will not only reduce the sensitivity of a receiver but at the same time must reduce the coupling of the receiver to its antenna, or increase the selectivity of the input circuit.

The Berne Radio List

We learn from *Wireless World* (June 12, 1929) that the first part of the so-called Berne list of radio stations is ready. This section (there will be five in all) contains a list of the commercial and official fixed and land stations of the world, both long and short waves. The first section costs 7.5 francs (Swiss) and may be obtained from the International Bureau of the Telegraph Union, Berne, Switzerland. The sum in United States currency is about $1.45.

Other sections of the list will be ready soon. They will list broadcasting stations, ship stations, special-purpose stations such as meteorological, air stations, etc.

Municipal Radio Laws

Tobe Deutschmann, Inc. is distributing a pamphlet prepared by Paul M. Segal and Paul D. P. Spearman of the Legal Division of the Federal Radio Commission. It deals with "State and Municipal Regulation of Radio Communication," and is dated May, 1929. The laws relating to prescribing local licenses, limiting the operation of reception apparatus (radiating receivers), restricting hours of operation, etc. are considered in the pamphlet, as well as those relating to "man-made static."

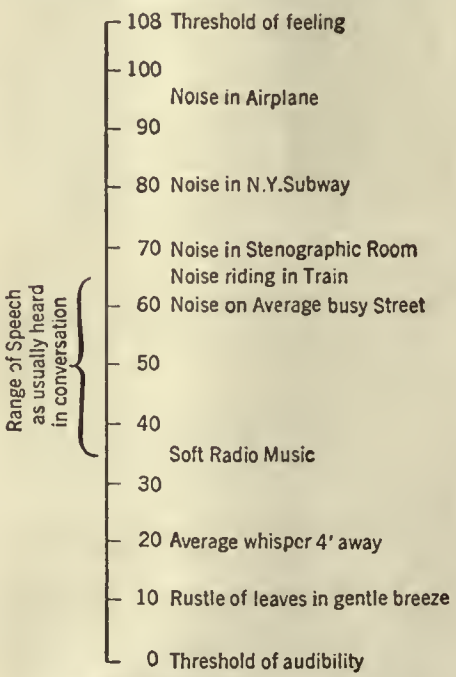


Fig. 1 — How sound intensities compare.

Comparison of Noise Intensities

The figures in Fig. 1 are taken from "Transmission of Sound through Wall and Floor Structures," by V. L. Chrisler and W. F. Snyder, *Bureau of Standards Journal of Research*, March, 1929. The units are logarithmic units like the DB. Thus, if the "threshold of feeling," where a sound becomes so intense it affects the nervous system as a pressure like that of a weight instead of a sound, is 108 units, the noise in an airplane is about 10-15 units below this figure. Note the high level of noise in a stenographic office.

Grid Leak Condenser Detection

Several articles on detection, written by Professor Terman of Stanford University have been published in RADIO BROADCAST. Mr. Terman recommends grid leak and condenser detection for its greater sensitivity, better frequency characteristic, and greater linearity when operated at high input voltages. Some criticism of this type of detector been has made and it has not been used generally because of the "loading" effect on the previous circuit. Some experimenters feel that the loss in gain in the previous circuit makes up for any gain in the sensitivity of the detector. Other workers in this interesting field claim that the grid leak and condenser detector contributes too much distortion in the form of harmonics.

In a recent letter Mr. Terman cites the following data of a graduate student at his university who has measured the output of a detector with a harmonic analyzer. "With a 227-type tube, 33 per cent. modulation, 90 volts on the plate, the voltage across a 10,000-ohm load may be as high as 5 volts with only 5 per cent. second harmonic. This indicates that with 100 per cent. modulation and a high-quality 3–1 transformer, over 30 volts could be applied to the following power tube without excessive harmonic distortion."

After all the argument in favor of bias detection and against grid leak and condenser detection, it would be rather amusing if a majority of receivers were to go back to the older form of demodulation a year or so from now. If, as it seems is true, a grid leak and condenser detector has a high input which is linear, while the bias detector is linear over only a very small range and very near the overloading point, the former may be demanded by the search for better fidelity.

An article from the laboratory of E. T. Cunningham, Inc., giving quantitative comparisons of the two general types of detection, is scheduled to appear in October RADIO BROADCAST.





In the Window

A new merchandising idea by MARVIN

JOBBERS are reducing stock investment, simplifying inventory and increasing turnover and profits by limiting their tube lines to one or two nationally known brands. If this is good business for the distributor it is an equally sound policy for the dealer.

With this new cabinet idea MARVIN makes it possible for every dealer to have a complete compact tube department that will give absolute stock control and show greater profits.

Sturdily built of steel and lithographed in full colors this cabinet displays and holds the number of tubes the average dealer should carry in stock.

Ask your MARVIN distributor how you can get this cabinet without cost, or write us.

MARVIN RADIO TUBE CORPORATION
IRVINGTON, NEW JERSEY
Sales Offices: 225 Broadway, New York City



Straight on the Counter



On the End of the Counter



Against the Wall





Selling MARVIN MASTER-BUILT RADIO TUBES *for you*

AN outstanding nation-wide radio broadcasting program will serve as a weekly reminder to almost every radio owner that MARVIN Master-Built radio tubes *serve better* and *live longer.*

Between these programs MARVIN newspaper advertisements, such as illustrated on the left, will consistently remind the radio public of MARVIN Master-Built quality.

Through eye and ear these millions of MARVIN messages are building sales for you



The MARVIN MUSICIANS *every Saturday night at 8:30 P.M over station* WJZ *and associated* N·B·C· *stations*

MARVIN colorful literature and display material tells and retells the story of the Master-Built tubes that *serve better* and *live longer*.

This advertising material effectively supplements MARVIN broadcasting programs and newspaper publicity and identifies MARVIN dealers everywhere.

There is an old saying that "goods well displayed are half sold." The MARVIN merchandising and stock cabinet, window lithography, window stickers and transparencies insure MARVIN dealers of maximum display value for the line.

Your MARVIN distributor will gladly furnish you with the advertising material illustrated on this page and explain the MARVIN Resale Help Plan in greater detail.





The MARVIN MUSICIANS

IN their regular Saturday Night Concert Hour the MARVIN MUSICIANS are striving to please the great radio tube-using public.

MARVIN engineers are also trying to please this same audience by making radio tubes that *serve better* and *live longer*. The Master-Builder illustrated below symbolizes the many famous radio tube engineers who are responsible for MARVIN quality. These scientists have made contribution after contribution to the advancement of the radio art and their latest achievements are the new MARVIN MY-227 and MARVIN MY-224 tubes.







Strictly a product of MARVIN'S own laboratories this Master-Built MY-227 tube creates a new world's record for quick starting time by heating up in *five seconds flat.*

Dealers everywhere are finding this tube invaluable for demonstration purposes and easier and more profitable to sell. Complete information upon request.

The instant approval of MARVIN MY-224 by dealers the country over is another testimonial to the Master-Builders.

This tube, on account of its ingenious construction, will not "short" even if dropped. Outer and inner shield-grids are doubly supported to prevent displacement or breakage and it maintains uniform electrical characteristics. Complete information upon request.

Marvin Radio Tube Corporation
Irvington, New Jersey

General Sales Offices:
225 Broadway, Transportation Bldg.
New York City

COPPER-OXIDE RECTIFIER VOLTMETERS

By R. J. KRYTER

Radio Engineer, Prest-O-Lite Storage Battery Corporation

WHEN performing experimental work in the field of radio, the ability to make quantitative measurements is of utmost importance. It is quite essential that one have instruments which will tell him just what is going on in the circuits he is studying. The average experimental laboratory is equipped with d.c. instruments for measuring the voltages and currents involved in vacuum-tube networks. On the other hand, the measurement of the alternating voltages and currents in these circuits is not always as readily accomplished as the necessary instruments are too sluggish in their movement, or require too much power for their operation. Thermocouple instruments have the first two disadvantages, moving-iron instruments have the last two, and dynamometer instruments have the first and last drawbacks.

A.C. meters in general are more sluggish than d.c. meters and require a great deal more power to energize them. This last drawback is a very serious one in radio measurements, for it often works out that more power is required to swing the meter's needle than is available in the circuit being studied. We are accustomed to d.c. voltmeters requiring only 1 milliampere to produce a full-scale deflection (sensitivity of 1000 ohms per volt) and know that a voltmeter consuming 10 milliamperes has a limited usefulness in radio measurements. On the other hand, a.c. voltmeters of the moving-iron and dynamometer types generally require from 15 to 100 mA. in the higher ranges and from 100 to 500 mA. in the lower ranges. The power consumption is usually several watts! Even the expensive and fragile thermocouple instruments require 10 mA. to produce a full-scale deflection.

Principle of Operation

When a d.c. instrument is placed in an a.c. circuit where the polarity is constantly reversing it merely reads the algebraic average of the reversals, which is zero. The customary method of measuring alternating currents is to design the meter so that its deflection is independent of the direction of the current flowing through it. The types of mechanism which will fulfill this requirement are limited, and are responsible for the shortcomings of a.c. instruments.

A second method of measuring alternating currents is to use a direct-current mechanism and to rectify the a.c. passing through the meter. This method is discussed in the present article and a simple and inexpensive arrangement is presented whereby the experimenter can use his d.c. instruments for a.c. measurements without materially impairing their sensitivity or their quickness of response.



A-C = A.C. INPUT TO RECTIFIER; B-D = D.C. OUTPUT OF RECTIFIER

Fig. 1

The method of measuring alternating currents by rectifying them and then passing the undirectional product through d.c. meters is old, but in the past has been complicated and inefficient. For this method to be a practical success, we must have a rectifier which is compact, self-contained, and highly efficient. Such a device is found in the modern dry-disc electronic rectifiers, such as the Westinghouse "Rectox" unit,

As every engineer knows, a.c. meters are both expensive and not universally useful. In this article is described a method of constructing a rectifier-voltmeter that will measure both alternating currents and voltages without many of the disadvantages experienced when meters of conventional type are employed.

THE EDITOR

and it is around this rectifier that the following method of measurement has been arranged.

The method makes necessary connecting in series with the a.c. circuit where current is to be measured, the a.c. input terminals of a full-wave rectifier consisting of four Rectox discs, and connecting the d.c. output terminals of this rectifier to a suitable milliammeter, as in Fig. 1. If voltage is to be measured instead of current, the milliammeter used is of the lowest available range and a multiplier is placed in series with a.c. terminals of the rectifier. The device is then connected across the points where potential is to be measured.

The characteristics of the a.c.-operated rectifier-meter will depend upon those of the d.c. instrument which forms the actual measuring unit. In general, the sensitivity will be approximately the same, the "dead-beat" qualities will be unchanged, and when used as a milliammeter the scale range will be quite similar to that of the d.c. instrument used. The writer uses Weston Model 301 instruments for this purpose, because they are sensitive, yet very rugged and are nearly perfectly "dead-beat." Similar instruments, such as those made by Jewell, Westinghouse, etc., will be suitable.

Due to the geometrical properties of a sine wave, the d.c. output of a theoretically perfect rectifier working into a resistive load is 0.901 times the effective value of the a.c. being rectified. This being the case, if our rectifier were perfect, the d.c. meter would read 90 per cent. of the true a.c. flowing in the external circuit. Although no rectifier is perfect, a dry-disc rectifier when properly used in this service so nearly approaches the above ideal that its divergence is hardly greater than the errors in the d.c. meter itself and can often be neglected. Therefore, when once the proper adjustment is obtained, it is only necessary to multiply the reading of the d.c. meter by $\frac{1}{0.901} = 1.11$. Due to the fact that this constant proportionality exists between the reading of the d.c. meter and the a.c. input, the scale of the resultant meter is practically uniform, rather than being of the inconvenient "square-law" type found in other a.c. meters.

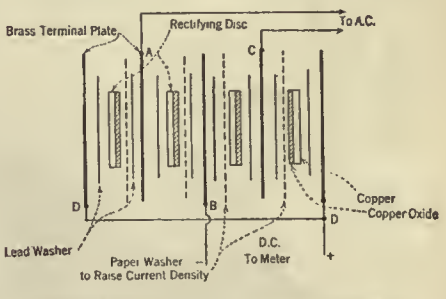
Accuracy

The instruments built by the writer are accurate up to about four-thousand cycles, but fall off gradually beyond this point, due to their inherent capacity. No attempt was made to prevent this effect in the writer's instruments and doubtless a material improvement in high-frequency characteristics could be made by proper design. In any case the rectifier will have enough capacity to render it useless at radio frequencies, in which field the vacuum-tube voltmeter has no rival.

At this point the reader may ask, "But will not the insertion of a rectifier in any a.c. circuit alter materially the wave form and other conditions in that circuit, and therefore render the measurement of doubtful value?" The answer is "No," and a careful inpsection of the circuits will make the reason clear. Note that the rectifier feeds directly into the d.c. meter which absorbs the entire output. Since the meter used is a milliammeter without any multiplier, its impedance is low and consists almost entirely of resistance. The rectifier may be considered merely as a synchronous switch which reverses the current to the milliammeter in step with the reversals in the line. Therefore, the rectifier-meter as seen from its input terminals is merely a small resistance and this will cause no appreciable alteration in any circuit in which it may be placed. The effect of leakage in the rectifier is negligible when the instrument is arranged properly and the distributed capacity of the rectifier becomes apparent only at the high audio frequencies. When used as a voltmeter the rectifier is in series with a resistance multiplier, and the effect upon the circuit under test is merely that of shunting the circuit with a high resistance. It is interesting to note that the rectifier-meter has a smaller phase angle than commercial meters of the dynamometer or iron-vane type.

Construction

The following directions apply to Westinghouse "Rectox" units of 0.6-amp. capacity such as are used in various trickle chargers. These directions also apply to other makes of rectifiers if proper modifications are made to compensate differences in construction and operation.



A-C = A.C. INPUT TO RECTIFIER; B-D = D.C. OUTPUT OF RECTIFIER

Fig. 2

Before constructing the special rectifying unit, the experimenter must decide the approximate current ranges he wishes to cover, so that he may adjust his rectifier accordingly. One of the peculiarities of the copper-oxide valve is that its degree of rectification and its energy efficiency depend upon the current density. At low current densities the copper-oxide couple ceases to rectify; the completeness of rectification and energy efficiency increase with increasing current density until the density becomes high enough to cause local heating; at this latter point the degree of rectification and the efficiency rapidly fall off. The exact current density desirable for any particular service depends upon the arrangement of discs used, upon the voltage across each disc, and upon the cooling provided. For use with meters the minimum density is about 30 mA. per square inch, the normal density is about 100–1500 mA. per square inch, and the maximum density about 2000 mA. per square inch, although this last quantity is determined entirely by the radiating surface provided.

The method of adjusting the current density is to cover the copper-oxide surface with a paper disc, cutting out a sector thereof to expose the area desired. The working area of the original disc is about 1.1 square inches, and this disc is suited for rectifying currents of 100–300 milliamperes.

The area of the disc is arrived at as follows: Although the disc is $1\frac{1}{2}$" in diameter, the oxide film is usually chipped or worn down for a distance of approximately $\frac{1}{16}$" in from the edge, leaving the outside diameter of the useful surface about $1\frac{3}{8}$". Now the area of a circle is $0.785\ d^2$, which, in this case, is $0.785\ (1.375)^2$ or about 1.48 square inches. The disc, however, contains a hole in the center whose area must be subtracted to get the actual area of the ring-shaped piece. This hole is $\frac{1}{2}$" in diameter, but again the film is imperfect for about $\frac{1}{16}$" from the edge, so that we must consider the hole as being $\frac{5}{8}$" in diameter as far as the oxide film is concerned. The area of a $\frac{5}{8}$" circle is $0.785\ (0.625)^2$ or about 0.31 square inch. Therefore, the maximum working area of the disc is 1.48 sq. in. — 0.31 sq. in. = 1.17 square inches. It will be noticed that the lead washers are made $1\frac{3}{8}$" in diameter and with a $\frac{5}{8}$" hole to allow for the above imperfections of the oxide film so that the washer itself has an area equal to that calculated above, thus definitely limiting the working area to this figure as a maximum.

Close inspection of the rectifying disc or the washer will reveal the fact that the washer seldom makes contact perfectly over its entire surface, there being small non-contacting areas due to imperfections in the oxide surface. This fact was allowed for in taking the working area as 1.1 square inches rather than 1.17 as calculated. Now suppose we wish to supply a 10 mA. d.c. meter, how will we restrict the working area? Since the normal current for the disc is 100 to 300 mA., and we wish to rectify only 10 mA., cooling by radiation will be excellent and we can use a moderately high-current density, say about 200 mA. per square inch. The area required will therefore be $\frac{10}{200} = 0.05$ square inch of rectifying surface.

Since the total working area of the disc is about 1.1 square inches, we need expose only $\frac{0.05}{1.1} = 0.045$ of this surface for the rectifying action, allowing the remainder to be covered by an insulating disc of paper. The simplest way of removing part of the paper disc is to cut out a sector or wedge, just as a slice is cut out of a pie. A complete circle includes 360° of angle, and, since we wish to expose only 0.045 of the circle, our sector will include $360° \times 0.045 = 16°$; that is, we will cut out a wedge-shaped slice having a 16° angle at the point. Now it is not at all necessary for this angle to be accurate, hence the following approximate method of laying it out can be used. On the paper disc lay out two lines at right angles, each line passing through the center. This will divide the circle into quarters and each quarter will include $360° \times \frac{1}{4} = 90°$. Now divide the circumference of one of these quarters into five equal parts and draw lines from two of the adjacent dividing marks to the center (See Fig. 5). This forms a sector with an angle of $90° \times \frac{1}{5} = 18°$, which is close enough to the 16° calculated above.

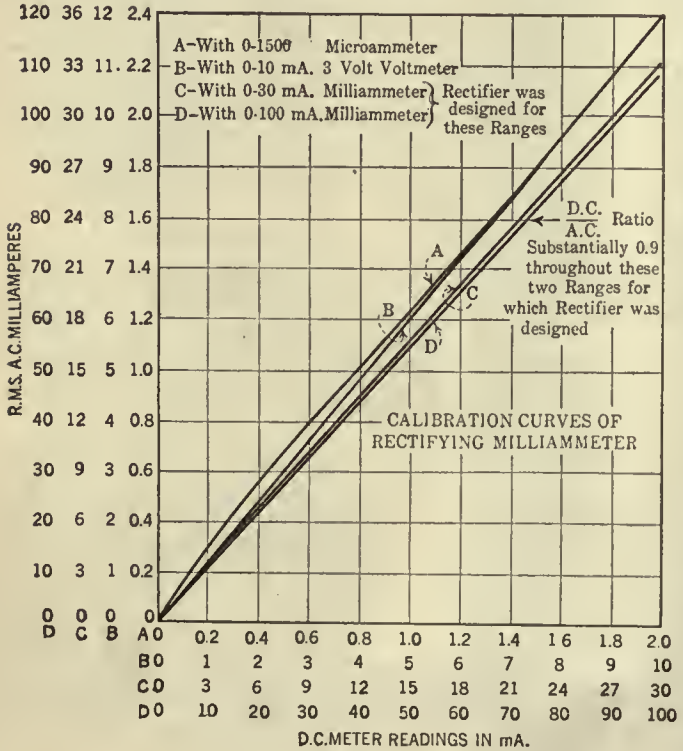


Fig. 3

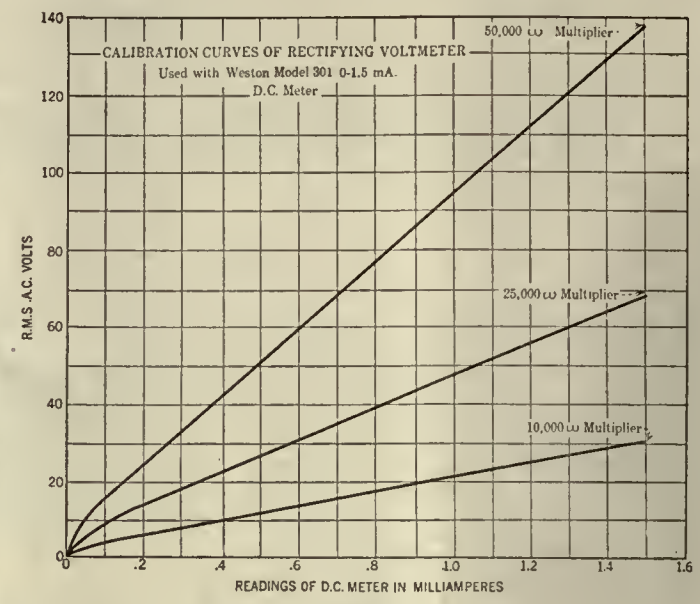


Fig. 4

Range of Operation

By the simple method described above, the working area of rectifying discs has been restricted so as to make the device most efficient for currents around 10 mA. Over what range may we expect satisfactory operation of this device? In general, it is not desirable to go below 50 mA. per square inch nor above 1000 mA. per square inch for efficient operation. Furthermore, this upper limit is allowable only when the total current through the stack is reasonably low, permitting good radiation of heat from the active surface. Applying these limits to the above design, we obtain current capacities as follows:

Minimum = $0.05 \times 50 = 2.5$ mA.
Maximum = $0.05 \times 1000 = 50$ mA.

Thus this instrument should operate satisfactorily over a current range of 2.5 mA. to 50 mA., a range of 20 to 1,

In general, this 20 to 1 ratio should not be exceeded; if it is desired to equip meters covering a greater range than this, several rectifying units of different working areas should be provided. However, if less accurate results were desired, the above meter could be worked over the maximum current density range described in a preceding paragraph, namely 30–2000 mA. per square inch, giving it a current capacity of 1.5 to 100 mA. Over such wide limits the constancy of calibration will be impaired and the deviation from straight-line calibration will be more marked. This is brought out in Fig. 3, showing the calibration curves of a single rectifier unit with four different milliammeters. The unit was designed for the 30–100 mA. range and it will be noticed that the curves for these two ranges are not only straight lines but practically coincide. The 10-mA. meter still gives a straight line, but with a different slope, while the 1.5-mA. meter gives a pronounced curve.

Assuming that the experimenter has decided upon the current range he wishes to cover and has calculated his working area accordingly, he is now ready to construct his special rectifier unit.

Adjusting the Rectifier

First disassemble the unit by unscrewing the two heavy clamping nuts with their lock washers and removing the central clamping bolts. It will be noted that the original rectifier unit consists of 16 rectifying discs arranged in two stacks of 8 each. Each stack is a complete four-cell full-wave bridge with 2 discs in each leg of the bridge, and the two stacks are connected in parallel by means of thin copper straps which also act as heat-radiating fins. Discard these connecting straps, and, using just one stack of discs, remove one of the two discs from each leg of the bridge leaving a full-wave rectifier composed of only 4 discs. Cover the copper-oxide surfaces

with paper washers appropriate to the output desired, face each rectifier disc on both sides with lead washers, and insert the brass terminal plates between the discs. (See Fig. 2.) Cut off the central insulating sleeve to the proper length and cut the bakelite end-plates to circular form. See that the discs with their washers and terminal plates are arranged as in Fig. 2, the rectifying discs being arranged in two pairs with their oxidized surfaces in each pair facing the center. Then reassemble the stack, clamping it as tightly as possible by means of the central bolt and nut. The unit is now ready for trial.

Connect the central terminal to the negative post of a milliammeter and the two outside terminals of the positive post. The intermediate terminals form the a.c. leads. (See Fig. 2.) In case the unit is connected to a milliammeter of low range, say 5 or 10 mA. full scale, try the following experiment: Place the a.c. input of the rectifier unit in series with one of the leads running from the output-coupling device of your radio receiver to your loud speaker. Turn on your set and you will find that the d.c. meter will give a visual indication of the actual signal current flowing through the loud-speaker windings, the needle following the rhythm of the speech or music being received. Watch for the surges of current caused by drums or bass chords on the piano; also note the wide range of energy in speaking voice.

Calibration

Next comes the item of adjustment and calibration. If the experimeter merely wishes to use his instrument to determine relative values, no calibration will be necessary. If it is desired, however, to have the instrument read in terms of actual milliamperes or volts, it must be checked against some kind of known standard. The simplest thing, of course, is to compare the rectifier-meter with a standard indicating a.c. meter if such an instrument is available. By making such a comparison the rectifier-meter can be adjusted for most efficient operation. The reading of the d.c. meter should theoretically be 0.90 times the reading of the a.c. meter and in

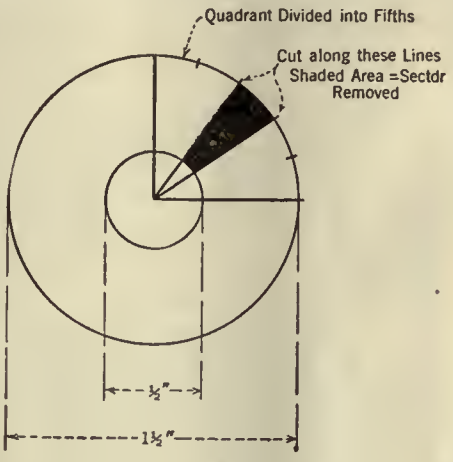


Fig. 5

no case need it fall below 0.83 times the a.c. value. If the d.c. meter reads lower than this, it is an indication that the current density is not right, that the stack has not been clamped tightly enough, or else the stack has been improperly assembled. A typical unit gave d.c.-a.c. ratios between 0.83 and 0.90 all the way from 1 mA. to 100 mA., even though it was used with 4 different d.c. instruments. This fact makes it possible to omit calibration if only approximately quantitative results are needed. After a little experience in constructing these devices, the experimenter should have no trouble in obtaining d.c.-a.c. ratios of 0.85 to 0.90 on the first trial, and, can assume, therefore, that the a.c. indicated by his instrument will be between 1.1 and 1.2 times the reading of his d.c. meter.

If it is desired to calibrate the instrument and no a.c. milliammeter is available but an a.c. voltmeter is at hand, the meter may be calibrated from a known voltage and a known resistance. If the experimenter desires only a rough check on his work and has no a.c. meter of any kind available, the 60-cycle house-current may be assumed as being 115 volts and the meter checked through known resistors. For example, a 10,000-ohm resistor will pass 11.5 mA. from a 115-volt line.

The range of a milliammeter can be extended by shunting, although this should be avoided if possible. The shunt should be placed across the a.c. input terminals to the rectifier. In the case of a voltmeter, the range of the instrument can be adjusted very conveniently by changing the value of the resistance-multiplier which is placed in series with the a.c. input. It is convenient to adjust the multiplier so that the volts applied will be some multiple of the reading of the d.c. milliammeter. Thus, if a 0—1.5-mA meter is used, the multiplier can be arranged so that full-scale deflection on the meter will be obtained with 15 volts or 150 volts applied.

Fig. 3 shows typical calibration curves of a rectifying milliammeter, the rectifier being used in conjunction with four different d.c. meters. Fig. 4 shows the calibration curves of a rectifying voltmeter. In this case multipliers of known fixed values were used, without making any attempt to produce an integral ratio between the voltage applied and the current read on the meter.

THE DEALER AND THE FINANCE COMPANY

(*continued from page 257*)

carry your own. The reason for this is that it gives you a third-party alibi in making prompt collections. You can honestly tell a customer that the finance company demands the money, and that if he (the customer) does not pay same, you will have to. It is often desirable or good business to use this leverage in making collections. I think any dealer's motto should be, "Get the money, keeping the customer in good humor whenever it is humanly possible to do so; but if you have to do it, get him mad enough to pay." We must not forget that statistics show that the number of businesses going into bankruptcy because of poor credits (or poor collections—the meaning is the same) is more than four times that of businesses which fail because of lack of capital. I am sure that bad debts or poor judgment in extending credit is the greatest cause of failure. Watch your overhead expense; don't buy carelessly; don't let employees' dishonesty or carelessness rob you of legitimate profits; but above all, *watch your collections*—get the money promptly when due.

So far we have been looking at this dealer-finance company relation from the standpoint of what the dealer should do. Now let's look at the other side. What about the man who buys your paper? What should he do to hold up his end of things?

First of all, of course, he should pay you promptly for all contracts as fast as he gets them from you. I know of companies who hold their dealers' checks up from two weeks to a month while they are "investigating." There is no reason for this. If you are dealing with an outfit who does this ask them to correct it, and if they fail to do so get another outlet for your paper.

Demand that you be notified promptly of a past due account. If the finance company expects you to be on the job helping them get their money, they certainly should notify you of delinquencies promptly. A radio dealer has to know a lot of things, but no one should expect him to include mind-reading.

Regarding Rebates

A contract may often be paid out before maturity, and if so the finance company should rebate a portion of the total handling charge originally figured in the contract. This will not be exactly on a pro-rata basis because a certain amount of work must be done in "setting up" the contract on the finance company's books, regardless of how long the paper runs. But an unexpected two or three dollars promptly refunded to a customer when he pays out ahead of time will make him feel mighty good toward you.

As mentioned before, very few finance companies can afford to send a collector after small individual amounts from purchasers; but nearly all of them have what is called a "road-man," or "contact-man." As the name implies, this man calls on all dealers who deal with his company. Here is your chance to get some valuable information. Talk over general business conditions with him. Find out what other dealers are doing—probably he can tell you exactly how some successful radio merchant has solved a problem which may be bothering you; or he can tell you of an out-of-the-ordinary window display he has noticed; and dozens of other valuable pointers. These suggestions apply also to your talking to jobber's salesmen who call on you, but the finance company's man will probably be more fruitful of good ideas, and what he tells you will not be colored by a desire to sell you something.

In closing let me say that during this year many millions of dollars worth of radio merchandise is going to be retailed on the monthly installment plan; and I hope that each of you will be successful in getting your share.

SCREEN-GRID SHRINKAGE SHRINKS

PRIVATE LAMENT among tube manufacturers regarding the abnormally high shrinkage in tubes of the 224 type continues, although it seems that shrinkage figures show a slight tendency to shrink themselves. We have heard of at least two manufacturers who can make such tubes with less than 45 per cent. shrinkage and of one manufacturer who has reduced the shrinkage to below 30 per cent.—which, we believe, is getting into the range at which profit begins. Such low shrinkage is a product of good mechanical design, independent research, and unceasing efforts to iron out small causes of trouble.

DESIGNING R.F. CIRCUITS FOR THE 224

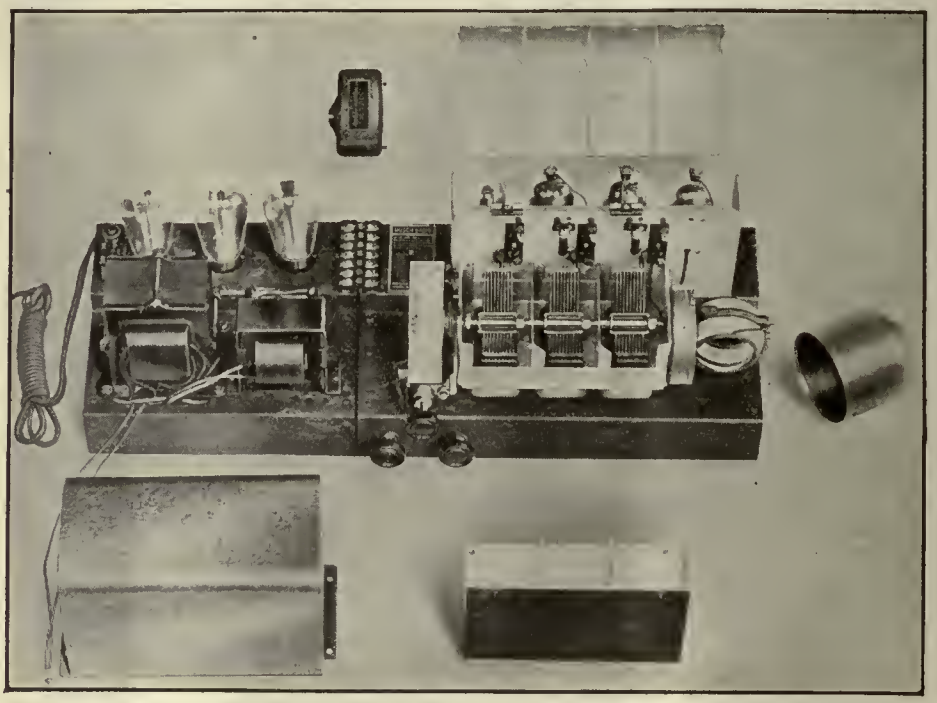
By BENEDICT V. K. FRENCH

Radio Engineering Division, American Bosch Magneto Corporation

THE NEW Bosch radio line represents an example of the commercial application of many new developments in the rapidly changing art of broadcast receiver design. Of outstanding interest are the use of the new screen-grid a.c. tubes as radio-frequency amplifiers, the linear high-voltage detector, and the single stage of push-pull audio power amplification. These features are incorporated in an all-steel design of exceptional mechanical strength which consists of two units, the radio chassis and the power pack, the two being assembled on a ribbed-steel base. The receiver is licensed under patents of the Radio Corporation of America and under patents and patent applications pending of the Radio Frequency Laboratories, Inc.

The schematic is given in Fig. 1. It discloses the use of three screen-grid a.c. tubes of the 24 type, interposed between four tuned circuits, a linear high-voltage detector of the 27 type, and, following this, a single stage of push-pull audio amplification using the new 45-type tubes. Rectified power supply is obtained from a single full-wave rectifier tube which also furnishes the exciting current for the electrodynamic loud speaker.

The electrical design of the receiver as a whole required the utilization of the high amplification of three screen-grid tubes (tetrodes) with a view to the selective properties of four tuned circuits and the input voltage requirements of a linear high-voltage detector whose output is made capable of working to full power the single push-pull stage of audio amplification.



This view of the Bosch screen-grid receiver shows the chassis with shield covers removed.

The R. F. Amplifier

Several considerations make it advisable to compensate the inequality of voltage gain over the broadcast band which is an inherent property of capacitance-tuned radio-frequency amplifier stages. In the types of antenna input circuits heretofore employed, the effectiveness of voltage transfer from the antenna to the first grid decreased rapidly with increasing wavelength. The circuit employed in this receiver represents a distinct departure in that a reverse effect is obtained. This comprises a unique type of capacity coupling for introducing the antenna voltage into a tuned antenna circuit. The constants of this type of circuit are proportioned so that antennas of any size can be accommodated and, in addition, changes in effective capacity of an individual antenna over the wavelength band have only slight effect on tuning.

The main element of this circuit is a variometer driven from the main gang condenser shaft through a gear ratio which is proportioned so that the stage tuning for the average antenna follows closely the frequency settings of the main tuning unit. The essential property of this tuning system is such that it serves to equalize the overall sensitivity of the radio-frequency amplifier and allows a design for uniform amplification over the entire waveband. The interstage transformers are of straightforward design comprising tightly coupled primary and secondary windings, the value of coupling being governed by a consideration of the sensitivity and selectivity requirement of the entire receiver. These are given in Figs. 2 and 3. For purposes of comparison, Curve A (Fig. 2) shows the sensitivity in terms of standards proposed some time ago by the I.R.E. This curve represents the field strength in microvolts per meter, in the vicinity of a four-meter antenna, necessary to produce a standard output level of 50 milliwatts. For measurement purposes, the antenna comprised a fixed capacitance of 200 mmfd. and a non-inductive resistor of 20 ohms. Practical considerations indicate the ad-

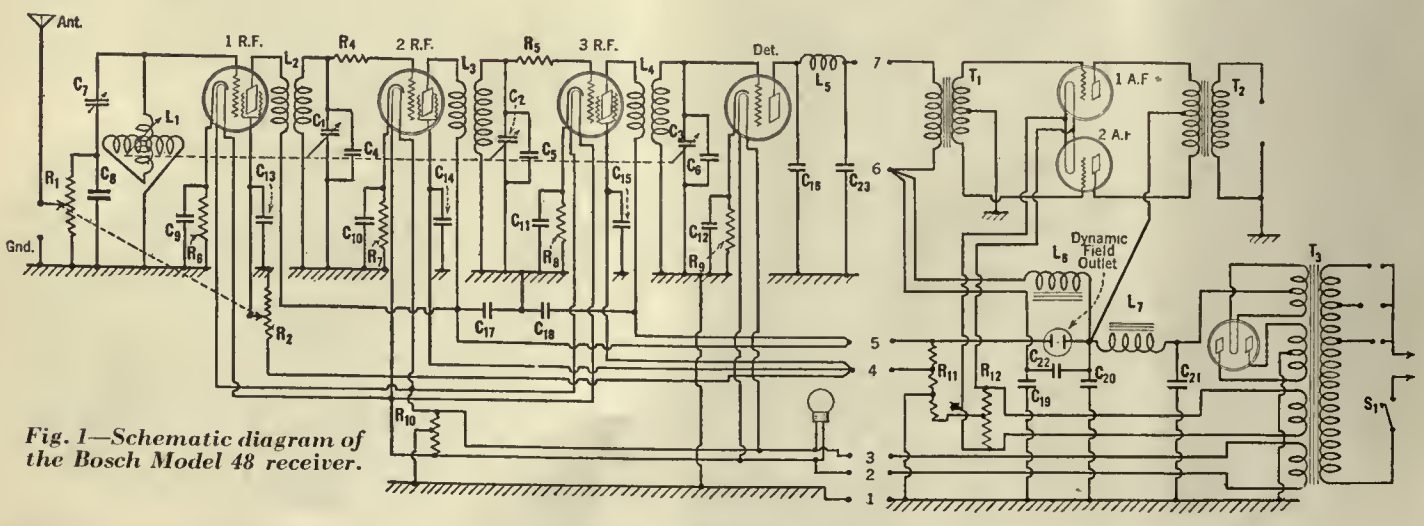


Fig. 1—Schematic diagram of the Bosch Model 48 receiver.

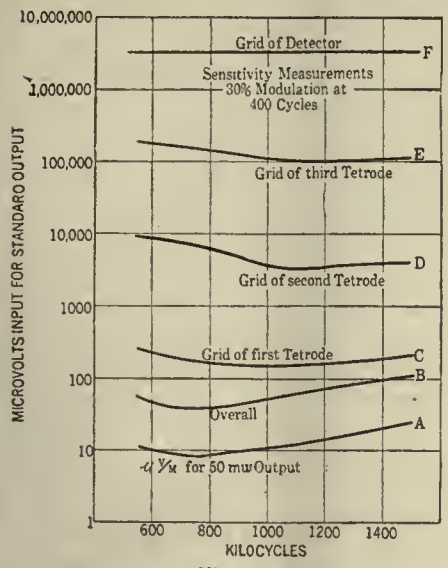


Fig. 2

visability of expressing the sensitivity in terms of actual microvolts input at an output volume level more in accord with actual reception conditions, and in curve B (Fig. 2), therefore, is given an analysis of the Model-48 in terms of microvolts input to the dummy antenna for an output volume level of 100 milliwatts. Curve C of Fig. 2 shows the microvolt level necessary on the grid of first tetrode to produce the same 100 milliwatts in the output. A comparison of curves C and B illustrate the point made above relative to the functioning of the antenna input circuit. It will be seen that the voltage gain obtained at the longer wavelengths is over twice that obtained at the lower wavelengths.

Curves D and E of Fig. 2 represent the microvolt level applied to the second and third grids, respectively, to obtain standard output, and curve F gives the number of microvolts necessary on the detector grid to produce standard output. All of these measurements were taken with the carrier modulated to 30 per cent. at 400 cycles.

Selectivity Characteristics

In curve A of Fig. 3 is given a selectivity curve of the Model-48 receiver taken at 600 kc., and for purposes of comparison curve B of Fig. 3 shows the selectivity curve of last season's Model-28. This latter model was considered a very selective receiver. It employed four tuned circuits in conjunction with 26-type tubes. The increase in selectivity, due to the use of tetrodes with the same number of tuned circuits, is apparent. The method of measurement and the ordinates chosen for the curves are such that small selectivity differences between receivers of the same class are clearly indicated. Possibly, this type of curve differs from the resonance curves usually shown to imply "knife-like" selectivity and "ten-kilocycle separation."

The problem of an adequate type of volume control for a high-gain tetrode receiver is a difficult one. Control of the screen or the grid-bias voltage, although effective in extinguishing the signal from the strong local station, introduces in its range of operation bad-quality distortion due to the non-linearity of the tetrode characteristic at high signal voltages. It is, therefore, necessary to reduce the applied voltage from the antenna simultaneously with the screen or grid-bias voltage.

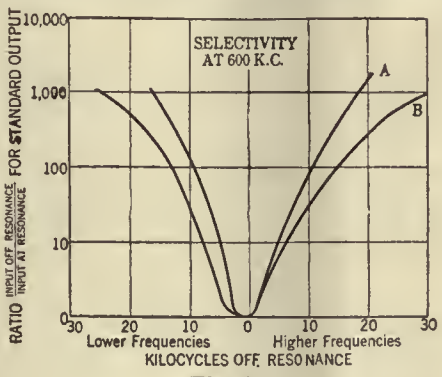


Fig. 3

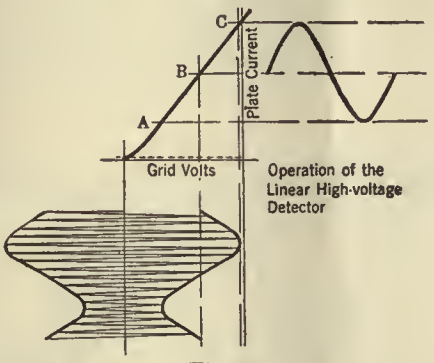


Fig. 4

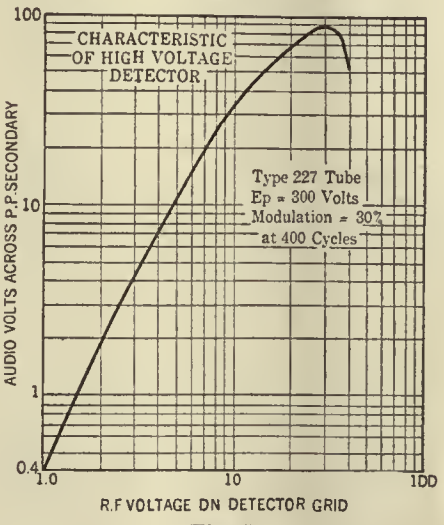


Fig. 5

Control of the antenna input voltage alone is inadvisable inasmuch as the receiver is allowed to operate always at full gain with a consequent possibility of a poorer signal-to-noise ratio as the signal input is reduced.

The Linear Detector

Vacuum-tube detectors in general use for broadcast reception may be classified as follows: the rectifying-amplifier, in which rectification occurs in the grid circuit, and amplifying-rectifiers, in which rectification occurs in the plate circuit.

The first class is represented by the grid-condenser, grid-leak type, which is used primarily as a weak-signal detector. With the usual constants chosen for this type of detector, the maximum audio-frequency output is such that two stages of audio-frequency amplification are required to bring the signal to a satisfactory loud speaker level. Plate circuit rectifiers include the anode-bend detector and the linear high-voltage detector. The former, as its name implies, operates over that portion of its grid-voltage plate-current curve which gives an audio output proportional to the square of its modulated radio-frequency input. This type, as ordinarily operated, suffers from the same limitation of output that characterizes the grid-condenser grid-leak type.

The type of detector used in this receiver will be termed the linear high-signal-voltage detector rather than a "power" detector. The term "power detector" has been used indiscriminately to describe any type of plate detection. In the strict sense of the word, power detection refers to the use of a detector directly supplying the loud speaker load. The action of the linear high-voltage detector (see U. S. Patent No. 1,698,668) is best explained by reference to Fig. 4 which shows a modulated radio-frequency voltage of high amplitude impressed on the characteristic with the result that operation takes place along the straight-line portion, giving an audio-frequency output which is directly proportional to the modulated radio-frequency input. In Fig. 5 is shown

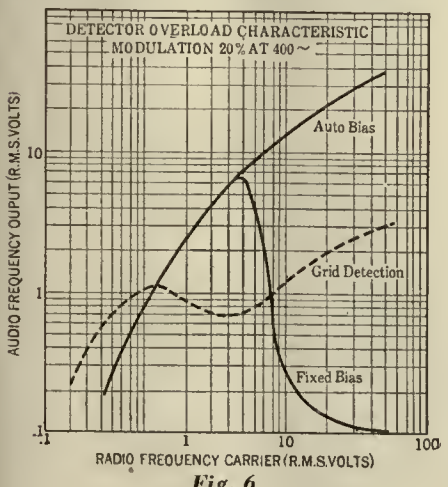


Fig. 6

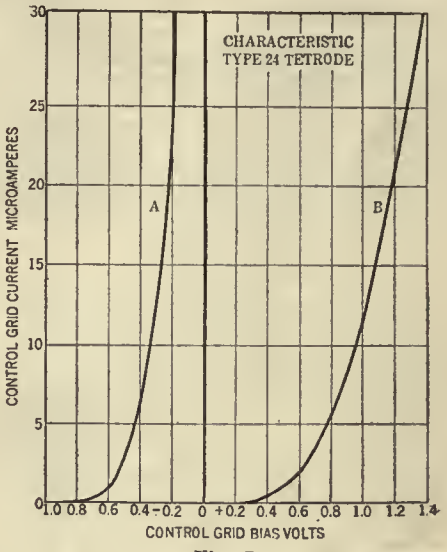


Fig. 7

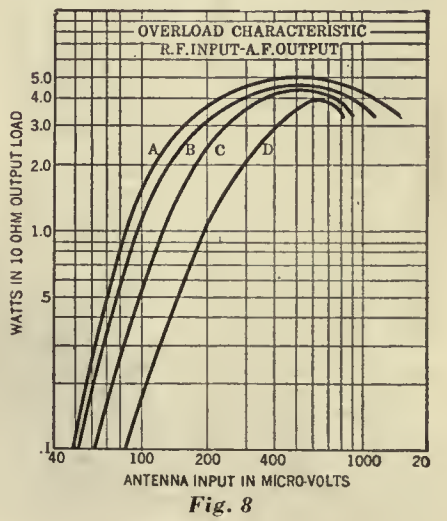


Fig. 8

the input-output characteristic of a typical case consisting of a 27-type tube with 300 volts applied between plate and ground, and a grid potential determined by the plate current flowing through an auto-biasing resistor of 15,000 ohms bypassed for audio frequencies by a 1-mfd. condenser. (Stuart Ballantine, "Detection at High Signal Voltages," *Proceedings* I.R.E., July, 1929, Contributions from Radio Frequency Laboratories, No. 11)

Automatic Grid Bias

The action of this auto bias, in extending the working range of the detector, is shown in Fig. 6. This figure also shows on the same scale of ordinates the output obtainable from a grid-condenser grid-leak detector operating at the same plate voltage. This curve is abstracted from an article by F. H. Drake, "An Aircraft Radio Receiver for use with Rigid Antenna" (Contributions from the Radio Frequency Laboratories, No. 8A, and *Proceedings* I.R.E., February, 1929.), and, although the data were taken on a different type of tube, it serves to show the relative performance of plate and grid detectors. The output obtainable is naturally a function of the modulation percentage, and the results in the instance shown were obtained with a thirty per cent. modulation. The curve illustrates the necessity of a high-gain radio-frequency amplifier since the proper operation of the detector is entirely dependent upon a high impressed voltage to the detector input. Mathematical analysis of detector action indicates that distortion incidental to square-law rectification increases rapidly with an increase in percentage of modulation. The linear type detector, however, is free from distortion up to very high percentages of modulation. This fact is of importance in consequence of the trend

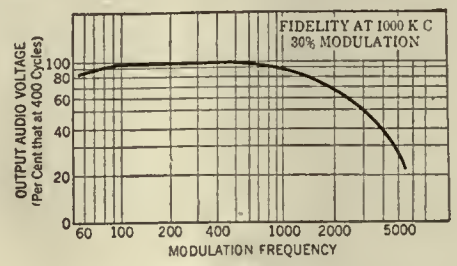


Fig. 9

toward higher percentage of modulation evident in modern broadcasting transmitters.

The design features of high-voltage detectors employing the 227- and 224-type tetrodes will be published shortly by P. O. Farnham. ("Contributions from the Radio Frequency Laboratories." No. 12)

Overall Characteristics

Sufficient output is obtained from the detector (Fig. 5) to operate the push-pull 45-type tubes to overload on stations of adequate field strength. Fig. 8 shows the relation between antenna input in microvolts and power output in watts. Curve A is taken for 40 per cent. modulation, curve B for 30 per cent. modulation, curve C for 20 per cent., and curve D for 10 per cent. It may be observed that an output of over three watts is obtainable before distortion enters as a limiting factor.

In development work on the receiver, it was discovered that with the operating constants recommended by tube manufacturers for the 24-type tetrode, the maximum power output was seriously limited at low percentages of modulation. An investigation disclosed the fact that voltage levels on the third radio amplifier grid were high enough to cause an appreciable flow of grid current, even though the measured peak r.f. voltage was less than the grid-bias voltage. A detailed study of the static characteristics brought out the important fact that in certain tubes of the 24 type, grid current existed for negative values of grid-bias voltage. Typical characteristics are given in Fig. 7. This effect seems a characteristic of the equipotential cathode tube. Curves A and B represent the extremes of a large group and it is, therefore, necessary to design for operation with tubes of type A. To guard against any possibility of grid current, the grid-bias potential has been increased in this receiver from the recommended value to $2\frac{1}{2}$ volts and the interstage transformers have been so proportioned that the decrease in stage amplification occasioned by the increase in plate resistance is compensated.

Fig. 9 gives the fidelity curve of the receiver. This is taken by introducing at the antenna post a 1000-kc. carrier of constant amplitude modulated to 30 per cent. The modulation frequency is changed through the audible range and the output noted.

THE LITTLE RED SCHOOL HOUSE COMES TO MARKET

(*Continued from page 265*)

effort, for example, the board members, after listening to the programs in their own homes, were quick to equip their schools as they realized that radio brings more in the way of education than can be purchased in any other way with the same amount of money. They discovered that for a fraction of a penny with the aid of radio a classroom can listen to men and women whom they could not bring to their school without an outlay of hundreds and sometimes thousands of dollars for the one session.

By far the larger share of sets, however, have been bought by organizations of parents, especially the Parent-Teacher Associations. Some sets have come from senior classes, athletic funds, dramatic societies, sales of a wide variety of articles, popular subscriptions, gifts from interested individuals and organizations such as Kiwanis, Rotary, Lions Clubs, Chambers of Commerce, lodges, and fraternities. Others have been donated by manufacturers, distributors, and dealers. Some have been provided by newspaper or magazine subscription campaigns, some by special festivals, pageants, plays, and even by Bunco parties. In many cases the funds have come from two, three, or even four sources. Everywhere the dealer has given special discounts and terms.

The fact that dealers are expected to give special discounts to schools may cause some to frown upon this "golden opportunity for radio." However, this is entirely the wrong attitude to take. Installing your radio in the school, even if you had to pay for the privilege, would probably prove to be an excellent investment when viewed from its advertising value. Also, it should be remembered that even though you grant a discount it does not mean that you will lose money, or that you will not make a little.

What Kind of Equipment

There is no particular type of radio equipment which is designed especially for schools, nor will there be as the requirements in different schools are so different. In the 150,000 one-room country schools any receiver which is satisfactory for home reception would be satisfactory. On the other hand, in larger schools a more elaborate installation or several smaller installations would be required in order to give adequate coverage of all the pupils.

In a majority of the schools to-day the installations are rather crude, and the arrangement of the apparatus is seldom conducive to the best possible results. In general it has been found that the best results are obtained with radio when the loud speaker is located in the classroom, and at present the tendency is to make installations of this type wherever possible. In the classroom with a small orderly group of pupils the teacher can aid the class by adding explanations, taking notes on the blackboard, following with a pointer on the map, etc., and her time is not taken up with discipline. Therefore, in a number of large schools several portable receivers are used in place of a large set in the auditorium. These sets are mounted in special cabinets on wheels which may be moved easily from one room to another as required.

Larger Installations

The most modern and practical type of equipment for the large school is a combination public- and group-address installation and the trend to install apparatus of this type is growing every day. In this connection the following letter indicates the results which are being obtained with such equipment.

Dear Uncle Ben:

The gift of the class of 1929 to the high school is in perfect working order. It is "The Magnaphone," the Schoolmaster of the Air, purchased as the class memorial gift. It cost $650 plus $25 per room for installation and loud speakers.

With it our principal, P. Q. Freeman, without leaving his office, can speak his message to one, all, or any group of rooms in the high school building. In addition he can transmit phonograph records to any or all rooms, or he can broadcast any radio program to any, all, or a few selected rooms at will.

Every student at the high school can now listen-in, without leaving his seat in the classroom, to the "School of the Air" programs that the principal believes he should hear.

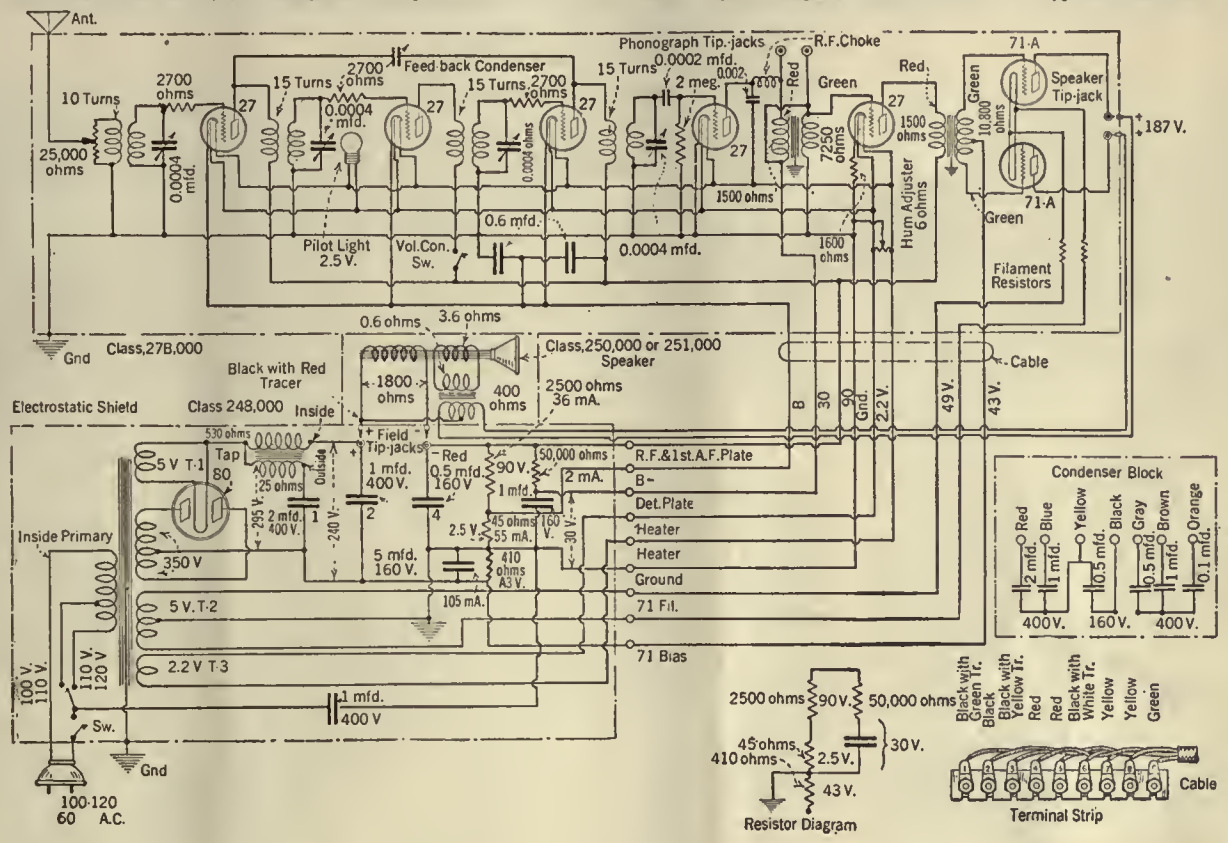
The Senior Class,
Bellefontaine High School,
Bellefontaine, Ohio.

The features of the combination public- and group-address installation are so clearly stated in the above letter that little need be said in addition. However, there is one great advantage which was not touched upon and that is the aid in preventing a panic in case of a fire. Instead of ringing a gong, which sets hundreds of little hearts palpitating with excitement, the principal can make his announcement to the rooms which he wishes to march out first, and in such a way they may be directed out of the building before they actually know there is a fire, thus avoiding any possibility of a panic.

No. 31 *Radio Broadcast's Set Data Sheets* September, 1929

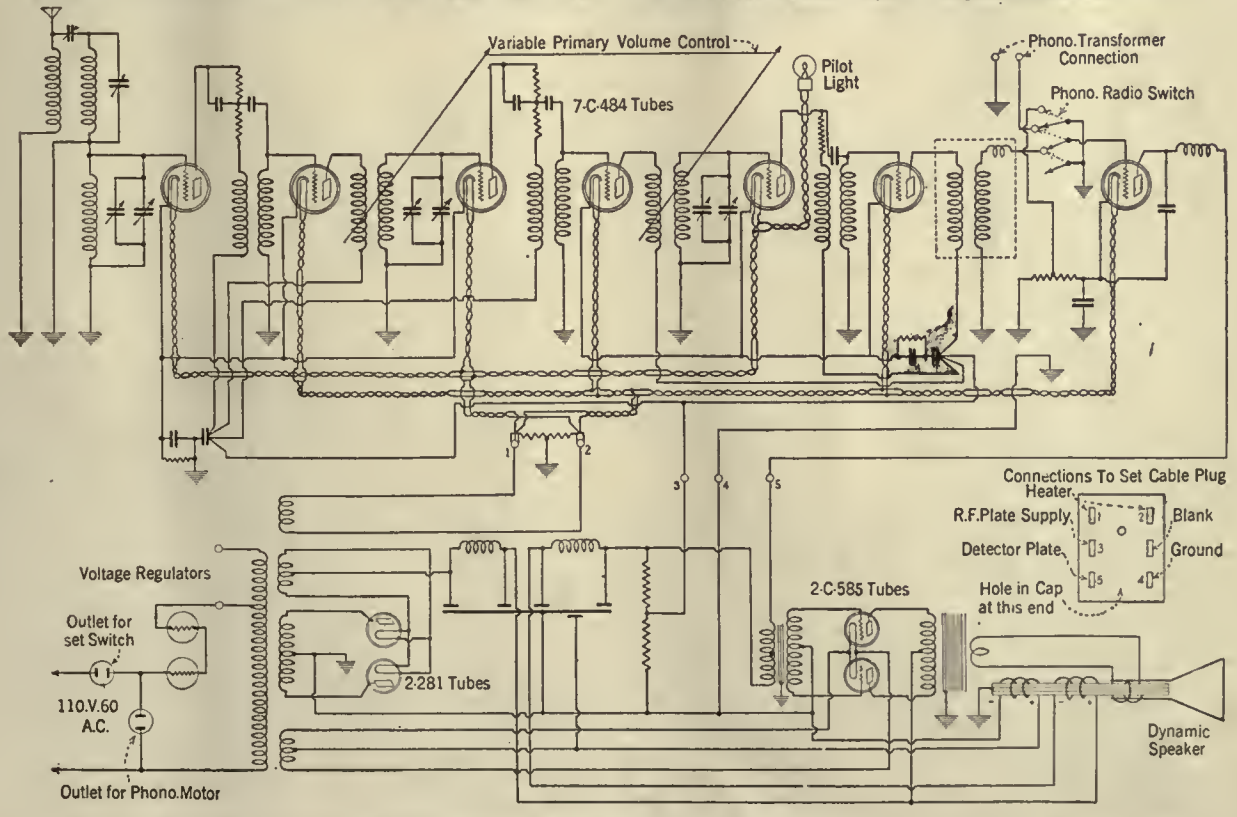
BRANDES MODELS B-15 AND B-16

This receiver is of the conventional tuned radio-frequency type with grid resistors to prevent oscillations. A grid leak and condenser detector is followed by a two-stage audio amplifier with two 171A-type tubes in push pull in the output. The volume control consists of a 25,000-ohm variable resistor connected across the antenna coil. Plate and grid voltages are obtained from a 280-type rectifier tube.



THE CONTINENTAL MODEL R-30

This receiver licensed under patents of the Technidyne Corporation contains several interesting features. The most important is the use of untuned r. f. stages between each tuned stage. Volume is controlled by adjusting the coupling between the primaries and secondaries of the tuned interstage transformers. Only one stage of audio-frequency amplification is used.



QUALITY CONTROL OF RADIO PRODUCTION

By DAVID SONKIN

Inspection Engineer, F. A. D. Andrea, Inc.

VERY LITTLE has been said of the modern methods of insuring a uniform and high-quality production in the manufacture of radio sets and auxiliary equipment. The application of inspection and test methods has long been used in high-speed production in the making of automobiles, electric motors, and the many other commodities manufactured and sold in large numbers. The application of the broad general principles used in these industries, when modified to suit the peculiarities of radio, produces interesting results.

Some years ago, when the manufacture of radio receivers began, the process was entirely along custom-built lines. Each receiver bore the earmarks and individuality of its builder. Often the same operator who milled the bakelite panels, drilled the holes, assembled the component parts into place (themselves elaborately built as separate entities) prepared each wire and soldered it into place, and even tested his finished product. Each completed set bore the builder's "fingerprints," his little personal idiosyncrasies.

It did not take very long for some of the more progressive manufacturers to realize that a more uniform product was necessary. How to obtain this uniformity and how to get it across to the manufacturing division was a problem. The producing department, free from a restraining influence and and partially uninitiated to the possibility that there could be any difference in performance of two units seemingly alike, had a natural antipathy towards anything that would tend to cut down the total figures of their day's production. The same parts were used in each set and the same wires were placed in the same places—how could there be any difference? The sets played, did they not? What could be wrong? The testers (originally drawn from the ranks of that interesting group, the "amateurs") passed them. (And did not amateurs have a reputation of being "tin-gods"?) Little was it realized that many times the tester had to revise the receiver and would introduce his very individual ideas in affecting the remedies. As we look back—how uncommercial they were!

The problem resolved itself into two distinct phases. First, how could we eliminate the disturbing factors which prevented a uniform product, and second, how could we combat that natural antagonism of one group of humans towards another criticizing group. At times, the latter was the more serious problem, for, in order to eliminate the disturbing influences, we had to find them—and to find them we had to utilize the very group that produced them. Research had to be conducted on a large scale, in a field not cognizant of what was desired and unskilled in the art of observation. Casual sampling, and the slow, deliberate investigation in the laboratory were unsuited to the speed of modern production. If something was wrong, it had to be discovered, a remedy evolved and applied immediately. With large quantities of material to handle, any delay in production or a continuance of a faulty operation would rapidly run into a serious loss in both time and money—and often resulted in the throwing of a large group of workers into enforced idleness.

The New System

Slowly, with studied care, an illustrative system of recording and noting the quality of one item after another was introduced. To begin with, those items which previous experience had indicated as most likely to give trouble were selected for the introduction of the system. Assignable causes, such as variations in the raw materials were soon discovered and better materials introduced. Better and improved methods of handling the product were insisted upon. It was very interesting at this time to notice a marked "toning-up" of the factory personnel—and appreciation of the value of the commodity handled was realized. Subconsciously, the operators ceased to handle the production of radio receivers roughly and began to take pride in their work and in passing along a good-looking product.

The control system indicated variations at times which could be traceable only to a deviation from the specified routine and sometimes to an influence assignable only to a characteristic of the mechanical means used in fabricating the product.

In the drawing of Fig. 1 we have plotted the ideal production—each and every unit is identical, 100 per cent. of the units are alike—a condition never attained. The more normal occurrence and variation can be represented by the curve of Fig. 2. Here the greatest percentage of units simulate the standard, and, as we proceed equal distances above and below the standard, we find a lesser and lesser number of units of the same characteristics, until at some distance from the standard no units exist. Even this curve represents an ideal distribution of the variation among units.

Some of the actual distribution curves experienced in manufacture are shown in Figs. 3, 4, 5, and 6. Fig. 3 represents a normal production curve in which the average is somewhat offset from the standard. Such a condition might easily exist in the production of a coil where the specifications were read 19 turns instead of 18 through a blur in the copy or a typographical error.

Fig. 4 represents a production where the maximum performance was expected and where a deviation from the standard could be only in one direction. An illustration of this exists in the production of iron-core choke coils which may have been specified with a butt joint. Maximum inductance was probably required. The introduction of the slightest gap reduced the inductance. (An excellent case where the engineering division can and does learn of the difficulties of manufacture).

In Fig. 5 we have represented a product made by two operators using the same equipment but working in two shifts. A confusing indicator was read differently though consistently by each. Here the remedy is accomplished by the use of a clearer instrument.

The result of selecting the better units of a given production to satisfy a critical customer, and of leaving the remainder for the indifferent and very often ignorant purchasers, is given Fig. 6. The dotted line completes the normal curve which indicates that originally there was good control of the product.

With an attitude of constructive criticism, whereby collective data is illustratively presented, it is not difficult to obtain the complete coöperation of the manufacturing group. The feeling that the Inspection Division is "out to get something" on the Manufacturing Department is replaced by free hearted desire by the latter to see and in more cases that one to actually demand some sort of control. "Let's see how the job is coming.—Build us a 'gadget' for checking!—That dope does show up that faulty machine! — Well, guess we'll have to replace the operator." Quality Control tells the story.

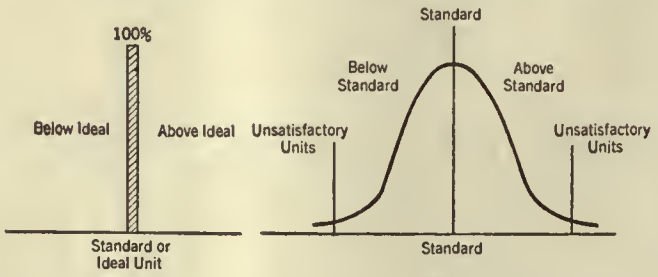


Fig. 1

Fig. 2

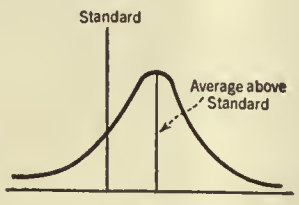


Fig. 3



Fig. 4

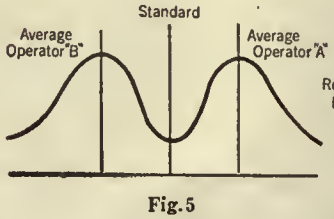


Fig. 5

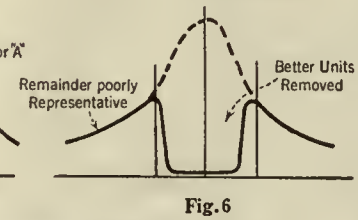


Fig. 6

Curves indicating efficiency of production

ADVANTAGES OF PRESELECTION

By JACOB YOLLES

Engineer, Technidyne Corporation



Jacob Yolles

THE IDEAL radio receiver must embody the following characteristics: (a) high amplification, (b) adequate selectivity, and (c) uniform reproduction of all tones in the acoustic range. These qualities are corequisite—they must not vary throughout the broadcast band. The latter two must not be affected by adjustments of the volume control. In this article an attempt will be made to describe the mechanism whereby the Technidyne Equase circuit conforms to these ideals.

Let us glance for a moment at the familiar academic diagram of Fig. 1. This shows the logical sequence of the operations upon an electromagnetic wave which are required for the successful reception of a program. This diagram is indeed old. It has been reproduced from text to text as a fundamental.

Regeneration

Considerable progress had been made in the field of selectivity as a result of the work of John Stone Stone with coupled circuits. In order to conform with the scheme of Fig. 1, an amplifying apparatus was required. Thus far, the single-tube circuit had been employed.

De Forest and Armstrong greatly enhanced the utility of the single-tube circuit by the contribution of regencration. Inductive feed-back and the ultra-audion had enabled a magnification of signals of from ten to fifty-fold to be realized. When programs were put on the air, however, it became apparent that nonregenerative receivers were needed for satisfactory reception. That multi-stage amplifiers were needed was also apparent. The problem then confronting the engineer was to find a suitable link for coupling amplifying tubes in cascade. The difficulty of securing a moderate degree of amplification was increased by the fact that relatively high frequencies (which are more difficult to amplify), had been allotted for broadcast purposes.

Untuned Amplification

In endeavoring to follow the logical scheme of Fig. 1, the early investigators sought to develop an untuned amplifier. They were not concerned with other functions within this unit since the selectivity developed by Stone was available, as were also detectors and audio amplifiers.

The ideal untuned amplifier is one that, without any adjustment, amplifies to the desired extent any one of a chosen band of frequencies, as, for example, the allocated broadcast band. Since the amplifier is to be used in connection with a selecting apparatus, it must not react upon the tunable circuits and render them unstable, make them oscillate, or impair their selective properties. For many years this ideal seemed to be impossible of attainment.

Invariably, the early untuned amplifier oscillated and squealed, had inadequate and poorly distributed amplification, and reacted strongly upon the tuning system. Stability was sought even at a sacrifice of efficiency. Some amplifiers were developed in which the oscillations could be controlled. What performance could be realized from these was due to regenerative feed-back and was limited to a very narrow band of wavelengths. In summarizing this phase of the early work, it may be said that the trend was to follow the logical scheme of Fig. 1, but that a complication of troubles hindered this type of development. A field was open for the inventor!

Tuned Radio Frequency

The next forward step taken by the receiving art was through the work of the Germans, Schloemilch and Von Bronk, and of Alexanderson. Their work laid the basis for tuned radio frequency. However, although they indicated the advantages that would accrue by the use of the tuned circuit itself as the coupling element, these advantages could not be realized in practice. The tuned circuit turned out to be extremely susceptible to regenerative feed-back. In fact, it was most suceptible to any reaction, either that of the grid-plate capacity of the tube into which it worked or the reactions from distant stages. (In the course of his research on tuned-radio-frequency amplifying systems, Lester L. Jones coined the expressions "adjacent-stage" and "distant-stage" feed-back. The former refers to reaction via the grid-plate capacity of the tube, the latter designates feed-back from later stages and includes common impedance, external magnetic, and capacitive coupling.)

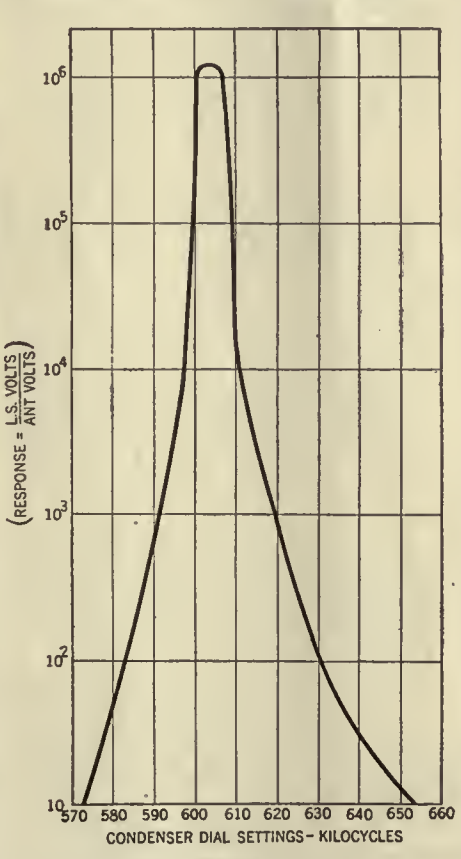


Fig. 2



LOGICAL SEQUENCE OF OPERATIONS IN RECEPTION

Fig. 1

Lester Jones' Melco-Supreme made its appearance upon the market in 1923. The description of the unique features incorporated in the Melco-Supreme is beyond the scope of this article, but the reader is referred to several patents (Nos. 1,658,804; 1,658,805; 1,664,513, and 1,712–214) which are a mine of information on the design of receivers of the neutralized tuned-radio-frequency type. It was, however, but a short time later that the Equase system was invented.

The Equase System

The Equase circuit arrangement is one that follows rigorously the scheme of Fig. 1. Selection is performed as a distinct, separate, and complete operation upon the signal before amplification and detection. This is known as *pre-selection*, and is an outstanding feature of the circuit. The following advantages are derived from this type of selectivity:

"Phantom" heterodyne whistles are greatly minimized. In the usual receiver all of these are not real heterodynes of the waves of stations. Some, which are called "Phantom" because they are not real beats in space, are produced in the plate circuit of the first radio amplifying tube. These "Phantom" whistles are of two distinct types. The simplest is an audio-frequency beat between a station wave and a harmonic of a local station, which harmonic is created in the plate circuit of the first r.f. tube. A single tuning circuit, even though adjusted to a short wavelength, will not reduce the amplitude of a powerful long-wave local station sufficiently to prevent this phenomenon.

Another "Phantom" whistle is of more frequent occurrence and is brought about by the fact that two long-wave local stations may be operating on frequencies whose sum can beat audibly with a desired higher-frequency station.

The phenomenon of "Phantom" heterodynes is not revealed by the ordinary selectivity characteristic. The additional information that is needed relates to the nature of the amplifying tubes employed (as regards the residual rectification), and to the distribution of the selectivity among the stages. In the Equase circuit, the selectivity is "lumped." The nature of condenser and coil circuits is linear as regard voltage and current amplitudes; in other words, they do not distort. The Equase selector reduces the interference to one part in a million whereas a single tuned circuit reduces it to but one part in a hundred.

"Square-Top" Selectivity

Another advantage of Equase selectivity lies in the "square-top" naturc of the tuning characteristic, over a single channel. With ordinary tuned radio-frequency systems, the high audio frequencies which contain the essentials of articulation, tone definition, and timhre, are not reproduced in their original intensity (rclative to the low and middle register), due to distortion of the modulation cnvelope of the carrier hy the "peaked-top" nature of the selectivity characteristic. Thus, amplitude distortion is introduced even before the signal reaches the detector.

The Equase selector uses four tuned circuits. This numher is sufficient to provide a degree of selectivity that is adequate. In fact, our experiments indicate that it surpasses the selectivity obtained with an equal numher of similar tuned circuits when used in a tuned-radio frequency receiver.

The selectivity characteristic shown in Fig. 2 was taken on the Sparton Equasonne (Sparks-Withington Co.), a receiver embodying the Equase circuit. It should be observed that the measurements were carried out to the extent of one part in one-hundred thousand, a practice that should he generally adopted. Even this degree of accuracy in estimating the shape of the selectivity characteristic does not reveal the whole selectivity, an air test being essential, as must become apparent when the phenomenon of "Phantom" heterodynes is regarded as interference.

Thc circuit diagram of the selector is givcn in Fig. 3. The four circuits are coupled as shown hy a comhination of capacitive, inductive, and direct couplings.

There are two criteria of the efficiency of a selector. One is the degrec of selectivity available and the other is the attenuation, viz., the ratio of output voltage to input voltage. The selectivity of the Equase selector, taken in thc real scnse of being able to reduce all manner of interference to a minimum, is very good. The attenuation is less than with the old-time selectors of the Stone era, even though at that time, four tuned circuits were not even anticipated. In the Equase four-circuit selector, fully seventy-five per cent. of the voltage across the first tuned circuit is available for energization of the first r.f. amplifier tube. This is due to the maintenance of optimum coupling and efficient coil design.

Amplification

The function of the untuned amplifier of the Equase circuit is to magnify the output from the selector to the degree necessary to operate the detector, audio, and loud speaker systems. The detector and audio amplifier as uscd in the Equasc system require about ten volts for satisfactory loud speaker operation.

The Equase amplifier as embodied in the Navigator (The A-C Dayton Co.) has the amplification characteristic shown in Fig. 4. Although the amplification increases rapidly as the wavelength increases, the response of the receiver as a whole is practically uniform over the whole hand. The amplification characteristic in this casc was purposely designed to increase with wavelength, since, on thc longer wavelengths, the efficiency of capacitively tuned selecting circuits falls off and the ahility of the antenna to ahsorh energy also diminishes. The response curve of the complete receiver is shown in Fig. 5.

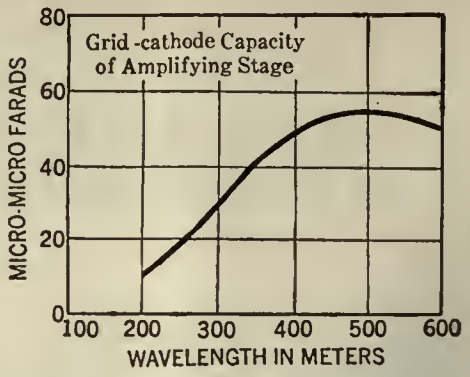


Fig. 6

Resonance Maintenance

The design of the untuned amplifier is unique. The principle of operation upon which the amplifier is based is "resonance maintenance." A novel design of untuncd coupling transformer further contributes to the success of the amplifier.

The "resonance maintenance" principle is described in Patent No. 1,673,287 issued to Lester L. Jones. It is based upon the fact that the load in thc plate circuit of an amplifying tube can be designed so as to make the capacity hetween the grid and cathode of the tube vary in a pre-determined fashion as the frequency of the impressed grid voltage varies. A typical curve showing how this capacity can vary automatically with the wavelength is shown in Fig. 6. The plate circuit loads are designed so as to make the input capacity approximate the variation of a tuning condenser over the broadcast band. By suitahly proportioning the inductance of the coupling transformers, resonance is maintained to a considerahle degree due to this automatic tuning effect. This feature provides high impedance loads in the plate circuits of the amplifying tuhes and enables a high "gain" per stage to be ohtained. Five stages of amplification are employed in present commercial receivers.

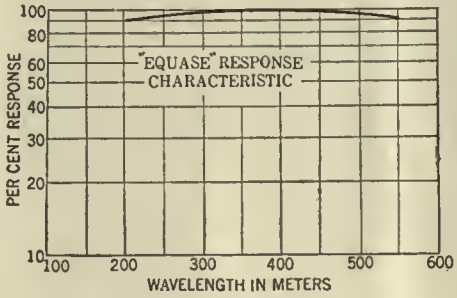


Fig. 5

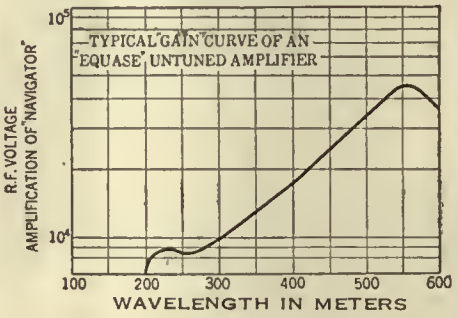


Fig. 4

The interstage transformers are of practically one hundred per cent. (unity) coupling. The unity coupling contributes at once both to high efficiency and stability. Distant stage magnetic feed-back is neutralized by a "pie" type of winding which provides astaticism and keeps the self-capacity of the transformers at a very low figure.

Stability

It has been mentioned that a reaction through the grid-plate capacity of a tube may he one which tends to over-damp the input circuit rather than make it regenerative. In other words, a grid-platc capacity reaction may be one which either adds resistance to a circuit or removes resistance from it. In the former case stability results. In the latter case instability and oscillation may result. In tuned-radio-frequency sets where the input circuits must be sharp and sclective, thc addition of resistance must be avoided with the same carc that regeneration is avoided. In a broadly tuned amplifier, such as the Equase, the increase of resistance is relatively unimportant as a damping factor, the function of selectivity being performed by thc selector. The dcsign accordingly is such as to maintain thc non-regenerative reaction.

Neutralization

The first tube of thc amplifier has a novel output circuit. Since the last tuned circuit of the selcctor is conncctcd to thc input of this tube, cspecial design is necessary. The plate circuit of this tubc is an impedance network which maintains a constant grid to cathode capacity for the tuhc, which is essential in order to avoid detuning of the selector, and it provides freedom from feed-hack or over-damping reaction at all wavelengths. It is a method in which the over-damping and rcgenerative tendencies are both madc to neutralizc each other. This inherent-in-the-circuit type of neutralization has been named "feed forward" by Lester Jones. The stability of the amplificr can be appreciated from the fact that thc tuhes are placed as close together as is physically practical, almost touching. No metal shielding whatever is employed.

In thc Sparton Equasonne, the Equase amplifier employed has the dimensions $8\frac{1}{2}$ by $3\frac{1}{2}$ inches. The A-C Dayton Navigator employs a different receiver layout in which a longer but narrowcr ($2\frac{3}{4}$ by $12\frac{1}{2}$ inches) amplifier is employed. Great flexibility in design is offcred to the design engineer due to the isolation of thc selcctive and amplifying functions, and the individual unit type of construction.

Detection

If one stage of audio amplification is cmployed, it is, of coursc, the last and power stage. The burden of supplying the power tube with sufficient a.c. voltage falls upon the detector. Research upon methods of detection led to the dcvelopment of the "anode-hend-power-detec-

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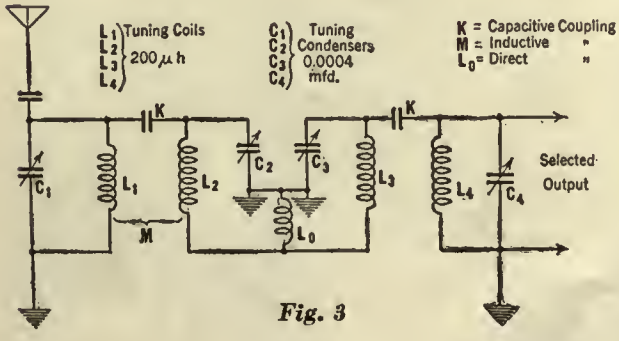


Fig. 3

THE LIGHT BULB—A HANDY RESISTOR

By WILLIAM H. WENSTROM

With the Laboratory Collaboration of William A. Morton, Jr.

LIGHT BULBS of various kinds are among the cheapest and most convenient resistors that we have. The difficulty attending their use has been that their resistances are far from constant. We often hear statements such as "the resistance of this bulb is about so-and-so." Actually the hot resistance of a bulb may be ten times its cold resistance. It is the aim of this article to take the guesswork out of light bulbs, and to place their use on some sort of scientific basis.

The use of light bulbs of course depends on Ohm's Law: $E = IR$, where E is the voltage drop across the bulb, I the current, and R the bulb's resistance at that particular current. The formula for bulbs in series is of course $R_1 + R_2 = R_T$; and for bulbs in parallel $1/R_1 + 1/R_2 = 1/R_T$. The currents of bulbs in parallel are added: $I_1 + I_2 = I_T$. For calculating the normal current of a bulb from its watts rating, we use the formula $W = I^2R = IE$.



The Author

Banks of electric light bulbs are quite commonly used in laboratories, school laboratories particularly, as a convenient variable load in making all sorts of measurements. It is useful to know the characteristics of a lamp bank at various voltages other than normal and in this article Mr. Wenstrom gives some data from which lamp bank characteristics can be calculated readily.

—THE EDITOR.

TABLE 1
HOUSE LIGHTING
BULB DATA

Bulb & Rating	Hot I	Hot R	Cold R
Tungsten			
115 V 10 W	.09	1280	140
115 V 25 W	.22	525	45
115 V 50 W	.44	260	23
115 V 100 W	.87	135	11
115 V 150 W	1.30	90	8
32 V 25 W	.80	40	5
32 V 50 W	1.60	20	3
240 V 25 W	.10	2400	205
240 V 50 W	.20	1200	125
240 V 100 W	.42	560	45
Carbon			
110 V 15 W 6 cp	.15	730	1250
110 V 50 W 16 cp	.46	234	415
110 V 100 W	.91	122	260
220 V 120 W	.55	400	700
	Mean of Calc.& Meas.Values	Calc.fm.Prec.Table	Meas.Values with small Currents

House Lighting Bulbs

Standard light bulbs are made with tungsten or carbon filaments. The older carbon bulbs are now practically obsolete for lighting purposes but are better than tungsten for most resistance purposes. The resistance of metals increases with increase of temperature; that of non-metallic elements decreases with increases of temperature. This means that the resistance of a tungsten filament increases as the current rises, while the resistance of a carbon filament decreases with a rise in current. The variation between hot and cold resistance is astonishingly large, particularly in the case of tungsten bulbs. General data on many standard bulbs appear in Table I. This table includes 115-volt, 32-volt, and 240-volt tungsten bulbs, and 110-volt and 220-volt carbon ones. Tungsten bulbs are also made in 110-, 120-, 220-, 230-, 250-, and 260-volt ratings. Any individual standard bulb listed in the table should test within 5 per cent. of the values given. "Cold resistance" is of course a relative term; the figures given are near enough to average zero current values for all practical purposes.

The resistance of a bulb not given in the table may be approximated. For instance, the resistance of a 120-volt bulb will be about 120/115 that of a similar wattage 115-volt bulb; the resistance of a 100-watt bulb will be about 50/100 that of a similar voltage 50-watt bulb.

How Resistance Changes

Now let us see how the bulb resistance changes between extreme values. In Fig. 1 we follow the changing resistances of two typical bulbs—a 115-volt 50-watt tungsten and a 110-volt 50-watt carbon—from zero current up to normal current. The carbon bulb starts with high resistance which decreases rapidly at first, and then less rapidly as it heats up. The tungsten bulb starts with extremely low resistance which rises fairly uniformly with the current—the curve is almost a straight line. Where we wish a fairly constant resistance at normal current, therefore, carbon bulbs are best (they also prevent a large initial current rush); where we wish a ballast action, or pronounced opposition to a rise in current, tungsten bulbs are best. Additional curves show how the voltage drop across each lamp varies with the current through it.

In constructing lamp banks we usually know beforehand the available voltage and the desired current. What we really wish to know, therefore, is the voltage drop across a given bulb or group of bulbs at a given current. In Fig. 2 we have curves from which this information can be calculated approximately for any tungsten or carbon bulb of any common voltage and wattage rating. For example, we wish to find the voltage drop across a 115-volt 100-watt bulb at a current of 0.5 ampere. Referring to Table 1, we find that the normal current of this bulb is 0.87

TABLE 2
FLASHLIGHT AND AUTO
BULB DATA

Bulb & Rating	Test E	Test I	Hot R	Cold R
Pilot 6 V	5	.15	35	10
Flashlight				
1.2 V	1.2	.50	2.4	.6
1.25 V	1.25	.75	1.6	.5
2.2 V	2.2	.25	8.8	1.8
2.5 V	2.5	.30	8.3	1.8
3.8 V	3.8	.32	12	2.5
H/c Ratio			4	1
Auto				
3 V 2 cp	3	.8	3.7	.9
6 V 3 cp	6	.6	10	1.7
6 V 6 cp	6	.9	6.7	1.0
6 V 21 cp	6	2.0	3.0	.5
12 V 3 cp	12	.3	40	6.0
18 V 3 cp	18	.2	90	12
Average Hot R-Cold R Ratio 6:1				

FILAMENT COLORS AT
PROPORTIONAL CURRENTS

Cold R	Dull Red	Bright Yellow	White	
Medium	½	¾	1	X Normal I
Below 1 ohm	⅔	¾	1	"
Above 5 ohms	⅓	⅔	1	"

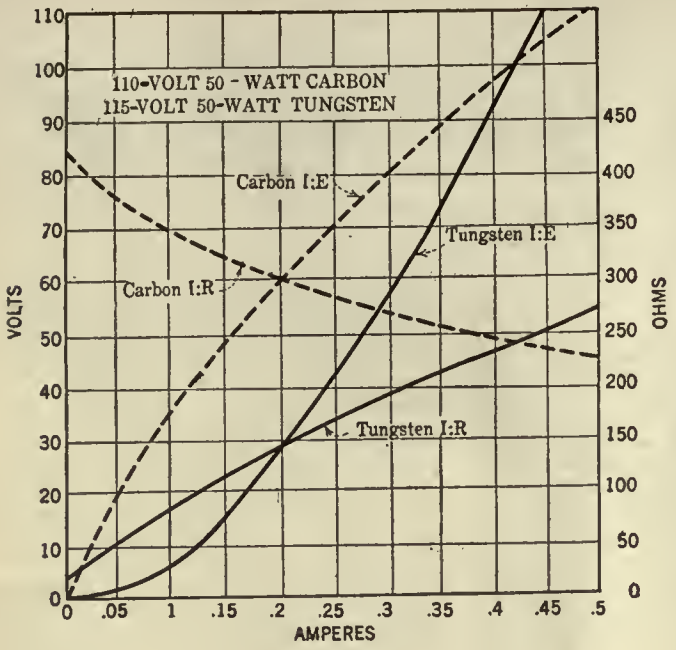


Fig. 1

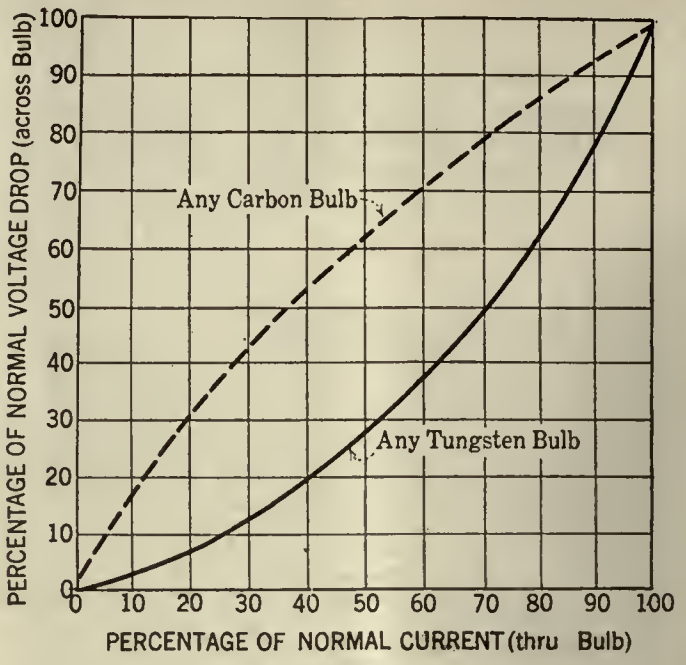


Fig. 2

ampere. Our given current is then 57 per cent. of the normal current. On Fig. 2 we project the abscissa corresponding to this current percentage up to the tungsten bulb curve. Then, projecting this point on the curve across to the ordinate or voltage percentage scale, we find that the voltage drop across the given bulb at the given current will be about 34 per cent. of its normal voltage drop, or 39 volts.

Auto and Flashlight Bulbs

Practically all auto and flashlight bulbs have tungsten filaments, so that their resistances increase with increase of current. Table 2 gives complete data on all bulbs in common use. Here again, any standard bulb should test within 5 per cent. of the table. It will be noted that the hot resistance of a flashlight bulb is around four times its "cold" resistance, and that for auto bulbs this ratio is about six to one.

In addition to their use as resistors, these bulbs have possibilities as emergency ammeters and milliammeters for rough measurements of alternating or radio-frequency currents. A suitable bulb is placed in the a.c. or r.f. circuit; then a similar bulb, connected in series with a battery, rheostat, and d.c. meter, is placed near it for visual comparison. The d.c. circuit is adjusted until the two bulbs are alike in color, when the d.c. meter gives the effective value of a.c. or r.f. in the other circuit. The bulbs should be interchanged to check their uniformity. One bulb may be used in first one circuit and then the other if desired, but this procedure introduces the inaccuracies of memory. The accuracy of the first method is probably better than $\pm$ 10 per cent.

For still rougher measurements we may use the filament color data at the end of Table 2. A medium resistance bulb, for instance, will show dull red at about $\frac{1}{2}$ normal current, and bright yellow at about $\frac{3}{4}$ normal current. While the accuracy of this method is not over $\pm$ 20 per cent. it may often be found useful. The accuracy of any method is greatest between filament colors of red and yellow.



Laboratory set-ups employed for determining the resistance of light bulbs under various conditions.

PROFESSIONALLY SPEAKING

(*continued from page 269*)

It seems to us that a receiver which selects a band of constant width would be somewhat better than one in which the amplification is constant. However, it must be admitted that the latter is an advance because it increases the "apparent selectivity" at high frequencies, and it makes the user think the set is more selective than it really may be.

We believe uniform sensitivity is desirable, provided that the sensitivity is great enough. We have seen some modern receivers in which the amplification varied over a very large ratio; we have heard that a prominent receiver has a gain curve that varies from something less than 10,000 at low frequencies to more than 200,000 at high frequencies. We do not believe such curves are desirable because of the poor apparent selectivity at high frequencies. Perhaps the designers feel that what the listener can get on the high-frequency channels is not worth listening to—and they may be correct. The tendency to devote only a few degrees of the tuning dial to the channels above 1000 kc. decreases or increases the apparent selectivity depending upon whether the receiver separates such channels or not. In other words, the local area in which the receiver is to be used determines whether or not it is considered locally as a selective or a broad set.

If 1929 is a year in which uniform sensitivity gains in popularity, perhaps 1930 will be a year in which uniform selectivity is attained. If so, let us hurry it along.

DESIGNING COILS FOR THE MODERN SET

By HUGH S. KNOWLES

Engineering Department, Silver-Marshall, Inc.



Hugh S. Knowles

Someone is credited with the observation that the difference between the work of a mathematician and an engineer lies in the fact that a mathematician has only one variable for his equations whereas an engineer has two—one of which is controlled by economic factors. We know of no case in which the economic factors are of more importance than in the design of a modern inexpensive radio receiver.

The S-M 722 receiver was designed with the object in view of providing a receiver with modern performance to market at less than $75.00. This meant that the receiver must have high gain in terms of this year's performance, a high degree of selectivity to make the increased gain *usable* as well as to keep the apparent selectivity up, and a good overall frequency characteristic which meant the use of at least one band-selector circuit.

This resulted in the use of a band selector or "siamese" circuit followed by two transformer-coupled screen-grid r.f. stages and a screen-grid detector followed by a transformer-coupled a.f. stage using a 227-type tube and a push-pull power stage using a 245-type tube.

Selection of Coils

A very important part of the design of the r.f. end of the receiver lay in the selection of a suitable coil design. The data which were obtained in the design of two screen-grid receivers last year, and in the receiver described in July, 1929, Radio Broadcast, were available for this purpose. The results of measurements on nine representative coils are listed in Table I.

The test circuit was composed of a low-impedance supply source having a frequency of 550 kc. and a series-tuned circuit including a two-ohm thermocouple. Instead of making two observations on each coil, such as would be required by the resistance-variation method of determining the coil power factor, an arbitrary figure of merit equal to the square root of the deflection divided by the capacity was used. The figure of merit, M, is tabulated in the eighth column. The test frequency of 550 kc. was chosen because the gain of a receiver of this type is always low at this point and the performance at this frequency is of prime importance.

Test transformers using secondaries Nos. 1 and 2 were available since this coil had been used previously. The interesting thing about the two coils is that the ratio of the selectivity factor (ratio of voltage at resonance to voltage 10 kc. off resonance) at 550 kc. to that at 1500 kc. is more satisfactory on the smaller coil. This may be accounted for by the fact that the smaller coil was wound on an ungrooved tube resulting in a lower dielectric loss at the high frequencies. Placing coil No. 2 in a larger shield than No. 3 (No. 4) resulted in an improvement which was too slight to warrant the greater physical volume and cost of the latter. Whereas the selectivity factor of the large coil (No. 4) varied from 5.22 at 550 kc. to 1.1 at 1300 kc., that of the smaller coil (No. 2) varied from 4.88 to 1.31 over the same interval. Coil No. 3 was selected because of its very good performance for a compact form.

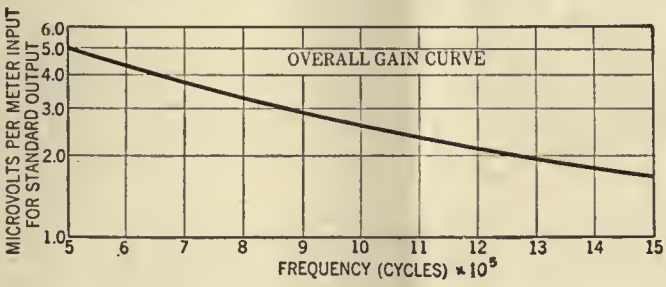


Fig. 3

Curves A, B, and C in Fig. 1 were run with a view to determining the possible gain in the antenna coupler using coil No. 3 as the secondary. Curve A uses a standard dummy antenna feeding a small primary winding (tapped for long antenna) Curve B was run with a 12.5-mmfd. condenser in series with the dummy tied directly to the grid. Curve C was run with the same circuit as B, except that it was coupled through the primary with a 25-mmfd. condenser. As a result of this test, the transformer shown in curve C was adopted because of the high gain obtained and because the gain ratio at the two ends of the broadcast spectrum was somewhat better than the other two. The high gain in the receiver makes it possible to use a low coefficient of coupling and an antenna which is sufficiently small to minimize detuning of the first condenser. With proper alignment the variation of the first tuning condenser is of the order of a quarter micro-microfarad.

Band-Selector Needed

When it was definitely established that satisfactory alignment of the first stage could be maintained with an antenna coupled to it, it was decided to place the band-selector circuit ahead of the first tube. This is very desirable since the frequency discrimination which occurs ahead of the first tube minimizes the possibility of stations having a high field strength, other than the one to which the receiver is tuned, of impressing sufficient input on the first 224-type tube to give second order variations in the output circuit which might be amplified sufficiently by succeeding stages (when tuned to the harmonic) to cause objectionable interference. The overall gain from antenna to grid of the first tube is entirely satisfactory because

Table I

Coil	Diam.	Turns	Wire	Spacing	Cmm+d.	Def.	$M=\sqrt{Def}/C$	Shield
1	2½″	72	25	diam.	355	94	2.73	None
2	1¾″	124	29	close	285	54	2.58	None
3	Same	"	"	"	350	64	2.28	2¼x2½
4	Same	"	"	"	300	56	2.48	3½x5
5	2″	105	22	close	281	63	2.84	None
6	Same	"	"	"	361	80	2.47	3½x5
7	1¾″	109	22	½d	398	90	2.50	Same
8	Same	120	Same	Same	340	81	2.65	Same
9	Same	123	23	1½d	306	66	2.65	Same

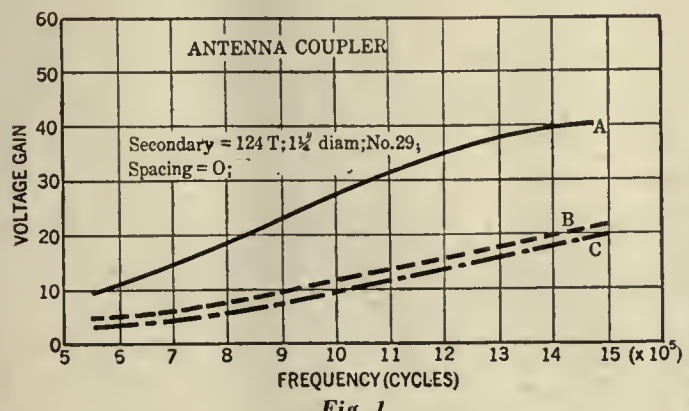


Fig. 1

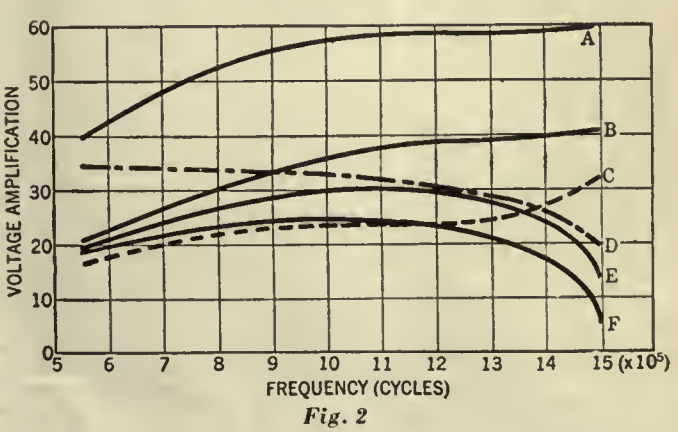


Fig. 2

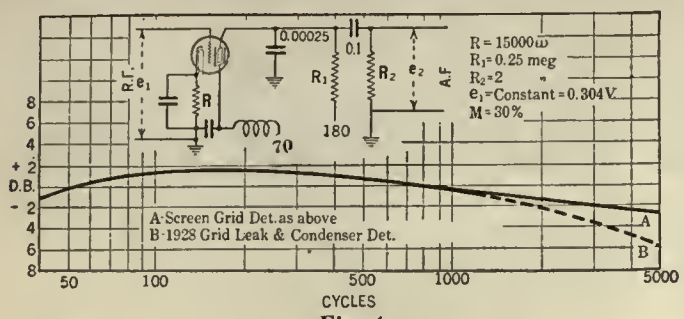


Fig. 4

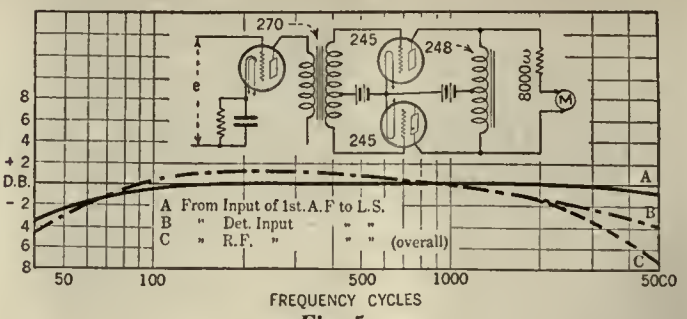


Fig. 5

of the fact that nearly optimum coupling relation exists over the whole frequency range; that is, ω M must equal the product of the resistance in the two circuits ($\omega M = R_1 R_2$). The frequency ratio is very nearly 3 to 1 and, since the resistance variation is of the same order, almost optimum coupling is obtained throughout the whole range.

Fig. 2 shows a characteristic group of transformer curves using the secondary No. 2 and various primaries, degrees of coupling, etc. The gain at 550 kc. varies almost directly with the primary impedance. The gain limiting possibilities at high frequencies of the primary to secondary capacitative coupling are shown in curves D, E, and F.

In curve D it would appear to be desirable to limit the high-frequency gain but the actual selectivity factor of coil B is superior, being 4.88 at 550 kc. and 1.31 at 1500 kc. as compared with 4.03 and 1.05 for coil D. The coil of curve A was adopted because of its high gain and the exceptionally good minimum-to-maximum gain ratio.

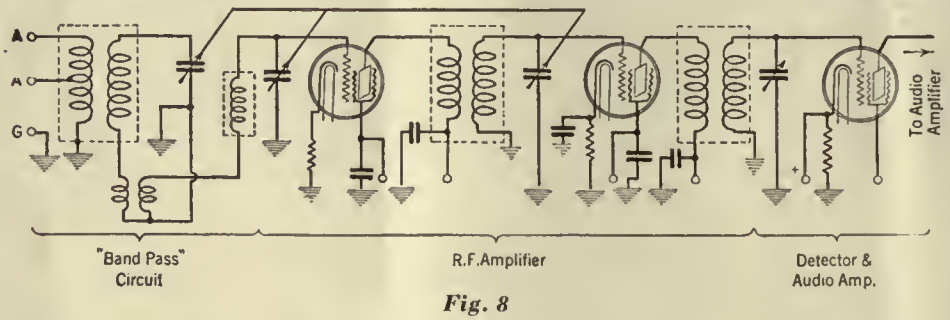


Fig. 8

Transformer Coupling

Transformer rather than impedance coupling was adopted because it is difficult to build a choke which will have a uniformly high impedance over the whole broadcast band and because of the difficulty of controlling the selectivity factor of the interstage coupling device. Whereas, in d.c. screen-grid tubes, the plate impedance is sufficiently high so that the resistance reflected into the tuned circuit is very low, in the case of a.c. screen-grid tubes with their lower plate impedance (particularly at high screen-grid potentials where the gain is great and the selectivity is actually needed) the reflected resistance, and hence the influence of the tube on the selectivity, is very considerable. Impedance coupled amplifiers also offer considerable alignment trouble and are apt to have a poor gain ratio.

The alignment problem is one of the most serious in receiver design, particularly where band-selector circuits which have to be symmetrical are concerned. Although the shielding problem is simplified by using two coils in one shield partition, and using the mutual as the "spacing" impedance, it is difficult to make the two circuits perfectly symmetrical because of the difference in the capacity to the two coils and possible differences in materials in the fields of the two.

In the first coil designs the maximum variation between stages (assuming identical condenser sections) was 3.35 micro-microfarads. In coils similar to D, Fig. 2, the variation ran as high as 7 micro-microfarads. The present design gives a maximum difference of 0.24 micro-micro-farads. This is obtained by reducing the leakage reactance of the transformers to a minimum (maintaining high values of "K" for the inductance used) and yet keeping the primary to secondary capacity fairly low and constant.

The use of plate-circuit rectification is now generally accepted and needs little comment. The use of a 224-type tube in preference to a 227-type tube seems advisable for the following reasons:

1. Higher detection coefficient (greater audio output for given radio-frequency input)
2. Improved frequency characteristic (better than leak-condenser type and superior to numerous bias detector arrangements)
3. Larger undistorted output for moderate plate voltage.

Point No. 1 is clearly shown in curve A, Fig. 6 on page 162 of July, 1929, RADIO BROADCAST. The frequency characteristic of the detector alone is given in A of Fig. 4. Curve B is flat from 100 to 1000 cycles and down 6 DB at 5000 cycles and is representative of grid leak condenser detectors of a year ago (2-megohm leak). Curve A, Fig. 5, shows the curve from the input to the first a.f. tube to the output of the 245-type tubes in push pull. Curve B shows the overall fidelity from detector to loud speaker. The improved detection coefficient makes it possible (with the same r.f. gain) to use a low-gain transformer with an exceptionally satisfactory transmission characteristic in working out of the first audio stage into the 245-type tubes. By using two audio stages with the transformer looking into the 245-type tubes working out of a low-impedance tube, such as the 227, the frequency characteristic is not made a function of the plate impedance which varies over wide limits in the conventional single audio stage detection arrangement and results in a considerably improved frequency characteristic. The input impedance of the power tube is not only usually low but also varies greatly so that it is desirable to work out of a low-impedance tube through a low-ratio transformer to minimize the loading effect of the power tubes.

The overall gain curve of the receiver is given in Fig. 3.

The overall frequency curve given in curve C, Fig. 5, indicates an attentuation in the r.f. end of 3 DB at 5000 cycles, which is slightly more than given in the selectivity curve, Fig. 6. With the loud speaker with which the receiver is used the high-frequency response, even at 550 kc., is very good and frequently called excessive by those who are accustomed to the more common values of attenuation or sideband cutting.

As a final check on the overall performance the input was held constant and the percentage modulation varied.

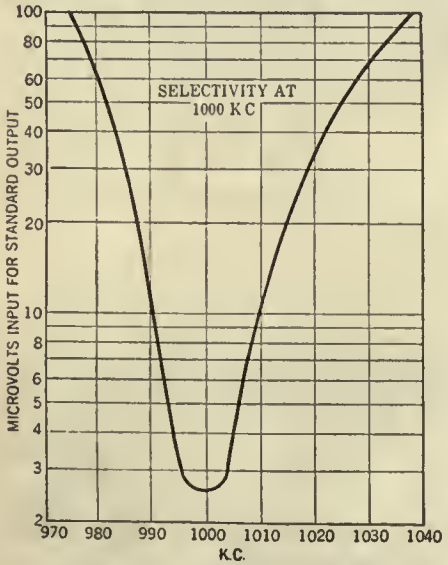


Fig. 6

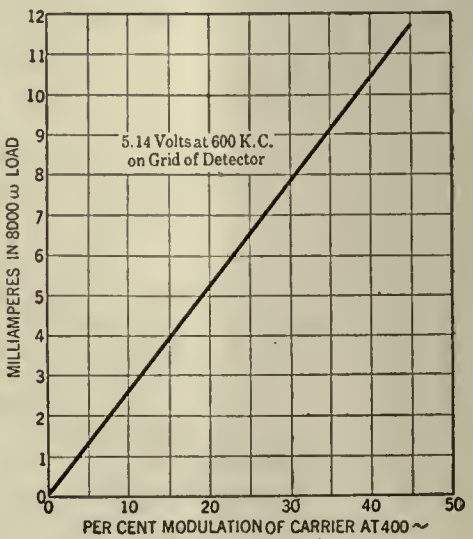


Fig. 7

The *Radio Broadcast* LABORATORY INFORMATION SHEETS

By HOWARD E. RHODES

THE aim of the RADIO BROADCAST Laboratory Information Sheets is to present, in a convenient form, concise and accurate information in the field of radio and closely allied sciences. It is not the purpose of the Sheets to include only new information, but to present practical data, whether new or old, that may be of value to all those in the engineering branches of radio. In order to make the Sheets easier to refer to, they are arranged so that they may be cut from the magazine and preserved, either in a blank book or on 4″ x 6″ filing cards. The cards should be arranged in numerical order.

Since they began, in June, 1926, the popularity of the Information Sheets has increased so greatly that it has been decided to reprint the first one hundred and ninety of them (June, 1926-May, 1928) in a single substantially bound volume. This volume, *Radio Broadcast's Data Sheets*, may now be bought on the newsstands, or from the Circulation Department, Doubleday, Doran & Company, Inc., Garden City, New York, for $1.00. Inside each volume is a credit coupon which is worth $1.00 toward the subscription price of this magazine. In other words, a year's subscription to RADIO BROADCAST accompanied by this $1.00 credit coupon, gives you RADIO BROADCAST for one year for $3.00 instead of the usual subscription price of $4.00.

—THE EDITOR.

No. 296 RADIO BROADCAST Laboratory Information Sheet **Sept., 1929**

Output Transformer Ratios

SOME INTERESTING curves which were published in a recent bulletin issued by the Ferranti Company are given on "Laboratory Sheet" No. 297. These curves show the transformer turns ratio necessary for use with power tubes of different plate impedances when used with dynamic loud speakers of various impedances. The chart covers tube impedances up to 15000 ohms and loud speaker impedances up to 55 ohms.

The charts are calculated on a basis that the tube is to work into an impedance equal to twice its own impedance. That is, for example, a tube with an impedance of 4000 ohms should work into an 8000-ohm load. Transformer ratios for output circuits are always calculated under this condition and the chart ought to prove quite useful.

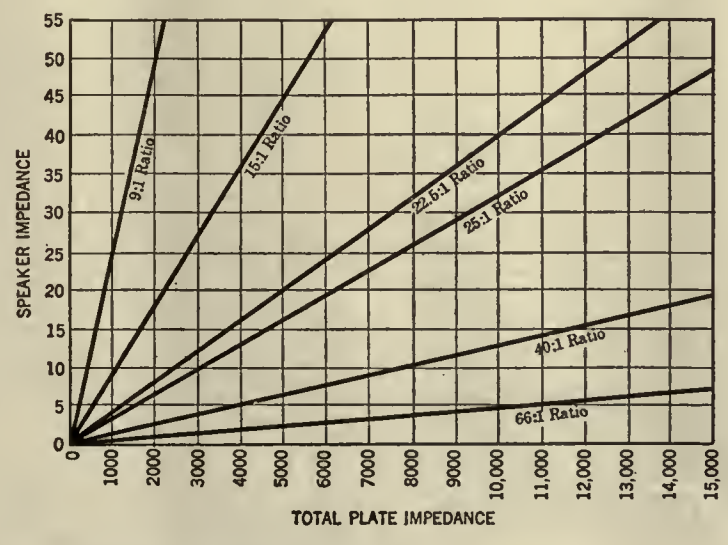
The required ratio of a coupling transformer is determined by taking the square root of twice the tube impedance divided by the loud speaker impedance. Expressed as a formula, the turns ratio of the transformer is equal to

$$T = \sqrt{\frac{2\,Rp}{RL}}$$

where Rp is the plate resistance of the tube
RL is the impedance of the loud speaker
T is the required turns ratio of the transformer

As an example, suppose we have a loud speaker with an impedance of 40 ohms and that we were going to supply it from a push-pull stage using two tubes each with a plate impedance of 5000 ohms. Substituting in the above formula we obtain approximately 22.5 as the required turns ratio. Checking this on the curves we find that the line corresponding to 40 ohms and the line corresponding to 10,000 ohms (two 5000 ohm tubes in push-pull give a total impedance of 10,000 ohms) intersect at a point corresponding to the line giving a ratio of 22.5:1 which checks our calculation.

No. 297 RADIO BROADCAST Laboratory Information Sheet **Sept., 1929**



HOW TUBE SALES GO

(*Continued from page 260*)

months for the last three years, and the illustration above indicates how sales vary during the average year. A table also gives exact tube sales in percentages by months for the last three years and for the average year. These figures are believed to be representative of the entire industry as they were prepared after examining carefully exact sales figures of several leading tube manufacturers.

An examination of the curves in the illustration below shows that sales during 1928 parallel more closely the average sales curve than the curves for the years 1926 and 1927. This may be explained by the fact that the outstanding special broadcasts during 1928 were more numerous and more evenly distributed throughout the year, and therefore, conditions were more nearly normal. On the other hand, 1928 has a higher peak during the month of October—sales for the month are 19.2 per cent. of the yearly sales—than either of the other years, which may be explained by the unusual interest displayed in the broadcasts of the political campaign.

In comparing the average curve with the three yearly curves the most interesting fact which will be noticed is that the peak of tube sales occurred at a different month in each of the three years. In 1926, sales were at a peak in November, which is considered normal as this is the height of the football season. The curve for that year also shows that sales in September were almost equal to those in October, which is unusual and which was probably caused by the great interest in the Tunney-Dempsey fight broadcast over a network of stations on September 23, 1926. In 1927, tube sales reached the peak of the year during September, and this unusual condition was unquestionably caused by the broadcasting of the second Tunney-Dempsey fight from Chicago on September 22, 1927. As already explained, the Presidential Campaign undoubtedly caused the shift of 1928's sales peak to the month of October.

Two interesting deductions may be drawn from the facts stated above. In the first place it may be assumed that tube sales would probably reach the peak of the year in November if they were not affected at an earlier date by some outstanding broadcast. This fact, however, is not proved by the average curve because the peak in October during 1928 had sufficient height to shift the peak in the average curve to this month. The second point of interest is that important broadcasts have a greater effect on tube sales to-day than in 1926. This is probably due to the fact that much greater areas are now covered by the large networks.

Strange as it may seem the sales curves also show that for the past three years tube sales have been decreasing during the first five months of the year—January to May. This tends to indicate that sales are affected more by important broadcasts than by the sale of new receivers. The increase in replacement sales in the fall naturally causes a decrease in sales during January, February, and March. If it is desired to flatten out the sales curve it is suggested that tube manufacturers inveigle Mr. Tunney to have a return bout with Mr. Dempsey sometime in March or April to be followed by a "barnstorming" trip between Al Smith and Senator Borah in May and June.

MARVIN'S NEW SALES PLAN

IN ORDER to introduce its new 5-second heater tube to the trade, the Marvin Radio Tube Corporation has arranged a special offer to its jobbers. This offer is to supply sets of five standard tubes, the first tube, the 227, being given free and the others billed to the jobber at 40–10–2 per cent.

No. 298 RADIO BROADCAST Laboratory Information Sheet **Sept., 1929**

Circuits for the 245-type Tube

MOST OF the new radio receivers are using audio power amplifiers which employ either one or two 245-type tubes, the tubes being arranged in push pull when two are used. Because of the wide use of this tube we give on this sheet and sheet No. 299 some data on the various circuit arrangements generally used with the 245.

CIRCUIT A

Two 245-type tubes are indicated in circuit A on "Laboratory Sheet" No. 299. The plate voltage required is 300 volts, 250 of which is impressed on the plate of the tube and the remaining 50 supplying the necessary C bias. The filament is shunted by the 10-ohm resistance. The C-bias resistance is calculated by dividing the required C bias, 50 volts, by the plate current, 32 milliamperes, and dividing by two since there are two tubes. This calculation shows that the C-bias resistance should have a value of 750 ohms as indicated.

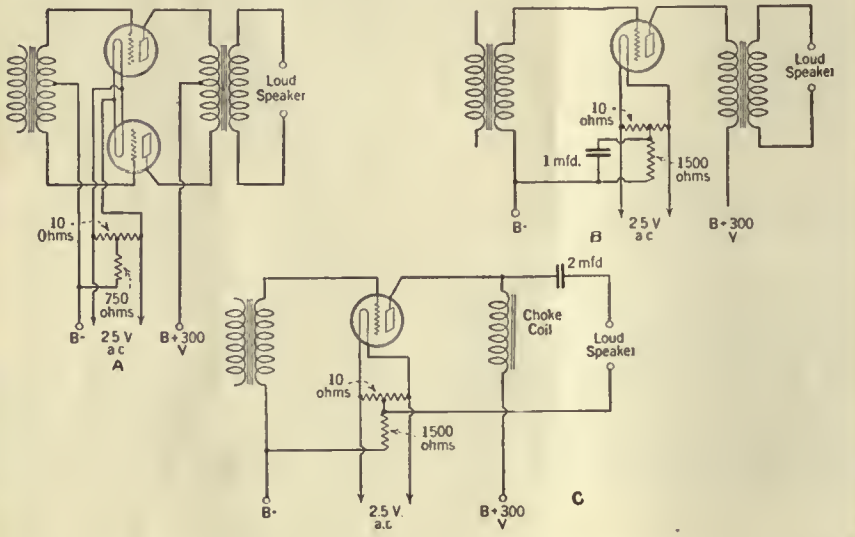
CIRCUIT B

This circuit shows a single 245-type tube with transformer output. The required plate voltage is 300 volts and the C-bias resistance is 1500 ohms. Since the a.c. current in the plate circuit must flow through the C-bias resistor to get to the filament, it is essential that the resistor be bypassed with a condenser of 1 or 2 mfd. The output transformer may be an ordinary one with a ratio of about 1:1, or it may be the transformer which couples the tube to the moving-coil system of a dynamic loud speaker, in which case, of course, it should have a step-down ratio.

CIRCUIT C

This arrangement is similar to that indicated at B except that a choke condenser output is used. With this arrangement d.c. current is kept out of the primary of the loud speaker or coupling transformer if one is required. Since one of the loud speaker terminals returns directly to the center-tapped resistor connected across the filament, if is not essential that any condenser be connected across this resistance.

No. 299 RADIO BROADCAST Laboratory Information Sheet **Sept., 1929**



No. 300 RADIO BROADCAST Laboratory Information Sheet **Sept., 1929**

Center-Tapped Filament Resistors

SEVERAL READERS have written us requesting information on what determines the value of the center-tapped resistance connected across the filament of an a.c. tube. In some cases it is apparently felt that this resistance must have a definite value in order to produce a definite load on the transformer secondary supplying the filament. This is seldon, if ever, the case, however.

No hard and fast rules can be given for the value of the resistance used across the filament. In fact a wide range of resistances can be used with equally good results. The important point to consider is the resistance of the filament across which the center-tapped resistor is to be connected and to make sure that the latter's resistance is fairly high in comparison with that of the tube. For example, if a tube filament has a resistance of 1 ohm then the total resistance of the center-tapped resistor should be at least 10 ohms and might well be higher. Never use a center-tapped resistor of an ohmage comparable to that of the tube across which it is to be connected.

One other factor is of some importance, especially in connection with the resistors placed across the filaments of power tubes. C bias for these tubes in a.c. sets is obtained by means of an additional resistor whose value is equal to the C-bias voltage required divided by the plate current of the tube. Actually, however, the center-tapped resistor also supplies some of the bias for the current in returning to the filament must flow through both halves of this resistance. In effect, therefore, the plate current flows through a resistor equal to one half the total value of the center-tapped resistance, since both halves of it are in parallel from the standpoint of the plate current. In calculating required values of C-bias resistance, it is wise, therefore, to substract from the calculated results one half the value of the center-tapped resistance. For example, two 171A tubes in push pull draw 40 milliamperes and require a bias of 40 volts. The value of the C-bias resistor should, therefore, be 1000 ohms. If, however, a 200-ohm center-tapped resistor (values as high as this are frequently used) is placed across the filament of the tube, one half of this value (100 ohms) should be subtracted from the required 1000 ohms leaving 900 ohms. This value should then be used for the C-bias resistor.

THAT TRADE GOSSIP

(*Continued from page 259*)

other, and have worked together. Every difficulty as to harmonious action has been the breeder of some new form of distribution, the mail order house, the department store, the chain store, the manufacturer's own retailing system—and yet the independent dealer, in the aggregate, remains the principal retail factor. He and the manufacturer understand each other a little better than they did once—but not well enough yet, by far.

Welcome the wholesaler's salesman, make him your friend, make him work for you, tell you the news of how other dealers are making a success, but do not exchange cheap and unreliable gossip with him. You can give him much and he can give you much that is real and important.

To your customer you must always appear substantial and reliable. There is money in your pocket in having him respect you. In your business, your customer looks up to you as an expert in a mysterious business.

"The customer is always right?" Not always. He is not right when he wants to take your profit away from you and you should have a nice way of telling him so. There is a nice way to do this, also a nasty way. The customer is not right when he wants to trade-in a bum set for many times what it will bring as junk. He generally is not as up to date about radio as he likes to appear. No he is not always right but he is interested, and that is the thing for you to build on. He needs education, both in your merchandise and in the common rights of a merchant.

Remember this about customers. They have been catered to, flattered, made love to by advertising to such an extent that they are all puffed up with the importance of their own little dollars. They do not know how to treat a dealer fairly. They do not realize that if he gives up his profits he cannot continue to serve them. But they are human. Most of them are trying to make a living for themselves. They are quite capable of being educated into being profitable customers.

News vs Gossip

The distinction we have made between "news" and "gossip" is often a hair-line distinction. How can we get the "news," which is wholesome, and kill the bad effects of "gossip"?

The first step is to see the seriousness of what it means and act accordingly. The next is to fix the imagination on being a successful dealer and act accordingly, that will keep any man busy.

Simple and self-evident as all these things are, we are very apt to ignore them. We are very prone to help foolish gossip along, then wonder why the good will in our industry is no better than it is.

Everybody has a stake in this.

"Among the many things we talk about, what is dangerous gossip, and what is real and valuable news?"

The only answer I can give to that is—You generally know that difference yourself if you will stop to think. Broadly speaking, any display of real enthusiasm for radio and radio merchandise is promotive and valuable, while knocking of radio, knocks at people in radio, indications of fear for radio's future are taking money out of your own till and throwing it away.

[Another article by Mr. Dickinson will appear in the October RADIO BROADCAST. In this article the advertising problems of a retail radio store will be discussed from all angles—*Editor.*]

IN THE RADIO MARKET-PLACE

(*Continued from page 277*)

up district offices in each territory and the district sales managers are now busily engaged in conducting jobber and dealer meetings throughout their respective districts, cementing closer contacts between the manufacturer and the dealers and getting the field in order for a record year.

The five district managers are R. C. Hopkins, C. H. Griffith, J. G. Baquie, C. A. Lindevall, and J. A. Ramsey.

R. C. Hopkins is at the head of the Eastern District, with an office at 39 Broadway, New York. His territory includes such distributing points as New York, Boston, New Haven, Albany, Rochester, Philadelphia, Baltimore, Syracuse, Scranton, Nashville, Atlanta, Miami, and New Orleans.

The Eastern Central District with headquarters at 547 Leader Building, Sixth and Superior Streets, Cleveland, Ohio, has C. H. Griffith in charge. His distributing points include Cleveland, Cincinnati, Columbus, Toledo, Detroit, Muskegon, Pittsburgh, and Buffalo.

Chicago is the headquarters of the Central District, with J. G. Baquie in charge. Jobber headquarters in this district include Chicago, Milwaukee, St. Louis, Peoria, Indianapolis, and Elkhart. Central District offices are now located at 702 London Guaranty Building, 360 North Michigan Boulevard, Chicago, Illinois.

C. A. Lindevall is at the head of the Western Central District with offices at 550 Gates Building, Kansas City, Missouri. In his territory are Minneapolis, Mitchell, Omaha, Kansas City, Oklahoma City, Dallas, Houston, and Memphis.

The Western District, with J. A. Ramsey in charge, includes San Francisco, Los Angeles, Portland, Seattle, Spokane, Boise, Butte, Salt Lake City, and Denver. Headquarters are located at 625 Market Street, San Francisco.

HAZELTINE PATENTS UPHELD

THE DECISION of the Federal Court of Brooklyn in upholding the Hazeltine Corporation patents for eliminating undesirable generative effects in radio was affirmed July 2nd by the Circuit Court of Appeals.

The Corporation, as a test case, sued E. A. Wildermuth, a wholesale dealer in Atwater-Kent models, which, it was alleged, infringed on the corporation's patents, applied for in 1920, and issued a year later. It was indicated that an appeal might be taken to the United States Supreme Court as all the Atwater-Kent models of that type are involved. The new Atwater-Kent screen-grid tube set is not involved, in the suit, however, although a Hazeltine representative is quoted as saying that a move against that type of set may be taken later.

EFFECTIVE RETAIL ADVERTISING

R. B. JOLLEY, Atwater-Kent dealer in Morristown, N. J., is going far and wide to advertise and promote his sales. This progressive dealer's latest stunt is to take full back-cover space in local motion-picture theatre programs.

"People who frequent movie theatres," says Mr. Jolley, "are red-hot prospects for the modern radio. That a definite part of their leisure time is devoted to entertainment—the more varied the better—is proved by their more or less regular movie attendance. I have found that this method of advertising is particularly effective, especially from a cost-versus-coverage standpoint. The majority of the average local motion pictures programs are two or four page leaflets—easily and quickly read. Your radio message, covering one entire page at an extremely low cost, possesses immediate force and direct appeal."

SPARKS-WITHINGTON INCREASES CAPITAL STOCK

WITH BUSINESS in hand to justify the promise of an unprecedented output of Sparton radios for 1929–30, and with the past season, a record year in profits the stockholders of the company authorized an increase in the capital stock from 400,000 shares to 2,000,000. At present there are outstanding 166,498 shares of common stock, and 7884 shares of preferred stock. Captain William Sparks, president of the company, states that booked orders starting after July 1 amount to double the business prospect of a year ago.

MAKERS TO EXHIBIT RAW MATERIALS

FIFTY MANUFACTURERS of parts and raw materials have indicated their purpose to exhibit to the public at the forthcoming national radio expositions, the Radio World's Fair, in New York in September, and the Chicago Radio Show, in Chicago, in October. G. Clayton Irwin, Jr., general manager of the two shows, has completed details for a "Parts and Raw Materials Section" in the shows, and a "Parts and Raw Materials Directory" to be made available to all. Such a directory will fill a definite need. There is no single source to which radio manufacturers may turn for information regarding parts or raw materials which enter into set, speaker, tube, or apparatus construction.

ADVANTAGES OF PRE-SELECTION

(*Continued from page 296*)

tor." This detector utilizes an ordinary heater-type tube such as is used in the amplifier. Suitable choice of operating voltages enable as high as 15 volts of modulated r.f. to be applied to the detector input without overloading.

In practice, the volume control is usually adjusted to provide sufficient amplification for raising the voltage of the received signal to a value of about 10 volts. The amplified signal is impressed directly upon the detector which is in the same container as the radio-frequency amplifier. The output of this detector when a 10-volt signal is impressed upon the input is sufficient to operate directly the largest power tubes employed to-day.

Power Supply Apparatus

The single stage of audio-amplification employed in the Equasc system has a gain of about $\frac{1}{5}$ of the conventional two-stage audio amplifier. The demands upon the filter are reduced in like proportion. In fact, the resistance of the field coil in the dynamic loud speaker may be used in place of the choke coils usually employed, and but two filter condensers are needed; and the residual hum is inaudible! The saving in weight and size of power unit and the minimization of service troubles brought about by this simplicity, results in a great economy indeed.

THE TUBE BUSINESS

(*Continued from page 278*)

OF INTEREST TO WIRE EXPORTERS

WILL MANUFACTURERS who desire to export tungsten-filament wire, oxide-coated wire, molybdanum wire, nickel ribbon, and wire net write to V. Hirota, managing proprietor, The Sun Denchi Seisakujo, No. 18 Zengenjicho, Nichome, Osaka, Japan. On June 10 this company desired names of manufacturers who sold such material for the construction of radio tubes.

SYLVANIA HAS NEW LAB

A "SALES ENGINEERING LABORATORY" has been established at the Sylvania plant to aid in "rendering the utmost in service to the user of Sylvania tubes." This laboratory, housed in a neat brick building some distance from the main factory, and equipped with modern measurement instruments, life-test racks, etc., is under the charge of Walter R. Jones. The main purpose of the laboratory is to maintain a "control" on the quality of Sylvania tubes; to maintain close contact with the field, and lend assistance in technical problems in regard to sales. In maintaining control on Sylvania output, tubes made at Emporium as well as at other tube plants will undergo constant life tests.

REGARDING TUBE LIFE

ARCTURUS ENGINEERS believe that radio tubes receiving proper care in the average sets of to-day will last two years. If tubes need to be replaced at short intervals the A, B, and C voltages are probably wrong or fluctuate due to line-voltage variation. It would be interesting to have the experiences of a sufficient number of servicemen to answer the question, "in actual service how long do present-day a.c. tubes last?"

KEEPING ABREAST OF THE TIMES

"A RADIO PLANT is no stronger than its engineering personnel," says Ernest Kauer of CeCo. "No institution can keep moving forward unless it maintains the vigor and imagination of its engineering department. Frequently the engineer's tests demand a rejection of from 25 to 50 per cent. of the day's output. This is an awful blow for the head of a plant to have to accept—but there is no way out. High standards are more important than ever this year, for many institutions are seeking volume to such an extent that there is apt to be a careless attitude toward technical standards."

NEW FILAMENT PREPARATION

A NEW PROCESS of coating the filament of a.c. tubes has been developed by Triad engineers. A non-oxide preparation is used which has proven highly effective in prolonging the life of the tubes. The Triad company, to quote Harry H. Stienle, sales manager, is a "new organization of old manufacturers." The company has floor space totalling something over five acres; has a daily capacity at present of 50,000 tubes which can be almost doubled when, and if, necessary or desirable; will spend more than a half-million dollars in advertising; will appoint only a limited number of jobbers.

The Executive Officers are George Cohy, president, Ely Egnatoff, treasurer, Harry Steinle, vice-president and general sales manager, and William Cepek, secretary. Its engineering staff includes S. U. Marie, Ph.D., Roger Williams, Ph.B., A. S. Friedman, Sc.B., and George Rylsky, E.E. M.E.



START THE RADIO SEASON WITH A REAL POWER AMPLIFIER

USE either the UX-250 Tube or the UX-245 Tube as a basis for equipping your set with up-to-date power amplification. Programs this year will far exceed all previous broadcasting and you can get each one as realistically as anyone could desire, for a reasonable cost.

POWER PARTS BY DONGAN

Designed especially for UX-245 Tube, the following Parts will build you the very latest and finest kind of Power Amplifier—the type used with the new high-priced receivers.

No. 994 Power Amplifier Transformer		$12.00
either No. 2189 Push-Pull Output Transformer	$12.00	
with No. 2142 Push-Pull Input Transformer	4.50	
or		
No. 3107 Straight Output Transformer	12.00	
with No. 2158 Audio Transformer	4.50	
D-946 Standard Condenser Unit		22.50
No. 5554 Double Choke (use in Filter Circuit)		11.00
No. 2124 Transformer (for Push-Pull Radio and Phonograph Amplifier)		6.00

Get complete information on the new and approved types of Power Amplifiers using UX-245 and UX-250 Tubes and Dongan Approved Parts. For immediate delivery of any of these parts send check or money order.

DONGAN ELECTRIC MANUFACTURING CO.
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TRANSFORMERS of MERIT Since 1911

There's Only One Audion

Radio tubes made in the laboratories of Dr. Lee De Forest, "The Father of Radio" are called De Forest Audions. The name on the base is your guarantee of getting the genuine.

DE FOREST RADIO CO.
JERSEY CITY NEW JERSEY



de Forest AUDIONS

New! A. C. Line Voltage Control

For Radio Set Manufacturers

A remarkably convenient and efficient device which *automatically* handles A. C. line fluctuations over a broad range.

Does not add to chassis cost.

For Details, Write Dept. RB9.

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Makers of the AMPERITE
The "SELF-ADJUSTING" Resistor

A Radio Parts Guide

THE NEW YAXLEY Catalog



Send for it today for complete listings of Radio Convenience Outlets, Connector Plugs, Rheostats, Fixed and Grid Resistances, Jacks, Jack Switches, Phone Plugs, etc.

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most amusing of the new smart accessories found every month in the pages of *The American Home*. $1.00 a year.

Garden City, N. Y.

ROBERT S. KRUSE

Consultant and Technical Writer

103 Meadowbrook Road, West Hartford, Conn.
Telephone Hartford 45327

HELPFUL TECHNICAL INFORMATION

A regular feature of RADIO BROADCAST is the series of Laboratory Information Sheets, which cover a wide range of information of immediate value to every radio worker, presented in a form making it easy to preserve them. To insure your having every issue, send your check for $4.00 for one year's subscription to

Subscription Department
Doubleday, Doran & Company, Inc.
Garden City, N. Y.

SM

New S-M Custom Receiver Designs Shatter All Records

Single Control

Perfect convenience in operation, with a tremendous gain in selectivity and sensitivity—that's what has been accomplished in the new S-M receivers. Newly developed shielded coils make possible, with straight single control, a degree of selectivity never before achieved, *even with multiple controls or verniers.* One tuning control, one volume control, an on-off switch—that's all. All these receivers have push-pull 245 output stages, and both broadcast receivers embody the latest band-selector tuning.

All-A. C. Operation

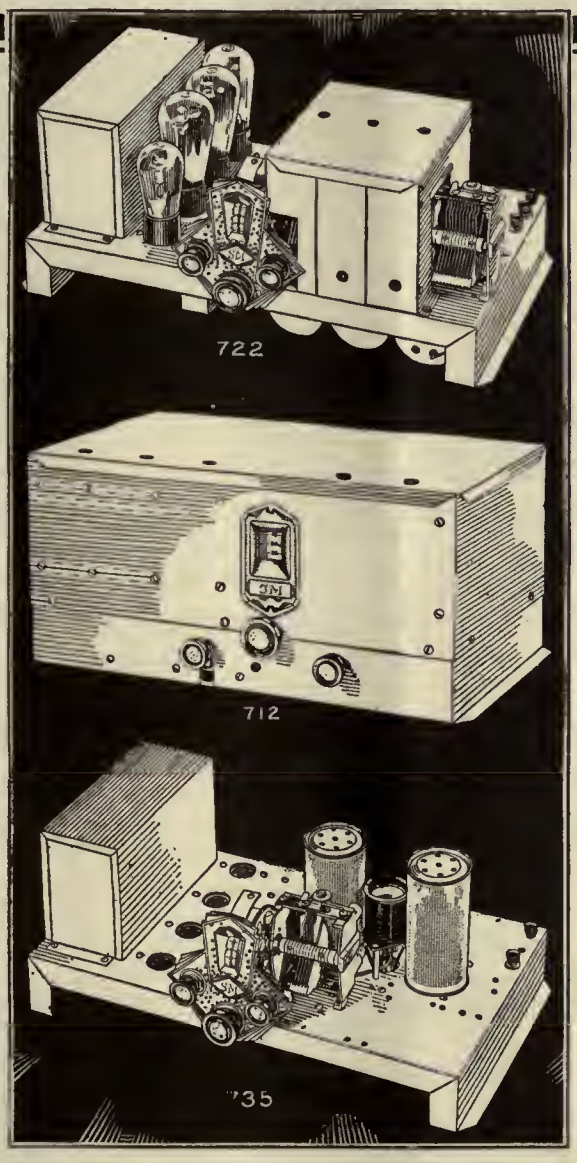
These receivers are *absolutely all-electric*—even the 735 short-wave set, the first of its kind ever offered on the market. Power supplies are *built into* the receivers—not separate. The *full* advantages of the new a. c. screen-grid tubes are secured. The characteristic superior S-M tone quality, distance-range, and selectivity are in these receivers as never before, due not alone to band-selector tuning but also to still greater refinements of design and accuracy of manufacture.

S-M Speakers and Power Amplifiers

Nothing more beautiful in sound reproduction has ever been heard than the new S-M dynamic speakers, when supplied from a powerful S-M push-pull audio amplifier—giving straight-line amplification from 5000 cycles down even to below 50. These new medium-voltage high-power two-stage amplifiers, using 245 tubes in push-pull are built into the 722 and 735, and an extra high-grade Clough-system amplifier is obtainable separately, as the 677.

Beautiful Cabinets

The handsome new 707 table model shielding cabinet, finished in rich crystalline brown and gold, suitable for 722, 735, or 735DC, is only $7.75. Special arrangements have been made whereby these receivers may be housed in magnificent consoles especially adapted to them. Be sure to send for the new Fall S-M General Parts Catalog, for details of these cabinets.



722 Band Selector Seven

Providing practically all 1930 features found in most new $200 receivers, the S-M 722 is priced absurdly low in comparison. 3 screen-grid tubes (including detector), band-filter, 245 push-pull stage—these help make the 722 the outstanding buy of the year at $74.75 net, completely wired, less tubes and cabinet. Component parts total $52.90. Tubes required: 3—'24, 1—'27, 2—'45, 1—'80.

712 Tuner

Far more selective and sensitive even than the Sargent-Rayment 710, the new single-control 712 with band-filter and power detector stands far beyond competition regardless of price. Feeds perfectly into any audio amplifier. Tubes required: 3—'24, 1—'27. Price, only $64.90, less tubes, in shielding cabinet. Component parts total $40.90.

677 Amplifier

Superb push-pull amplification is here available for only $58.50, less tubes. Ideal for the 712. Tubes required: 2—'45, 1—'27, 1—'80. Component parts total $43.40.

735 Short-Wave Receiver

A screen-grid r. f. stage, new plug-in coils covering the bands from 17 to 204 meters, regenerative detector, a typical S-M audio amplifier, all help to make this first a. c. short-wave set first also in performance. Price, wired complete with built-in power unit, less cabinet and tubes, only $64.90. Component parts total $44.90. Tubes required: 1—'24, 2—'27, 2—'45, 1—'80. Two extra coils, 131P and 131Q, cover the broadcast band at an extra cost of $1.65.

Adapted for battery use (735DC) price, $44.80, less cabinet and tubes. Component parts total $26.80. Tubes required: 1—'22, 4—'12A.

Did You Get the Red-Hot News in the July RADIOBUILDER?

Keep up-to-date on Silver-Marshall progress; don't be without THE RADIOBUILDER. New products appear in it in advance of public announcements—all of the receivers and cabinets above were described in detail and illustrated in THE RADIOBUILDER for July. Many hints on operating and building appear in it. Use the coupon.

It Looks Like a Big Year For S-M Service Stations

Custom-builders using S-M parts have profited tremendously through the Authorized S-M Service Station franchises. Silver-Marshall works hand-in-glove with the more than 3000 professional and semi-professional builders who display this famous insignia. If you build professionally, let us tell you all about it—write at once!

SILVER-MARSHALL, Inc.

6403 West 65th St., Chicago, U. S. A.

Silver-Marshall, Inc.
6403 West 65th Street, Chicago, U. S. A.

....Please send me, free, the new Fall S-M Catalog; also sample copy of The Radiobuilder.

For enclosed.....in stamps, send me the following:

.... 50c Next 12 issues of The Radiobuilder
.... $1.00 Next 25 issues of The Radiobuilder

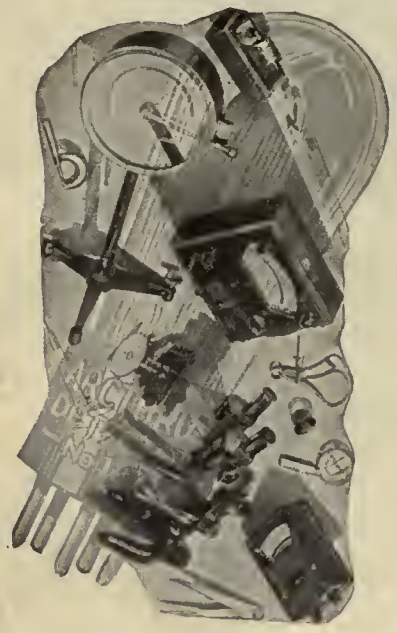
S-M DATA SHEETS as follows, at 2c each:

....No. 3. 730, 731, 732 Short-Wave Sets
....No. 4. 255, 256, etc., Audio Transformers
....No. 5. 720 Screen Grid Six Receiver
....No. 6. 740 "Coast-to-Coast" Screen Grid Four
....No. 7. 675ABC High-Voltage Power Supply
....No. 8. 710 Sargent-Rayment Seven
....No. 9. 678PD Phonograph-Radio Amplifier
....No. 10. 720AC All-Electric Screen-Grid Six
....No. 12. 669 Power Unit (for 720AC)
....No. 14. 722 Band-Selector Seven
....No. 15. 735 Round-the-World Six
....No. 16. 712 Tuner (Development from the Sargent-Rayment)
....No. 17. 677 Power Amplifier for use with 712

Name.....

Address.....

Precision manufacturing safeguards correct design



THE most advanced principles of design, the most unique features of construction, cannot in themselves produce tubes of uniform characteristics. *Manufacturing accuracy must measure up to engineering skill in every respect.*

The unvarying excellence of Arcturus Tubes is due as much to painstaking production methods, rigidly adhering to accurate standards, as to unique design. This rare combination has gained widespread recognition for these exceptional tubes.

By inspecting every tube 137 times, approving only those tubes whose characteristics fall within the narrowest manufacturing limits, ARCTURUS has set a standard of uniform quality unsurpassed by any tube on the market today.

ARCTURUS

BLUE A-C LONG-LIFE TUBES

ARCTURUS RADIO TUBE COMPANY ~ Newark, N. J.

TESTING SCREEN-GRID TUBES



The Type 443 Mutual-Conductance Meter tests triodes and screen-grid tubes with equal ease. Manufacturers, jobbers, and dealers are using this instrument to make inspection tests.

It is compact, easy to operate, and thoroughly reliable.

Send for Descriptive Literature

GENERAL RADIO COMPANY

30 State Street
Cambridge, Massachusetts

274 Brannan Street
San Francisco, California



A Beautiful NEW Panel Plate



for the Famous

HAMMARLUND DRUM DIAL

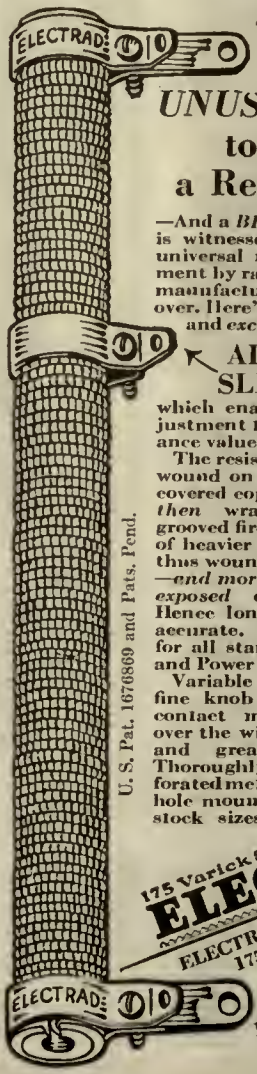
RICHLY embossed, pebbled bronze in the modern mode. It has grace and charm appropriate to the superb dial mechanism back-panel that delighted thousands of set builders last season.

The control knob can be mounted *anywhere* on the panel. Illuminated scale.

Write Dept. RB9 for Details

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For Better Radio
Hammarlund
PRECISION
PRODUCTS



"What an *UNUSUAL* Way to Wind a Resistance"

—And a *BETTER* way too, as is witnessed by its almost universal use and endorsement by radio engineers and manufacturers the world over. Here's another unusual and *exclusive* feature, the

ADJUSTABLE SLIDING CLIP

which enables instant adjustment to the exact resistance value desired.

The resistance wire is first wound on a small asbestos-covered copper core. This is *then* wrapped around a grooved fire-clay base. More of heavier resistance wire is thus wound in smaller space *—and more of its surface is exposed and air-cooled.* Hence longer-lasting—more accurate. Sizes and ratings for all standard Eliminator and Power Pack use.

Variable models also, with fine knob adjustment—the contact moving *ENDWISE* over the wire with less wear and greater smoothness. Thoroughly air-cooled. Perforated metal shield, one-hole mounting. 22 stock sizes.

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Please send TRUVOLT literature.
Name .....
Address .....

COMMAND
the ENTIRE WORLD with Pilot's Double Duty
SUPER-WASP



CUSTOM SET-BUILDER'S PRICE

A combination short wave and broadcast receiver covering all wave lengths from 14 to 500 meters. Price of kit includes two sets of five interchangeable plug-in coils, full-sized blueprint, and complete assembly data.

$29.50

Slightly higher west of the Rockies

Why miss half the *joy* of radio? The Pilot Double-Duty Super-Wasp, designed by Robert S. Kruse internationally famous short-wave authority, will give you *radio's greatest thrill* for a few dollars and a single evening's "work" with screwdriver and pliers. Uses only four tubes—*including the super-sensitive screen grid!* Enthusiastic radio fans report *nightly reception* of Chelmsford, (England), PCJ Eindhoven (Holland), Costa Rica, Central and South America, Canada, Cuba, South Africa and Australia! Exceptional results because exceptionally engineered, and priced right because produced in the world's largest radio parts plant! *Hear the Super-Wasp at any authorized Pilot Agency.*

PILOT *Now Makes* RADIO TUBES!

Pilotron tubes *"Built for Professionals"* are especially designed and constructed for the professional radio engineer, custom set-builder and amateur—an audience which is super critical—*and has a right to be!* Moreover Pilotron tubes are available many months before you can obtain them from the usual sources. This gives custom set-builders an opportunity to use new tubes long before they are available in manufactured receivers. You would think that because of this, Pilot tubes would cost more—but they don't! Pilot's self-contained manufacturing provides *definitely superior* tubes at the usual prices! Stocked by all Pilot authorized agencies.

PILOTRON



BUILT *for* PROFESSIONALS

TRADE MARK REGISTERED



DEALER'S OPPORTUNITY! The Pilot policy of encouraging individual experimentation and custom set-building is the greatest single factor in stabilizing and maintaining the parts and kit business. Technically qualified and financially responsible dealers are invited to write for details of our agency plan.

HOW TO KEEP STEP WITH NEW DEVELOPMENTS. Send 50c for four quarterly issues "Radio Design" and membership in the Radio International Guild, *a world-wide organization* of radio engineers, experimenters, and custom set-builders. Radio Design, Dept. A. 103 Broadway, Brooklyn, N. Y.

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A Radiotron for every purpose

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RADIOTRON UX-222
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RADIOTRON UX-171-A
Power Amplifier

RADIOTRON UX-210
Power Amplifier Oscillator

RADIOTRON UY-224
Screen Grid Radio Frequency Amplifier (A. C. Heater)

RADIOTRON UX-240
Detector Amplifier for Resistance-coupled Amplification

RADIOTRON UX-245
Power Amplifier

RADIOTRON UX-250
Power Amplifier

RADIOTRON UX-226
Amplifier (A. C. Filament)

RADIOTRON UY-227
Detector Amplifier (A. C. Heater)

RADIOTRON UX-280
Full-Wave Rectifier

RADIOTRON UX-281
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RADIOTRON UX-874
Voltage Regulator Tube

RADIOTRON UV-876
Ballast Tube

RADIOTRON UV-886
Ballast Tube

The standard by which other vacuum tubes are rated

Look for this mark on every Radiotron



The national magazine advertisement reproduced at the left is one of the 1929 Radiotron series, each of which carries the signature of a leading radio manufacturer.

Dealers enjoying the largest tube sales—and making the biggest profits—are those who carry the full line of RCA Radiotrons—and are never out of stock. Radio customers naturally choose the stores that have a reputation for always being stocked with the complete line of RCA Radiotrons.



Superior resources of research and manufacturing guarantee to RCA Radiotrons the finest possible quality in vacuum tubes. They are the standard of the industry—and so accepted by both the trade and the public.

RADIOTRON DIVISION
RADIO-VICTOR CORPORATION OF AMERICA • NEW YORK • CHICAGO • ATLANTA • DALLAS • SAN FRANCISCO

RCA RADIOTRON

RADIOTRONS ARE THE HEART OF YOUR RADIO SET

THE COUNTRY LIFE PRESS, GARDEN CITY, NEW YORK

OCTOBER 1929

RADIO BROADCAST

UBLISHED FOR THE RADIO INDUSTRY



PECIAL FEATURES IN THIS ISSU

How Shall the Dealer's Advertising Dollar Be Spent?

Lessons from the Automobile Industry

The Telephone Rings the Doorbell Today

Are the Coming Changes in Distribution Methods? · News of the Radio Industry · Paths to Profit in Se
ested Sales Ideas · Design of the Colonial Receiver · The Future of the Pentode Tube · The Tube Busines

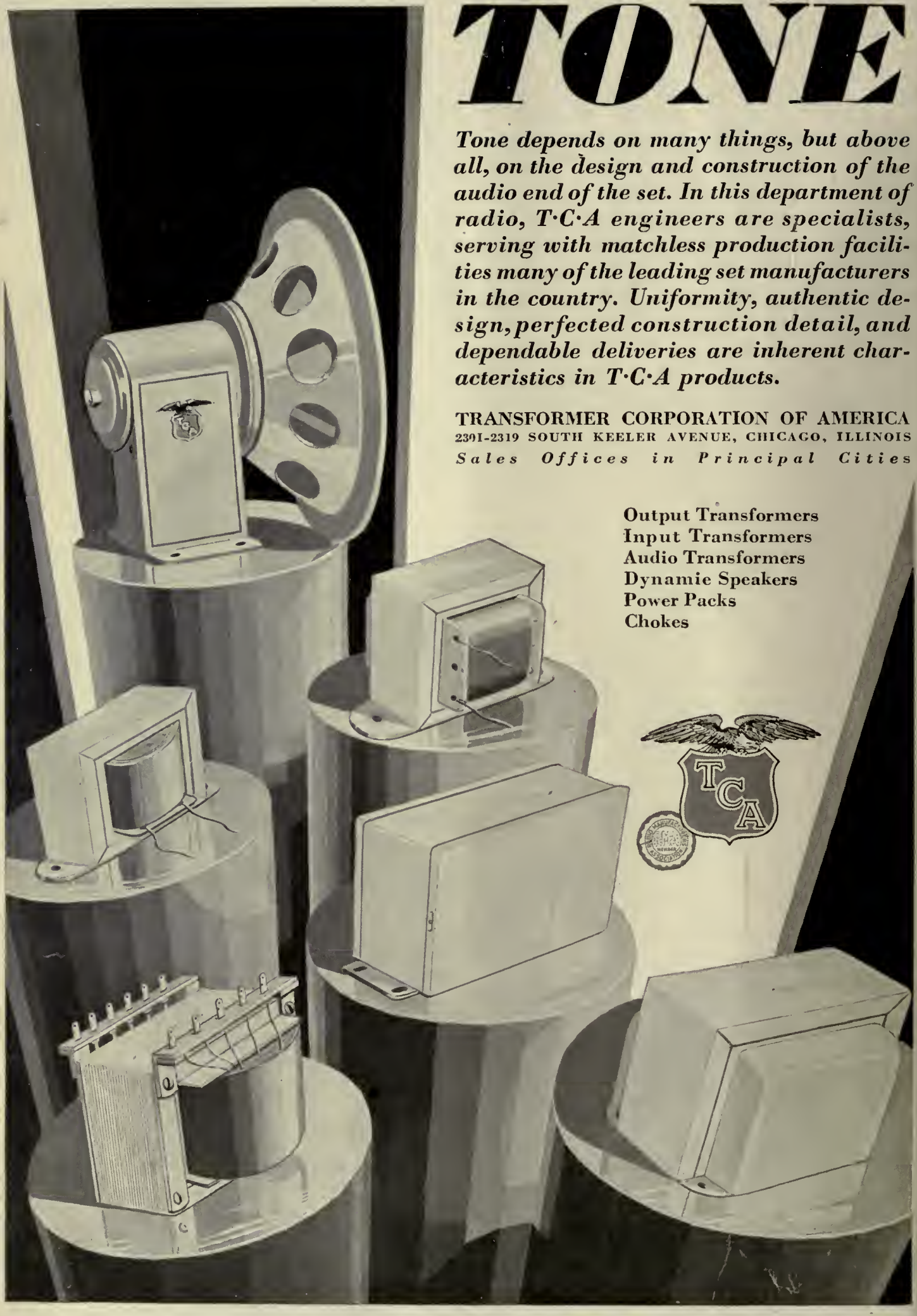
THIRTY FIVE CENTS

UBLEDAY, DORAN & CO., INC. ◆ GARDEN CITY, NEW YORK

TONE

Tone depends on many things, but above all, on the design and construction of the audio end of the set. In this department of radio, T·C·A engineers are specialists, serving with matchless production facilities many of the leading set manufacturers in the country. Uniformity, authentic design, perfected construction detail, and dependable deliveries are inherent characteristics in T·C·A products.

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Output Transformers
Input Transformers
Audio Transformers
Dynamic Speakers
Power Packs
Chokes

RADIO BROADCAST. October, 1929. Published monthly. Vol. XV, No. 6. Published at Garden City, N. Y. Subscription price $4.00 a year. Entered at the post office at Garden City, N. Y., as second class mail matter. Doubleday, Doran & Company, Inc., Garden City, N. Y.

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Have every set sent out on demonstration functioning at maximum efficiency.

Keep all sets sold in continuous efficient operation at negligible cost.

Know that the tubes you sell or install are right by testing them under actual operating conditions. Defective tubes cause a large percentage of radio troubles.

Make real profits in servicing by saving time and increasing efficiency.

Eliminate expensive and annoying returns to distributor or factory by making all adjustments or repairs in the owner's home accurately and quickly.

Build "good will" thru the enthusiastic satisfaction of your patrons—an ever growing asset to your business.

All of this can be accomplished *only* by the use of the SUPREME DIAGNOMETER—the *only* service instrument that insures *thorough, scientific service work.*

If you don't buy a SUPREME you pay for it anyway many times over in wasted time and inefficiency. If you buy a SUPREME you pay for it but once and it becomes a permanent asset for your business, earning dividends daily in actual cash and customer good will.

Don't deprive yourself of these additional profits by delay.



The *Only* Complete Portable Radio Testing Laboratory

Thorough and Complete, yet surprisingly simple. The SUPREME RADIO MANUAL gives full instruction and much valuable radio information.

No other radio testing device can anywhere near approach the range, completeness and flexibility of the SUPREME DIAGNOMETER. A test will show you. Send for ours which is confidently called "A Test that Challenges Attention." Some of the outstanding features of the SUPREME are:

All tubes tested under actual operating conditions. Provides the only tube test of dependable value.

Screen grid socket analysis without oscillation.

750 Volt 4 scale A.C. and D.C. meters, 3 scale milliameter.

Self-contained power plant.

Modulated radiator for testing, synchronizing, neutralizing.

External connections to all apparatus.

Tests both plates '80 type rectifiers.

All continuity tests without batteries.

Universal analyzer plugs.

Handy carrying case providing compartments and space for all tools and spare tubes.

---and a request for complete specifications will reveal numerous other superiorities.

"Set Testers" prove only 29% to 40% efficient in comparison with the SUPREME DIAGNOMETER

Supreme Service League

To Radio Owners: Look for this emblem in your radio shop, on the lapel button or card of your service man. It is your guarantee of dependable radio service. Cash in on the prestige the SUPREME SERVICE LEAGUE is building.

Order NOW

Present production permits immediate deliveries but the momentum of sales is such that buyers are cautioned to place their orders now.

Reservations will be made against all orders placed for future delivery on specified dates. Make use of this plan to avoid disappointments.

(Most good distributors carry the SUPREME DIAGNOMETER in stock. If yours cannot supply you, send order direct on form to the right.)

Supreme Instruments Corp.
342 Supreme Bldg.
Greenwood, Miss.

Please ship SUPREME DIAGNOMETER Model 400-B on basis checked below.

☐ Net cash $139.50.

☐ Time payment plan—$33.50 cash and 8 monthly payments of $15.00 each.

All prices are F.O.B. Greenwood, Miss. No dealer's discount.

Date shipment desired.....

Signed.....

Firm Name.....

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Street Address.....

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City.....

State.....

Please give three or more bank or trade references and names of distributors from whom most purchases are made.

SUPREME

Radio Diagnometer

Makes every conceivable test on any Radio Set-

The Big News



RADIO TUBE MERGER LINKS 4 COMPANIES

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...move to create a new unit in radio tube industry was announced yesterday...

THE "NEW YORK TIMES," AUG. 24, devoted almost an entire column to the announcement of the National Union Radio Corporation.

NATIONAL UNION RADIO PLEDGES QUALITY TUBES

"Finest Tubes science can design" assured by Executive Vice-President

"One of the basic features of National Union policy," says Nathan Chirlestein, Executive Vice-President, "is quality tubes Our plans call for extensive testing systems, expert engineers, every precaution necessary to make National Union Tubes stand for the utmost in quality. We know very well that you can't sell a bad tube twice. So you can rest assured that every effort will be made to assure jobbers and retailers everywhere the finest tubes science can design."



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is Out!

Newspapers From Coast to Coast Herald the Entry of a New Giant Into the Tube Business . . .

National Union Radio Corporation

takes its place beside R. C. A. and Cunningham . . . experts now forecast the end of present chaotic trade practices



On August 23rd at 4:10 P. M. the final papers were signed . . . a clerk released the news to 1100 newspapers . . . the National Union Radio Corporation had at last become a fact!

The radio editors of a big New York paper describe it as "The most important radio news this year."

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"National Union will do much to stabilize the radio tube business."

Retailers the country over are greeting the news with enthusiasm.

National Union with a capacity of 75,000 tubes a day becomes one of the three largest manufacturers of radio tubes in the world.

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Directed by a group of the country's ablest radio executives, it should quickly win a position at the head of the radio industry.

Through a reciprocal agreement with R. C. A., National Union will have the benefit of every important existing radio patent.

Look for big things from this new organization. Look for the fairest trade practices in the business. Look for the finest tubes science can devise.

More big news will follow during the next few months. Watch the next issue of this magazine.

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This new book contains most of the information that anyone seriously interested in Radio would want to know. Subjects *never before treated in a Radio book* are covered here in a thorough, simple, and lucid manner.

26 Chapters: Introduction to Radio; Magnetism—The Electron Theory; The Production of Electromotive Force; Electromagnetic Induction; Motor-Generators—Starters; Curve Diagrams; Storage Batteries and Charging Circuits; Meters; Alternating Current and Frequencies; Condensers—Electrostatic Capacity—Capacity Measurements; Vacuum Tubes; Receiving Circuits; Alternating Current Operated Receivers and A-C Tubes; Telephone Receivers—Loudspeaker Reproducing Units; Commercial Receivers; Rectifier Devices—Rectifier Circuits—Voltage Divider Resistors—Filter Circuits; High Voltage Condensers; Antennae or Aerials; Resonnnee; Commercial Broadcast and Telegraph Transmitters; Commercial Tube Transmitters; Short Wave Transmitters and Receivers; Spark Transmitters; The Arc Transmitter; Direction Finders—Radio Compass; Radio Telephone Broadcast Transmitter Equipment; Appendix.

"Radio Telegraphy and Telephony" was published in May. You will find in this book the most recent information on current principles, methods, and equipment. Over 900 pages for $7.50. You may have it on approval for 10 days—but as one radio expert wrote us, "Ten minutes, not ten days, should be sufficient to convince any real radio man that he needs 'Radio Telegraphy and Telephony.'"

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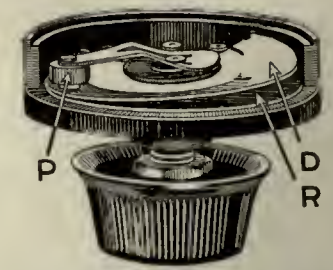
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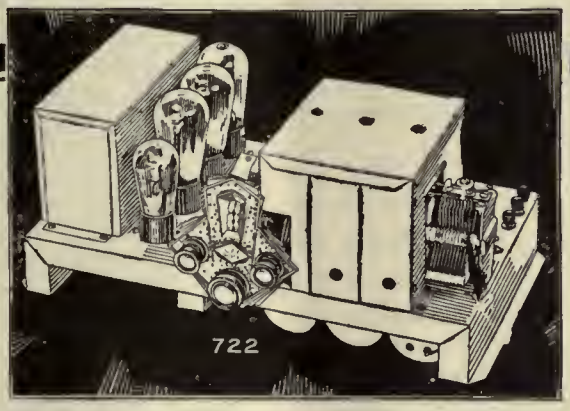
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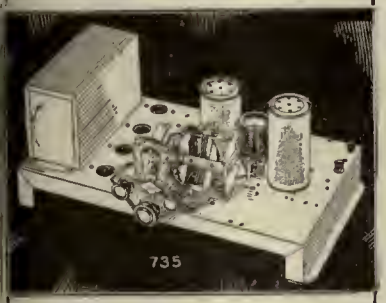
S-M 707 metal shielding table cabinet in beautiful crystalline brown and gold for 722 or 735, $7.75 net.

Three beautiful console cabinets, adapted especially for mounting S-M 722, 735, or 712 with 677 by the I. A. Lund Corporation, are available from leading supply houses: see the new S-M Fall Catalog.

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power unit; the component parts total $44.90 net. Tubes required are: 1—'24, 2—'27, 2—'45, and 1—'80.

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You know the Sargent-Rayment Seven—universally found to be the most sensitive broadcast receiver ever developed. Here, in the new 712 Tuner, is every feature of the 710 Sargent-Rayment—the five tuned circuits, the ultra-perfect shielding—the extra-fine r. f. coils—all built into an all-electric strictly single-dial tuner, with band selector tuning and power detection. Tubes required: 1—'27, 3—'24. Completely wired in satin-finish metal shielding cabinet, less tubes, $64.90 net. Works into any audio amplifier.

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Complete circuit diagrams of the 722 and 735 were first published in the RADIOBUILDER for August. Valuable suggestions on building and servicing are to be found in every issue. Use the coupon.

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RADIO BROADCAST

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PUBLISHED FOR THE RADIO INDUSTRY

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. . . *among other things*

THIS MONTH we take a few lines to quote the plaint of a dealer who has the problem of selling radio in a rural community. His shop is in North Dakota. He says: "Have the radio manufacturers forgotten there is a rural population? I do not know of a commercial receiver that is practical and at the same time economical in operation for the user of batteries that can even approach the satisfactory performance of the modern socket-powered sets.

AS A DEALER in a rural community I expect approximately fifty per cent. of my business from the rural population who have no electric light service, and I have to get along with magnetic loud speakers and the power output of a 112A tube, unless they can afford an extensive outlay of B batteries and continual charging of storage batteries to operate a larger power tube and dynamic loud speaker.

IT IS MY impression that any manufacturer who would market a practical four- or five-tube screen-grid set with a low plate-current consumption and the volume level of a 171A tube or more would be amply rewarded for his efforts. As it is, sales on battery sets will be bound to slump badly and a large potential market is being sadly neglected."

LET THE rural dealers take heart. It will not be long that the battery-user will be penalized for his lack of electric power service. Some sets are already on the market to meet this requirement—and it is a real one—and more are on the way. We should not be surprised to see new tube design contribute greatly within the next twelvemonth to a more complete answer to this need.

THE ROCHESTER, Buffalo-Niagara, Cleveland, and Toronto sections of the Institute of Radio Engineers are sponsoring a district convention to be held in Rochester, N. Y., November 18 and 19. Papers will be delivered by A. Hoyt Taylor, W. A. MacDonald, W. C. White, and others.

—WILLIS KINGSLEY WING.

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Arcturus *Blue* A-C Tubes are so well designed and carefully built that they cut costly tube trouble to the minimum. Dealers who equip all their A-C sets with these exceptional tubes have found by actual experience that *Arcturus Tubes cut service calls 50% or more.*

This means greater profits from set sales, and thoroughly satisfied customers. Arcturus *Blue* Tubes make any A-C set do its best because they act in 7 seconds, do away with hum, give true tone and hold the world's record for long life.

If you are not now selling these perfected tubes, write for all the facts and join the ranks of satisfied retailers who are making more money with Arcturus.

ARCTURUS RADIO TUBE COMPANY
NEWARK, N. J.

ARCTURUS

BLUE A-C LONG-LIFE TUBES



THE TELEPHONE RINGS THE DOORBELL

By
EVERETT M. WALKER



The 1930 Method to Approach Prospects Who May Be Interested in Purchasing a New Radio Is to Make Use of the Latest and Most Practical Means of Communication, and so—Use the Telephone.

"APPROACH YOUR prospect from the inside of his own home and you will have greater chances of selling successfully a new radio receiver, than you would through the more or less antiquated 'doorbell-ringing method.'"

This is the precise form in which Ernest W. Boyce, sales manager of R. H. McMann, Inc., a New York distributor, related to the author a scheme of direct selling which during the past radio season proved to be highly successful in approaching potential new set-owners through a direct canvass method. This plan is also being operated at top capacity during the current fall season to facilitate sales through dealers in the metropolitan area.

Selling the 20th Century Way

"This is the twentieth century," Mr. Boyce points out, "the age of science, with the automobile, radio, and last but not least the telephone. The 1930 method to approach a person who may be interested in purchasing a new radio receiver is to make use of the latest and most practical means of communication, and so—'why not use the telephone?'"

"Certainly, Mrs. Jones, who is home all day, or that is, practically all day, busy with the various duties of keeping the home in order, will answer the telephone more readily than the door-bell, and listen to the 'talk' of a house-to-house canvasser, who may take possibly a half-hour of her valuable time."

This, summed up, is virtually the plan of making use of the telephone to approach a potential set purchaser which Mr. Boyce introduced to aid dealers who are in the territory of the McMann distributing company. Although Mr. Boyce is rather modest about claiming credit for the telephone method of approach, saying that stock houses, and other organizations conducting a direct sales business have demonstrated successfully the practicability of the telephone, as far as is known, this is one of the first instances where it has been used successfully in the radio industry.

The telephone plan is this: The distributor first conducts a simple survey of a dealer's territory to determine the number of residents and the approximate buying power of each (the method of obtaining this information will be related in the following paragraphs). These facts are laid before the merchant, and it is suggested that he adopt the telephone method of approach, employing the services of an experienced operator supplied by the jobber.

After outlining his territory, the dealer is supplied with the telephone number of every resident in his district. This information may be obtained from the telephone company for a nominal cost. A telephone operator is furnished by the distributing company, the requisite being that the dealer pay the salary. Each operator is trained in the technique of conducting a telephone canvass, and is supplied with printed cards which outline the procedure of approaching Mrs. Jones.

The first week the operator is on duty she starts early in the morning and goes down the list of numbers, asking questions on whether or not the home is radio equipped, type of receiver employed, etc., carefully noting down the answer opposite the question on the card. At the end of the day these are filed. The conversation, according to Mr. Boyce's method is as follows:

The First Contact

"Good morning! Is this Mrs. Jones?

"I represent the American Bosch Company. We are conducting a radio survey in this territory. Would you mind telling me whether or not you have a radio receiving set in your home? Yes! What make did you say it was—and model? How long have you had it?. Are you well satisfied with its performance?" etc.

"That will be all, Mrs. Jones. Thank you for giving us this information."

Through this method of approach the dealer may determine exactly who, in his territory, has a radio receiver. The data obtained also enable him to compile an accurate prospect file giving the make and age of each receiver in use.

After the approach, Mr. Boyce points out, a follow-up is essential in order to make a sale, and this should be done about a week after the first contact is made. The operator again calls Mrs. Jones, tells her she represents the manufacturer of a certain radio receiver, and volunteers a demonstration in the home.

Conversation for the second call is something like this:

"Good morning, Mrs. Jones! I represent the American Bosch Radio Company. We are wondering if you would not like to hear one of our latest all-electric receivers. It is quite an improvement over the set you now have, and incorporates the latest innovations in receiving apparatus.

"What evenings this week would you and Mr. Jones be at home? Thursday! All right, we will have our representative call at 8 o'clock in the evening, if convenient, and we assure you of a pleasant evening's radio entertainment."

Thus, the appointment is made. And, says Mr. Boyce, according to data taken from dealers employing the system, seventy-eight per cent. of the prospects who permit the home demonstration have purchased a new model receiver of the manufacture demonstrated after the first call. These results were determined after the first tests of the telephone sales method which was conducted in a more or less experimental manner last fall. The seventy-eight per cent. result is very remarkable, and should not be regarded as the average in the final analysis. It represents only a few small territories canvassed to determine the feasibility of the experiment, and, should it be applied to a greater number of territories of varying purchasing power, it is believed that the average might drop to as low as fifty or sixty per cent. By way of comparison, it may be noted that in other trades where such telephone schemes of selling have been applied, forty per cent. successful reaction is considered good. This latter percentage is more than sufficient to warrant wider use of the telephone sales method.

The salesman, Mr. Boyce explains, enters the home completely equipped to install the demonstration set, which is usually a cabinet model. If antenna and ground connections are not readily available, he produces a temporary antenna system which will permit the receiving set to perform at its best under the existing local conditions. His clue to tell of the relative merits and sales points of the particular receiver, is when Mr. Jones asks, either the price, or whether other cabinet models are available.

In a foregoing paragraph mention was made of Mr. Boyce's system of obtaining information on the purchasing power of the average individual in each dealer's territory. This, of course, determines to a large extent what make and price receiver will be exploited. The information is readily available through electric light, telephone, and other public service or public contacting companies, who have such data on hand.

First, the dealer outlines his territory, and determines the number of homes he is adequately equipped to service. The average income of the power company or telephone company is obtained from either organization for small cost. Fifteen per cent. is added as a correction factor to compensate any possible expansion during the ensuing year. The constant for determining the approximate number of receivers which should be sold is, of course, dependent upon the price of the receiver. In the case of the Bosch set, Mr. Boyce says, sixty per cent. is the mark set for the dealer. At any rate, after computation, it is not difficult to decide what price set should be exploited.

With the telephone plan placed in operation by the R. H. McMann company, the special operators are trained by the distributor and are, after the dealer agrees, assigned to conduct the "1930 method of approaching prospects."

Card No. 1

TELEPHONE SURVEY OF RADIO SALES PROSPECTS

Smith Radio Service Company 1711 Broad Street, East Newton

Name_____ Date interviewed_____

Address_____ Is name a good prospect?_____

City_____

Phone Number_____

(1) Type of set owned?_____

(2) When bought?_____ (3) Battery or A.C.?_____

(4) Performance satisfactory?_____

(5) If he does *not* own a Radio set, place check here_____

(6) Is he interested in radio?_____

(7) Remarks_____

In conducting a radio sales canvass over the telephone Mr. Boyce's representative first asks the questions listed on the above card. Two weeks later she calls to offer a free demonstration and obtains the data required by card number two.

Card No. 2

TELEPHONE CANVASS FOR RADIO SALES

Smith Radio Service Company 1711 Broad Street, East Newton

Name_____ Date interviewed_____

Address_____ Successful?_____

City_____ Is second follow-up advisable?_____

Phone number_____

(1) Type of set owned_____

(2) When bought?_____ (3) Battery or A.C.?_____

(4) Can appointment be made?_____ When_____ Time_____

(5) Not interested; Why?_____

(6) Will be interested at later date?_____ When_____

(7) Remarks:_____

FEATURES THAT SELL RADIO

By
DUDLEY WALFORD



Designed and photographed by Larry June

A FEW COILS of wire, some sockets, condensers, resistors, and a few soldered connections produce a radio receiver, an instrument that gives more entertainment to more people throughout the world than any other device. And every succeeding year brings improvements and refinements in the instrument, so that the user gets improved operation of one kind or another from a new radio receiver. What are this year's improvements? What are the changes in present receivers over past models that make sets easier to operate, or easier to install, or give better quality, sensitivity, or selectivity? From these viewpoints we analyze, in the following paragraphs, some of the important features to be found in the new receivers. However, we make no attempt in these notes to decide to what extent the advantages inherent in the various features have been actually realized in practice.

Screen-grid Tubes: It seems natural to start with the screen-grid tube for it is the most important new feature. This tube, when properly used, makes a set very sensitive so that more distant stations can be heard or a smaller antenna can be used with satisfactory results. Because of the high amplification obtainable from screen-grid stages, special detector circuits which produce less distortion can be used. In addition, such detectors need be followed by only one stage of audio-frequency amplification—and both of these changes may result in improved quality and decreased hum.

Decreased A.C. Hum

Power Detection: This is a term used to describe a characteristic of certain receivers which use a detector operating at comparatively high signal levels and followed generally by only one stage of audio-frequency amplification rather than customary two stages. Detectors which are followed by only a single audio stage must operate at voltage levels some twenty-five times higher than detectors of the type used a year ago, and because they operate at these high levels they are frequently referred to as power detectors. Probably the major advantage of such a detector is that it permits the use of one audio stage which means that the set will have less hum and also that the quality may be better due to avoiding the distortion occurring in the eliminated a.f. stage. Sometimes one will see references to "linear high-voltage detectors," which term indicates a detector with linear characteristics. Since detectors which have curved characteristics produce distortion, linear detectors are an advantage from the standpoint of fidelity. A so-called power detector may or may not have a linear characteristic.

The term power detector, as it is now being used, is really not very accurate. When this term was first used it was intended to refer to detectors from which sufficient power could be obtained (without any audio-frequency amplification at all) to permit the operation of a loud speaker directly from the detector tube. It is now used to indicate the use of high-voltage plate-circuit detectors.

Improved Fidelity

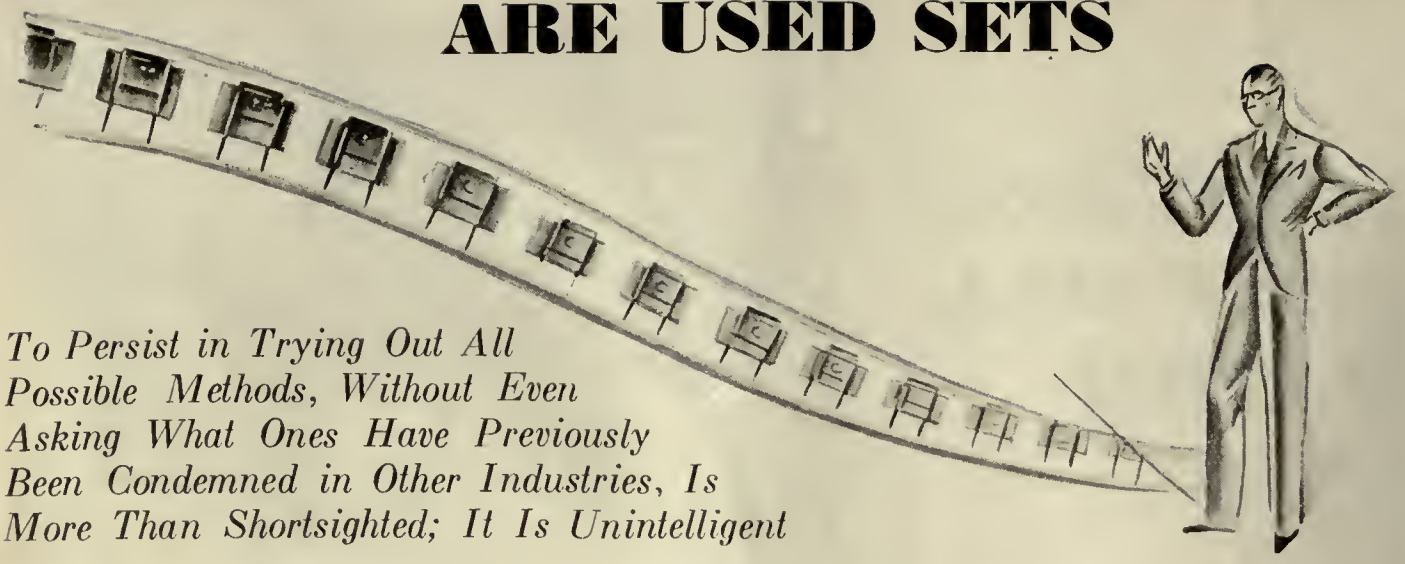
Band-Pass Tuning: Band-pass tuning is used in a receiver to improve the fidelity by preventing the elimination or reduction of high audio tones and improving the selectivity by making the sides of the tuning response curve very steep rather than curved. If the use of band-pass tuning in a receiver is of any advantage it will show up in the performance of the set by improving the quality and selectivity.

Automatic Volume Control: Automatic volume control simplifies the operation of the receiver. It removes the necessity of varying the volume control in tuning from one station to another. This variation is accomplished automatically; it is no longer necessary to operate the volume control manually. With such a set the volume from all stations is practically the same up to the limit of the sensitivity of the receiver. Once having set the volume control knob to a satisfactory point the user is assured that all stations will be received at the same volume. Automatic volume control helps to reduce the bad effects of fading by increasing sensitivity automatically as the signal fades and decreasing the sensitivity automatically as the signal strength increases.

A feature of some sets using automatic volume control is a "tuning meter," a milliammeter mounted on the front of the set. In tuning a station the operator watches the meter and adjusts the tuning dial to give the greatest deflection of the

(*Concluded on page 368*)

ARE USED SETS



To Persist in Trying Out All Possible Methods, Without Even Asking What Ones Have Previously Been Condemned in Other Industries, Is More Than Shortsighted; It Is Unintelligent

THE AUTOMOBILE industry is thirty years old. The radio industry, in the proportions and perplexities of an industry, has a history less than a third as long. And because even the brightest youngster needs wise counsel to balance and direct his energetic smartness, more and more radio executives are saying, "Look at what the automobile industry has done in different cases."

There is no reason why the radio trade should surrender any of its initiative, no reason why its executives should humble themselves and sit at the feet of the more venerable automotive chiefs, accepting all their words as binding gospel for radio enterprises. That would be more harmful than would an isolation policy of indifference to all that the older industry has experienced.

There is very good reason, however, why the radio industry should make keen appraisal of all the steps in the development of the automotive industry; should study all its past problems, determining what similarities they bear to problems now appearing or likely to appear in the radio business, and surveying the older industry's solutions of its problems with an eye to finding the merits and weaknesses in each.

Such a study is particularly effective in the merchandising end of an industry. Merchandising is an economic science, and as such has basic laws and tenets that are as applicable to radio sets as to sewing machines, to pipe organs as to chummy roadsters. To overlook that fact, and to persist in trying out all possible methods without even asking what ones have previously been condemned after bitter experience in other industries, is more than shortsighted; it is unintelligent.

"The worst mistake the automobile industry made was in thinking that its problems were unique and unprecedented in the history of merchandising," said H. R. Cobleigh, staff secretary of the National Automobile Chamber of Commerce,

SUCCESSFUL AND UNSUCCESSFUL

Name of Plan	Principle	Operating Method
Saginaw	Maximum Allowance	Dealers fix resale values on all models for past 5 years, and exchange these figures among themselves.
Windsor	Market Price Information	Current sales figures on used cars published in newspapers by coöperating dealers.
National Used-Car Market Report	Maximum Allowance	Published periodically, sets allowance prices, all models and all makes, for 12 zones in United States.
Oklahoma	Market Price Information	Used car transactions reported weekly at meeting of coöperating dealers.
Boston	Maximum Allowance	All used car sales reported to Central Bureau, which in turn reports to all members.
Cincinnati	Maximum Allowance	Similar to Boston Plan.
Cleveland	Coöperative selling of used cars	Central Inspection Bureau, coöperatively maintained, certifies reconditioned cars and approves selling price.
Appleby	Monopoly of used car business	"Motomart," financed by dealer association, appraises, buys, and sells all used cars in district.
Omaha	Coöperative junk-yard	Junk-yard, financed by dealers, scraps all cars unfit for use, salvages and sells secondhand parts.

*"Motomart" buys used car, gives customer a receipt instead of cash, and dealer honors cashes receipt.

LIKE USED CARS?



When Local Dealers Fail to Coöperate, All Trade-In Schemes Fail—Mistakes the Automotive Industry Has Made—What Can the Radio Industry Learn from the Automobile?

during a recent discussion. "For years our people, manufacturers and distributors alike, persisted in using the trial and error method of solving our selling problems. Nothing like the automobile had ever been known before, and the natural but erroneous conclusion was that no similar sales problems had ever arisen before. For years we struggled along with the problem of used-car allowances, trying this and that and the other method of getting a sound policy that would cover a majority of cases; but it didn't occur to us that the piano trade had faced that same problem and worked out a fair solution to it years before it bothered us."

The mistakes that have already been made are not the ones to be feared; a mistake once made and recognized is a mistake well on the road to correction. It is the errors unwittingly committed in the early stages of a new problem, the wrong steps taken before the magnitude of the problem has become apparent, the mistakes not yet made but in the unrealized process of being made, that are to be feared and fought. And it is just there that the study of the experiences of others is essential; without that study, the budding problems in one's own industry cannot be recognized at their true worth, the first false steps cannot be prevented.

Two problems have been costly, and still are being costly, to the automobile industry: the used-car problem and the service problem. The radio industry is beginning to meet exactly analagous problems, and should decide upon the wisest methods, rather than upon the most convenient makeshifts, for handling the trade-in set allowance and the service problems. Many radio men think they have found satisfactory solutions of those problems; some of them are sure they have. But a review of the various measures tried out by the automobile industry will at least give radio executives food for thought. This article will deal with the used-car problem, since that is the one which bulks largest in the minds of automobile men, and has for twenty years.

AUTOMOTIVE TRADE-IN PLANS

Formula for Resale Valuation	Trade-in Allowance	Remarks
1st yr.—list less 40% 2nd yr.—balance less 20% 3rd yr.— " " 25% 4th & 5th yrs.— " 20%	Resale value less reconditioning cost and 20% commission.	Has operated successfully for 10 years.
The current cash price for reconditioned used cars is the resale valuation.	Resale value less variable commission and reconditioning cost.	Is being used in more than 50 large cities.
The current cash price for reconditioned used cars is the resale valuation.	See operating method.	Started by Chicago Automobile Trade Ass'n. Still in use.
The current cash price for reconditioned used cars is the resale valuation.	Determined by each dealer to suit himself.	Abandoned after a few weeks' trial.
Multiply list price by .58—1st yr. .40—2nd yr. .30—3rd yr. .24—4th yr.	Resale value less cost of reconditioning.	Central bureau staff paid by dealers. Abandoned after 3 years' trial.
1st yr.. 60% of list 2nd yr., 45% of list 3rd yr., 36% of list 4th yr., 29% of list	Resale value less reconditioning cost and 10% commission.	Lasted 8 months. Dealers failed to notify Central Bureau.
Determined by Inspection Station.	Resale value less reconditioning cost and variable commission.	Still in use. Has increased market for used cars, has fixed resale values.
The current cash price for reconditioned used cars is the resale valuation.	None*	No dealers permitted to buy or sell used cars. Has been abandoned.
	Very small—determined by each dealer to fit each transaction.	Protects dealers from buying same car 3 or 4 times. Is being adopted all over.

this receipt as part payment on new car. When "Motomart" sells the used car, dealer

The crux of the used-car problem, to the individual dealer, is expressed in the statement that he must take a loss in order to make a profit. The list price of the new car allows him a satisfactory profit; but when he accepts a used car at an arbitrary trade-in valuation, he has decreased the amount of his profit by the amount of the trade-in valuation. The point on which he must make his decision, the consideration that should govern the size of his trade-in allowance, is "How much loss can the total transaction absorb and still leave me a satisfactory profit."

Some dealers still feel that they are the best judges of that point, and that each individual case should be considered on its own merits. But experience has shown them that, for the majority at least, the used car problem is too big for individual solution with safety.

Alfred Reeves, general manager of the National Automobile Chamber of Commerce, gives the following illustration of what the used-car problem has come to mean to the dealer. It is an actual case, and there have been altogether too many of them for the comfort and peace of mind of automobile dealers.

A man, whom we might as well call Brown, decided to buy a car. He had never before owned a car, but he knew what kind of car he wanted, and he knew what it would cost him. He also knew that the trade-in allowance was a very important factor in buying a car. He went to an auto junk-yard just outside the city in which he lived, and asked the proprietor if he could borrow an old car for the afternoon. The proprietor, a friend of Brown and a good fellow not averse to making a dollar or two in rental if he couldn't make a sale, agreed; Brown drove away in a decrepit, but mobile, old ark.

He drove up and parked in front of the salesroom of the dealer whose car he had decided to buy, walked in, and was an easy prospect for the floor salesman. He agreed to buy the model he wanted, and as the delighted salesman started to write out the sales order, Brown waved a nonchalant hand toward the broken-down wreck at the curb

"Of course, you'll give me an allowance on that car of mine," he said.

The salesman looked, swallowed hard, and not wishing to spoil a sale, agreed to allow him $150 on his old car. Brown seemed satisfied, and the deal went through. As Brown was about to leave the salesroom, he hesitated, and said, "Tell you what. I'm pretty attached to that old tub outside; it's given me years of good service. Rather than part with it, I'll buy it back from you at $75."

The salesman, glad of the chance to get rid of the white elephant, agreed. Brown drove the ancient bus back to the junk-yard, gave the proprietor $10 for the loan of the car, and came out a clear winner of $65 on the deal.

That is not an average case; but it has happened more often than it should. Now, what has the automobile industry done to prevent such dealer losses in handling used-car trade-ins?

A number of plans have been devised and tried by automobile dealers in all parts of the country. The more important of those plans are summarized in the table accompanying this article; from one or another of the nine plans mentioned there, more than forty variations have been conceived and tested. Almost all of them, together with four of the basic plans, have been abandoned after costly trial periods.

The one feature common to all the plans, and the point particularly important to the radio trade, is that the dealers of each city must coöperate in finding the solution of the problem. Until automobile dealers agreed to make peace among themselves on the trade-in allowance, the problem remained beyond solution, and was actually turning the expected profit on new-car sales into unexpected loss.

A glance at the accompanying table will show that the important factor is the method of determining the resale value of a used car before accepting it in trade. If the dealer can know what he is going to get for the reconditioned used car, he can set his trade-in allowance on it so as to insure a satisfactory profit on the whole transaction.

The first method of determining that valuation, the "maximum allowance" principle, figures theoretical depreciation on each make and model of car, and establishes a "maximum allowance" beyond which the dealer should not go unless he wishes to take a loss. The second, and increasingly popular, is the "market price information" principle, which declares that a used car is worth what it will bring in the used car market, not what it ought to bring. By posting current used car transactions in a given city or area, the current resale value of every make and model of car in that area can be accurately known. This is the principle on which the Windsor plan works, and the Windsor plan is considered the best solution of the trade-in problem. It is being introduced by dealers all over the United States, and has been in use in Canada for some years now.

Under the Omaha plan, automobile

(*Concluded on page 368*)

clippings

J. M. Skinner (Philco): "The radio fan of today who is careful in his choice of set should be able to get ten times as good performance as he was able to get a year ago."

C. A. Earl (Earl Radio): "It is now an assured fact that radio is an all-year business."

Thomas A. Edison (Edison Radio): "I have always liked my job."

Herbert E. Ives (Bell Telephone Laboratories): "Color television constitutes a definite further step in the solution of the many problems presented in the electrical communication of images."

M. H. Aylesworth (N. B. C.): "We realize that the appeal over radio, in order to bring results, must be brief and interesting and infrequent."

Arthur Freed (Freed-Eisemann): "More than three quarters of the population of the United States cannot afford to buy a radio receiver that is priced over $100 without inconvenience."

Gordon C. Sleeper (Temple): "Instead of hurting the phonograph industry, radio is now proving to the public the possibilities in reproducing phonograph records. The phonograph industry is now grateful for strides made in radio and in particular for the perfected electro-dynamic speaker."

Commander Edward Ellsberg (U. S. N.): "It is one of the features of our age that, regardless of apparently insurmountable difficulties, what public opinion truly demands speedily becomes feasible."

Harold A. Lafount (Radio Commission): "The number of receiving sets in use in the Fifth Zone has more than doubled in the past eighteen months."



The window of the Cable Piano Company, Chicago, winner of the first prize in the Majestic contest.



J. L. Hudson Co., Detroit, received second prize for this attractive window



The third prize was awarded to Lyon & Healy, Chicago, for their conception of "Looking Inside a Majestic Radio."

SAVING THE SUMMER SLUMP

A Double-Barreled Advertising Campaign Tying in With a Nationwide Dealer Window Trimming Contest is the Plan Followed by One Manufacturer in Boosting Radio Sales in Summer

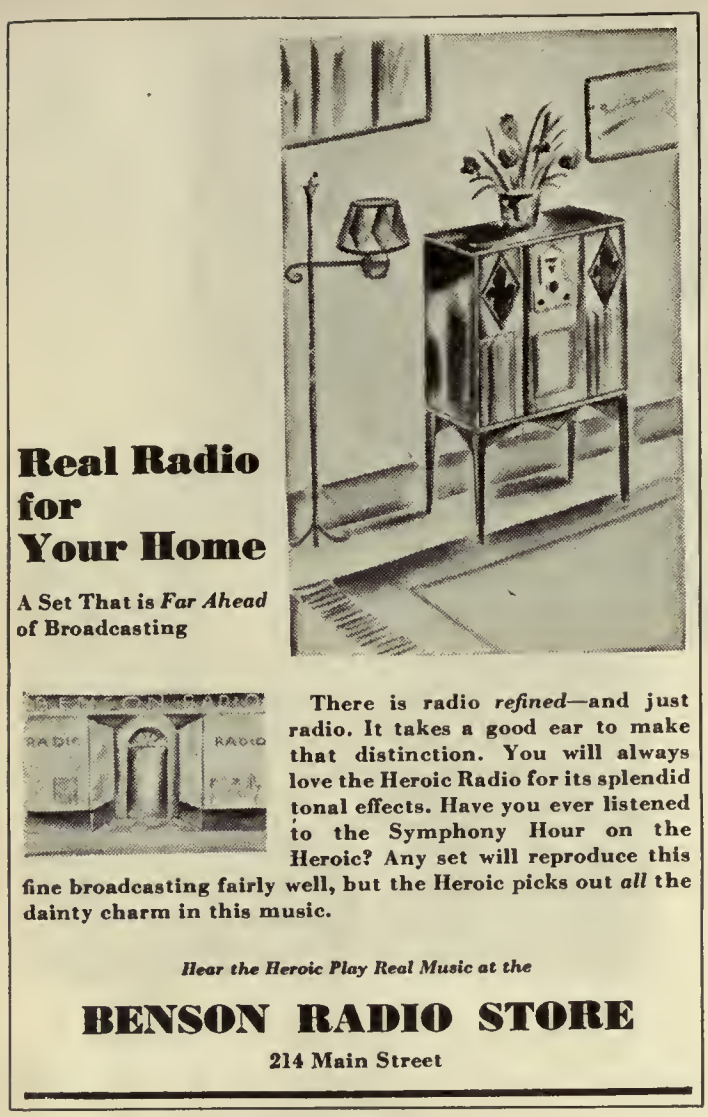
IN THE PAST the radio trade as a whole has been content to sit by idly in the summer and allow sales to follow their natural course, chiefly because it was not believed that business could be good during the hot months. This year, however, Duane Wanamaker, advertising manager of the Grigsby-Grunow Corporation, decided that, as far as his products were concerned, he *had* to ward off the summer slump in radio. The plan which was followed included a window trimming contest with district and national prizes in which all Majestic dealers were invited to participate and an extensive national advertising campaign urging the public to watch the windows of Majestic dealers during "National Majestic Week." The nature of the advertising campaign was such that it was of decided advantage to all dealers to coöperate, and, as a result, more than 4000 dealers submitted photographs of their windows to the judges of the contest.

The three windows which won the highest national prizes are pictured at the top of this page. The first prize winner is an especially interesting window, although the most important feature—motion—does not show in the picture. The loud speaker was removed from the set which was exhibited and in the loud speaker opening was placed a piece of ground glass. A small projector inside the set threw a moving picture on the glass.

(Right) Gray, Trimble & Smith Electric Co., Bloomington, Ill., receive honorable mention for "The World in Your Home." (Below left) A consolation prize was awarded to the Maynard Music Store, Salisbury, N. C., for "The Most Humble Home Can Afford a Majestic Radio." (Below right) This modernistic impression of "A Cozy Spot in Springtime" by the Power Furniture Co., Portland, Ore., received honorable mention.







Have You Personality? —Then Sell It

The Local Shop Needs Personality—Do Your Advertisements Reflect It?—If You Sell Radio as a Well-Built Machine or as a Fine Musical Instrument, Choose that Appeal in Your Advertisements—How Best to use Manufacturers' Cut and Copy Service.

By HOWARD W. DICKINSON
Merchandising Consultant

THE DEALER must have something worth advertising. This thing is personality. The great house of Tiffany and Company offers jewelry, silverware, precious stones, glass, china, and so on. All are carefully selected and, I verily believe, all sold at very reasonable prices.

That, however, does not explain Tiffany. The charm of house personality on top of modern business intelligence makes that great house.

A Radio Personality

The name, A. Atwater Kent, means a great business in radio receiving sets. It also spells a very colorful personality, a personality which fairly exudes idealism with respect to mechanical perfection and performance. Just try to figure out what the personality of A. Atwater Kent is worth to-day to A. Atwater Kent, the manufacturer.

What started me off this way? A remark of a manufacturer of radio sets somewhat to this effect: "How shall we get our retailers to do the right kind of advertising? Well, they don't know much about advertising, often do not know how to write advertisements very well, so the best thing I know of is to furnish them with copy already written."

This is why so many manufacturers offer you their cut and copy service. Generally, it is good stuff—good advertisements about *their* products which *you* sell. When you are busy, haven't time to write an advertisement or get one written, you use a manufacturer's cut service, putting your own name in the place left for "dealer's name."

Probably it is true that professionals have written these advertisements, presumably the manufacturer's advertising department or his advertising agent. They are about goods which you offer for sale. True, but they are not about *you* and your business in general. They have the manufacturers' personality, rather than your own.

They are good, easy to get, and you should take advantage of them and use them when they fit your needs, but not, in my opinion, all the time.

They have to be written to fit everybody, and consequently cannot quite reflect the individuality of your own shop or your own personality.

When you use them, you tie up your shop with that manufacturer's merchandise (and that is valuable) but in addition to that you have the chance of using the personality of your shop in advertising it as an attractive and interesting radio headquarters, that is, if it is one.

If it isn't, it lacks personality. If it lacks personality, some should be supplied.

How can we supply it? Only by turning our minds out of their ruts and pointing them in a different direction.

Look at Your Display

Here's what I mean. The man who runs a shop has selected (or fallen for) certain lines of merchandise. He has decided how much stock to carry and carries it. He has folders and advertising matter, strewn about for his customers to pick up.

His show cases, display tables and all have been arranged according to spaces in his shop. In nine cases out of ten the arrangement is conventional and uninteresting, the windows are poorly decorated, possibly not changed often enough.

If the customer goes in, he is courteously attended. If he knows just what he wants he can get it. But the feeling that this is a fine place to visit is too often lacking. The "personality content" of the place is low.

Generally, the personality content is low because only merchandise is displayed and not very well displayed either. Suggestion of the use of that merchandise is altogether lacking. It is true that in your shop you can tune-in and demonstrate a radio set. You can get a little hash of broadcasting under most unfavorable conditions, but the customer feels that he is never going to *know that set* till he gets it home. Obviously, it is no pet of the dealer's. He tells the customer that it must be good because the great So and So Company make it. He has been told the same sort of thing for twenty years about most everything he has bought. There is no savor in it.

Now how can we put in the "personality" content? Obviously, according to the personality of the boss himself. If he has or can get any artistic sense, let him show it in the arrangement of his shop.

Selling the "Insides"

If he can only see his job as the sale of machinery, by all means let him get that phase of personality working, let him and his salesmen demonstrate the "insides" of a set. "See what a splendid mechanical job this is!" "How nearly impossible to get out of order." "Notice that fine mechanical finish inside and out." "Precision." "Endurance." "Simplicity." "Fool proof." and all those things. They are effective, always were, always will be. His shop begins to show the personality of exactness, mechanical correctness, durability. The manufacturer's goods gain new salcability and increased reputation through being commended by a dealer of such obvious mechanical ability.

This kind of personality, as all kinds, should breathe forth from the shop's advertising; a house which appreciates mechanical perfection, which offers well-made goods, goods that will stand up and do their work. If I am thinking of a set principally from the viewpoint of its "standing up" and giving long service, the "personality" of this shop will appeal to me greatly.

The man who owns this shop should put his mechanical idealism into his advertising. "We pick our sets for their splendid construction and ease of operation." "The shop where quality and accuracy rule." "We know this receiving set, it should need almost no servicing." "Of the last 100 sets we have sold, only three have been back for repairs, and those only minor ones." "We get these sets in perfect condition for you—and then they should operate for years with little or no care."

Such ideas should be in the advertising of the shop which goes in for mechanical perfection. They are practical ideas, persuasive ideas, ideas which are salable. They give a "personality" impression of a very important kind, which should be borne out by the appearance and the personal work in the shop itself.

The Artistic Approach

The proprietor of another shop may have less of the mechanical sense and more of the artistic sense. He may be able to understand those fine distinctions of tone quality and refinement of reproduction which the average ear cannot get.

Our second proprietor should put the quality of his artistic personality into his advertising. Whatever the prices of his goods, he is a quality merchant, That fact can be made profitable. Here are points he can stress in his own advertisements which will make that apparent:

"Are you appreciative of tone quality? those fine shades of distinction between *just a receiving set* and a real musical instrument? The new Blank receiver is a truly remarkable reproducer in its tone quality and beauty."

"There is *radio refined*—and—just radio. It takes a good ear to make that distinction." "A set you will always love for its splendid tonal effects." "Have you ever listened to the So and So Hour on the Blank Radio Receiver? Any set will reproduce this fine broadcasting fairly well, but the Blank Receiver seems to pick out all the dainty charm in this music."

Such sentences and paragraphs show taste and musical appreciation in the personality of their sponsor. If he hasn't those qualities it may be expensive for him to claim them. He will be selling, and recommending, on the wrong basis and his customers will find it out. He must be of a personality to carry out in his own conversation what he suggests about himself in his advertising.

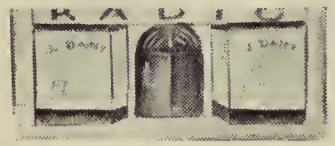
Here is a great mistake which many advertisers make. *Instead of turning their advertising to the real personality of themselves and their business, they use their advertising to bluff their readers into thinking they are something which they are not.* This inevitably slows up their efforts instead of speeding up. When we deal personally with a man we discover whether he makes good on what he pretends or not.

Of course, we are living in a period of pretense, bluff, and hypocrisy, but we realize it as never before and consequently

(*Concluded on page 366*)

LOOKING INSIDE

we pick  our sets for their splendid construction and ease of operation  take, for instance, the Barnes-Newell  we know this receiver; it needs almost no service



Radio sets installed by Deny's are right when they leave our floor and right mechanically and electrically when we leave them in your home. Of the last 100 Barnes-Newell sets we sold, only three have been back for repairs. Buy your Barnes-Newell from Deny's where quality and accuracy rule.

J. DENY RADIO STORE

716 East Front Street



L. T. Breck, sales manager, Kolster Radio Corp.

A Merchandising Plan That Sells Radio

Dealers Participate in the Cost of Broadcasting, Reaching New and Old Customers By Direct Mail, a Follow-Up Plan Producing 40% Returns, Expert Service for the Small Dealer

THE owner of the three- or four-year-old receiver usually says to himself: "Well, the old music box has been good enough for the past three years (and it certainly has tuned-in a lot of distance), why should I buy a new one?" Consequently, unless permitted to hear a new model receiver, either in his own home or at his local dealer's store, he will not be in the market for a new set until his antiquated set ceases entirely to function. New prospects must be had, and old users must be told of new merchandise.

This, according to L. T. Breck, sales manager of Kolster, is exactly why it is necessary for the dealer to resort to a direct selling method in order to keep his sales quota up to par, and incidentally to fill his territory with "good sets for good broadcasting."

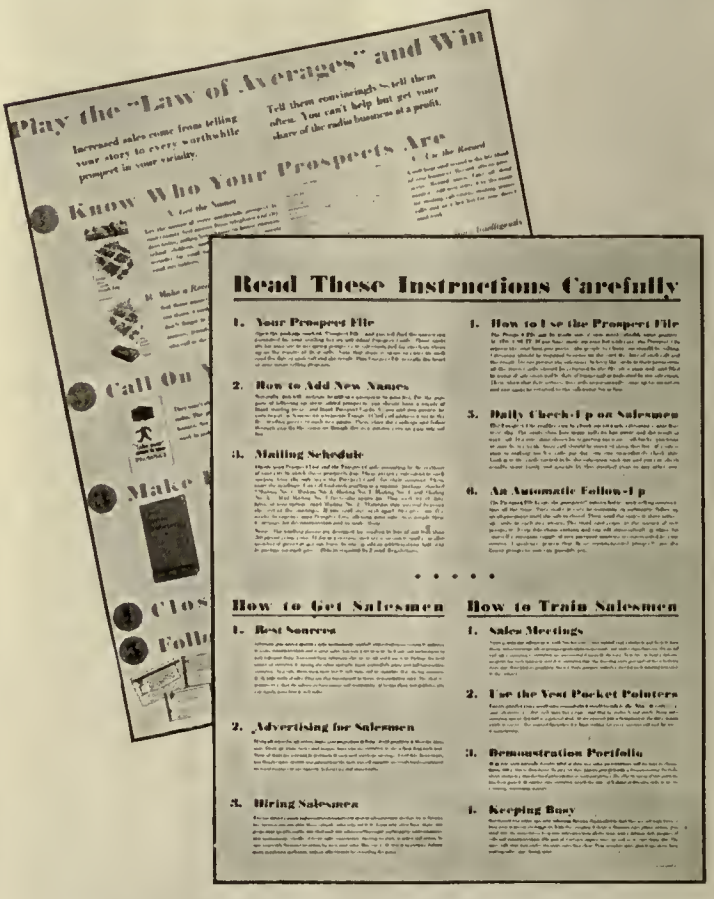
The problems of the dealer in preparing his own direct mail advertising copy, window display material, etc., are manifold. Printing in small quantities, particularly where it has to be of high grade in order to accomplish its sales mission, is costly. Manufacturers, however, prepare good sales material on a wholesale scale, and supply it to their dealers through the jobber. The manufacturer can do a more complete job for far less money than the dealer, and probably many times more efficiently. The manufacturer, too, is equipped financially to employ the best obtainable copywriters, artists, and printers, and can produce, for example, four-color folders for far less money than the dealer could have a black and white card printed.

Such a scheme of merchandising sales service has been compiled by Mr. Breck for both the Kolster Radio Corporation and the Brandes Corporation.

This new plan has been initiated in order to aid the small dealer. His merchandising problems are acute with increasing competition. The small dealer holds an important position in the radio merchandising structure and if his success is impaired the manufacturer suffers.

The dealer service provided by the Kolster organization is comprehensive and has elements new in radio selling.

For the amount of $23.50 the dealer may purchase a window-display unit which stands about seven feet high, with his name across the top in bronze. Twelve insert cards, backed by an automatic flasher, which say in large black



Dealers are furnished with carefully prepared printed matter which helps them solve their problems.

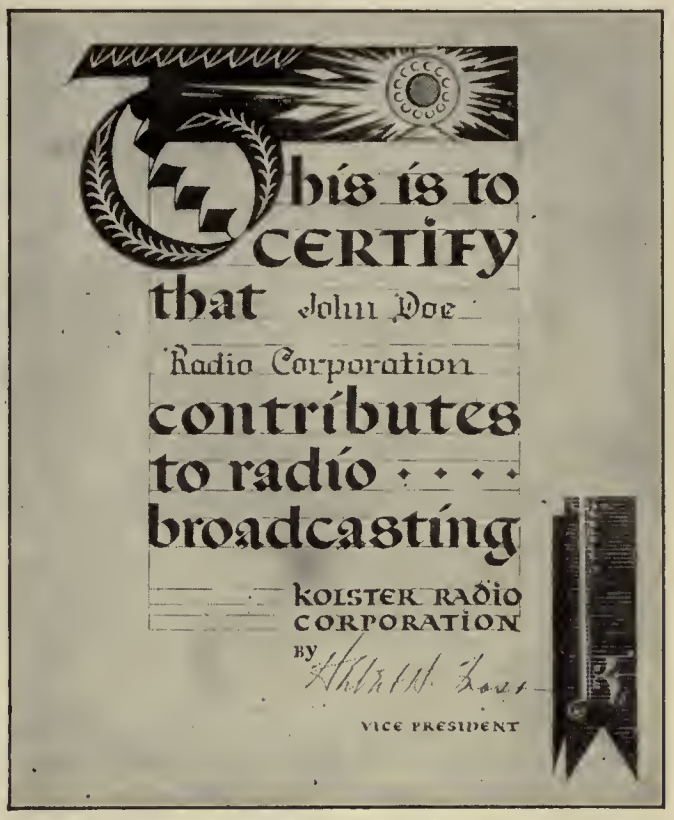
letters, "Our Servicemen Are Experts," "Radio Makes a Lasting Gift," "Out of the Air—Education—Entertainment," etc., not prominently displaying the set manufacturer's name, are supplied—one for each month.

In addition to the window display, the dealer receives a "broadcast diploma" which states "This is to certify (name of dealer) contributes to broadcasting" and a supply of 200 folders printed in four colors for counter distribution. This diploma identifies the dealer to the customer as a member of an organization sponsoring broadcasting, thereby allowing him to share in the credit for radio entertainment. The diploma prominently displayed in the dealer's shop creates good will among the prospective set purchasers and links the dealer closely with Kolster broadcasting in particular.

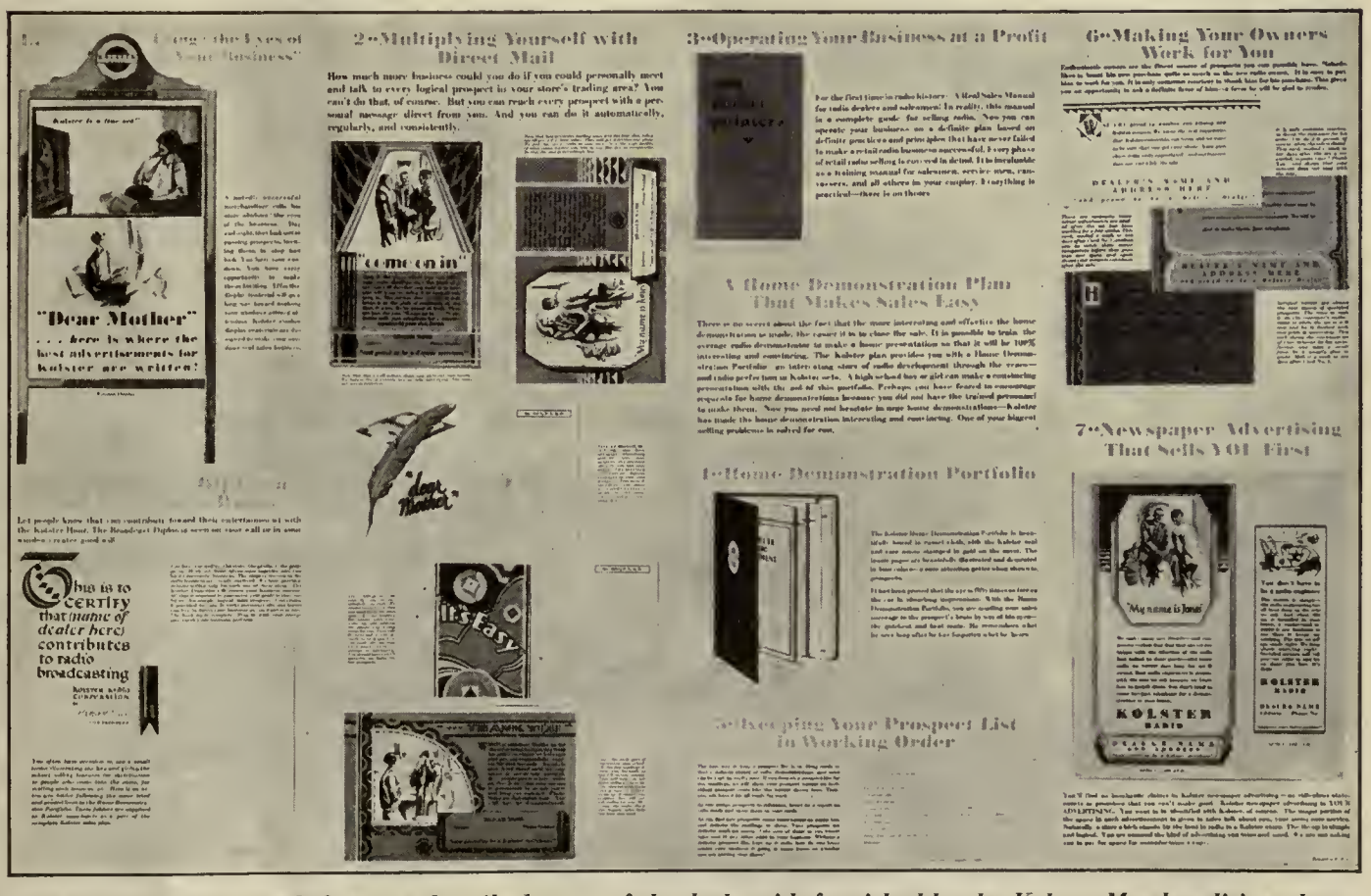
The second unit of the Kolster merchandising service consists of an elaborate direct-mail service for dealer use in reaching prospects. The dealer supplies the names of 200 prospects to the manufacturer, and for the sum of $30 five separate pieces are mailed to each prospect by the manufacturer. The first mailing requests the prospect to visit the dealer's store, and inspect his merchandise. The second volunteers a home demonstration—and the third, fourth, and fifth tell of the advantages of owning a radio receiver, without making particular reference to the Kolster company. Bringing the dealer into the spotlight, playing him up to the customer, rather than emphasizing the manufacturer, is an outstanding feature of this service. It is done to bind the customer closely to the dealer using the service, who, rather than the manufacturer, is the actual contact with the customer.

This mailing service, Mr. Breck believes, is the ideal method of approach for house-to-house canvass, and should be followed within reasonable time by a salesman. In order to make it simpler for the canvasser, a complete sales plan is supplied as the third unit, gratis. This gives an outline of "sales talk" with cross reference to an excellent, illustrated demonstration portfolio. Also, the dealer is supplied with prospect cards to insure his keeping an accurate and readily used list of potential set owners.

(*Concluded on page 368*)



This diploma showing that the dealer contributes to the support of broadcasting has proven an excellent good will builder.



On the folder illustrated above are described many of the dealer aids furnished by the Kolster Merchandising plan.



KEEPING SERVICE SOLD

By JOHN S. DUNHAM
President, QRV Radio Service, Inc.

Often, not only the radio, but the customer needs fixing—Little things keep service sold—Cheap and successful ideas which make service pay a profit

LAST MONTH the writer discussed some phases of radio service and compared them with similar ones in the automotive business. In solving our own problems, a few of the things the automotive industry has learned about service can help us all. Some of the methods used in the author's own organization which have proved to be productive of real dividends will, we are sure, interest every dealer. And *all* of the ways of doing things which can be profitably applied in a purely service organization can be applied with *equal profit* in *every* dealer's service department.

It doesn't cost any money to *lose* customers—there are few things which can be more easily and rapidly accomplished—but it *does* cost real money to gain new ones. The fewer customers we lose, the less we have to spend getting "replacements" for them. Likewise, the more names we can keep as steady customers, the less we have to spend in advertising to extend our clientele, because *a satisfied customer is the best advertising medium in existence.* It thus becomes profitable for us to expend a good deal of energy, and some money, for the operation of a carefully planned system for "keeping our radio service sold."

The Customer's Viewpoint

In an excellent talk which the Editor of RADIO BROADCAST gave before a dealer group at the Buffalo Convention of the Federated Radio Trades Association last February (see RADIO BROADCAST, May, 1929), he brought out the rather novel idea that perhaps the average dealer does not consider the effect on the customer of the service he renders. Perhaps the dealer fails to put himself in the customer's place and imagine just how the service rendered would appeal to him were he actually the customer. The average service department is prone to consider that service has been properly rendered when the set has been properly repaired. Actually, proper service has *only* been rendered when the customer has been pleased. If service is to be successful, the fixing of radio receivers, while absolutely essential, must be secondary to the main object of "fixing" the customer as well. He must lose any desire he may have felt to "throw the damn radio out the window," and decide that it is now working better than it ever did before, that the serviceman and the rest of his organization are obliging and efficient workers, and the world, after all, well worth living in.

Office workers of the service department can do much to create a strong and pleasant impression in a set owner's mind. The very first impression made when a new customer telephones in to have a serviceman call is extremely important. The voice of the person who answers the telephone is worth a great deal. We have consequently made sure that those who answer the telephone in our office have pleasing voices.

When our Telephone is Answered

When our telephone is answered, correct English is invariably used, by our operator and a definite appointment is made with the customer to suit his convenience always, rather than our convenience; he is asked not only for his address and telephone but also for his apartment number, business address and telephone, the make and model number of the set he uses, and what his specific complaint is. Those details are necessary to the performance of good service and they give the average customer an impression of business-like efficiency. He leaves the telephone saying to himself, "Well, *that* outfit sounds as if they knew their business." If the person who calls has called for service before, that fact—if not remembered immediately—is determined by rapid reference to the active file, which is within easy reach, before the customer has done much more than give his name. In that event no question is asked him other than about his complaint, and if he starts to give details such as type of set and equipment, or his apartment number, we reply: "Thank you, we have all that information," and he again gets an impression of business-like methods that he would not get were he asked all of the details he had given the first time he called for service.

Home Contact

The telephone procedure in the office is only the beginning of the process of making a thoroughly pleasing impression on the customer throughout the service department's business relations with him. The most important part of it is the contact made in his home by the serviceman. Our servicemen are old enough so that they don't look like high school boys. They are neatly dressed, their shoes are polished, their hands and finger nails are clean. They are intelligent, clean-cut and mature young men. Their appearance, manners, and speech instill in the customer confidence in their experience and ability. They endeavor to get more details of the com-

plaint than were given to the office by telephone, *before* they start to work. They carry the most modern and efficient testing equipment available and their tools and supplies are neatly arranged and always in good condition. If they find it necessary to use any tools after having made tests, they spread out a special cloth on which to lay those tools. If it is necessary to pull the chassis out of the cabinet to do soldering or other work, that is done over the cloth to avoid any possibility of injury to a fine rug or polished floor. When the work has been completed, tools are replaced in an orderly manner, a piece of slightly oiled cheese cloth is wielded to remove any finger marks from the wooden or bakelite panel, and the cabinet, if wooden, is rubbed over. The work-cloth is used and the brief polishing done whether or not the customer is present, as a matter of invariable routine.

If the chassis or the whole set must go to the shop, the serviceman first returns to his car and brings up a heavy, soft covering in which he wraps the chassis or cabinet, which minimizes the possibility of scratches or other damage and impresses the customer with the individual care accorded to his own pet radio. When the set has been repaired without the necessity of removal, or when it has been returned, hooked up, and tested after a shop job, the customer is invited to tune-in the set himself to be sure that he is satisfied with its operation before the serviceman leaves.

These points, which have utility and almost invariably impress the customer, are in themselves small things, but collectively they create an atmosphere of thoroughness and endeavor to please that is vitally important in the gaining of a customer's good will to such an extent that he is entirely willing to pay a good price for that kind of service. They *retain* his good will so consistently that he will continue to be a steady customer.

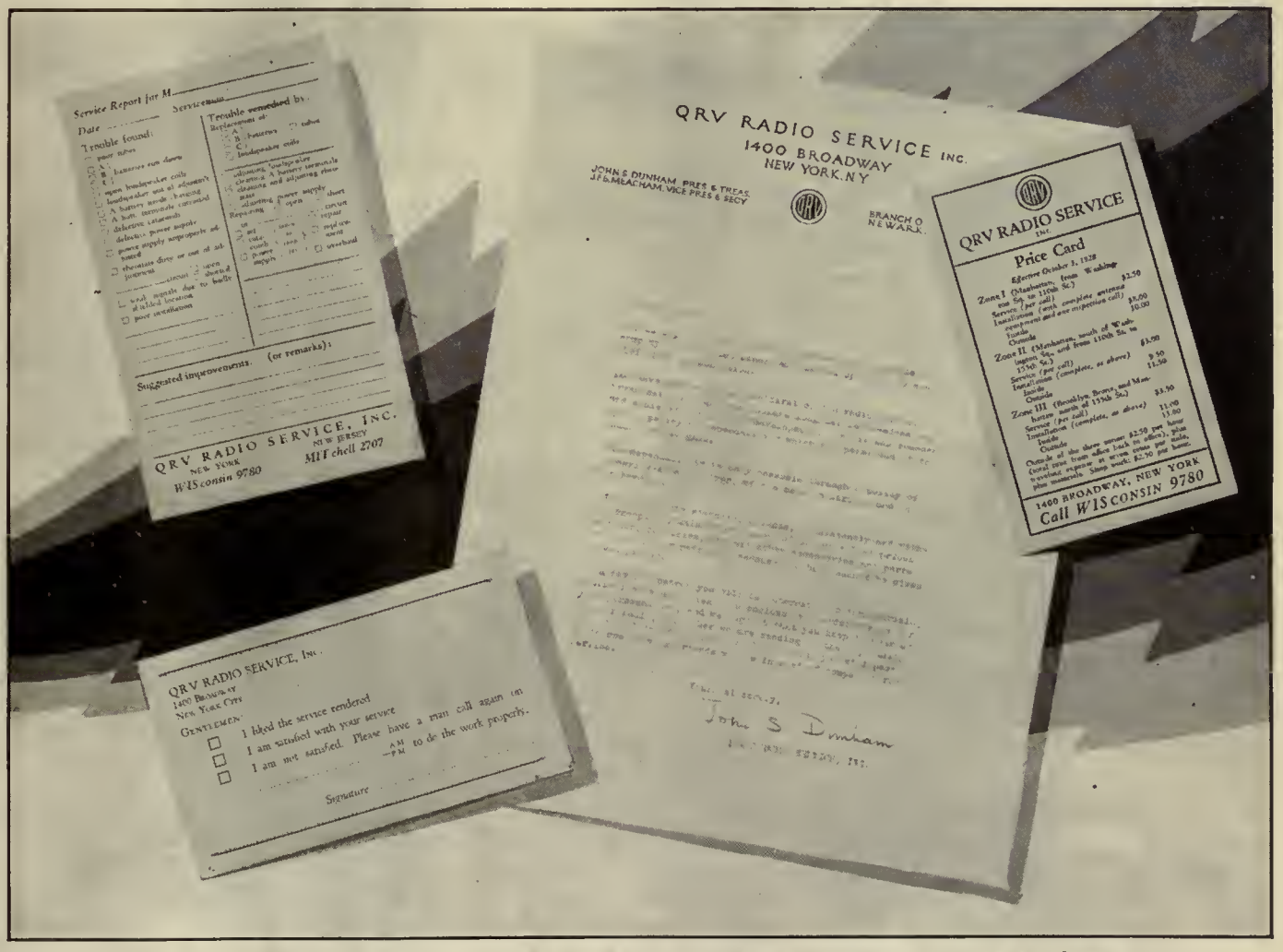
Handling Complaints

Even when the owner of a radio is pleased with its performance immediately following the visit of a serviceman, the job of the service department is not yet completed. The customer must remain satisfied with the operation of that set. A month may be a reasonable interval between service calls for one type of set, and six months for another type, but whatever that length of time is, the customer must be satisfied that the intervals between service calls are not shorter than they ought to be. Always there are a small percentage of cases in which service was not properly rendered in one respect or another. As long as we deal with humans there will be just, and a few unjust, customer complaints. We urge customers on our billheads, in red ink, to do us the very great favor of complaining if they are not entirely satisfied with our service, and we ask for *immediate* complaint in order to permit prompt adjustment.

Many people, when not entirely satisfied with a service call, or even when actively dissatisfied, will neglect to complain in the pressure of business or other affairs, or will conclude that the service organization is no good and go to another outfit instead of allowing the first concern the opportunity of making good on their own work.

If a man has a complaint to make but does not make it immediately, or perhaps does not make it at all, his woe usually becomes magnified as time goes on. If he can be induced to complain immediately and is not argued with,

(*Concluded on page 368*)



A few of the cards used by the QRV Radio Service, Inc., to build up customer good will



TESTED SALES IDEAS

These Pages Will Serve Each Month as a Clearing House For Merchandising Ideas of Proved Value Which May Be Presented in a Consise Form. This New Department of Radio Broadcast *Is one Which Every Dealer Will Find of Definite Value in Making His Business Pay*

Coöperative Dealer Broadcasting

St. Louis Atwater-Kent dealers, in conjunction with their local distributor, the Brown and Hall Supply Company, have begun a local program of broadcasting over KMOX and WIL. Programs last fifteen minutes, are primarily musical, and will extend over a fifteen-week period. Each dealer participating —and there are more than seventy-five—receives mention in one of the programs as joint sponsor. Twice during each program, an Atwater-Kent dealer's contest is announced with a new console model as the prize. Listeners are advised that to enter the contest and to be eligible for the prize, an entry card must be secured from their nearest dealer. Newspaper advertisements, containing a directory of dealers, are published during the run of the program. Listeners entering the contest learn that the winner of the essay contest describing what they think of the new Atwater-Kent screen-grid set will receive the prize console set. Each dealer compiles a mailing list from names of entrants in the contest, and a circular letter is sent to each entrant with which is enclosed five cards with the request that they be distributed among friends.

Sell Your Golf Clubs Receivers

An Edison dealer in Richmond, Va., sold the Westwood Golf Club in Richmond a new set, after coöperating in competitive trials. This club, one of the most popular of the



public courses in the city of Richmond, reports that members now spend more time in the club house than ever before because of the use of the radio. After the set had been installed only a week, the dealer secured two live prospects and several others are in the offing. Many clubs are already radio-equipped, but many bought sets in the heyday of battery operation and are in the market for a new set with the convenience and improved operation now possible. Sales to or-



ganizations of this sort usually represent cash transactions, a pleasant thing to most dealers, but their greatest advantage is that the set they have sold is a continual advertisement of itself before a group of men whose buying power is frequently as high as any in the community.

Striking Window Demonstration

To show the dependability of the Fada receiver, we put a Model 10 on life test in our window, with suitable placards announcing the details to those who pass by. We have run this operating test considerably over 6000 hours, which as a marathon, makes Mr. Pyle's bunion derby look like a 100-yard dash. The set is still going strong without sign of set or tube failure.

—CARL ZEITLER, Zeitler Piano Company, Chicago, Illinois.



Advertising Value of Good Delivery Trucks

Some type of automobile or truck is essential to the radio dealer's equipment. Usually, this important item is selected haphazardly without a careful consideration of its utility and advertising value. The type of delivery car best suited to the needs of the radio dealer is the sedan-delivery car. It resembles in appearance a standard two-door sedan or coach, with the exception that the side windows are replaced by solid panels. In the rear of the body, there is a wide door, making the interior easily accessible. At present, this type of body is available from both Ford and Chevrolet as a stock model.

This type of vehicle has definite advantages not found in any other type of car which the radio dealer may be using. First is utility. The rear door and substantial body, as well as easy-riding qualities make the transportation of consoles and other heavy radio equipment possible without incon-







Have You a Pet Sales Idea?

These pages will be a regular feature of *Radio Broadcast* where we shall present ideas, both big and little, which are of proved service to dealers. If you have a pet sales idea, a stunt that produced results for you, tell us about it. *Radio Broadcast* will pay $5 for each contribution used. A letter will describe the idea, a rough pencil sketch or photograph will help illustrate it and we shall do the rest. If you have a pet sales idea, send it in. Address Merchandising Editor, *Radio Broadcast*, Garden City, New York.

venience in loading or unloading. The second important point is appearance and advertising value. In addition to being smart in appearance, this type of car offers an ideal place to display the name and trademark of the dealer. Thirdly, there is the matter of economy. These cars cost about $600 and are economical to run. Their bodies are weather-proof and lock more securely than does the body on the average light delivery truck.

Many dealers are content with any car, as long as it possesses four wheels and the ability to run when supplied with gasoline and a driver. Some thought expended on the value of a neat and economical delivery car should result in definite improvement in the status of dealers in their communities. Good looking delivery trucks are directly connected with increases in business.

—Albert R. Hodges, Providence, R. I.

Novel Window Display

My window was filled with old Atwater-Kent radio sets and a large banner across it carried this legend: "No orphans in this line." The oddity of the wording on the banner and



the variety of the sets shown attracted much attention from passers-by and showed a comfortable increase in sales at the store of the new Atwater-Kent set. It is believed that this idea is genuinely novel.

—Frank Muldoon, Freehold, N. J.

Building a Prospect List on New Sales

We mail an attractive card to each of our present customers, bearing the headline "How to Keep Your Radio in Per-



feet Condition Without Cost." Copy on the card goes on to explain the offer which is: for every prospect name furnished by the customer which results in a bona fide sale, the customer receives credit for $5.00 which can be used in the purchase of tubes, accessories, or in payment for service. Many sales of new sets have resulted from returns of these cards.

—Booker's Music House, Lebanon, Pa.

Dramatizing the Uselessness of the Battery Set

Dealers in the San Francisco area cooperated in a positive sales idea on a negative subject—trade-ins. Two thousand battery sets were collected and burned outside the City Hall



in San Francisco. The fire was held on August 17th, the opening day of the Pacific Radio Exposition. A few of the best sets were donated to poor families, but all others were burned. Dealers worked together in telling the public that the sets were out of date and possessed no trade-in value.

Selling the Farmer—At the Right Time

Dealers in Iowa equipped their cars with a battery radio set and visited centers of threshing activities. The visits of the dealers were timed at the noon hour when the threshers had time to stop and listen to broadcasting, when they were in the mood to relax and hear 1929 radio reception. Farmers who too often say they are too busy to talk are overcome by visits at this time and dealers in the Des Moines area reported many new prospects lined up by this method.





THE RADIO DEALER'S ADVERTISING DOLLAR

No advertising formula fits all dealers, for location and area served bring their own problems in deciding advertising expenditure. The dealer should estimate his gross sales in order to advertise throughout the year intelligently. Three to five per cent. of gross should be spent among all forms

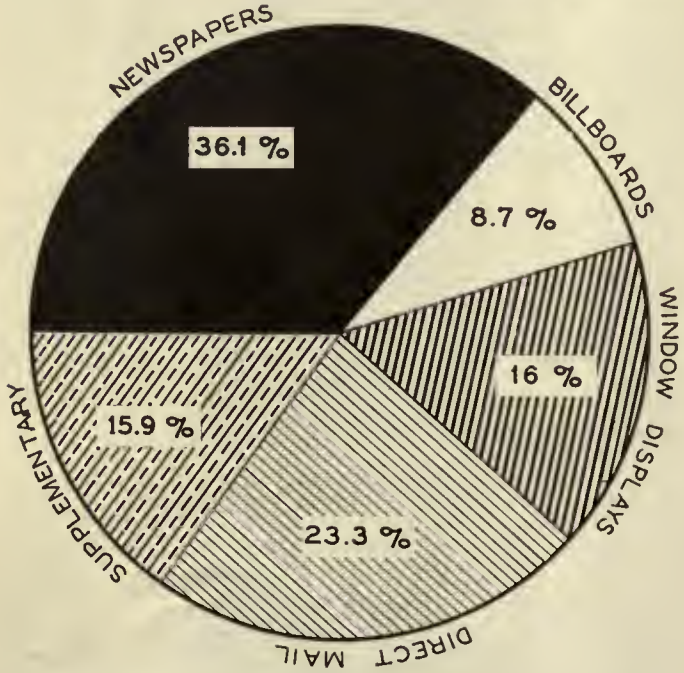
HOW SHOULD the dealer expend his precious advertising dollar? Should the local newspaper receive the greatest share? Is direct mail a force that should be more widely used in helping dealers to ring dollars up on the cash register? How do the advertising problems of the rural dealer differ from those of the large city dealer? And, finally, are *all* large city dealers alike? Up to the present these important questions have been answered, if, indeed, they have been answered at all, by each dealer in his own way, and if the truth be told, manufacturers themselves have not had much really dependable information on which to base their plans for advertising help to the dealer.

Some real answers to these questions have been obtained from a survey in which more than 15,000 dealers were asked to state their experience. The dealers from whom this information was secured represented all classes, handled a wide variety of lines, and their replies were made without the knowledge that any one company was interested in whatever they might say. For the results of the survey and the information in this article, we are indebted to the Radio-Victor Corporation of America, for whom the survey was made.

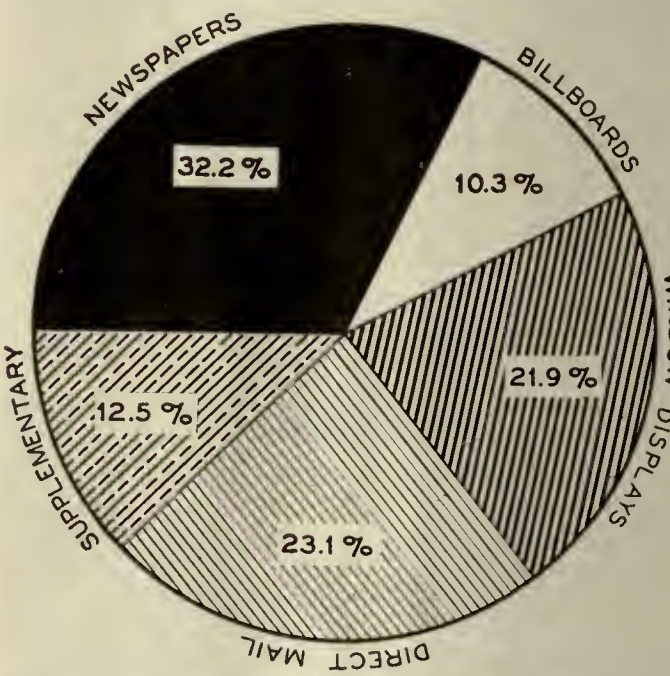
The results of this tabulation of representative dealer-experience indicate the very important fact that the usefulness of various forms of advertising in producing returns depends on whether the dealer is a large one or a small one, and whether he is operating in a large city, small city, or in rural or suburban territory.

In using the information summarized here, the dealer must first decide into which of these classes his store fits. Having decided this, the pie charts on these pages show him at once what percentage of his total advertising expenditure should be allocated in the different classes of productive dealer advertising mediums.

How many different *productive* mediums are there? The paragraph above suggests how the dealer's dollar should be divided, and five classes are mentioned. Let us review the purpose and value of each of these groups.



Large dealers located in strategic positions in large cities favor newspaper advertising.



This chart indicates how dealers in small and suburban cities spend their advertising appropriation.

Advertising that dealers use falls into certain definite classifications as follows:

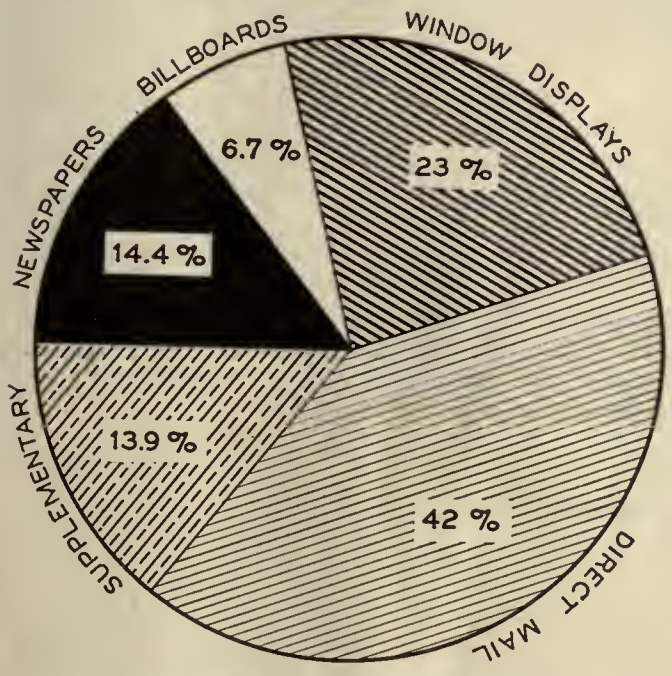
1. Newspaper advertising.
2. Billboard poster advertising.
3. Window displays.
4. Direct mail.
5. Supplementary advertising (folders, lantern slides, novelties, etc.)

The amount of money set aside for advertising should depend upon the estimated gross sales volume for the coming

year. The advertising appropriation should be from three to five per cent. of the expected gross sales, the average appropriation being about four per cent. of gross sales. If, for example, gross sales are estimated as $25,000 then the advertising appropriation would be about $1000. If these figures applied to a dealer operating in a small city then the charts would indicate that thirty-two per cent. or $320 should be spent in newspapers, twelve and one half per cent. or $125 in supplementary advertising, twenty-three per cent. or $230 in direct mail, twenty-two per cent. or $220 in window displays, 10.3 per cent. or $103 in billboards. From such a distribution of his advertising appropriation the average dealer may expect the best results.

Effective advertising by a radio dealer can be expected to do five things.

1. Interest prospects in radio who have no set at present.
2. Sell new equipment to prospects whose radio is out-of-date.



Direct-mail advertising is popular with dealers operating in outlying sections of large cities.

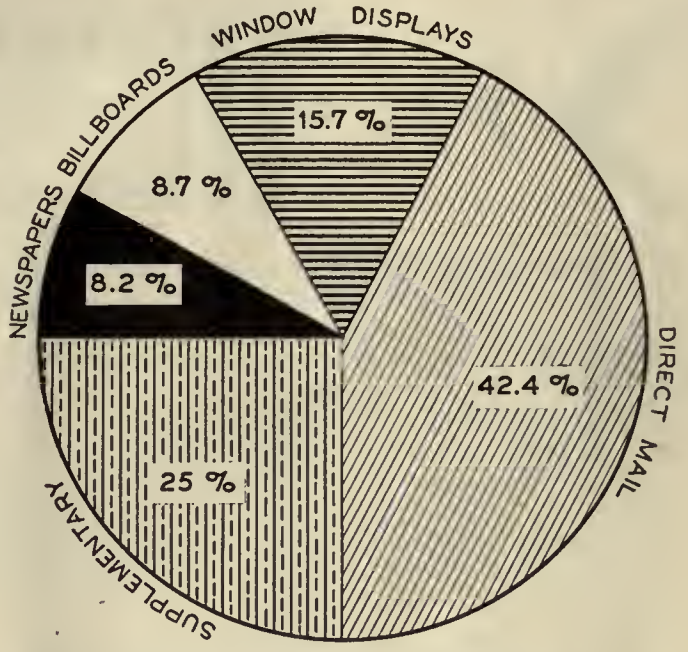
3. Bring prospects to your store.
4. Keep your name continually before your market.
5. Build good will and prestige for you as a radio dealer.

There are certain mental reactions through which a prospect must be led before a sale can be consummated. First, the salesman must get the prospect's attention; second, that attention must be changed to interest; third, the interest must be developed into an appreciation of the value of the merchandise; fourth, appreciation must be carried to the point where desire is created; and fifth, that desire must be generated into the action that completes the sale.

Sometimes these five steps are accomplished in an instant, but more often days and even weeks of intensive salesmanship are required. The most economical form of salesmanship, the form that no modern business ever attempts to do without, is printed salesmanship—or as it is commonly called—advertising.

Advertising and What It Does

Newspaper advertising places the dealer's selling message for a large audience at low cost per reader. It is one of the most effective means for telling a story to all types of people. Newspaper advertising can be used most economically by dealers who draw business from the entire territory in which



Dealers in rural territories find newspaper advertising the least effective of the five types.

the newspapers circulate. When dealers draw business from only a small portion of the territory covered by a newspaper there is considerable expensive waste circulation and some other form of advertising will usually prove more economical and effective.

Newspaper advertising will yield particularly large returns when the copy is of the announcement or special inducement type. Mention of special terms, service, demonstrations, etc., are necessary to bring prospects to a store in profitable numbers.

Window display advertising has a characteristic possessed by no other type in that it is advertising at the point of sale. A prospect sees something in the window that attracts his attention—interests him, and without undue effort he walks into the store. It has been estimated that the entire population of a town or shopping section pass the store window of a dealer located on a main street within one week.

Large stores whose windows dominate the street find the merchandising display card of great value while dealers with smaller windows find the attention-getting colorful cards more effective.

Billboard posters serve well as reminder advertising to those who read as they run. The poster's particular advantage lies in the portrayal of merchandise in brilliant color and in a most impressive manner. They display your message before people who do not read newspapers, and get your story across the second time to those who do.

The effectiveness of poster advertising depends upon location. Two factors govern good location: its value as measured by pedestrians and vehicular traffic and its position in relation to clear visibility and readability by this traffic. Unless both factors are satisfactory to a dealer a particular location should not be accepted.

Direct-mail advertising as a means of increasing business is of exceptional value in that it is the only form in which the advertising messages can be directed to specific prospects. With this form of advertising you can select definitely the prospects you want to reach with a direct-mail campaign consisting of a number of units. You are assured of getting the full cumulative value of advertising because each advertisement reaches the same prospect.

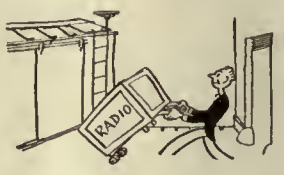
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The MARCH

The Problem of Reducing Prices
How Distribution Costs Can be Lowered

How About The Place of the Jobber?

THE AVERAGE purchaser of a radio receiver is usually amazed if he learns that more than half his expenditure is devoted to meeting the cost of distribution. He is even more startled if he discovers that the cost of production of a radio receiver is rarely more than one fifth of its list price. From this, he concludes that the radio industry is blessed with the most inefficient system of distribution imaginable. Actually, practically any specialty product sold to the consumer is as expensive to distribute as radio.



It is impossible to assign average percentages, showing how the consumer's dollar in radio is spent. This is due to the fact that the actual expenditure per receiver for materials and labor fluctuates between wide limits, depending upon how widely the cost of research and tooling up is spread, the percentage of efficiency in utilizing manufacturing facilities, and how successfully the effects of over-production are avoided. For example, a plant with a capacity of 100,000 receivers, utilized to only fifty per cent. of its maximum capacity, has a materially higher cost per set than one operating at one hundred per cent. of capacity. These and many other factors vary greatly, not only among different manufacturers, but season by season with each manufacturer. In general, the substantial reductions in the cost of radio receivers to the consumer have been effected almost entirely through manufacturing economics, and not through increased efficiency of the distribution system.

Over and above the cost of production, the manufacturer meets a substantial national advertising expense, contributes to better broadcasting, pays considerable amounts for royalty, development, and research. Usually the goods pass from the manufacturer to the jobber and from jobber to dealer.

A vital question to the industry is to discover ways that savings may be effected in order to make possible a still further lowering of prices and a consequent broadening of the sales opportunity. Most efforts to reduce selling costs are aimed at the elimination of the jobber or finding some substitute for him. Radio is hardly a perishable product, yet the radio jobber shows little tendency to stock goods. Too often, he chooses chiefly to watch the credit of the individual dealer. He sells when consumer demand is built up by the manufacturer's efforts. Otherwise he may pronounce the line a flop and concentrate on something else.

The jobber's function appears to be easily assumed by the manufacturer and, as a consequence, many have tried the experiment of establishing their own distribution branches at principal centers or distributing through a jobbing house in which they have an interest. But, as in the automotive industry, the jobber is found more or less essential to distribution.



Practically every automobile manufacturer has sought to eliminate the jobber by establishing manufacturer's branches but, in general, this has not been found profitable. Manufacturers could not make branch managers apply the same selling zeal and the same watchfulness of the manufacturer's interests as a jobber whose profits are automatically measured by his ability. When the difficulty of finding suitable representatives is successfully solved, then the factory finds that the cost of maintaining factory branches about equals that of selling direct to the jobber, while the manufacturer's responsibility is considerably increased. Furthermore, automobiles are delivered to dealers with sight draft attached to the bill of lading, so that there is no important credit function involved as in the case of the radio jobber.

The only prospect of economies through the elimination of the jobber is, therefore, the absorption of the jobber's profits by the manufacturer, either through ownership of the jobbing business or the assumption of the jobber's function. This represents little or no saving to the consumer because the increased risk, investment, and organization required under such a plan makes additional profit to the manufacturer essential.

How Can the Dealer's Position Be Improved?

ONLY THE dealer, then, seems a prospect for cutting distribution costs. Anyone who has studied the financial position of the average dealer is convinced that forty per cent. is the minimum with which he may do business. This is not due to the fact that forty per cent. is too small a margin per sale, but because of the seasonal character of the radio business, service costs, end-season dumping and price-cutting, which tend to dissipate the profits made during the more active months.

The fortunes of the radio dealer cannot be judged on the basis of outstanding successes. It is the case of the average dealer which we must consider. The discounts extended to him, when stated in percentage, are large, but, when gross margin with the average annual turnover is considered, it becomes obvious that the discounts cannot be materially reduced in the search for lowered costs.

The solution, in our opinion, lies in altering the radio dealer's function. Fundamental changes are gradually taking place, leading to the development of a specialty retail store with radio as the most important and major item of sale, but not dependent solely upon the radio industry for its profits. Experience will gradually evolve a better combination of items which will increase turnover and gross sales without requiring additional personnel, space, selling expense, or materially increased capital over that at present invested by the radio dealer. Such combinations as radio with electrical refrigeration, home motion pictures, electrical appliances, phonographs and records, sporting goods, toys, and automotive accessories are among the many possibilities.



The day is passing when the radio dealer must be a tech-

OF RADIO

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nically trained specialist of such a high order that he cannot be expected to possess other special knowledge. Nor is the day far distant when no installation of any kind will be required to make the radio set function other than plugging it into the light socket. Antenna and ground will not require separate connections because both of these will be obtained through the power line or otherwise. Service is already a decreasing problem and, compared with the day that storage batteries had to be charged and "B" batteries renewed, it has become negligible.



Aside from reducing cost of manufacture, the most effective attack on reducing cost to the consumer is by making the lot of the dealer more profitable and more stable. The present position of the industry, with its large dealer discount, is peculiarly unsatisfactory to all parties. The solution does not lie in larger discounts but in an improvement in retail distribution to insure greater profits with smaller discounts. The function of the radio dealer as a whole is uneconomic because he works at full efficiency only a small fraction of the year. It is needless to say that there are numerous exceptions and that many dealers are making substantial and regular profits. The exceptions do not alter the facts. The important point is that the general level of prosperity of the radio dealer must be improved by making him work efficiently at all seasons and turn in a profit at the end of every month.

A Medal for Commissioner Lafount

WHILE VACATIONING at Grafton, W. Va., Judge Ira E. Robinson, Chairman of the Federal Radio Commission, stated in an address before the Grafton Rotary Club that he had fought a hard battle in order "that radio will always be preserved for the common use and not for the gain of powerful combines. . . I have fought all along for the people's rights as against the demands of the R. C. A. and other companies that would take complete charge of the nation's air channels for commercial uses."



Even when he is resting, the doughty commissioner has his hatchet ready! The only question which is unanswered is whether, in opposing the Radio Corporation, the commissioner is not taking a stand against the ultimate welfare of the nation. Decentralized and competitive communications are bound to be inefficient and costly. The attempt to make communications highly competitive means nothing less than a complete surrender of American solidarity in the spirited international competition for independent worldwide systems of communication.

But it is not hard to understand the commissioner's hesitation in trusting the future of communications to a single group of capital. Our legislators, however, have been able to permit monopolistic operation of other quasi-public functions, such as railroads, telephones, and power systems, by establishing suitable regulation. Would it not be more to the interests of the people at large to permit the continued growth and building up of an efficient and unified international communications system and, by suitable regulation, to prevent the monopolistic communication organization, built up under its control, from misapplying its great powers?

While Commissioner Robinson was thus theorizing at home, Harry A. Lafount visited every corner of his extensive fifth zone. He conferred with 276 individuals representing broadcasting stations, 46 desiring construction permits for 31 new stations, 29 representatives of chambers of commerce, 118 spokesmen for listeners' clubs from 19 cities, 172 persons pleading for public or private companies using radio for communication purposes, 27 who want to use radio for private message transmission, 16 amateurs, and the representatives of air transport companies at 16 airports.

Through this active and conscientious study on the ground of conditions within his zone, Commissioner Lafount is thoroughly conversant with the problems as they exist among broadcast listeners and the various fields of communication, including the newest and potentially one of the greatest, aircraft communications.

Commissioner Starbuck spent considerable time on aircraft allocations, held conferences in Washington with short-wave experts and representatives of the air transport companies, and prepared reports and conclusions.

Commissioner Saltzman and Commissioner Sykes were not heard from, presumably because they did not address the chambers of commerce in their home cities. They, doubtless, did not dismiss radio from their considerations during the months of relief from Washington hearings.

We take this occasion to pin an imaginary, but none the less genuine, medal upon the breast of Commissioner Lafount for his conspicuous and outstanding conscientiousness which is only too little appreciated by the radio public and the radio industry which it supports. There is no more thankless job than that of being Federal Radio Commissioner and Commissioner Lafount's devotion to his task is worthy of the utmost public commendation. We have no hesitation in saying that we greatly admire and appreciate his efforts.



The Courts Strengthen Commission's Position

ALTHOUGH IT has not received much attention in the press, the decision of Federal Judge Wilkerson, of Chicago, granting an injunction against the American Bond & Mortgage Company, applied for by the Federal Government to restrain that company from operating station WOK without a license, is a broad and substantial upholding of the Radio Act. The decision not only affirms the Federal Radio Commission's control over broadcasting and its powers to close down stations without violation of the Fifth Amendment of the Constitution, regarding property rights, but it is a most scholarly and studied opinion. Judge Wilkerson fully understood the problem and set forth all the important points bearing on the situation of federal regulation of broadcasting in this masterly decision.—E. H. F.

PROFESSIONALLY SPEAKING



WE STILL HAVE GROWING PAINS

THE RADIO INDUSTRY congratulates itself that it is no longer a boy's experiment—it is a man's business. It says it has graduated from the realm of home-made radio into that of standardized quantity production. The industry would have us believe that radio engineering is in a state of almost zero excitement; that as fast as new developments come along they are assimilated by set designers. But we are of the opinion that radio engineering continues to suffer from growing pains.

We shall not mention the fiasco of a.c. tubes and receivers put into hurried production in 1927; but now that the screen-grid tube is here let us look the situation in the face calmly before other new tubes make their appearance.

It may be a fact that set designers have their business organized so well that once a receiver is turned over to the production department, they can look forward to another year's receiver—but visits to prominent set manufacturers disclose the fact that too many engineers are design men part of the year and production men the rest. There is too little time to sit down and think. It may be a fact that tube engineers know pretty well how to add another element to a tube, how to make machinery to speed up the production of a new tube, but our impression gained from walking the long aisles in tube plants is that the tube engineer is always too near the day when a new tube is actually needed by the sales force. There is too little time to work on a new project; too little time to experiment.

There is still a greater source of trouble in the present set-up. It is the lack of liaison between set engineers and tube engineers.

This lack of liaison is aptly illustrated by the present screen-grid rage. In May a prominent manufacturer of receivers announced that he would make screen-grid sets to meet the demand of those who liked to experiment and to try out things, but he hesitated to recommend or promote the sale of anything until it had been thoroughly proved. The announcement concluded with the statement that although the screen-grid set which had been developed was equal to any other set about to be put on the market, it was little or no better than a receiver constructed on older principles using three-element tubes.

In July, a well-known manufacturer told us that of the many screen-grid sets sent into the field, nearly all, sooner or later, got into trouble. The difficulty is one of tubes rather than one of circuit. Some sets of tubes work properly; others work very poorly. Some tubes "paralyze" when the volume control is varied, and the ordinary tube tests do not show up what is wrong. Apparently the trouble is gas or secondary emission which changes the characteristics of the tube when the volume control reduces the plate current.

In August, the Research Division of RADIO BROADCAST got in touch with many representative dealers, asking them "What effect will screen-grid radio have on set sales?"

Some dealers felt it would have no effect; others thought that 90 per cent. of their sales would be of the new type. The consensus was that about half of this year's sales will be screen-grid sets.

This is interesting. But the note of warning and hesitation that was in nearly every reply is more impressive. One dealer crystallized the general feeling by stating "We will endeavor to push sets that do not have screen-grid tubes. We have tried eight different makes of tubes and found that only a very small percentage of screen-grid tubes will function properly. The sets themselves operate very effectively when proper tubes are installed but the service problem will be tremendous."

Why, may we ask, did not the set engineers and the tube engineers find out this potential grief before so many sets got into the field?

The matter is put succinctly by Ernest Kauer, president of the CeCo Manufacturing Company.

"There is too little preliminary contact between tube and set engineers. The ideal condition will be when the two branches of engineers consult together in advance of a desired development; define their problem together and work to meet it together. Just as a set can be no better than the tubes that are in it, by the same standard the tubes cannot give their full value if the set engineering fails to utilize the tube's characteristics."

So long as tube engineers do not get together with set engineers, the public must pay for the early days of experimenting. We have long advocated that every tube plant should be equipped with a well-trained circuit engineer; we must add that every set plant should have a good tube engineer on its staff. The difficulty, probably, is to find the required engineers.

FEATURES FOR 1930 RECEIVERS

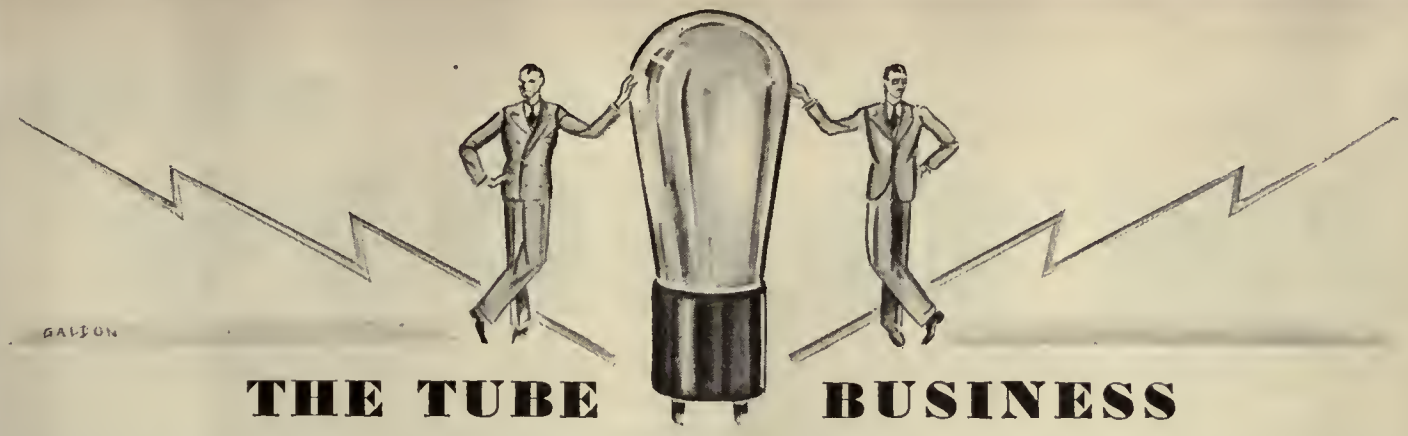
WILL 1930 be a remote-control year?

At the present moment there is no single feature in sight for next year which equals the screen-grid tube as a new talking point. The manufacturing department and the engineering department of radio plants are thankful for this; by the same token the publicity department and the sales department are worried. No new gadget to sell!

Controlling a radio receiver from a distance seems to be the predominantly recurring thought in most receiver engineers' minds to-day. As one engineer-president puts it, "Remote control removes the talking point from radio and projects it into the realm of mechanics."

We have seen several of these remote-control mechanisms and we have the same awe and respect for them that a mechanical engineer has for an intricate radio circuit. One such device has a time clock attachment which enables the user to pretune his entire evening's entertainment. By punching a series of buttons, or setting a series of levers, his radio will be tuned automatically to the Red network at 8:00 o'clock, to the Blue at 9:00, to another station or back to the

(*Concluded on page 368*)



THE TUBE BUSINESS

FINANCIAL NOTES

SONATRON TUBE earned $3.29 per share in year ending March 31 compared to 71 cents a year ago. Pilot net sales for the first six months of 1929 amounted to $706,399 compared with $552,110 for the same period of 1928, a gain of approximately 27 per cent. A stock issue of 38,000 shares of no par value common stock of the Hy-Vac Radio Tube Co., Newark, has been decided upon. The outstanding capitalization upon completion of this financing will consist solely of 125,000 shares.

PRODUCTION NOTES

PRODUCTION OF Speed (Cable Radio Tube) tubes has been speeded up to 25,000 daily, 15,000 a.c. and 10,000 d.c. tubes. A plant has been acquired to produce tools and parts needed for the manufacture of tubes. Altogether 47,000 square feet of floor space are devoted to Speed production.

An entire unit of the new Areturus plant (we have seen it and it is a beauty) is being devoted to the manufacture of 180-type rectifier tubes.

Marvin is operating six tube plants in an effort to satisfy the demands of Marvin jobbers. No tubes are being sold to set manufacturers—all go through normal distribution channels.

CeCo is confining the activities of its old plant to the production of screen-grid tubes only. The daily output is 10,000. The new plant (four acres) will have a capacity of 35,000 daily by mid-August and 45,000 by mid-October. It produces all types except screen-grid tubes.

A new Sonatron plant is coming into full production of screen-grid tubes. It will have a total capacity of some 40,000 tubes of this type a day.

REGARDING QUICKER HEATING

WE QUOTE the following letter from Allen B. DuMont, Chief Engineer of De-Forest:

"Quick heating in a.c. tubes is no longer a deep mystery. There are several ways of achieving this desired end. However, to make a tube heat quickly, operate quietly, and live a long time, is quite another story.

Many methods resorted to in obtaining quick heating are not sound. The desired end is obtained at the sacrifice of mechanical and electrical strength, as well as the span of useful life. The elimination of the insulating tube in the heater cathode, for instance, makes for quick heating. But it also makes for a weaker mechanical construction, and paves the way for short-circuited tubes even with normal handling. The practice of overloading the heater wire makes for quicker heating, but also for shortened life. The use of less insulating material without compensating such reduction by using a stronger material makes for quicker heating but also for a weaker tube.

No one can deny the need for quicker heating. However, I hope that the industry will not run a race on heating time at the expense of the more important factors involved. Also, let us not forget that in many of our quick-heating tubes we are rapidly approaching the heating time of the -45 power tube and the -80 rectifier, so that nothing can be gained by faster heaters."

EIGHT TUBE MAKERS BROADCAST

PEOPLE WORRIED a lot in the early days of broadcasting about who was to pay the bills. The following table of tube manufacturers who take time on the air shows how the tube business contributes toward broadcasting maintenance:

TUBE MANUFACTURER	DAY	HOUR	NETWORK
Sonatron	Sunday	8:30 P. M.	Columbia
DeForest	Sunday	10:00 "	Columbia
CeCo	Monday	8:30 "	Columbia
Ken-Rad	Monday	10:00 "	WJZ chain
Eveready	Tuesday	9:00 "	WEAF chain
Sylvania	Wednesday	8:30 "	WJZ chain
Triad	Friday	8:00 "	WJZ chain
Marvin	Saturday	8:30 "	WJZ chain

A NEW FILAMENT METAL

A SAVING of $250,000 a month in the manufacture of radio tubes has been effected by the development by Westinghouse engineers of Konel, a new metal useful for filaments. This metal is a substitute for platinum and costs but a few dollars a pound compared to $180 an ounce for the rare white metal. The life of filaments using this new metal is approximately ten times as long as that of other filaments; they produce the same emission but at a temperature 175 degrees colder. The new metal is harder to forge than steel and is very tough at high temperatures where most metals lose their strength.

SELLING S. G. SETS

A WHOLESALER in Newark, N. J. sends us the following instance of how screen-grid sets are sold—sometimes. He actually witnessed this sale.

Customer to dealer: "Well, has this set a screen grid?"

Dealer to customer: "Oh, yes, Madam, here is the screen," pointing to the covering over loud speaker, "and the grid is inside."

NEWS FROM SYLVANIA

FROM OUR friend Monte Sohn of Pickard Sohn (who writes the good-looking Sylvania copy) comes the news that a half-million Sylvania listeners prefer the classics and old-time songs to jazz. This note is prefaced by the remark that "I think this vastly better than the conventional literary contribution as to who is the biggest manufacturer of radio tubes, who has the most millions of acres of floor space, and whose officials think the radio industry is enjoying prosperity."

We agree heartily with Mr. Sohn. We have been compiling, recently, a table of "discounts." It started when we went through two radio factories. In one the chief engineer said he was turning out 200 sets a day, and in another plant the number of dealers was slated to be 1500. On returning to the office, we discovered press releases stating that the first manufacturer had a daily output in excess of 1000 sets, and the second had 3000 dealers. Evidently the discount figure on daily set production is about 5 to 1 and on dealers is about 2 to 1. We are attempting to find out by what amount to discount the extraordinary tales of daily tube production with which we are flooded.

Incidentally, the hard-looking gang at the bottom of the page is the Sylvania Foresters who may be—and are—heard from WJZ's chain on Wednesdays at 8:30 P.M. New York time.

Come again, Mr. Sohn.



The Sylvania Foresters in Action



• • • NEWS RADIO

New Merchandising and Other Services by R.M.A.

Several new services to radio manufacturers and expansion of other services to R.M.A. members and the industry generally have been ordered by the Board of Directors of the Radio Manufacturers Association. The R.M.A. Board provided for new and comprehensive merchandising service, and enlargement of its engineering, traffic, legislative information, patent, and other services.

The Merchandising Department, in charge of Major H. H. Frost of New York, chairman of the R.M.A. Merchandising Committee, and William Alley, merchandising manager, was authorized by the Board of Directors to launch at once the new merchandising service for manufacturers, and approved an extensive program recommended by the Committee. Efforts will be made immediately to guard against any possible prospect of overproduction of radio products, particularly during the next few months. Strictly within the limitations and in observance of the law, the Merchandising Department will recommend to manufacturers that their production schedules be checked against the present and prospective future orders, to guard against undue expansion.

The R.M.A. Engineering Service, under the direction of Walter E. Holland, new Director of Engineering, also will be extended and reorganized.

For the public and in support of broadcasting also, the Board of Directors decided to undertake to present another series of special R.M.A. programs this fall, to be contributed by various manufacturers, and broadcast on national chains. This enterprise will be in charge of B. G. Erskine, of Emporium, Pa., Chairman of the R.M.A. Broadcasting Committee. It follows the successful series of nearly a score of R.M.A. programs presented last spring.

Research at Temple

A visit to the new Temple factory in the Chicago Clearing district disclosed, under the guidance of Paul Andres, chief engineer and vice-president, the amazing fact that complete laboratories are established and working at full steam for all the major departments of radio engineering. Such departments, each under the guidance of an expert, are audio frequency design, radio frequency design, loud speaker design, production tests methods, over-all receiver measurements, mathematical research, research into raw products, etc. In each of these laboratories was a group of men measuring everything that entered—or which would ever enter—a Temple product. In the words of "Prof" Andres, Temple is building heavily on future security, and security does not lie in following what someone has already done.

New Jensen Plant Built in Record-Breaking Time



The picture above shows the Jensen Radio Manufacturing Company's plant in the Clearing Industrial district at Chicago as it appears with the completion of the new unit which was built in record-breaking time. Less than a month elapsed from the time ground was broken for the foundations until the installation of machinery and equipment was started. The Jensen plant is now a city block long and measures 140 feet deep, providing over 60,000 square feet of manufacturing floor space. It is said to be the largest single factory in the world devoted exclusively to the manufactur of loud speakers and reproducers.

In the foreground of the picture is the Jensen day shift numbering approximately 600 employees.

Switch tracks of the Chicago Belt Railroad which run directly into the building for the loading and unloading of factory output and materials enter at the rear of the structure.

Less Income for R. C. A.

The recent quarterly financial statement of the Radio Corporation of America shows a smaller income than that reported for the previous quarter. For the first half year, earnings are estimated at 35.2 cents per share on 6,526,000 common shares and amounted to $4,996,487 available for dividends.

In the past, the first half has been the least profitable for the R. C. A. The second quarter of 1929 is the most unfavorable for some years. Net earnings for the June quarter were $1,409,299 against $3,587,188 earned in the March quarter. Accurate comparisons with former years cannot be made because the two quarterly reports of this year include operations of the Victor Talking Machine Company which was merged with R. C. A. at the start of the year. A tabulation of earnings follows:

	2nd qtr. 1929	1st half 1929
Gross income...	$28,796,766	$60,439,593
Expenses, etc...	27,387,467	55,443,106
	1,409,299	4,996,487

The balance remaining, after preferred dividend requirements are met, for the second quarter is $58,896, and $2,295,682 or 35.2 cents a share on the common shares outstanding.

Kolster In Germany

Ellery W. Stone, president of the Kolster Radio Corporation, announced recently that an agreement had been signed in Berlin between Kolster-Brandes Limited and Telephonfabrik Berliner Aktiengesellschaft, of Berlin, for the manufacture and sale of Kolster and Brandes models in Germany.

Under the proposed plan the radio division of Telephonfabrik Berliner Aktiengesellschaft, one of the oldest telephone and radio companies in Germany, will be merged with Kolster-Brandes' German operations. In the future, the Kolster-Brandes receivers will be manufactured in the factories of Telephonfabrik Berliner Aktiengesellschaft in Berlin and Hanover, and will be sold in Germany by a company to be known as Kolster-Brandes Tefag. Control of the latter company will be held by Kolster-Brandes Limited, but there will be no public offering of the minority stock, since it will be subscribed for by Telephonfabrik Berliner Aktiengesellschaft.

"The arrangements with Telephonfabrik Berliner," said Mr. Stone, "will permit Kolster-Brandes Limited to avoid the German duties on Kolster-Brandes models imported from our British plants. In addition, Kolster-Brandes Limited will secure the benefit of the strong radio patent situation which Telephonfabrik Berliner now holds in Germany.

OF THE • • • INDUSTRY

East Battles West for Next Trade Show

Whether the RMA trade show will be held in New York City, Atlantic City, some other Eastern city, or returned to Chicago is providing spirited conversation for the entire radio industry.

So aggressive has become inter-city competition for this major industrial event, that Jess Hawley, vice-president of United Reproducers Corp. and chairman of the R.M.A. show committee, is now engaged in personally inspecting the facilities which each competing city has to offer.

At the conclusion of a visit to Atlantic City in August, Mr. Hawley said that he had not reached a definite conclusion.

Kansas City Radio Show

The Kansas City Electrical and Trade Show will be held in Convention Hall during the week September 21 to 28. Sam Furst is trade show manager and reports that all 80 booths and 14 demonstration booths have been sold.

Chicago Radio Show

The Chicago Radio Show will be held this year from October 21 to 27 at the Coliseum. It is held, as usual, under the auspices of R.M.A. and managed by G. Clayton Irwin, Jr. Raw products manufacturers will be represented at the public show for the first time this year.

C. R. Leutz, Inc. to Move

C. R. Leutz. Inc., manufacturers of "Phantom" and "Silver Ghost" receivers, for many years located in Long Island City, are removing their manufacturing plant to Altoona, Pa. A New York sales and executive office will shortly be established. It is planned to increase the sales of Leutz sets by general advertising, and different distribution methods.

Personal Notes

The thousands of friends of B. G. Erskine, president of the Sylvania Products Company, who make Sylvania Radio Tubes, will be delighted to learn that he is once more back on the job and almost completely restored to health.

Mr. Erskine was stricken with a bad cold in Buffalo on April 27, and this developed into pneumonia.

George H. Kiley, a director of R.M.A. of New York, presented his resignation because of his new connection with Radio-Victor. The Board elected Leslie F. Muter of Chicago as his successor. Mr. Kiley also was compelled to resign as Chairman of the Foreign Trades Committee and was succeeded by H. H. Pollock of New York. Mr. Muter was elected Chairman of the Credit Committee to succeed Donald MacGregor of Chicago who resigned.

W. F. McAuliffe, who has been a member of the Kolster Radio merchandising division since 1925 and stationed at times on both the Pacific and Atlantic coasts, has been appointed assistant to the executive vice-president, St. G. Lafitte. Mr. Lafitte and Mr. McAuliffe have their offices at 39 Broadway, New York.

An official of the Temple Corporation, A. J. Bovier, traffic manager, has been appointed as a member of the traffic committee of the Radio Manufacturers Association. The appointment has just been announced by R.M.A.

F. C. Scrimsher, who recently joined the Ken-Rad Corporation as special sales representative, has been assigned to the Southeastern territory. Under this plan he will serve jobbers of Ken-Rad tubes in Virginia, North and South Carolina, Tennessee, Georgia, Florida ,Alabama, Mississippi, and Louisiana. Before his connection with Ken-Rad, Mr. Scrimsher was for years associated with the automotive industry and has a wide acquaintance among jobbers throughout the country.

Dr. O. E. Brown, eminent mathematician on the faculty of Northwestern University for the last five years, who has just received his Doctor of Philosophy degree at the University of Chicago, has joined the research staff of the Temple Corporation.

His duties will consist of a mathematical analysis of circuits and research work from a purely technical angle to determine ideal circuits and their constancy, in which work he will be assisted by J. Swallow and a group of practical radio engineers.

A. Crossley, formerly of the Bureau of Standards and lately chief engineer of the Steinite Radio Company, has joined the Howard Radio Company, of Chicago and South Haven, Michigan, as chief engineer.

H. Bobker, whose name is well known in radio tube circles, is now associated with the Triad Manufacturing Company, makers of Triad tubes of Pawtucket, R. I.

Howard W. Sams has just been appointed director of territorial sales for Silver-Marshall, Inc., Chicago. He resigned as New York district sales manager of E. T. Cunningham, Inc., to accept the new position, which makes him McMurdo Silver's personal sales representative throughout the United States.

Reorganization of Daven Corp. Complete

The Daven Corporation has been reorganized, having been through receivership proceedings. The new concern is known as the Daven Company. Lewis Newman is the new president. The Daven Company has purchased stock on hand, trade name, good will, and manufacturing equipment of the former company. The address remains as before, 158 Summitt Street, Newark, N. J.

The Daven Company now is doing approximately 65 per cent. of its business directly with manufacturers and the remainder is jobber trade. Products made are tubes, resistors, voltage dividers, grid leaks, etc.

New Michigan Short Wave Law

A new law in Michigan provides a fine of $1,000, imprisonment for six months, or both, for equipping or using an automobile with a short-wave receiver unless the car is used and owned by a police officer or a police permit has been granted. The law is intended to prevent unauthorized receipt of police broadcast warnings.

Sparton Demonstrate Utility of Airplanes



Coöperating with the Jackson, Michigan, Chamber of Commerce in its aggressive program of aviation promotion, the Sparks-Withington Company of that city have arranged an interesting demonstration of the handling of heavy merchandise by airplane. This year's program is a "State to State Tour" by members of the aviation committee of the Chamber of Commerce, the tour including capitals of states. Accompanying the tour the plane "Sparton" will carry a Sparton Radio receiver to each capital for presentation to the governor of the state. After the presentation a new instrument will be taken aboard from the local distributor's warehouse, and this in turn transported to the capital of the next state.

Grigsby Forms British Subsidiary

The Grigsby-Grunow Company, makers of Majestic all-electric radio sets, is forming an English subsidiary, according to William C. Grunow, vice-president of the company. B. J. Grigsby, president of the concern, is in England relative to the formation of the Grigsby-Grunow, Ltd., he said.

"Plant sites are being selected and within the next few months the English company will be in quantity production," he declared.

England and the Continent, in the opinion of Mr. Grunow, are six years behind America in the utilization of radio sets.

Bosch Users Report

For some time, American Bosch has put customer questionnaires in their sets. They asked for helpful criticism. Bosch owners have used them and sometimes write long letters going into detail. An analysis of the returned questionnaires indicates how Bosch customers classify the desirable features of the set. The analysis:

Tone	18.7%
Volume	17.3
Appearance	16.8
Distance	14.2
Operating Simplicity	16.4

News of Patent Suits

No. 1,173,079, E. F. Alexanderson, Selective tuning system; 1,195,632, W. C. White, Circuit connections of electron-discharge apparatus; 1,231,764, F. Lowenstein, Telephone relay; 1,251,377, A. W. Hull, Method of obtaining constant direct-current potentials; 1,426,754, R. S. Mathes, Circuits for electron-discharge devices, appeal filed January 4, 1929, C. C. A., 3d Cir. Doc. 4027, Shamrock Mfg. Co. v. Radio Corporation of America.

No. 1,266,988, Pridham & Jensen, Amplifying receiver; 1,448,279, 1,579,392, same, Electrodynamic receiver, filed April 30, 1929, D. C. E. D., Pa., Doc. 5029, The Magnavox Co., v. Atwater-Kent Mfg. Co.

Recently Issued Patents

No. 1,724,191, Combined Radio Receiver and Phonograph Reproducer and Recorder. Alfred N. Goldsmith, New York, N. Y., assignor to Radio Corporation of America. Filed June 12, 1925.

No. 1,724,399, High-Frequency Transformer. Harold F. Elliott, Palo Alto, Calif., assignor, by direct and mesne assignments, to Victor Talking Machine Company, Camden, N. J., Filed September 17, 1927.

No. 1,724,819, Method and Means for Reducing Retroactive Currents in Audion Amplifiers. Stuart Ballantine, White Haven, Pa., assignor to Radio Frequency Laboratories, Inc., Boonton, N. J., Filed June 2, 1925.

New Location for Steelman

Steelman, Inc., exclusive Fada wholesalers in New York City have moved from 24 Murray Street to 235 Fourth Avenue.

President's Message

By Michael Ert

President, Federated Radio Trade Ass'n.

The officers of the Federated Radio Trade Association wish to take this opportunity to extend to every radio tradesman, a welcome to participate in the activities of our Association and its affiliated groups.

In order that the general conditions within the industry may be improved, the Federated Radio Trade Association has built itself as a national organization of associations engaged in the development of the radio industry.

It has as its prime purpose, the encouragement of friendliness and coöperation between all branches of the industry in the great battle for the consumers' dollars. It constantly watches Federal, State, and local legislation so that any legislative acts will not be detrimental or hamper the progress of the industry, but rather that all acts will be for its betterment and advance.

In a series of articles throughout the coming year we will outline the various activities that might be engaged in by radio trade associations to a profitable advantage. Many unbusiness-like practices in the trade can be eliminated through joint coöperation and we appeal to you to coöperate with our organization in attempting to bring about greater stabilization in the industry and better conditions for all concerned.

News of the *F.R.T.A.*

It is vitally necessary in an industry as new as radio that all members of the trade coöperate in eliminating evils which arise. It is the belief of the officers of the Federated Radio Trade Association that the best and quickest way to stabilize the industry and eliminate the practices which are eating at the core of the industry is to form local associations in every city and municipality, teaching in this way coöperation by the manufacturers, wholesalers, retailers, and the consumer.

The Federated Radio Trade Association issued a book, *How to Organize a Local Radio Trade Association*. This book emphasizes the requirements for a local radio body and lists the more common organization errors. Among the subjects covered are initial meetings, constitution and by-laws, officers and board of directors, dues, meetings, committees, incorporation, and legal counsel. Model constitution and by-laws are provided, suitable for adaption to local conditions. Logical policies for local associations on legislative matters are outlined and a model interference ordinance is provided.

A number of associations maintain an interference department and employ a capable man for the tracing down and elimination of the community's interference problems. Forms and reports for this work have been developed. These show the causes of interference and outline the ways to remedy them.

One of the industry's most difficult problems—that of satisfactory servicing—has already been solved in such cities as Chicago, Milwaukee, St. Louis, Minneapolis and San Francisco by a means of a system of examining, grading and registering servicemen. This activity, logically carried on by their local headquarters, provides one of the biggest opportunities for service because it is now generally recognized that the efforts of the sales department and the service department are just about inseparable. A good serviceman is also a salesman; in addition to his technical qualification he should have some measure of sales ability including good appearance and address.

It is recommended that every registered serviceman carry an identification card and that grades be set up so that they are in conformity with the classification of other local associations which will enable servicemen making changes in the locality to carry on to their own best interests and the best interests of the industry.

Some local associations stimulate interest and increase public good will by joint newspaper advertising, joint broadcasting, and sometimes by the provision of suitable programs upon special occasions.

Because cost accounting is one of the principal factors in merchandising, several local associations have uniform cost accounting systems so that members may compare cost of doing business with a view to increased profit. Some groups employ an accountant to make a monthly check-up of members' books which is an invaluable service to all the dealers privileged to enjoy it.

One local association has succeeded in instituting among local finance companies a system of insurance to cover radio sets on which there is an unpaid balance and also on radio sets sent out on demonstration but not yet sold. The insurance on demonstration equipment is contingent on the dealer giving all his business to one finance company and covers the full amount of the set's value. Insurance on unpaid balances covers not only fire but theft, tornado and conversion for and by any cause.

The power obtained through local organization can influence the proper wiring of apartment buildings for radio, the quality of programs broadcast locally.

A partial list of the achievements of the Federated Radio Trade Association includes publication of the *F.R.T.A. News*, exploitation of National Radio Week each fall; efforts to obtain reduction of insurance rates on radio stocks in store and warehouse; a study of the possibilities of a national credit and collection service.

Other outstanding contributions of the Association to the industry include the conduct of an annual forum for the secretaries of local radio trade associations; ironing out radio show dates in fall so that the various shows will not conflict to the disadvantage of manufacturers planning exhibits; the conduct of an annual meeting of radio show managers; provision of membership trade-mark cuts and certificates to all members.

Distributors Appointed

TRIAD: The Spencer Company, of Memphis, Tennessee, has been appointed factory representative for Triad Tubes covering the entire southern territory.

KELLOGG: The Fleer-Petty Auto Supply Company, 2823 Locust Street, St. Louis, Mo., has been appointed to handle Kellogg sales in the St. Louis district and surrounding counties.

The Louisville territory will be handled for the Kellogg Company by the L. & L. Tire and Battery Company, 307 N. Kentucky Ave., Louisville, Ky. The territory consists of a number of counties around Louisville in Kentucky and a few counties in Indiana.

The Raub Supply Company, Mulberry, James and Concord Sts., Lancaster, Penna., has been appointed to cover the central Pennsylvania territory. They will operate in Lancaster, Harrisburg, York, Wilkesbarre and the surrounding territories.

The southeastern territory has been taken over by the Universal Motor Company, Inc., 1710 Altamont Ave., Richmond, Virginia.

SPEED: The Martwel Corporation, 1501 Broadway, N. Y. C., special sales representatives for Speed radio tubes, has just announced the appointment of several new Speed distributors. G. J. Seedman Co., Inc., of Brooklyn, for Greater New York; Northern Distributing Co., of Newark, for Northern New Jersey and the Syracuse Auto Supply Co. for Central New York State.

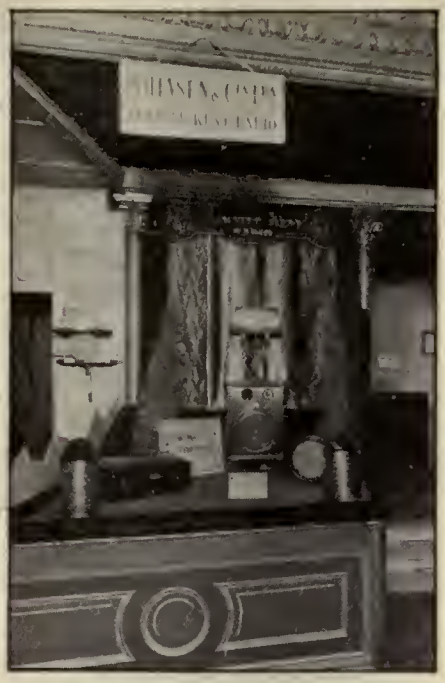
A. C. DAYTON: The Ideal Radio Cabinet Mfg. Co. Inc., of 151 West 19th Street, New York, will distribute A. C. Dayton Co. receivers.

TEMPLE: The Temple Corporation announces appointment of the following distributors: Wisconsin Auto Supply Co., of Wausau, Wis.; Maass Radio Corporation, of Baltimore, Md.; Broom Distributing Co., of Binghamton, N. Y.; Johnson-Ferrill, of Louisville, Ky., and Henry L. Walker, of Detroit, Michigan. About 70 jobbers and over 3000 dealers are now selling Temple receivers, according to Gordon C. Sleeper, vice-president and sales manager.

GREBE: Brothwell H. Baker, sales manager of A. H. Grebe & Co., Inc., of Richmond Hill, N. Y., announced the appointment of Stewart-Downey, Inc., 700 Beacon Street, Boston, Mass., as distributors of Grebe products in the Boston territory which consists of Massachusetts, Vermont and the western half of New Hampshire.

Stewart-Downey, Inc. is a newcomer to the ranks of radio distributors but it enters the field with a wealth of personal experience in back of it. John Stewart and Joseph A. Downey organized the Radio Department of The Boston Post in 1923 and have been in charge of this department ever since.

SONORA: Appointment of the K. W. Radio Co., Inc. as New York Metropolitan distributor of Sonora radio, Sonora phonograph and Sonora radio-phonograph combinations, including the well-known Melodon, has been announced by Eugene P. Herrman, president of the Sonora Phonograph Co., Inc. Headquarters of the K. W. Radio Co., are at 350 Hudson



This interesting booth was set up recently at the Buenos Aires 1929 Radio show by Ditlevsen and Co., Atwater-Kent distributors.

Street, New York City. The officers are Leonard Welling, president, and Gus Krouse, treasurer.

KELLOGG: In Cleveland a factory branch has been established by the Kellogg Switchboard & Supply Company. Office and warehouse space has been leased at 1531 W. 25th Street.

The branch will be in charge of F. W. Lorenz, formerly sales representative for the Ohio territory. Assisting Mr. Lorenz are Mr. Shibler and Mr. Moran.

Crosley Distributor Appointment

The Dallas branch of the Shield Company, Crosley distributors, is under new management, E. B. Howard having succeeded C. B. Wakefield who has resigned to go into the wholesale furniture business.



Inside the Spear and Company store, New York City, there has been erected a miniature brick house in which they exhibit their outstanding features.

Distributors Sales Meetings

TENNESSEE: The Atwater-Kent dealers of the Memphis territory, held their annual Dealers Conference at the Hotel Peabody, Memphis, Tenn., August 14th, under the auspices of the Braid Electric Company, Atwater-Kent distributors.

Luncheon was served at 12 o'clock and the business meeting followed immediately after the official photograph and the address of welcome by E. E. Hyde, Braid Electric Co. W. W. Gambill, Braid Electric Co., opened the meeting, and was followed by E. L. Hollingsworth, A-K territory manager, John F. McCoy, A-K Mfg. Co., Ben B. Barber, Atwater-Kent sales promotion dep't. Luther Still, assistant territory manager and W. W. Gambill, Jr., Braid Electric Co.

The next day, Thursday, was devoted to a service school conducted by Atwater-Kent service officials, for dealers' servicemen.

TEXAS: The Shield Company, Inc., of Dallas and Ft. Worth, announces that their regular Crosley dealer convention was held on the top floor of the Texas hotel in Ft. Worth on August 7th. Short talks were given by officials of the Crosley Radio Corporation and representatives of the Finance Companies who will handle the finance paper for the dealers this coming season. This year promises to be a big one in radio and from the speedy replies which the dealers are making on the invitation letter, this year promises to be the largest and most enthusiastic convention which The Shield Company has held. Practically all the dealers have expressed their enthusiasm for the new Crosley line for the coming season by ordering heavier at this time of the season than at any time in the past.

PENNSYLVANIA: The dealers served by the Edison Distributing Corporation of Pittsburgh had their first opportunity to view the new Edison Light-O-Matic models at a special exhibit in the William Penn Hotel, Pittsburgh, on July 26, 27 and 28. The exhibit was arranged and conducted by H. F. Andre, branch manager at Pittsburgh, assisted by H. H. Silliman, eastern sales manager of Thomas A. Edison, Inc. Several hundred dealers attended.

NEW YORK: The Majestic Distributors, Inc., sponsored a novel and interesting banquet, tendered to the Morison Electrical Supply Co., of New York City, on the evening of July 31, 1929. The banquet was held in the ballroom of the Hotel Pennsylvania, New York City.

There were present 170 salesmen, sale managers and executives of the Morison Electrical Supply Co., together with the executives and salesmen of Majestic Distributors, Inc. Herbert E. Young, general sales manager for the Grigsby-Grunow Co., of Chicago, Ill., was the guest of honor and delivered a message on "Outside Selling and Sales Promotion." C. T. Morison, president of the company bearing his name, also talked, outlining the plans and policies to be employed in the campaign which were to be directed on Majestic Radio Receivers during the month of August.

IN THE RADIO MARKETPLACE

News, Useful Data, and Information on the Offerings of the Manufacturer

Improved Philco Speaker

PHILADELPHIA STORAGE BATTERY COMPANY: A seamless fabric cone ten inches in diameter and entirely moisture proof is responsible to some extent for the improved reproduction obtained from the new Philco dynamic loud speaker. In the Philco receiver there is an acoustic equalizer by which the user can vary the reproduction to suit his personal preference. The dial is calibrated in channel numbers reading from 55 to 150.

Trav-Ler Portable Sets

TRAV-LER MANUFACTURING CORPORATION: Deliveries of the new portable radio receivers were started near the end of July. The line comprises three models in prices from $65 to $100. All of the sets may be adapted readily for operation on batteries, 110 volts a.c., or 110 volts d.c. The sets use four tubes consisting of one screen-grid tube, detector, and two audio tubes. The Standard model lists at $65.00, the De Luxe model at $75.00, and the Aristocrat at $100.00.

New Bosch Radio Tubes

AMERICAN BOSCH MAGNETO COAPORATION: This company will market a complete line of tubes under its own name. Bosch tubes in all standard types will be available.

The Radiola Model 66

RADIO-VICTOR CORPORATION OF AMERICA: The new Radiola 66 employs an improved a.c. super-heterodyne circuit which includes the tuned antenna coupling circuit, one stage of r.f. amplification, oscillator, first detector, two



stages of intermediate-frequency amplification, second detector and one stage of audio-frequency amplification. The power output tube is the 245. The single tuning control is marked with readings from 0 to 100 which are projected and magnified for easy tuning. List price: $225.00.

Mountford Resistors

C. E. MOUNTFORD: This company has designed a resistance capable of meeting all usual requirements for use in modern radio receivers. The resistor has been designed for manufacturer's use to sell at a low price.

Oxford Loud Speakers

OXFORD RADIO CORPORATION: An auditorium type loud speaker having a diaphragm diameter of approximately 12 inches has been added to the regular line of dynamic loud speakers. The auditorium type is designed especially for use in theatres or in receivers where exceptional volume is required. According to Frank Reichmann, vice president and chief engineer, the plant is working at full capacity supplying dynamic loud speakers to set manufacturing companies.

Portable Phonographs

CASWELL MANUFACTURING COMPANY: This company manufactures portable phonographs and completely a.c. operated portable turntables with magnetic pick-ups. The Powertone



model illustrated above uses a General Electric synchronous motor and a Pacent Phonovox electric pick-up. A record album is built into the cover. List price: $49.50. The following portable phonographs are made: The Aristocrat, $35.00; the Monarch, $25.00; the Gypsy, $20.00; the Melody, $15.00; and the Model 12, $12.50.

United Air Cleaner Line

UNITED AIR CLEANER CORPORATION: This company is manufacturing a complete line of magnetic and dynamic loud speakers, two complete screen-grid receivers, and also an electric turntable and a magnetic pick-up unit. The receivers are made by the Sentinel Manufacturing Company, a division of the United Air Cleaner Corporation.

DeJur-Amsco Condensers

THE DEJUR-AMSCO CORPORATION: This company announces a new line of multiple condensers of the "bath-tub" type, complete with dial assembly. They may be had in from one to four gang units with or without dial and with from two to eight gang units with dial.

Phonograph Equipment

MOTOR PLAYER CORPORATION: This company manufactures portable electric turntables and phonograph pick-up units. Style II portable contains an electric motor and phonograph pick-up and lists at $65. The Style I at $60 is similar but is contained in a somewhat less expensive cabinet. Separate phonograph pick-up units list at from $10.45 to $19.00.

Electric Phonograph Units

ALLEN-HOUGH CARRYOLA COMPANY: This company manufactures electric turntables designed for use by manufacturers in making either phonographs or combination radio-phonographs. The motor is of the synchronous type and revolves the turntable at 80 r.p.m. The Rotrola is an electric turntable and phonograph pick-up



unit housed in a small cabinet and designed for use in conjunction with radio receivers to permit the reproduction of phonograph records. List price: $45.00.

Transmitting Apparatus

JENKINS AND AYAIR, INC.: A number of different styles of transmitting condensers and inductances are being manufactured by this company. Type KB variable condenser has a maximum capacity of 0.0006 mfd. with three-inch spacing between plates. The overall height is 68 inches and the overall weight is approximately 120 lbs. The condenser is priced at $550.00 net f.o.b. Chicago. The Type B inductances are made up with from 14 to 20 turns and are priced at $10.00 per turn. Ordinarily the inductances are built of copper strip but they are made of copper tubing if desired.

Supreme Diagnometer

SUPREME INSTRUMENTS CORPORATION: The Model 400-B is a complete instrument for making all types of tests on tubes, receiving sets, power units, etc. The instrument is known as a "Diagnometer" and is, according to the manufacturers, equivalent to a complete portable laboratory. Approximately 40 different tests can be made.

New Zenith Models

ZENITH RADIO CORPORATION: Four new receivers were announced recently by this company. They are known as the Models 52, 53, 54, and 55 and are priced at from $175 to $700. All of them incorporate automatic tuning and screen-grid circuits. Double push-pull amplification is used with two 227-type tubes in the



first push-pull stage, and two 245-type tubes in the second or output stage. The Model 55 includes a device for remote tuning. Models 54 and 55 are designed for operation with a built-in loop antenna.

Super Akra-Ohm Resistors

SHALLCROSS MANUFACTURING COMPANY, manufacturers of Super Akra-Ohm resistance units: The Type 7-M units have an accuracy within 0.5 per cent. and the type 14-M has accuracy within 0.25 per cent. The break down voltage of the insulation on the wire is approximately 250 volts.

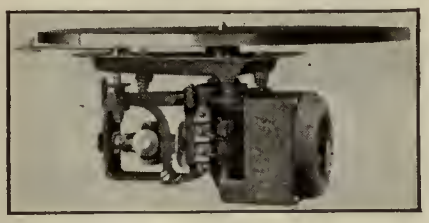
New Pacent Line

PACENT ELECTRIC COMPANY: Phonograph pick-up units and electric turntables of the following models are now available. Type 106-A, a pick-up without tone arm, $12.00; type 106-B phonograph pick-up with counterbalanced tone arm, adapters, and volume control, $15.00; type 106-C Ultra Phonovox consisting of special pick-up with counter-balanced tone arm, gold finished, $25.00; type 140 electric phonograph

motor, $25.00; type 301 Electrovox consisting of a type 140 motor installed in a cabinet, $75.00.

Motors for Phonographs

General Industries Company: A complete line of spring and Electric motors for phonograph and phonograph-radio combinations are



manufactured by this company. The standard electric motor types are designed for 110-volt 50-60 cycle a.c. operation. The large spring motors have a capacity of about five standard 10″ records from one winding.

New Dynamic Chassis

Trimm Radio Manufacturing Company: A dynamic loud speaker chassis has been developed by this company. The Model n100 is designed to be supplied with field power from the power unit. The Model dv102 is supplied with an output transformer to match conventional types of power tubes.

Phonograph Apparatus

Ultraphonic Products Corporation: This company is manufacturing the Upco electric phonograph pick-up unit which is sold complete with tone arm and volume control. The impedance is 600 ohms at 1000 cycles and the output is 1.2 volts at 200 cycles. Lists complete at $20.00.

Radio Service Material

Louis P. Hornung, Jr. Laboratories: This company supplies radio service material such as record cards, service call cards, letter heads, etc. A test bench has been designed with the requirements of radio service work in mind. It is made of heavy material with ample space for handling complete sets, and space for a large test panel. Net price: $29.00.

New Lightning Arrestor

L. S. Brach Manufacturing Corporation: The Arres-Tenna is a new protective device designed to protect radio receivers against lightning which may reach the set either through the antenna or through the lighting system. The device lists at $2.50 and carries a $100 insurance guarantee.

Belden Antenna Kit

Belden Manufacturing Company: A new complete antenna kit containing every item



of material needed to install a complete antenna and ground system has been placed on the market by this company.

New Eveready Series 30

National Carbon Company: The Eveready Series 30 (Models Nos. 30 to 40) receivers employ a seven-tube single-dial antenna-operated all-electric a.c. chassis, having three stages of r.f. amplification, detector, and two stages of a.f. amplification. The power stage consists of two 171a tubes in push pull. The rectifier is a type 280. The receiver employs a variometer in the first tuned circuit, thus making the sensitivity of the set more uniform throughout the entire broadcast band.

Electrad Resistors

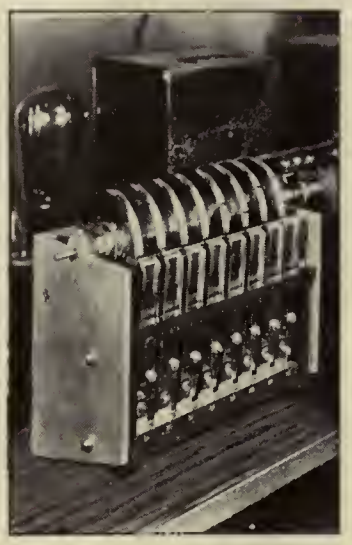
Electrad, Incorporated: Several new lines of fixed and variable resistors are being manufactured as follows: Super Tonatrols, a group of heavy-duty volume-control resistors, in values from 10,000 to 50,000 ohms; Truvolt sliding contact resistors, in values up to 5000 ohms; Truvolt air cooled resistance banks, in values up to 21,000 ohms; Wire-wound grid leaks, in values from 5,000 to 50,000 ohms.

Amperite Line Control

Radiall Company: The Amperite self-adjusting line voltage controls for a.c. receivers are designed to handle a line fluctuation of about 30 volts maintaining the output constant within about 10 per cent. The voltage drop across the control varies from about 20 to 40 volts, so that the transformer primary must be wound for about 80 volts. The manufacturers guarantee a life of about 2000 hours.

Automatic Tuning Control

Carter Radio Company: An automatic control tuning device was recently announced by this company. It cannot be attached to an existing receiver but is designed to be incorporated into the set during its manufacture. The



device is operated by pressing push buttons each of which functions to tune the receiver to the station whose call letters are indicated on the button which was pressed. When a button is pressed an arm makes contact with a drum. This closes the motor circuit which immediately begins to revolve and continues to do so until the variable condensers have been brought to the correct point to receive the desired station. The device is also adaptable to remote-control operation. Any number of remote-control devices may be employed to control the receiver from various locations. The device was designed by A. W. Plenser, engineer of the Carter Radio Company.

New Diaphragm Material

Stevens Manufacturing Company: This company makes a special diaphragm material which is used in a number of dynamic loud speakers being made by various set manufacturers. The diaphragm material is known as Burtex and consists of a special fabric which can be pressed into any desired shape and impregnated with a water-proofing compound to make it impervious to moisture.

Burton-Rogers Tube Checker

Burton-Rogers Company: The new Model B tube checker is equipped to test both a.c. and d.c. screen-grid tubes as well as all other standard types of tubes. It is completely supplied with power from the a.c. lines and a tube is checked by simply putting it into the appropriate socket and noting the reading of the single meter The net price to dealers is $22.75.

New Phonograph Pick-up

E. Toman and Company: The Toman Super Pick-up is designed for use in electrically reproducing phonograph records. List price is $17.50.



Phonograph Pick-Up Units

Buckingham Radio Corporation: This company makes several types of electric pick-up units as follows:

Model a—Pick-up only. Manufacturer's type	$10.00
Model a-1—Pick-up only with bracket	10.45
Model a-201—Pick-up with bracket, volume control unit, and adapter for d.c. sets	15.45
Model a-227—Pick-up with bracket, volume control unit, and adapter for a.c. sets	15.55
Model c—Pick-up only with tone arm, Manufacturers' type	14.00
Model c-201—Pick-up with tone arm, volume control unit, and adapter for d.c. sets	19.00
Model c-227—Pick-up with tone arm, volume control, and adapter for a.c. sets	19.00
201—Adapter model for d.c. sets	1.25
227—Adapter model for a.c. sets	1.35

"X-Core" Dynamic Speakers

The Magnavox Company: The "X-Core" dynamic loud speakers made by this company are available in a number of different models. Either the unit alone or the unit mounted in a cabinet may be purchased. The units are priced as follows:

No. 106—7¾″ cone, 110–190 v. d.c.	$21.00
No. 107—10½″ cone, 110–190 v. d.c.	23.00
No. 108—7¾″ cone, 180–300 v. d.c.	21.00
No. 109—10½″ cone, 180–300 v. d.c.	23.00
No. 200—7¾″ cone, 6–12 v. d.c.	22.00
No. 201—10½″ cone, 6–12 v. d.c.	24.00
No. 400—7¾″ cone, 105–120 v. a.c. 60 cycles	31.00
No. 401—10½″ cone, 105–120 v. a.c. 60 cycles	33.00
No. 402—7¾″ cone, 105–120 v. a.c. 25 cycles	32.00
No. 403—10½″ cone, 105–120 v. a.c. 25 cycles	34.00

Jewell Set Analyzer

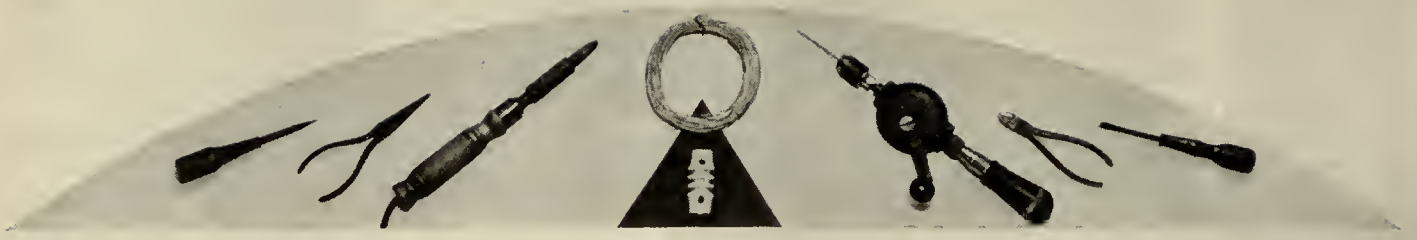
Jewell Electrical Instrument Company: A new four-instrument set analyzer designed to meet all the requirements of modern set testing has been designed by this company. Space is



provided for carrying tools and replacement tubes.

Automobile Receiver

Automobile Radio Corporation: This company makes the Transitone radio receiver designed for installation on the dash board of automobiles. The antenna is concealed in the top of the car and the loud speaker is attached above the windshield or hidden under the dash board.



THE SERVICEMAN'S CORNER

To start off the "Corner" this month we have a short article describing a peculiar short circuit trouble. This contribution comes from B. B. Alcorn, of the Kew Radio Electric Company, of Kew Gardens, Long Island, N. Y. Most readers of this department will remember Mr. Alcorn as the author of a series of articles on "Practical Service Methods" which was published in Radio Broadcast.

"An unusual complaint which will be of interest to the readers of the "Servieeman's Corner" has recently come to the attention of the writer. It concerns a Zenith receiver having a Jones type plug used for the connection. The same type of trouble could easily develop in any set using this connector and might for a time prove as baffling as it did for the writer.

"The set was found to he inoperative with all the indications of a short. It was checked earefully, but no fault eould be found in any of the parts. Then the power pack was checked and here the test showed a decided short, yet each individual part seemed to be O.K. Finally the short was run down to the cahle and finally to the connection plug.

"These plugs are made of small hrass cotter pins run through holes in a block of insulating material. If the ends of these split pins are open a trifle too wide it is easy for them to cateh on the edge of their socket and bend over. This is what happened and, in bending, it had beeome firmly wedged against the next pin, effectively shorting out the filament supply for the ux-226's. This particular point was about the last place that one would look for trouhle and in the writer's experience it is the first time that a short of this kind has come to his attention."

Metal Eyelets Cause Trouble: H. W. Hendelson, Radio service and merchandiser, of Vandalia, Mo., cracks another hard nut.

"We reeently had a short that was a hard one to locate. We knew this short was in the r.f. plate circuit, but could not locate its position. We tested the by-pass condensers and found them O.K. The r.f. coils were attaehed to the subpanel with metal eyelets and one resistanee strip in the filament circuit was also attached by an eyelet. These eyelets also furnished the hole for the wiring to pass through to the r.f. stages. The wires going through these holes were rubher covered with a cotton covering between rubber and wire, and this insulation appeared to be O.K. where it went through subpanel. However, it seemed to me that there was no other plaee for a short, so I opened one wire at a time, watehing the meter as I did so. As I opened the wire going through the eyelet that held the filament resistance I got a zero reading on meter, thus locating the short. I plaeed a piece of spaghetti tubing around all wires going through eyelets and in this way corrected the trouhle."

On the Use of Relays: J. P. Kennedy, senior student in E. E. at Notre Dame, and radio serviceman of South Bend, Ind., sends through a couple of notes on relays:

"The most troublesome feature about relays used in conjunction with sets having fixed resistors for filament control has been the excessive voltage drop across the series actuating coil. As three-quarters of an ampere is usually enough to work these relays, a shunt of nicrome or other resistance wire may be bridged across the series coil terminals. The amount of wire will vary for different sets and relays hut can always be determined by leaving the set turned on and attaching the resistance wire to one terminal and touching various points on the wire to the other terminal. When the relay clicks, it means the resistance wire shunt has too low a resistance and the desired length is that which just permits the relay to operate when the set is turned on and off.

"One of my customers has a double outlet plug in the B-power unit side of the relay box and a floor lamp alongside the radio conneeted to the extra outlet plug. When the radio is turned on, of course, the floor lamp lights. The effect is charming."

Reducing QRN in D.C. Districts: "The writer, whose job is servieing radio sets around the West End Avenue section of Manhattan, has had quite a bit of experience in curing artificial static caused by electric refrigerators, sparking motors, heating pads, and other electrical appliances. Sometimes it has been difficult to locate the offending instrument and then again there have been so many of them that it would have heen impossible to fix them all.

"Most of this artificial static is picked up by the lead-in wire and the writer has found that a marked reduetion of static is obtained, especially where the set itself is of the shielded type, by raising the antenna as high as possible above the roof and replaeing the ordinary rubber-covered lead-in wire hy some Beldenamel shielded hook-up wire ($3.50 for a 100-foot roll) and connecting the shielding to the ground binding post of the set."

J. Futterman, Bronx, N. Y.

A Few Fireworks: Albert Corideo, radiotrician and authorized S-M service station, of Waterbury, Conn., finds hurry calls diverting.

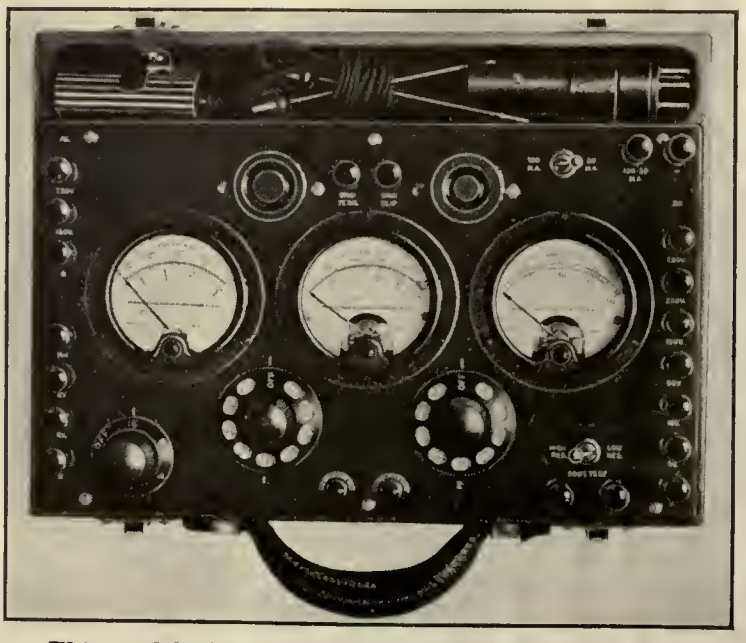
"A woman living two doors away from me came dashing into my laboratory pale with fright shouting that her radio was on fire. I made a dash for her house, and got there before her. There was a curl of black smoke rising from the receiver in the dining room. I pulled the plug from the socket, pulled the console away from the wall, and through the smoke in the set observed a bright red spot.

"After giving the receiver and power pack a testing which lasted an hour I found it in good condition. The part that was hurning was the insulating material on the power rheostat.

Screen-grid receivers have been on the market just about long enough to develop characteristic faults and ailments. The screen-grid set by now has become a part of the serviceman's daily routine. We particularly solicit contributions from servicemen on the problems of screen-grid servicing, which direct attention to characteristic troubles and their correction. These troubles seem to be lack of selectivity, noisy tubes, short life, and marked fluctuation in signal strength.

We will pay special rates for unusually interesting contributions on screen-grid trouble shooting.

—The Editor



This model, No. 547, is Weston's latest test equipment. It is designed to run every practical test on d.c. and a.c. receivers, including screen-grid sets.

"I replaced the tubes again and turned on the current. The tubes did not light, but a bright red spark showed up in the 281-type tube. I replaced this tube with a new one, and the set was back in working condition again. In examining the rectifier, I noticed that the filament had broken, and one of the broken ends was touching the plate, causing a short in the tube, which in turn heated the winding of the rheostat."

C. WASHBURN, JR., of Jacksonville, Fla., suggests reversing antenna and ground posts on many receivers suffering from low sensitivity. The improvement in sensitivity is generally due to increased regeneration with the removal of the stabilizing effect of the ground.

A Useful Voltmeter Formula: BORIS S. NAIMARK, service engineer with the Riverside Radio Service Company of New York City, notes the formula in "Strays from The Laboratory" for August for determining the value of an unknown resistor with a voltmeter and a battery.

$$R = \left(\frac{E}{E_1} - 1\right) R_m$$

Where R is the unknown resistor
E_1 the voltage indicated on the meter
E the voltage of the battery
R_m the resistance of the meter

Mr. Naimark points out that this same formula can be used to determine the correct value of a resistor to be used as a voltage multiplier to secure any desired range with any voltmeter.

Let R equal the value of the resistor
E_1 full-scale voltage of the meter itself
E the voltage desired at full scale
R_m the resistance of the meter

If, for instance, we have a meter reading up to 100 volts, having a resistance of 1000 ohms per volt, and we desire to place a resistor in series with it so that it will indicate full scale on 500 volts, what value of resistance should we use?

The calculation is simple:

The calculation is simple:

$$R = \left(\frac{500}{100} - 1\right) \times 100{,}000 = 400{,}000 \text{ ohms}$$

A Grounded Transformer: "After an electrical storm last week I was called upon to service an Eveready set. I first discovered that the fuse was blown in the light line, and, in trying to replace it, I found that the line was grounded. After disconnecting the radio set the fuse stayed put.

"Upon close inspection of the set I found the socket panel of the power pack was badly burned near the transformer, and, upon testing the transformer, found the primary to be grounded. Everything else OK.

"After removing the transformer from the set I failed to test it, which was careless of me. Replacing it with a new transformer I was surprised to find that I still had the same ground.

"The primary taps on an Eveready set run to spring contacts which are set in the rubber socket panel and the panel is supported by angle strips along each side.

"The spring contacts on one side are about an inch from the angle strip support, but I found that the lightning had burned the panel and left a smoke or carbon deposit thick enough to ground these spring contacts to the angle supports that held the panel in place.



This is an ideal type of truck for radio service work. Note the ladder for making antenna installations.

"After sanding off this deposit of carbon everything was OK."

BLAINE MARTIN, Cleveland, Ohio.

Installation and Operation of Moving Coil Speakers: "Many times you will run across a customer who wants receptacles for a dynamic loud speaker of either the 6-volt field type or the 90-volt field type, in two rooms.

"The easiest method to use for this purpose is to attach an old tube base on the speaker leads and wire a radio tube socket on the floor in the rooms desired, thus providing the necessary four contacts for the field and moving coils."

C. H. JENKINS, Radio Service
Audubon, New Jersey.

Pepping up a Crosley: EUGENE O. WHITAKER, in charge of service with the American Electric Company of St. Joseph, Mo., notes a cause of sensitivity drop in a Crosley.

"Sometimes a Crosley Showbox set, model 706, loses its kick after a few months use and new tubes do not always remedy the trouble.

"I have found that in some cases this loss of volume is caused by a sideway movement of the stator plates of the condenser in the first tuned r.f. stage. This can be remedied easily by loosening the two set screws holding the rotor plates to the shaft and slipping the plates to the center of the stator plates again. This puts the condenser in resonance with the other two and the set will tune as sharply as ever."

How Long Do A.C. Tubes Last?: George Lewis, of the Arcturus Radio Tube Company, thinks that the average set owner should get along for two years on one set of tubes. Offhand, service contacts tend to indicate that two sets of tubes a year is nearer the mark. We should appreciate first-hand data on this.

A Home-Made Tube- and Set-Tester

WE PRESENT the following service contribution from G. WESLEY TAYLOR, of Berkeley, California, for the benefit of those servicemen who make their own test equipment, and who endeavor to incorporate, in single test devices, as large a number of functions as is effectively practical. While there are several commercial types of testing equipment that may effect individual tests more conveniently than Mr. Taylor's arrangement, the versatility and economy of this device will recommend it to many servicemen.

"The average tester tests tubes with the current supplied by the receiving set. The tester described on this page tests tubes regardless of the condition of the batteries in the receiving set, and will rejuvenate them if necessary. An oscillator is built into the circuit to facilitate adjusting the receiver in case it is not possible to pick up a broadcasting station.

"The d.c. voltmeter is a Weston with an 0–5 range. By removing the resistance, this instrument was converted into 0–8 milliameter. The proper resistances and shunts were determined by the use of Ohms Law to give the desired ranges. The a.c. voltmeter is a Jewell with a range of 0–15. Removing the resistance from this meter provided an instrument with a range of about an 0–8. The above meters were on hand—therefore the extra work. If it is necessary to buy the meters an 0–1.5 d.c. milliameter and an 0–8 a.c. voltmeter should be selected. The ammeter was purchased from an auto wrecking house for the sum of fifty cents. The shunt and the coils were removed and replaced with new coils having more turns to lower the range below that desired. The range was then adjusted to suit by means of a new shunt.

OPERATING AND SERVICE MANUALS AVAILABLE

IN RESPONSE to a recent questionnaire submitted by RADIO BROADCAST, the radio manufacturers listed below have indicated their willingness to supply operating and service data on their receivers to us for distribution to legitimate servicemen. In order to secure this material it is necessary to direct your request to RADIO BROADCAST *on your business stationery*, enclosing the correct amount in stamps or money-order when a charge is indicated.

F. A. D. Andrea, Inc.: Wiring diagrams and special sheets covering current models. No charge.

All-American Mohawk Corporation: Instructions and Service Manual (specify model). No charge.

Bremer-Tully Manufacturing Company: Instruction Books and Service Manuals. No charge.

Colonial Radio Corporation: Instruction Books, Service Sheets and Service Manual, at 50c., 25c., and 50c., respectively. Bulletins number 31A-C, 31D-C, 32A-C and 32D-C are also available.

Continental Radio Corporation: (Slagle), Service Manual. No charge.

Columbia Phonograph Company, Inc.: Service Manual. Nominal charge not yet determined.

Crosley Radio Corporation: Instruction Sheets or Service Manuals (indicate receiver model numbers) No charge.

Day-Fan Electric Company: Complete Service Manual. Price: fifty cents.

Electrical Research Laboratories, Inc.: Instruction Bulletins and Service Bulletins. No charge.

Charles Freshman Company, (Earl and Freed receivers): General literature. No charge.

Federal Radio Corporation: Instruction Books and Service Manuals (specify receiver model). No charge.

A. H. Grebe and Company: Operating and Service Data (specify receiver models). Nominal charge.

Grigsby-Grunow Company (Majestic Radio): Operating and Service Sheets. No charge.

Stewart-Warner Speedometer Corporation: Instruction Books, Service Manuals and Wiring Diagrams (specify receiver types). No charge.

Steinite Radio Company: Service Manual in standard binder, 50c., leather binder, $1.00.

Silver Marshall, Inc.: Service Bulletin, Silver Radio Instruction Booklet. No charge. Data Sheets, two cents each. General catalog, no charge.

Temple Corporation: Service Bulletins. No charge.

United Reproducers Corporation: Operating Data, Service Data. No charge.

U. S. Radio and Television Corporation: Service Manuals. No charge.

"Constructional details other than those suggested in the pictures, and the diagram are not really necessary.

"The regular circuit tests are made with a test cable-plug made from the X base of an old '99-type tube and a cable with phone tips on the other end. The cable used should have leads sufficiently heavy so that there will not be an appreciable voltage drop when testing a.c. tubes. The phone tips are attached to the four tip jacks on the right of the panel, starting with the grid on the left, the filament leads in the middle, and the plate on the right. The tube base is plugged into the socket that it is desired to test, using a suitable adapter if necessary, and the tube is placed in the tester. The two switches below the a.c. voltmeter and the rheostat should be in the off position.

"Placing a shorted phone plug into the phone jack on the extreme left of the panel will cause the d.c. voltmeter to read the grid circuit. The 500-volt range should he used when testing the grid circuit of a power tube. This test will not give a true voltage reading because of the resistance in the grid lead and will indicate continuity only. The next jack will read the plate voltage on a 500-volt scale. If the set is d.c. operated the third jack will read the filament voltage on a 50-volt scale. Pushing the button on the left below the a.c. voltmeter will short the 50-volt resistance and the voltage can he read on the 5-volt scale. If the polarity is reversed it can be changed by turning the switch above the button for the 5-volt range. The fourth jack reads the plate current. The switch below the plate-current jack is for the shunts for the milliameter, 1 being for the 8 mA. scale, 2 for 25 mA., and 3 for 100 mA. If the set is a.c. operated, the filament voltage is tested by turning the a.c. switch, being the one to the right below the a.c. meter, to the 'on' position, making sure that the rheostat is in the 'off' position.

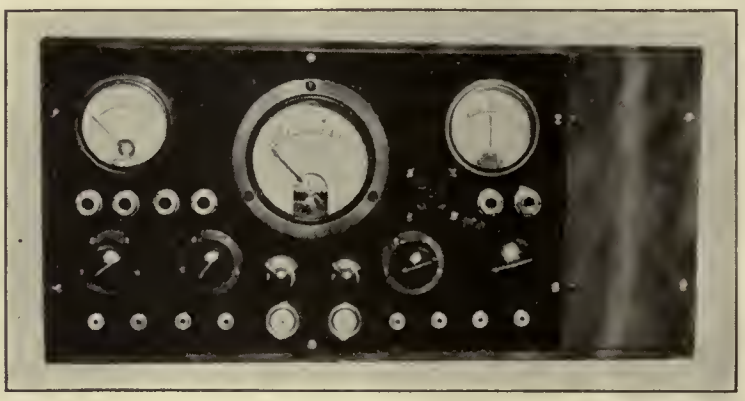
"If it is desired to use the meters independently the tip jack to the extreme left is the plus lead. The second tip jack is for the milliameter lead. The switch below the plate current jack controls the milliameter shunts.

"The third tip jack is for the d.c. voltmeter. The switch to the extreme left and above the plus lead controls the voltmeter resistances, 1 for 5 volts, 2 for 50 volts, and 3 for 500 volts. The fourth tip jack is for the 3–0–3 ammeter in the upper right corner of the panel. This meter is used for testing chargers, etc., it being connected so that if the plus lead is connected to the plus of the battery the meter will read discharge when the set is turned on and charge when the charger is turned on. The ammeter is used whenever there is any question about the polarity of the charger or its charging ability. The two middle tip jacks of the four on the right of the panel are for the a.c. meter. The a.c. switch should be on and the rheostat off.

"A toy transformer with adjustable voltages is used for filament supply. The one used gave from 2.5 to 25 volts in steps of 2.5 volts. The plate voltage is supplied by a tapped resistor across the 110-volt leads. The switch below the socket controls the filament voltages, 1 for 2.5 volts, 2 for 5 volts, 3 for 7.5 volts, and 4 for 10 volts. The rheostat is connected in the circuit to give closer regulation of voltage.



The Beynon Radio Shop insure the neat appearance of their servicemen by providing the coats shown above.



Front panel view of the home-made test set described by Mr. Taylor.

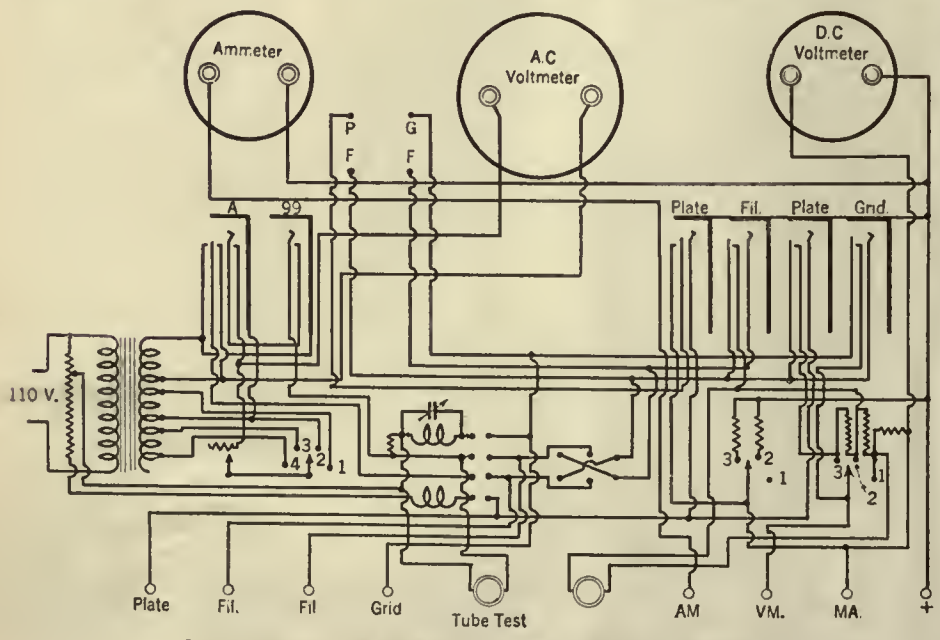
"The testing of a tube is accomplished by attaching the cord to a convenient light socket and placing the tube in the socket. The a.c. switch should be in the 'on' position and the filament voltage adjusted by means of the voltage switch and the rheostat. The phone plug should be placed in the plate current jack. The meter should now read about 1.6 mA. for an A tube. Pushing the button below the a.c. switch will short the grid resistance, and the plate current should now be about 5 mA. The voltage on the plate is about 80 volts. It is also possible to test 280- and 281-type tubes in the same way.

"A coil is connected in the grid and plate circuits in the proper relation so that the tube will oscillate when making the tube test. It may be necessary to reverse the plate voltage leads to make the tube oscillate. The desired frequency is obtained with a 0.0005-mfd. variable condenser that can be adjusted with a screwdriver. The oscillator is tuned to about the middle of the broadcast band and may be used in place of a broadcasting station whenever needed for set adjustment. The condenser is mounted inside the case and may be varied if necessary with a screwdriver through a small hole in the back.

"The rejuvenation of tubes is accomplished by placing the tube to be rejuvenated in the socket and the adjustment of the filament voltage to the baking value, 4 volts being correct for the '99- and '20-type tubes, and 7 volts for the A-type tubes. The phone plug is placed in the phone jack nearest the socket which disconnects the voltmeter and applies the flashing potential of 12 volts for the '99- and '20-type tubes. The other jack disconnects the voltmeter and applies the flash voltage of 17.5 for the A-type tubes.

"The line voltage may be checked by turning the voltage switch to the 5-volt tap and reading the meter. By testing the line voltage at various times a reading can be obtained which will represent 110 volts. Any variation above or below will indicate a similar change in line voltage proportional to the voltage being read on the meter.

"A duplicate phone plug was made from a piece of $\frac{1}{4}$" brass rod threaded on one end to take a rubber binding post top and the opposite end turned to the shape of a phone plug. To facilitate construction the wiring diagram is drawn as the instruments appear from the back of the panel, but the operating instructions are given as the instruments appear from the front.



Complete wiring diagram of Mr. Taylor's test set.

What Every Radio Dealer Should Know About His Tube Business

By J. J. STEINHARTER
President, Cable Radio Tube Corporation

IN 1927, 30,000 dealers sold 33,662,247 tubes —an average of 1123 tubes per dealer.

In 1928, 31,000 dealers sold 61,552,846 tubes —an average of 1985 tubes per dealer.

In 1929, 39,000 dealers will sell 100,000,000— an average of 2564 tubes per dealer!



1927 sales 33,662,247 | 1928 sales 61,552,846 | 1929 sales 100,000,000 (*estimated*)

Courtesy "Radio Broadcast"

The tube business is growing—more sets, more tubes per set, new type tubes, more tube sales per dealer. Are you getting your share?

Of course, half the story is in the line you carry.

Is It A Quality Line?

Speed tubes are triple-tested . . . first quality tubes. Made by a company making tubes since 1924. Speed executives served an apprenticeship of over 20 years in incandescent lamp manufacture.

Is It A Complete Line?

Speed tubes include types 201A, 199, X140, WD11, WD12, 200AA, 112A, 171A, 171AC, 245, 210A, 250, 226, 227, 280, 281, 224AC.

Is It A Progressive Line?

Speed had a 224AC type in 1928. Speed's 227 has been perfected to heat in 5 seconds—by test. Speed adopted solid carbonized plates months ago.

Speed's new manufacturing equipment is the very latest and best. Speed raw materials are A1.



J. J. STEINHARTER

Is It A Well-Advertised Line?

Speed tubes are advertised in full pages in the *Saturday Evening Post* . . . in all the leading trade and fan radio magazines . . . in great newspapers from coast to coast . . . with direct mail, counter cards, window displays, and every dealer help.

Is It A Profit Line?

Speed's quality makes for satisfaction, sales, and resales. Speed's return policy is most liberal. Speed's discounts are right. Speed is the tube for profit.

Remember, 100,000,000 tubes this year! Get your share—handle the right line. Franchises are going fast.

As we say in consumer advertising, "Step Right Up And Call For Speed."

SPEED
CABLE RADIO TUBE CORPORATION
84-90 N. NINTH ST., BROOKLYN, N. Y.
MAKERS OF RADIO TUBES
SINCE 1924

Advertisement





TO THE MIGHTIEST VOLUME

the Webster Electric Pick-up Reproduces Perfectly!

OVER the entire range of recorded music . . . from the faintest soprano inflection to masterful passages on the tympany . . . the Webster Electric Pick-up reproduces faithfully. This fidelity of tone, this ability to capture the most delicate harmonies and intonations of voice and instrument, has won for the Webster supremacy in its field.

As a result of Webster's supremacy in everything that counts in an electrical pick-up, its dealers have enjoyed a profitable success with it everywhere . . . a success based on tremendous public demand.

The public wants the Webster Pick-up because it alone embodies all those features that mean true tone quality. Every part in its construction is perfectly matched and balanced. Greatest travel freedom of the needle is assured by a frictionless stylus bearing. The built-in volume control in Model 2-A is a distinct Webster feature, making the unit extremely compact and easy to install.

If you have not yet investigated the sales possibilities offered by the beautiful appearance, matchless tone qualities, and precision workmanship so evident in the Webster Electric Pick-up, do so today. Many leading jobbers have already placed orders for their stocks.

Order direct if your jobber has not received his.

WEBSTER ELECTRIC COMPANY, *Racine, Wisconsin*



The New Webster Model 2-A includes Pick-up head, supporting arm, built-in volume control and adapters. List Price $17.50.

The Webster Electric Theater Pick-up for use with 16" records. Two Models— Standard and Low Impedance. Model 2-D $25.00, Model 2-D-1 $30.00. Matching Transformer $6.50.

Pick-up head, Model 2-B. Both models readily adaptable to either battery operated or A. C. sets.



Model 2-B includes Pick-up head, separate volume control, and necessary adapters. List Price $13.00.

Webster Electric Pick-up



STRAYS *from* THE LABORATORY

Regarding Band-Pass Circuits

A letter addressed to the engineers of a number of large receiver manufacturers recently asked the question, "Why is it that you do not recommend the use of band-pass filter circuits in your receivers?" The general opinion seemed to be, to judge from the replies, that such circuits were more expensive than simple resonant circuits and the result secured therefrom did not pay. In this connection it is interesting to quote from a recent communication from Dr. F. K. Vreeland.

"It is possible to convert one of the popular-priced and widely-sold radio receiving sets into a band receiver at a cost of only thirteen cents. All that is necessary in such an operation is the removal of several feet of wire. Of course, this is but one of several possible applications of one element in the Vreeland system, and is cited merely as an answer to the question of the added cost involved in the use of the band receiving system. No doubt, in production this small item could probably be reduced materially."

Efficiency of Crystal Control

Dr. J. H. Dellinger of the U. S. Bureau of Standards is authority for the following figures giving the efficiency of crystal control of transmission frequency: the usual broadcasting station frequency is maintained accurate within one part in 1000; with constant-temperature crystal control the accuracy of adjustment and maintaince may be within a few parts in 100,000; with extraordinary efforts the frequency can be maintained to within one part in 10 million.

Data on Pentodes

We are still keeping in mind the interest in the pentode tube in Europe, and the growing interest in this country in tubes of greater efficiency for the power stage. The curves in Figs. 1 and 2 are published through the courtesy of the manufacturers of Igranic output transformers designed for use between pentode tubes and their corresponding loud speaker loads. The curves show the characteristic obtained by working a pentode (Mullard PM 24) into various resistive loads with various turns ratios in the transformer.

The curves show that reasonably good fidelity may be secured from such tubes and transformers. One point upon which we hope to have data soon is the purity of the output obtained from such tubes. Whether or not the output has a high percentage of harmonics is the question that may ultimately decide whether pentodes will be used in this country.

Eight Good Slogans

The following lines appear on the margin of the circular describing the *1929 Standards Year Book* of the Bureau of Standards. They are good slogans:

Standardization—Keynote of Industrial progress, Science—the Guide of Industry.
Standardization—Essential to Mass Production.
Measurement—The Master Art.
Standardization—A Basis of Efficiency.
Standardization touches every human activity.
Standardization is an active continuing process.
Standardization applies New Experience and Science.

Engineering Limits

An article is being prepared for Radio Broadcast which will discuss the problem of the engineering limits to be imposed upon broadcast receivers. That is, should a receiver be held within a five-to-one ratio in overall sensitivity, or is a closer limit desirable? In the meantime it is interesting to note that two engineers representing fairly large set manufacturers feel that a two-to-one variation in sensitivity is about all that can be expected in production—that is, receivers between the limits of 4 to 8 microvolts per meter in sensitivity would be passed out of the production department. In this regard we wonder how many manufacturers have the courage to reject sets which have too great sensitivity? Certainly it was common practice not so long ago for manufacturers to pick out the best sets for members of the firm, influential jobbers, etc.

One engineer suggests that the best method of setting production limits is to push about 1000 sets through under careful supervision, and to measure the receivers and therefrom set the production limits. It would be interesting to the Editors to have other engineers' ideas on this matter.

New Government Books

Research Paper No. 70 of the Bureau of Standards is entitled "Some Observations of Short-Period Radio Fading" and details the work of T. Parkinson, associate physicist. It is a reprint from the *Bureau of Standards Journal of Research.*

The 1929 edition of the *Standards Year Book* may be obtained from the Superintendent of Documents for one dollar. Its contents includes chapters on the standardization of weights and measures; standardizing the calendar; international, national, and federal standardizing agencies; a bibliography, etc. It is the third edition of this invaluable book.

Cost of Quartz Crystals

A letter from S. J. Wise & Co., 47 Rue Nationale, Antwerp, Belgium, encloses the prices of crystal control apparatus made by this concern. Quartz crystals can be supplied for wavelengths from 35 meters to 500 meters at prices varying from $8.00 for 3 per cent. precision to $16.00 for 0.1 per cent. precision. For wavelengths above 500 meters the crystals cost $7.50 for 3 per cent. precision and $15.00 for 0.1 per cent. precision. Crystal blanks can be supplied at $4.50 for thicknesses varying from 0.5 millimeter to 5 millimeters.

Radio Sets for the Farm

We are glad to quote from a letter from J. C. Gilbert, specialist in market news and radio of the Department of Agriculture, who read our recommendation that set manufacturers get busy on a cheap economical battery operated receiver for rural communities (page 144, July, 1929, Radio Broadcast).

"I wish to congratulate you on having

(*Concluded on page 364*)

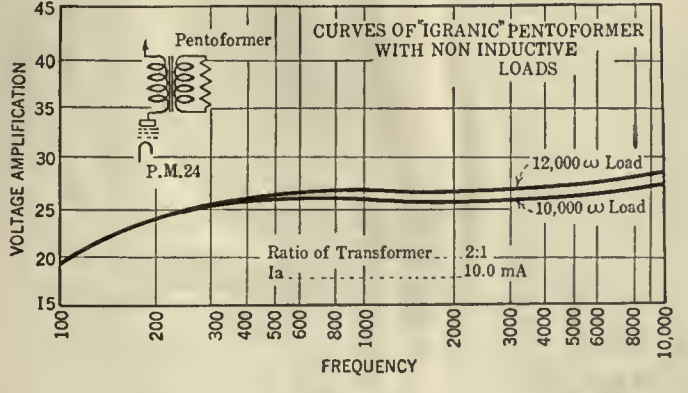


Fig 1.

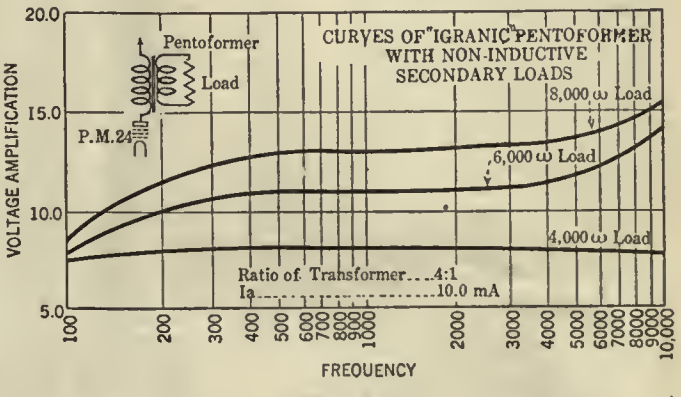


Fig. 2.

GRID-LEAK VS. BIAS DETECTION

By J. M. STINCHFIELD

Engineering Department, E. T. Cunningham, Inc.

MANY RECENT advances in the theory of detection of a modulated r.f. carrier have given the development engineer a good theoretical basis for improving the performance of the detector stage in radio sets. The work of Carson, Llewellyn, Chaffee, and Ballantine in this country, and of Colebrook in England, was of fundamental importance. The relation of tube and circuit components has been investigated and the influence of these factors on the performance of the detector stage has been indicated.

The theory indicates the following factors to be of importance in the design of the detector stage.

Grid-leak Detection

(1) The modulated r.f. voltage is applied from a resonant circuit through a grid condenser to the grid and cathode terminals of the tube. A loss of r.f. voltage will occur in the grid condenser. Usually this loss is determined principally by the effective input capacity of the tube to r.f. and the capacity of the grid condenser.

(2) Rectification takes place in the grid circuit due to the change in slope (where the action is essentially that of high-vacuum electron conduction) of the grid-current grid-voltage curve. Small internal grid resistance and small external grid-circuit impedance to the r.f. increase the rectification. The grid resistance is that due to electron conduction and is entirely analogous to plate resistance. The tuned r.f. input circuit will be damped some depending upon the grid resistance of the tube and to a less extent upon the grid-leak resistance. This will affect both the gain and selectivity from the r.f. stage.

(3) Among the rectified components will be direct current and audio frequencies. The direct-current component of the rectification will flow through the grid leak producing a small change in the effective d.c. bias voltage. In traversing the grid circuit the audio frequencies will encounter the high impedance of the grid condenser and the high resistance of the grid leak. The tuned r.f. circuit obviously offers negligible impedance to the audio components. The audio-frequency voltage developed between the grid and cathode terminals, due to the impedance of the grid leak and condenser combination, are amplified by the tube in the usual way. When considering the plate circuit load impedance of an amplifier tube, a load impedance that is much larger than the tube's internal plate resistance at all frequencies will give uniform output. Since nearly all of the voltage in the circuit is developed across the load, no change can occur as the load impedance changes with frequency. In the same way, when the a.f. load in the grid circuit is high at all frequencies with respect to the tube's internal grid resistance, the voltage across the load will be independent of frequency. The a.f. input capacity of the tube must be added to the grid condenser capacity when calculating the impedance.

(4) The tube will also amplify the r.f. This r.f. in the plate circuit will produce some plate-circuit detection, depending upon the change in slope of the plate-current curve. The plate detection is nearly in phase opposition to the grid detection, though usually much smaller in magnitude, so that a small decrease in the audio output results. A by-pass condenser for the r.f. is usually connected from plate to cathode. While this tends to increase the plate rectification, it has a large effect in reducing the input capacity and increasing the input resistance resulting from feedback through the grid-plate capacity. For example, with a c-327 grid-leak detector and a 50,000-ohm resistance plate load, removing the plate-filament by-pass condenser had a negligible effect on the output when the r.f. input was supplied by a potentiometer, but when supplied by a tuned stage the voltage gain in the r.f. stage was changed from 7.4 to 3.1. The r.f. amplifier was a c-327 giving a gain of 10 when feeding a biased detector.

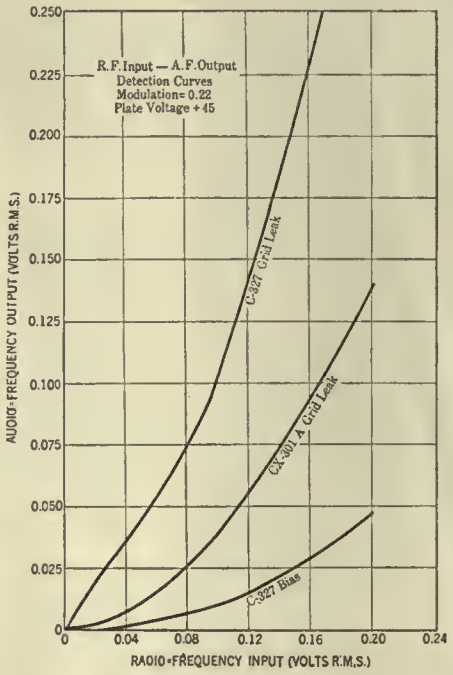


Fig. 1

The r.f. bypass and an r.f. choke in the plate circuit also help to prevent the r.f. from loading up the audio amplifier and from being radiated back to the input. If the impedance of the r.f. bypass at the highest a.f. is not several times larger than the impedance of the a.f. load and the tube resistance, the output at higher audio frequencies will be reduced.

Bias Detection

(1) When the grid is biased negatively beyond the point at which grid current begins to flow, no rectification will occur in the grid circuit. The modulated r.f. voltage applied to the grid and cathode terminals is amplified by the factor *mu* and appears in the plate circuit. The rectification takes place in the plate circuit. Since the amplification factor is not absolutely constant, particularly in the region of the plate-current cut-off, some non-linear amplification results. This increases the rectified a.f.

(2) Small internal plate resistance and external plate circuit impedance increase rectification. The external plate-circuit impedance can be kept low to r.f. by a by-pass condenser connected between the plate and cathode terminals. This also helps to maintain a high input impedance in the grid circuit by reducing feedback through the grid-plate capacity.

The rectification produces a number of component frequencies which include direct and a.f. currents. If the d.c. resistance of the plate circuit load is high there will be an appreciable decrease in the effective d.c. plate voltage. The a.f. voltage output will depend upon how large the a.f. load impedance is with respect to the internal plate resistance of the tube. The r.f. bypass may reduce the load impedance at the higher a.f.

In the following the overall performance characteristics of some tube types widely used as detectors are compared.

Fig. 1, shows a comparison of a CX-301A tube and a c-327 tube operated in a grid-leak detector circuit. The voltages and the circuit constants are favorable to both types. It is evident that the detector sensitivity is greatest with the c-327. The lower curve of Fig. 1 shows the a.f. output of the c-327 as a bias detector. The load of the biased detector in this figure was a 150-henry choke shunt by an 0.25-megohm resistor and an 0.0001-mfd. condenser. The other detectors looked into an Amertran DeLuxe first-stage transformer.

The sensitivity, i.e., the a.f. output for any given r.f. input,

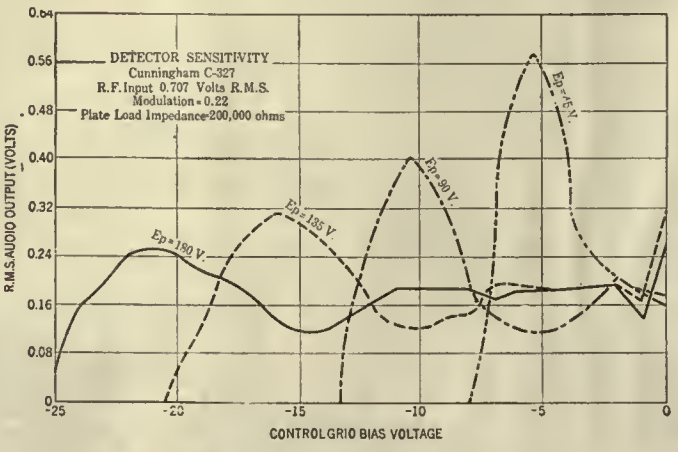


Fig. 2

is greater for the grid-leak detector than for the biased type. Increasing the number of a.f. stages or r.f. stages in receivers increases greatly the problems of stability and fidelity. Due to this fact, and to the desire to get weak or distant stations, the grid-leak detector has been universally popular in the past. The trend toward high-quality, low-ratio audio transformers, and power tubes requiring large signal input voltages has increased the output required from the detector. Improvements in the r.f. amplifier have been toward more selectivity and better fidelity, which involved more tuned stages and incidentally more amplification.

The use of the screen-grid tube increases greatly the stable r.f. amplification. All of these factors put higher input and output demands on the detector.

The grid-leak detector at normal recommended operating voltage shows a rapid falling off in output when the signal exceeds a few tenths of a volt. The operating range may be extended some by adjustment of voltages and circuit constants. The higher voltages required for increased output, increase greatly the internal dissipation, and at the same time increase the possibility for gas and grid emission. Also, the high resistance in the grid circuit tends to aggravate this condition. At the voltages most favorable to grid-leak detection the grid-cathode input resistance is so low that the performance of a preceding stage of tuned r.f. amplification is greatly impaired.

The bias detector has not been popular in the past because of low sensitivity. It is, however, well adapted for use with larger signals. It is readily adapted to any range of operation by increasing both the grid-bias and plate voltages. The plate current and internal dissipation is so small that the c-327 tube with a maximum rating of 180 volts as an amplifier may be operated at a plate voltage of 250 volts (maximum) provided the d.c. plate current with normal maximum signal does not exceed 5 mA. The selectivity and gain in the preceding r.f. stage are not reduced by the bias detector.

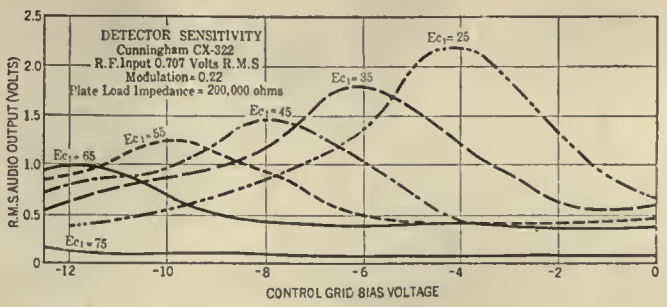


Fig. 3

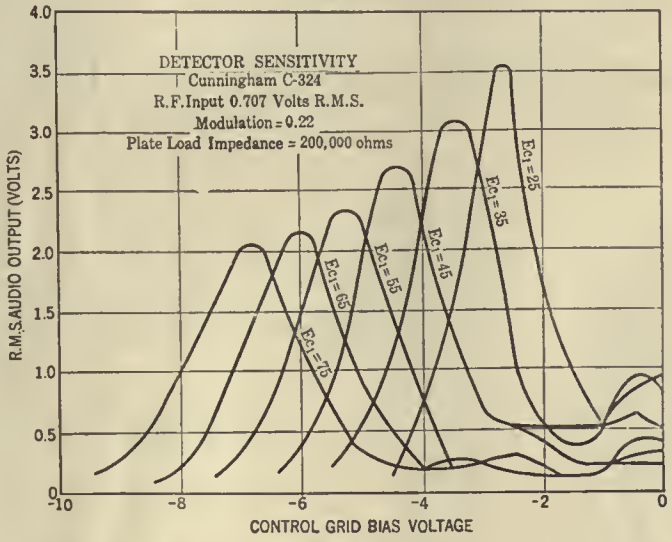


Fig. 4

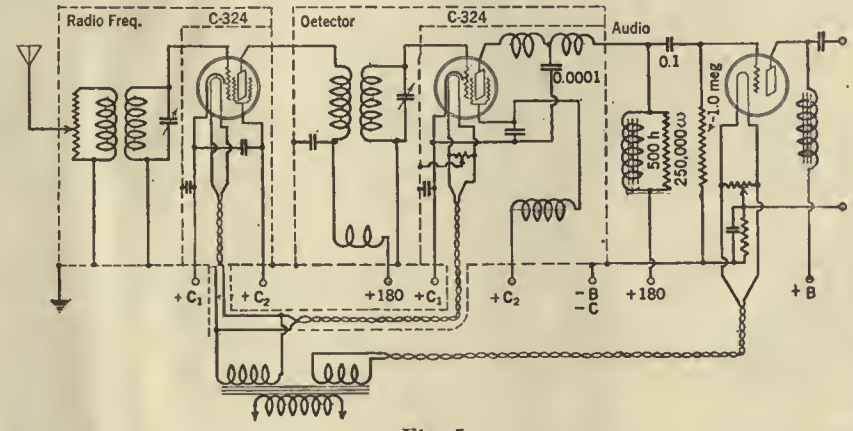


Fig. 5

The bias detector has been universally popular in the past because of low sensitivity. It is, however, well adapted for use with larger signals. It is readily adapted to any range of operation by increasing both the grid-bias and plate voltages. The plate current and internal dissipation is so small that the c-327 tube with a maximum rating of 180 volts as an amplifier may be operated at a plate voltage of 250 volts (maximum) provided the d.c. plate current with normal maximum signal does not exceed 5 mA. The selectivity and gain in the preceding r.f. stage are not reduced by the bias detector.

There are other advantages of a high-output detector. Small a.f. disturbance such as microphonic noises or a.c. hum, become negligible with low gain a.f. amplification. Improved a.f. characteristics are obtained with a simplified and less expensive a.f. amplifier. The effects of stray coupling between the power pack and the audio stage are less.

The detector sensitivity characteristics of a c-327 bias detector are shown in Fig. 2. A signal of 0.7 volt r.m.s. was maintained on the grid. The a.f. output is plotted against C-bias voltage, for several plate voltages. These curves show that there is a decrease in sensitivity as the plate voltage is increased. They also show the best bias voltage for a given plate voltage. The range of bias voltages for peak sensitivity in several tubes were within one volt. At the higher bias voltages, the shift in sensitivity for several tubes operated at a fixed bias was not great enough to create a decided preference for any one tube. On the negative side the detector sensitivity curve falls rapidly to zero. The plate current is approaching cut-off and the internal plate resistance becomes high. The positive side of the detector sensitivity curve gives more uniform sensitivity and a lower plate resistance.

The best operating condition for small signals would be slightly on the positive side. This would give best a.f. fidelity consistent with high sensitivity. A low plate voltage increases sensitivity, but decreases uniformity of performance between individual tubes. As the signal amplitude is increased there is some change in sensitivity. No serious overloading or objectionable distortion occurs until the signal amplitude has exceeded the point at which grid current begins to flow. The signal amplitude can be extended somewhat into the grid-current region before an actual decrease in a.f. output occurs. At this point the harmonic distortion rises rapidly. Continued increase of signal amplitude may reduce the a.f. output to zero.

Operating Characteristics

Up to the grid-current point the variation of a.f. output with r.f. input usually is found to follow a law somewhere between the first and second power, that is, between square-law and linear detection. The per cent. distortion decreases as a linear law is approached. Beyond the grid-current point the output falls below a linear law and distortion increases rapidly. Damping of the r.f. input stage begins at the grid-current point. This would seem to be the upper limit which the signal peak should not exceed for best results. The maximum signal limit may be increased somewhat for a given plate voltage by increasing the bias. Biasing beyond the plate current cut-off may badly distort small signals.

The increase of d.c. plate current with signal causes a loss of d.c. plate voltage if the resistance of the load is too high. The plate voltage should be high enough to avoid this condition, especially when

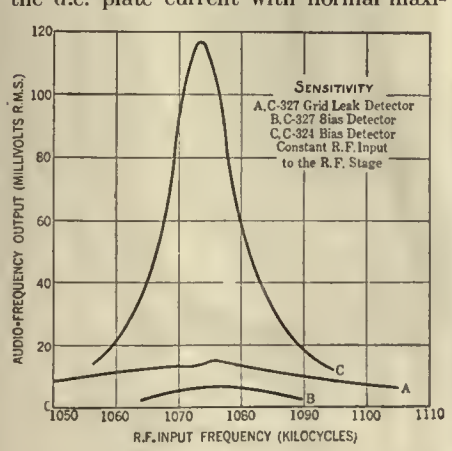


Fig. 6

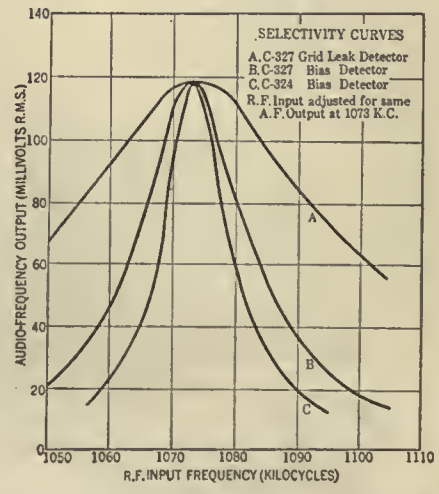


Fig. 7

the detector is biased by its own plate current. In calculating overloading of this type the peak a.c. voltages on the grid and plate must be considered in addition to the changes in d.c. voltage. The grid voltage goes positive from the dynamic d.c. operating point by the amount of the amplitude of the modulated carrier voltage. At the same time the instantaneous plate voltage may swing below the dynamic d.c. point by the amount of the audio peak output voltage. To avoid overload distortion the minimum instantaneous plate voltage should always be greater than the maximum instantaneous grid voltage. When a screen-grid tube is used the minimum instantaneous plate voltage should always be about ten volts above the screen-grid voltage to avoid distortion. This type of overloading may he avoided easily by a suitable choice of operating voltages.

The desire to realize the full advantage of the high-output detector has, in some instances, resulted in operation too near the overload point. While it is entirely practical to eliminate the first a.f. stage, the use of a low-gain a.f. stage permits operation well below the overload point. Since it is difficult to design an a.f. transformer that will give high-quality reproduction with a biased detector, impedance coupling is preferable. The first a.f. stage may be coupled through a relatively inexpensive yet high-quality, one-to-one-ratio a.f. transformer to a single or push-pull power stage. In this way the overload capacity of the detector and a.f. system may be increased greatly, especially with the push-pull power stage.

Plate Vs. Bias Voltages

Plate voltages and corresponding bias voltages satisfactory for the type c-327 tube as a bias detector are:

Plate Voltage	*Bias Voltage*
45.0	—5.0
90.0	—10.0
135.0	—15.0
180.0	—20.0
250.0 (max.)	—30.0*

*The 250-volt maximum is recommended only when, with normal maximum signal, the d.c. plate current does not exceed 5 mA.

High-Output

Figs. 3 and 4 show detector sensitivity curves for types cx-322 and c-324. Bias detection is recommended as most satisfactory with either tube. The screen-grid types combine the advantages of sensitivity and high output. Radio-frequency inputs of a few volts can be applied without overloading. Outputs large enough to operate a cx-345 directly from the detector are readily obtained.

To show the actual performance of the detector stage the signal was applied to a c-324 r.f. stage with the tuned secondary of the r.f. transformer coupled to the detector, as in Fig. 5. The detector plate load impedance was 200,000 ohms. (power factor 0.96; d.c. resistance 3000 ohms.)

In Fig. 6 the sensitivity with the c-327 grid-leak detector is shown by curve A. Curve B shows the sensitivity with the c-327 bias detector, and curve C with the c-324 bias detector. All three curves were obtained with the same signal at the input to the r.f. stage. It is evident that both the sensitivity and selectivity is decidedly superior with the c-324 tube. The difference in selectivity is shown best in Fig. 7. The operating conditions are the same as for Fig. 6, except that the r.f. input was increased until the same a.f. output was obtained at resonance. If a horizontal line is drawn through these curves at 0.5 of the maximum ordinate, the frequency width between intercepts on this line is a measure of the selectivity. The width of curve A for the c-327 grid-leak detector is 57 kc. For curve B, the c-327 bias detector, the width is 22. kc., and for curve C, the c-324 bias detector, the width is 12.5 kc. The load in Figs. 6 and 7 consisted of five Amertran 854 type choke coils in series, and shunt by an 0.25-megohm resistor and an 0.0001-mfd condenser.

The fidelity characteristics are shown in Fig. 8. The a.f. output in millivolts is plotted against the audio frequency for a constant r.f. signal with constant modulation. Curve A is for the c-327 grid-leak detector using a one-megohm grid leak, a 0.00025-mfd. grid condenser, and the primary of an Amertran transformer (first-stage type) for the plate load. The plate-cathode r.f. bypass was a 0.0005-mfd. condenser. Curve B is for the c-327 as a bias detector in the same circuit but with the grid leak and condenser removed and an appropriate bias voltage on the grid. A greater loss of low frequencies occurs with the bias than with the grid-leak detector. The output from the c-324 bias detector is shown by curve C. For this curve the plate load was approximately 150 henries shunted by a 0.25-megohm resistor. The plate-cathode r.f. bypass was 0.0001-mfd. The characteristic is uniform except for the large loss below 200 cycles. The use of a 500-henry choke shunted by a 0.25-megohm resistor is recommended as a satisfactory load for the c-324 bias detector. A choke employing a series of pie windings to reduce distributed capacity is preferable. One that does not saturate with 1.5 to 2.0 milliamperes is adequate.

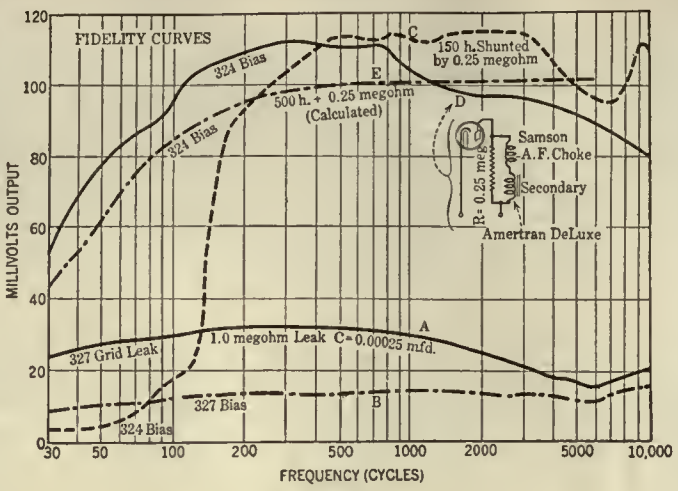


Fig. 8

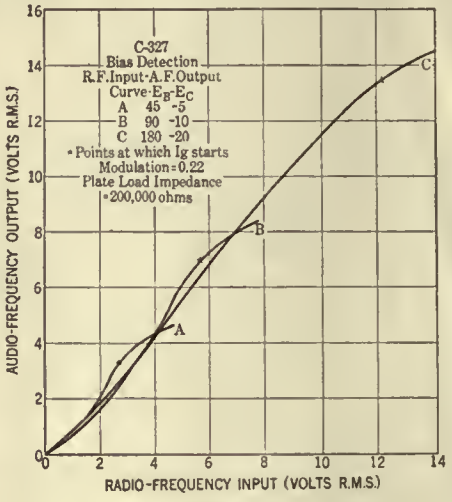


Fig. 9

Input-Output Characteristics

In Fig. 9 the a.f. output voltage is plotted against r.f. input voltage for the c-327 tube operating as a high-output bias detector. The modulation was 22 per cent. and the plate load was 200,000 ohms.

Fig. 10 shows the input-output characteristics of several tubes operating as high-output bias detectors. Curves A, B, and C are for the c-324 tube with screen-grid potentials of 25 volts, 45 volts, and 75 volts, and bias potentials of −2.5 volts, −4.5 volts, −7.5 volts, respectively. The plate supply was 180 volts, the load impedance 200,000 ohms, and the modulation 22 per cent. Curve D shows the output from the c-324 self biased by its plate current through a 25,000-ohm resistor. Curve E shows the output from a type cx-322 tube at 180 volts on the plate, 45 volts on the screen-grid, and −9.0 volts of grid bias. Curve F is for the c-327 at 180 volts on the plate and −20.0 volts grid bias. The points at which grid current starts to flow (for 22 per cent. modulation) are marked.

Fig. 11 shows the output obtainable

(*Concluded on page 364*)

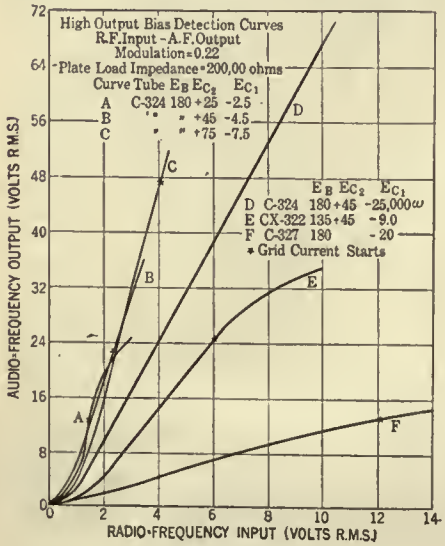


Fig. 10

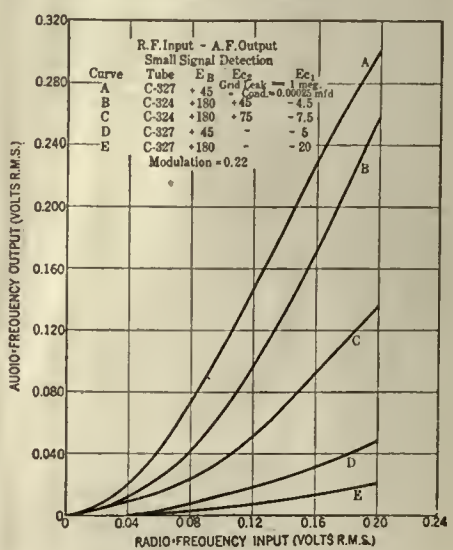
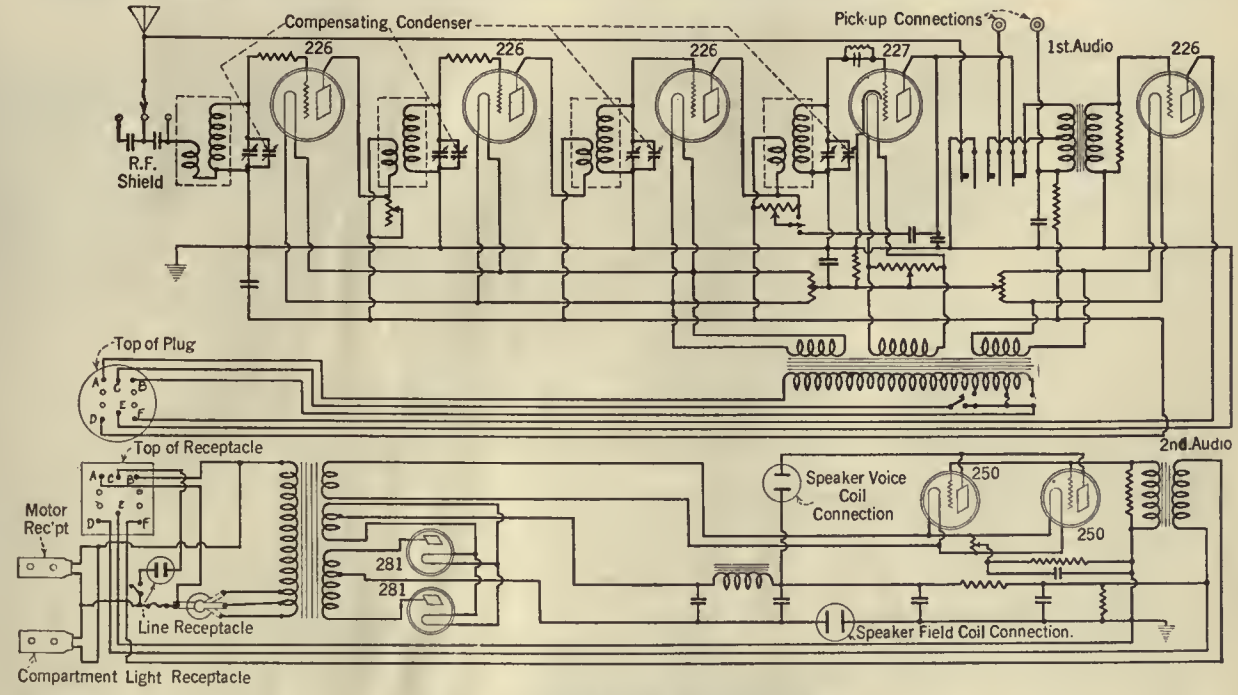


Fig. 11

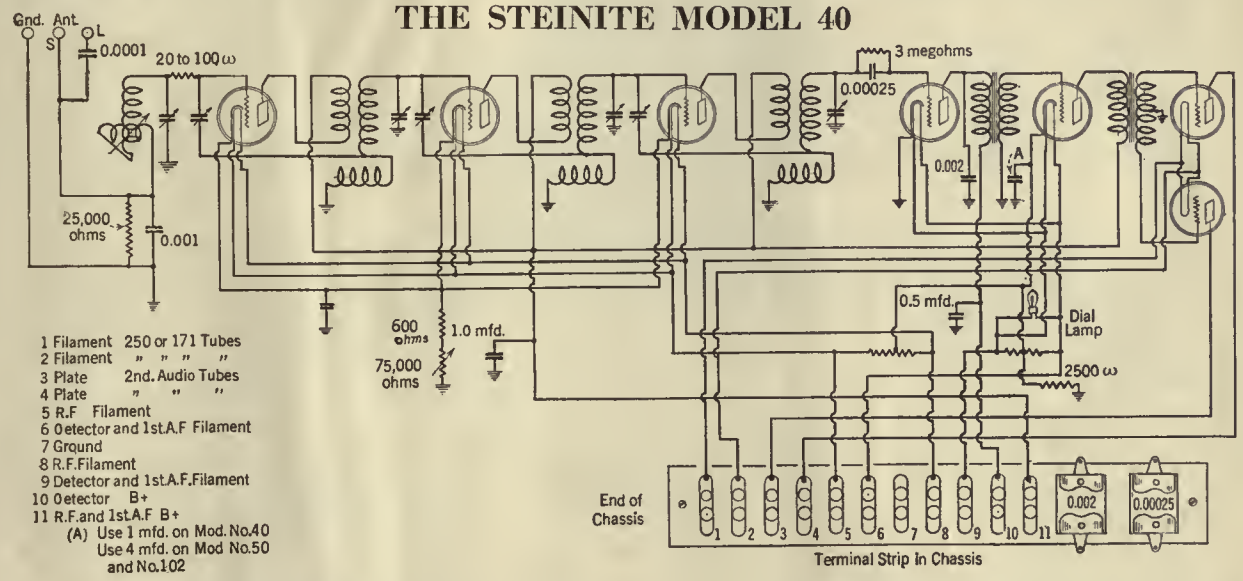
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THE EDISON MODEL C-1

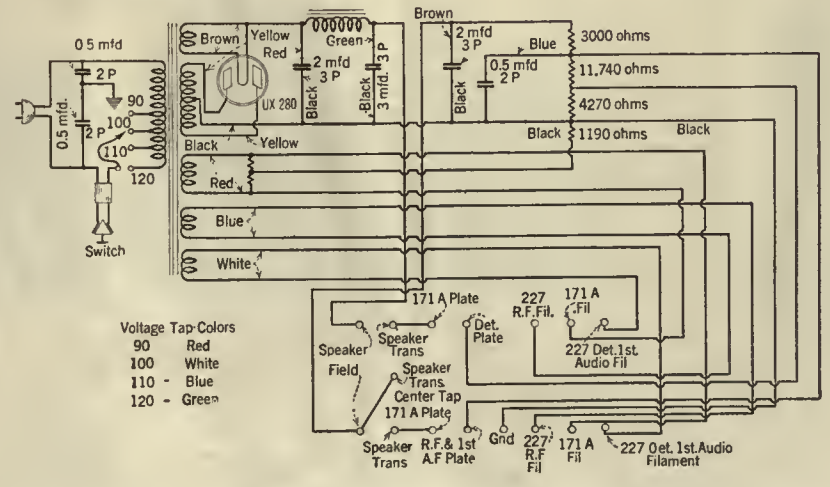
Two 250-type tubes in push pull are used in the output circuit of this receiver. Field supply for the dynamic loud speaker is obtained from the filter system. The circuit shows the switch controlling the connections to a phonograph pick-up unit. One detail which is not shown in this diagram is a grid suppressor connected in the grid circuit of the third 226-type tube.



THE STEINITE MODEL 40



1 Filament 250 or 171 Tubes
2 Filament " " " "
3 Plate 2nd. Audio Tubes
4 Plate " " "
5 R.F Filament
6 Detector and 1st A.F Filament
7 Ground
8 R.F. Filament
9 Detector and 1st A.F. Filament
10 Detector B+
11 R.F. and 1st A.F B+
(A) Use 1 mfd. on Mod. No. 40
Use 4 mfd. on Mod No. 50 and No. 102



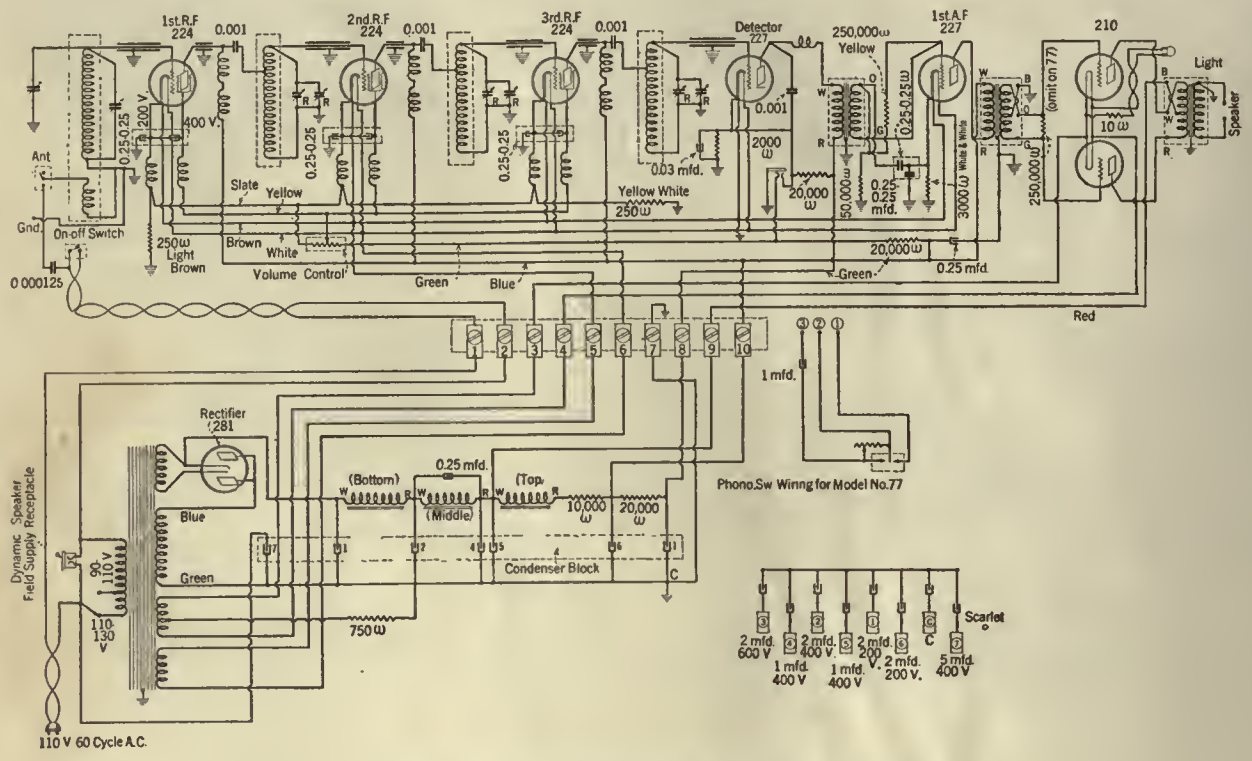
Voltage Tap Colors
90 Red
100 White
110 - Blue
120 - Green

A six-tube receiver using a rather interesting arrangement for maintaining resonance between the first and other tuned circuits. The power unit is of conventional design using a 280-type full-wave rectifier. The power transformer primary is tapped at four points to permit satisfactory line voltage control from 90 to 120.

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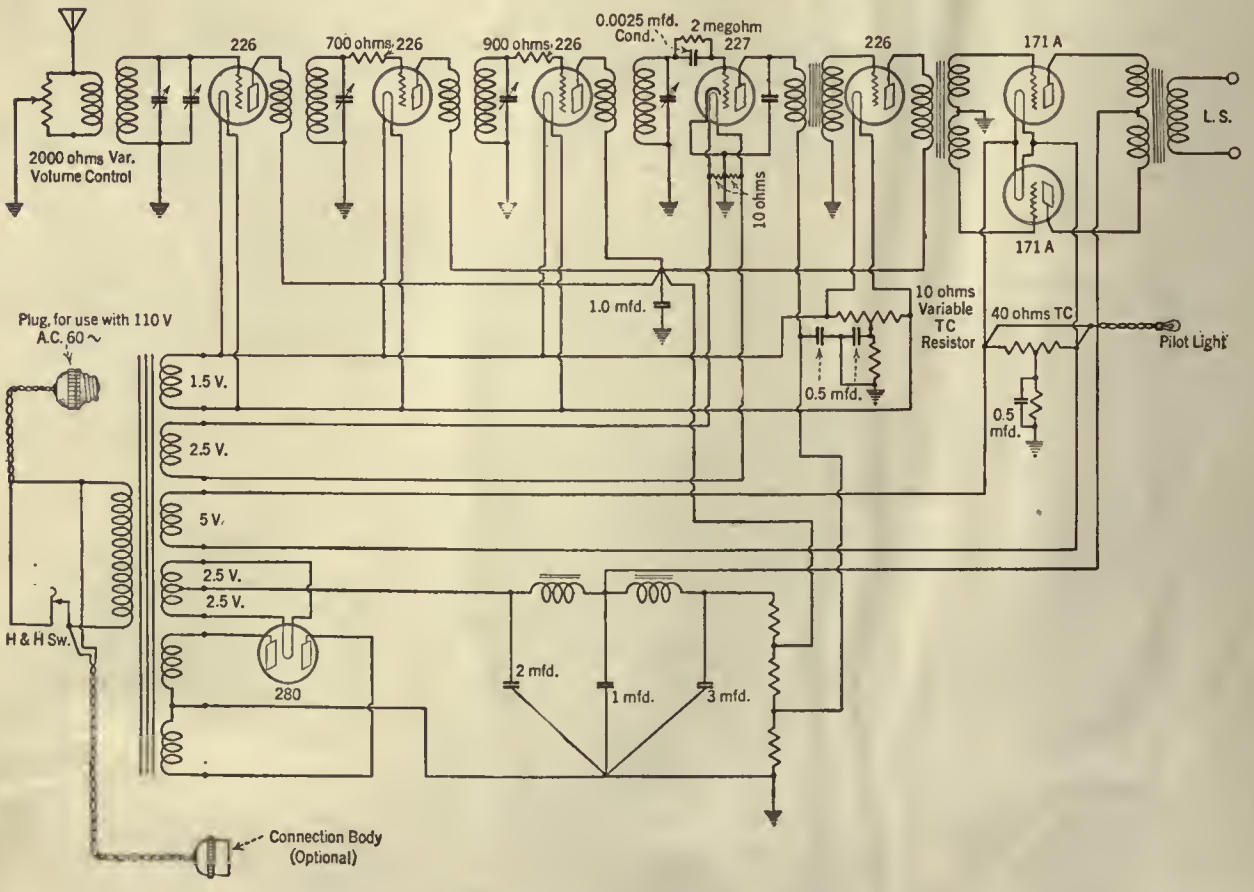
THE FADA MODELS 55 AND 77

This receiver uses three screen-grid tubes in the r.f. stages followed by a plate-circuit detector and a two-stage transformer-coupled audio amplifier. Note the shielding around the grid nnd plate leads of the r.f. amplifier tubes and the use of r.f. choke coils in the cathode and screen-grid leads. The output tubes are two 210's in push pull.



THE BUCKINGHAM MODEL 80

A conventional six-tube receiver using three stages of r.f., a grid leak and condenser detector, nnd a two-stage transformer-coupled audio amplifier. Grid suppressors are used to prevent oscillations. The volume control varies the input from the antenna circuit.



AUTOMATIC VOLUME CONTROL

By VIRGIL M. GRAHAM

Radio Engineer, Stromberg-Carlson Telephone Manufacturing Company



Virgil M. Graham

A SCREEN-GRID receiver is generally considered as one employing at least two screen-grid tetrodes in a radio-frequency amplifying system. The automatic volume control feature is a circuit arrangement which maintains the signal level at the detector practically constant, when, of course, the received signal is above a certain minimum value.

The R. F. Amplifier

The radio-frequency amplifying system of the Stromberg-Carlson No. 846 Receiver is very similar to that employed in the receiver described by the writer in August, 1929, RADIO BROADCAST. Therefore, only the portions of the r.f. amplifier that have been changed or that have to do with the addition of the automatic volume control circuit will be discussed here. Fig. 9, the complete schematic circuit of the receiver, illustrates the arrangement of the r.f. amplifier. It will be noted that a grid capacitor and resistor are included in the control grid circuit of each radio stage. This arrangement allows the bias voltages to be supplied to these control grids without disturbing the ground connections on the "low" sides of the secondaries of the r.f. transformers.

The control-grid biases of the first two r.f. tubes are obtained from two sources. The minimum values are determined by the IR drop in the resistors connected in series with the cathodes of these tubes. These minimum biases are connected in series with the voltages supplied by the automatic volume control circuit (which are, of course, zero when no signal is being received). The function of the automatic volume control circuit will be described in a later portion of this discussion. The control-grid bias for the third r.f. amplifier is obtained from the voltage drop across the cathode resistor only, as the automatic control does not operate on this stage.

Automatic Volume Control

The automatic volume control circuit consists of a 227-type tube with the necessary resistors and capacitors as shown in the schematic circuit. The function of this arrangement is to supply bias voltages to the first two r.f. amplifier tubes, the voltages being proportional to the strength of the received signal. These biases, increasing as the signal strength is increased, keep the r.f. voltage practically constant at the detector grid.

The grid of the volume-control tube is coupled to the plate of the last r.f. amplifier tube through an 0.00025-microfarad capacitor. This arrangement allows the proper radio voltage to be supplied to the control tube without getting the effect of the whole input capacity and losses of this tube in the tuned secondary of the last r.f. transformer. The turns ratio of the transformer being close to 1:2, the effect of this capacity and loss will be reduced to approximately one quarter when reflected into the tuned secondary circuit. This amount, of course, is negligible. Bias voltage is fed to the grid of the control tube through a 2-megohm resistor.

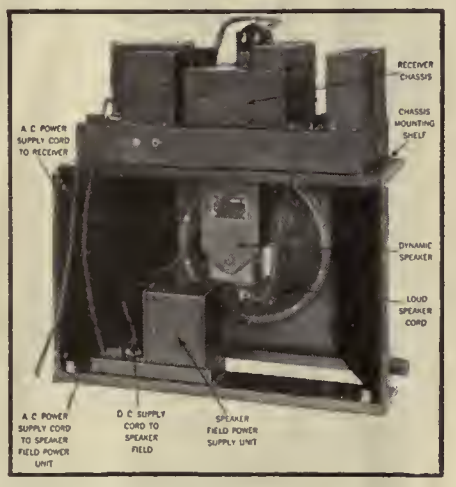


Fig. 1—The three units composing the receiver mounted on the box-type baffle. This assembly forms a complete operating unit which is placed in the housing cabinet.

The plate circuit of the control tube consists of two 100,000-ohm resistors in series, with a 0.5-microfarad capacitor between the plate and ground to bypass the radio-frequency current and to prevent it from feeding back to the control grids of the r.f. amplifier. The voltage drops of the plate current in the two 100,000-ohm resistors are used to supply the "controlling" biases to the grids of the first two r.f. amplifiers. The bias of the first r.f. tube is secured from across both resistors and that to the second r.f. tube is obtained from across one resistor only. Thus, the "controlling" bias on the first r.f. amplifier is twice that of the second. This plan is followed because the signal voltages are greater on the second r.f. amplifier than on the first, so that the second cannot have as high a control-grid bias (when these biases approach the cut-off points of the tubes) if overloading is to be avoided. These "controlling" biases are, as mentioned above, in series with the minimum biases supplied by the cathode resistors.

The grid bias of the control tube is fixed so that with no signal there is practically no plate current flowing. When a signal of the proper value to operate the automatic control is received, sufficient r.f. voltage is applied to the grid to cause plate current to flow, the amount of plate current being in proportion to the strength of the received signal. In other words, the action is similar to that of a peak vacuum-tube voltmeter. The plate current, flowing through the 100,000-ohm resistors and varying proportionally with signal strength, gives varying control-grid biases on the first two r.f. amplifiers. These varying biases regulate the gain of these two r.f. stages. These actions, reaching an equilibrium for any strength of signal, maintain the strength of the signal at the detector substantially constant, after a certain value of input is reached.

Fig. 5, shows the relative output of the

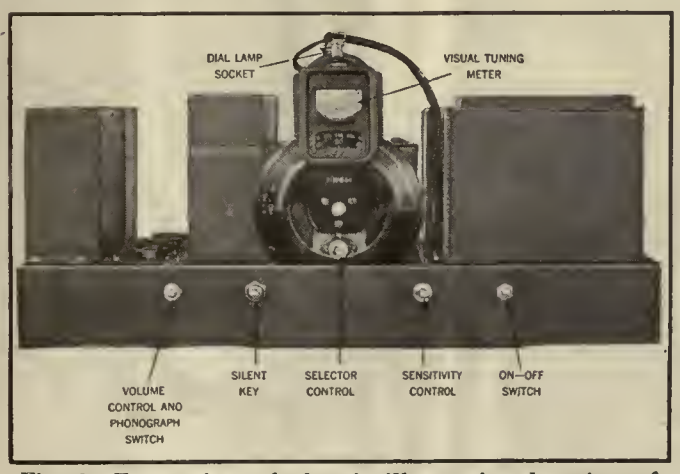


Fig. 2—Front view of chassis illustrating location of controls and the arrangement of the visual tuning meter and selector dial in one escutcheon.

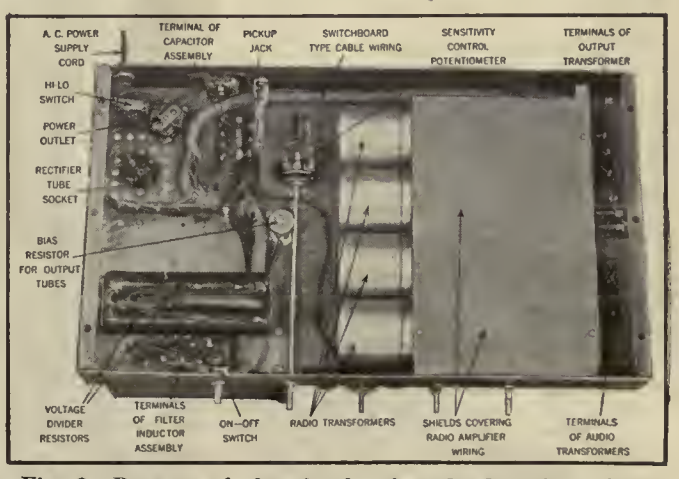


Fig. 3—Bottom of chassis showing the location of the shielding for the radio transformers and other apparatus in the radio amplifier.

receiver with variation of signal input in microvolts at the antenna terminal. This curve does not represent the absolute sensitivity of the receiver, but is used to show the action of the automatic volume control. Thus, it can be seen that after the signal input to the receiver passes 50 to 60 microvolts (at the knee of the curve), the output is practically constant up to 100,000 microvolts or one-tenth volt. Above this value of input, the first r.f. amplifier tends to overload and it is necessary to use the "sensitivity control" to reduce the input from the antenna to the r.f. amplifier. This control is discussed further in a following paragraph. The slight rise in the curve at 100,000 microvolts shows the beginning of this overloading effect. It should be remembered, however, that this value represents a very strong local signal.

The proper operation of a receiver equipped with the automatic volume control necessitates some sort of resonance indicator; that is, some means which will indicate when the receiver is tuned exactly to the carrier of the signal being received, is necessary. The resonance indicator in this receiver is a "visual tuning meter" which is connected in series with the cathode circuit of the second r.f. amplifier and operates on the plate current of this tube. When the received signal increases in strength, as it does when it is "tuned in," the automatic control bias on this tube is increased and the plate current decreases. Thus, the station received should be tuned so that the minimum indication of current is obtained. The meter is mounted in an inverted position so that the receiver is tuned for the greatest deflection of the needle which moves from left to right (in the direction of the arrow on the meter dial).

When operating this receiver, it will be found that some stations will come in with good volume without affecting the needle pointer. This is due to the high sensitivity of this receiver as shown by Fig. 6. The r.f. inputs in microvolts, shown on this graph, give a standard signal of 50 milliwatts output. Fig. 5 shows, as mentioned above, that the automatic volume control is designed so as to start to function at an r.f. input of from 50 to 60 microvolts, as this has been found to be the most satisfactory value in all respects. This indicates that quite a strong signal could be obtained from the loud speaker before the automatic volume control starts to function. Furthermore, such a signal would not give a volume in the loud speaker greater than that set by

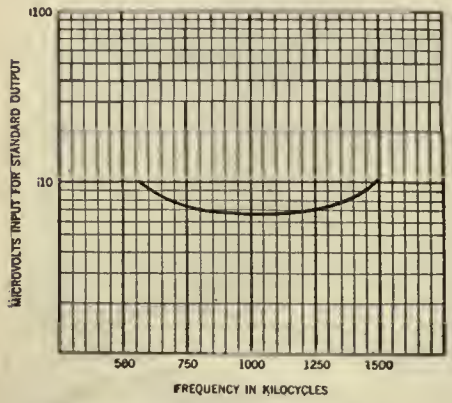


Fig. 6—Sensitivity curve of No. 846 receiver. Note that the ordinate is plotted in microvolts input and not in microvolts per meter.

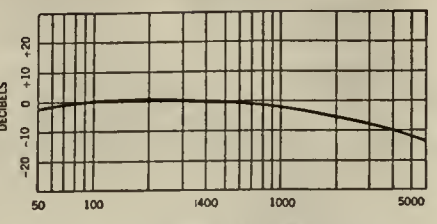


Fig. 4—Overall fidelity characteristic of chassis of No. 846 receiver.

the manual volume or level control. It should be borne in mind, however, that such signals are comparatively weak, and would not be recognized at all by many receivers.

The Power Detector

The linear power detector is of practically the same design as used in the Nos. 641 and 642 receivers, except that the grid leak and capacitor arrangement is omitted because the phonograph pick-up connection is not made to the detector grid in this receiver.

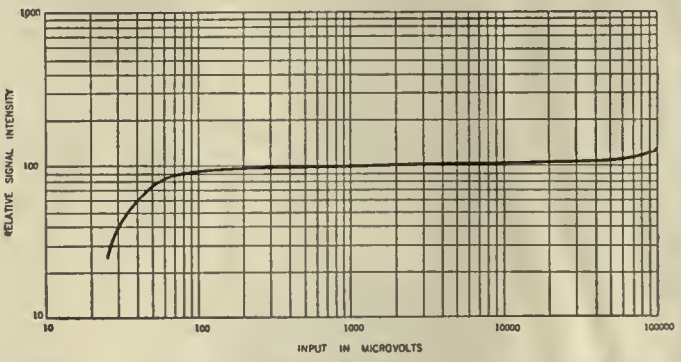


Fig. 5—Graph illustrating the action of the automatic volume control.

The output of the detector feeds a very high impedance 1:1 ratio audio transformer. In order to obtain maximum possible plate voltage on this tube, it is necessary to carry the cathode (in series with which is the biasing resistor) and the grid return to the negative "B" line. The negative "B" line, in this case, is "below" ground potential on account of the voltages necessary for the automatic volume control circuit, where ground is the most positive potential used. This arrangement accounts for the rather unusual bypassing in the detector circuit.

The Audio Amplifier

The audio amplifier of the No. 846 receiver consists of two stages. The first stage uses a 227-type tube, and the second or output stage employs two 245-type tubes in push pull.

The manual volume or level control, is a voltage divider across the secondary of the 1:1 input transformer, used to vary the signal voltage applied to the first audio grid. The moving contact, or lever, of this unit is connected to ground while the grid is connected to one side of the transformer (through the pick-up switch). This greatly simplifies the insulation problem and eliminates troubles due to hand capacity which would be present if the grid were connected to the moving element. The "Volume Control" in a set which provides a substantially uniform signal at the detector, must be at the input of the audio amplifier for satisfactory operation.

The pick-up switch acts so as to connect the output of the pick-up outfit to the grid of the first audio tube in place of the secondary of the first audio transformer. This switch is actuated by turning the volume-control knob in a counter-clockwise direction as far as it will go. At this position a cam acts on the switch levers. When the pick-up switch is in position for phonograph operation, both terminals of the secondary of the audio transformer are grounded, greatly decreasing the possibility of capacity coupling of the signals from the r.f. to the audio amplifier. The push-pull input transformer is of large size, having a turns ratio of 1:3.6 on each side in order to obtain enough amplification for operation of the phonograph pick-up unit.

The Power Supply

The power supply for this receiver consists of the usual power transformer with the necessary secondary windings. There are three low-voltage windings; one for the heaters of the r.f. amplifier, first audio, and volume control tubes, one for the detector heater, and one for the power output tubes. The detector heater winding is provided with an adjustable hum balancer and the winding for the output tubes filaments has a fixed mid-tapped resistor. The remaining winding has a grounded mid-tap.

The rectifier is of the conventional 280-type and supplies current to a special two-stage filter. Each stage of this filter is equipped with the tapped inductor, which, in combination with proper capacitors, gives much better filtering action with smaller coils and capacitors than does the conventional "brute-force" type.

The B supply for the output tubes is taken from the junction point of the two sections of filter. This allows the second inductor to be made considerably smaller. This connection also prevents "motorboating" due to coupling in the power supply between the output tubes and any of the preceding tubes as it introduces a whole stage of filter between the respective "B" supplies.

The plate voltage to the detector is supplied through a 10,000-ohm resistor connected to the output of the second filter stage. The remaining voltages are supplied from the voltage-divider resistors and where necessary have filtering capacitors shunting the resistors.

The built-in electrodynamic loudspeaker is very sensitive and, in order

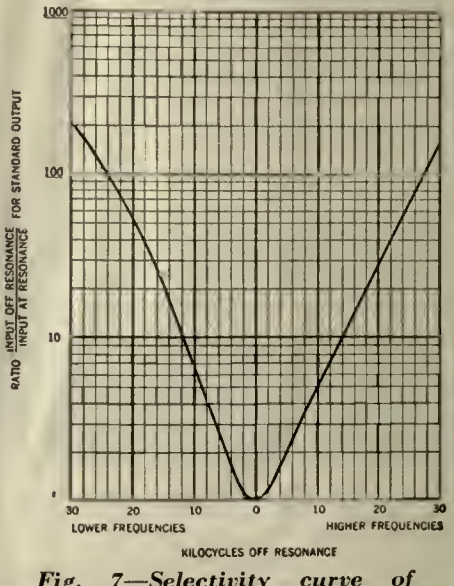


Fig. 7—Selectivity curve of screen-grid receiver with automatic volume control taken at 1000 kilocycles.

that no sacrifice of this characteristic be made due to low field excitation, a separate power supply unit is provided to furnish field current. This unit includes a power transformer, a 280-type rectifier, and a filter capacitor. The use of the extra rectifier tube allows full voltages to be applied to both the output tubes in the chassis and to the loud speaker field without overloading either rectifier.

The operation of this receiver is very simple and extremely convenient. As stated above, there is a "visual tuning meter" provided which indicates when the received station is tuned to resonance. This arrangement is essential in a receiver employing automatic volume control as when a powerful station is tuned in, the control functions to keep the volume from the loud speaker at the same level while the dial is rotated over the audible range of that station. However, it can be noticed readily that the fidelity of reproduction is correct only at the resonance point. For this reason the meter is provided in order that proper tuning can be obtained easily and accurately.

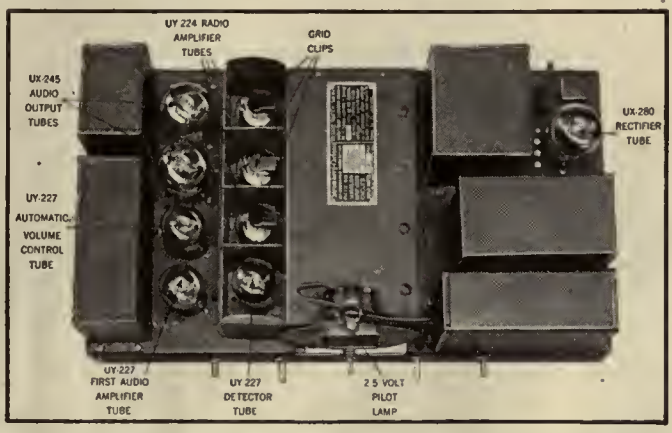


Fig. 8—Top view of chassis with cover over radio and detector tubes removed, showing the location of all the tubes and parts on the chassis.

It should be remembered that the automatic volume control circuit varies the sensitivity of the receiver in proportion to the strength of signal. That is, when a strong signal is received the receiver is relatively insensitive and when a weak station is received the sensitivity is increased. Thus, when no signals are being received the sensitivity is at maximum, and when tuning from station to station the sensitivity is extremely high.

In order to achieve "silent tuning" whereby the listeners would not be annoyed by "static noises" picked up on account of this high sensitivity and by undesired stations, a "Silent Key" is provided. This key shorts the moving coil of the dynamic speaker through a predetermined resistance. This arrangement allows just enough signal to come through the loud speaker to let the operator know if the carrier wave he has tuned in by the "tuning meter" is being modulated. The necessary resistance in this case is obtained by properly proportioning the lead wires to the key.

The manual volume or level control, in a receiver employing the automatic volume control circuit, must be a control to vary the signal input to the audio amplifier as the signal level at the detector is practically constant when the received signal is at or above the value that actuates the automatic control. Of course, the detector can never be overloaded due to the action of this automatic control. Normally, the manual volume control is set for the desired room level and does not need to be touched unless a station is tuned in which has very low percentage modulation or the signal strength goes down below the value required for operation of the automatic control. In regard to the latter case it should be emphasized that such a signal is a very weak one, and on most receivers would not be "received" at all.

The "Sensitivity Control" previously mentioned is a potentiometer connected in such a manner as to vary the input from the antenna to the r.f. amplifier. This is used to reduce any extremely strong local signals which would cause the overloading effect in the r.f. amplifier (indicated in Fig. 5) when signals above 100,000 microvolts are received. In locations where there are a number of powerful stations nearby, it is advisable to keep this control partially turned down all the time, particularly when only the local stations are desired. Of course, when very distant stations are being searched for, this control should be at maximum sensitivity.

One can readily check the action of the automatic volume control by tuning in a strong signal and varying the sensitivity control. The signal from the loud speaker will not change over a wide range of movement of the dial, but the visual tuning meter will vary, indicating the different strengths of signal supplied from the antenna to the r.f. amplifier. The capacity-resistance series network between the

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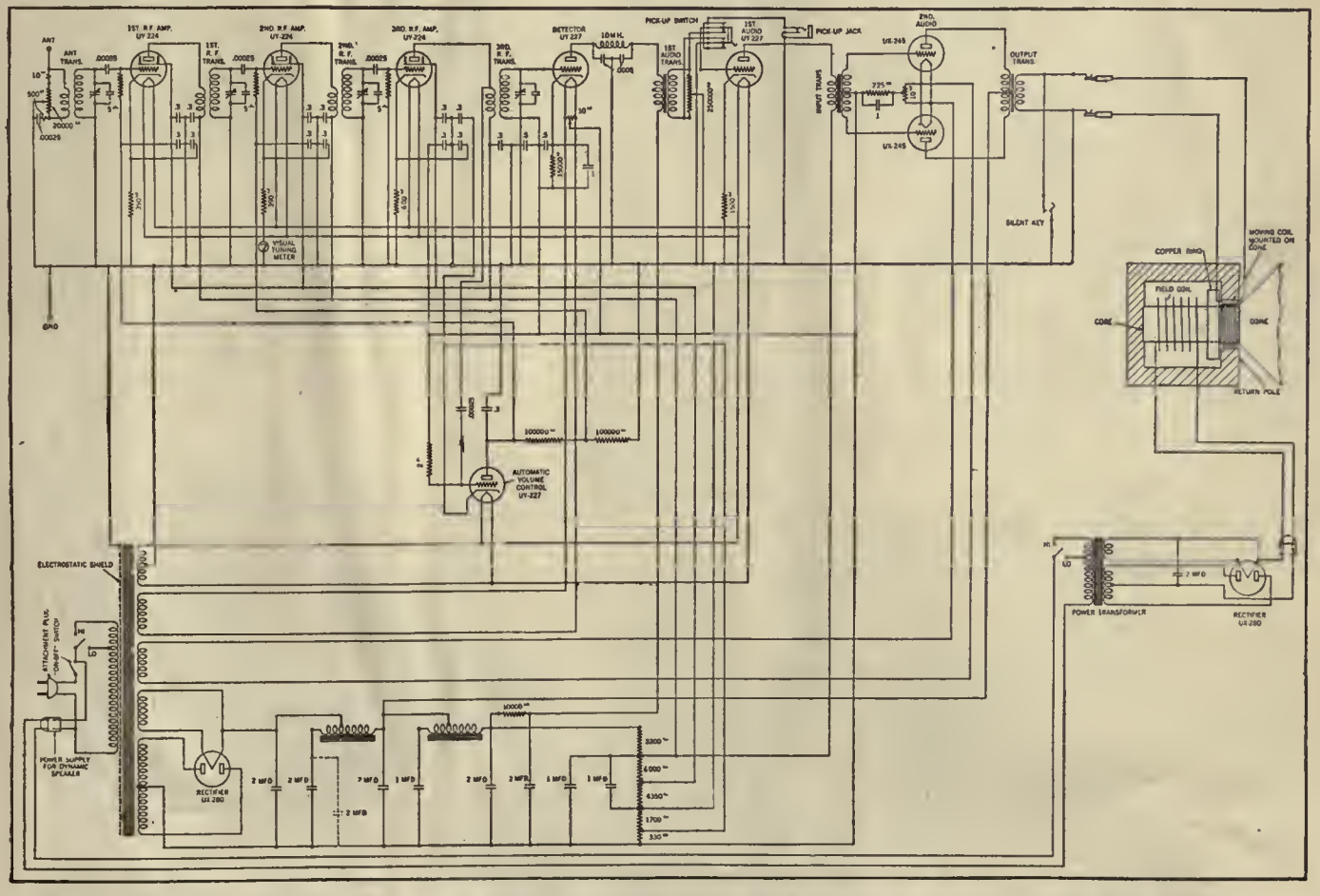


Fig. 9—Complete schematic diagram of the Stromberg-Carlson No. 846 receiver, showing the circuits of the chassis, the loud speaker, and the speaker field power supply.

DESIGN OF THE COLONIAL MODEL 32A.C.

BY DR. FULTON CUTTING

President, Colonial Radio Corporation



Dr. Fulton Cutting

In the laboratories of the Colonial Radio Corporation, experiments in the use of screen-grid tubes have been in progress for the past two years, having been started when the d.c. screen-grid tube first became available. The experiments with d.c. screen-grid tubes were found helpful in many ways in further work with the a.c. screen-grid tube. The essential results of this laboratory work have been incorporated into the latest Colonial receivers. In this article we will describe in detail some of the interesting features to be found in the Model 32 A.C. receiver.

The schematic circuit diagram of this receiver is given in Fig. 1. As the diagram indicates, the set consists essentially of a three-stage r.f. amplifier, a plate-circuit detector, and a two-stage transformer-coupled audio amplifier. Screen-grid tubes are used in the three r.f. stages and in the detector circuit. The first audio tube is a 227 and the second audio stage contains two type 245 tubes in push pull.

There are only two essential controls: the station selector and the volume control. The selector control drives the shafts of four variable condensers through the medium of a vernier gear and a series of phosphor bronze belts. A pointer, traveling across a one hundred division scale on the panel, indicates the setting of the selector.

If all four stages were accurately tuned to a single frequency, side-band cutting would result to a degree which would depend upon the shape of the top of the resonance curve for the entire tuner. However, if each stage were tuned to a different frequency, the four resultant peaks being spread out over a 5000-cycle band, much less side-band cutting would result. By properly adjusting these circuits, a resonance curve for the entire tuner could be obtained which would have a nearly flat top, 5000 cycles wide. In the Model 32 receiver, this principle has been followed, and successive stages are tuned to carrier frequency, 2000, 3000, and 4000-cycle side bands, respectively. The graph of Fig. 2 emphasizes the advantages of this system by contrasting the shapes of the resonance curve for the entire tuner before and after the "staggering" of the tuning. Mistuning in this manner of course decreases the gain (in this particular case the overall gain with all circuits in resonance was twice that indicated in Fig. 5).

System of Coupling Audio Stages

An ingenious coupling scheme is employed between the detector and first audio amplifier. This consists of a resistance and capacitance network designed to compensate automatically the deficiencies of the second stage coupling transformer, so that the amplification between the detector and the output of the second audio stage will remain constant on all frequencies in the lower half of the audio scale.

The mathematics of this arrangement are very interesting. In Fig. 3 are shown the

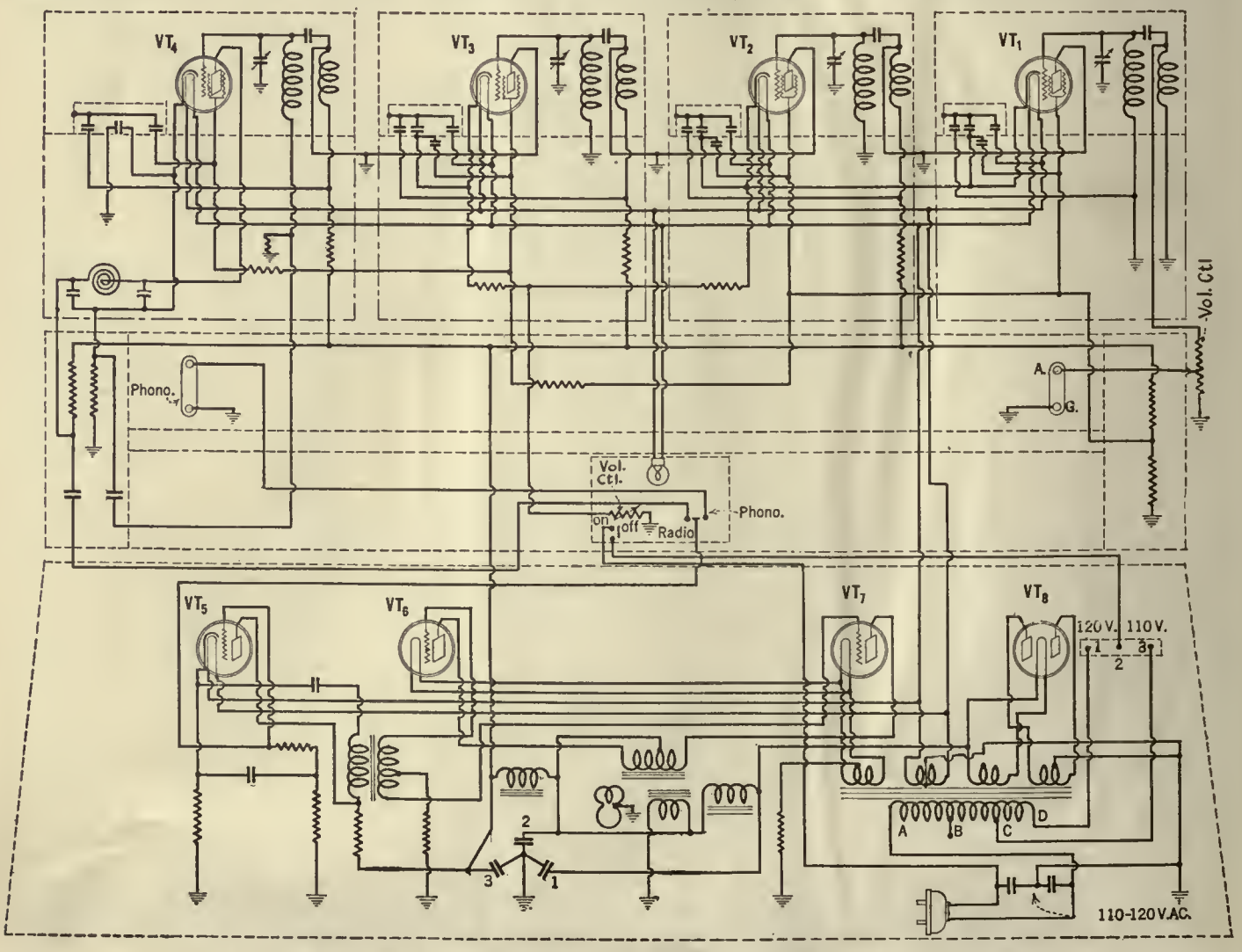


Fig 1—The complete schematic diagram of the Colonial Model 32 A.C. receiver.

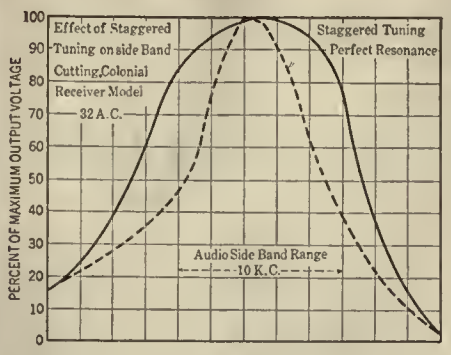


Fig. 2

essential qualities of the audio circuits under consideration. The detector output is represented by a generator having a voltage $\mu_1 E_{g_1}$, the plate resistance of the tubes are represented by R_{p1} and R_{p2}, respectively. R and C, together, form the coupling impedance between the detector and the first audio stage, and L is the inductance of the primary of the second stage coupling-transformer. The relation $\frac{E_{g2}}{E_{g1}}$ will be represented by α_1 and $\frac{E_L}{E_{g2}}$ by α_2.

When the plate resistance of the detector is very high with respect to its load impedance, as is the case in this particular instance where R_{p1} is in the order of several million ohms, the expression for the amplification in the detector circuit may be approximated with sufficient accuracy by the equation:

$$\alpha_1 = \frac{\mu_1 \left(R^2 + \frac{1}{\omega^2 C^2}\right)^{\frac{1}{2}}}{R_{p1}} \qquad (1)$$

and that for the amplification in the first stage by

$$\alpha_2 = \frac{\mu_2 \omega L}{R_{p1}\,(R_{p2}^2 + \omega^2 L^2)^{\frac{1}{2}}} \qquad (2)$$

The combined amplification of both circuits is obviously the product of α_1, and α_2. Referring to equations (1) and (2), the total amplification may evidently be expressed by the equation

$$\alpha_1\alpha_2 = \frac{\mu_1\mu_2 L \left(\omega^2 R^2 + \frac{1}{C^2}\right)^{\frac{1}{2}}}{R_{p1}(R_{p2}^2 + \omega^2 L^2)^{\frac{1}{2}}} \qquad (3)$$

Within limits, the amplification will be constant at all frequencies in the lower portion of the audio scale when

$$\frac{\left(\omega^2 R^2 + \frac{1}{C^2}\right)}{(R_{p2}^2 + \omega^2 L^2)} = k \qquad (4)$$

Transposing,

$$\omega^2 R^2 - k\omega^2 L^2 = kR_{p2}^2 - \frac{1}{C^2} \qquad (5)$$

which condition, when satisfied, will give the uniformity of amplification that is so desirable. Solving equation (5) for R, L, and C, and simplifying:

$$R = \frac{L}{R_{p2}C}$$
$$L = CRR_{p2}$$
$$C = \frac{L}{RR_{p2}}$$

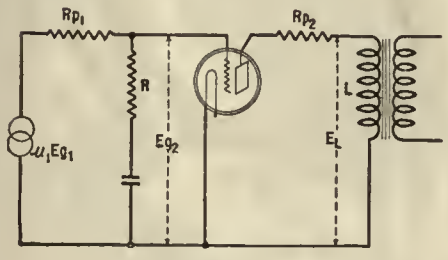


Fig. 3

Fulfilling these requirements actually peaks the first audio amplifier at the lower frequencies to a degree which accurately compensates the decreasing impedance of the second-stage transformer primary at the low end of the scale.

The principal limiting factor in this scheme is the possibility of overloading the grid of the first a.f. tube by reason of the high amplitudes attained at low frequencies with this arrangement. In the Model 32 receiver, this is provided for by the use of a second-stage coupling-transformer having a characteristic that requires only moderate compensation in the equalizer.

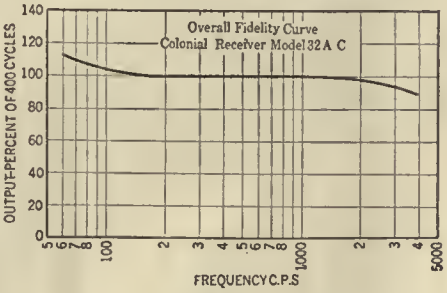


Fig. 4

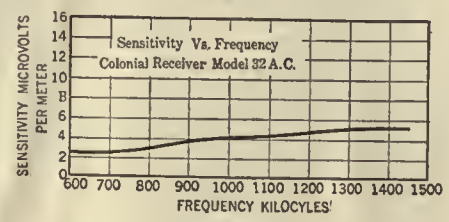


Fig. 5

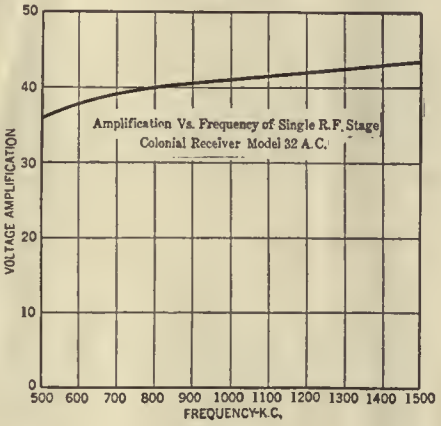


Fig. 6

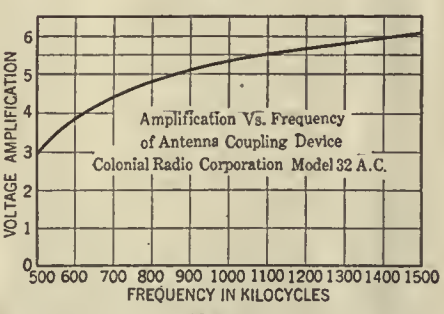


Fig. 7

The fidelity characteristic—antenna to output circuit—is given in Fig. 4.

Sensitivity of the Set

The sensitivity, in terms of microvolts per meter, averages about 2½ microvolts over the entire broadcast band. The sensitivity curve is given in Fig. 5. It will be observed that it is practically flat throughout the entire range. This was accomplished with a unique coupling scheme be-

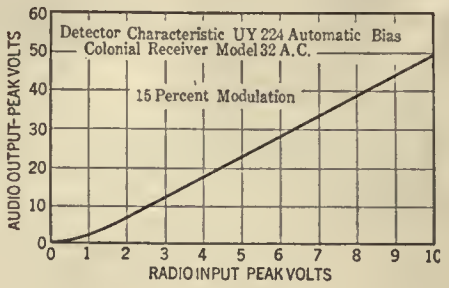


Fig. 8

tween stages in the r.f. amplifier. This coupling, as indicated in the circuit diagram, consists essentially of a tuned r.f. transformer having a 450-turn primary with a 5-mmfd. capacity connecting the high side of the primary with the high side of the secondary. The primary, with its distributed capacity and circuit capacity in shunt is resonant at some point below 500 kc. At 1500 kc. the arrangement functions essentially as tuned-impedance coupling, as the greater part of the current flows directly to the high side of the tuned secondary.

Radio-frequency filters in the leads supplying voltages to the screen-grid tubes are, of course, essential, for one of the most serious causes of feed-back is conduction through common leads. Filters comprised of resistances in series and condensers in parallel were found to serve admirably. Several such filters are used in each tuned stage. Each filter serves three purposes.

(a) As an r.f. filter
(b) As a means for securing a desired d.c. voltage drop
(c) As an a.f. filter, to reduce the line frequency ripple in the d.c. applied to the 224's.

This last effect is particularly important in the case of screen-grid tubes as they have a tendency to rectify readily. Any ripple applied to their elements, especially their control-grids, modulates the signals and results in more disturbance in the output than would occur with any other type of tube. It is necessary to keep the peak value of the ripple on the plate below 0.15 volts, that on the screen grid below 0.05 volts, and that on the control grid below 0.03 volts. Figs. 6 and 7, respectively, indicate the gain per stage in the r.f. amplifier and the gain in the antenna circuit.

The r.f. transformers are constructed as follows. The secondary consists of a single layer wound with 102¾ turns of No. 30 enamelled wire. The primary, consisting of 450 turns of No. 36 d.s.e. enamelled wire, is wound on a wooden bobbin inside one end of the secondary.

Cross-Talk

This term is used to describe the condition that exists when the same station is

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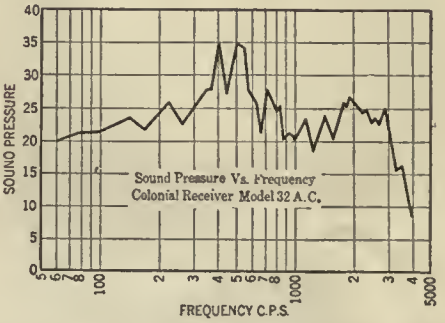


Fig. 9

A Study of Performance and Possibilities

AN ENGLISH OUTPUT TUBE, THE PENTODE

By W. T. COCKING

Radio Engineer, Receptite Company, London



W. T. Cocking

A few months ago Radio Broadcast published a brief description of the pentode, a new power output tube which is now common in England. Although, as far as the writer is aware, there is none available in America at present, it is certain that if it offers a real advantage over other tubes some firm will market it before long; but before this happens it is desirable that its advantages and disadvantages should be well known. In this article the writer gives a description of the tube's special characteristics, and explains what it will and will not do; together with data which he has collected in the course of a year's experimenting with it in receivers intended for commercial production. At first sight it may seem that there are no special conditions to be observed when using the pentode, but this is not the case, although many people in England still seem to believe so.

The writer of this article is a radio engineer by profession and can vouch for the accuracy of the facts given; he has for the last five years been radio engineer of the Receptite Co., London, England, in whose laboratory the data given have been obtained in the course of experimental work in connection with the design of receivers intended for commercial production in England.

—The Editor.

Several Types Available

The tube which the writer has chosen for the purpose of illustration in this article is the Mullard P. M. 22; he has chosen this tube because it was the first pentode on the market, and because he has therefore had more experience with it than with any other. As a matter of interest, pentodes are now available with filaments for a two-, four-, or six-volt A battery, and of several different makes.

As the name pentode implies, the P. M. 22 has five electrodes, a filament, three grids and a plate. It is fitted to the standard English four-pin base, to which the connections for filament, control-grid and plate are taken in the usual way; on the side of the base, however, a binding-post is fitted for the connection to the auxiliary grid. The electrodes are all mounted inside each other in the following order: filament, control grid, auxiliary grid, outer grid, and plate.

The filament is of the coated type, and in the two-volt pattern takes a current of 0.3 ampere, but in the six-volt pattern only 0.1 ampere, like the majority of English tubes. The electrodes are all assembled in a horizontal position, but they cannot be seen clearly as the tube is heavily gettered. In use, the control grid and plate are treated in exactly the same way as those of a triode, the auxiliary grid is connected to the same source of high potential as the plate; the outer grid, however, is connected internally to the centre of the filament, and it is impossible to make any connection to it.

In Table I are given the maker's published figures for the characteristics of the P. M. 22. It is important to note that when the tube is used at its maximum plate and auxiliary grid potentials, the amplification factor and plate resistance are very different from the rated figures, at the working point, A (Fig. 4); they are 47 and 27,000 ohms, respectively. This large difference is principally due to the higher voltage used on the auxiliary grid, the maker's curves being taken at 100 volts only, although individual specimens vary far more than is the case with triodes.

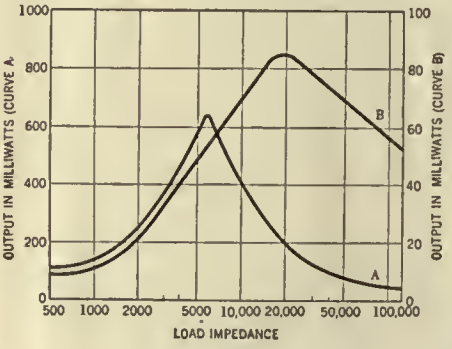


Fig. 1

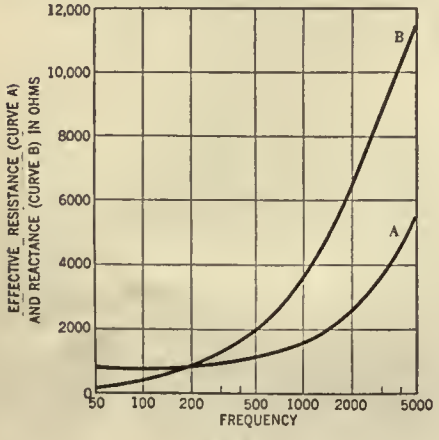


Fig. 2

The plate-current plate-voltage curves of the P. M. 22 with a voltage of 150 on the auxiliary grid are given in Fig. 4; it will be seen that they are totally different from those of any triode. If a perfect pentode could be made, its curves would be horizontal straight lines, just as the curves of a perfect triode would be straight lines inclined at an angle to the base. Although the perfect pentode cannot be obtained, Fig. 4 shows that for plate voltages above about 60 volts the curves are almost completely straight. When voltages lower than 150 are applied to the auxiliary grid the curves are not nearly so straight, they commence curving at about 120 volts plate potential; but when the auxiliary grid potential is higher than 150 volts the curves approach more nearly to the ideal, for they are straighter at low plate voltages and they are nearer to the horizontal. More than 150 volts, however, is in excess of the maker's rating, and if it were used it would probably result in a short life for the tube.

To those accustomed to high-resistance triodes the high plate current of the pentode comes as a surprise. A triode of the same internal resistance will take perhaps 2 mA., but the pentode takes 22 mA., and requires a negative C bias of $10\frac{1}{2}$ volts with 150 volts on the plate; while the total current requirements are still greater, for the auxiliary grid takes a current equal to about 25 per cent. of the plate current, so at 150 volts the total current will be in the neighborhood of 27 mA.

Question of Power Output

In investigating the conditions under which a power tube must operate, the first thing to do is to find out what the maximum power output is with various load impedances in the plate circuit, and at the maximum rated plate voltage and current for the tube. The easiest way of doing this is by drawing straight lines through the point A, the working point, Fig. 4, which represent the effect of a pure resistance in the plate circuit, the slope of the lines being inversely proportional to the value of the resistance. The maximum output is calculated by taking the values for plate voltage and plate current at the points where the resistance load line crosses the grid voltage curves for the maximum signal voltage which can be applied without distortion. In this particular case, if the load is such that it is possible to apply to the control grid a signal voltage the peak value of which is equal to the negative C bias, then the plate voltage and plate current should be taken at the points where the load line crosses the curves for 0 and negative 21

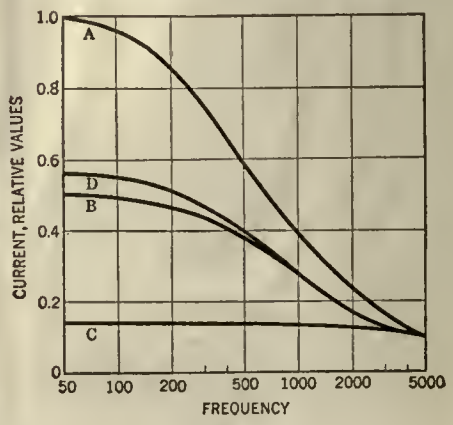


Fig. 3

volts. Then the power output can he calculated from the usual formula:

$$P = \frac{(Imax-Imin)\ (Emax-Emin)}{8}$$

current being expressed in amperes and powers in watts, and the percentage distortion from the formula:

$$D = \frac{100\ [\frac{1}{2}\ (Imax + Imin) - Ino]}{(Imax - Imin)}$$

Ino=no-signal plate current

If the curves of Fig. 4 are carcfully examined it will be scen that for high values of load impedance, above about 6000 ohms, the peak value of the input voltage to the control grid must be reduced below the figure equal to the negative C bias in order to avoid distortion due to the curvature of the tube characteristics at low plate voltages. With a load of 50,000 ohms, the input must not exceed 3 volts peak value to avoid distortion. This is not a peculiarity confincd to the pentode, for it occurs with triodes also, but it usually passes unnoticed for with a triode grid current usually occurs first. Curve B of Fig. 1 shows the power output with all loads, and with the input constant at 3 volts for all loads; this curve shows also that the greatest gain, not undistorted output, is obtained when the load impedance is approximately equal to the internal plate resistance of the tube. Throughout this article the word "gain" is used to mean the relation between the output powcr and the voltage input to the control grid, therefore, maximum gain is obtained when the output per input grid volt is greatest, which occurs when the load resistance and plate resistance are equal. It will be seen that for the higher values of load impedance the output for a given input voltage is much greater than with any three-electrode power tube.

Power Output of Pentode

The maximum undistorted power output of which the pentode is capable when the grid peak voltage is the maximum which can be applied for a given load is shown by curve A of Fig. 1, in which the input voltage is constant at 10½ volts pcak value for loads up to 6000 ohms only. For loads of higher values the input steadily decreases to 3 volts at a load of 50,000 ohms. It will be seen that the maximum output when the load resistance has a value of about 6000 ohms, or roughly one fifth of the tube resistance, is totally different from the results with triodes; and considering the plate voltage used the figure for the output with this load is quite high, being 640 milliwatts. The grid peak voltage required to produce this output is only 10½ volts. Compare this with a UX-171A tube, with an output of 700 milliwatts with 180 volts on the plate, at an input peak voltage of about 40.

As far as the gain per stage is concerned, then, it is obvious that no other power tube can compare with the pentode. But, unfortunately, there is the relative gain at diffcrent loads to be considcred. No loud speaker which has yet becn invented offers the same load impedance to the tube at all frequencies, consequently

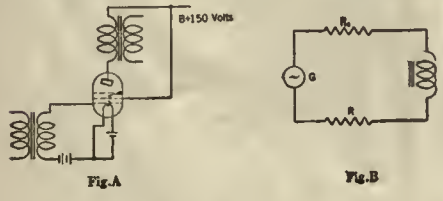


Fig. 5

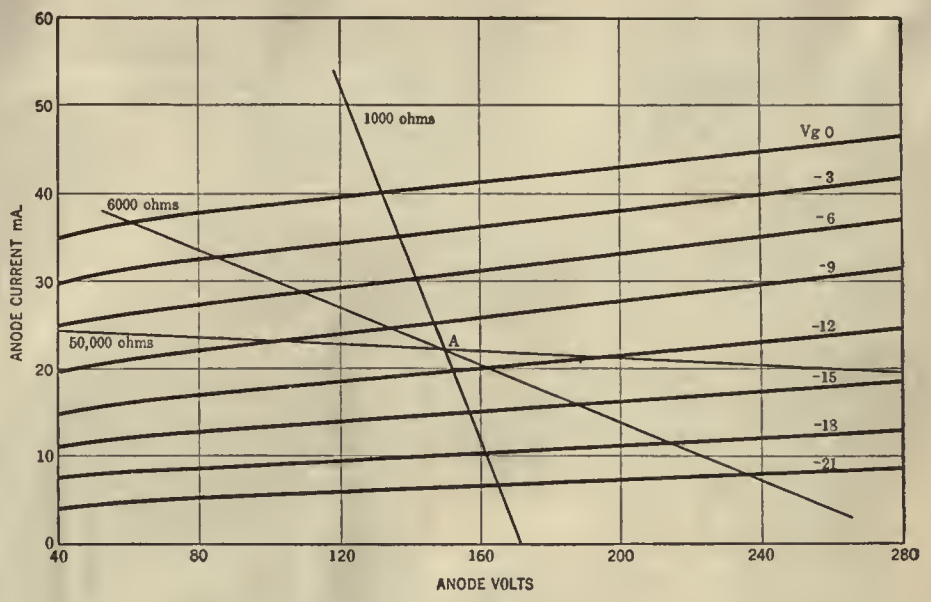


Fig. 4

at different frequencies the gain is different, with the result that both high and low notes are reproduced less strongly than those in the middle of the scale. Usually, however, this loss is not serious with a triode, and if desired adequate compensation can be obtained, either in the amplifier or in special output circuits.

Table I

Constants of Mullard P. M. 22.

Max. Fil. Volts		2	Plate Volts	Neg. C. Bias
Filament Current		0.3 amp.	75	−3
Max. Plate Volts		150	100	−6
Auxiliary Grid Volts		150	125	−7½
Plate Resistance		62,500	150	−10½
Amplification Factor		82	{ at anode and auxiliary grid 100 volts, control grid zero.	
Mutual Conductance		1310		

The anode and auxiliary grid should always have the same potential applied to them.

There are two ways in which the relative gain at various frequencies can be found. One way is similar to that employed to find the output of a tube with various load resistances. But, as the loud speaker load is usually inductive, a straight line cannot be drawn on the tube curves to represent it accurately; it is necessary to draw an ellipse, and the method then becomes more complicated. Another way, and by far the easier, is to calculate the current through the loud speaker at various frequencies. It is, of course, necessary to know what the relative currents at various frequencies should be, otherwise any results would be useless, for there would be no standard of comparison. It is unfortunate that data as to the constants of so many of the loud speakers on the market are unknown, except to their makers, and sometimes even to them! The writer has chosen for illustration one of the best English rced-drive type loud speakers (similar to an ordinary magnetic cone—*Editor*), the Amplion "Lion," and its effective resistance and reactance are given in Fig. 2, curves A and B, respectively. It is neccssary to give a curve showing the reactance at various frequencies, as the inductance is not constant, but decreases with an increase of frequency; the effcctive resistance increases with frcquency owing to losses in the iron.

In Fig. 5A is shown the circuit of the output stage when a pentode is used, and in Fig. 5B the equivalent electrical circuit assuming that the transformer is free from losses and that the leakage inductance is negligible. In this circuit L represents the inductance of the loud speaker and the effective resistance, both multiplied by the square of the transformer ratio. R_a is the tube's plate resistance, and G is an alternator supplying a voltage equal to mE_g where m is the amplification factor of the tube and E_g is the r. m. s. voltage applied to the control grid. At any frequency, then, the current flowing through the circuit is given by:

$$I = \frac{mE_g}{\sqrt{[(R + Ra)^2 + \omega^2 L^2]}}$$

where

$$\omega = 2\pi f +$$

In Fig. 3 curve C, this current is shown for a pentode of 27,000 ohms plate resistance with the Amplion loud speaker, and in curve D for the same tube and speaker when the output transformer has a step-down ratio of 4-1 instead of 1-1. It must be emphasized that these curves do not show actual values of current, but merely relative values, and that for easy comparison they are all made to coincide at one frequency. Now these two curves alone are useless, for the shape of the correct curve is unknown; that is, the shape of the curve which, in practice, would give the best results. Curves A and B of Fig. 3 give the rclative current with triodes of 1000 and 2000 ohms resistance respectively, and it can be taken that any curve falling between these two limits will be satisfactory; for the loud speaker manufacturers recommend for best results an output stage having an impedance of between 1000 and 2000 ohms. It is worthy of note that the current must be very much greater at low than at high frequencies, as with all reed-drive type loud speakers; and that at any frequency the sound output is proportional to thc square of the current.

Moving Coil Speakers and Pentode

The curve (c) for a pentode with a 1-1 output transformer shows that the current variation over the entire frequency band is but small, as thc variation of the speakcr impedance at different frequencies is almost completely swamped by the high tube rcsistance. This curve cannot be

considered satisfactory, for it indieates poor reproduction of the bass notes; a note of 50 cyeles would be reproduced at only one-tenth of the amount with a 2000-ohm triode. This is amply proved in practice, for bass notes are almost inaudible. Curve D, however, when a 4-1 transformer is used is very similar to those for 1000- and 2000-ohm triodes, and as would be expected there is no audible differenee between a 2000-ohm triode and a pentode with a 4-1 transformer, provided that the volume is small. That is where the trouble comes in, for, from what has just been said, it can be seen that for use with the best reed-drive type loud speakers, the pentode is useless unless a suitable output transformer is used to makc the load impedance high. But, if the load impedance is high, the undistorted power output is greatly reduced, although the stage gain is increased. In the particular case mentioned, when the 4-1 transformer is used with the Amplion loud speaker, the load varies between 13,000 and 200,000 ohms, and the maximum undistorted power output is consequently only about 85 milliwatts; which can hardly be considered sufficient for good quality if reasonable volume is desired. The control grid input for this output is but 3 volts peak.

When a loud speaker of the moving-coil or dynamic-cone type is used the results are different, for this type of loud speaker requires constant current at all frequencies; so that it would seem to be ideal with a pentode. The usual impedancc variation is between 1000 and 4000 ohms over a range of 50 to 5000 cycles, being greatest at high and low frequencies and least at a frequency somewherc about 500 cycles. [The author is speaking of English speakers —*Editor*].

In practice, with a low-resistance triode, this causes a falling off in the current at both high and low frequencies; the platc resistance of the pentode is so high, however, compared with the speaker impedance that the variation makes a negligible difference to the total circuit impedance; and it is this total circuit impedance which alone limits the current. The result is that the current remains constant over the whole frequency range, which, with this type of speaker, is what is wanted. It should be carefully noted that the current will only remain constant provided that the speaker impedance is small compared with the tube's plate resistance, for only then is any variation in its impedance swamped. This means that if a transformer ratio is used to get a large stage gain, the tone of the reproduction will be neither better nor worse than with a triode, but that the power output will be small due to the effectivc speaker impedance being high compared with the plate resistance. On the other hand, if the effective impedance is adjusted to be about 6000 ohms, the power output will also be at its maximum (640 milliwatts) and the variations of the speaker impedance will be swamped by the relatively high tube rcsistance, with the result that the current will be constant at all frequencies and a fair output will be obtained. Theoretically, the moving-coil loud speaker would work much better with a pentode than with a triode as regards tone, but in practice so much depends upon the whole design of the loud speaker. With some speakers the results are improved, with others they are the same, while with still others they are distinctly worse. Many speakcrs of this type have a pronouncccd resonancc at some high frequency, and while this is not serious with a triode, and is even sometimes advantageous owing to the falling current at high frequencies, with a pentode it often makes reproduction sound shrill.

A Look at the Future

It will be seen from the foregoing that it is useless to cxpect good quality from a pentode with a rced-drive loud speaker unless only a small output is required, when a step-down output transformer can be used. With many moving-coil loud speakers, however, the results are at least as good as with a triode, while the power output is not much different from that of a triode on the same plate voltage, the input voltage to the control grid to produce this output will bc only about one-third to one-quarter of that necessary with a triode.

The chief use for the pentode seems to lie in inexpensive receivers which makc no pretense of giving the best quality, and where compactness and low cost are of prime importance. It is worthy of note that no English firm is at prescnt using it in their best receivers; it is confined to their cheaper models and to portable sets, where weight is a great consideration. In this connection the largc gain which can be obtained from the pentode with a high-impedance load often enables thc audio-frequency tube between the detector and the power stage to be omitted. Also, most of the cheap cone loud speakers, such as are used with these sets, have a fairly high impedance, usually about 20,000 ohms and upward, so that no output transformer is necessary for tone correction.

Any output transformer or choke which is to be used in the plate circuit of a pentode must have a much higher inductance than is necessary with a triode, owing to the higher plate resistance. An inductance of between 40 and 80 henries is usually considered satisfactory.

As the present tendeney in radio is toward better and better quality, it seems probable that the present popularity of the pentode will decline; particularly as, even now, triodes are available giving larger powcr outputs with a fairly largc stage gain. In this connection a recent addition to power tubes in England is the Marconi P. 625, which is rated to withstand 250 volts on the plate with a current of 24 mA., and a negative C bias of 24 volts. It has an platc resistancc of 2400 ohms and an amplification factor of 6, giving a mutual conductance of 2.5 mA./v; the undistorted power output is approximately 1000 milliwatts. The filament is of the coated type and requires a current of 0.25 ampere at 6 volts. Now this tube will give a stage gain of about one-fifth of that which can be obtained with a pentode with a load of 20,000 ohms, but it will give an undistorted output of about 12 times that with the pentodc. It is truc that the platc voltage required is nearly double, but this is of little moment nowadays when socket power units are eommonly used. If the pentode is used with the best load for powcr output the stage gain is about three times that of the P. 625 tube, but the latter tube still gives a grcater output, about 1.5 times.

It is the writer's opinion, therefore, that there is little advantage to be gained by using a pentode in place of a really good triode powcr tube, the only thing in which it scores is in stage gain; and its superiority herc is not sufficient to make its use worth while, except in receivers where quality is only a sceondary consideration, such as lightweight portable sets. This latter type of set is very popular in England, and the pentode is bccoming very common in them, due solely to its high stagc gain, for the high plate current does not make for economical operation from small dry batteries, which have nearly always to be used in these sets.

DESIGN OF THE COLONIAL MODEL 32 A.C.

(*Continued from page 359*)

picked up at several different points in the band. It results from poor selectivity in the first r.f. tube on signals of sufficient intensity to overload this tube. When the first tuned circuit is not sufficiently selective to prevent two different carriers from simultaneously reaching the grid of the first r.f. tube, a series of beat frequencies will be set up in the plate circuit of the first tube as well as the interference caused by the modulation of either carrier, by the audio component of the other carrier. Their amplitude will vary with the combined amplitudes of the two carriers. When the receiver is located in the vicinity of several broadcasting stations, these beat frequencies become very important in the creation of cross-talk. To prevent the cross-talk which occurrs when the voltages impressed on the grid of the first tube are sufficiently high to cause it to draw current, a 750,000-ohm resistance shunted by an r.f. by-pass condenser is placed in series with the r.f. inductance in the d.c. path of the grid current. This reduces the d.c. voltage on the grid without reducing the r.f. signal. At the same time any slight grid current flowing through it increases the negative voltage on the grid due to the IR drop through the resistor. In this manner the selectivity of the first tuned circuit is preserved and cross-talk eliminated.

Volume is controlled by variation of the cathode potential with respect to the other elements of the tube, at the same time varying the antenna input by means of a 10,000-ohm potentiometer on the same shaft as the bias unit. The volume control is a 75,000-ohm variable resistance which acts as a grid-biasing resistor or more properly as a cathode bias and resistor.

A screen-grid tube is used in this receiver as a detector. By shunt feeding through a 400,000-ohm resistor, 280 volts are applied to its plate. Plate rectification is used and the graph of Fig. 8 shows the gain of this tube as a detector as well as the high audio-frequency output available without overload.

The characteristics of the loud speaker were taken by a series of sound pressure measurements. The procedure employed was as follows: A radio-frequency carrier of constant amplitude, modulated at audio frequencies by a variable beat-frequency oscillator, was introduced into the input of the receiver. A correction for the pressure increase due to the reflection from the microphone was made on the basis of an equivalent sphere. A typically representative curve of the Model 32 receiver is shown in Fig. 9.

This measurement is actually a complete overall fidelity measurement of the entire receiver. It tells the complete story of the fidelity of reproduction and takes every factor into account, including side-band distortion, audio amplifier characteristics and speaker characteristics. The characteristics of the speaker itself may be determined by comparing the sound pressure curve with the fidelity curve previously given.

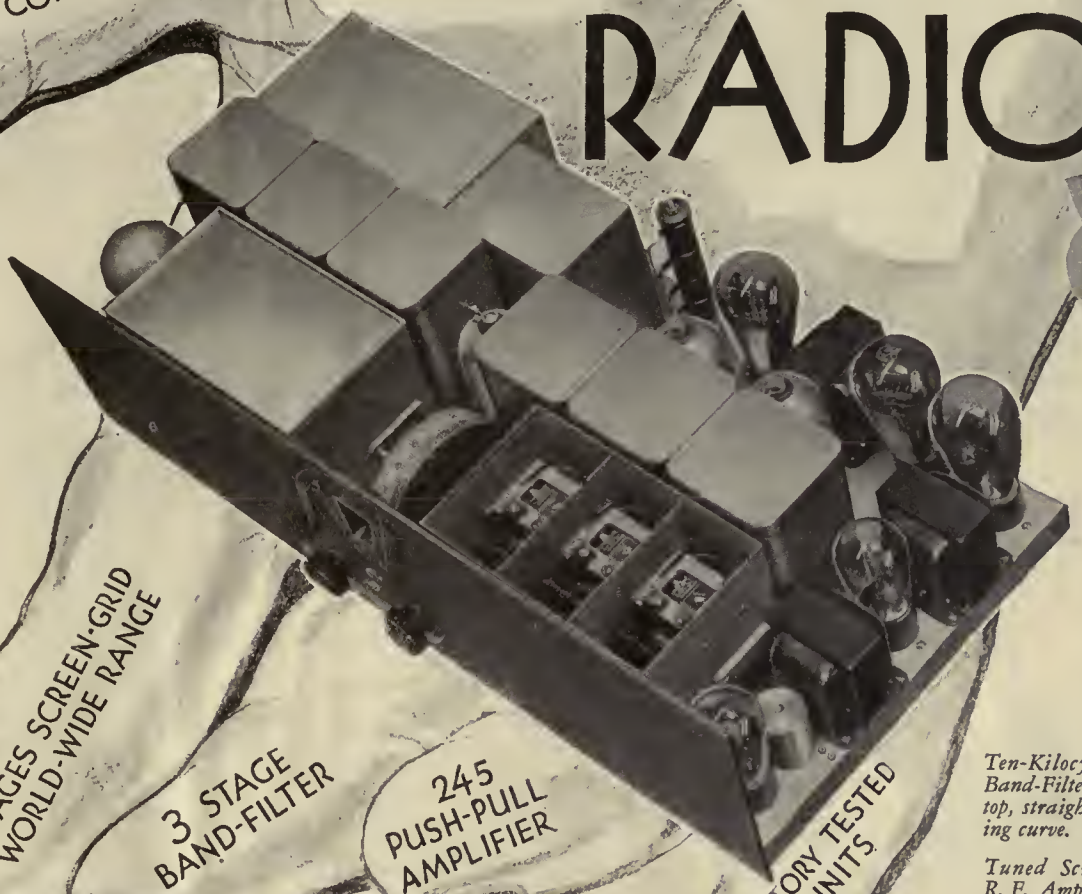
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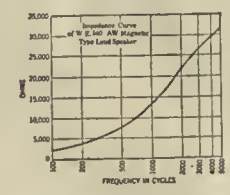
No. 301 RADIO BROADCAST Laboratory Information Sheet **October, 1929**

Output Transformer Ratios

OUTPUT transformer ratios required for use with cone or horn type loud speaker are shown on the chart on Sheet No. 302. This chart, reproduced from a recent bulletin of Ferranti, Inc., covers the range of loud speaker impedances from 0 to 6500 ohms and tube impedances from 0 to 15,000 ohms. On Sheet No. 297 in the Sept., 1929, issue, a chart was given of output transformer ratios for use with moving-coil type loud speakers.

In the case of horn and cone type loud speakers the bulletin suggests that the impedance used in determining the transformer ratio should be the impedance of the loud speaker at about 200 cycles. The impedance at this frequency may with fair accuracy be taken as 2.5 times the d.c. resistance of the winding. That is, a loud speaker with a d.c. resistance of 2000 ohms has an impedance at 200 cycles or approximately 2000 times 2.5 or 5000 ohms.

Owing to the fact that the impedance of cone type loud speakers frequency varies from 1000 to 30,000 ohms between 200 and 5000 cycles, ideal results are not possible but transformer ratios determined as indicated above will give best results. As an example of the manner in which the impedance of a magnetic loud speaker varies we show on this sheet an impedance curve the Western Electric 540 AW.



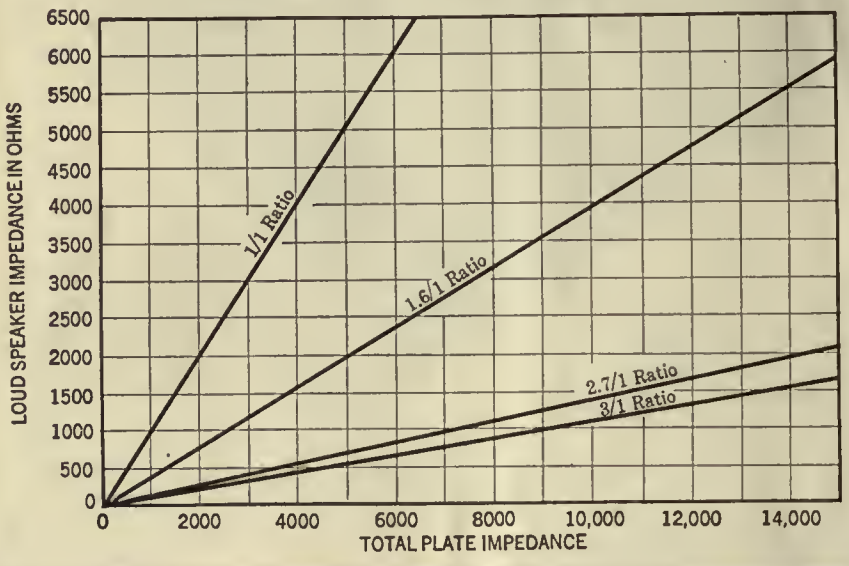
An example will help to make perfectly clear the use of the chart on sheet No. 302.

Example 1. A loud speaker has an impedance of 4000 ohms at 200 cycles. It is to be used in a push-pull circuit using two tubes each with a plate impedance of 5000 ohms. What transformer ratio is required?

Two 5000-ohm tubes in push-pull give a total impedance of 10,000 ohms. Referring to the chart we find the horizontal line corresponding to a loud speaker of 4000 ohms impedance intersects the vertical line corresponding to a tube impedance of 10,000 ohms at a point corresponding to a transformer ratio of 1.6 to 1.

No. 302 RADIO BROADCAST Laboratory Information Sheet **October, 1929**

Output Transformer Ratios



No. 303 RADIO BROADCAST Laboratory Information Sheet **October, 1929**

"Power" and "Linear" Detection Explained

"POWER detection" and "linear detection" are two terms frequently used to describe certain characteristics of new receivers. On this sheet we explain briefly what these two terms mean.

A power detector (according to the popular definition) is one operated at fairly high values of input voltage. Power detectors are frequently followed by a single stage of audio frequency amplification because sufficient a.f. voltage can be obtained from them to load up a power tube. It should be realized, however, that power detectors are not always followed by single audio stages but may be followed by a two-stage audio amplifier. The important factor is the signal level at which they operate. Accurately defined, however, the power detector is one from which sufficient power may be obtained to operate a loud speaker directly.

Ordinary detectors operate on what is called a "square law," that is the a.f. output voltage is proportional to the square of the r f. input voltage. Such detectors produce some distortion especially if the r.f. input is modulated at fairly high percentages. The distortion reaches a maximum of 25 per cent. when the input signal is modulated 100 per cent. The present tendency in broadcasting is to increase the modulation to 100 per cent. so as to utilize as completely as possible the output of the transmitter. Linear detectors will produce very little distortion on 100 per cent. modulated signals and it is for this reason that this type of detector is increasing in use.

A detector is "linear" when its a.f. output is directly proportional to the r.f. input. Such detectors produce a distortion of about 10 per cent., with 100 per cent. modulated signals in comparison with the 25 per cent. distortion produced by square-law detectors. The decreased distortion (from 25 to 10 per cent.) due to the linear detector is readily noticeable to the ear.

It should be pointed out that the fact that the detector operates at high signal levels does not necessarily mean that it is linear. C-bias detectors are linear over only a small portion of their operating characteristic.

STRAYS FROM THE LABORATORY

(*Continued from page 349*)

the courage to make this plain and straightforward statement in the face of what is apparently a distinctly different tendency.

"For the past eight years the writer has had charge of the radio market news broadcasting for the United States Department of Agriculture and I feel that anything said in the interest of the farmers by technical radio men indicates an appreciation of a situation with which we have been dealing for a long time.

"At the present time there are more than a hundred radio stations broadcasting crop and market reports for the benefit of farmers. This information is handed to the radio stations by the branch office representatives of this Bureau located in different parts of the country. All of these offices are connected by leased wire and all of the wire lines lead into the Washington office, so that every branch office is in touch with every other branch office and with headquarters. In a sense our service is that of chain broadcasting although the information is not poured into a single microphone but the information is disseminated over our leased wires and broadcast by each station.

"In order to avail himself of this vital market information, upon which the success of his farming largely depends the farmer must have a radio set that is selective enough to make certain selections among radio stations and sensitive enough to bring in clearly stations during the daytime that may be 100 or 150 miles away.

"Although the aim of the electric power interest is to provide the farmer with electric light and power as rapidly as good business will permit, nevertheless there is a potential market of nearly six million homes not provided with the facilities for using modern electric sets.

"In the last eight years this office has tried out a great many types of battery operated radio receiving sets and I believe that if a three- or four-tube set capable of meeting the requirements which I have briefly sketched could be devised there would be a very good market for it."

GRID LEAK VS. BIAS DETECTION

(*Continued from page 352*)

with very small signals. The lower plate voltages give somewhat better small-signal sensitivity. The sensitivity of the c-324 bias detector is slightly less than the sensitivity of the c-327 grid-leak detector. Fig. 6 shows that the sensitivity of c-324 bias detector exceeds the sensitivity of the c-327 grid-leak detector when the effective amplification in the preceding radio-frequency stage is included.

In conclusion the writer wishes to thank D. F. Schmit for helpful comments and suggestions and to acknowledge the assistance of members of the Cunningham Laboratory.

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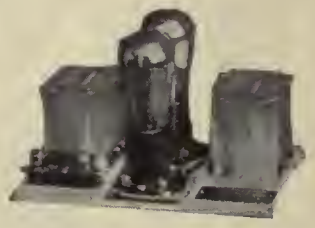


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AUTOMATIC VOLUME CONTROL

(*Continued from page 357*)

"free" end of the sensitivity potentiometer and ground is an equalizing arrangement which tends to keep the attenuation constant over the whole broadcast band. The ten-ohm resistor in series with the sensitivity potentiometer is to prevent the signal from being cut off entirely by this control.

To select a station with this receiver the operator depresses the "silent key" and rotates the "station selector knob." To make the approximate tuning adjustment he observes the selector dial, and after this he observes the needle of the "visual tuning meter" for the accurate tuning. The selector knob is moved slowly back and forth over a short distance until the maximum deflection of the meter pointer, in the direction of the arrow on the meter dial, is obtained. The silent key is now released and the signal is heard from the loud speaker. Now the manual volume control is adjusted, if necessary, to secure the proper room volume. When tuning from station to station the above procedure is also followed, but the manual volume control seldom will require resetting.

Mechanically this receiver is of similar construction to the Nos. 641 and 642 receivers. The pictures accompanying this article, Figs. 1, 2, 3, and 8, illustrate the construction of the chassis.

HAVE YOU PERSONALITY? —THEN SELL IT

(*Continued from page 325*)

genuine sincerity stands out as it never did before. We are in a hypocritical period, not because we like it, but because we haven't yet worked out of it and beyond it.

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  (b) Study them for style, approach, display, and learn from them something about how to have your own advertisements prepared.
  (c) If they seem to lack anything, write your opinions to the people who put them out and thus help to make them better.

(2) Treat your own advertising very seriously. It is your message to your own trade. If a true message it should win friends by its sincerity. If you are a good, honorable chap at heart, the most profitable thing for you is to have everybody feel that to be true. Most people are really that way. The biggest response there is the response to sincerity. If you are a successful fakir by nature, you won't come here for advice anyway and you won't take it when it is given.

Both merchandise and merchandisers can win on their merits, provided those merits include the very important one of *being able to present their case well.* This means for you the development of sales and advertising skill. Don't leave all your advertising work to the manufacturer. Get in to it up to your neck yourself.

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HOW many radio dealers are there who having tried to operate their own servicing department have given it up in disgust and "farmed out" the work to an outside service agency? Throughout the retail trade radio servicing has occasioned more grief and put more red figures in the ledger than any other branch of the radio business.

Yet it has been demonstrated time and again since the Weston Model 547 Radio Set Tester was brought to perfection and put on the market that radio servicing can easily be made one of the most profitable departments of radio retailing. With this set tester the service man's work is reduced to a certainty. No more is it necessary for the service man to waste time hunting for trouble. Model 547 gives him the answer instantly. The speed with which his work is accomplished reduces the cash loss occasioned by waste of time and enables him to do ten jobs in the same time it formerly took him to do four. Furthermore, his work is final.

Once the job is done there is no necessity for a return call and the customer is satisfied and becomes a friend of the organization which uses the Model 547 Weston Radio Set Tester as its "trouble shooter."

Weston Model 547 is provided with three instruments—all 3¼" diameter and furnished



with bakelite cases. Carrying case, movable cover, panel and fittings also are made of sturdy bakelite.

A. C. Voltmeter—750/150/16/8/4 volts. The three lower ranges are brought out to the Tester plug, and all five ranges are brought out to binding posts. 750 volt range is for testing secondaries of power transformers. 16 volt range is to provide for 15 volt A. C. tubes. Operations have been reduced—only one selector switch being necessary.

D. C. Voltmeter—High range increased to 750 volts. Other ranges—250/100/50/10/5—all six ranges brought out to binding posts and Tester plug.

D. C. Milliammeter—Double range—100/20 M. A. provides for lower readings with better scale characteristics.

Tests—On A. C. sets the heater voltage and plate current can be read throughout the test while the D. C. voltmeter may be indicating plate bias or cathode voltage.

Self-contained, double sensitivity continuity test provided. This can also be used for measuring resistance as well as testing for open circuits. Grid test can be made on A. C. or D. C. screen grid tubes—also the '27 tubes when used as a detector—without the use of adapters. Two sockets on the panel—UY tube adapters eliminated.

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Use 2-to-1 ratio input transformer	T-2922	12.00
Screen grid power detector "224" to any single power tube, use "Autoformer" for choke-resistance type of standard circuit	R-190	$5.00
Screen grid power detector "224" to any push-pull power tubes use R-190 Autoformer for parallel feed to detector plate and 2-to-1 coupling transformer	T-2922	$12.00

Speaker Couplings

Single "245" tube to dynamic speaker with built-in transformer, to cone speaker, or to magnetic speaker—Use either one or two transformers	T-2876 T-2901	$6.00 12.00
Use choke-condenser coupling, employing one choke	R-196	5.00
Single "245" tube to moving coil of dynamic speaker—Use transformer	T-2902	$12.00
Push-pull "245" tubes to dynamic speaker with built-in transformer, to cone speaker, or to magnetic speaker—Use coupling transformer	T-2880	$12.00
Use choke coupling, employing double choke	T-2420	8.00
Push-pull "245" tubes to moving coil of dynamic speaker—Use either one of two transformers	T-2629 T-2903	$10.00 12.00

Filament Supplies

For six "224" screen grid tubes or six "227" tubes—Use filament transformer (10.5 amps at 2.5 volts)	T-3660	$9.00
For two "224" tubes or two "227" tubes and one or two "226" tubes use double voltage transformer	T-3081	$9.00

Power Compacts

For filament current, plate current and bias on "245" push-pull power stage, also plate current for set. Contains filter chokes. Uses one 280 rectifier tube	R-245	$24.00
For filament current, plate current and grid bias on single "245" power tube and one "226" audio tube, also plate current for set. (Requires extra T-3081 filament transformer.) Contains filter chokes	R-480	$17.00

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ARE USED SETS LIKE USED CARS?

(*Continued from page 322*)

dealers in Omaha, Kansas City, St. Louis, Cincinnati, Milwaukee, Louisville, Chicago, Pittsburgh, Boston, and other large cities have found a way to slaughter the useless, decrepit old cars that, though worth no more than a ten dollar bill in the used car market, are continually reappearing as trade-ins on new sales. Furthermore, the coöperatively operated junk-yards are in many cases paying dividends out of the proceeds of the secondhand parts business they do; and, even in the one or two cases where the junk-yards are not yet paying their own way, the dealers who finance them consider the investment a wise insurance against the loss that the old cars might cause them if permitted to return into the used car market.

The used-set problem is just commencing to assume serious proportions in the radio trade. Those proportions, however, will become more serious as the years go on. And if the radio dealers, by adapting one of the proved successful automobile plans to their needs, or by devising a sound plan of their own, can avoid the experiments and costly mistakes that will come if they wait until the problem is beyond control, it seems that a little study of the accompanying table wouldn't be wasted effort.

THE RADIO DEALERS' ADVERTISING DOLLAR

(*Continued from page 333*)

Where newspaper and billboard advertising is used to blanket the territory, direct-mail advertising should be used for a concentrated drive on a list of preferred prospects.

Supplementary Advertising

The most effective forms of supplementary advertising in use by dealers are:

1. Catalog and Individual Folders. These can form a remarkably complete and effective supply of literature covering every possible requirement.
2. Store Signs. Large outdoor advertising signs, illuminated window displays, decalcomanias and other attention-compelling items for store fronts and interiors.
3. Lantern slides. These can well consist of an assortment of colorful slides illustrating receivers and loud speakers for advertising in any of the various ways slides are used.
4. Novelties, such as blotters, balloons, calendars, matches, fans, etc.

When the dealer is pressed by printing salesmen who wish him to use their direct-mail circulars, by newspaper advertising representatives who extol the merits of their medium, the combined experiences of the dealers covered by this survey should be of great help. The dealer's dollar must be effective.

PROFESSIONALLY SPEAKING

(*Continued from page 336*)

first station at 9:30 and so on, through the entire evening.

The call for remote-control apparatus has been felt in the "high-brow" service shops on Park Avenue. In July, one such service organization had orders for two sets of apparatus which would enable the radio set, installed in the servants' quarters, to be operated from any part of a large apartment. The cost of the apparatus could go as high as $2000 for each installation. At that time no apparatus was generally available, and the service engineer either had to design his own equipment—which would eat up his profits—or to delay on the sale until such apparatus was available.

Cabinet manufacturers may see some cause for worry in the advance of remote-control apparatus. They may reason that future sets will be installed in a closet, or in the basement, or somewhere else out of sight, and controlled by plugging a loud speaker and a push-button arrangement into outlets in each room in the house. The radio set may come to look like an electric meter, stuck up on the wall in some out-of-the-way place where it can be serviced easily.

At the present moment remote control is confined to expensive receivers, but at least one designer of this new radio apparatus is planning to sell two receivers next season, one with and one without such a control feature. The difference in price is said to be only $20.

Whether or not 1930 will be a remote-control year, it behooves radio engineers to brush up on their mechanics and strength of materials.

KEEPING SERVICE SOLD

(*Continued from page 329*)

but every effort is made quickly and cheerfully to remedy the thing about which he has complained, the importance to him of that short period of dissatisfaction becomes very greatly lessened and he soon forgets about it.

We have in operation a highly satisfactory plan to secure early complaints. When the report card of a job has been turned in and the information transferred to the permanent record, that card is placed in a numerical file under the date which is a week after the job was performed. Each day the cards under that date are removed and each customer is telephoned to find out whether the radio is operating satisfactorily. If the customer is not satisfied, a man is immediately sent back without further charge to remedy the difficulty. If there is no one at home when we telephone, we send a special return postcard which expresses to the customer our desire to know whether he is entirely satisfied with our service. The card has provision on the return portion for him to signify, merely by making a cross mark in a square, whether he is pleased, barely satisfied, or dissatisfied, and in the latter case just what day and time he would like to have a man call to take care of the complaint. The result of the telephone call, or the postcard, is that the number of dissatisfied customers is reduced to a low figure and a large reduction is made in the *loss* of customers who were dissatisfied and who, instead of complaining, went elsewhere for service. Incidentally, but of great importance, the percentage of bad debts is lowered concurrently with lowering of the percentage of dissatisfied or only quasi-satisfied customers.

Another small thing we do to try to make the customer realize that he is dealing with an established dependable concern and to make him feel that we are really interested in him is a form letter which goes out to each new customer the day after the first service has been completed. It welcomes him to the ranks of those who use our service, implies a solid background of many years in business, outlines our policy of maintenance of list prices, explaining that good service cannot be given at cut prices, and encloses a convenient sized card containing our prices, telephone number, and address. While the letter is multigraphed and the signature a cut, it is a very carefully done job and the fill-in is done so that it almost exactly matches the multigraphing.

HOW ONE DEALER-MERCHANDISING SERVICE WORKS

(*Continued from page 327*)

Another unit consists of "follow-up" or "thank-you" cards, designed to be mailed to the customer within a short period after a sale. Contained in each of the cards is question, "How do you like your radio receiver?" Request is made for the names of two people who "would like to hear a Kolster receiver in their home." The service is completed with a wide assortment of copy and layout for newspaper tie-up advertising. Some of the newspaper copy suggestions feature the dealer's store and subordinate the manufacturer.

Mr. Breck, in commenting on the "thank-you" cards, says that on an average so far dealers are receiving approximately forty per cent. return on the cards mailed. Forty per cent. of, let us say, two hundred cards mailed, would mean the dealer received eighty, and providing each contained two names, the prospect file would be richer by a total of 160 names. In this manner the dealer who subscribes to the whole service will always have a large prospect file and a good card system to keep it readily operative.

The total cost of the complete Kolster service to the dealer is $59.50. While this cost actually covers only half of what it requires to prepare the entire service, Mr. Breck says, "by paying for it, the dealer cannot escape an active appreciation of the service. If the dealer himself were to undertake a sales plan as comprehensive as this on his own initiative it would probably cost considerably more than double."

FEATURES THAT SELL RADIO

(*Continued from page 319*)

indicator. Exact tuning of the set to the carrier of the station is possible—and it is only when a set is accurately tuned that the best possible fidelity is obtained.

Remote Tuning Controls: With remote control one can tune the set from a box located at some distance from the receiver. Several controls may be wired so that the tuning and volume can be controlled from various rooms. Pressing the proper button on the control box automatically tunes the set to the desired station. Pressing the button closes an electric circuit which causes a small motor in the receiver to revolve the tuning condensers to the correct point to receive the station. Generally a maximum of eight stations can be tuned-in in this manner. We can now sit in an armchair with the control box alongside and tune from one station to another without even taking our feet off the footrest! Like the burlesque show, it's a good device for that tired business man.

Other Features: Reduced hum from the loud speaker is an improvement apparent in many of the new sets. It is made possible by more carefully engineered circuits and by the use of single-stage audio amplifiers. Few features of the new receivers will have more appeal to a prospective customer than the lack of hum—which many have come to associate as a necessary evil of a.c. receivers. To many other prospects the various new types of tuning dials will have a very definite appeal. Many new receivers use a "tone control" with which it is possible for the user to vary the relative prominence of the high or low frequencies to suit his individual taste. From a modern well-designed receiver a purchaser may expect a fidelity of reproduction and general performance that leaves little to be desired.

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Prepared by Official Examining Officer

The author, **G. E. STERLING,** is Radio Inspector and Examining Officer, Radio Division, U. S. Dept. of Commerce. The book has been edited in detail by **ROBERT S. KRUSE,** for five years Technical Editor of QST, the Magazine of the American Radio Relay League. Many other experts assisted them.

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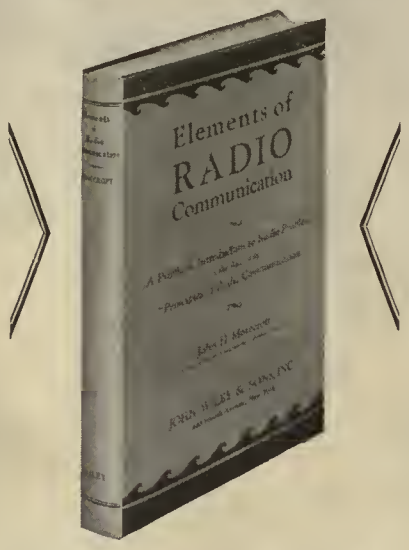
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