

RADIO BROADCAST

MARCH, 1927

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AMONG OTHER THINGS. . .

SINCE all of our readers are not privileged to tour through Doctor Alexanderson's fascinating laboratory at Schenectady, the next best thing is to read of what one may see there. Edgar Felix's leading article gives one a very good idea of just what has been done at Schenectady. When a paper was presented at the Institute of Radio Engineers convention in January, there was some bitter discussion, all centering around the fact that the developments chronicled were not new. Into that discussion we have no desire to enter, for the important fact seems to us that a workable system has been presented which may lead to various practical applications in the immediate future.

MORE information about the popular R. B. "Lab." circuit is published on page 467 and an article in April will furnish additional experimental details of this circuit which offers so much of interest to the home constructor. In the "Listeners' Point of View," some of the first results of the readers' questionnaire are detailed. They cast an interesting light on the feeling of radio listeners about radio programs. After reading more than 500 of these replies, we believe that every soprano would be wise to make immediate plans for leaving the country. Our April and May numbers will contain more material from these answers.

THE many users of current-supply devices and the many more who are prospective purchasers will find the article beginning on page 477 of great interest. Our discussion of these devices should also prove of distinct aid to the radio dealer. Our remarks, while somewhat frank, are aimed to help the user and prospective purchaser and should only be interpreted for what they are, a collection of data which should make current-supply devices more satisfactory in actual use. Those who have been waiting for constructional data on the new Grimes R. G. S. receiver will find the long-awaited article on page 480.

THROUGH an omission which we greatly regret, a credit line was omitted from the frontispiece in our February issue. The photograph and the information were kindly supplied by the Westinghouse Electric & Manufacturing Company, some of whose products are used in the installation in the lighthouse mentioned.

PRINTERS' INK for January 13th shows that RADIO BROADCAST printed in its January number a total of 24,205 lines of advertising, being exceeded in this field only by Radio News.

THE April RADIO BROADCAST will contain an especially interesting article on the R. B. "Lab." circuit, of particular importance to those who have already constructed the two- or four-tube models. There will be another Radio Club of America paper, dealing with loud speakers, another of James Millen's excellent articles on the use and home construction of current-supply devices, and all the usual departments, including a more complete listing of manufacturers' booklets. Ross Gunn of Yale University has submitted an unusually interesting article on coils and coil design, scheduled for April, which is well worth waiting for.

—WILLIS K. WING.

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SEEING
M O R E
THAN THE
MICROSCOPE

Electrons, which are very important in radio, are too small for any microscope to make visible. Yet our eyes can watch their paths—study their habits.

In the laboratories where Radiotrons are studied there are instruments which make all these things possible—and more. Knowing how many electrons leap across from the filament to the plate of a vacuum tube is in its way as abstruse a study as the measurement of distant stars by astronomers. Yet this abstruse research has a definite application in the RCA Radiotron in your radio set. That is why the laboratories back of RCA spend millions in scientific research that is far too much like "pure science" for an ordinary manufacturer.

Radiotrons are improved and new ones are developed, to make radio better. Because this research shows in results, Radiotron users keep five great factories busy!

Watch your tubes, always, for the RCA mark. You will find it on Radiotrons for every purpose.



clear up the
tone

Do you get a blast when you turn the volume up a bit? Do you get sweet, clear tone at low volume, but noise when it's louder? The trouble's probably right in one tube—the tube in the last audio stage. The Radiotron laboratories discovered that no ordinary tube can let big volume through clearly. Change one tube to an RCA power Radiotron. *Then* turn up the volume . . . and it comes through *clear!*

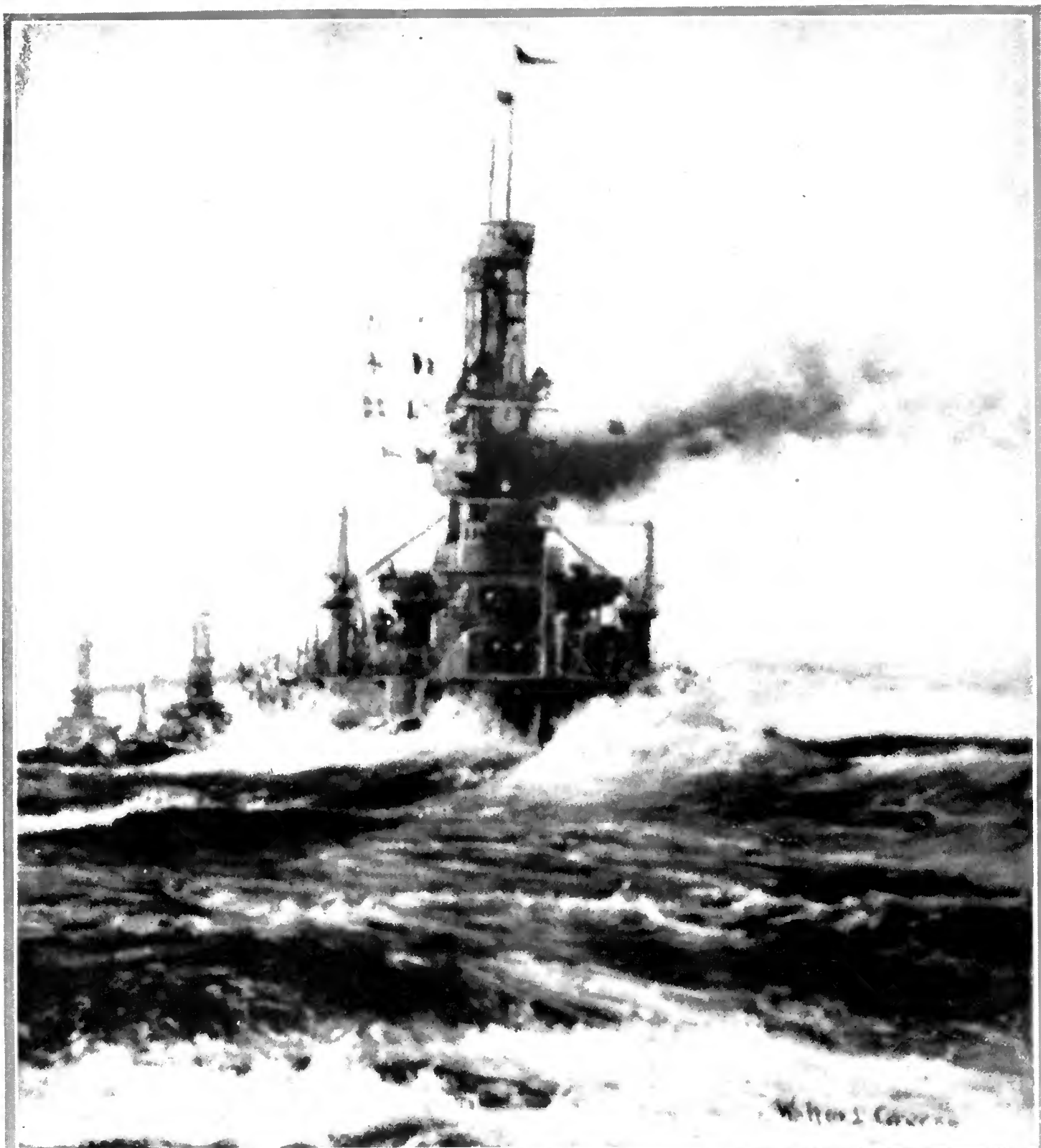
Bring your storage battery set up-to-date with
a power RADIOTRON UX-171 or UX-112
a detector RADIOTRON UX-200-A
and RADIOTRONS UX-201-A for all-round quality.

Bring your dry battery set up-to-date with
a power RADIOTRON UX-120
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RADIO CORPORATION OF AMERICA - NEW YORK - CHICAGO - SAN FRANCISCO

RCA  **Radiotron**

MADE BY THE MAKERS OF THE RADIOLA



A PHOTOGRAPH SENT BY THE ALEXANDERSON METHOD

The system of photograph transmission employed by Dr. E. F. W. Alexanderson is successful in attaining very excellent quality, as this reproduction of a painting by Walter L. Greene shows. The subject was transmitted at the rate of sixteen square inches per minute

RADIO BROADCAST

VOLUME X



NUMBER 5

MARCH, 1927

Television: Europe or America First?

An Account of the Experiments of E. F. W. Alexanderson in the Field of Television and Radio Photography—How the Present System of Radio Photography Has to Be Speeded Up Two Thousand Times to Attain Television

By EDGAR H. FELIX

CONFIDENT predictions of the coming of television have been made so frequently during the last year that even proverbial pessimists must by this time be convinced that we will soon be able to see as well as hear by radio. Research in this field has attracted scientists and experimenters in almost every corner of the world, and numerous systems for the transmission of still photographs are in successful operation.

More, perhaps, has been written about the experiments of European engineers in this branch of science than of Americans. One must not presume, on this account, that America lags behind. There is every reason to suppose that experiments conducted here are as fully advanced as are those of fellow experimenters abroad, and we may, as the era of radio vision fast approaches, be the spectators at a thrilling international neck to neck struggle for priority, the outcome of which will result in the perfection of an economically practicable system of television.

An attempt to predict just how much water will flow under the bridges before the millennium would be futile. There are still many difficulties to be overcome, but, so rapidly has the art progressed to its present high standing, that one cannot doubt but that it will not be many years hence before we shall be able to see as well as talk with our friends in London and Paris as we sit in our homes in America.

Of the several systems of television now being developed abroad, probably the most advanced is that of John L. Baird, a Scotchman. A British company has already been formed to exploit his system of television

in England, and plans have been formulated for the marketing there of a combined Telesvisor, radio receiver, and loud speaker in a cabinet only 24 x 20 x 18 inches, which is to sell for the equivalent of about \$250.

A story in the December, 1926, *RADIO BROADCAST*, explained very fully the Baird system of television, and it will not be further described here.

The obstacles which the amateur experimenter finds in the path of his participation in radio photographic research to-day are the highly complex apparatus required—still far beyond the skill and patience of an average experimenter to build and to manipulate—and the necessity for an in-

vestment in equipment which places radio photography out of reach of the casual experimenter. These factors are not insurmountable in the commercial development of picture transmission and, as a consequence, we have several radio and wire news picture channels offering transatlantic or national service.

International radio communication itself was once in this stage. Such communication between the United States and foreign countries was made possible by means of huge, high-power transmitters, involving investments of hundreds of thousands of dollars. Then came short-wave vacuum-tube transmission which brought amateurs in all parts of the world in touch with each other, utilizing transmitting equipment costing less than the average broadcasting receiver. A simplification of equal significance is in prospect for picture transmission.

In the hope of learning how far from the reach of the serious amateur experimenter radio photography lies, the author visited the laboratories of several scientists. In Washington, the Jenkins equipment was seen; in New York, the Bell System's apparatus was viewed; and, in Schenectady, the Alexanderson device was demonstrated to the writer. At each of these laboratories, highly developed apparatus could be seen in action—apparatus capable of excellent photographic reproduction over wires or by radio. Jenkins' work has often been described, in these columns and elsewhere; the Bell System's equipment is too complex and too expensive for consideration as an amateur pastime; last but not least, is Alexanderson's system, which the writer was privileged to examine



A RADIOED PICTURE

This photograph of Norma Talmadge is a good example of the wealth of detail which can be transmitted by the Alexanderson system of radio photograph transmission

recently and, for an entire day, to question its inventor as to its functioning.

Dr. E. F. W. Alexanderson, the well-known General Electric research engineer, has concentrated on the problem of picture transmission during the last few months with a view to developing simple apparatus within reach of large numbers, rather than looking toward a revolution of method. Alexanderson's extraordinary record in the radio field is characterized by his ability to get down to simple basic principles. He was the first to apply the vacuum tube to tuned radio-frequency amplification; the first to use it for transmission of radio telephony; the first to develop a practical source of high-frequency energy for radio telegraphy and telephony; and the first to analyze the polarization of short waves.

His recent announcement of his work with radio photography and television came only after a long period of experiment. While chief engineer of the Radio Corporation of America, his attention was focused on the problem by a speech of Owen D. Young, forecasting the transmission of the entire page of a newspaper by radio photography rather than the laborious word by word system. As a result of this remark, Alexanderson concentrated his attention on the subject, and it was he who afterward took steps to organize the development of the transoceanic photo-radio service which has since become known through the work of Captain R. H. Ranger.

During the last few months, Doctor Alexanderson has concerned himself with simplification and improvement of the apparatus, and the discovery of newer, simpler, and more rapid instruments of transmission and reception. Some of the photographs reproduced on these pages are samples of the success which has already attended his efforts. It has required twenty minutes heretofore to transmit a good 4 x 5-inch photograph, but those shown herewith were transmitted at the rate of sixteen square inches a minute. The reproducing apparatus used in making these photographs comprises a standard General Electric oscillograph with some adaptations for controlling a beam of light according to the intensity of the received radio signal. This light is flashed upon a revolving cylinder which is synchronized with the transmitting equipment. On the revolving cylinder is a sensitive photographic paper which makes a print according to the intensity of the light flashed upon it.

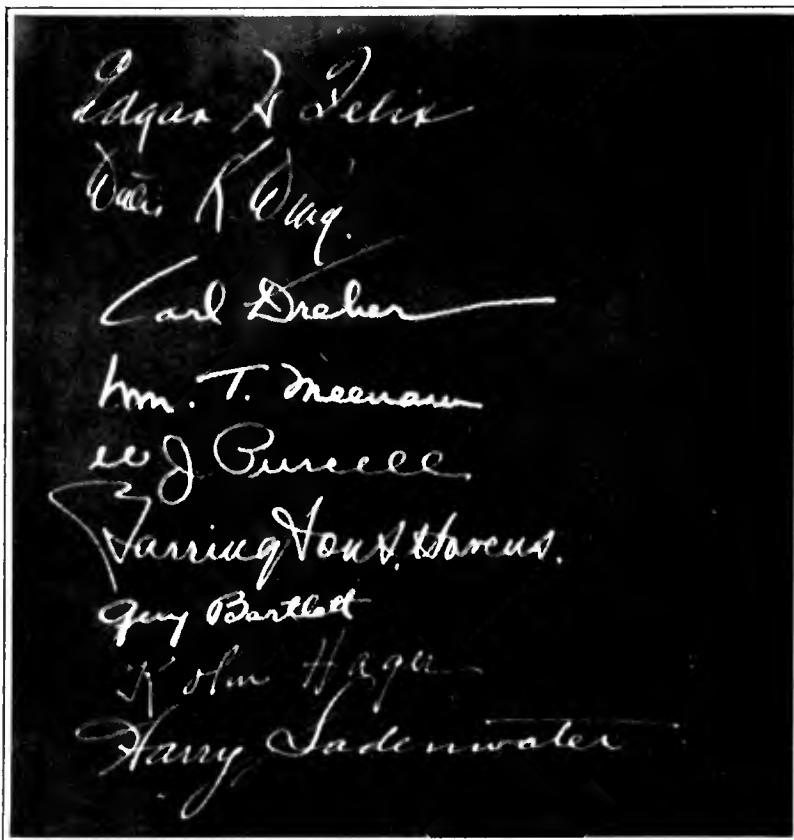
The design of the receiving apparatus is relatively simple. A synchronous motor, which may be powered from the sixty-cycle power line, revolves a cylinder of a certain diameter which moves, at the same time, from side to side along a threaded shaft. The rotating and side to side motion thus permits a single beam of light, fixed in direction, to cover systematically the entire surface of the paper upon which the print is to be made. This light-sensitive paper is, of course affixed to the revolving drum. The intensity of the beam of light is controlled by a shutter actuated by a received radio signal. An expensive laboratory oscillograph is not essential; a cruder device, consisting essentially of a telephone receiver

entailing the making of photographic prints. Motion pictures are a form of recording and reproducing motion but, instead of the medium of a film for the purpose, television uses an electric system capable of transmission over long distances. Television has the same relation to radio photography as motion pictures have to still prints.

Transmitting a good 4 x 5-inch still picture in a little more than a minute may seem like a long step toward the attainment of television. With true television, however, sixteen complete pictures must be transmitted a second in order to give the eye the impression of continuous motion. That means speeding up the process very considerably. Doubling the speed of almost any mechanical or electrical system is task enough for any engineer, but to step up a delicate and accurate process almost two thousand times is a problem of tremendous magnitude. Even the feat of tenfolding the earlier speed of transmission, which Doctor Alexanderson has already accomplished, is a remarkable tribute to what may be achieved by ingenious mechanical and electrical refinement. Clearly something radical is necessary to make the system work the two thousand times faster necessary for television. It is recognition of this fact which has led many experimenters in radio photography to await a new and radical invention before pronouncing television as a forthcoming certainty.

Alexanderson works on the theory of using what science has already made available rather than waiting for revolutionary means and methods which may never come. He does not believe in speeding a machine far beyond its normal capacity, for that makes neither for safety nor reliability. Instead, it is char-

acteristic of his research methods to find ways and means of dividing the work involved by new and ingenious methods so that it falls within the capabilities of existing systems. The Alexanderson system of transoceanic telegraphy, for example, was invented on that principle. In order to get the required signal strength, he divided up the antenna in a multiplicity of units with the result that the local losses in the ground were reduced to one-tenth. Thus the high-power telegraph stations of the Radio Corporation, using the Alexanderson 200-kw. alternator, are giving a signal strength that with older methods would have required 2000 kw.



ONE OF THE ADVANTAGES OF THE PHOTORADIO SYSTEM

Is its accuracy in the transmission of signatures, as is shown in this example. Reading from top to bottom, the signatures shown in this photograph are of: Edgar H. Felix, the author of this article; Willis K. Wing, editor of RADIO BROADCAST; Carl Dreher, chief engineer of wjz; W. T. Meenam, W. J. Purcell, Barrington S. Havens, and Guy Bartlett, of the General Electric Company; Kolin Hager, chief announcer of wgy; and Harry Sadenwater, chief engineer of the General Electric Company's broadcasting stations, WGY, KOA, and KGO

and simple shutter will serve the experimenter. With apparatus reduced to these simple terms, the amateur experimenter has not long to wait for his embarkation in this new branch of the radio hobby.

ALEXANDERSON'S TELEVISION EXPERIMENTS

THE development of this simplified reproducing equipment is only preliminary to the problem which is engaging Dr. Alexanderson's attention. Instead of producing a photographic print in two minutes, Dr. Alexanderson is seeking to solve the problem of television. Television enables the observer to see what is taking place at the point of transmission without

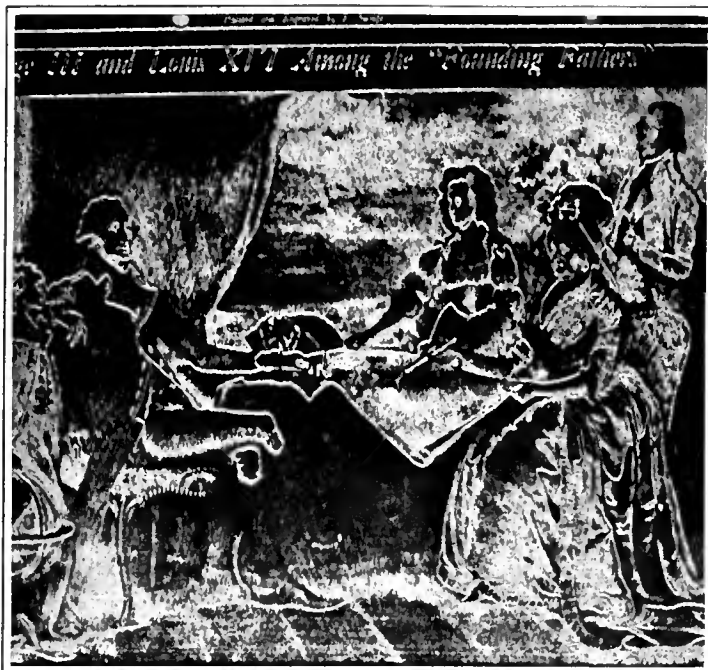
THE REQUIREMENTS FOR
TELEVISION

THE essentials in television are light waves which control the current output of photo-electric cells, according to the intensity of the waves submitted to them; vacuum tube amplifiers, which increase these fluctuating currents to a magnitude sufficient to modulate a high-frequency carrier wave; high-frequency radio waves, for transmitting the light-wave modulated signal through space to receiving systems; and amplifiers and selectors that control a local source of light which in its turn is passed and deflected by regulated mirrors so as to cover the surface of a projection screen sixteen times a second. Here we have, in one paragraph, enumerated the essential elements of a television transmitter and receiver, every one of which must be adapted, electrically and mechanically, to work accurately at very high frequencies.

The minimum requirement for the production of a clearly intelligible and enjoyable moving photograph is the undistorted projection of 300,000 light images per second, each of a correct intensity and properly placed in relation to all the others. No small task. Three-hundred thousand light beams, each of the correct intensity and correctly placed, flashed successively upon the screen!

The transmission of music is possible because of the physiological and psychological ease with which sound impulses are sensed. An eighty-piece symphony orchestra, playing many different notes a second, each with its fundamentals and numerous harmonics in correct balance, blends into a single, though highly complex, sound wave, consisting of variations of air pressure, involving frequencies no higher than ten or fifteen thousand per second. Such sound impulses are not appreciably distorted by the elimination of all those outside the essential frequency range, lying between 100 and 6000. The contributions of all the separate instruments of the orchestra are scrambled into a single air wave and the ear, fed a reproduced duplicate of this air wave, is so trained that it is able to unscramble the work of each instrument and to be conscious of them individually and collectively.

Our receiving apparatus for light waves is somewhat more complex. The eye responds simultaneously to separate impulses from millions of different directions. Look through a tiny pin hole, restricting your vision to one point, and, if it is small enough to actually give you one point in the distance, you will be conscious of only two factors of sight, intensity and color. Eliminating color, the eye, focused on a single point, sees only the degree of light and

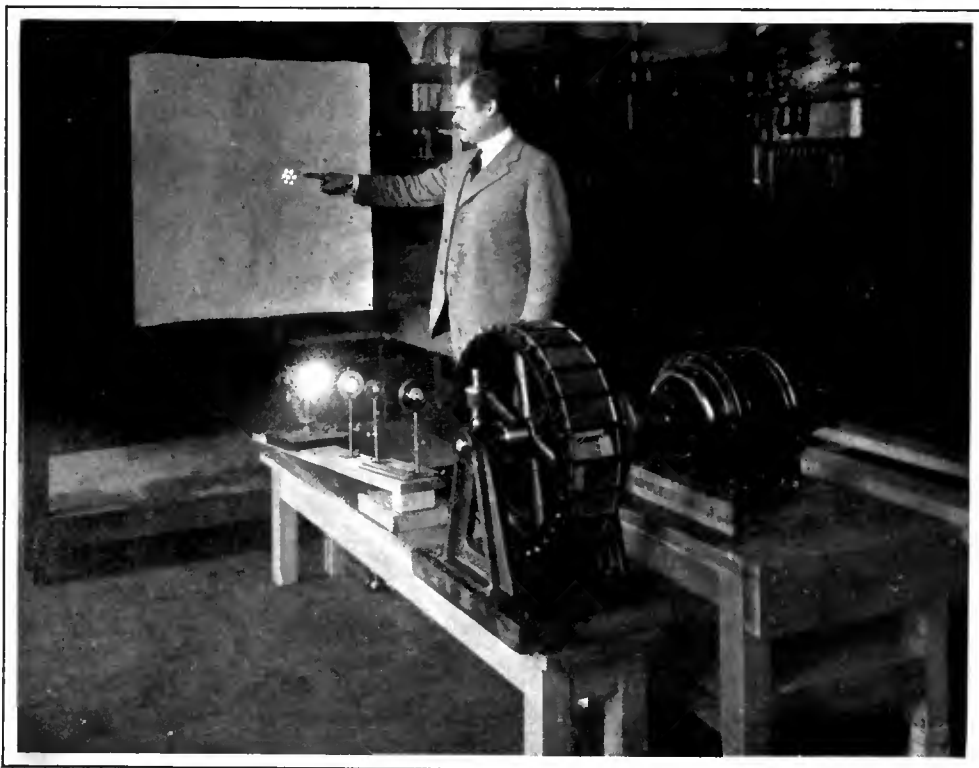


ONE OF THE FAILURES OF RADIO PHOTOGRAPHY

The distortion in this picture, which was transmitted by the Alexanderson system, could have been remedied by proper adjustment of the receiving equipment. This is a good way of visualizing the distortion which is often audibly apparent in an ordinary radio receiver

darkness. Distance, size, and relative position of an object is gained only when the eye sees many different points. Consciousness of length, width, height, spacing, and direction is attained only by response to millions of light rays, reflected from literally millions of points within range of vision. There is no simple blending of light waves into one, as we have with sound waves.

vision apparatus. If he used a little shutter which regulated the intensity of the beam and flexed his wrist rapidly enough to cover an appreciable area of the blackboard, he would perform the mechanical part of the work which is the weak link in the television chain. But there is no wrist, mechanical or physical, sufficiently flexible to direct a single point of light, varying in intensity



TELEVISION PROJECTOR APPARATUS

Doctor Alexanderson is here shown demonstrating the apparatus with which he hopes to be able to transmit moving pictures by radio. The large drum in the left foreground has twenty-four mirrors on its periphery, and, when not revolving, reflects, as shown in this picture, the cluster of seven lights. When revolving at high speed, the whole screen appears to be completely covered with brilliant light

In television, by reflecting a beam of light from the surface of a photograph to a sensitive photo-electric cell, we may convert into an electric current an expression of the intensity of light or darkness of a single point on the photograph. By moving our point of observation, the reflected light beam, up and down and across our picture until its entire area is covered, we transmit our picture by means of the reflected light of varying intensity. This process, speeded up and maintained, would give us television. The light waves, photo-electric cells, radio transmission apparatus, and the very short-wave radio carrier is capable of absorbing and transmitting accurately a sufficient number of impressions to give us television. But the mechanical part of the system is hopelessly inadequate.

The small boy who flashes the sun's rays by his mirror on the schoolroom blackboard simulates the mechanical part of our tele-

according to a pre-arranged succession, so as to make a continuous orderly picture consisting of 300,000 separated or blended light impressions.

In the words of Doctor Alexanderson:

"When we embark on such an ambitious program as television, it behooves us to reason out, as far as it is possible, whether the results we expect to get are going to be worth while even if our most sanguine hopes are fulfilled. We are dealing with the photo-electric cell, the amplifier, the antenna, and the radio wave. The photo-electric cell and the amplifier employ the medium of the electron which is extremely fast, but the use of the radio wave itself imposes certain speed limitations on account of the limited scale of available wavelengths. The question therefore remains what quality of reproduction may we ultimately expect in a television system if we succeed to take full advantage of the ultimate working speed of the radio wave? An experimental study of the problem, and the conclusions, may be illustrated by the comparison, of some pictures made at different speeds.

"The three pictures (shown on this page) were made with the selective shade process under conditions similar in character to that of one of our long-wave transatlantic transmitting stations, with a wavelength of 12,000 meters, or a wave frequency of 25,000 cycles. The picture to the left is the result we get if the time of transmission is two minutes. For the middle picture, the transmission time is four minutes and, for the picture to the right, eight minutes. Everything else in the three cases is identical. Relatively these pictures represent the effect of sluggishness of the tuned antenna upon the sharpness in the reproductions. The two-minute picture is not as sharp as the eight-minute picture.

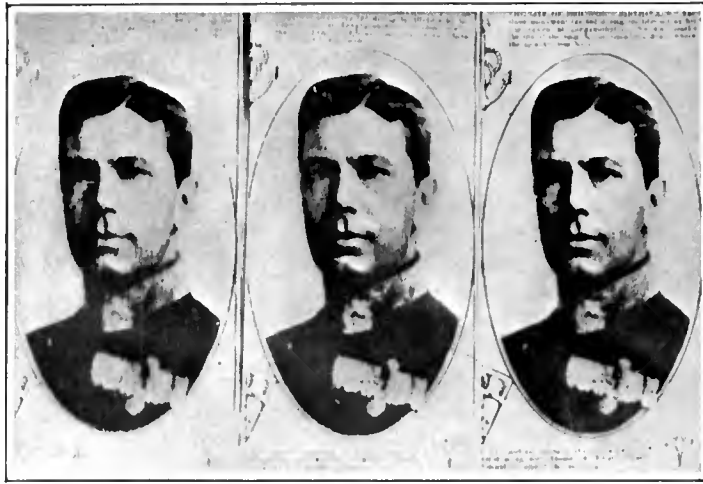
"By using a wavelength of twelve meters instead of 12,000 meters (a wave frequency of 25,000,000 cycles instead of 25,000 cycles), the sluggishness can be reduced. If now, the photo-electric cell and the amplifier and the light control can keep up with this pace, the radio wave will do its part and transmit a picture in 1-1000th part of two minutes, *i. e.*, in one-eighth of a second. We are thus able to predict that it will be possible to transmit a good picture in a space of time which is of the order of magnitude of the time required for moving picture operation, the exact figure being one-sixteenth of a second."

THE MODEL PROJECTOR

IN DOCTOR Alexanderson's laboratory, there is a model of a television projector, consisting of a source of light, a lens, and a drum carrying a number of mirrors. When the drum is stationary, a spot of light, reflected from one of the mirrors, is focused on a spot on the picture to be transmitted. This spot of light is the brush that paints the picture. When the drum revolves, the spot of light passes across the picture, as a new mirror, which is set at a slightly different angle, comes into line to reflect the

beam. Thus the light spot passes over the picture until the whole is covered. If we expect to paint a light picture of fair quality, the least we can be satisfied with is ten thousand separate strokes of the brush. This means that the spot of light should pass over the picture to be transmitted in one hundred parallel paths and that it should be capable of making one hundred separate impressions of light and darkness in each path. If we now repeat this process of painting the picture over and over again sixteen times in a second to obtain satisfactory television, it means that we require 160,000 independent strokes of the brush of light in one second! To work at such a speed seems at first inconceivable; moreover, a really good picture requires that the speed be raised to something like 300,000 picture units per second. Doctor Alexanderson says:

"Besides having the theoretical possibility of employing waves capable of high speed signalling, we must have a light of such



SUCCESSFUL TRANSMISSION ON LONG WAVES

It is not so rapid as on the short ones, as far as radio photograph transmission is concerned, due to a lag element which creeps in. These pictures were transmitted with 12,000-meter (25,000-kc.) apparatus. That on the left was sent in two minutes; that in the center, in four minutes; and that on the right, in eight minutes

brilliance that it will illuminate the screen effectively, although it stays in one spot only one three-hundred thousandths of a second. This is one of the serious difficulties because, even if we take the most brilliant arc light we know of, and no matter how we design the optical system, we cannot obtain sufficient brilliancy to illuminate a large screen with a single spot of light. The model television projector was built in order to study this problem and to demonstrate the practicability of a new system which promises to give a solution to this difficulty. The result of this study is briefly that, if we employ seven spots of light instead of one, we will get 49 times as much useful illumination. Off hand, it is not so easy to see why we gain in light by the square of the number of light spots used, but this can be explained with reference to the model. The drum has twenty-four mirrors and, in one revolution of the drum, one light spot passes over the picture twenty-four times, once for each mirror; and when we use seven sources of light and seven light spots we have a total of 168 light spot passages over the screen during one revolution of the drum.

"The gain in using seven beams of light in multiple is twofold. In the first place, we get the direct increase of illumination of 7 to 1, but we have the further advantage that the speed at which each light beam must travel on the screen has been reduced at a rate of 7 to 1, because each light spot has only 24 tracks to cover instead of 170. While the light itself may travel at any conceivable speed, there are limitations of the speed at which we can operate a mirror drum or any other optical device, and the drum with 24 mirrors has already been designed for the maximum permissible speed. A higher speed of the light spot can therefore be attained only by making the mirrors correspondingly smaller, and a mirror one-seventh as large will reflect only one-seventh as much light. The brilliancy of the light spot would therefore be only one-seventh of what we realize by the multiple beam system, which gives seven light spots seven times as bright, or 49 times as much total light.

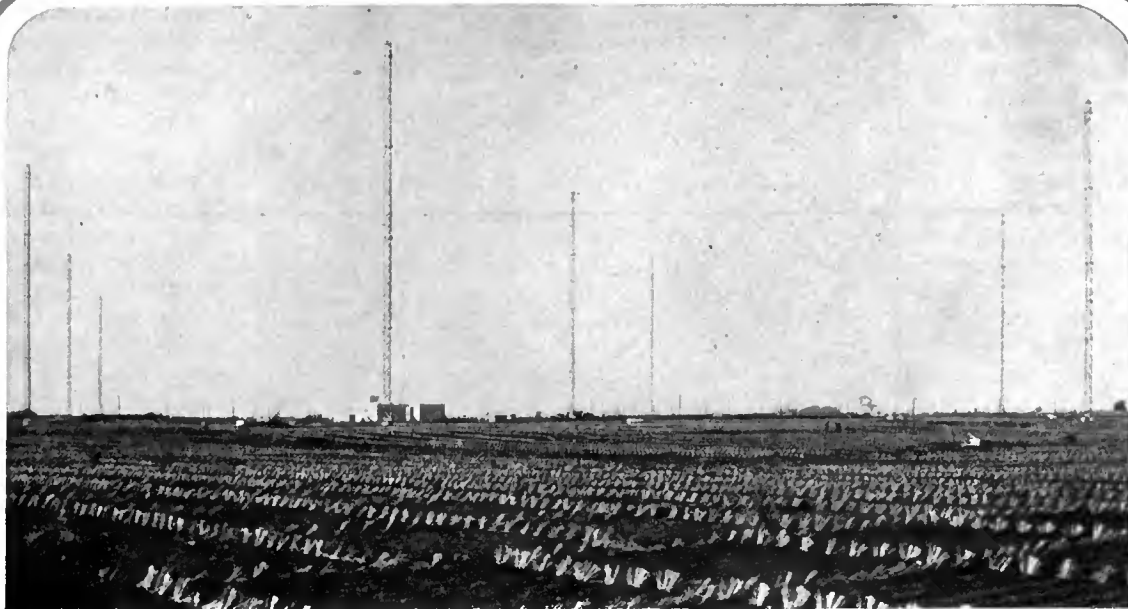
"There is another advantage in the use of the multiple light beam. Each light beam needs to move only one seventh as fast and therefore needs to give only about 43,000 instead of 300,000 independent impressions per second. A modulation speed of 43,000 per second is high with our present radio practice, but yet within reason, being only ten times as high as we use in broadcasting."

There is ample promise in the fruition of Doctor Alexanderson's work. By the use of seven television carrier waves, spaced 100 kilocycles, available, for example, by using the band between 20 and 21 meters (15,000 and 14,284 kc.), and an improvement of existing equipment, television is entirely within reason. How long this process of refinement will require, Doctor Alexanderson is unwilling to predict, but it seems to be in prospect within a relatively short period.

SIMPLE SYSTEM BEING DEVELOPED

ANOTHER line of experiment being carried out by Doctor Alexanderson, dependent not upon accurate modulation and demodulation, is a simple system of radio photography (not television) which promises to bring it soon within reach of amateur experimenters. The system is not subject to the vagaries of fading. It does not depend on accurate modulation as do the transmission of music and full tone radio photography, but upon interruption, as does code radio telegraphy.

The amateur radio photographer—and there will soon be many of his kind—will obtain a permanent proof of the reception every time he uses his photo-receiver. Unlike the broadcast fan, he cannot say that he heard with perfect clarity and comfortable volume a distant station, if he did not do so. The radio photograph gives unmistakable evidence of reception and of the distortion-free operation of the receiver.



THE MARCH OF RADIO

News and Interpretation of Current Radio Events

Radio Regulation in the Great Game of Politics

TWENTY million broadcast listeners are being auctioned in the game of politics. If their fate has not been determined by the time this appears in print, radio might as well be written into the bad debts column of this year's entertainment budget. To the radio industry, Congressional failure to provide sorely needed legislation would be little less than a catastrophe, though, fortunately, one from which eventual recovery is not impossible.

The 1926 season might well have been radio's best and biggest year. Reception conditions have been extraordinarily good; without wavelength tangles, nationwide listening, even during fairly early evening hours, would have been within the capabilities of almost any good five-tube receiver. Instead of rising to new levels, Christmas sales were below normal. The year's loss of sales, resulting from chaotic broadcasting conditions, is not less than \$175,000,000. This estimated sales loss is based on the assumption that the number of sets sold this season would have been ten per cent. larger than last year, had there been no wavelength troubles. Owing to higher average *sale price and profit per set* and a

reduced number of large producers, most radio set makers, however, are in a stronger position than last year and gross sales figures for the industry will probably equal last year's total. The *number* of sets sold this year is probably twenty per cent. smaller than last year.

The public's apathy to the depreciation of radio entertainment should teach the industry a cruel lesson. Radio, instead of being the most important interest in the life of the broadcast enthusiast, second only to affairs of the heart and to the means of gaining food and shelter, is now apt to be easily displaced and forgotten. If radio reception is not good, the listener now takes to his motor car or to the movies, while the radio industry bites its nails impotently. Those professionally interested in radio have, of course, been much aroused, but the resulting action has been largely confined to optimistic public statements about how good business is or to the general effect that radio reception is not bad. No industry, shivering from a vital blow, has ever demonstrated less ability and less initiative in arousing public support.

On the other hand, radio has held too firm a place in the public estimation to suffer long from its present ills. Regulation is bound to come sooner or later, unless the moguls of radio are willing to go back to

hemstitching, running errands, and repairing bicycles. Telephotography as a hobby for the home constructor looms imminent, offering him the trials of experiment and the thrills of true achievement. Radio showmanship improves steadily and quality of reception attainable with modern receivers rises to new heights. The one real cloud on radio's horizon is the overcrowded ether, which can be dispelled only by real leadership on the part of the industry. Had public opinion been aroused by such leadership, radio legislation would not now be settled entirely on political considerations.

Let no one be fooled by the political buncombe emanating from Washington about the "defense of the people against monopoly and autocracy." The real issue is that the White Bill is the Administration measure, supporting the successful handling of broadcasting problems by the Secretary of Commerce and proposing to continue it with the aid of an advisory committee, while the Dill Bill is the opposition measure, designed to detract from power of the Secretary of Commerce and to take from him credit for the regulation of radio. To smooth the way for the Dill Bill, its regulating commission provides attractive and comfortable feather beds for political casualties.

The radio industry's Coördinating Com-

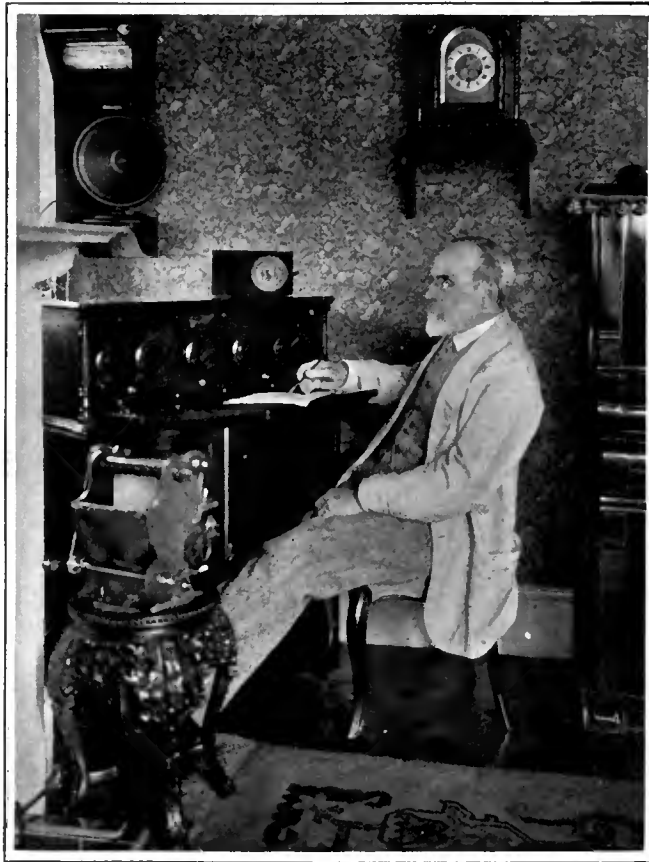
The photograph forming the heading above shows a wireless station among the Japan rice fields. The station is at Keniskawa, eight miles from Tokio.

mittee, lacking the support of broadcast listeners, has done the best possible job it could under the circumstances. To save the industry from a crisis, it undertook to support any legislation which had a chance of being passed, whether it was the best possible law or not. It played the political game astutely and the unfortunate and unavoidable result is that the political game is made a permanent pastime for the radio industry. The members of the Committee could not well afford to antagonize the politicians before whom they must later appear for their private interests.

The Conference Committee's temporizing attitude is well shown by an excerpt from their report to the Congressional Conference Committee:

This Committee is aware of the many interpretations of the effect of the two forms of radio control provided in the Senate and House Bills. It is also aware of the wide difference in the terms of these two forms and the consequent differences of opinion on this subject. From the point of view of legislative expediencies, the Committee would prefer not to pass upon this subject, or make a statement in favor of one of them, but feels obliged in this important matter to express an opinion solely on its idea of the good of the industry and the radio listener.

The Committee urges that, in the discussion of this matter and in the final decision, whether it is a compromise or not, the imperative need of immediate legislation compels the acceptance of some principle of control, if failure to agree will prolong and increase the difficulty of legislation. It is true that any form of control might be made effective, at least until



AN ENGLISH RADIO ENTHUSIAST

William Calvert Bramwell of Dingley Dell, Teddington, England, who is said to be one of the oldest radio listeners in England. He is 82. During the 1926 international radio broadcast tests, Mr. Bramwell slept all afternoon in order that he might listen for American stations from one to six A. M. English time

corrective measures can be taken, if experience proves the necessity for a change.

Included among the Committee's nine members are representatives of two wavelength jumpers, an interest which considers

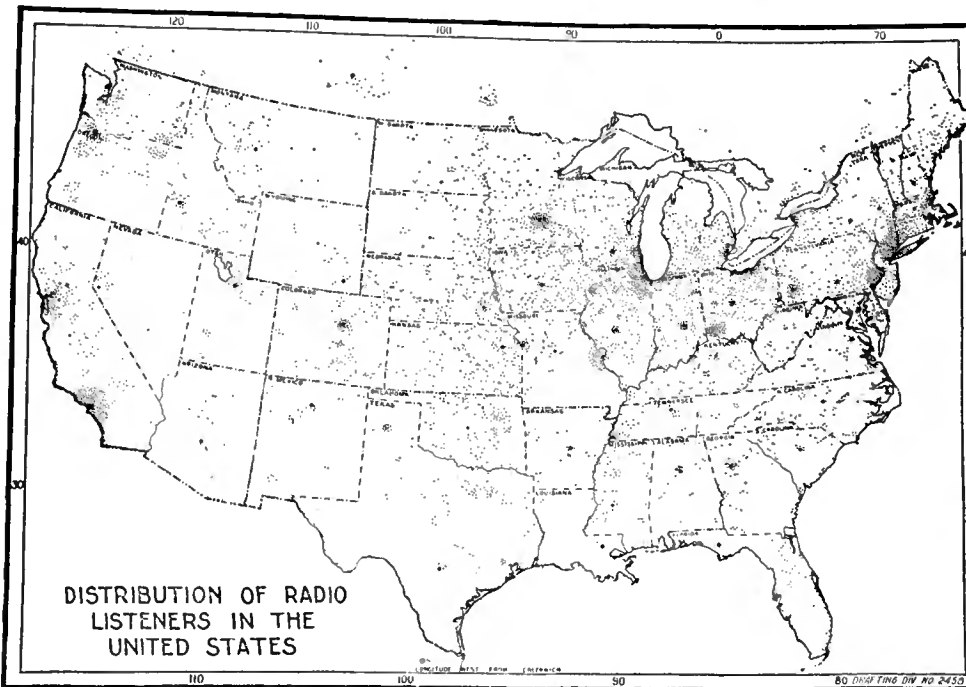
radio broadcasting as a potential rival to its business, and a spokesman for the amateurs. Yet the Committee did a most unselfish and constructive job, supporting as it did, priority as the determining factor in assignment of wavelengths, [See "March of Radio," September and November, 1926.] five-year station licenses instead of two-year licenses and urging that distinction be made between the broadcaster's rights with respect to the government and with respect to each other. This latter proposal was stressed by the Air Laws Committee of the American Bar Association in its comprehensive report to the Conference Committee, which came out strongly and fearlessly against an executive commission to handle the issuance of station licenses.

Had the radio industry's Coordinating Committee been solidly backed by twenty million broadcast listeners, it could have dictated the terms of the bill with only radio's best interests in mind. It could have insisted forcefully on maximum power to the Department of Commerce with only advisory and limited appellate powers to the Commission. It could have forced the adoption of definite limitations to the number of licenses issued and to the basis upon which they are to be granted. In

absence of widespread listener support, its attitude was wisely one of compromise. The radio industry owes a lasting debt of gratitude to its hard working representatives in Washington. The industry has no one but itself to blame that they could not do more than they did.

Danger of Monopoly in Broadcasting

MONOPOLY of broadcasting, which is such delightful music for the politician's song, is most effectively fostered by the fact that there is no incentive to the establishment of rival broadcasting chains. With an excessive number of broadcasters, the listening audience is so divided that the value of individual stations outside of the National Broadcasting chain is too problematical to be saleable on a large scale at the high rates necessary to maintain a truly rival chain. With political management for radio wavelength assignment, the chances of having the number of stations reduced by consolidation or elimination to the small number of 200 or 225 necessary to clear and unimpaired reception are made rather remote. Had the legislators concerned themselves with what is good for broadcasting, they would have set up a definite formula as to the number of stations which the present broadcasting band can accommodate. In the September and October issues, we suggested the divis-



DISTRIBUTION OF RADIO LISTENERS IN THE UNITED STATES

WHERE THE RADIO LISTENERS ARE

The dots represent localities from which one or more letters have been received by one of several broadcasting stations on the east or west coast. No inland stations were considered in this particular survey

ion of the broadcast band into two classes, national and local, assigning two thirds of the available channels to about 75 national stations and one third to about 125 stations, serving local interests.

Such a proposal would make it possible for the broadcast listener to tune-in at least 50 of the 75 high grade key stations when reception conditions are favorable and to hear at least twenty of the smaller stations. The number of stations offered the listener decreases proportionately as the allotment of stations is increased over this proposed alignment. By accommodating more stations, service to the listener is decreased instead of increased. The question of how many licenses shall be issued should be considered in the light of service to the largest number of listeners rather than how many of those who desire to broadcast.

The American Bar Association Air Laws Committee, headed by Chester W. Cuthell, pointed out that the Constitution prohibits the confiscation of private property without compensation. But consideration should be given to the fact that most excess stations were placed in operation in the face of express warnings that there was no room for them on the ether. To compensate such stations is like paying a trespasser in an apple orchard for heeding a "no trespassing" sign. The true value of a broadcasting station is not its physical equipment but the habitual audience which its faithful service has attracted. On that basis, the stations which cause heterodyne whistles marring the programs of long established broadcasters are worth less than nothing, having, as their assets, only antagonized listeners.

The present monopoly of the National Broadcasting Company in extended chain broadcasting will be permanently ended when ether conditions are cleared. The establishment of rival chains is a prospect impossible of consummation as long as the ether remains overcrowded.

The Future of Commercial Broadcasting

THE economic structure of radio broadcasting is unique in that those who are served do not pay directly for its maintenance and the radio industry which it supports assumes little or no responsibility for it. Unrelated businesses, since all manner of advertisers use the medium, are broadcasting's principal source of support. Fortunately, the greater the merit of the commercial program, the more effective its goodwill influence; otherwise commercial broadcasting would be an abuse instead of a boon. It has brought the list-

ener the highest quality of radio talent in the world and, with that, full justification for its existence.

Significant changes, however, are possible in the structure of the broadcasting world. The trend now is to extend a single chain so that subscribing stations tend to lose their identity and individuality. They become mere extensions of a New York studio. In time, there may be two chains. But the number of chains cannot increase indefinitely, as long as outlying stations become closely affiliated with one chain or another. Eventually, the listener, although able to hear twenty or thirty stations with his set, may be restricted in his choice of program

standards and their audience. A selfish program manager, or one faced with little competition, will have a predominance of features which pay him good revenue. In the end, his audience will become smaller and the value of his time proportionately reduced. Others, seeking the greatest possible audience, will pay for high grade sustaining features, use only commercial features selected for their program value, and thereby build large audiences. Thus program values will be automatically maintained. Naturally, time of the latter stations will be worth more than that of the less discriminative station and commercial broadcasters will be willing to pay proportionately higher sums to use their facilities.

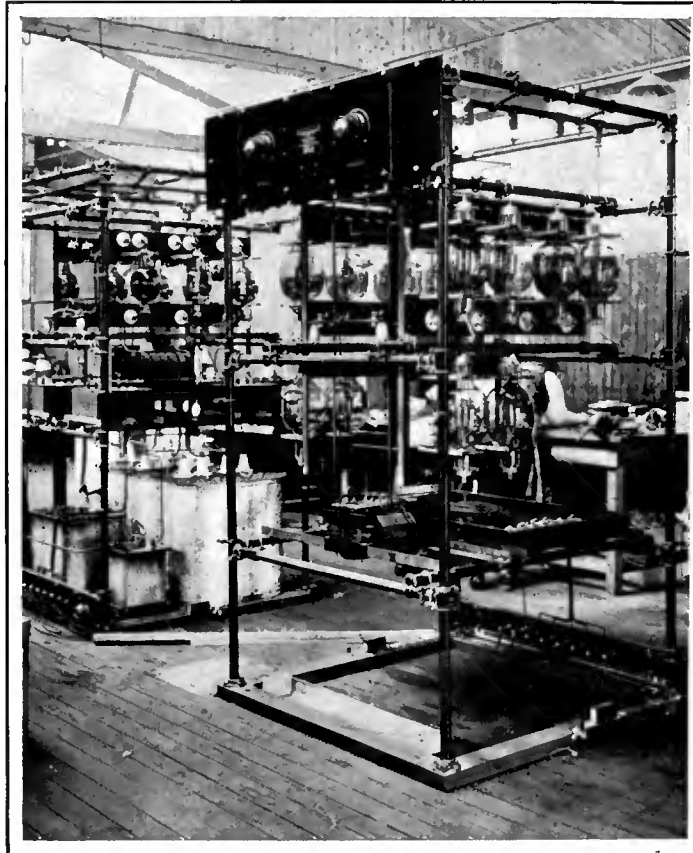
Vaudeville booking is conducted much in this way. Each theater has its representative. Together they haggle and bargain, balancing cost of feature against program attractiveness. The better the feature, which the commercial broadcaster offers, the less he will pay for his time on the air and, conversely, the higher the standards of the station, the more it will demand from the broadcaster. Any one who wishes, whether he be educator or anarchist or both, may submit himself to broadcasting stations, either paying or being paid according to his program attractiveness, for the privilege of making himself heard. Thus supply and demand, program attractiveness and station value, will rule broadcasting costs and the opportunity to use the microphone will be automatically extended to all who can sell themselves to station managements. Individuality of stations will be encouraged and listening clientèles will take definite forms, according to individual station program policies.

Viewed abruptly, this is a rather nebulous scheme, but, if we consider it step by step, it is a fairly logical prospect. The

value of the chain system has been demonstrated by a single large broadcasting chain. Improved radio regulation will encourage two or three chains, each likely to have fairly similar and competing features. Then the inevitable reaction to standardized programs and widespread uniformity will assert itself and the line of demarcation between specific chains will disappear.

Problems for the Radio Commission

A POLITICAL commission, seeking to regulate radio, will be confronted with many difficulties. During the last few weeks, WEAf's program has been marred by a heterodyne whistle. Inquiry at the station reveals the surprising in-



3 LO MELBOURNE, AUSTRALIA

A part of the equipment of the popular 5-kilowatt Melbourne broadcasting station. This station has often been heard in American Pacific Coast cities

material to a local program and to one or two chain programs. Such a system would not long survive because it would rob radio of its variety.

In the end, we would not be surprised to see a complete divorcement of program presentation from station operation. Broadcasting artists will appear at one of a score of radio studios, each serving a nationwide wire network. Station program managers will piece out their programs as their policy dictates from any of the thirty or more program sources available. Each station manager will use his own judgment in determining program balance and feature value. For commercial programs, stations will receive compensation varying with the attractiveness of the feature and based not only upon their location but also upon their program

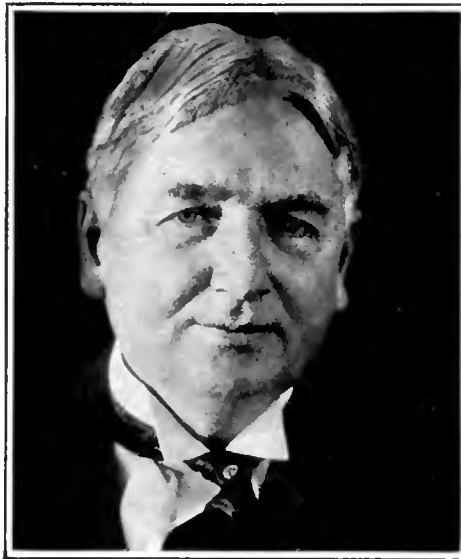
formation that they do not know what station is causing the interference. With a little careful tuning, we were able to find out that the station in question was WCFL, operated by the Chicago Federation of Labor. The National Broadcasting Company cannot be blamed for avoiding a quarrel with the great labor organization, regardless of the motives which caused the latter to select that particular wavelength for its operation. The Chicago organization sought a broadcasting license after the ether channels were filled and probably felt indignation that the interests of a great monopoly had an exclusive channel. If petulance animated their choice of wavelength, it has been visited fully as much upon the ranks of labor which enjoy WEA's programs as it has to the detriment of WEA. A political commission, fearing the alleged political influence of labor organizations, might be a little hesitant in applying the principles of priority and service to the listener in such a case.

Remarkable Short-Wave Transmission

CONTINUED use of high-frequency transmission must lead any serious investigator to the conclusion that we know nothing about how high frequency waves travel. The experience of station 2 NZ, operated by a New Jersey amateur, using 300 watts power, indicates some of the strange vagaries of short wave transmission as observed by this operator. A station clearly audible at a certain distance north, may be inaudible at the same distance to the west. Forty-meter stations in New England are rarely heard in New York and stations fifty miles north of New York are seldom heard after 8 P. M. on this wavelength. Yet stations from the south can be heard at varying distances, depending largely upon the weather. Conditions to the west are even more uncertain. When West Coast stations come in well in New York, New York stations deliver a weak signal to them and vice versa. Foggy and drizzly nights, usually poor for broadcast reception, are good for short-wave transmission. When Brazilian stations come in loudly in New York, it is difficult to deliver an audible signal from powerful New York short wave transmitters. On the other hand, communication with Australia and New Zealand gives fairly constant signals. There is less variation in New Zealand reception in New York than there is in reception from middle western stations.

The Month In Radio

THE U. S. Lighthouse Service is now operating 29 radio beacons, 13 of which are recent installations. The radio beacon emits a distinctive signal so that it is easy to identify. Its direction may be determined by means of a radio compass. A navigator, making for New York, first picks up and locates the



ARTHUR WILLIAMS

New York City

Vice-President, Commercial Relations, The New York Edison Company. Especially written for RADIO BROADCAST:

"A discarded radio set is of no use to anybody. It adds nothing to home life, in which it can be made an important adjunct, from the standpoint of education, entertainment, and general home attractiveness. Our own justification for supplying radio programs is primarily, if not entirely, based upon the fact that radios in use consume electric current, either from primary or charged batteries, or directly from the light circuit. I recently testified before the Public Service Commission that our increased revenue due to the use of radio was about a million dollars yearly. One of the significant results concerning the radio has been the seeming satisfaction of the consumers that the increase in their electric bills is justified with the extra use due to radio; possibly they are thinking of their families, more contented to stay at home, or of the lessened drains on their purse for theater tickets, or for evening excursions, which in these days, especially, make very noticeable invasions upon one's bank account."

Nantucket Shoals Lightship when he is some 300 or 400 miles out. Approaching nearer, he hears the Fire Island signal and finally the Ambrose Channel light vessel directs him to the mouth of the channel. A beacon is being installed in Long Island Sound for ships using the inner course. The active beacons are distributed at most of the dangerous points along the coast, nine on the Pacific, one on the Alaska coast, nine on the Atlantic, two on the Gulf and eight on the Great Lakes. 400 ships, flying the American flag, are now equipped with radio compasses.

THE tremendous growth of the radio industry, one might believe, would reflect itself in increased consumption of copper. In his address before the American Mining Congress, Thomas D'Arcy Brophy stated that the radio industry absorbed from two to three million pounds of copper per year out of the total of 765,000,000 pounds used in the United States. Radio insignificance as a buyer of copper is indicated by the fact that the automotive industry uses 245,000,000 pounds, electric refrigeration about 45,000,000 pounds and lightning rods 15,000,000 pounds.

THE Radio Market News Service has been extended to station KFKX which serves a large area in the great plain states not heretofore reached by the Department of Agriculture's comprehensive radio service to farmers. The number of rural listeners is estimated to have passed the million mark and already half a million enrollment cards have been received by the United States Farm Radio School. Ninety broadcasting stations in every section of the country lend their facilities regularly for half an hour daily to the agricultural radio service.

IN THE season of annual reports by cabinet members, it is interesting to note the references to radio. Secretary Wilbur states that the fleet requires considerable modernization of its radio apparatus in order to avoid interference with radio broadcast entertainment. The Navy has developed high-frequency radio transmitters which give long range communication at low initial cost and maintenance. Both aircraft and submarine radio have benefited from research in radio during the past year. An extensive radio weather service for aircraft in flight in the New York-Washington-Norfolk area, is in operation and it is hoped to extend the system of radio communication and radio direction finding along other important air routes. Photographic records have been obtained, showing the time difference in the travel of radio waves between two points directly and by reflection from the Kennelly-Heaviside Layer, giving another check on its height above the earth. The Naval Research Laboratory has supplied the needs of several government departments for quartz oscillators, used as frequency standards in broadcasting stations. The naval radio intelligence system ashore now comprises 133 stations, including those for communication with the fleet, coastal stations for marine traffic, aircraft stations, harbor stations and radio compass transmitters. During the year, the Navy handled 14,362,987 words, of which half were for other departments of the Government. The increased use of high frequency transmission has contributed largely to the growth of the Navy's traffic.

THE daylight ship to shore transmission record was broken when station KFS at San Francisco communicated with the S. S. *President Wilson* while that ship was 3120 miles west of that port.

ACCORDING to figures issued by the Department of Commerce, the number of stations licensed since July 1 is 108; 34 changed locations; 126 increased power; 93 shifted wavelength; 102 stations are under construction; 63 are about to increase power, and 168 have advised that they are soon to apply for licenses. 22 of the stations licensed since the 1st of July are of more than 500 watts power and 24 of the old stations, licensed prior to July 1, have increased their power to 500 watts or more. Had not that fatal oversight been made in the last few moments of Congress's session last summer, which failed to make effective the joint resolution passed by both Houses prohibiting issuance of additional licenses, the 108 new stations, the 102 under construction and the 168 projected would not be in the problem to-day.

The transatlantic telephone circuit opened successfully on January 7, with full hours of service, from 8:30 to 1 P. M., New York time. Perhaps an ambitious commercial broadcaster will employ it to send his program to European stations. The rate will be about twenty-five dollars a minute or only two and a half times WEA's toll rate.

A High-Quality Amplifier for the R. B. "Lab" Receiver

Constructional Details of an Amplifier in Which Bypass Condensers and Chokes Have Been Included to Avoid Audio Regeneration

By JOHN B. BRENNAN

Technical Editor

IN THE November, 1926, RADIO BROADCAST, the author described the construction of a complete four-tube receiver embodying the fine points of the R. B. "Lab" circuit which had been developed by several engineers, and on which a very considerable amount of work had been done in the Laboratory of RADIO BROADCAST.

Soon after, a receiver was built which was subsequently described in the January, 1927, RADIO BROADCAST, consisting merely of the two-tube tuner part of the original four-tube receiver. This construction was presented to our readers so that they could tie up this efficient receiver circuit with any unit audio amplifier, such as the Alden Truphonic, the National combined impedance-resistance amplifier and plate supply, the Millen audio channel, and such resistance amplifiers as the Heath, Amsco, Allen Bradley, and others.

Strangely enough, practically every type of audio amplification is represented in this list excepting our old stand-by, transformer-coupled audio amplification, and it is to fill this gap that the paper herewith describes in detail the construction of a transformer-coupled audio amplifier of high merit.

The "Lab" circuit in any form deserves nothing but the best of audio amplifiers. It is a circuit that will satisfy the most critical of builders on points of selectivity and sensitivity; to successfully amplify the output of the detector tube, an amplifier of proved value should be employed.

In the four-tube receiver described in November, 1926, an audio channel was used which gave complete satisfaction where tone quality and volume were concerned, and it is for this reason that the use of the elements employed therein are continued in the construction of the amplifier described here.

When using high-grade transformers, such as the Amertran De Luxe, it is possible that any slight defect elsewhere in the circuit will be noticeably amplified and cause distortion. This is especially true where an a. c. operated B power-supply unit is employed with an amplifier employing these transformers.

Since such power supply units have a shunt tapped resistance across the output to obtain the various plate B voltages, there is a coupling effect produced, due to the resistance which is common to all plate circuits. That is to say, the common resistance couples together the various plate circuits and causes regeneration at audio frequencies which in some cases is detri-

mental to tone quality. To overcome this disadvantage, it is necessary to employ bypass condensers and r. f. and a. f. choke coils so placed that no coupling takes place. This has been done in the amplifier described here.

RADIO BROADCAST Laboratory would be greatly interested in receiving reports from readers who have constructed the R. B. "Lab" circuit in either the two or four-tube style and

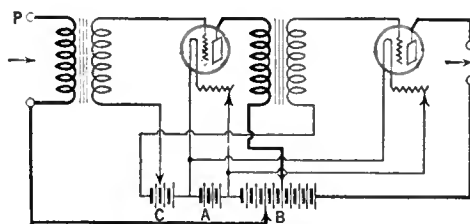


FIG. 1

who have experienced trouble in the use of B power-supply devices with their receivers.

Other notes of interest, where they concern construction details, operating notes, or results, are of especial concern to the Laboratory staff, and we welcome such reports addressed to the magazine. Photographs of interesting models built by readers are also quite welcome, for by reproducing these, it is possible to give wide circulation to valuable kinks of construction.

The purpose of this article is primarily to describe the construction of a two-stage audio-frequency amplifier which may be combined with the two-tube shielded R. B. "Lab" Receiver described by the author in the January RADIO BROADCAST. In addition, some notes on tubes

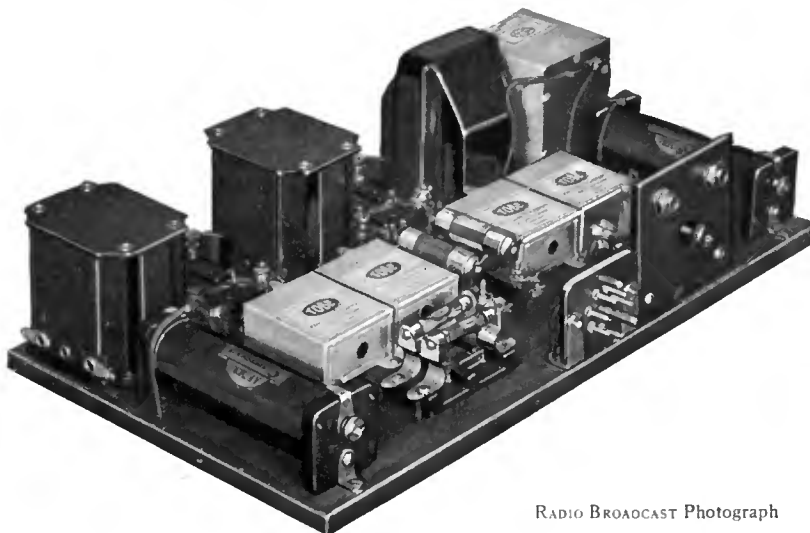
satisfactory for use with either the two- or four-tube R. B. "Lab" receiver are also included.

Aside from its especial use with this tuner circuit, the two-stage amplifier may well be worked with any other tuner unit the builder may have on hand. Such an amplifier, for instance, could very nicely be used in conjunction with a short-wave tuner. For this latter form of work it is not absolutely essential that two audio stages be employed as most of the reception is done with the aid of headphones, and two stages would produce too loud a signal for comfort. For this reason, together with others, an interstage jack has been included behind the first audio stage so as to enable the operator to plug in after the first audio amplifier. Since the output jack is of the filament-control type, the last audio tube does not remain lighted when the phone plug is inserted in the interstage jack, and, therefore, the half ampere of filament current which the semi-power tube consumes is saved.

On the point of stability, the amplifier shown here incorporates all the worth while features of bypassing and audio frequency filtering that seem to be of definite value. This is especially true when it is considered that, since the amplifier is built as a unit and will quite likely be stowed away in some remote place, necessitating the use of long battery and other connecting leads, there are bound to be some deleterious coupling effects produced, unless such bypassing is resorted to.

In brief observation of the functioning of the bypass condensers and audio chokes, etc., let us analyze the circuit diagram of an amplifier shown in Fig. 1. Here no bypass condensers, audio chokes, or grid filters are shown. It will be seen that audio currents in either the grid or plate circuits of the tubes, to return to the common connecting point (the minus-A lead), must first course through the battery leads which might be several yards long. In the plate circuits, the return is made to a series of B batteries which are common to all the plate circuits. Any resistance in the B batteries will tend to couple the various plate circuits together thereby setting up an audible oscillation, or tendency to produce regeneration.

In cases where a. c. operated B power-supply devices are employed, the situation becomes more complicated because usually the various B voltages are obtained from the a. c. device by taking a drop through a resistance common to all the B plate circuits, as stated previously. Here we have a definite, known resistance to



RADIO BROADCAST Photograph

THE ARRANGEMENT OF THE APPARATUS

In the base layout is shown the placement of the various parts. The wiring, it may be noted, is not entirely visible, for at the terminal of each piece of apparatus, a small hole is drilled in the base-board to allow the wiring to be passed through to the under side. Such an arrangement makes for neatness of appearance

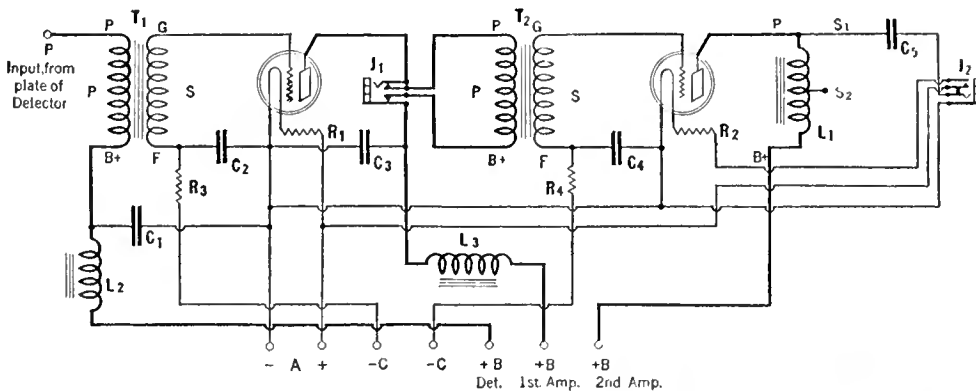


FIG. 2

contend with. In batteries, the resistance coupling effects are produced usually when the batteries become old.

Considering this coupling action, it is obviously desirable to provide a return path for the audio currents, and also to prevent their dividing between the provided path and the battery path. In the first place, condensers will provide the necessary return path direct to the negative-A lead. In the second place, audio chokes and grid filter resistors, when placed in series with the plate and grid circuits respectively, will impede the flow of these currents to the batteries and will necessarily make the currents travel through the bypass condensers provided for that purpose. This is made more clear by referring to the circuit diagram Fig. 2, which is similar to Fig. 1 with the exception that the condensers, chokes, jacks, and filters have been included.

The Samson audio chokes have been employed in the amplifier described. What the audio choke does for the plate circuit, the grid resistor does for the grid circuit. In both cases it will be noted that first an element impedes the flow of the audio currents through the leads which connect either to the batteries or the a. c. supply device, and, secondly, a bypath is provided for these currents so as to make a short return to the minus A of the tube.

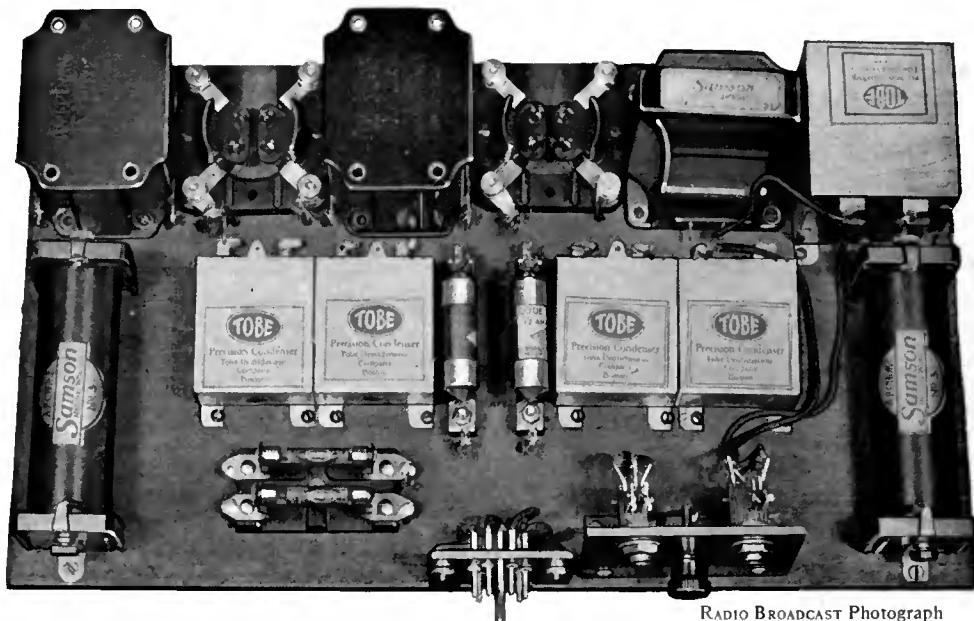
Both grid filters and plate impedances, with their associated bypass condensers, are to be highly recommended; in fact, may be an absolute necessity when an a. c. operated power-supply

device furnishes the B and C potentials. However, where B batteries are employed, the grid filter resistors may be dispensed with. Note, however, that only the grid resistors are omitted, not the grid bypass condensers.

The several photographs accompanying this article serve to acquaint the builder with the mode of construction employed and very little effort is necessary to construct a similar amplifier.

The materials required to duplicate the construction of the two-tube amplifier unit as shown here is as follows:

- 1 Wood Base-Board 8" x 14" x 1/2" . . . \$.25
- T₁, T₂—2 Amertran De Luxe Audio Transformers 20.00
- 2 Airgap Sockets 1.20



RADIO BROADCAST Photograph

THE COMPLETE AMPLIFIER UNIT

In this illustration, the box has been removed. Note that the sockets and transformers, etc., are arranged along the rear edge, while the associated apparatus in the left front part of the base-board. The double resistor mount, located in the left front part of the base, holds the resistors which make up part of the grid filter circuit, so necessary when an a. c. operated power-supply unit is employed to furnish the B and C voltages.

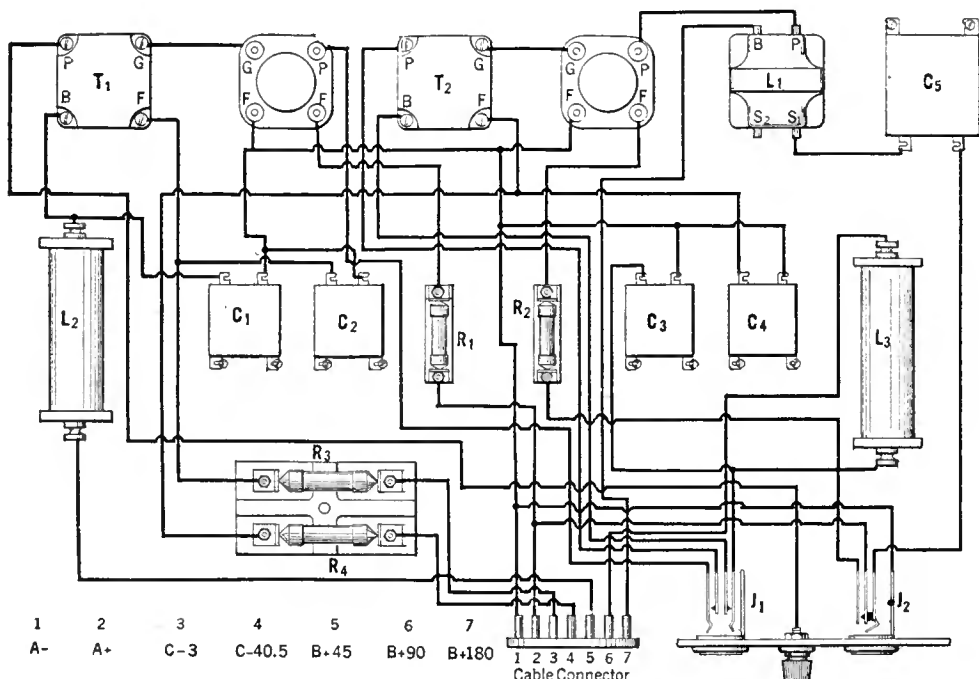


FIG. 3

- L₁—1 Samson Output Impedance, Type O 5.00
- C₅—1 Tobe 4-Mfd. Output Condenser 3.50
- C₁, C₂, C₃, C₄—4 Tobe 1-Mfd. Bypass Condensers 3.60
- L₂, L₃—2 Samson Audio Chokes, No. 3 6.00
- R₁, R₂—2 Brachstats, 1/4-Amp. and 1/2-Amp. 2.00
- 1 Lynch Double Resistor Mount50
- R₃, R₄—2 Lynch Resistors, 1/4-Meg. 1.00
- 1 Yaxley Cable Connector and Plug 3.50
- J₁—1 Yaxley Single-Circuit Filament Control Jack, No. 703C65
- J₂—1 Yaxley Double-Circuit Jack, No. 70365
- 1 Binding Post10
- Bakelite, Screws, Wire, etc.50
- Wood for Cabinet 1.00
- Aluminum Paint50
- TOTAL \$49.95

To assemble the amplifier, refer to Fig. 3, which shows the disposition of the various parts on the base-board, and to the photograph on this page. The bakelite strip is drilled in accordance with the details shown in Fig. 4, and is mounted on the front edge of the base in the position shown.

After the parts have been securely mounted, the wiring is attended to. It will be observed

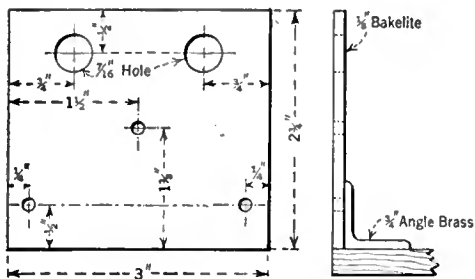


FIG. 4

that, due to the close placement of the transformers and sockets, exceedingly short leads between these parts are possible. It is possible to run much of the wiring, especially the longer leads, under the base-board, through holes drilled near the various terminals. When the wiring has been completed, a box may be assembled around the base. A light coating of shellac will fill up the pores of the wood after which a coat of aluminum paint may be applied to the entire cabinet sur-

potential when a certain fixed value of grid bias is applied. In the case of a C battery detector there are certain values of B battery that must be employed in conjunction with the value of the grid bias used. Both go hand in hand.

A table of B and C voltages for various output tubes is given here.

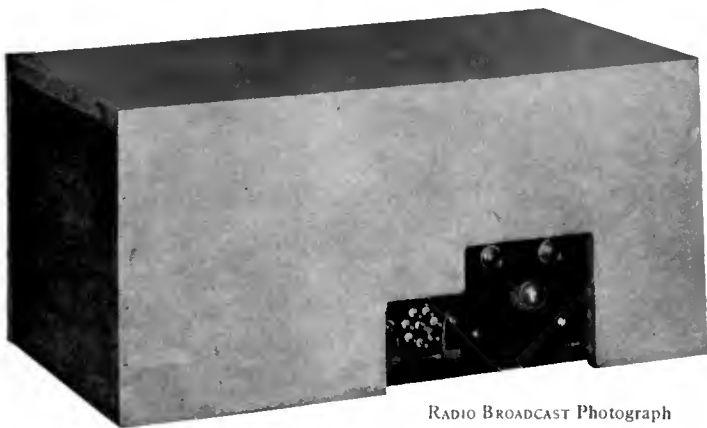
UX-112		UX-171	
C	B	C	B
6	90	16 1/2	90
9	135	27	135
10 1/2	157 1/2	40 1/2	180

Under all normal conditions the C battery detector will work satisfactorily with 4.5 volts on the grid and 45 on the plate. Some tubes, however, refuse to oscillate over the whole band with these voltages. The remedy is obvious; increase the B voltage to 67 1/2 or increase the regeneration capacity by twisting a pair of insulated wires and

If it is desired to employ the new detector tube, UX-200-A, it is well to replace the grid leak and condenser to the detector circuit and to run the grid return to the negative filament lead.

Stabilization of the receiver, together with more accurate neutralization, is bound to occur when the bypass condensers are applied to the radio-frequency amplifier and detector circuits. This is especially true of the C-battery circuits because in most cases the leads to the C batteries are quite long with every chance for serious coupling or pickup. The bypass condensers eliminate the probability of the coupling and in turn make the receiver more possible of complete neutralization.

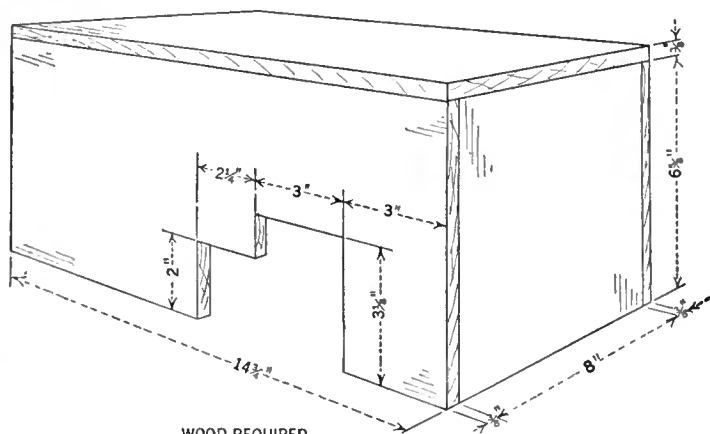
It is not amiss to include the bypass condensers, together with the necessary r. f. choke, in the plate circuit of the r. f. tube so as to provide complete bypaths for the r. f. currents. This precludes the possibility of r. f. currents finding their way into the battery circuits. The circuit diagram, Fig. 6, shows the addition of bypass condensers, (Cx) and r. f. choke coil (Lx) to the radio-frequency amplifier and detector circuits.



RADIO BROADCAST Photograph

THE EXTERIOR OF THE AMPLIFIER CABINET

For the fastidious constructor who desires the same color scheme for his amplifier as his two-tube R. B. "Lab" receiver (which is finished in natural aluminum), a box can be assembled to fit over the amplifier, and be finished with aluminum paint. The illustration shows such a box with the amplifier inside



- WOOD REQUIRED
- 2 Sides 8" wide by 6 3/8" high by 3/8" thick
 - 1 Front 14 1/2" long " 6 3/8" " 3/8" "
 - 1 Back 14 1/2" " " 6 3/8" " 3/8" "
 - 1 Top 8 3/4" wide " 14 1/2" long " 3/8" "

All stock is 3/8" thick, hard-wood preferable

FIG. 5

face. This latter coat is only necessary when the builder desires to have his amplifier look like the aluminum cabinet of the two-tube shielded R. B. "Lab" Receiver described in the January RADIO BROADCAST.

Fig. 5 shows the assembly details for the box, together with a complete material list of the wood required. The manner in which the various pieces are assembled is clearly shown, and no difficulty will be experienced in this respect, providing the constructor has taken care to cut his wood exactly as specified. The box fits over the base upon which is mounted all the amplifier apparatus, and in the front is cut an opening so as to allow access to the connector plug, and jacks, etc.

After assembling the box, carefully sandpaper the surface. The finer the surface, the better will be the finish of the aluminum paint. If brads are used to hold the pieces together, they should be countersunk, and the small head holes filled with soap. If screws are used, be sure to spot the holes first, then drill out, with a drill several sizes smaller than the diameter of the screw.

CORRECT PLATE POTENTIALS

VALUES of batteries for use with receivers and amplifiers depend chiefly upon the type of tubes employed. The output tube of an audio amplifier, if it be of the semi-power variety, necessitates the use of a definite value of plate

attach one end of each wire to the regeneration condenser. The other two ends should be insulated from each other. The main advantage in varying the detector operating voltages is in obtaining a state of regeneration which is considered satisfactory for operation over the entire wavelength range. However, it will usually be found that 4.5 volts of C battery with 45 volts plate battery on the detector tube will be universally satisfactory.

In the four-tube receiver the variable resistance controlling volume is situated near the left end of the panel while the interstage coil to which it is connected is quite a distance away from it, necessitating long leads which may give rise to intercoupling. By the use of the choke Lx, the r. f. currents are kept out of the resistance and bypassed to the negative line through the condenser Cx.

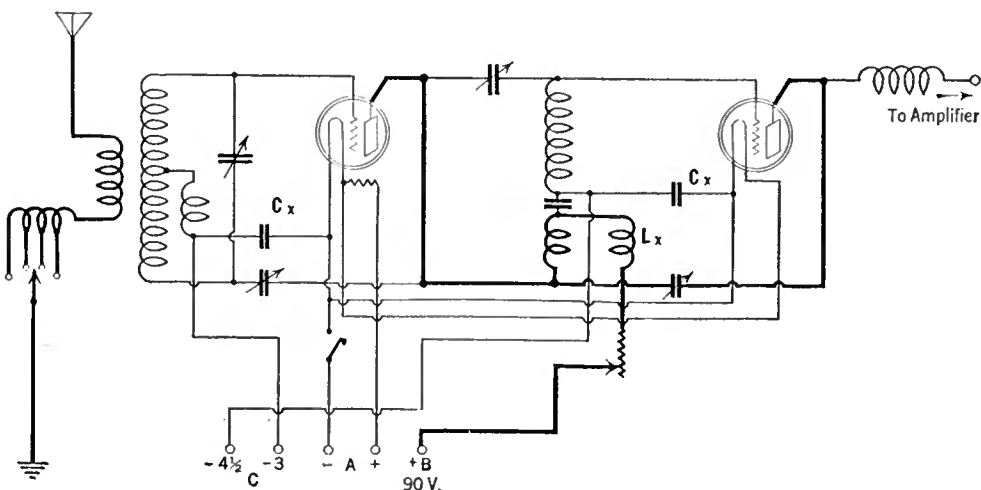


FIG. 6

Electrifying the "Hi-Q" Receiver

The Construction of an A. C. Operated Power-Supply Device for the Hammarlund-Roberts "Hi-Q" Receiver which Supplies B Current for All Tubes, A and C for Power Tube

By LESLIE G. BILES



THE "HI-Q" IN A CONSOLE

Which holds all the power equipment and also a Stevens conoidal loud speaker, the latter being concealed behind the grill

IT IS true that, not so many months ago little or no attention was given in the matter of choosing tubes of different characteristics according to the duties they were required to perform in a radio receiver, but nowadays such selection is carefully made by almost every radio constructor. Reference to the circuit diagram of the new Hammarlund-Roberts "Hi-Q" receiver, Fig. 1 (reproduced from the author's article on this receiver which appeared in the January RADIO BROADCAST), offers the information that the grid return of the detector tube is connected to the negative filament lead. This connection necessitates the use of one of the new special detector tubes of the 200-A type. For the radio-frequency stages, the 201-A type tubes can be used.

When it comes to the output tube, there seems to be a lot of confusion as to the proper tube to use. Shall it be a 201-A, a 112, or a type 171? The use of a power tube greatly increases the amount of energy that can be delivered to the loud speaker without distortion, but plenty of voltage for the power tube is necessary for full amplification.

The relative values of these three tubes as power handling devices when used with the proper grid and plate potentials are as follows:

TUBE	GRID VOLTS	PLATE VOLTS	UNDISTORTED OUTPUT (MILLIWATTS)
201-A	4.5	90	15
112	9	135	120
171	40.5	180	700

Since the 171 type, under the conditions given in this table, will handle six times as much as a 112, and forty-seven times as much as a 201-A tube, its superiority is unquestioned.

With the advent of the power tube, it has become increasingly economical to utilize a

device to obtain some or all of the necessary power for a receiver from the a. c. mains. The following data relates to the construction of a power-supply device that has been designed by the author for use with the "Hi-Q" receiver. It supplies a. c. for lighting the filament of the last tube, B voltage for the entire receiver, and C bias for the last tube.

A small-capacity storage battery may be used, in conjunction with a trickle charger and automatic relay, to light the filaments of the other tubes. This combination will result in a set up that will require very little attention except the periodical addition of distilled water to keep the plates of the storage battery covered.

A few minor alterations, necessitating the changing of about half a dozen connections of the audio amplifier in the Hammarlund-Roberts "Hi-Q" set, will have to be made so that the power device can be used to light the filament of the 171 tube and supply the high negative bias.

The following additional material will be necessary:

- 1 Tube Veritas Resistor, 2000-Ohm . . . 1.10
- 1 Durham Metallized Resistor, 50,000-Ohm75
- 1 Lynch Double Resistor Mounting50
- 1 Tube Condenser, 1-Mfd.90
- 1 Yaxley Pilot Light Bracket, No. 31050
- 1 Brass Angle Bracket, 1/2 x 1/2 Inches05
- 1 Piece Panel Material, 3 x 1 inches10

TOTAL \$11.90

(Similar standard parts may of course be used).

The new connections of the amplifier which is shown as part of the circuit in Fig. 1, are shown in Fig. 2. To make the changes, it is necessary to follow the subsequent procedure:

Loosen the screws holding the audio amplifier to the baseboard. Remove the wire from the 135-volt binding post and the wire from the "P" terminal of the output tube.

The jack is not to be used again, and may be removed, a pilot light bracket being installed in its place on the panel. Raise the amplifier and remove the wire connecting (at the end of the sub-panel) Amperite No. 3 to the tube socket and the other wire from Amperite No. 3 to the plus A lead of the set. Replace the Amperite mounting with a double resistor mounting.

Disconnect the wire running from the minus A binding post to the minus terminals of the audio tube sockets and the soldering lug on shield section 1D. Connect the minus-A post to the minus terminal of the power tube socket and connect a branch to the lug on the shield.

Remove the wire connecting the minus-F terminal of the second audio transformer to the minus-C binding post.

Connect the minus-B binding post to both

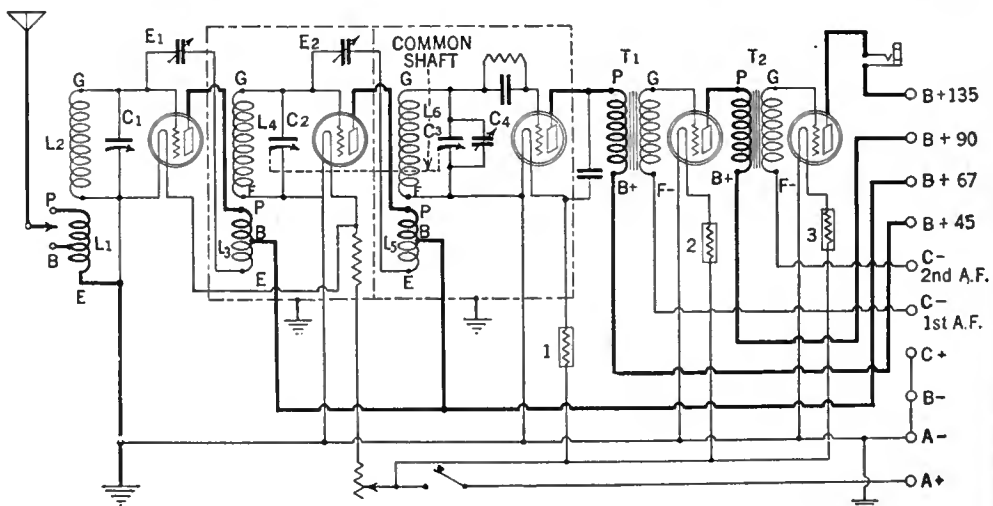


FIG. 1

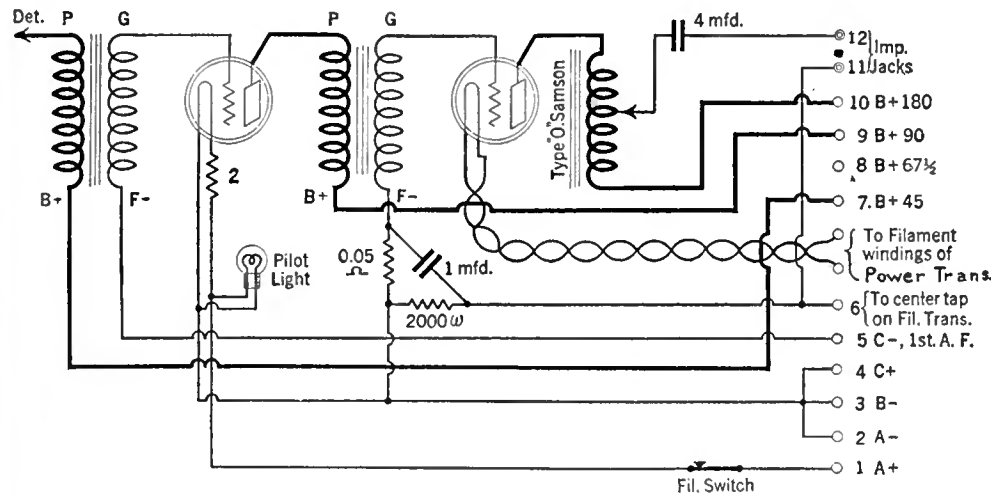


FIG. 2

terminals of the double resistor mounting at the end toward the main control panel.

Connect the minus-F terminal of the second audio transformer to the terminal of the resistor mounting nearest the transformer and in the clips of the mount place the 50,000-ohm resistor. Mount a 1.0-mfd. condenser on the baseboard directly opposite the double resistor mounting and connect one terminal to the soldering lug of the resistor mount which is connected to the F terminal of the transformer.

Connect the remaining terminal of the resistor mount to the minus-C binding post (No. 6 in Fig. 2) and continue a branch wire to the unconnected terminal of the 1.0-mfd. condenser.

A piece of double conductor lamp cord, about two feet long, should be connected to the filament terminals of socket No. 5 to be later attached to the power unit, as the filament of the 171 tube is to be heated by a. c.

The output impedance should be mounted in the unoccupied space at the extreme left of the baseboard. The 4.0-mfd. condenser can be most conveniently mounted by making a small hole in shield section 2B and fastening the condenser against the side of the shield.

Fasten the Imp telephone jacks in the small strip of bakelite and mount this assembly to the baseboard by means of the small brass angle bracket.

In making the following connections for the output device, shown in Fig. 3, use No. 14 Celatsite or other well insulated wire:

Make a connection from the P terminal of the power tube socket (passing the wire between shield sections 1C and 2A) to the P terminal of the output impedance.

Run a wire from the 135-volt binding post to the B terminal of the impedance. Connect terminal S1 of the impedance to one terminal of the 4.0-mfd. condenser, and the other terminal of the condenser to one of the Imp jacks. Connect the other Imp jack to the center tap of the filament transformer.

THE POWER UNIT

NOW let us tackle the job of building the power unit according to the diagram, Fig. 4, or the picture layout, Fig. 5. After the instruments are mounted in place, it only requires sixteen connections to complete the unit. The following is a list of the apparatus required:

- 1 Thordarson Power Compact, R-171 \$15.00
- 1 Tobe B Block, No. 760 11.00
- 1 Yaxley Automatic Relay, Type No. 444 5.00
- 1 Yaxley Cable No. 660 3.50
- 1 Q. R. S. Red Top Full-Wave Rectifier Tube 6.00

- 1 Benjamin Socket, No. 904075
 - 2 Clarostats (Variable High-Resistance Units)4.50
 - 1 Tobe Veritas Resistor, 10,000 Ohms.1.10
 - 1 Tobe Veritas Resistor, 5000 Ohms1.10
 - 1 Sangamo Bypass Condenser, 1.0-Mfd. Series B1.95
 - 2 Lynch Single Resistance Mounts70
 - 1 Baseboard, 7 x 9 x 1/2 Inches25
- TOTAL \$50.85

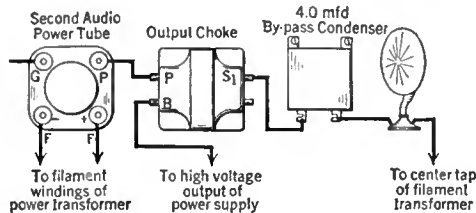


FIG. 3

For the sake of clarity in giving these instructions, we shall assume that the outfit is to be housed in a console cabinet as shown in the illustration, in which case the relay may be mounted on the inside of the cabinet.

There is no set rule for laying out the instruments; the arrangement shown in the photograph on this page will be found to provide short leads and facilitate the wiring. Be absolutely sure that you leave sufficient room between the Thordarson Compact and the Clarostat to enable the cable plug being inserted in place without hindrance from either of these parts or the connecting wires.

In wiring the power-unit, use No. 16 Celatsite, or No. 14 bus wire with Acme cambric insulating tubing. Do not use poor quality insulation.

Three pieces of flexible rubber-covered wire, about eighteen or twenty inches long, are required, one of which is to be connected to the A-plus (red) terminal of the cable connector and another to the A-minus (green) terminal. Connect the remaining lead to the C terminal on the

filament side of the power Compact. The A-plus wire is later to be connected to terminal No. 1 of the automatic relay and the A-minus is to be connected direct to the negative terminal of the storage battery. Terminal No. 2 of the relay connects to the positive terminal of the storage battery.

The console makes an ideal installation as it permits the batteries, power-supply unit, charger, and other incidentals to be kept out of sight. It should be selected to harmonize with the other furnishings in the room where it is to be used.

The Superior console, shown in the photograph on page 470, may be secured with a Stevens conoidal speaker built in the compartment at the top, or the loud speaker may be purchased separately to be hung on the wall or placed in a different part of the room.

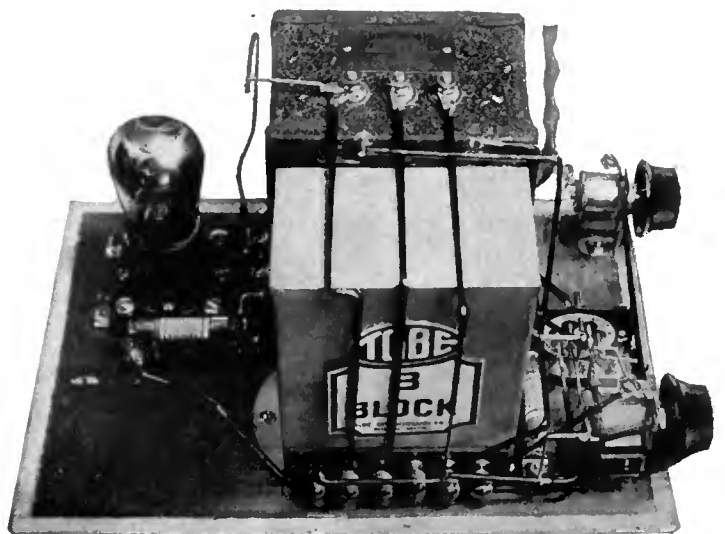
The compartment of the Superior console in which the "Hi-Q" is to be mounted, is in reality a drawer. It is unnecessary to remove the receiver from the baseboard on which the instruments are mounted. The console drawer is furnished with a walnut front slotted in the center to facilitate cutting out a section of the drawer so as to permit the panel of the "Hi-Q" to be mounted behind this walnut drawer front, as shown in the photograph.

After this section has been cut out, a narrow walnut beading, such as is used in picture framing, should be fastened around the edges to give it a finished appearance. The "Hi-Q" should then be placed in the drawer and securely fastened in place.

Fasten the automatic relay on the inside wall of the cabinet as shown in the illustration on page 472, and then place the storage battery and trickle charger in position. A number of convenient holes in the base-board have been provided for passing the cable and other connecting wires from the storage battery and power-unit to the receiver in the lower compartment.

Pass the cable through the larger hole directly over the audio amplifier. Each lead of the cable (except the green and brown) has a little metal tag fastened to it indicating to which binding post of the receiver it should be attached. The brown lead should be connected to the B-plus 67 1/2-volt binding post and the green lead to the B-plus 90-volt binding post.

Now connect the flexible wire from the C



THE POWER-SUPPLY UNIT

This device has been designed for use with the "Hi-Q" circuit, and supplies A and C voltages for the power tube in addition to B voltages for all the tubes in the receiver

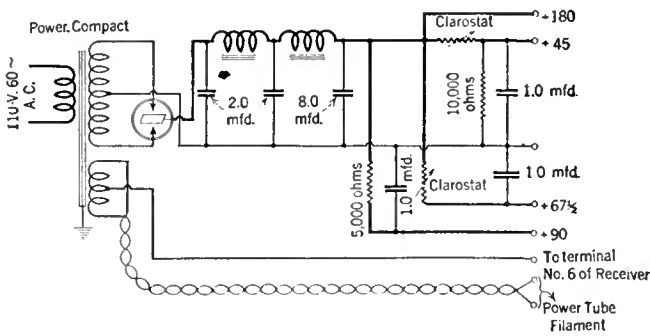


FIG. 4

terminal on the filament side of the Thordarson Power Compact to the minus-C binding post (the fifth binding post from the rear of the base-board). Then connect the twisted leads from the filament terminals of the power tube to the two terminals marked "F" on the power compact, connecting one wire, of course, to each terminal. Inasmuch as the filament of this tube is heated by alternating current, we do not have to worry about polarity.

The connections are completed by inserting the leads from the cone speaker in the 1mp jacks and then placing the clips of the trickle charger on the proper terminals of the storage battery—the red lead going to the positive terminal.

The set is now ready for test. Insert the cables from the power compact and trickle charger in their respective sockets of the automatic relay. Connect the relay cable to the a. c. source.

Before turning the combination rheostat and switch to light the tubes in the set, make sure that the controls of the Clarostats are screwed all the way out, by turning them in a counter-clockwise direction.

Then turn the rheostat to the "on" position and adjust the Clarostats. Caution! Never cut out all the resistance of these units by turning the controls as far as they will go in a clockwise direction, as you are apt to paralyze the tubes. Adjust the Clarostats on a weak signal for maximum volume and clarity.

A milliammeter, with a scale of 0 to 50 mA., will be found valuable in achieving quality of reproduction. This measuring instrument is to the physician; it enables us to see the functions of certain parts not otherwise visible to the eye.

Temporarily connect the milliammeter in the minus-B lead from the power unit to the receiver, remembering that the plus terminal of the meter connects to the receiver.

Tune-in a powerful local signal and observe the deflections of the indicator needle. The needle will fluctuate with the music; the louder the signal, the greater the deflection. The normal movement of the needle is slightly downward toward the lower end of the scale as loud signals are received. If the needle swings violently upward it is evidence of too high grid bias, and distortion is being introduced which will mar reproduction. Insufficient grid bias will cause excessive downward fluctuation of the needle. To increase the bias, use a lower value of resistor

than the 2000-ohm size specified. Increasing the value of the resistor decreases the bias.

If any difficulty is experienced in equalizing the radio-frequency stages, the procedure can be simplified by the addition of two Sangamo Series A 0.25-mfd. bypass condensers in the following manner: Remove the right-hand screw holding the detector circuit tuning condensers to shield section 1 C. Place a spacing washer under one terminal of the bypass condenser, and fasten it to the shield by replacing the condenser mounting screw. This screw provides one connection to the bypass condenser as the shield is grounded to the negative part of the A battery.

Connect the remaining terminal of the bypass condenser to the B plus terminal of the second radio-frequency auto-couple coil.

The other bypass condenser is mounted by making a small hole in shield section 2C directly back of the detector-tube socket. This condenser is wired in the circuit in the same manner as the previous one.

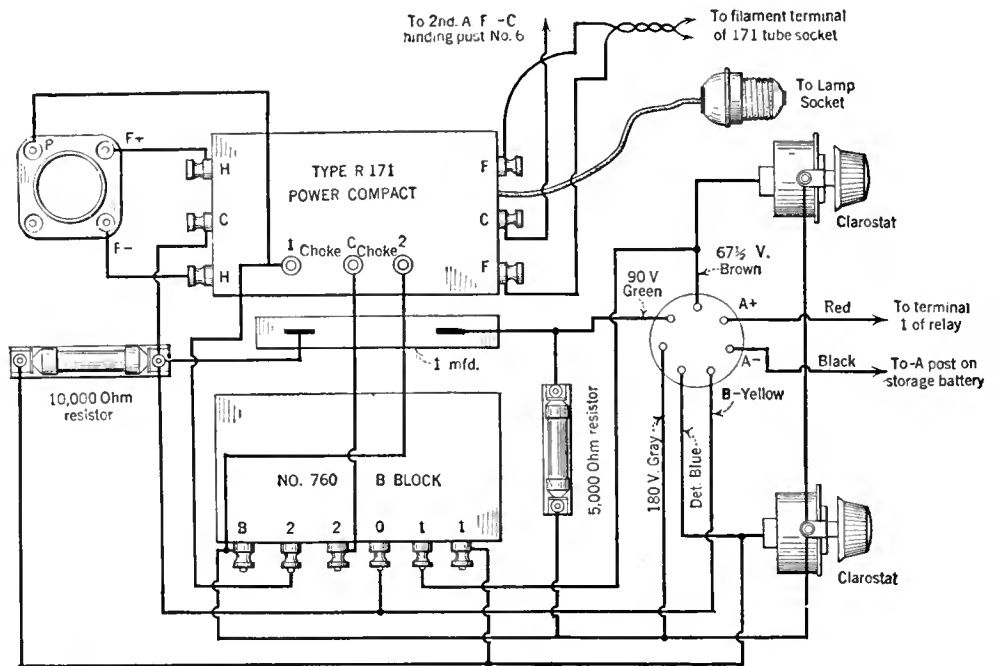
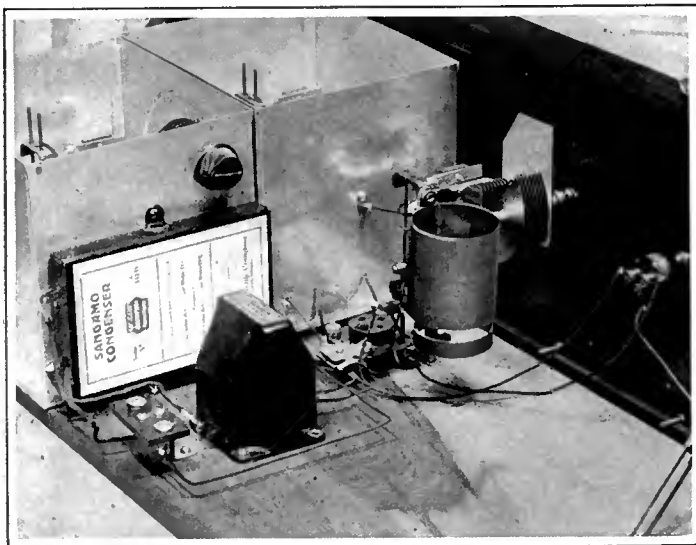
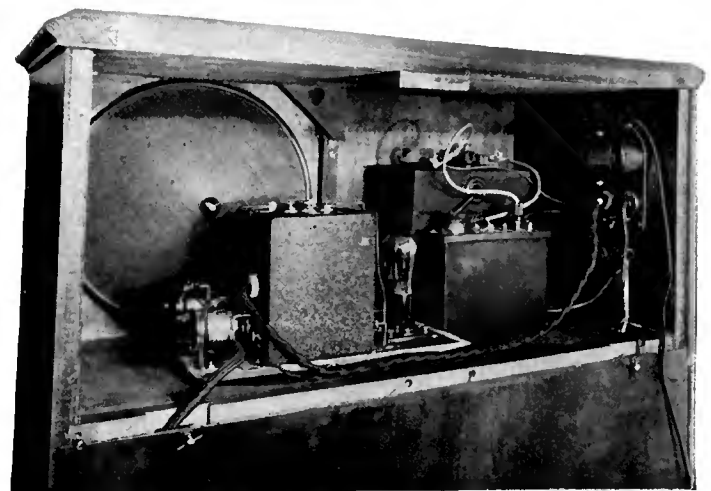


FIG. 5



THE OUTPUT DEVICE

It may be placed in the cabinet behind the condenser tuning the first r.f. stage



A CLOSE-UP OF THE POWER EQUIPMENT

Showing the storage battery, relay, trickle charger, and power-supply device. Note the substantial and well-insulated wiring

THE LISTENERS' POINT OF VIEW

Conducted by John Wallace

Why There Should Be More Vice in Radio

RADIO is too infernally virtuous. Now, before you apprehensively snatch this copy of RADIO BROADCAST from your little children's hands and consign it to the fiery maw of your furnace, let us make haste to add that we have no particular objection to virtue. It is an entirely praiseworthy institution. But, it always shows itself to best advantage when, for purposes of dramatic contrast, it shines out resplendently from the midst of accompanying vices—even if they be only petty ones. So, our thesis is: resolved, that radio acquire a few vices.

Radio, as we find it at present, is absolutely, utterly and completely devoid of vice. Its goody-goodyness is positively obnoxious. The goody-goody is always obnoxious. For the very virtue of which he boasts is a sterile thing, a negation. In the same manner, radio's flagrant virtue is a negative quality. And since its vice is a completely absent quality it follows that radio has no positive qualities at all, no tendency either towards good or towards evil. In other words it has attained that reprehensible and muchly-to-be-avoided state of complete *innocuousness*.

Than innocuousness there is nothing we know of that is more supervacaneous, nugatory, barren and ineffectual (don't ask where we got those!). The worst feature of innocuousness is that it is the very antithesis of stimulating.

Generally when anybody comes out with a categorical and emphatic statement (such as our contention that radio should acquire some vices), you may look close to home for the reason for the remark. And in the ruthless light of introspection perhaps we should own up to the motive underlying our plaint. The individual whose lot it is to make written comment on any current event rejoices when he encounters a scandal in his particular field of observation. The existence of something vicious gives him something provocative to write about. He may jump in right merrily and flay it, or defend it, according to his lights. The writer on politics has an occasional Teapot Dome scandal over which he may wax wroth and wordy. The drama critic now and again is confronted by an affronting play concern-

ing which he may spill many words, all of which will be gobbled up by his readers. The commentator on society has his occasional Countess Cathcart to provide material for sensational writing. The sports editor discovers that some team has been bought off in advance. All this, deplorable as it is, adds zest to the day's work.

No possibility of the occurrence of the unexpected faces your poor radio reviewer. Year in, year out, radio pursues the even and spotless tenor of its ways.

We say that radio's career has been spotless advisedly. For where indeed is there the slightest smirch of a scandal on its blanched books? To be sure, there was one—the exception that proves the rule. A year or so ago it was discovered that a bootleggers' ship hovering off the Pacific Coast was in some mysterious manner receiving informative assistance from the mainland. It developed that a radio announcer was so wording his announcements as to convey to the bootlegger crew advice concerning the movements of the prohibition forces. The story was printed far and wide and for a time it looked as though radio was going to feel its oats and supply something to talk about besides programs. But alas no, it settled back into its dull, unmischievous routine. And recently a New York announcer got into trouble for his pronouncements on religious tolerance.

We hardly know what to suggest. Friends of ours have come graciously to our assistance with

suggestions, but most of them are unprintable. Among them: why not, some day, from our eternally polite loud speaker, a burst of blasphemous language? That would be something to get indignant about. For instance a "remote control" microphone might be installed in some low pool hall. The resulting broadcast would be delightfully vulgar and obscene. As a result ministers would preach sermons from their pulpits; the press would break out in reproachful editorials; the station manager would be tried for disorderly conduct or murder or arson, and finally the station's broadcasting license would be revoked.

Would the net result of this "outrageous procedure" on the part of a "perniciously dangerous" station be entirely harmful? It would not. On the contrary it would be vastly useful. A wave of revulsion at bad language would sweep the nation. Spurred on by sermons and editorials and Womans' Club committees, the country would gloriously and noisily become purged of all inclination towards bad language. Pool halls would be padlocked everywhere and the country would settle down to a new era of belligerent virtue. And radio would have a nice white feather in its cap.

Or suppose some station should undertake to broadcast a series of Saturday night lectures by prominent murderers entitled: "A Few High Lights in My Career." F'rinstance as follows:

This is station KLM and now we present to you our regular Saturday night feature "Half Hours

With Prominent Prisoners." To-night folks we are fortunate in being able to present to you Minnie Glabstatter, the Tiger Woman. Miss Glabstatter, you will recall as the lady who poured her first husband into the meat chopper and drowned her second one in the gold fish bowl. She will now tell you her plans for doing away with the present Mr. G. Miss Minnie Glabstatter. . . .

A monstrous suggestion! But why not? The newspapers do it. And think of the stations who refused to lower their standards and stoop to such broadcasts. How they would shine by contrast. The *New York Times* seems much more virtuous for being found side by side, on the stands, with the tabloids.



INGA CRAWFORD AT WRVA, RICHMOND
Miss Crawford is the staff pianist at this Virginia station



DON BERNARD OF WAIU, COLUMBUS

Mr. Bernard is studio director of the station. Beside the duty of devising the radio programs for this station, Mr. Bernard occasionally contributes a tenor solo himself

means of the coded message. But is this golden opportunity for transgression avoided? Is it! This comment from wgy's manager:

The Schenectady station does not encourage the personal message and its management permits the use of our powerful facilities, only when the request for broadcasting is sponsored by the police authorities of the city from which the message comes and after all other agencies have failed. This rule is rigidly adhered to as the only means of protecting the listener from a great many "lost persons" announcements and of preventing impostors, criminals, publicity seekers, and practical jokers from imposing on the station management and listeners.

And this from wjz:

We receive numerous such requests daily, all of which we decline as politely as possible for several reasons. wjz's prime motive is to entertain the public. Such messages, while at times they may be humorous to those not vitally interested, are not entertaining. If we accepted any, we would be obliged to accept all, and soon we would be broadcasting nothing else. Another reason for refusing such material is the possibility of unscrupulous persons abusing the latest invention of science and making it an ally of evil rather than of good. If we were not extremely careful, it would be possible, by means of coded messages, for criminals to use the broadcasting stations as a means of communication. Rum-runners, by means of a coded appeal for a lost article, could let accomplices know of the whereabouts of a shipment of contraband, or a master criminal could give last minute instructions to his thugs by means of a prearranged coded appeal for a missing person. With over five years experience in the broadcasting field, we feel that it is much better for the general public that personal messages are not broadcast.



JOY BARTHELSON OF KGO

Miss Barthelson is a member of the Pilgrims, who are frequently heard from KGO at Oakland, California

The opportunities for vice are countless. This station might devote itself to luring young girls off the farm, while that one busied itself at undermining the democracy. This one might preach that the world is flat, while that one defiled the ether with an unexpurgated baritone solo of "Frankie and Johnny." This one might broadcast recipes for homebrew, while that one divulged chorus girls' confessions.

As was evidenced by the instance of the bootleggers' boat, radio's most convenient way of getting itself mixed up in a scandal would be by

Now if the stations weren't so darned careful not to be agents of evil, think what a zest would be added to our listening-in. We could all become amateur Sherlock Holmeses. Imagine the pleasure of matching our wits against those of master criminals and the thrill of decoding a message and telephoning it to the proper authorities just in time to prevent the blowing up of the Federal Building!

But, seriously, radio has got to shake itself free of its blind conformity to all that is considered accepted and proper in this day and age, or run grave risk of dying of dullness. Without



THE KDKA LITTLE SYMPHONY ORCHESTRA

Many listeners commented favorably on this ensemble in replying to the questionnaire which recently appeared in this department

resorting to any of the drastic means we have suggested earlier in this article it may enliven itself by this simple expedient: a relaxing of its censorship restrictions.

You may retort that radio hasn't any censorship. It is true that there is no official body of reformers sitting glumly in a committee room, attired in head phones, and with fingers placed in readiness on a key that will at a moment's notice charge the ether with a blue-penciling burst of static. But every broadcasting station manager is a self appointed censor, and heaven knows the self appointed censor is the most conscientious of the lot.

Of course he doesn't consider himself a censor; he regards himself as merely a necessarily prudent fellow. He says to an unknown or suspect artist, "Let me see a copy of your speech." If the MS. in question lambastes the Methodists or decries trade unionism or belittles Babbitry, or in any way whatsoever implies that God's not in his heaven or all is not well with the world, he is told "Dear sir, you cannot say that. Some of our listeners would be annoyed." Under the present regimen, the program inspector is right. For broadcasting stations are still trying to be all things to all men and as a result cannot touch on anything even dimly controversial.

In the field of printed publications, a field which very closely parallels broadcasting, we find very few periodicals, whether magazines or newspapers, that are attempting to please everybody. The *Atlantic Monthly* is much despised in one quarter and idolized in another. *True Confessions* is forbidden in some homes and read aloud in others. Personally, we are infuriated by *International Studio* and pleased beyond words by *The Arts*. Only one magazine do we find that attempts to please everyone and that is the *Saturday Evening Post* (also known as the Advertising Mens' Trade Paper). And where, we ask you, is there a duller, less inspiring, more innocuous sheet? We do not mean that there is no room for the *Saturday Evening Post*. Its "More Than Two and a Half Million" belies that. But there is room for no more than one magazine like it.

The trouble with broadcasting is that every station is trying to be the *Saturday Evening Post* of the air. It simply can't work out that way. Some of them have got to take it upon their shoulders to emulate the *Dial*, or *La Vie Parisienne*, or the *Dearborn Independent* or *Snappy Stories* or the *Radical Review*.

Every single station is doing its darndest to maintain its state of innocuousness. Now innocuousness never got anyone anywhere. The remark "The Fundamentalists are very nice people" can certainly be classified as innocuous. As such, its effectiveness is nil. It neither makes the Fundamentalists more fundamental nor the Modernists

more modern; nor does it open to either the viewpoint of the other. But say instead: "The Fundamentalists are a bunch of addle-brained hypocrites" and see what happens. Immediately there is action. Minds long covered with cob webs are stimulated to mental exertion. Which is in itself a good thing.

There is nothing more stimulating than opposition. Nothing so tickles one's superiority complex as the listening to statements by an advocate with whom one does not agree, and who is, for that reason, an arrogant idiot. We say to the station managers: Cut loose! Far less enmity will result from the broadcasting of controversial subjects than you think.

What if a few listeners are ruffled at being referred to as imbeciles or menaces, the whole business will be infinitely more lively and hence more fun.

Radio is too infernally virtuous!

Generally as a background, except when something of unusual merit is being broadcast.

Every evening Radio. (Other activities are the background.)

Your suspicion is right. We smoke, drink our very old rye (at least two weeks old), and talk and talk, and when the radio interferes we turn it down, or shut it off altogether.

Usually as to a regular show. Select programs carefully. Do not listen to all the "bunk" on the air.

If something special, a feature worth while, we listen until the bitter end. Generally however radio is "background."

50-50
Listen about 25 per cent. Use as background 75 per cent. (Your suspicion is correct.)

Yes we give it our undivided attention, when programs are good—otherwise we choke it off.

For a good feature program we listen as though at the theater. Many programs aren't worth listening to, so the set is turned off to avoid competition.

Used as a background mostly, because the general program is of such quality that neither the artist nor the selection is such as to demand continuous attention.

Usually tune-in w/j; listen and read a good book or magazine. Down to an art now—can even absorb Voltaire and Olsen simultaneously.

2. Do you regularly tune-in on distant stations or do you regularly rely on your local stations? [This was question two.]

Rely on local stations primarily because congestion has almost ruined dx reception.

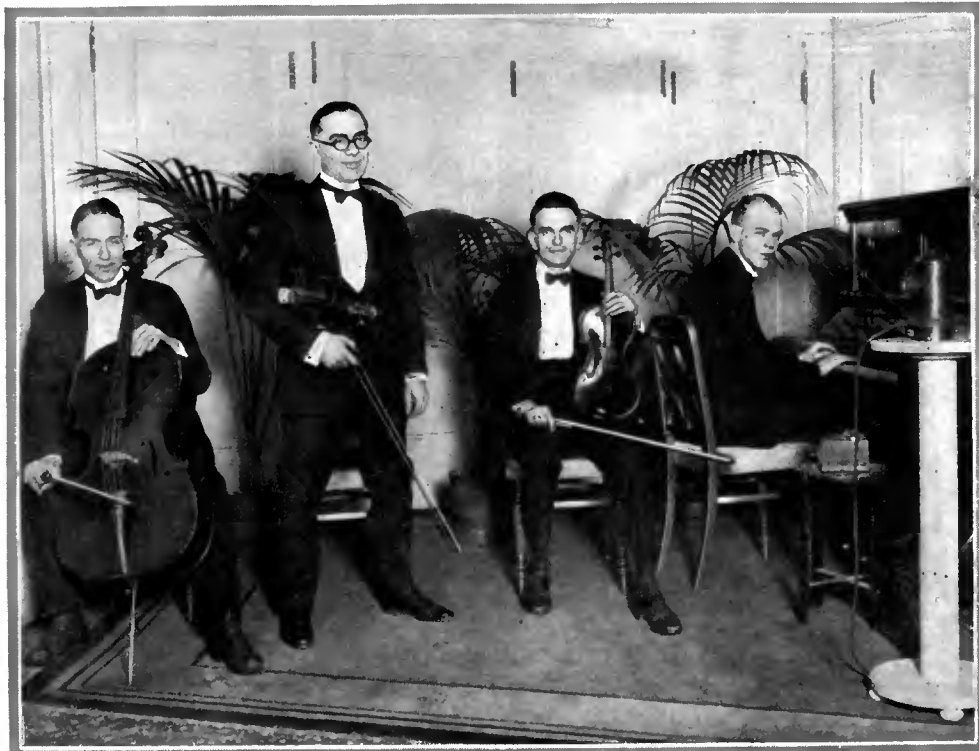
I am emphatically a dx hound. I get more pleasure from a distant program or a new station than from any amount of locals, who are always with us.

The station from which the program sounds best regardless of location. dx means nothing to a sensitive receiver. All stations are locals.

Probably three fourths of our entertainment comes from the local or near-by broadcasters, but, the lure of distance still holds its charms. I have often seen the statement made that the dx hound is vanishing and this is all wrong. It is a natural error. Most radio writers are experimenters and the realization finally comes to all experimenters that we must as yet rely on the locals for consistent good reception. The new owner of a radio set demands distance . . . and if his set does not get distance regularly he is dissatisfied. The man who knows nothing of radio expects too much. The man who knows much of radio expects reception over great distances to be decidedly inferior to that of locals—nevertheless most of us still get a kick out of hearing that station two thousand miles away.

The distant ones. If I relied on KFNH and KMA, KSO, KFEQ, etc. I'd be nuttier than I am now. WHO and KFAD only decent stations out here. (Nebraska.)

90 per cent. local, 10 per cent. distance.
Yes sir!! dx gives a thrill that locals, no matter how good they are, cannot produce. The man who says he only wants locals has a good reason for saying it. His set won't get anything else. If



AT KOA—THE BROWN PALACE STRING ORCHESTRA

For more than a year this organization, under the direction of Howard Tillotson has been broadcasting dinner concerts from the Denver station of the General Electric Company

Answers the Questionnaire Brought Forth

SINCE we prepare this department many weeks in advance of publication, at the time of writing the first responses to the questionnaire in the January issue have only just come in. And very painstakingly and drolly filled out they are! Of course we won't be able to deduce any general conclusions as to the tastes of our clientele until all the replies are in, so the statistics will have to wait until the May issue. But in the meantime it seems only fair that we share with you the fun of reading the replies. Here are excerpts from the hundred or so answers we have at hand:

1. Do you listen to your radio as you would to a regular show, or do you simply turn it on and use it as a background to other activities? [This was the first question asked].

I always listen to the radio as I would to a regular show. If conversation or other activities must be indulged in, I shut off the radio.

he could get dx easily he would be just as much of a fan as the real dx bug.

The writer is a dx hound. This comes after the program part of the family retires.

Rely on local (Cleveland) or near-by stations. dx in my opinion is a thing of the past.

I try regularly in spite of the advertisers, "hi-power," and the congested wave channels. What would the average receiving set be like to-day if there had never been any so called "dx hounds"?

What do you call distant stations? For clearness and volume our (Florida) best programs come from Chicago and New York, KDKA excepted.

Keep two complete sets in commission. One in living room for general entertainment and quality reproduction. One in den for fishing, but the fishing has become almost impossible of late due to congestion of ether.

Confirmed dx hound of worst variety. Not interested in dx. Bore me stiff to hear or read anything concerning dx. Rely entirely on local New York and Newark stations. (not more than 5 in all.)

3. If you had a hundred minutes to listen to all, or any part of the following broadcasts how would you apportion your time? (At the center of the page is a table set up from a random selection of ten ballots arranged in parallel columns. Plays and speeches don't seem to be faring so well!)

4. What are the six best broadcasts you have heard? [This was the last question.]

Answers to this question, as you may suspect, cover a lot of ground. Here are a few we come across oftener than others as we glance through the replies: Radio Industries Banquet; Dempsey-Tunney Fight; Victor concerts; National Broadcasting Company Inaugural program; McNamee's World Series 1925; Goldman Band; various Atwater Kent and Eveready Hours; Boston Symphony; New York Symphony; Balkite, Maxwell, Ipana, Goodrich, Royal, A & P, Clicquot, Whittall, and so forth, Hours; Ford and Glenn; Jones and Hare; President's Messages; Army-Navy Game; 1925 and 1926 Democratic National Convention; U. S. Marine Band; Damosch Recitals; KDKA Little Symphony; WGN's "Down the Mississippi"; Dr. Cadman; KDKA Westinghouse Band; "Roxy"; Penn. Railroad Hour, etc.

Perhaps the most interesting bits of information gleaned from the questionnaires are the unsolicited remarks decorating the margins. Also a number of readers have contributed lists of "pet peeves." Many original and valuable suggestions are made. But lack of space necessitates reserving these quotations for a future issue.

Broadcast Miscellany

WOS is conducting a Missouri Music Appreciation Contest, sponsored by that state's Department of Education. The contest is open to any student in any rural, elementary or high school in Missouri. The final contest will be held Monday evening, March 14. Certificates of award will be given by the Missouri Department of Education to the students. The plan was decided upon to stimulate a greater interest in music among school children and to direct their taste towards good music.

THE erstwhile WOAW is now broadcasting under the letters wow, which is the official insignia of the Woodmen of the World. At the

time the station was granted its license to broadcast in 1923, it asked the Department of Commerce for permission to use wow as a call but at that time the steamer *Henry J. Bibble*, operating on the Pacific Coast, had been assigned this call. Removal of radio apparatus from the vessel recently caused cancellation of the letters. wow's station has been completely reconstructed and new equipment installed with a power of 1000 to 2500 watts.

WSM, following a month's silence during alterations, has returned to the air by way of a brand new transmitter, a 5000-watt Western Electric.

THE George Gershwin concert on the Eveready Hour we considered pretty hot. The composer himself was at the piano, and was assisted by the Eveready Orchestra and singers. Of course Gershwin had to be good. But added to the inevitable merits of the artist was the rare skill exhibited by whoever arranged the program. It was ably balanced, the serious compositions deftly relieved by lighter ones, and the announcements were terse and interesting. Outstanding numbers on the program were his incomparable songs "Suanee" and "I Was So Young and You

INSTRUMENTAL MUSIC	<i>Serious</i>	15	25	50	10	100	28							
	<i>Light</i>	30	25		40		30	40	30	15	15			
	<i>Popular</i>	30	25		20		1		30	15	30			
VOCAL MUSIC*		1	10	20	5		1	10		5	10			
RADIO PLAY					10					15				
SPEECH				5						5				
EDUCATIONAL LECTURE					5		20			20	10			
MISCELLANEOUS NOVELTIES		23	10	30	10		20	50		10	20			
TOTAL MINUTES		100	100	100	100	100	100	100	100	100	100	100	100	100

*An astounding number of answerers here make marginal and deprecatory remarks about sopranos. Another goodly number demands to know why we didn't leave a space for sporting events. Probably we should have; but we limited ourself to programs originating in the studios.

Were So Beautiful." And in more pretentious vein: the "Concerto in F" and "Rhapsody in Blue."

THE Atlantic Broadcasting Corporation purchased the Grebe group of stations, including WAHG and WBOG. The new organization has its studio on the seventeenth floor of Steinway Hall, New York City. The transmitters are located at Richmond Hill, Long Island. Its first undertaking was to change the WAHG call letters. The station's call is now WABC; its power is 5 kw.

H. V. KALTENBORN of the Brooklyn *Daily Eagle*, on the subject of radio education:

Another possible development is the creation of an endowed radio university, consisting of a super-power broadcasting station and a special staff of educators selected for their ability to make a wide popular appeal by the lecture method. Such an university would at the same time be a radio research institute free from all the handicaps which circumscribe the influence and activities of the commercial stations. It would not provide entertainment in competition with other stations, but would constantly experiment with new ideas. With an endowment of \$1,000,000 and an operating expense of \$100,000 a year, such a radio university could rival institutions spending twenty times as much, in the number of its students, character and value of courses, and general contribution to good citizenship. Here is an opportunity for a benefactor who is looking for a new way to do something for mankind. Whoever creates the first radio university will set a force in motion that may revolutionize popular education. The opportunity is a rich one for constructive achievement in the development of our democracy.

FROM KOA is available from time to time a band made up of twenty saxophones. It is directed by James M. Reese

WOR, in cooperation with the Bureau of Information Pro España of the International Telephone and Telegraph Corporation, and the Spanish Chamber of Commerce in New York, is presenting, at present writing, a series of Monday night concerts by the Spanish Symphonic Ensemble under the leadership of Julian Huarte. A commendable effort has been made in arranging these programs to include Spanish music of a type that is more or less unfamiliar.

FRANK REICHMANN, radio manufacturer, opines that "politics, the biggest business in the world, finds itself way behind all other big business in making use of the latest method of advertising. There are Eveready Hours, Ipana Hours, Maxwell Hours, and almost a hundred other hours, but up to now there hasn't been a Republican Hour or a Democratic Hour:

What a marvelous opportunity it would be, let us say, for the Democratic Party to sponsor a series of performances of Paul Whiteman and his orchestra; they have established themselves

in the minds of the public as a political organization with advance ideas; they have a jazz mayor in New York and a syncopated governor of the Empire State—why shouldn't they establish a real Syncopated Hour each week over a chain of stations? Now the Republican Party and its old guard, might do well to establish its Hour with an old-time orchestra such as is now touring vaudeville. It would keep in the minds of the public the rustic simplicity of the Coolidge régime without saying a word about it. Of course that would almost leave the Socialist Party without a musical

counterpart for broadcasting purposes but upon second thought this wouldn't have to be so, for modernistic music such as is sponsored by the "League of Authors and Composers" fits in ideally with the Socialist program. This provides for the three major parties. It would be up to any new political groups to do some tall thinking for a musical setting. There should always be music enough for all.

ACCORDING to the results of research made by the publicity staff of WBAL, only eight per cent. of the radio fans in this country and Canada are women. Concerning this discovery they comment: "This fact may not be of any actual significance, but it is nevertheless provocative and causes one to consider a bit regarding it. While we have no idea of offering any alibi for the women, the reason for their evident lack of enthusiasm for the radio is no doubt largely due to the fact that women, generally, have but little mechanical sense and, lacking that, they naturally lack the patience to become dial experts. Many letters that come to WBAL are signed 'Mr. and Mrs.' but nine times out of ten such letters are written in a bold, masculine hand."

This does not necessarily mean that women are not as interested in the radio and its development as the men. But just as it has only been within comparatively the last few years that women generally have become automobile drivers, just so will it likely be another decade or more before they will begin to grasp the technical and scientific side of the radio when they will develop from casual "listeners-in" to ardent fans themselves.

What You Should Know About B Power-Supply Devices

Sparks from the Radio Broadcast Laboratory Where Many Units for Supplying Power to the Radio Set Directly from the Lighting Main Have Been Tested—Intelligent Selection Not Easy—Helpful Suggestions for the Prospective Purchaser and User

By EDGAR H. FELIX

RADIO BROADCAST'S laboratory is an ever changing scene. Daily, shipping crates, boxes, and packages arrive, bringing the latest developments of manufacturers. These products are subjected to every conceivable performance test, with a view to determining their value to the broadcast enthusiast.

Among these daily surprises, there is always a large percentage of plate potential power-supply devices. Outwardly, they are all quite similar—a few binding posts, two or three regulating resistances, a tin box finished by some ingenious process, and an instruction sheet. The leaflets, describing these devices for the delectation of potential customers, make like claims of unflinching reliability, silence, unfluctuating output, and capacity to meet the requirements of any set. One would think from such casual observation that all power-supply devices are about alike in their possession of unalloyed virtues. Some brands approach in performance tests these widely claimed good qualities, but others are nothing more nor less than downright failures.

To write of B battery substitutes in general terms, with the object of assisting in their wise selection and their proper maintenance, is difficult because there are no simple rules to guide the prospective purchaser. Faithful readers, radio oracles of their communities, buyers of radio concerns and prospective purchasers, however, write for aid on these matters so frequently, that we know information on the commercial variety of power-supply devices is in great demand. The problem is to give really helpful advice which will aid in appraising the performance of a device, without suggesting a series of impossible laboratory tests.

The history of plate potential supply has been one of continuous progress. Plate potential is the food of the radio set, just as vacuum tubes are its heart. If the plate potential nourishment is not satisfactory, the receiver is bound to be anaemic in its performance. From the beginning of radio, power supply devices have been forced to lag behind tube development for, as new tubes with new requirements come on the market, existing supply devices become inadequate.

POWER-SUPPLY'S BIGGEST PROBLEMS SOLVED

THE power supply devices sold during the first season they appeared on the market were hopeless failures. In the first devices 201-A tubes were used as rectifiers. So inadequate were one or two receiving tubes for feeding plate current to five or six tubes of equal size that power supply devices received a serious setback in public estimation. Then came the new special rectifier tubes, giving adequate current output and fairly steady voltage regulation. Improved filament and non-filament type tubes placed on the market early this season, and certain successful chemical rectifier devices, have finally made the plate potential power supply

an acceptable accessory to any radio set of heavy plate current drain.

But the troubles of power supply devices are not entirely solved. The radio industry had quite generally adopted the attitude in its advertising literature that the products of to-day are perfect and that yesterday's weaknesses are entirely overcome. It resents public discussion of imperfections, fearing the effect upon sales. If one whispers that condensers in B power-supply devices are liable to puncture, the wrath of a dozen manufacturers is likely to be heaped on one's head. Yet, the automobile industry thrives, although in its thirtieth year, tires still puncture, valves must still be ground and spark plugs must still be renewed.

We propose to discuss the weaknesses of plate potential devices to aid buyers in their selection and users in overcoming their weaknesses. A little foreknowledge will protect the radio industry from its worst enemy—a disappointed customer.

WHY NEW WEAKNESSES DEVELOP

THE most important limiting weakness of the B power-supply unit has already been practically conquered by the development of tube and chemical rectifiers capable of supplying adequate current of the necessary voltage for almost any type of tube. The weakest link of any chain is always the first to break. A year or two ago it was the tube; now that the tube has come up to requirements, other parts of the B device are beginning to show their failings. This year, condenser breakdown and, to a limited degree, failure of regulating resistances, are the principal sources of service calls. Next year, as condenser weaknesses are overcome, it may be something else. And so it will continue, each problem becoming of lesser magnitude.

The satisfaction which any such device gives bears a fairly close relation to its cost. A B-supply unit can be built to fit almost any price. The cheaper it is, the greater must be its failings. A fifteen-dollar instrument may perform almost as well as a hundred-dollar one on demonstration, but whether it will stand up in use is certainly open to question.

The remarkably fine spirit of service shown by the better manufacturers assures the buyer that he will be protected in his investment if he selects a familiar and freely advertised brand. The first rule in the purchase of a B battery substitute is insistence upon a well known make, purchased through a reputable and responsible dealer. This is of even greater importance than what may be gained by a technical study of such devices.

Essentially, the B power-supply device comprises:

(1) a transformer which steps up the line voltage to an amount determined by the require-

ments of (2) the rectifier element and the voltage output desired therefrom; (3) a system of inductances and filters to smooth out the rectifier tube's pulsating output; (4) a potentiometer output device to obtain various voltages.

RECTIFIERS, TUBE AND CHEMICAL

THE majority of makers use tube rectifiers of some sort. Not all tubes used in B power-supply devices, however, are perfect. Whether the advantage lies with filament or non-filament types is not as certain as might appear. The fact that there is no filament to burn out in some tubes is a striking argument in their favor. As a matter of fact, however, a filamentless rectifier after long use undergoes vital changes in its gas content so that it loses its rectifying properties. Thousands of filamentless and filament type rectifiers have been subjected to heavy service for as long as two years without breakdown, so that the superiority of one type or the other has not been very forcibly demonstrated. The advantage of large and uniform production which makes receiving tubes superior, applies also to rectifier tubes. Therefore, avoid an unknown tube, with or without filament, and give preference to products of known and established reputation.

Chemical rectifiers, such as those using tantalum and lead as elements, serve for years and some of the best devices made are of the chemical type.

FOLLOWING MAINTENANCE INSTRUCTIONS

ONE warning to the owner of a chemical type of rectifier: Follow the manufacturer's instructions as to maintenance religiously. Adding a few drops of distilled water every few weeks is a very slight labor, much less attention than you give to keep your pet geranium in good health. If you fail to add water periodically, you are bound to have rectifier trouble. If you do obey instructions, you are likely to obtain years of reliable and economical service.

Also watch particularly the instructions given as to placing the chemical type of unit out of service if it is not to be used for a month or two. With some chemical rectifiers, if you do not observe certain precautions, you will find them totally dead when you return from your vacation. Nor can they be resuscitated from their collapse at your callous abandonment without the purchase of new rectifier elements. The precautions which must be observed are quite simple.

Some manufacturers, however, are somewhat bashful in telling you that their power units require a bit of care. If you do not buy from a conscientious dealer who warns you of such things, write a letter to the service department of the manufacturer, asking for instructions as to how the device may be placed out of service temporarily. This simple act may save you ten or twelve dollars.

VOLTAGE REGULATION

THE usefulness of a power device is determined by the range of current drains it supplies at usable voltages. This is termed its voltage regulation. If the unit is of insufficient capacity, it will deliver less to the tubes of the set than the required voltage at heavy current drains. Voltage regulation is modified by the filter element of the device, so that the only way to be thoroughly sure of its capacity is to measure its voltage output over the entire range of current drains encountered with normal receiving sets. The accompanying diagram shows the voltage outputs of several devices tested at the RADIO BROADCAST Laboratory. Before considering the significance of these curves, however, we will examine the filter element, an essential part of the circuit.

The filter is essentially a condenser "tank" fed through high impedances which absorb low frequency current variations. The rectifier pumps out a pulsating current, just as a giant water pump, filling a reservoir. The chokes act like a breakwater, seeking to meet the impact of the pump strokes, so as to make the reservoir beyond as smooth as possible. At the far end of the condenser reservoir, smooth, ripple-free current is drawn. Obviously, the larger the impedance of the chokes and the larger the capacity of the condenser the smoother the output wave form.

No amount of inspection will reveal the ruggedness of the condensers or the impedance of the chokes. The size of the choke is not a guide to its effectiveness because a large choke with a cheap iron core may not be as good as a small one using high quality, selected and aged iron.

AVOIDING CONDENSER BREAKDOWNS

THE purchaser of a B power-supply device can reduce the chances of condenser breakdown to almost nil if he obeys the instructions of his dealer and those in the booklet accompanying the device as to the order in which receiving set tubes

and B unit should be turned on and off. Some manufacturers are quite precise in their instructions; others neglect to mention this important point. The mystifying failure of a power device which has given good service throughout the previous evening is probably the penalty of turning on the set incorrectly.

In going over the instruction booklets of a number of manufacturers, we do not find any uniformity in their recommendations. In the absence of advice from the manufacturer, the best practice is to turn on the receiving set first and then the power unit. This places an immediate drain on the device so that excessive voltages will not be encountered. The strain on the smoothing condensers is thereby greatly reduced. When turning off the set, first turn off the B supply unit, thus dissipating the charge which would otherwise remain on the smoothing condenser. Then turn off the receiver tubes. If this practice is invariably followed, the chances are that little or no difficulty will be encountered due to condenser breakdowns. These instructions had best be followed unless the manufacturer definitely states they are not necessary. Many devices are so constructed that difficulties of this nature do not arise.

The series of curves in the accompanying diagram were prepared by RADIO BROADCAST Laboratory, showing the voltage output of numerous makes of B supply units throughout the normal range of current drains. All of these devices show that the voltage falls as the current drain increases. If the tubes of the receiver are not lighted, the current drain is zero and the instantaneous voltage rises in some cases to dangerously high values.

These curves also show the great variety in the output of different devices. Some, when subject to heavy load, strain and weaken because the rectifier tube is not capable of supplying the demand. Others hold up well. Those giving the most uniform output are of two types, (1) chemical rectifier devices and (2) those

equipped with ballast or voltage regulator tubes. The chemical devices obtain their good voltage regulation because of their low internal resistance, while the regulator tube types accomplish the result because they automatically vary the rectifier tube's load so that the output is maintained at a specific voltage. The chemical types do not, in a general way, cost more than the usual run of B power-supply devices but those equipped with regulator tubes are more expensive than the average, but they give good service with almost any kind of set.

The family of voltage regulation curves shows a tremendous variation in the performance of different devices. It is a well known fact that a B power-supply unit may give satisfaction with one make of set and fail with another seemingly quite similar. This may be due to faults in receiver design, but more than likely it is due to the power devices' inability to furnish the plate voltage required by the set at its particular current drain.

SELECT A B-SUPPLY UNIT THAT MEETS YOUR SET'S REQUIREMENTS

SINCE the voltage output of most B-supply units depends upon current drain, selection is a matter of knowing a receiver's plate current requirements and finding a device which delivers sufficient voltage for each of the tubes in the set at that particular drain. If the plate voltage supplied to a radio-frequency amplifier is somewhat too high, the average set is almost certain to oscillate. To give leeway in plate voltage output, most B devices are equipped with variable resistances. These and other resistances in the output circuit must be suitably bypassed. A resistance not properly bypassed may cause coupling between two or more stages of the amplifier and thus cause a squeal.

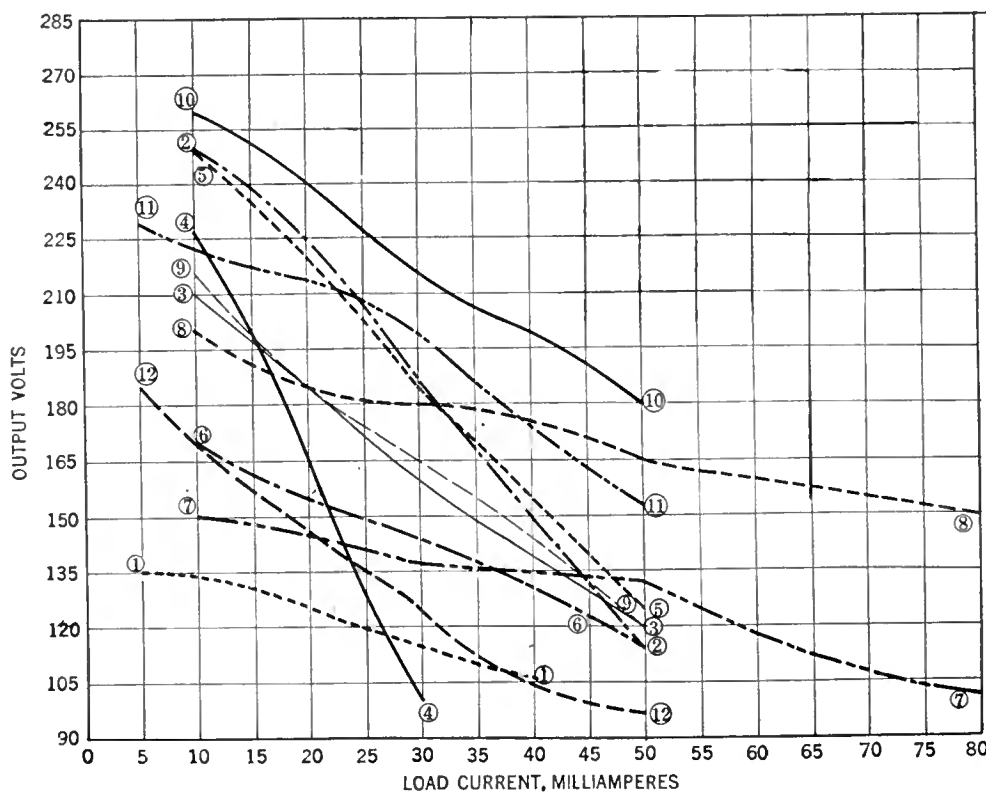
Howling and whistling is usually due to excessive plate voltage supply to radio-frequency amplifier or detector tubes. The lower the current drain the higher the voltage output of most B-supply devices regardless of the terminal markings on the binding posts. Whistling is usually curable by readjustment of voltage supply to the set. A few poorly designed units with inadequate bypassing condensers, cannot be cured of their whistling tendency by adjustment of voltages supplied to the set.

DETERMINING THE CURRENT DRAIN

IF YOU know the exact drain of your set and the voltage required by each tube, it is not difficult to determine, from the voltage regulation curve, whether a certain B-supply device will give it the required plate voltages at the required current drain. As an aid to those who do not possess an accurate milliammeter for measuring current drain, the accompanying table gives the plate current of standard tubes at grid potentials and plate voltages customarily used. Individual tubes vary somewhat from the figures given, and a small percentage deviation in filament current or plate voltage modifies the figures somewhat. But the table is better than no guide at all; with its aid, it is possible to compute the total current drain of almost any receiver. The $1\frac{1}{2}$ -volt positive grid bias figures should be used as the basis for determining the plate current of detector tubes in circuits where the grid return is made to the positive filament lead.

INTERPRETING THE VOLTAGE REGULATION CURVE

THE curves in the diagram on this page show the maximum voltage output of various typical B power-supply devices at various current drains. Device No. 1, for example, gives 128 volts at 18 milliamperes and 115 volts, at 30 milli-



CURRENT-VOLTAGE CURVES

These curves are of a dozen typical B power-supply units and were made in the RADIO BROADCAST Laboratory. They indicate clearly how the output voltage rapidly drops as the current drain is increased

amperes. This device, being equipped with a regulator tube has a good output. It would therefore, be suitable for use with a receiver using an UX-171 tube in the last stage. Device No. 10 would also power such a receiver satisfactorily. The voltage output from each of the other voltage terminals also falls proportionally as these curves indicate.

If accurate data as to the output at various current drains is not available, it is impossible to obtain it with an ordinary voltmeter. The current drain of an ordinary voltmeter is sufficient to modify greatly the output of the B device so that the reading is valueless. A special high-resistance instrument, such as a Jewell No. 116 or a Dongan, Type A, is necessary to measure the voltage output correctly.

Some power-supply devices are equipped with C battery output terminals, eliminating the necessity for a C battery as well as B battery. C batteries are inexpensive and usually give at least a full year's service, hence their elimination, although a convenience, is not of paramount importance.

CAUSES AND ELIMINATION OF THE HUM

THE silence of output is an important factor in the service ability of B power-supply device. This is universally claimed for every power device which we have seen, although attained by comparatively few. The fact that a hum is drowned out by a loud program does not alter the fact that it introduces distortion and imperfection in the musical output. We quote the following sentence from the advertising literature of one manufacturer to show how freely the quality of silence is claimed:

The — B-supply device is totally free from hum, even on earphones.

Then, turning to the operating instructions which the customer receives after he has purchased this brand of B device, we read:

Turn on the current by means of the switch on the supply cord. A very slight hum should be discernible when you listen with each ear about a foot from the unit. This hum shows it is functioning properly.

Under the circumstances, the only criterion in judging the quietness of B-supply device is the listener's own ears.

The hum may be due to inherent faults in design or, with better devices, to the manner in

RECEIVING TUBES														
GRID POTENTIAL		+1½ (Det.)			0				-1½		-3		-4½ -9	
PLATE POTENTIAL →		22½	45	90	22½	45	67½	90	45	67½	90	45	90	135
TUBE: 201-A		.65	2.3	7.7	.25	1.3	3.4	6.0	.6	2.1	4.7	.25	3.2	2.0
200-A		.75	3.0	5.5	1.1	2.0	2.9	4.0	1.0	1.5	2.5	.4	1.1	.6
199		.61	2.0	5.0	.36	1.4	2.8	4.2	1.0	2.1	3.6	.5	3.0	2.5

POWER TUBES																
GRID POTENTIAL		-9		-16½		-18			-22½		-27		-35		-40½	
PLATE POTENTIAL →		135	90	90	135	250	135	135	350	425	180	112	120	171	210	
TUBE: 112		9.0	—	3.1	—	—	7.4	—	—	—	—	—	—	—	—	
120		—	—	—	—	—	—	—	—	—	—	—	—	—	—	
171		—	10.0	—	—	—	—	16.0	18.0	22.0	20.0	—	—	—	—	
210		—	—	—	—	12.0	—	—	—	—	—	—	—	—	—	

which they are installed. Cheap devices have small smoothing condensers and chokes. This accounts not only for their objectionable hum but also for the manufacturer's ability to produce the device at low cost. More expensive

A slight hum is not at all objectionable, but, if it can be heard several feet from the loud speaker, your dealer should be consulted immediately, while the device is still new. He may be able to quiet the device by better placing or improved voltage adjustment; otherwise, he should replace it.

There is no more satisfactory method of testing a B power-supply device than by giving it several days' trial in your own home. A cut price dealer cannot afford to do this for you. The insurance of satisfaction, resulting from buying from a reputable dealer, makes it wise to pay the extra cost involved.

Another brand of blue sky claim, made by some B device manufacturers, are those dealing with the cost of operation. Apparently, B-power units cost next to nothing to operate; a few cents a month at the most.

The chemical types draw a heavy current for the first few minutes of operation, when they are first installed, but the power soon falls to a reasonable figure. The average tube or electrolytic device draws from 15 to 35 watts, according to load; those with one stage of power amplification, between 45 and 50 watts; and regulator tube equipped devices, from 30 to 35 watts.

Using a set an average of 15 hours a week, the total watt hours per month for a 30-watt unit is about 2000 watt-hours, or from 14 to 50 cents a month, according to the power rate. But current is not the only cost. To this must be added tube upkeep and depreciation. Figuring five years' life for a \$50 device, depreciation averages 80 cents a month. Tubes at \$4.00 a year add another 35 cents a month. So that instead of "ten cents a month," as one maker once advertised, costs may be as high as \$1.00 to \$2.00 a month. This should not, however, be compared directly with B battery costs because good B devices also give much greater convenience, there being no heavy batteries to carry and install. They also give a steady, instead of progressively falling, voltage output.

From the foregoing dissertation upon the ills and weaknesses of B power-supply devices, one might conclude that they are very unsatisfactory and uncertain devices. As a matter of fact, their most serious imperfections have already been conquered and, if care is used in selection and a few simple precautions observed in care and operation, they give highly satisfactory and lasting service.



A TYPICAL B-SUPPLY DEVICE

Similar to many tested in the RADIO BROADCAST Laboratory. It is a product of the Cornell Manufacturing Company, Long Island City

devices sometimes hum, but this is generally due to improper adjustment. The most common cause of hum is magnetic induction from the transformers and chokes into the receiving set. By carefully changing the angle and distance of the B device from the set while it is in use, a position can usually be found which eliminates magnetic induction. Another cause of hum is excessive detector voltage or excessive amplifier voltage, or open or improper C battery connections.



NEW UNITS FOR SUPPLYING B POWER

The Valley B Power, using Raytheon tube; the Balkite Combination Radio Power Unit, which, when connected to the A battery furnishes power both to A and B circuits. It is controlled by the filament switch on the set and is automatic. Price \$59.50. Next is the General Radio Power Amplifier and B supply. Finally, the All-American "Constant B" using a Raytheon tube, which sells for \$37.50

Building the R. G. S. Inverse-Duplex Receiver



A FRONT OF PANEL VIEW OF THE R. G. S. RECEIVER

Constructional Data on a Four-Tube Receiver so Made as to Give Six-Tube Efficiency—Operating Instructions, Emphasis Being Laid on the Correct Usage of the Antenna Tap Switch—Test Results Obtained with This Receiver

By DAVID GRIMES

THIS article is the third in a series describing for readers of RADIO BROADCAST the latest circuit developments in the new Inverse Duplex System. The present article gives the constructional details for the adaptation of these developments to a radio receiver—the new R.G.S. receiver. The parts selected for the R.G.S. were chosen only after many tests on many different makes of apparatus had been made, and overall performance, based on the particular requirements of these circuits, was always the deciding factor. Particular attention was devoted to the design of the audio channel.

Too much emphasis cannot be placed on this phase of the circuit in view of the great demand for receivers delivering good audio quality. It is quite essential to have bass notes, but, at the same time, the high notes cannot be sacrificed in this sudden rush for the deep pitches. Many receivers have this limitation present so that, while they are resonant and mellow on music, they are indistinct for vocal reproduction. By pronouncing the letters in the alphabet, it will be noticed that many of them are merely the vowel "e" prefixed by some high-pitched sound produced by the lips or teeth. Such letters are b, c, d, g, p, t, v, z. Without excellent reproduction of the high audio frequencies, all of these letters would sound alike.

Tone quality is only one of the several features on which the real performance of the new Inverse Duplex is built. By far the most important factors are equal r.f. amplification and uniform r.f. selectivity throughout the broadcast band. From descriptions in the preceding articles, the reader should be well aware that the r.f. filter feedback circuit is responsible for this innovation. Yet, the satisfactory performance of the radio circuit is not based only on the filter coil. The electrical constants of the r. f. filter coil were determined solely with a definite type of r.f. tuned transformer. The design of the filter coil and the design of the tuned transformer are correlated because the object of the feedback circuit is to compensate the inherent deficiencies in the tuned transformers. To make the con-

struction easy, the simplest type of tuned transformer was decided upon before the final values were determined for the filter coil. So please do not adopt some other type of tuned transformer because it is the "ideal" type in some other circuit.

The same coordinate design extends throughout the receiver, so all of the values given have been determined by considerable research. These values, while not critical, should be adhered to if the remarkable performance which this receiver is capable of, is to be expected. In a word, do not attempt substitution as, in this case, will be poor economy in the end.

Having determined the circuits and the proper apparatus to use, the next step is to mount correctly the units so that no detrimental interaction occurs. Reference should here be made to Fig. 1, which shows the top view of the base panel, on which is mounted the equipment. The relative positions of the various parts are indicated in the diagram.

The R.G.S. receiver has been arranged for two-control tuning by combining the second and third tuning condensers on one grounded shaft. This allows the antenna tuning condenser, C₁, to be adjusted separately, which tends toward greater flexibility. Thus, any change in the antenna tap switch which necessitates a change in tuning of the associated tuning condenser, can be made without reference to the double-tuning condenser.

In order to allow for any variations in coils, condensers, wiring, or tubes, and still benefit by the excellent selectivity of the receiver, a small vernier variable condenser, C₄, is placed across the detector tuning unit. This tuned detector

circuit is not quite as sharp as the other two tuned coils, so the adjustment of the vernier, when located here, is not critical. Its best adjustment should be found, however, especially if maximum selectivity is desired. The adjustment of this vernier may be slightly different at the various wavelengths.

One section of the physical arrangement will need explaining at once. It appears on the surface that all known engineering rules have been violated in the mounting of the second and third tuning coils. Under ordinary circumstances, coils so mounted would result in instability and oscillation, due to the third coil feeding back into the second. But this all depends on the polarity of the feedback. It is quite true that trouble would occur if these two coils were similarly mounted—so they are not. The third coil is mounted upside down with respect to the second coil. The grid end of the third coil is at the bottom near the baseboard, while the grid end of the second coil is at the top. This causes a slightly opposing feedback to occur, but due to the very loose coupling between the coils, this opposing feedback is only noticeable at the short waves. The stabilizing influence is needed when no shielding is employed as oscillation tends to take place by means of electrostatic feedbacks without the shields. Thus, mounting these two coils in the manner outlined, entirely dispenses with the need for r.f. shielding to obtain stability.

The antenna coil is placed at right angles to the other two tuned coils so that no magnetic feedback is possible, and the remote location of it precludes any possibility of electrostatic feedback from the other coils. The antenna coil is slightly different in its construction. The primary winding is preferably located inside the filament end on a separate section of tubing, while on the other two coils, the primaries are wound on the same tubing as the secondaries, at the filament end. Details of the construction of these coils are repeated here in Fig. 2.

The two radio-frequency tubes and the detector are located near their associated tuning units so that the grid leads may be kept short. The ganging of the two condensers thus up-

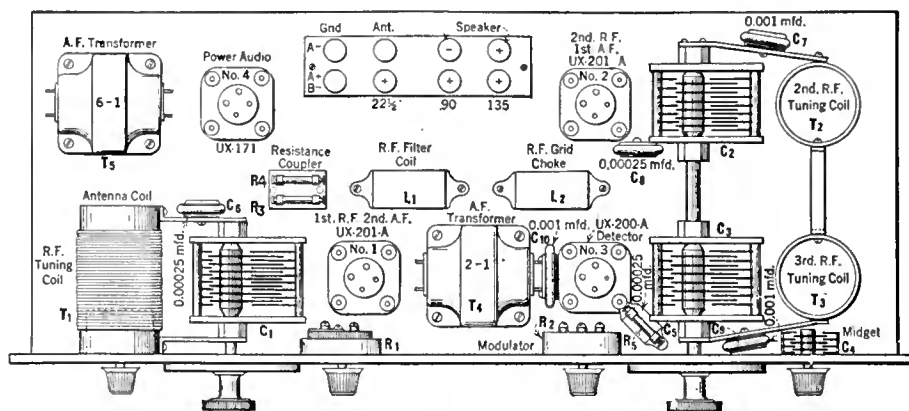


FIG. 1

In this sketch the placement of all the parts entering into the construction of the receiver is clearly shown. The base, which is supplied with the kit, comes drilled so that all the parts may be readily mounted as shown

sets the conventional arrangement somewhat, placing the second r.f. tube behind the detector. The two audio transformers are purposely widely separated to prevent annoying audio howls. The power audio tube is placed near this third audio transformer to give a short grid lead. This places the tube somewhat out of line.

The r.f. filter coil and r.f. grid choke may be placed in line, as shown in Fig. 1., with no resulting trouble, because their magnetic fields are very small.

All wires, except those connecting the apparatus with the grid circuits, and the leads to the socket grids themselves, should be run under the base panel in the shortest possible manner, irrespective of criss-crossing. By keeping all of the grid wires above the panel, sufficient separation is obtained to prevent oscillation and extraneous pick-ups. The bypass condensers, with the exception of those on the detector socket, are mounted on the tuning coil frames.

this antenna switch is that the correct tuning position of the variable condenser associated with this coil will change slightly whenever a change is made in the tap switch setting. As the length of the antenna is increased, the setting of the tuning condenser drops below the setting of the double condenser, while shortening the antenna will bring the proper setting of the single condenser back to approximately the setting of the double condenser for any special station.

To make this antenna switch operation clear, a few examples will be given. Assume that a 570-kc. (526-meter) DX station is to be tuned-in.

(300 and 400 meters) usually come in best with the antenna switch on position 3, although, here again, selectivity may not be best until the setting is dropped to tap 2 and the single tuning condenser reset. On distant stations between 1500 and 1000 kc. (200 and 300 meters), either tap 2 or 1 will be best. In operating the set for the first time, tap 3 is suggested, as it is a very good compromise for all wavelengths. Even then, you may be required to drop this to a lower tap if a local station is choking the detector tube.

The next important control is the volume regulator. This controls the audio energy at its source. By means of this volume control, the audio is kept within the limits of the tube so that quality may be had with good volume. If this adjustment is set too high, distortion will first take place in the ux-171 power amplifying tube. If it is boosted still higher, overloading of the resistance stage will occur, producing a choking noise in the loud speaker. Merely reducing the volume will restore the set to normal. In practice it is best to leave this control about a quarter or one-half the way on at most, unless more volume is desired on the weaker stations. When shifting from one station to another, always keep the volume control down. It has no effect on tuning so no tuning readjustment is necessary when operating this knob.

The 2-ohm rheostat regulates the current in the filaments of all four tubes, and when turned to the "off" position, acts as the cut-off switch. By using a low resistance, formed of many turns of large wire, a smoothly operating control of the tubes is obtained. The total variation in the rheostat only changes the voltages on the tubes from four to six, while this two-volt change offers just the right amount of variation, for the new ux-200-A detector tube. The rheostat has, therefore, practically no effect on the amplifying tubes, but mainly controls the detector tube for best sensitivity and freedom from noise. For normal performance, the rheostat should be turned slightly more than half way on, placing about 5 volts on the filaments.

A schematic diagram of the R.G.S. receiver is given in Fig. 3, while Fig. 5 is a detailed wiring

OPERATING INSTRUCTIONS

THE operating instructions are next to be considered. The R.G.S. receiver is very simple in this regard, considering its exceptional performance. Extreme selectivity and distance-getting ability have always been associated with delicate adjustments. Not so with the R.G.S. receiver. This is due to the exceptionally efficient long-wave amplification that the circuit produces. But the operator must follow certain suggestions if the ultimate is desired. No two circuits require the same tuning adjustments, and the new Inverse Duplex is no exception to this. It has its own simple operating peculiarities which are fully discussed here.

In the first place, it is necessary to understand the correct operation of the antenna switch. The selectivity, distance, and tone quality will depend a great deal on the proper setting of this switch. No other adjustment is nearly so important. This switch connects with a series of taps on the antenna primary coil. The first tap connects with two turns only, the second with four turns, the third with eight turns, the fourth with sixteen turns, and the fifth tap with thirty-two turns. As the taps are increased, it is as if the antenna were being lengthened and, as the lower taps are used, it is as if the antenna had been shortened. The antenna tap switch acts like an electrical reel by means of which the antenna can be electrically lengthened or shortened.

It is this lengthening and shortening of the antenna that is so important in order to secure best reception under all conditions. If you understand just what effect a long or a short antenna has on receiving conditions, you will understand fully the effect of the antenna tap switch. A short antenna always makes a receiver more selective and at the same time brings in the short-wave stations with more volume. A long antenna broadens the tuning of a set somewhat, especially at the short waves, but brings in the long-wave stations with greater efficiency.

Still another function of the antenna switch must be considered. When receiving some powerful local station, the radio energy can easily overload the detector tube. By cutting down the antenna somewhat (dropping to a lower tap), the radio energy can be reduced and the detector will then deliver an undistorted output.

An important thing to remember in adjusting

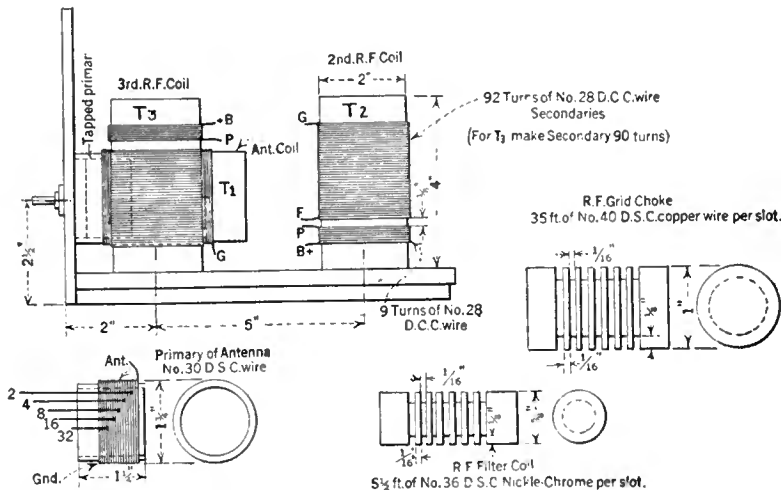
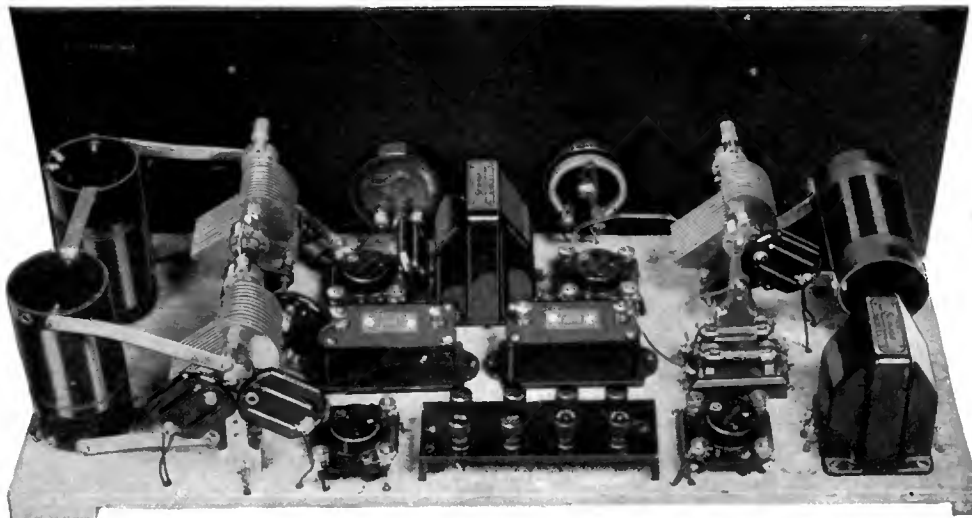


FIG. 2

The coils and chokes for the R.G.S. receiver are wound in accordance with the specifications given here. Note that the secondary for T3 is wound with only 90 turns of wire while the other two tuning coils have a 92-turn secondary

Under ordinary conditions tap 5 (32 turns) would give best results, and the single condenser dial might read 85 while the double condenser would read 92. But near-by local stations being heard in the background might make more selectivity a necessity. Hence tap 4 (16 turns) is used. Probably nothing would be heard upon dropping to tap 4, until a readjustment of the single tuning condenser is made. On tap 4, the single condenser would probably read 88. Upon shortening the antenna, the tuning position will be found to have risen slightly. Some locations demanding super selectivity might force the antenna setting down to 3, which is pretty low for a long-wave DX station around 600 kc. (500 meters).

Distant stations between 1000 and 750 kc.



STUDY THIS PHOTOGRAPH IN CONJUNCTION WITH FIG. 1

In this back-of-panel view the manner of running the under-base wiring through holes in the base is shown

diagram. All of the dotted lines in this latter drawing represent wires run below the base panel. The solid wires are run above the base panel. This scheme forms a very neat layout as well as automatically affording some separation between the grid and plate wires.

Specific types of tubes are recommended with

miles from WEA F and 25 from wjz. The excellent selectivity, even at the long waves, is at once apparent. While wjz and WEA F blanket any distant reception between them, the dials do not have to be turned very far either side to bring in the remote stations without interference. The location where the tests were conducted in

locals and unfavorable to Western reception. Several well-known standard radio receivers have failed to bring in even one distant station in this locality under modern congested conditions of the air.

The following is a list of parts necessary for the construction of the R. G. S. receiver described in this article:

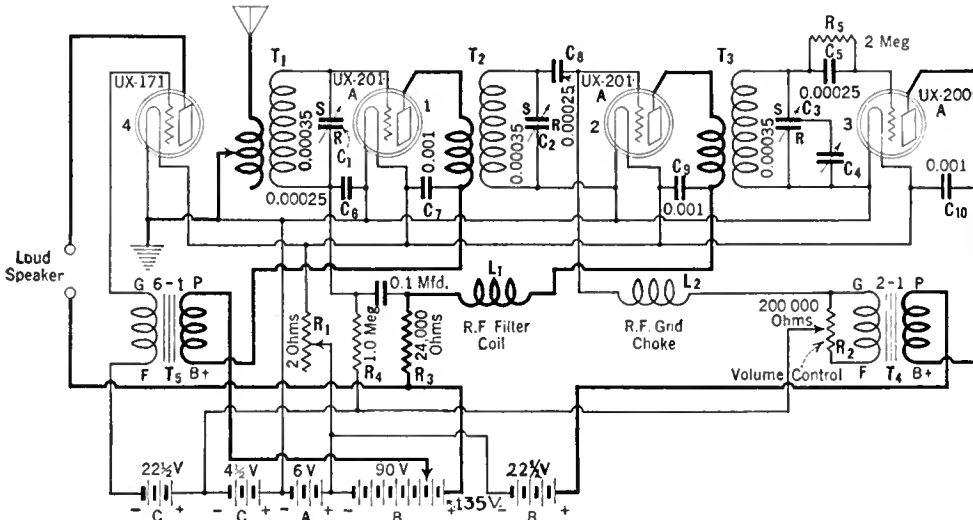


FIG. 3

To identify the various units as indicated here it is well to refer to Fig. 1. The same identification letters have been used for this diagram and Fig. 1. This schematic circuit gives one the general idea of the circuit employed while the wiring diagram shown in Fig. 5 is a direct aid in the actual wiring of the receiver

this circuit design for very definite reasons. The high efficiency of the receiver is obtained through coordinate operation of the various parts—including the tubes. This applies particularly to the detector. To insure the same exceptional performance as obtained here in our laboratories, use the tubes recommended. These are given in Fig. 1.

It is fully realized that it is no easy matter to

Staten Island is even worse than the mileages indicate. The New York stations come in with practically undiminished volume, traveling the intervening distances mainly over water, while the distant Western stations must pass through a high ridge that runs north and south through the center of Staten Island. This locality is thus favorable to the reception of New York

C ₁ —1 National Single Condenser, 0.00035-Mfd.	}	\$26.50
C ₂ , C ₃ —1 National Double Condenser, 0.00035-Mfd. Each Section		
2 National Dials		
T ₁ , T ₂ , T ₃ —3 National-Grimes Tuning Coils, with Antenna Switch	}	5.00
T ₄ —1 Samson 2-1 Audio Transformer		
T ₅ —1 Samson 6-1 Audio Transformer		5.00
4 Spring Sockets		3.00
C ₄ —1 Hammarlund Vernier Condenser, 15-Mmfd.		1.25
1 DeJur Resistance-Coupler (with Condenser)		1.50
R ₂ —1 Centralab Modulator 200,000 Ohms		2.00
R ₅ —1 Lynch 2-Meg. Resistor	}	1.75
R ₄ —1 Lynch 1-Meg. Resistor		
R ₃ —1 Lynch 25,000-Ohm Resistor		
C ₆ , C ₇ , C ₈ , C ₉ , C ₁₀ —5 Sangamo Condensers (3—0.001-Mfd. and 2—0.00025-Mfd.)		2.30
1 Front Panel (Drilled and Engraved)		6.00
1 Base Panel (Drilled)		4.00
L ₁ —1 Grimes R. F. Filter Coil		2.50
L ₂ —1 Grimes R. F. Grid Choke		2.50
8 Eby Binding Posts and Drilled Terminal Strip		2.00
C ₅ —1 Dubilier Grid Condenser, 0.00025-Mfd.		.25
R ₁ —1 DeJur Rheostat, 2 Ohms		1.10
Acme Connecting Wire		.75
R. G. S.—Grimes Blue Prints and Instructions		4.50
TOTAL		\$71.90

The above selection of parts may be obtained in kit form complete with front panel and base panel drilled and engraved.

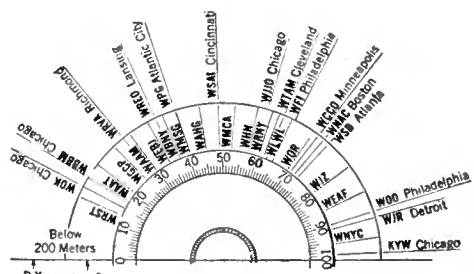


FIG. 4

In this representation of a tuning dial are shown the Greater New York locals in one group while the distant stations which were received through the locals are shown in the outside band

fairly present the real performance of a radio receiver because so much depends upon local conditions. This has led to the generally accepted practice of comparative demonstrations between some well-known receiver and the one under test, so that, other conditions being equal, the actual performance of the new receiver could be judged in terms of some standard. Many such tests, conducted in many difficult localities have revealed the high selectivity of the R.G.S. Inverse Duplex receiver. Fig. 4 shows at a glance the performance of an R.G.S. receiver tested at Grasmere, Staten Island, while all the locals were on the air. Grasmere is about 10

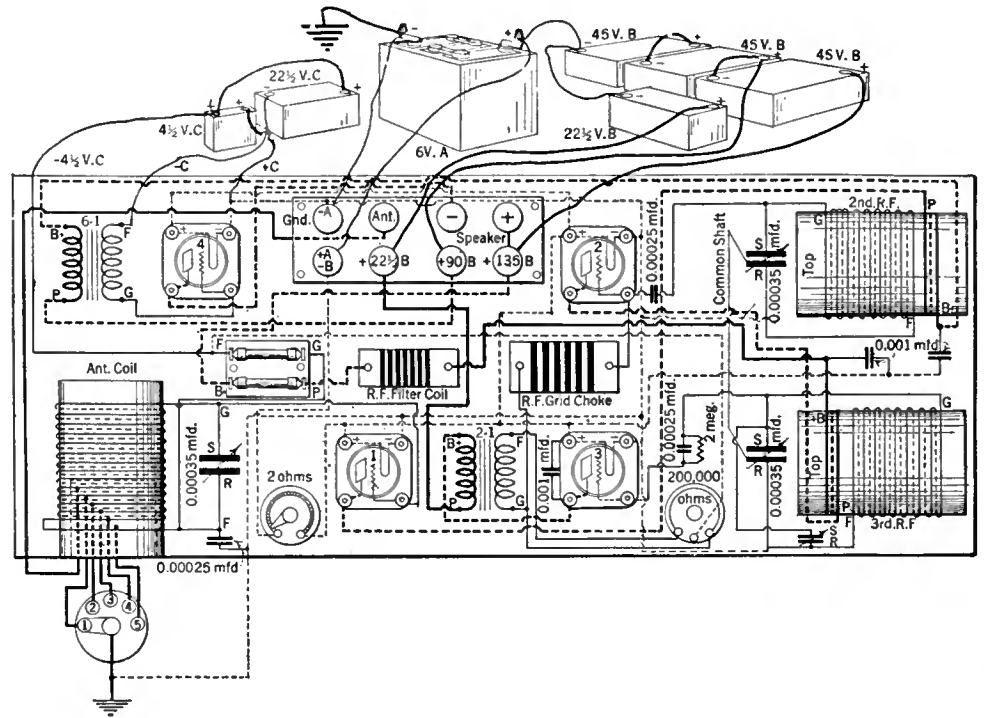
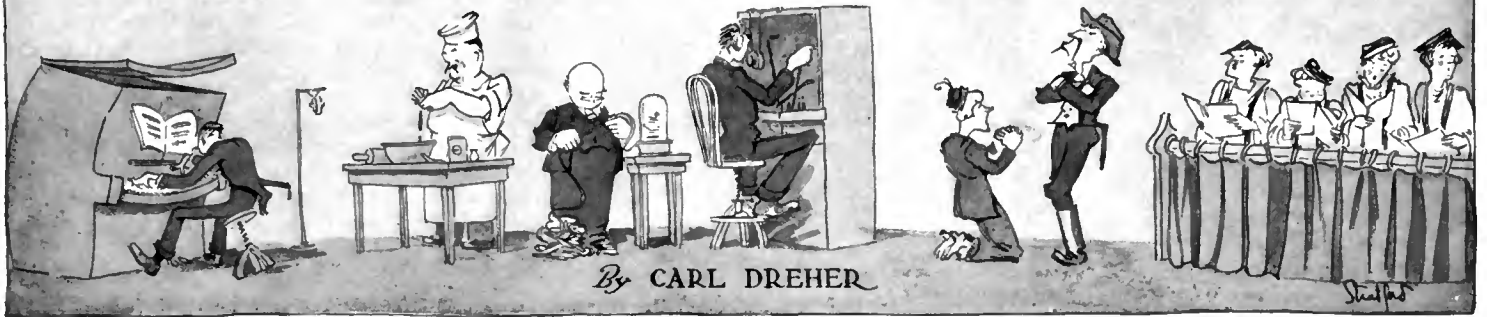


FIG. 5

This wiring diagram, aside from showing the point to point wiring, coincides with the parts layout shown in Fig. 1. As an aid in wiring, the two should be referred to constantly. The dotted lines show those wires which are run below the base while the solid lines indicate those connections which are made above the base

AS THE BROADCASTER SEES IT



Drawings by Franklyn F. Stratford

An English Experiment in Highbrow Broadcasting

RECENTLY, looking over an issue of the *British Radio Times*, I noticed with interest that the B. B. C. had put on, through 3 L.O., two scenes from Thomas Hardy's great epic poem, *The Dynasts*. Furthermore, they featured it, giving it a place on the program at 8.55 one evening.

The Dynasts is the story, told in blank verse with occasional rhymed couplets, of the Napoleonic wars. It is one of the few epic poems of modern times, and far more original, moving, and artistically successful, to my mind, than such an effort as Tennyson's *Idylls of the King*. But it is highbrow stuff. Although it sheds lustre on the English tongue, not one in a hundred of English-speaking people has ever heard of it. Even many readers who are not totally ignorant of Hardy's novels—every high school student has heard of *Tess of the d'Urbervilles*—are unaware that as he approached old age, the novelist turned again to his first medium, poetry, and, in the years between 1903 and 1908, published this epic-drama in three parts, nineteen acts, and one hundred and thirty scenes. It is a beautiful and magnificent creation, but hardly the sort of thing to appeal to readers of the tabloid newspapers. To savor it properly, one must have some literary background. Hence I was surprised to see the thing on a radio program. Radio, in general, goes in for the lighter amusements.

The two scenes broadcast were, to be sure, those of a most nearly "popular" cast, the first on the quarter deck of the *Victory*, Nelson's flagship at the battle of Trafalgar, and the second in the cockpit of the vessel, where the Admiral ended his romantic and stirring career some three hours after a French sharpshooter picked

him off from the mizzen-top of the *Redoubtable*, as the ships were lashed together, both on fire, their cannon mowing down the crews with chain-shot and ball, and the decks running with blood. This scene must have been pictured in the reading through the London transmitter, although I doubt whether some of the realistic details of the description, such as "splinters looped with entrails of the crew," were retained, to harrow the sensibilities of the modern Britons. But surely the beautiful lines spoken by the captain of the *Victory*, awakened from his reverie when the dying Nelson asks him:

What are you thinking, that you speak no word—
those lines, surely, were not omitted. It is pleasant to think of them winging their way over those very farms of Wessex which inspired the poet when he wrote:

*Thoughts all confused, my lord:—their needs on deck,
Your own sad state, and your unrivalled past;*

*Mixed up with flasbes of old things afar—
Old childish things at home, down Wessex way,
In the snug village under Blackdon Hill
Where I was born. The tumbling stream, the garden,
The placid look of the grey dial there,
Marking unconsciously this bloody hour,
And the red apples on my father's trees,
Just now full ripe.*

And then, after the Admiral dies with the battle still raging overhead, the Chorus of the Pities, to the accompaniment of aerial music:

*His thread was cut too slowly! When he fell,
And bade his fame farewell,
He might have passed, and shunned his long-drawn pain,
Endured in vain, in vain!*

Stuff more estimable, I should say, than the noises of the competition to "decide the chicken calling supremacy of the Adams County Poultry and Pet Stock Association," actually being pumped through the long-suffering ether of the sovereign state of Nebraska at this writing. Send in your votes, dear listeners. Which would you rather have, Hardy or a hog-calling contest?

The Listener Behind the Scenes

IN THE December, 1926, RADIO BROADCAST with a loud blare of trumpets, I unloosed a new idea on the radio world, in the form of a scheme to entertain the jaded listeners by taking them behind the scenes of the broadcast studio and showing them, on the air, how the miracle is worked. New idea, did I say? The contents of the following polite note, dated Nov. 17, 1926, from Mr. Hugo Gerns-



"A MORE ESTIMABLE BROADCAST THAN A HOG-CALLING CONTEST"

Drawings by Franklyn F. Stratford

back of WRNY, have a bearing on that question:

I noted with interest on page 181 of RADIO BROADCAST that you suggest taking the listener behind the scenes. From the enclosed program which we ran some time last month you will see we actually did this, with excellent results. It is a feature which I originated, and I am sorry you didn't listen in to it. We had everything that you could think of, behind the scenes. We even actually tried out artists and showed the public how the microphone was placed, how the artist was walked back and forth.

Then the whole next week's program was discussed and the listeners shown how a program is put together. Further, all the technical details, such as gain on the control board, distortion, modulation, and all other technical points, were graphically shown. The program lasted about one hour.

The program in question was distributed to the customers of WRNY's "Novelty Night," on October 15th, and it was entitled "Behind the Scenes in a Broadcast Studio." The evidence is conclusive. All I can add is that, as these inventions burst on me about two months before they can be printed, Mr. Gernsback and I must have had the idea at about the same time. If there were any money in it, no doubt we should be suing each other, in accordance with time-honored radio traditions. But, alas, there is only glory, and Mr. Gernsback indubitably walks off with that.

A slightly dissimilar intimate broadcast was put on extemporaneously at WSAI on November 15th, according to a report from that station. It appears that Mr. Paul A. Greene, Director at WSAI, was making an advance announcement to the Cincinnati populace, some minutes before the start of the National Broadcasting Company's gala opening program from New York, scheduled to start through WSAI at 8 P. M. Suddenly there issued from a monitoring loud speaker in the booth the voice of the control operator, designated in the report as "Larry": "Watch 'em, they're (meaning New York) going to be early." Nobody knew that this little studio admonition had been radiated until the listeners began to call in to ask who was early, what had happened, can't you do it again for little Robert, etc.

I have always maintained that the listeners like accidents on this order. They provide a kick in several ways. First, there is the glimpse behind the scenes. Second, it is something unusual and therefore exciting. Third, it is pleasing to see another fellow slip on a banana peel and go on his ear, especially if he is wearing a top-hat. To be in on one of those few occasions when a dignified broadcasting station lets loose on an unexpected world one of the yelps or barks constantly circulating behind the curtain—that is a rare treat. The listeners, I know, love it. But when it happens in a station with which I have anything to do I admit I fall into the state of Mark Twain's cat throwing a fit in a platter of tomatoes.

So much, therefore, for behind-the-scenes broadcasts, intentional and unintentional. A little of them goes a long way.

Fashions in Broadcasting

IN THE radio world the changing flux of styles rules, just as in the choice of clothing, smart night clubs, and summer resorts. And just as irrationally, it may be added, for, while the advent of a new style is frequently based on something sensible enough, the imitations of the original innovation generally result in a foolish pursuit of novelty in all its forms, good and bad.

An example: cone loud speakers. The cone speaker was originally introduced to the broadcast listeners in the form of a well-designed tympanum with a high-grade, balanced armature type of unit. It was superior to the commercial horn speakers that preceded it, and quickly attained deserved popularity. Other good cone speakers were put on the market to satisfy the demand. So far, so good. Now, to the eye, the main difference between the old loud speaker and the new was in the substitution of a flaring cone of parchment or paper for a horn. Inevitably many people jumped to the conclusion that any cone speaker was superior to any horn. This superstition was speedily utilized by some small manufacturers who turned out, in the aggregate, quantities of almost worthless speakers equipped with the magic cones. The units were not of the balanced armature type; they were simple telephone

receivers no better than those used with cheap horn loud speakers. They had small, thin diaphragms, with the inherent double frequency component and generation of overtones due to unsymmetrical displacement of the diaphragm. They lacked true lows and they lost the highs; in between they were prolific in harmonics, resonance peaks, and rattles. Any novice in electro-acoustics could predict the performance after one look at the construction, but the things sell because they are cheap and because they are in the fashion. Many people with fair horn speakers spend money for cones the characteristics of which are no better than, if they are as good as, those of the horns they supplant. If they kept the horns and equipped the set with a power output tube, they would be spending their money far more wisely. If, after that, they bought a good cone speaker, they would be making real progress with the art. But instead, they follow the fashion blindly and nobody profits but the fly-by-night manufacturer.

The broadcasters in a given locality frequently display a similar weakness at the transmitting end of the circuit. The broadcasting stations, like newspapers, watch each other pretty carefully. One of them develops a popular feature—a singer of sea-chanteys, let us say. It is rumored around town, among the broadcast directors and their attendant concert managers, hungry artists, and spies, that W— got five thousand letters in two days as a result of the sea-chantey program. Immediately all the assistant program directors rush down to the docks, seeking warblers of sea-chanteys. Finding none, they resort to vaudeville agencies, organizations of retired minstrel singers, drummers who are said to be talented in imitating the late Lew Dockstader, and other such luminaries of the entertainment world. The air is then filled with renditions of "Give Me Some Time To Blow the Man Down," and the public is supposed to be satisfied. But, nine chances out of ten, none of the imitations proves popular. The style has been followed, not in the essential elements which made the first program successful, but only in the external, immaterial factors.

The fault is the same in both cases—that of the actual situation regarding the cone speakers, and that of the hypothetical sea-chantey program. Each contains true elements of progress. The reward is public approval. Then come the imitations, some good, but mostly bad, since the object is a quick, easy profit, and external features are more readily imitated than inherent characteristics. When there is room for them in the market, the good imitations succeed, which is salutary. Sometimes the bad imitations are also swept along to temporary commercial success on the tide of public interest. That is not salutary. It is a case of clever men exploiting the tendency of human beings to run in droves. The only remedy lies in honesty and scientific progressiveness on the part of the organizations at the selling end of the radio business, and a discriminating intelligence on the part of the purchasers and listeners. That takes time to cultivate. But, as one shrewd observer said, all that glistens is not gold, and, as a later immortal pointed out, you cannot fool all of the people all the time.

One Who Cannot Be Surpassed

THE prize this month, or any other month, goes to the remote control operator who was caught one Sunday morning eating his breakfast while broadcasting a church service. He had set up, cut in all the microphones, been put on the air; then he had calmly strolled



"THEY RUSH TO THE DOCKS, SEEKING WARBLERS OF SEA CHANTEYS"

around the corner for his unpostponable meal. I admire that man. He went the limit. All the broadcasters who have ever unbalanced an orchestra, neglected a gain control, or reduced the plate current of an amplifier to zero by overloading—they are all pikers compared to him. If I had the money, and that fellow could be purchased, I'd exhibit him in a cage at every broadcast station in the country, with a sign around his neck reading, "Greater Gull Hath No Man Than This."

Abstract of Technical Article

IV.

THE NATURE OF LANGUAGE—A RÉSUMÉ OF RECENT WORK ON THE PHYSICS OF SPEECH AND HEARING, by R. L. Jones, Engineering Dept., Western Electric Co., Inc., *Journal of the American Institute of Electrical Engineers*, Vol. XLIII, No. 4, April, 1924.

SINCE the organs of speech are substantially the same in different races, and are capable of emitting only a limited variety of sounds and pitches, the elements of speech show many similarities in different languages. The organs of speech include the lungs, which supply the motor element in the form of streams of air expelled through the vocal passages. This bellows-action of the lungs, as far as speech is concerned, is a secondary function, the primary object being the interchange of oxygen and carbon dioxide, without which life cannot be supported. The breath supplied by the lungs passes between two muscular ledges whose tension and separation may be varied, permitting vibration over a range of frequencies—the vocal cords. The tongue and lips shut off or permit the breath to issue, and also have some influence in determining the resonance effects of the mouth, nose, and throat cavities. What we have, essentially, is a system of bellows, vibrators, valves, and resonance chambers, all adjustable with remarkable speed and precision, and controlled by reflex actions which become largely unconscious after speech has been learned.

The sounds of speech, as represented by letters, fall into five classes: (a) Pure vowels, (b) Transitional vowels, (c) Semi-vowels, (d) Stop consonants, (e) Fricative consonants. In English, there are thirty-six letter sounds. The production of pure vowels involves vibration of the vocal cords in a manner characteristic with each speaker. There is a fundamental tone, somewhat lower for men than for women, with overtones. The mouth and throat cavities reinforce some of these harmonics, according to the position of the tongue and mouth. For example, the long *u* sound, as in "tool" is formed with the lips rounded, and the tongue drawn back so as to make the mouth a single cavity resonant at about 300 cycles. This single cavity is used for other sounds of *u*, *o*, and *a*, the resonance peak for broad *a*, as in "far" being around 1000 cycles, with the tongue no longer much raised, so that the effect of the throat cavity begins to be felt in a double resonance. This double peak becomes pronounced in the short *a* of "at," where the mouth and throat form connected cavities, with two-reinforced tones between 800 and 1200 cycles. For the long *e* sound the resonance peaks are more widely separated, the frequencies being in the neighborhood of 300 and 2500 cycles. The tongue in this case is well forward, affording a large resonance chamber in the throat and back of the mouth, with a small cavity between the tongue and the lips for the higher frequency.

Transition vowels or diphthongs are formed in passing from one vowel to another. For example, *w* is simply *u* plus a pure vowel. If one pro-

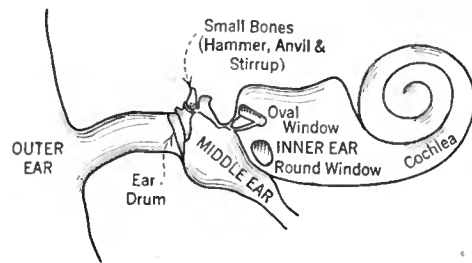


FIG. 1

nounces the long sound of *u*, followed by a pure vowel, such a word as "way" is the result, the *w* being a characteristic transition vowel.

H is simply a forcible expulsion of breath through the glottis (the opening between the vocal cords) preceding a vowel. This letter is classified as a transitional vowel. *L* and *r* partake of the nature of both vowels and consonants, and receive a separate classification as semi-vowels.

Stop consonants are characterized by the formation of a stop in some part of the mouth. The sound of the consonant "p" is made by exerting breath pressure against the closed lips, and suddenly parting them, releasing the air. The same motions, plus vocalization, produce "b." The unvoiced stop consonants are *p*, *t*, *ch*, and *k*. Those involving the vocal cords are *b*, *d*, *j*, and *g*. The nasal group, in which breath is released through the nose, comprises *m*, *n*, and *ng*.

Fricative consonants, as distinguished from the stop group, utilize the rushing or hissing sound of breath passing through an outlet, involving the lips, tongue, teeth, or palate. These are the same organs of the mouth and throat used in producing stop consonants, so that the essential difference is the complete closing and subsequent release for the stops, and an incomplete closing for the fricatives. Similarly, vocal cord vibrations are present in some cases and absent in others. For example, the sound of "f" is obtained by expelling the breath through the outlet between the upper teeth and the lower lip, without vocalization. If the voice accompanies the same procedure, "v" is the result.

Jones next describes briefly the equipment for physical analyses of speech. This portion of the paper, and the curve of the energy distribution of speech, or, as Jones entitles it, the "Acoustic Spectrum" of English, are taken from the Crandall-MacKenzie paper on "Analysis of the Energy Distribution in Speech," abstracted in the January RADIO BROADCAST. As was stated there, the vowel sounds carry most of the energy of speech. The reason for the 200-cycle maximum in the energy distribution curve is shown by some analyses of sung vowel sounds presented by Jones. These show maximum components, in every case, close to 200 cycles, for one particular speaker. The higher frequencies, up to 6000 cycles or more, are carried by the consonants, and, because their importance in determining intelligibility is by no means proportional to their

weak energy, cause the most difficulty in high quality electrical reproduction.

The paper continues with a description of the mechanism of the ear. The outer ear is essentially a collector of sound in the form of air waves, which impinge on the drum separating the outer from the middle ear. The middle ear contains a mechanical transmission chain of small bones which carry the sound vibrations to a membrane or oval window giving access to the inner ear. Some small muscles in the middle ear have the function of accommodating the mechanism for effective hearing of sounds of various intensities. The inner ear is a delicate and complicated system for converting acoustic vibrations into nerve currents. It is essentially a spiral shell of bone, the cochlea, filled with liquid, and containing the rod-like terminals of the auditory nerves, some 3000 in number, constituting the basilar membrane. These rods appear to respond selectively to vibrations of different frequencies, thus permitting the apperception of pitch. Besides the oval membrane through which the vibrations are received, the inner ear is provided with a round window or membrane which may be bulged out by the liquid in order to relieve excess pressure. Fig. 1 shows the general features of the auditory system as described above. This picture represents my own idea of the anatomy of the ear, and is not given by Jones.

We do not know precisely how changes of intensity of sound are detected by the ear: it may be through proportionate agitation of the nerve terminals, or by the width of the band affected on each side of the point of selective vibration.

The ear mechanism between the drum and the nerve terminals has a definite vibratory impedance, varying like any other such system with frequency and amplitude. At very high frequencies, say 20,000 cycles per second, the impedance may be so high that no perceptible energy reaches the inner ear. We may expect a varying sensitivity, accordingly, to sounds of varying pitches. This characteristic is shown in Fig. 2, which is part of Fig. 4 of Jones' paper. From this curve, showing just audible sounds at various pitches, we note that the maximum sensitivity of the human ear is at about 3000 cycles, and is fairly constant between about 500 to about 7000 cycles per second. The variation of sensitivity is great; a note of 30 cycles or 17,000 cycles requires a million times as much energy to become just audible than one of, say, 1000 cycles. The region most essential in speech is roughly that in which the ear is most sensitive, pointing to a progressive evolution of both organs to a common basis of operation, now sapiently utilized by the telephone companies in furnishing a 200-2000 cycle band for the conversation of their customers.

Sounds may be felt by the ear as well as heard, if the intensity is sufficiently great (about 1000 dynes R. M. S.). The curve of sensitivity of feeling for sounds is roughly the reflection of the hearing curve shown in Fig. 2, it being concave downwards, with a maximum at about 1000 cycles, and dropping off to the limits of audition, which are about 20 cycles on the low end, and 20,000 on the high, for the average person of normal hearing. In other words, very low and extremely high pitched sounds are felt as easily as they are heard.

While even the energy required for feeling is not great, that required for audibility is marvelously small. In the favorable region shown in Fig. 2, the minimum audible tone corresponds to a pressure change per square centimeter of about 0.001 dyne. This, Jones states, is about equivalent to the weight of a section of human hair one thousandth of an inch long, which is something like a third of its diameter!

(To be continued)

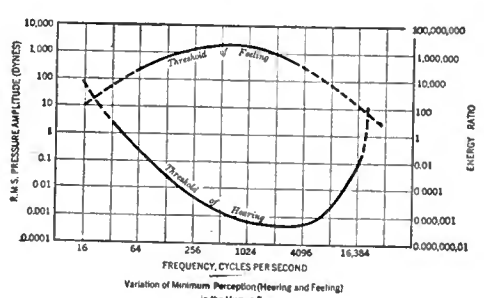


FIG. 2

Curious Problem for a Broadcaster

NEATLY typewritten note received by a New York broadcasting station during October, 1926:

WE, THE POWERS OF THE ETHERIC PLANE, authorize you to broadcast the following:

MAN SHALL EAT NO MORE FLESH WHILE THE WORLD STANDS; AND IN THE DAY THAT HE EATETH THEREOF HE SHALL DIE.

Later communication written on the same typewriter:

WE, THE POWERS OF THE ETHERIC PLANE, authorize you to broadcast the fact that on the fifteenth day of November, Nineteen Hundred and Twenty-six, a book entitled *The Love-Story of the Ages or the Second Coming of Christ* will be placed upon the book-stands of New York, N. Y. and Washington, D. C. No comments are permitted. Any neglect in the fulfillment of our instructions is punishable by instant death.

The officials of the broadcasting station, pleased at the prospect of a speedy termination of their miserable lives, did nothing. They were rewarded, after an interval, by the following gracious proclamation:

WE, THE POWERS OF THE ETHERIC PLANE, commend your acceptance of our directions, and wish to state that the difficulties you have experienced thereto have been owing to our intervention. You will not begin the broadcasting of material already submitted, until Monday the eighteenth of October: and because of the spirit in which you have undertaken to carry out our instructions, we are calling your attention to the fact that on the first day of December, 1926, New York, N. Y. and Washington, District of Columbia, are to be totally destroyed by fire. You are permitted to dispose of personal and business property to the best advantage, placing the proceeds in a private vault in Philadelphia, headquarters of E. P. Dutton & Company, Publishers, after the fifteenth of November.

Possibly the POWERS OF THE ETHERIC PLANE got that way from trying to devise a plan for regulating radio in such a manner that Congress, the public, the Administration, and all the broadcasters will be pleased.

Note for Radio Historians

DO YOU remember, you radio men whose memory goes back to 1915 or thereabouts, the silicon detectors then used by the United States Navy, one of which it was every amateur's hopeless dream to possess? They were worth, in the glory of their swivel joints, bright nickel plate, and hard rubber bases, some \$15, and in those days \$15 was a lot of money. Well, passing down Cortlandt Street, the foremost abattoir of radio equipment in New York and the world, the other day, I noticed a heap of those detectors on sale before one of the shops. They were the genuine article, engraved with the traditional formula: "Silicon-Antimony Detector, CR-535, Manufactured for Navy Department, Bureau of Steam Engineering," and they were to be had at 75 cents apiece. And nobody was buying them! *Sic transit gloria mundi.*

Broadcast Station Service Data

USEFUL tables from Dr. Alfred N. Goldsmith's paper on "Reduction of Interference in Broadcast Reception" in the *Proceedings of the Institute of Radio Engineers*, Vol. 14, No. 5, October, 1926:

Estimated service range of stations of various powers, in the eastern portion of the United States.

ANTENNA POWER	SERVICE RANGE
5 watts	1 mile
50 watts	3 miles
500 watts	10 miles
5000 watts (5 kw.)	30 miles
50,000 watts (50 kw.)	100 miles

Type of service corresponding to various field strengths.

SIGNAL FIELD STRENGTH	NATURE OF SERVICE
0.1 millivolt per meter	Poor Service
1.0 millivolt per meter	Fair Service
10.0 millivolts per meter	Very Good Service
100.0 millivolts per meter	Excellent Service
1000.0 millivolts (1.0 volt) per meter	Extremely Strong Signal

Memoirs of a Radio Engineer

XVII

DURING the second term of my radio course at the College of the City of New York, the United States entered the war. Radio, which had been considerably upset by the preceding years of anxious neutrality, now had the lid clamped down with a sharp official snap. Even the great triangular antenna which covered the campus of the College, with its six wires running from the tower of the Main Building to Townsend Harris and Mechanic Arts, had to be taken down, although shortly afterwards two of the wires went up again for the United States Navy's listening-in station, which was installed during the summer of 1917. But before going on with the story, I had better try to give a picture of how things stood at this time in the radio world.

The war started in 1914, as we are not yet likely to forget. In the early months of 1915 I was writing a weekly newspaper column of radio comment for the Rockville Centre *Owl*, under the heading, "Wireless for Amateurs." Probably these were not the earliest descriptive articles on radio to find a place in a newspaper, but certainly they were among the grandfathers of the present radio supplements and critiques. There were about twenty-six of these *Owl* radio essays which astonished the uncomprehending burghers of Rockville Centre, a suburb not very far from Garden City, where these recapitulations now go into print; but our only interest in them lies in the fact that the red flames of the conflagration to the east cast their glow even on that innocent radio column, loaded with all the wisdom of my nineteen years. Two quotations may be justified on this account:

"Within a little more than three years," I wrote on May 14, 1915, "there have been three great maritime disasters. Together they account for the loss of almost four thousand lives. Ice sent the *Titanic* down into the sea weeds; an ill manœuvred collier was the end of the *Empress of Ireland*, and now the *Lusitania*, has gone to take her place in that company. Men build ships and sail them on the sea, but the sea insists on its percentage, and takes it on occasion. It is remarkable, too, that when Nature spares a ship, man, with his no less

effective weapons, goes ahead and sinks her. Yes, the *Lusitania* is gone. We are never going to hear her spark again. It feels rather queer when you reflect that only last Saturday you heard her working Sea Gate as she steamed down the Bay. Only a week ago, and now her funnels are in the mud, and the fish are eating the insulation off her multiple tuner. A sad end for such a fine ship, and one that is doubly sad because it can accomplish no possible good to anybody, least of all to the people who caused it."

"Never before in the memory of the oldest wireless operator has the air above New York City been as busy as this week. The number of radiograms transmitted every hour is astonishing. They are sent out by several classes of stations. First of all there are the battleships, big and little, lying in the Hudson. They use shrill, high frequency sparks in communication with the Brooklyn Navy Yard on various short wavelengths; 750 meters is perhaps the one most used. The Navy Yard, in addition, transacts its usual business with Newport, Fire Island, Philadelphia, and Arlington. Sea Gate takes care of the coastwise liners. Then we have WCG at Bush Terminal attending to the needs of a large brood of Sound steamers. The *Herald* sends war bulletins on reduced power. As if all this was not bad enough, the inevitable British cruiser off the Hook chimes in occasionally. Considering the great amount of business transacted, there is remarkably little confusion. Everybody sends the signal number "4" before transmitting. This is a double question: "Are you clear? May I transmit?" The answer *K* or *I* indicates that the inquiring station is at liberty to send off its radiogram. The answer "Min" or the standard abbreviation of •-••• indicates that transmission will cause interference. The word "rush" after a call entitles one to special consideration. It means that the operator is burdened with an important message which he wants to get off as soon as possible."

It was the war that first brought the interference problem into radio, what with the enormous increase in shipping and general message traffic. The congestion of the ether, as we know it in broadcasting, is nothing new. As, according to the law of Malthus, population always presses on the means of subsistence, so, since about 1915, the number of radio stations has always pressed on the available ether channels. Aside from this factor, however, the average radio operator in United States waters heard little about the war, whatever was going on behind the scenes. There were the *Herald* bulletins I wrote about, sent on reduced power so that the German receiving stations could not possibly utilize them. And the British cruiser droned out long messages in numeral code to Halifax, or to another unit of His Majesty's Navy, as she lay guarding the entrance to New York Harbor, so that no Teutonic vessel could venture out or in. Many thousand tons of German shipping lay bottled up at the Hoboken docks during 1914, '15, and '16. Then the United States went in. The German ships were seized by the United States Navy. And, while it was about it, the Navy also seized American radio, from the power board to the antenna insulators, and held it in duress for two years.

A Five-Tube Non-Oscillating Receiver

Wherein an Effective System of Receiver Stabilization is Described—The Causes of Oscillation in Radio-Frequency Circuits—The Triple Duties of the Milliammeter

By T. H. NAKKEN

THIS article is concerned with a method of stabilizing radio-frequency amplifiers and the application of this system to a five-tube receiver employing two tuned r.f. stages, a non-regenerative detector, and a transformer-coupled audio amplifier. The receiver has only two tuning controls because a gang condenser, C_2 is used to tune the second and third coils. It is capable of giving excellent tonal quality when worked with a good quality loud speaker, and is absolutely stable in performance. The receiver is easily and permanently stabilized, and will not squeal once it has been adjusted. It tunes sharply and will satisfactorily separate local stations.

In designing any tuned radio-frequency receiver, one of the most important problems is to properly stabilize it, since any ordinary high-frequency amplifier has an inherent tendency to oscillate, and when this occurs, reception is ruined by the howls that are created. Stabilization can be obtained in various ways, and it will be worth while to orient very briefly our thoughts regarding these different methods.

Perhaps the ideal way of preventing oscillations in a high-frequency amplifier is through the use of a bridge system, since such a method does not introduce any loss, and is, theoretically at least, capable of being arranged so that its effect is practically constant over the entire band of broadcast frequencies. However, a bridge system is difficult to adjust, necessitates that the apparatus be laid out very accurately, and that the wiring be carefully done. There are indeed few receivers on the market efficiently designed and completely neutralized.

Diametrically opposite to this method, we have the simple "losser" systems. Resistance in series with or across the tuned circuit very effectively prevents oscillations, but it also precludes considerable amplification. Such systems are generally easy to adjust but are not constant in effect over the entire broadcast spectrum. Consequently, if adjusted so as to prevent oscillations at the high frequencies (short wavelengths) where they are most likely to occur, the loss in amplification at low frequencies is considerable.

Between these two methods (the bridge systems, constant over the broadcast band but difficult to adjust; and the "losser" system, very simply adjusted but also very inefficient and unequally effective over the broadcast band), there lies a third system, also quite easy to adjust and fairly constant in effect at different frequencies. This leads us to the Phasatrol, a stabilizing device used in the receiver illustrated in this article. The Phasatrol is easily adjusted and will completely prevent oscillations. Also its effect is fairly constant with frequency so that only a slight loss of amplification at low frequencies

(long wavelengths) occurs. To properly understand the action of the Phasatrol, one should fully realize why a radio-frequency amplifier always tends to oscillate, and it will be attempted to give here a simple, understandable explanation of the reasons causing oscillation.

We all realize that a vacuum tube is an extremely sensitive device, which amplifies almost completely without any distortion any kind of electrical disturbance which is experienced by its grid—the one element which controls its actions. Now, in a radio receiver there are many electrical currents flowing in various circuits, and each one of these circuits creates its own electrical disturbances, which easily may act upon one or more of the grids of the different vacuum tubes. This reaction of the various circuits is called coupling, and only too easily gives rise to the familiar squealing, always an indication of oscillations in the receiver. This oscillation is the nightmare of every radio manufacturer and experimenter, and ceaseless labor is being expended everywhere to prevent the occurrence of these oscillations.

Oscillation will almost invariably occur when there exists coupling between the various stages of radio-frequency amplification, and, in general, we may say that there are two ways in which circuits can be coupled, *i.e.*, inductively and capacitively. By judicious design we may construct receivers in which extraneous coupling has been reduced to an absolute minimum, by using parts that show the least tendency to act as coupling devices, and placing them in such a way that the danger of coupling is largely prevented.

But even when in the receiver itself, not the slightest chance exists for coupling of any kind whatsoever, there would remain one coupling device, which always tends to cause oscillations and instability. This is the amplifying tube itself, in which there exists an inherent capacitive coupling factor due to the proximity of its elements, notably its plate and grid. Any change in the potential of the plate reacts capacitively upon its grid, and these changes in plate potential almost invariably occur in such a way that their disturbing effect on the grid coincides with the original disturbance on the grid. This means, then that this inter-element capacity has the

effect of building up the original disturbance, and when this happens, oscillation is sure to occur, unless proper action is taken in the design of the receiver to prevent this inter-element capacity from having such an effect. When we analyze why this influence of the plate upon the grid has the effect of causing oscillations, we will understand the method employed in the Phasatrol to overcome this.

Generally, in a radio-frequency amplifier, the coupling device between two successive stages is a tuned r.f. transformer. Such a transformer almost invariably consists of an untuned primary and a secondary, the latter being tuned by means of a variable condenser. The plate circuit contains a coil and therefore the circuit obeys the laws that govern the behavior of alternating currents in inductive circuits. Now it is a well known fact that, in such a circuit, the current lags behind the voltage, as it is expressed. This means that, as there is a difference in the time of maximum voltage and the maximum current in such circuits, the current reaches its maximum value after the maximum voltage has been developed. This then can also be expressed by saying that the voltages are ahead of the current, which in this instance is very important. When we now consider that the current fluctuations in the plate circuit are due to disturbances on the grid, it follows that, when the currents lag behind the voltages, the potential changes in the circuit, and of the plate, therefore, are advanced with respect to the plate-current changes.

When the plate changes in potential, which change of potential is always larger than the original impulse on the grid, the plate reacts upon the grid, due to the fact that the two form a small condenser. The back action of the plate on the grid is therefore a capacitive one, and there is an electrical law which states that in capacitive circuits the voltages lag behind the currents, meaning that the voltages developed reach a maximum only after the current has reached its maximum, or rather, when the current has already passed its maximum. This is exactly the reverse action of an inductive circuit.

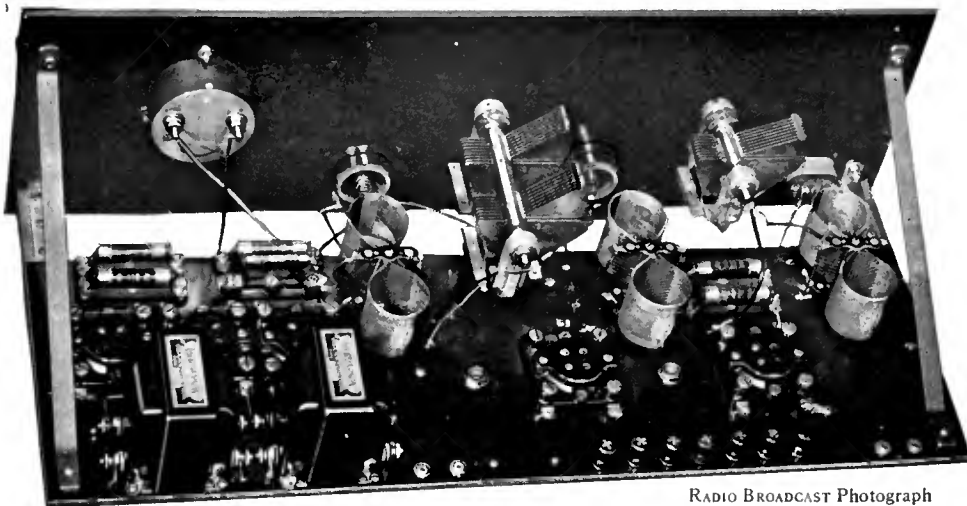
When we look at these facts, we will see that the voltage variations of the plate are in advance of the current, but that the voltage variations of the grid, due to those on the plate, experience a lag. These voltage variations of the grid due to the plate circuit variations, will almost coincide with the disturbances on the grid which caused the changes in plate current in the first place. In other words, the back coupling, due to the capacity between the tube elements, reinforces the original impulse and this condition causes the further building up of the original impulse, and either regeneration, or, if the back action is strong enough, oscillation, occurs.

It follows that, if we only



RADIO BROADCAST Photograph

A FRONT ASPECT OF THE RECEIVER
The milliammeter serves as an excellent check on the quality, as explained elsewhere in this article



RADIO BROADCAST Photograph

HOW THE APPARATUS IS ARRANGED

This rear view clearly shows the neat layout of the parts on the sub-panel

could cause this back action of the plate upon the grid not to coincide with the original impulse, there would be less danger of oscillations being caused by this inter-element capacity. A method of doing this is illustrated in the accompanying circuit diagram. In this circuit we see that we have placed a shunt resistance, R, in the plate circuits of the r.f. tubes. Here we see that condensers C, and primary inductances L, are shunted by a plain resistance R, which kind of circuit is an ideal absorption circuit, its effectiveness as such depending upon the size of the resistance.

It will be seen that the plate circuit now contains a capacity as well as an inductance, and that, due to the presence of these two, the relationship between voltage and current is changed, so that the plate voltage variations will more or less coincide with the current variations, as the inductive effect is largely offset by the capacity, which has an effect opposite to that of the inductance. The effect of the condenser will not completely prevent oscillations but will make it much more difficult for them to occur. The remaining tendency toward oscillations is overcome by the variable resistance. The resistance is more effective at high frequencies where the back coupling tending to create oscillations is greatest. The Phasatrol then fulfils its function in two distinctly different ways: First, it changes the phase relationship of potentials and currents in the plate circuit, so that the potential variations of the plate are much less liable to be the cause of oscillations, while in the second place, the device acts as an absorption circuit which can be accurately adjusted to the exact requirement of every individual receiver.

THE NECESSARY PARTS

REFERRING again to the diagram, we see that, for the exception of the Phasatrols, which are placed in dotted lines, the receiver is a conventional one in most respects. A list of parts used in the receiver is given below:

L ₁ , L ₂ , L ₃ —Three Bodine Matched Coils	\$6.00
Five Eby Sockets	2.50
R ₁ —Four Amperites, Type 1-A	4.40
R ₂ —Amperite, Type 112	1.10
T ₁ , T ₂ —Two Thordarson R-200 Audio Transformers	16.00
C ₁ —Hammarlund Midline Condenser 0.00035 Mfd.	4.75
C ₂ —Hammarlund Midline Gang Condenser (2—0.00035 Mfd. Sections)	8.00
Lynch Single Resistor Mounting . . . . .	.35

R ₃ —Lynch 2 Megohm Grid Leak . . . . .	.50
Seven Eby Binding Posts	1.05
Four Carter Pin Jacks . . . . .	.60
S—Cutler-Hammer Filament Switch . . . . .	.60
R ₄ —Electrad Royalty 700,000 Ohm Variable Resistance	2.00
R ₅ —Electrad Royalty 500,000 Ohm Variable Resistance	2.00
MA—Jewell Panel Mounted Milliammeter 0—50 Scale	7.50
Two Eby Dials	5.00
Wire . . . . .	.50
P ₁ , P ₂ —Two Electrad Phasatrols	5.50
C ₃ —Electrad 0.5 Mfd. Bypass Condenser . . . . .	.60
C ₄ —Sangamo 0.00025 Mfd. Grid Condenser . . . . .	.40
C ₅ —Sangmo 0.001 Mfd. Fixed Condenser . . . . .	.50
C ₆ —Electrad 1 Mfd. Bypass Condenser	1.80
TOTAL	\$71.65

Panel 7 x 23 inches
Sub-Panel 7 x 23 inches

The placement of the parts is evident from the photographs, and these, in conjunction with the circuit diagram, should give sufficient information to enable a home constructor to build the receiver. The "figure-eight" Bodine coils are placed on the market in sets of three matched coils, and this makes it possible to use the Hammarlund gang condenser and thus eliminate one control. The 700,000-ohm Royalty variable re-

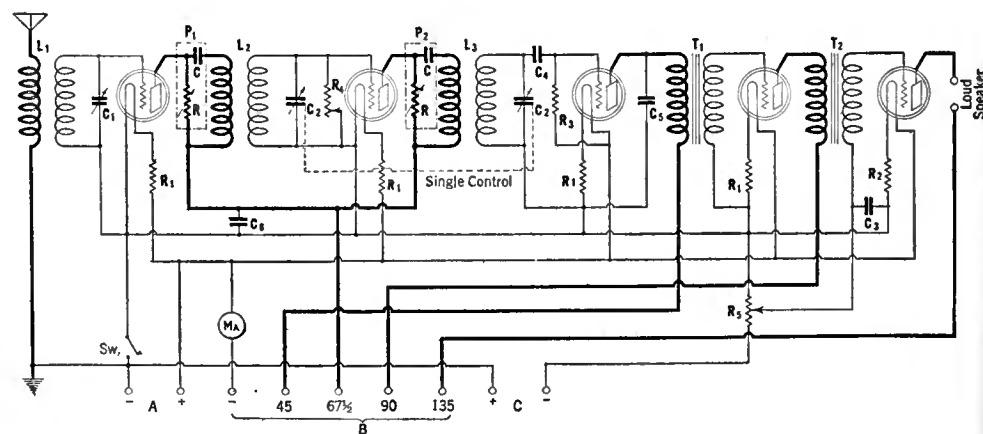
sistance located near the left center of the panel, is the volume control. Since this control is in the r.f. stage, it is possible to prevent overloading of the detector on strong local signals.

The milliammeter to the left on the panel is placed in the common negative B-battery lead. The meter used in the model had a 100-mA. range, but a 50-mA. range is large enough. The receiver ordinarily draws about 25 mils, with a 112 type tube in the output. With a 171 type output tube, the total plate current will be about 35 mils.

The meter is an excellent accessory because it will serve to check up on the quality of the reception. To understand this use of the meter, one only has to remember that, in order to be undistorted, the signal currents should be pure alternating currents, increasing and decreasing from the mean value of the steady current to the same extent. If this condition is fulfilled, the meter needle should remain still even with the loudest signal. Violent fluctuations of the meter will always be indicative of distortion, which can usually be remedied by adjustment of the C bias.

In order to make the best use of the meter for this purpose, there is installed on the front panel a Royalty 500,000-ohm potentiometer, which is shunted across the C-battery connections. The moving arm is connected to the F lead on the second audio transformer, and has also a connection to one of the terminals of a 1-mfd. condenser, whose other terminal leads to the general minus line. This control enables us to adjust the C-battery voltage to the best value possible, the meter giving visible evidence when the correct value is reached. There is still another service, for which the meter will prove of invaluable service, *i.e.*, in the stabilization of the receiver.

To do this successfully, the condenser dials should be turned to about 10. When, now, one of the two dials is moved, and the receiver is in oscillating condition, the needle of the meter will suddenly jump, as the dial passes a certain point. As soon as the correct position of the Phasatrols is found, the meter will remain perfectly still when tuning; the Phasatrol is then adjusted to greatest sensitivity on a short wavelength station, and the receiver is ready for operation and logging. In adjusting the Phasatrols, reduce each unit a small amount at a time—otherwise it is quite possible to make the receiver broad in tuning and a loss of sensitiveness will be noticed particularly on the long wave stations. In this way each resistance will remain about equal, in value, and give best results.



THE CIRCUIT DIAGRAM OF THE RECEIVER

Using Phasatrols in which these units are shown in dotted lines. Separate B-plus binding posts are indicated for the r. f. and first a. f. plate voltages but these two may be combined as was done in the model made up. Also no C-plus post is used on the model since this lead was connected to the negative-A post. Only seven binding posts are then necessary. The antenna and ground are connected through pin jacks, as are also the loud speaker leads

Constructing an Amplifier-Power Supply Device

How to Build a Three-Stage Resistance-Coupled Power Amplifier Operated from the A. C. Mains—Data for the Winding of the Power Transformer, Choke Coils, and Output Impedance, Are Given

By JAMES MILLEN

THE cost of the various parts required for the construction of combination high quality amplifiers and a. c. operated power-supply devices of the type described in this and the past two issues of RADIO BROADCAST, is rather high. As the power transformer and choke coils contribute a good share toward this figure—say \$30—many constructors who have the necessary facilities and patience may deem it worth the trouble to construct their own units.

The main difficulty to be overcome in the construction of small power transformers and filter chokes lies in securing suitable laminated iron cores. If the core can be secured from a toy transformer or some other such piece of apparatus, then the job is very much simplified. If not, then a sheet of transformer steel, such as No. 29 gauge Apollo special electrical sheet, must be cut into strips one inch in width, and the strips used to build up the cores, as shown in Fig. 1, A and B.

Though, perhaps, this can be done by hand, it will be best to take the sheet to a tinsmith and have it cut into the desired size pieces with a pair of squaring shears. The individual pieces must be cut to as near a uniform size as possible, in order to facilitate the final core assembly. If the edges are burred, then the burrs should be removed. Commercially, burred laminations are passed through a set of steel rollers, but the home constructor will doubtlessly have to resort to the tedious process of filing.

When a sufficient quantity of the proper size laminations have been gathered together to provide a core one inch in thickness, each should be given a thin coat of shellac and allowed to dry before assembling. The assembly of the cores for the chokes and transformer is not the same. It will be noted, in B, that each successive layer of laminations for the transformer core overlap, while no overlapping of the strips takes place in the cores for the choke coils.

First let us take up the construction of the coils for the chokes. Two chokes, consisting of two cores and two coils, are required. The coils are preferably wound on forms made from wood to the dimensions given in Fig. 1, C. As a great

many turns of wire are to be wound before the two choke coils and transformers are completed, it is well worth the time to construct some simple form of winding machine if a lathe is not available for the purpose. A simple, yet quite practical coil winding machine can be rigged up by mounting the coil form or bobbin on the hand wheel of a sewing machine. Another way is to make use of a hand drill clamped in a vise.

The two choke coil windings consist of approximately 5000 turns each of No. 31 enamel wire, random wound on the two forms. Care must be used in winding to exert an even tension on the wire at all times. It is also extremely important to guard against short-circuited turns. A single short-circuited turn is quite sufficient to make an otherwise excellent coil entirely worthless. The finished coils should be protected with several layers of wrapping paper.

When assembling the cores around the choke coils, the method shown in Fig. 1, A, should be employed, so as to form air gaps at the end of each core. A piece of paper of about half the thickness of one of the pages of RADIO BROADCAST should be placed in each of the air gaps so as to prevent the two adjacent core legs from touching each other. Clamps should then be made from strips of brass or steel and the entire core firmly fastened together with the gaps pressed as tightly closed as the paper will permit. Should it, for any reason, be desirable to use these same chokes with heavier currents than will be encountered within the amplifiers described, the size of the air gaps should be increased by inserting several thicknesses of paper.

THE TRANSFORMER

ALTHOUGH the transformer actually consists of fewer turns than even one of the choke coils, more time will probably be required for its construction because it consists of several individual coils, or windings, placed one on top of the other. First, next to the core (which is shown in Fig. 1, B.), comes the 110-volt winding, or primary. This winding consists of 840 turns of No. 26 enameled copper wire, layer

wound, with a strip of glassine or Empire paper between each layer. If a little care is taken, no great difficulty will be experienced in making a neat layer-wound coil. When the primary has been completed, several layers of heavy wrapping paper, or better yet, Empire cloth, should be wound in place before starting the filament winding.

The filament winding, for use with a 171 power tube, consists of 40 turns of No. 20 cotton-covered enamel wire. A mid tap is brought out at the 20th turn by bringing out a long uncut loop and twisting it into the form of a double wire.

There is a very definite reason for placing the filament winding between the 110-volt primary winding and the high-voltage secondary winding. All parts of this filament winding are at all times within a few volts of ground potential, which enables this winding to serve as a most satisfactory electrostatic shield between the 110-volt winding and the high-voltage winding. This has the effect of greatly reducing the line disturbances, principally the ninth harmonic of the fundamental power line frequency which is at times so evident in the loud speaker of a. c. operated sets in which no provision for electrostatic shielding is made.

On top of the filament winding, several more layers of insulating material are placed before winding the high-voltage secondary. This high-voltage secondary consists of 3520 turns of No. 31 enameled copper wire with a tap taken out at the 1760th turn. Glassine or Empire cloth should be placed between the layers of this coil.

In assembling the power transformer, so stack the core pieces that there are no air gaps, as shown in Fig. 1, B. As in the core of the choke coils, the transformer core must be tightly fastened with core clamps made from strips of brass or steel. The clamps are shown in Fig. 1, D.

THE OUTPUT IMPEDANCE

ALTHOUGH a choke similar to one of the filter chokes just described will serve quite excellently as an output impedance, it is needlessly large and cumbersome for the purpose. A

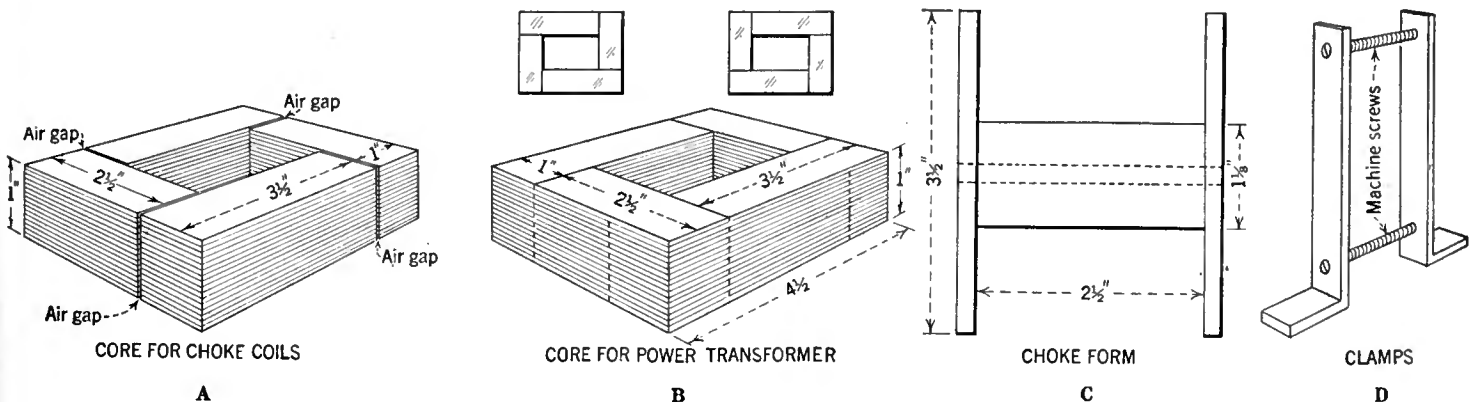
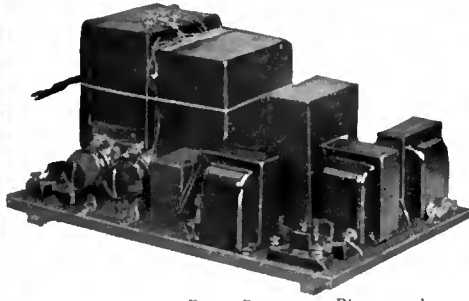


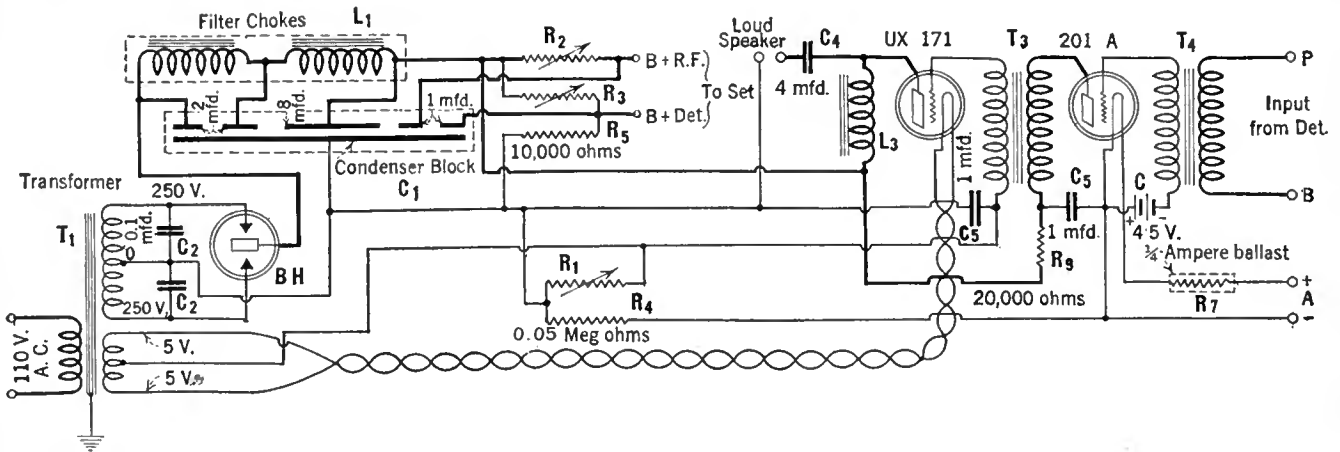
FIG. 1



RADIO BROADCAST Photograph

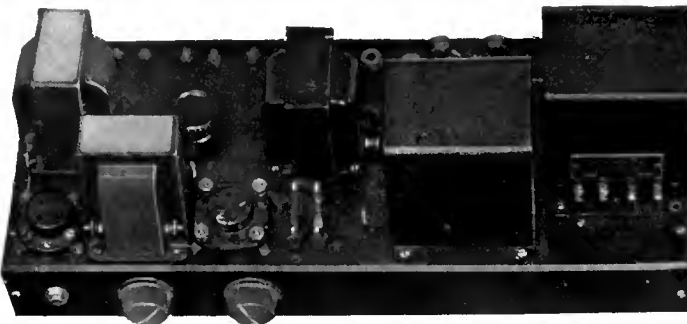
THE LIST OF PARTS

T ₁ , L ₁ , C ₂ —Thordarson Power Compact, No. 71 . . .	\$15.00	R ₁ —Tobe Veritas, 2000 Ohms . . .	1.10
C ₁ —Potter Condenser Block . . .	12.50	L ₃ —Thordarson Impedance, Type R-196 . . .	5.00
C ₄ —Polymet 4-Mfd. Condenser . . .	3.50	T ₃ , T ₄ —Two Thordarson Type R-200 Transform- ers . . .	16.00
C ₅ —Two Polymet 1-Mfd. Condensers . . .	2.00	R ₂ , R ₃ —Two Clarostat Variable Resistors . . .	4.50
Three Airgap Sockets . . .	1.80	Base-Board, Wire, Posts, C Battery . . .	1.00
Lynch Double Mount . . .	.50	UX-201-A Type Tube . . .	1.75
Two Lynch Single Mounts . . .	.70	UX-171 Type Tube . . .	4.50
R ₇ —Lynch Equalizer No. 4 . . .	1.00	Raytheon B H Rectifier Tube . . .	6.00
R ₄ —Lynch Metalized Filament Resistor, 0.05 Megohms . . .	.75		
R ₃ —Tobe Veritas, 20,000 Ohms . . .	1.10		
R ₅ —Tobe Veritas, 10,000 Ohms . . .	1.10		
		TOTAL . . .	\$79.80



A TRANSFORMER-COUPLED AMPLIFIER-POWER SUPPLY DEVICE

Designed to supply B voltage for the whole receiver. The filament of the output tube is supplied with a.c., and C voltage is also obtained from the mains for this tube. The circuit diagram gives the connections and constants used in the circuit. Above is a photograph of the complete unit which is unusually compact



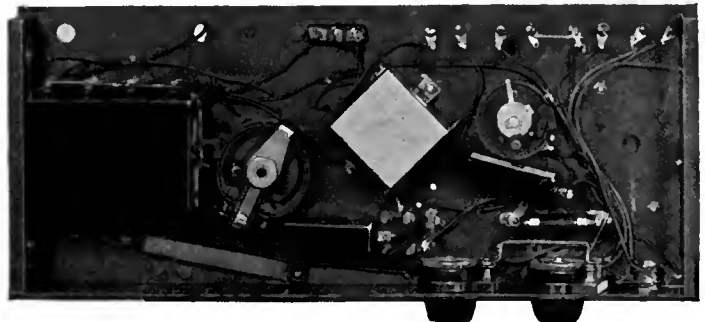
RADIO BROADCAST Photograph

ANOTHER AMPLIFIER-POWER DEVICE

The circuit diagram which applies to the amplifier device illustrated here is substantially the same as that shown in the box above. The 5-ohm resistance strip specified in the list of parts should be connected in series with one of the filament leads of the power transformer to drop the voltage to 5 volts. The potentiometer, R₁₃, is connected across the filament terminals of the power tube socket in order to obtain the equivalent of a center tap. The total capacity in the filter section is 8-mfd. as opposed to the usual 12-mfd.

THE LIST OF PARTS

T ₁ —General Radio Power Transformer . . .	\$10.00
L ₁ —General Radio Filter Chokes . . .	10.00
C ₁ —Four American Electric Filter Condensers, 2 Mfd. . .	7.00
C ₂ —Two Tobe 0.1-Mfd. Buffer Condensers . . .	1.40
C ₃ —Two American Electric Bypass Condensers, 1 Mfd. . .	2.40
L ₃ —Thordarson Choke, No. R-196 . . .	5.00
C ₄ —Tobe Fixed Condenser, 4-Mfd. . .	3.50
T ₁ , T ₂ —Two Rauland Lyric Transformers . . .	18.00
Three Sockets (General Radio, Benjamin) . . .	1.75
R ₇ —Rheostat, 10 Ohms . . .	.75
Resistance Strip, 5 Ohms (Taken from Old Rheo- stat) . . .	.75
R ₃ , R ₃ —Two Electrad Royalty Resistors, No. 2 and No. 3 . . .	3.00
Lynch Double Resistor Mounting . . .	.50
R ₁ —Tobe Veritas Resistor, 2000 Ohms . . .	1.10
R ₄ —Durham Metalized Filament Resistor 0.05 Megohms . . .	.75
Two Electrad Short Jacks . . .	.50
Binding Posts . . .	.45
Bakelite . . .	3.00
Garfield Brackets . . .	1.25
R ₁₃ —Potentiometer, General Radio, Type 214 . . .	3.00
UX-201-A Type Tube . . .	1.75
UX-171 Type Tube . . .	4.50
Raytheon B H Rectifier Tube . . .	6.00
TOTAL . . .	\$85.60



RADIO BROADCAST Photograph

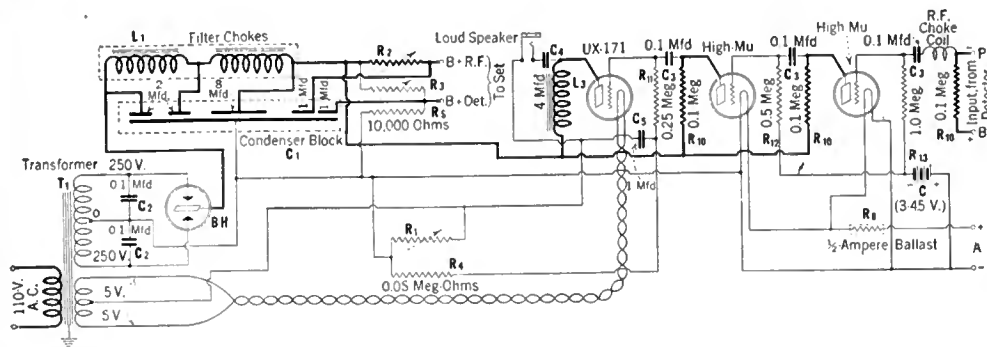


FIG. 2

more compact, and more easily constructed coil, can be made from an old audio transformer core. The one used in the amplifier shown photographically on this page and schematically in Fig. 2, is wound on the core of an old type 231 General Radio audio transformer. Any transformer core of equal or greater cross section ($\frac{1}{2}'' \times \frac{1}{2}''$) will prove satisfactory. The coil consists of from 6000 to 8000 turns of No. 34 enamel covered wire, random wound. In assembling the core, the core pieces should be so stacked as to provide a slight air gap.

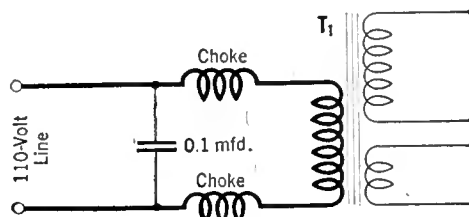
It will be noticed that the home-constructed transformers and chokes used in the amplifier shown on this page are not shielded. It will also be noted that the transformer is not placed very close to the choke coils and that it is placed in such a manner relative to the choke coils so as to provide a minimum of coupling for stray electromagnetic flux. There is generally quite a field of stray or leakage flux in the immediate neighborhood of a home-constructed transformer, unless the core is exceedingly well made. Should this flux link with the turns of the choke coils, an alternating voltage will be set up across the terminals of the chokes, and so produce a hum in the output of the radio set.

Undesirable magnetic coupling between the transformer and choke coils can be eliminated in either of two ways. One is that utilized in the construction of the model shown here, *i. e.*, the wide separation between the different units, and the other is the complete shielding of the transformers and chokes as shown in some of the models using commercial parts, such as the one shown on page 492, using General Radio power transformer and double choke units. In order to be effective, this shielding should consist of completely closed boxes of sheet steel of not less than 25 mils in thickness. These boxes, or containers, must be sufficiently large so as not to come closer than within $\frac{1}{2}$ inch of any part of the transformer or choke cores, and of course, they must be grounded.

The following is a list of parts employed in the construction of the home-made amplifier-power supply device described here (other parts similar in electrical characteristics can be used):

T ₁ —Transformer	} Home-made	. \$ 5.00
L ₁ —Two Choke Coils		
L ₃ —Output Choke		
C ₁ , C ₂ —Filter Condenser Block (Polymet)		11.50
C ₃ —Three Coupling Condensers, 0.1 Mfd. (Polymet)		1.80
C ₄ —Output Condenser, 4-Mfd. (Polymet),		3.50
C ₅ —Bypass Condenser, 1 Mfd. (Polymet)		1.00
4 Eby Binding Posts		.60
R ₁ —Centralab Radiohm, Variable, 0-2000 Ohms.		2.00
R ₂ —Centralab Radiohm, Variable, 0-25,000 Ohms		2.00
R ₃ —Centralab Radiohm, Variable, 0-500,000 Ohms		2.00
Yaxley Open-Circuit Jack		.50

3 Lynch Double Mounts	1.50
Lynch Single Mount	.35
R ₅ —Elkay Equalizer with Mount, No. 2	.75
R ₁₀ —Three Durham Metalized Filament Resistors, 0.1 Meg.	2.25
R ₁₁ —Durham Metalized Filament Resistor, 0.25 Meg.	.50
R ₁₂ —Durham Metalized Filament Resistor, 0.5 Meg.	.50
R ₁₃ —Durham Metalized Filament Resistor, 1 Meg.	.50
R ₄ —Durham Metalized Filament Re-	



R. F. Chokes are approximately 200 millihenries (1500-turn Honeycomb coils)

FIG. 3

sistor 0.05 Meg.	.75
R ₅ —Tobe Veritas Fixed Resistance, 10,000 Ohms	1.10
Base-Board, Wire, Fahnestock Clips, Etc.	1.00
Two High-Mu Tubes.	5.00
UX-171 Tube	4.50
TOTAL.	\$48.60

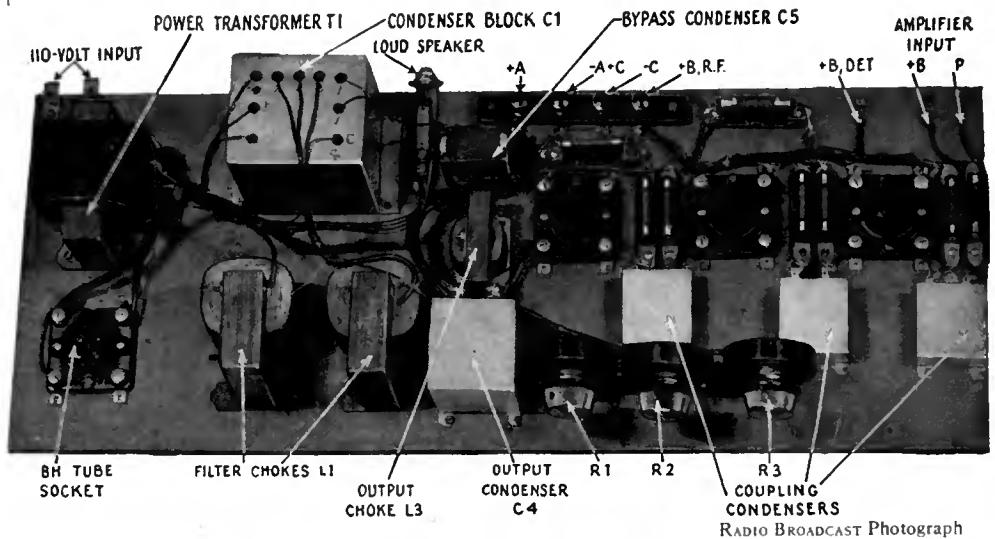
Frequently, in outlying districts, difficulty is encountered due to the introduction of radio frequency disturbances into the radio receiver, via the power unit, from the local power line.

Although this condition generally presents a problem for local solution, a general cure may be accomplished in a good many instances by the introduction of the arrangement of choke coils and condensers in the power line, close to the transformer, shown in Fig. 3.

LINE BALLAST LAMPS

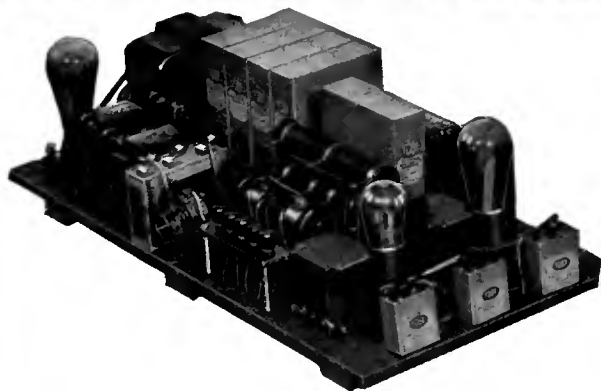
THE uv-876 and 886 Radiotron ballast tubes, as used in the Radiola 30, the RCA 104 loud speaker, and several of the Victor and Brunswick electrically operated phonographs, are for the purpose of automatically adapting these devices for operation on power supplies of different line frequencies and voltages, rather than, as their name might indicate, serving to counteract fluctuating line voltages. While they will compensate, to a marked degree, such line fluctuations, this compensation is not at all necessary where B and C power is obtained from the same power-supply device, as variations of the one automatically tend to neutralize or counteract any harmful results which might be caused by variations of the other. The tubes were designed for use with one particular amplifier and power supply and not for experimental or home construction purposes. For this reason it is not advisable to attempt to use one of the Radiotron ballasts in a home-constructed power unit for not only will the construction become somewhat involved, due to the necessity of rebuilding the power transformer for a 60-volt instead of a 110-volt supply and of "loading" the secondary circuit until the primary current is of the proper value, but nothing is gained where the device is to be used in any one locality. Whether the line voltage is 105 or 120 makes no real difference in the performance of a home-constructed amplifier, for the various B and C voltages are obtained by means of variable resistors which may be adjusted to supply the desired voltages.

There is one position in which the line ballast tube is of real service, other than that of making a power unit readily adaptable to power lines of different frequency and voltage, and that is in connection with an A, B, C, unit, such as was described by B. F. Roland in the October, 1926, issue of RADIO BROADCAST. In this instance, it is extremely important that the filament current for the 199 tubes does not fluctuate to any appreciable extent with variations in line voltage. The line ballast tube will reduce these fluctuations to a negligible amount.



THE HOME-MADE AMPLIFIER-POWER SUPPLY DEVICE

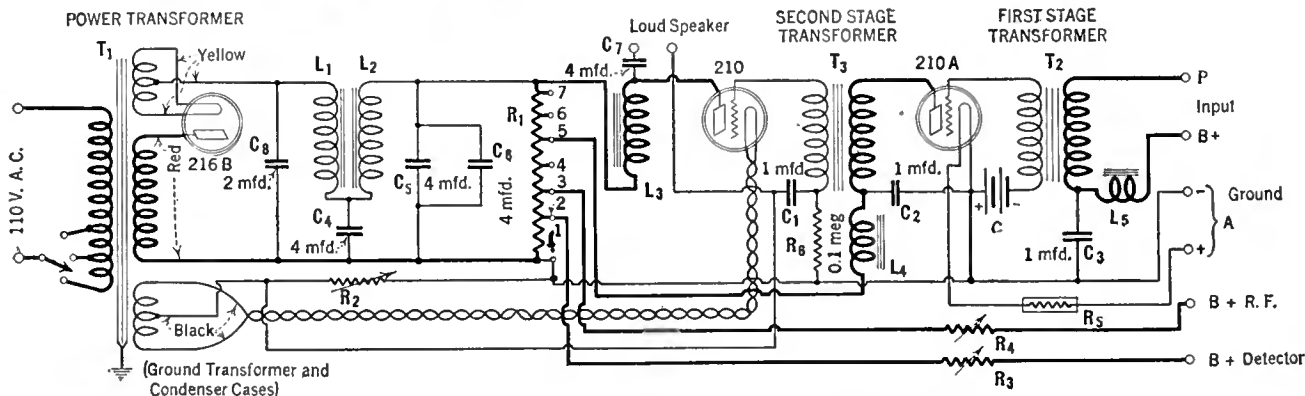
The schematic diagram of which is given at the top of this page, in Fig. 2. The Polymet condenser block contains the two buffer condensers, C₂, in addition to the others required in the power side of the device



RADIO BROADCAST Photograph

THE LIST OF PARTS

T ₁ —Amertran Transformer, Type PF-52	\$18.00	C ₄ , C ₅ , C ₆ , C ₇ —Four Tobe 4-Mfd. Power Pack Condensers, No. 604	28.00
R ₁ —Amertran No. 400 Resistor	7.50	C ₈ —Tobe 2-Mfd. Power Pack Condenser, No. 602	4.00
L ₁ , L ₂ , L ₃ —Three Amerchokes, Type No. 854	12.00	Carter Short Jack	.25
T ₂ , T ₃ —Two Amertran Deluxe Transformers	20.00	Eveready C Battery, No. 771	.60
R ₂ , R ₃ , R ₄ —Three Clarostats	6.75	Six Binding Posts, with Strip	1.00
R ₅ —Elkay No. 4 Equalizer and Mounting	.75	Three Airgap Sockets	2.25
L ₄ , L ₅ —Two Samson Audio Chokes, No. 3	6.00	Base-Board	.75
R ₆ —Lynch Fixed Resistor, 0.1 Megohms	.75	UX-210 Tube	9.00
C ₁ , C ₂ , C ₃ —Three Tobe 1-Mfd. Bypass Condensers, No. 301	3.75	UX-201-A Tube	1.75
		UX-216-B Rectifier Tube	7.50
		Lynch Single Resistor Mounting	.35
		TOTAL	\$130.95



A HIGH-VOLTAGE A.C. OPERATED POWER AMPLIFIER

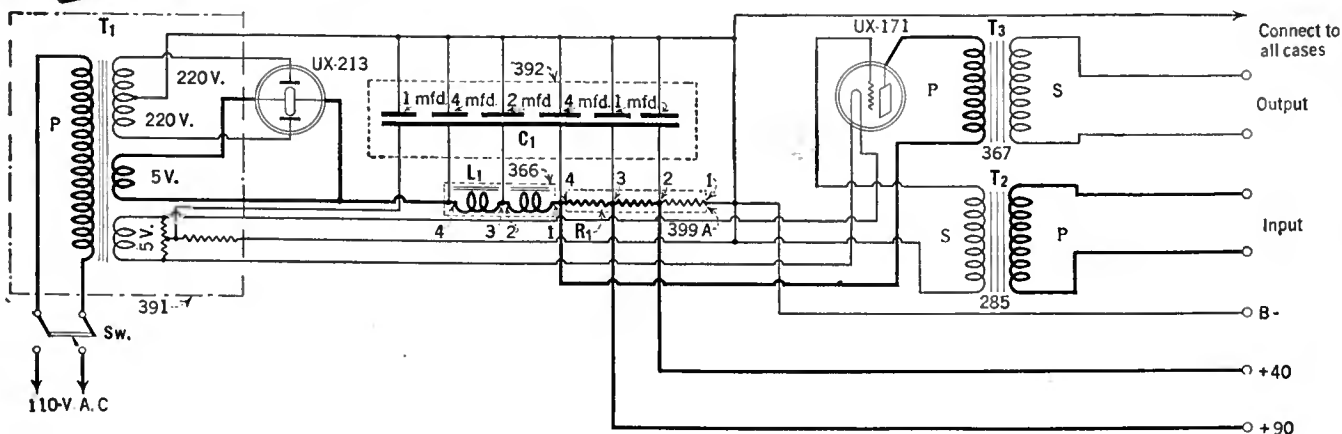
Which employs the 216-B as a rectifier and a 210 power tube in the last stage. Filament current is supplied from the a. c. mains for the last tube, as is also the grid voltage. The circuit gives the connection and values of the different apparatus. A preferred arrangement of this amplifier, using an UX-171 output tube, was shown in the upper box on page 385 of the February RADIO BROADCAST



RADIO BROADCAST Photograph

THE LIST OF PARTS

T ₁ —General Radio Power Transformer Unit, Type 391
C ₁ —General Radio Condenser Block, Type 392
L ₁ —General Radio Choke Block, Type 366
R ₁ —General Radio Voltage Tap Resistance, Type 393A
T ₂ —General Radio Input Audio Transformer, Type 285
T ₃ —General Radio Output Transformer, Type 367
2 Sockets
Sw—1 D. P. D. T. Snap Switch
7 Binding Posts, with Terminal Strip
1 Base-board
1 Attachment Plug and Cord
1 UX-171 Tube
1 UX-213 Tube
These parts may be obtained in kit form, price \$47.50 without tubes



A ONE-STAGE AMPLIFIER-POWER SUPPLY DEVICE

Employing an UX-213 tube as a rectifier and an UX-171 as an amplifier tube. Plate current is supplied for the tubes in the main part of the receiver. The various elements enclosed in dotted lines in the circuit diagram indicate that such may be obtained in one unit. The photograph shows the general layout of the amplifier unit. This amplifier is particularly adaptable to the "Universal" Receiver

Equipment for the Home-Constructor

How to Use Some of the New Equipment Tested and Approved by the "Radio Broadcast" Laboratory

By THE LABORATORY STAFF

THE first articles of new equipment to be described this month are the chokes, impedances, and transformers made by the Samson Electric Manufacturing Company, and which are illustrated on this page. These various pieces of apparatus were tested in the Laboratory and some data are given below with regard to their characteristics and uses:

TYPE 85—This is a small radio-frequency choke coil satisfactory for use in filtering out of a circuit any radio-frequency currents. Three of these chokes were tested in the Laboratory and gave an average inductance of 90 millihenrys and an average resistance of 220 ohms. The impedance of these chokes to the lowest radio frequency used by any broadcasting station is approximately 283,000 ohms. Their impedance at the highest audio frequencies, say 8000 cycles, is only 4500 ohms, approximately, which is negligibly small in comparison with the impedance of an audio transformer. Two of these choke coils were used in the two-tube shielded "Lab" receiver which was designed and constructed by Mr. John B. Brennan, one of them being located in the radio-frequency stage and the other in the plate circuit of the detector tube. These r.f. chokes measure about $1\frac{1}{2}$ " long and are about the same height. They are supplied with both soldering lugs and binding posts. Price \$2.00.

TYPE 125—This choke coil is similar to the type 85 and can be used for the same purposes. Three of these chokes gave an average inductance of 200 millihenrys and an average d.c. resistance of 400 ohms when measured in the Laboratory. Home-constructors unfamiliar with chokes and their uses might consider a resistance of 400 ohms to be too high, but this is not so. Suppose we had a 201-A tube in an r.f. amplifier, operating with 90 volts on the plate and a $4\frac{1}{2}$ -volt C battery. The plate current would be about 0.002 amperes. Now, if we wanted to keep the r.f. currents out of the B battery we would put a choke coil, K_1 in Fig. 1, in the plate circuit of the tube, and then bypass the r.f. currents to the filament with the condenser C_1 . If the choke coil was a type 125 its impedance at 500 kilocycles would be 627,000 ohms. Its impedance, being proportional to the frequency, would be even higher at higher frequencies.

The drop in plate voltage across this choke coil will be equal to the plate current (0.002 amperes) times the d.c. resistance (400 ohms). The loss in plate voltage then figures to be 0.8 volts, which is an insignificant amount. This is the only effect of the choke coils resistance (not impedance), that is, to cause a loss in plate voltage, and an ordinary resistance could be used with equally effective results were it not for the comparatively high loss in plate

voltage which it would cause. If a resistance were to be used, it would be necessary to employ one with a value of $627,000 \text{ ohms}$, and then the loss in plate voltage would be $627,000 \times .002 = 1254 \text{ volts}$. To impress 90 volts on the plate would require a battery with a voltage of $1254 + 90$, or 1344 volts! Hence a resistance is entirely unsuited. If you ever want to arrange a receiver so that the radio frequency currents in the plate circuit are kept out of the battery, use a choke coil and never a resistance. Price \$2.25.

TYPE 3—This choke coil is for use in filtering audio frequency currents out of any circuit. The average inductance of three samples proved to be 3.1 henrys, and the average resistance, 586 ohms. These choke coils are suitable for use in audio frequency circuits whereas the other choke coils are designed for radio-frequency circuits. Two points at which these chokes might be used are indicated in Fig. 1, K_2 , where they function to prevent, to a considerable extent, coupling in the plate supply which might cause

howling. These chokes are usually unnecessary when the amplifier is supplied from B batteries but are frequently of value if a line power-supply device is used for the plate supply. They measure about 4" long. Price \$3.25.

TYPE D—This is a dual impedance made in accordance with the Donle design. Three of them can be used in constructing a three-stage high-quality audio amplifier. Price \$5.00.

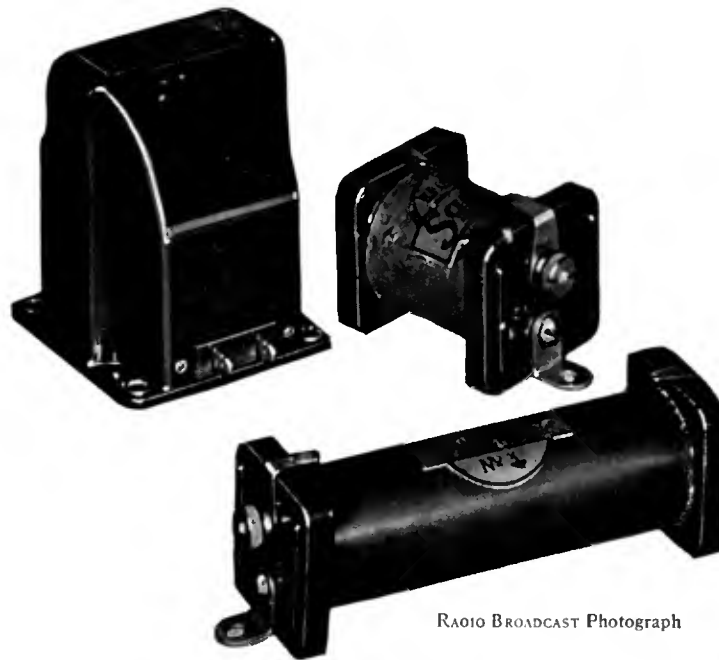
TYPE G—This is a grid impedance satisfactory for use in the grid circuits of an impedance-coupled amplifier. Price \$4.50.

TYPE P—A plate impedance of this type may be used in the plate circuit of an impedance amplifier, and an excellent double impedance amplifier may be made up using type P impedances in the plate circuits and type G impedances in the grid circuits. Price \$4.50.

TYPE O—This is an output impedance to be used in eliminating the direct current from the windings of a loud speaker. A fixed condenser with a capacity of two microfarads or more must be used in conjunction with this output device. See Fig. 1. Note how the audio currents indicated by the dotted lines flow directly back to the filament and do not pass through the battery. Price \$5.00.

SYMPHONIC TRANSFORMERS—The Symphonic audio frequency transformer is a comparatively new product of the Samson Company put on the market to supply the home-constructors' demand for a very high-quality unit. The transformer is enclosed in a brushed copper case which gives it a very nice appearance.

Two of these units were used in an amplifier constructed in the Laboratory, and proved very satisfactory. The amplifier which was constructed is illustrated on page 494 and it was used with good results in conjunction with several different receivers, including the R. B. "Lab" two-tube shielded receiver. The price of the Symphonic Transformers is \$9.00 each.



RADIO BROADCAST Photograph

A GROUP OF SAMSON APPARATUS

The No. 3 choke is in the foreground and the small choke in the rear is a type 125. The grid impedance, type G, is on the left. The other impedances made by Samson are similar in appearance

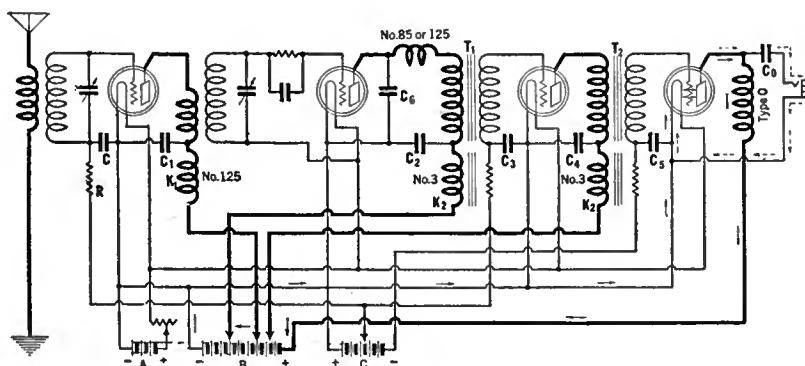


FIG. 1

In connection with the use of the above-mentioned Samson apparatus we would suggest that interested home-constructors write to the Samson Electric Manufacturing Company and obtain from them their booklet entitled *Audio Amplification*. This booklet, costing twenty-five cents, contains a great deal of information regarding circuits using the apparatus described here.

B POWER-SUPPLY DEVICE

THE Greene-Brown Company's B power-supply device is an excellent unit capable of supplying sufficient voltage for the operation of an ordinary radio receiver using a 171 type tube in the output.

A photograph of this plate supply unit is shown on page 494. It is equipped with a high-

voltage tap for supplying a power tube such as the 171, and an intermediate voltage tap for the other audio and radio frequency stages and a third tap for supplying the detector plate voltage. The voltage at both the detector and intermediate taps is variable so that any desired voltage can be obtained. There is a terminal on the front of the device to which a ground may be connected. This unit uses a QRS double-wave rectifier tube of the filamentless type. A rectifier of this type has a very long life so that no replacements should be necessary for many months of service.

In testing these devices, the Laboratory fre-

A POWER SUPPLY DEVICE

Made by the Greene-Brown Manufacturing Company. Price, \$39.50



RADIO BROADCAST Photograph

quently resorts to the use of the oscillograph. The oscillograph is an electrical instrument which will show visibly whether there is any residual ripple in the output voltage of the device. This plate supply unit showed a perfectly flat output on the oscillograph. The curve is shown in Fig. 2, and for purposes of comparison, we show alongside of it a curve taken on a power-supply device which is about two years old. The ripple, shown up by the oscillograph, would make this old device very unsuited for use in conjunction with present-day amplifiers. The Greene-Brown unit, with its flat output char-

installation automatic, and decrease the amount of attention which must be given to the various pieces of apparatus, as the switching on and off of the various power units is automatically accomplished. The 110-volt a.c. supply is connected to the cable on the switch. The cable from the trickle charger connects to one plug on the switch and the power cable on the power-supply device connects to another plug. When the set is turned on, the switch automatically connects the 110-volt supply to the power-supply unit and disconnects the trickle charger. Turning the set off actuates the switch so that the trickle charger is turned on and the power supply turned off. The filament switch on the receiver controls the entire installation. These switches are easily wired into the circuit. They consume no power and are fool proof.

TRICKLE CHARGER

THE France Manufacturing Company makes a non-acid chemical trickle charger which will supply current to a storage battery at a rate of $\frac{1}{2}$ ampere. Price, \$10.00. This trickle charger, shown in an accompanying photograph, is constructed in a very simple manner so as to make all the parts easily accessible.

For the benefit of those readers not familiar with trickle chargers, such a device consists of

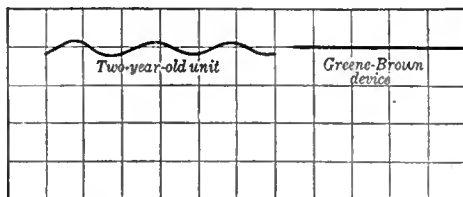


FIG. 2



RADIO BROADCAST Photograph

AUTOMATIC POWER RELAYS

The device on the left is made by the Jewell Electric Instrument Company. That on the right by the Yaxley Manufacturing Company

acteristic, can be used without any danger of an audible hum in the output of the receiver. Both of these curves were made when the devices were delivering a 20-milliampere load.

AUTOMATIC SWITCHES

TWO automatic switches, the Yaxley (\$5.00) and Jewell, are shown in a photograph on this page. They are for use in conjunction with a receiver when the plate voltage is obtained from a power-supply device and a trickle charger is used in conjunction with the storage battery. These switches are similar in construction and design to the Brach Controlit described in the February issue on page 379.

These switches make the operation of a radio

device that will automatically do this. Therefore, this trickle charger might be used very satisfactorily in conjunction with either the Yaxley or Jewell switch mentioned above, to make a radio installation requiring practically no attention, except to add a small amount of water to the trickle charger and battery every few months.

CABLE CONNECTORS AND CONVENIENCE OUTLETS

IT IS becoming increasingly common to find the radio receiver installed in the living room, and the power amplifier and batteries down in the basement. To connect these two installations together the products of the Yaxley Company will be found valuable.



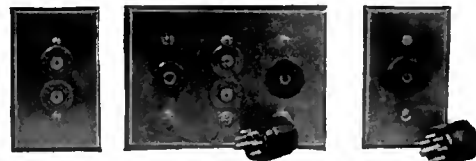
RADIO BROADCAST Photograph

A TWO-STAGE AMPLIFIER

An amplifier made up using two Samson Symphonic transformers

One of their cable connectors, No. 670, might be attached to a receiver with the leads from the radio receiver connected to the cable terminal plug on the convenience outlet No. 350, shown in the center of the picture, the convenience outlet being mounted in the baseboard in the living room at a point convenient to the receiver. Leads then pass down the walls of the house or through a hole in the floor into the basement, where they might terminate in another convenience outlet.

Leads from this outlet are then connected to



RADIO BROADCAST Photograph

YAXLEY CONVENIENCE OUTLETS

The No. 136 outlet illustrated at the left has two terminals—for the antenna and ground. The type 350 in the center has, besides these two terminals, a telephone jack and a cable connector plug. The type 137 at the right contains only a cable connector plug. Prices, \$1.00 to \$4.50

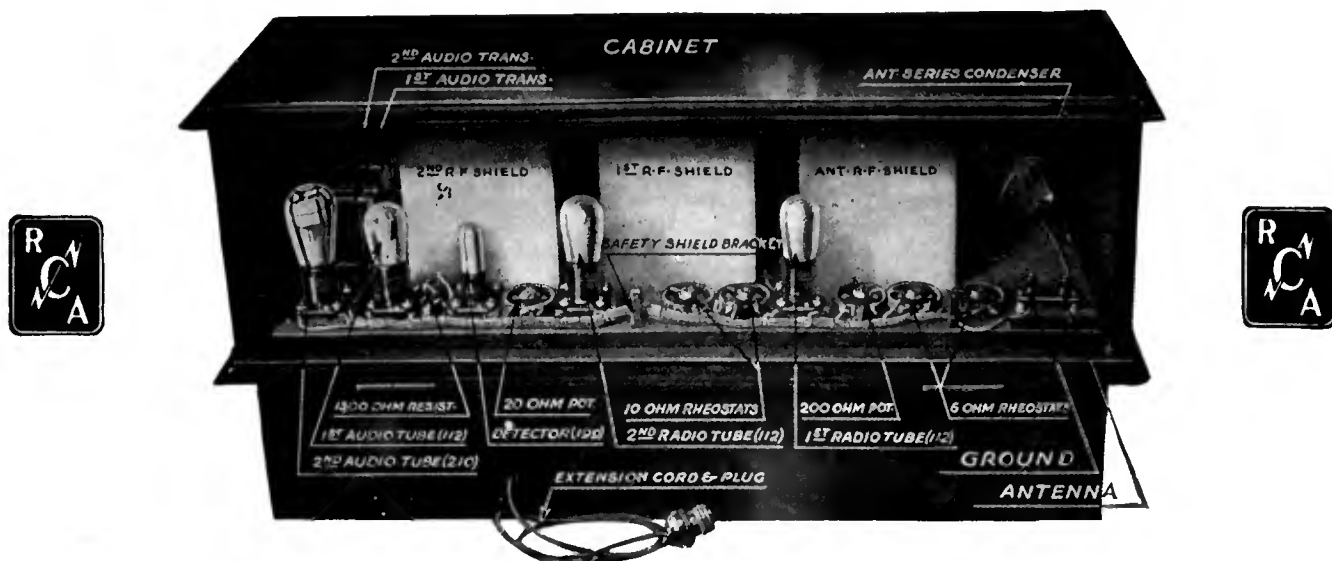
the batteries and to the input of the power amplifier, while the output of the power amplifier can then be again brought up to the convenience outlet located in the living room and connected to the loud speaker jack on the outlet. The batteries in the basement may be controlled by an automatic switch so that the entire installation is automatic in operation.

The No. 670 cable connector contains seven leads, all of them differently colored and marked with cable markers. The leads are marked as follows: A+, A-, B+ Det., B-, B+ Amp., and two blank leads that may be used for C battery connections.



RADIO BROADCAST Photograph

THE FRANCE TRICKLE CHARGER



AN INTERIOR VIEW OF THE GAROD EA RECEIVER
Note the neat cabled wiring at the rear of the sub-panel

A. C. as a Filament-Supply Source

A Description of a Popular Commercial Receiver—the Garod Model EA—Which Is Operated Entirely from the A. C. Mains

By **B. F. MIESSNER**

Chief Engineer Garod Corporation

THE operation of radio receivers directly from the a. c. house mains has always been a problem which has greatly interested radio engineers. After extensive research, and the accumulation of a great amount of data, the problem of design has been solved in a few instances. Whether a. c. operation will entirely supplant other means of powering the receiver is a question which will have to be left for the future.

Of the tubes in commercial use, the 112 type has been found to lend itself most readily to a. c. operation. This is due, in the most part, to the heavy oxide coated filament which does not fluctuate so much in temperature with the alternations of the current. By using the correct grid, plate and filament voltages as previously shown, the operation of such tubes is entirely satisfactory. As yet, no completely satisfactory means have been devised to use a detector supplied directly by a. c. To take care of this, it is customary that one of the 199 type tubes be used, its filament being energized by the total plate current of the other tubes in the receiver.

In the February issue of *RADIO BROADCAST* was discussed, with the help of curves, the different types of tubes and their characteristics under actual a. c. operation. The preceding article also dealt thoroughly with the different causes of hum and the methods of eliminating it. The present article will take up the practicable application of a. c. operation to a commercial receiver.

The Model EA Garod receiver has been designed and produced to meet a growing need for a receiver in which all batteries are eliminated, and with a much finer and fuller tone quality than has hitherto been available. The receiver is of the neutrodyne type, employing five tubes in the receiver and one rectifying tube in the a. c. power supply unit. It is made under licenses from Hazeltine and from the writer.

The power conversion system does two things; first, it develops an alternating current suitable for excitation of the filaments of the amplifier tubes, and second, it develops a direct current for supplying the plate current of all the tubes and the filament current of the detector tube.

The power-supply unit is mounted in the table portion of the receiver, and is entirely enclosed in an enameled sheet-iron box. The top and sides are removable as a whole without disturbing the enclosed apparatus which is mounted on the base-board. The opening or lifting of the lid opens an automatic safety switch which cuts the line circuit so that the user can not make accidental contact with high voltage terminals. The unit is designed to operate on a. c. lines of 60 cycles, 110 to 125 volts. It will not operate on 25 or 40 cycles, or on direct current, but seems to operate satisfactorily on a 50-cycle line.

To provide for voltages which differ slightly from the usual 110-volt standard, the transformer primary is tapped at different points which are designed to take care of any voltage variation in the mains and still provide the same value of voltage for the vacuum tubes.

There are three secondary windings on the power transformer, one of 7.5 volts and 3 amperes for exciting the filaments of the amplifier tubes in the receiver; another of 7.5 volts and 1.5 amperes for exciting the rectifier tube filament; and a third of 525 volts and 60 milliamperes for providing the a. c. for rectification of the B supply power.

To prevent the passage of electrostatic disturbances from the lighting circuit to the receiver circuits, a shield winding is provided, consisting of a layer of wire insulated from, and between, the primary and secondary windings of the transformer. One end of this winding is connected to the transformer clamping frame

and grounded through the power box and receiving set ground.

The line current from the house lighting socket enters the power box through the attachment cord provided, one wire of which has connected in it the operating switch mounted on the front of the table. This side of the line is connected through one of the fuses on the output terminal board to one side of the transformer primary. The other side of the line enters the power box and connects directly to the other fuse, and from this through the automatic switch, to the other side of the transformer primary. These fuses are provided to protect the power converting equipment from overloading, which might result from excessively high line voltage, or from connection to direct-current or 25-cycle lines, which would produce excessive current in the transformer, and which might burn it out.

House lighting fuses ordinarily are of 15-ampere capacity, and would provide no protection whatsoever for the power equipment. The power consumed by this receiver is approximately 100 watts, the primary current being about $\frac{1}{3}$ of an ampere at 110 volts. The fuses are rated at one ampere and will open the circuit should the primary current of the transformer exceed one ampere. No apparatus other than the A winding on the transformer is necessary for providing the filament current. The system, therefore, is exceptionally simple in this regard, as no conversion system from alternating current to direct current, such as is used in most power driven receivers, is necessary. The power equipment provided is used chiefly for B power of high voltage and high current capacity, which is so desirable in providing distortionless reproduction at the required volume.

The B supply portion of the power equipment consists of the rectifier tube, the high-voltage

secondary winding of the transformer, the choke coil, several condensers, and resistors.

The rectifier tube and transformer winding together provide a half-wave rectifier for the a. c. supply, and the filter system converts this rectified a. c. into practically pure direct current. Directly across the rectifier output is a 4-mfd. condenser which is flash tested at 3000 volts before assembly at the factory. Its purpose is to provide a reservoir for d. c. energy and a bypass for a. c. energy.

In series with the positive side of the filter line is the choke coil marked A in the accompanying diagram. It is a 50-henry choke having two air gaps of 0.01 inches formed by ten-mil paper between the laminations forming the two halves of the choke coil's magnetic circuit. This choke coil has a resistance of approximately 600 ohms and consists of about 7000 turns of copper wire.

Across the filter line, on the output side of the choke, is another 4-mfd. filter condenser which functions as a d. c. reservoir and as an a. c. bypass to further smooth out the ripple of the rectified current. The voltage across the first 4-mfd. condenser should measure approximately 400 volts (r. m. s.). The actual peak value of the voltage across this condenser is approximately 525 volts. The second 4-mfd. condenser has approximately 364 volts (r. m. s.) across it, and its rated operating voltage is 600 (the same as the first one).

The plate supply of the second audio or power tube is taken from the filter output on the output side of this filter choke coil. A reduced B voltage is obtained for the radio- and first audio-amplifier tubes of the receiver by connecting in series with their plate supply a 5000-ohm resistor. This resistor is at the front of the power box at the right-hand side. To ventilate it properly, holes have been provided beneath it and above it in the power box lid so that air may circulate and prevent overheating. These same holes also provide for ventilation of the rectifier tube.

Directly across the filter line, between the B and the output side of the 5000-ohm resistor, is a 100,000-ohm fixed resistor which is located in the rear right-hand corner of the output terminal board. It is soldered in the connecting clip provided for it. This resistor prevents excessive voltages in the filter circuit when the set load is taken off by the removal of all the tubes.

To the left of the 100,000-ohm resistor is a 500,000-ohm one of similar type mounted in the same manner, which provides a plate current of reduced voltage for the detector tube. The voltage of the input side of the 500,000-ohm resistor, or directly across the 100,000-ohm resistor, is the voltage which feeds the two radio- and the first audio-amplifier tube plate circuits. It should measure about 150 to 175 volts, depending upon the adjustment of grid voltage for these tubes, as will be explained later.

Across the output side of the 500,000-ohm resistor supplying the detector plate circuit is a 1-mfd. condenser whose function it is to still further eliminate the slight alternating current ripple superimposed upon the direct current output of the filter system. Inasmuch as the audio frequencies of the plate circuit of the detector tube are twice amplified, that is, by the first and second audio tubes, the plate circuit

supply for the detector tube must be perfectly smooth and without any variation.

THE OUTPUT DEVICE

INCLUDED in the power box assembly, besides the power conversion equipment proper, is the output choke (B in the accompanying diagram) together with a 1-mfd. condenser, the two combining to form an efficient output device for the protection of the loud speaker and to better quality. The plate circuit of the second audio tube is fed from a point on the output side of the filter choke, A, through the output choke B. This latter choke is, of course, connected in series with the lead to the plate circuit of the second audio tube.

The output choke for the loud speaker coupling is mounted on the rear side of the transformer. Air gaps in the two choke coils are provided for the purpose of giving maximum in-

ductance to the chokes at the particular value of direct current flowing through the coils. If the air gaps provided by the paper spacers were omitted entirely, magnetic saturation of the iron core would result, and this would produce a considerably lower inductance in the coil than if saturation did not occur. It has been found that, for a given amount of direct current in the coil, a definite size of air gap will provide the maximum amount of inductance. Choke A, which must carry about 60 milliamperes of direct current, requires a considerably larger air gap than the choke B, which carries only the plate current of the second audio tube (approximately 25 milliamperes).



A COMMERCIAL A.C. OPERATED RECEIVER
It is the Garod EA receiver, the circuit diagram of which is shown on the following page

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The two 4-mfd. filter condensers, the detector bypass condenser, and the 1-mfd. loud speaker output condenser are all mounted in a condenser unit installed beneath the output terminal board.

The terminals on the power box are arranged for connection to the cable leads coming downward from the receiver.

The pilot light receives its illumination from

the rectifier tube and thus an extra lamp for this duty is dispensed with. The rectifier tube socket is mounted in such a position that the majority of rectifier tubes fit in it with the long axis of the elliptical plate in a vertical position, so that no danger of a sagging filament touching the plate will be encountered.

USING A LOOP

THE radio circuit of the EA receiver, as has been stated is of the neutralized tuned radio-frequency type, consisting of two such stages, a detector, and two stages of transformer-coupled audio-frequency amplification. The receiver is designed for use with antenna and ground, and these, in as good a form as possible, should always be used. In locations, however, where it is impossible to put up an outdoor antenna, an indoor antenna or a portable loop may be used. A loop may be connected directly across the antenna and ground binding posts and should be tuned by means of the radio-frequency volume-control knob (left-hand small knob) which operates a series tuning condenser.

In some localities, where many powerful broadcasting stations are located and interference is troublesome, a loop may be preferable to an outside antenna. By tuning the loop, and by virtue of the directional effects obtained by turning the loop, selectivity of a considerably higher order is obtained over that of an outside antenna. The range, however, is reduced.

When an antenna is used, the series antenna condenser is of great service in controlling the radio-frequency input to the receiver. It is also possible, by means of this condenser, to change the electrical length of the antenna within wide limits so as to change the overall selectivity of the receiver. When the condenser is all in, it is short-circuited so that the full antenna pick-up is available. As its capacity is decreased, the energy transfer is decreased, and the selectivity of the receiver is increased, in the same manner as if the actual physical length of the antenna itself were reduced.

Coupled to the antenna through the first radio-frequency transformer primary is the tuned input, or grid circuit, to the first radio-frequency tube. A bypass condenser of 0.006 mfd. is connected between the low-potential side of this grid circuit and the filament for the purpose of bypassing radio-frequency currents which otherwise would be compelled to flow through various portions of the receiver, including particularly the grid biasing resistance common to the plate circuits of the receiver.

The plate circuit of the two radio-frequency tubes is bypassed by a 0.01-mfd. condenser to the filament circuit for the same purpose as the grid bypassing condenser. The radio-frequency transformers consist of low loss bakelite tubes upon which are wound the primary and secondary coils of the transformer.

In the operation of the vacuum-tube filaments on a. c., it is necessary to use negative biasing on the grids to eliminate a certain type of disturbing hum which would otherwise be produced. The biasing necessary for this purpose, and for the normal biasing required for the audio tubes to prevent distortion, is obtained from the voltage drop across the resistors in the negative

leg of the B supply to the filament circuit. The normal biasing voltage for the first and second radio stages and first audio stage is obtained from the voltage drop across the 200-ohm variable resistor in the receiving set on the right-hand side of the first radio tube socket.

Since the total plate current of all the tubes of the receiver passes through this resistance, and since this resistance is variable, the biasing on these tubes may be controlled by a variation of this resistance. Its chief value is in the control over the total plate current which energizes the detector filament and which control makes it possible to change the natural vibration period of the detector filament. It is found that a small percentage of the 199 detector tubes, even with the use of the best obtainable cushion sockets, will pick up energy from the loud speaker and develop an audio frequency or acoustic howl between the detector and loud speaker. If the loud speaker is resting in its normal position on the top of the receiver cabinet it is possible to eliminate this howl by a small change in the 200-ohm biasing resistance. This will change the filament current in the detector tube, and so alter its natural vibration period that the sound energy fed back will be out of phase with the vibration in it, and thus stop the howl. The detector filament, as before explained, is inserted in the negative B lead and is energized by the total plate current (approximately 60 milliamperes), of all the amplifier tubes in the receiver. Across this detector tube filament is connected a fixed resistor of 1000 ohms which will maintain the B circuit should the detector tube be pulled out while the set is in operation. A sudden interruption of the circuit by the removal of the detector tube will produce a high inductive voltage across the choke coil which would be impressed upon the filter condensers, and might possibly cause their breakdown were the resistance not to be included.

The first and second radio-frequency tube filaments are connected in parallel and have resistances connected in them. The first audio tube also has, in each leg of its filament supply, a variable resistor. These resistors are provided for the purpose of regulating the voltage of the tubes at the desired value below the 7½ volts supplied by the A winding of the transformer for use directly upon the filament of the 210 power tube.

A one-half megohm potentiometer regulates the signal voltage to the first audio tube for volume control, and a one-quarter megohm fixed resistor across the second audio grid circuit adds a slight load, which improves quality.

SELECTIVITY AND DISTORTION

TESTS have proved that there is a definite point in selectivity in the radio-frequency circuit of a receiver beyond which a designer cannot go without materially increasing the distortion introduced. If the selectivity is too high, the side bands which carry the higher audio frequencies of the broadcast signals will be cut down materially, and the reproduction will suffer because of this. The EA receiver has been de-

signed to provide as satisfactory a degree of selectivity as is possible without materially, or seriously, cutting off the higher frequencies by side-band elimination. You will find receivers which are more selective than the EA receiver, but a careful examination of reproduction quality will show that side bands are probably being cut by the more selective receiver, and that the

cies by capacitive bypass, and with windings of extremely high inductance for the preservation of extremely low tones, which form the foundation of the musical structure.

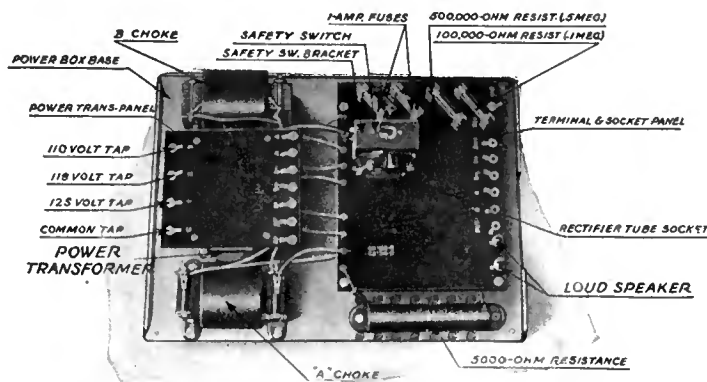
In addition to these high-quality transformers, another extremely important feature is the use of power tubes for the prevention of overloading and the reproduction of low tones at high volumes.

Even with the best of transformers it is not possible to reproduce the whole audio spectrum as transmitted by our better broadcasting stations with tubes of ordinary size and operating at ordinary plate voltages. The 210 power tube provides an undistorted output energy of approximately 100 times that obtainable with the 201-A tube and for this reason provides an amplifier of correspondingly lower distortion.

The 201-A tube will not reproduce the lower tones, necessary for satisfactory musical reproduction, at the volume levels ordinarily used in the home. A 210 tube will accomplish this result very easily and

will, in addition, extend the volume many times without distortion so that practically full tone reproduction is available without distortion.

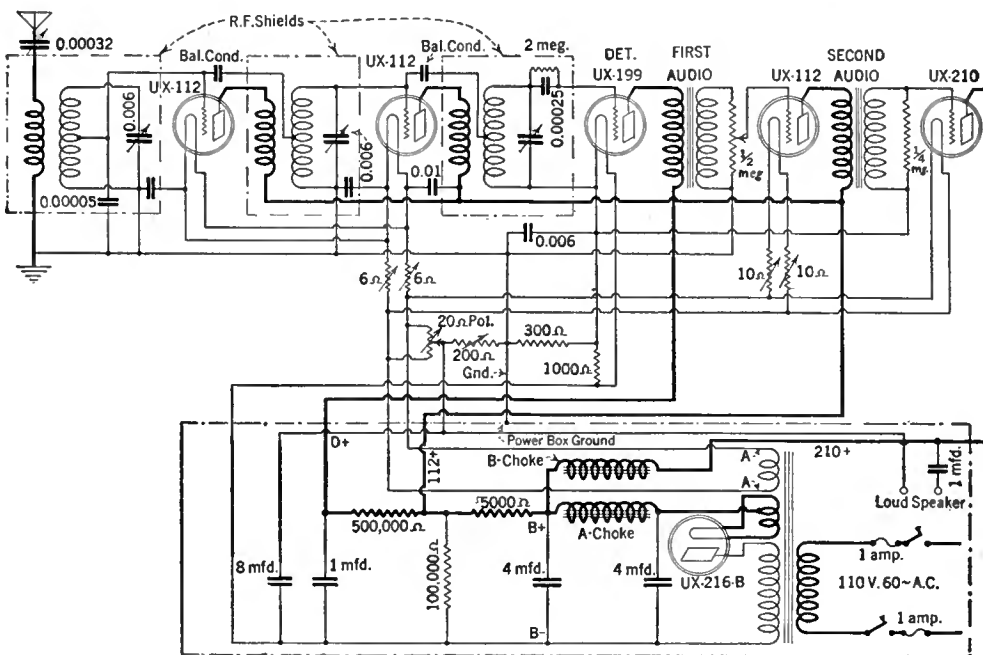
Another factor of importance in connection with the high tone quality in this receiver is the use of an output coupling device for the loud speaker. The use of a large size choke coil and a condenser as an output coupling is the simplest and best way to eliminate distortion resulting from high plate current in the loud speaker windings. In addition, the use of this coupling removes the high B voltage of the power-tube plate circuit from the loud speaker terminals and entirely prevents any danger of accidental shock from such a cause.



THE POWER CONVERSION UNIT

reproduced quality is sacrificed because of it. Overall resonance curves for the whole receiver show a band width at one-half the resonant response of about 7 kilocycles at 500 meters and 15 kilocycles at 300 meters.

In addition to the inherent design of the radio-frequency circuits which reduces side-band cutting in this receiver, there is provided an audio-frequency amplifying and reproducing system which has been designed with utmost care for the preservation of all the frequencies present in the broadcast music. The transformers are of special construction, with a large amount of iron to prevent saturation, and coils of large dimensions to prevent the loss of high frequen-



THE CIRCUIT DIAGRAM OF THE RECEIVER DESCRIBED

Adequate protection of the power unit from the mains is provided by the fuses

RADIO BROADCAST is the official publication of the Radio Club of America, through whose courtesy, the foregoing paper has been printed here. RADIO BROADCAST does not, of course, assume responsibility for controversial statements made by authors of these papers. Other Radio Club papers will appear in subsequent numbers of the magazine

Book Reviews

A Biography of Emile Berliner, Inventor of the Microphone—What the Radioman Should Know about Isobars, "Highs," "Lows," etc.

The Microphone in the Making

EMILE BERLINER—MAKER OF THE MICROPHONE. By Frederick William Wile. Preface by Herbert Hoover. Published by the Bobbs-Merrill Company, Indianapolis, Indiana. 353 pages, 30 illustrations. Price, \$4.00.

WHEN Herbert Hoover writes the preface and Frederick W. Wile the text, a book is produced worthy of your notice. That the subject is Emile Berliner, one of the picturesque personalities of the past fifty years, assures interest to the reader—and profit, also, if one would learn from history in its most attractive form of biography. Emile Berliner aided two arts with important inventions at strategic moments in their early days, the art of the telephone in 1877, and that of the phonograph ten years later.

Inventions, whether of means or methods are, broadly speaking, products of evolution; they arise like brachiopods, Java men, or four-toed horses from antecedent conditions. Given a suitable and general state of scientific knowledge, the induction motor and the telephone, insulin and permalloy, the quantum theory and relativity, are inevitable, although the name of the inventor will depend on accidents of native ability, personal interest, and background of experience. Individual credit is not thereby lessened; genius is enhanced, not diminished, by a timely setting.

For the genius of Emile Berliner, the early days of telephony and of the phonograph provided the timely environment. These arts had been created, respectively, by Alexander Graham Bell and Thomas A. Edison. For both arts, the stage was set by the existing knowledge of electricity, although both had resisted previous efforts of other inventors. To Bell had come the accomplishment of the telephone through a happy combination of clear thought and laboratory discovery—the latter arising from the transmission of the twang of a vibrating-reed armature and the former a recognition, which would be expressed in our modern terms by saying that a carrier current must be modulated in exact conformity to the speech significance which is to be transmitted.

The only carrier current of those days was that of zero frequency, being the direct current conveniently derived from batteries. Its modulation, as we now recognize, is possible whenever through speech there is correspondingly varied, in a circuit containing a battery, either inductance, resistance, or capacity. Capacity variation is relatively inefficient; and the development of a condenser-transmitter therefore awaited the more timely setting of the present days of vacuum tube amplifiers. Inductance variation is not nearly so inefficient, and with it no battery is required, provided what is varied is the reluctance of the magnetic path of a permanent magnet which links with the transmission circuit. This method—that of the electromagnetic transmitter—was Bell's earliest system; although insensitive, it was peculiarly adapted to his discovery, for the same mechanism may be used interchangeably to convert current variations into a relative motion of the magnet and its armature, that is, to act as an electromagnetic receiver.

Historically, modulation by varying the resistance of a circuit came last. In one form, however, it came promptly; for Bell's first complete sentence was effected by an electrolytic transmitter in which a plunger, actuated by the diaphragm of the transmitter, vibrated more or less deeply into an electrolyte. Such was the art when it aroused young Berliner to intensive experiment and eager study, who already had his time well filled with earning his living and with efforts to learn the manners, customs, and language of America. And he won through, with a variable-contact resistance and a conception of possible multiple contacts, which proved a patent of value because other and famous inventors were following similar lines. Edison, for example, he beat in filing date by thirteen days; but the story of his invention and its later litigation is too exciting and too well told to be abstracted.

A coincident contribution which Berliner made to the telephone may best be described in its modern terms as "carrier suppression in direct-current carrier circuits." Working for two-way transmission, and curiously enough, attempting to use his variable-contact resistance device both as a transmitter and as a receiver, he found it necessary to employ local batteries and to couple the local circuits through transformers to his main transmission line. The modulated direct current of the local transmitter circuit, therefore, induced in the main circuit an alternating current corresponding to the modulations; the transformer action eliminated the direct current. All this before the real days of alternating-current technique, at a time when transformers were induction coils used only as spark coils in giving shocks, setting off explosives, or demonstrating luminous effects of electricity. Ever since, the name "induction coil" has been used in telephone parlance for the transformer which passes the modulation of a transmitter out into the line.

After a time, Berliner left telephony and turned toward the phonograph art which Edison had initiated. In the latter's instrument, sound was recorded by a groove the depth of which was supposed to be proportional to the sound intensity. In other words, a narrow trench was dug into the wax by a cutting needle and the contour of the bottom of the trench was a succession of ups and downs, hills and valleys, the levels of which corresponded to the volume of the recorded sound, and the frequency, to its pitch. The graving tool was driven by a diaphragm upon which the sound waves impinged. Obviously, the mechanism of the system was faulty. As the diaphragm approached the end of its vibration it was required to dig most deeply into the wax; but that was impossible, because the force which it could exert grew less as the turning point of its vibration was approached.

Berliner solved the difficulty by causing the graver to trace a wavy line—in effect, an oscillograph of the sound. There was then a lateral cut of uniform depth, instead of a vertical cut of varying depth. Simultaneously, he solved the problem of the reproduction of phonograph records; for his graver cut its trace in a thin film of wax on a metal disc and thus permitted the etching of the exposed line of metal. For years, until superseded by electroplating methods, Berliner's photo-engraving process of making ma-

trices for records was successfully employed; and that, with further developments, made the gramophone of "the gay 'nineties"—the precursor of the talking machine, which, by a cumulated series of developments, has become the Orthophonic of to-day.

JOHN MILLS.

Radio Prognostication

THE WEATHER FOR RADIO LISTENERS, BROADCASTERS, AND OTHERS: By Eugene Van Cleef. Published by the Taylor Instrument Companies, Rochester, New York. 34 pages. 7 illustrations. (See booklet listed as No. 67, page 512.)

THE conversation of two gentlemen of some literary attainments brought together at a party for the special benefit of their followers may serve to introduce a little booklet of more than passing interest on a subject of more than passing importance:

"Nice weather we're having," opened the conversation between the two.

"I never talk about the weather," was the stiff rejoinder.

"It's the only thing I ever talk about," replied the first, thereby closing the conversation permanently.

"The Weather for Radio Listeners, Broadcasters, and Others" is the booklet, and the author is Eugene Van Cleef, who needs no introduction to the readers of RADIO BROADCAST. The booklet is published by the Taylor Instrument Companies of Rochester, New York.

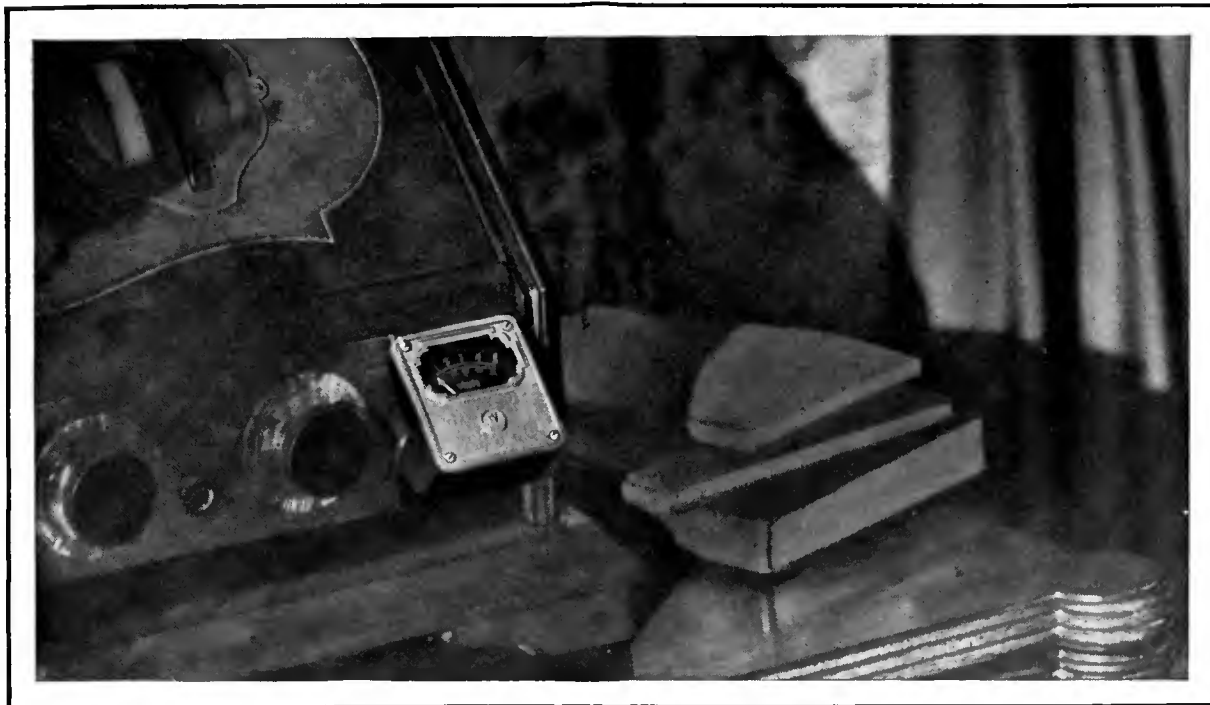
The weather, Mr. Van Cleef points out, as a topic of conversation should not be relegated to those who have nothing else to talk about, but should be considered as worthy of our best favored conversationalists. It is the common topic for talk among all peoples of the earth, and although most people have something to say about it, after reading Mr. Van Cleef's book, one need not be in the class mentioned by Mark Twain as those who talk a lot about the weather, but do not seem to do anything about it.

Weather affects radio reception as everyone knows, and a lot of us know that isobars, "lows", and "highs" have something to do with the matter too, but it remains for the Taylor Instrument Companies to try to explain, with Mr. Van Cleef's aid, what it is all about. This he does with considerable ability, not only stating the apparent relation between long distance reception and the barometric pressures existing over the country, but explaining something of the nature of static as well.

As a matter of fact, the burden of the little booklet is to interest listeners in the study of weather and its effect on radio, and it may be pointed out, for those who don't know, that the Taylor Instrument Companies have organized a vast group of widely distributed listeners who desire to have their share in undermining the secrets of good reception.

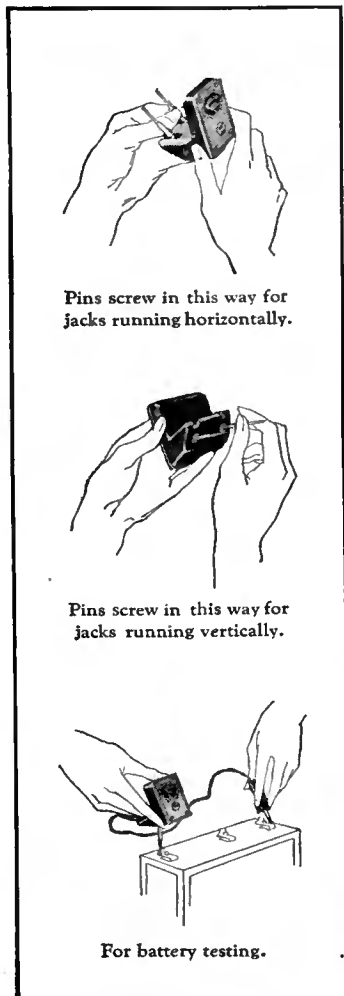
Even if one does not care to take an active part in collecting data on weather and radio, the booklet gives a good picture of how one can study weather maps with the object of prognosticating for himself the probabilities for good "dx".

KEITH HENNEY.



This clever little "pin jack" voltmeter sets off your set!

It's new, it's portable, it fits any arrangement of jacks—it's Westinghouse!



Pins screw in this way for jacks running horizontally.

Pins screw in this way for jacks running vertically.

For battery testing.

Here's a pin-jack voltmeter that really beautifies a fine set — a Radiola, a Brunswick, a Victrola, any one equipped with pin-jacks. It's the most accurate instrument of its type made. It shows you the way to long tube and battery life, and the clearest reception.

The voltmeter is attached by screwing in the pins and plugging them into the jacks of the radio. No matter how the jacks may be arranged—horizontally, vertically, or one above the other as in the Radiola 20—the pins can be set to fit them. The dial always peers up into your face—set at an angle for convenient reading.

There's no reason why a voltmeter should look like an alarm clock. There's no need for it to have leads running from the jacks to the top of your set. This one has a gold lettered dial, bronzed pointer and face plate. It is easily removable, for checking "A," "B" and "C" batteries, or for other purposes.

And how moderately priced! Two tubes prematurely burned out cost as much to replace as you would pay for a Westinghouse Voltmeter.

	PRICE COMPLETE
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West of Rockies to Pacific Coast.....	\$7.00

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Price Slightly Higher
West of Rocky Mountains

Electrify your radio. Let the set switch operate "A" Trickle Charger and "B" Eliminator automatically with light socket current.

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The Radio Broadcast

LABORATORY INFORMATION SHEETS

INQUIRIES sent to the Questions and Answers department of RADIO BROADCAST have until recently been answered either by letter or in "The Grid." The latter department has been discontinued, and all questions addressed to our technical service department are now answered by mail. In place of "The Grid," appears this series of Laboratory Information Sheets. These sheets contain much the same type of information as formerly appeared in "The Grid," but we believe that the change in the method of presentation and the wider scope of the information in the sheets, will make this section of RADIO BROADCAST of much greater interest to our readers.

The Laboratory Information Sheets cover a wide range of information of value to the experimenter, and they are so arranged that they may be cut from the magazine and preserved for constant reference. We suggest that the series of Sheets appearing in each issue be cut out with a razor blade and pasted on filing cards, or in a note book. The cards should be arranged in numerical order. Several times during the year, an index to all sheets previously printed will appear in this department. The first index appeared in November.

Those who wish to avail themselves of the service formerly supplied by "The Grid," are requested to send their questions to the Technical Information Service of the Laboratory, using the coupon which appears on page 528 of this issue. Some of the former issues of RADIO BROADCAST, in which appeared the first sets of Laboratory Sheets, may still be obtained from the Subscription Department of Doubleday, Page & Company at Garden City, New York.

No. 73

RADIO BROADCAST Laboratory Information Sheet

March, 1927

An A. C. Operated Power Amplifier

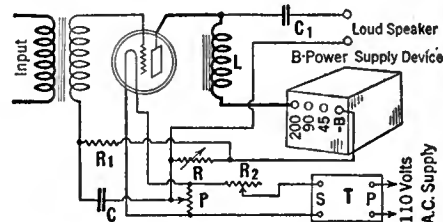
CONNECTION TO AN ORDINARY RECEIVER

MANY standard a.c. operated power-supply devices available at present are capable of supplying sufficient voltage for the proper operation of a 171 type tube. When this tube is used in conjunction with such a device in an ordinary receiver, the filament is usually lighted from a storage battery, and a dry cell is used to bias the grid of the tube. A few slight changes, however, will make it possible to light the filament of the 171 from an a.c. source and to obtain the necessary grid bias by means of a resistance in the plate circuit of the tube.

- The following parts will be required:
 T—An ordinary bell transformer giving about 6 volts on the secondary.
 P—200-ohm potentiometer.
 R—500- to 5000-ohm variable resistance.
 R₁—25,000-ohm fixed resistance.
 C₁—2- to 4-mfd. bypass condenser.
 C—1-mfd. bypass condenser.
 R₂—10-ohm rheostat.
 L—Output choke coil.

A circuit arrangement such as is shown makes the one-stage power amplifier entirely independent of any local supply of energy, since all the necessary

voltages are now being drawn from the a.c. power lines. In the operation of the unit, the potentiometer, P, should be adjusted to that point at which the hum in the output circuit is at a minimum. Generally it will be found that the center point of the potentiometer will give minimum hum.



The variable resistance, R, controlling the grid bias, should not be lowered to a value less than 1000 ohms. It should be adjusted to that value (something above 1000 ohms) which gives the best quality of reproduction.

No. 74

RADIO BROADCAST Laboratory Information Sheet

March, 1927

Resistance-Coupled Amplifiers

GRID LEAK-CONDENSER COMBINATIONS

SOME information regarding resistance-coupled amplifiers is to be found in an article by Sylvan Harris published in the December, 1926, issue of the *Proceedings of the Institute of Radio Engineers*, and, incidentally, the data given in the proceedings confirm some calculations and measurements made by the Laboratory of RADIO BROADCAST about a year ago.

When a mathematical analysis is made of the resistance-coupled amplifier, it becomes evident that a very large coupling condenser need not necessarily be employed. It is the combination of the coupling condenser and the grid leak which determines the quality that can be obtained from such an amplifier. If the coupling condenser is made large, the grid leak resistance may be made small, and if the coupling condenser is small, the grid leak resistance can be increased a proportional amount, and the same frequency characteristic will be obtained in each case.

In the article in the Institute's organ, some curves were given showing the relationship between the value of the grid leak resistance and the size of the coupling condenser for a 201-A type tube. From these curves we can easily determine what value of coupling condenser must be used in conjunction with any particular grid leak, in order to obtain a certain definite frequency characteristic.

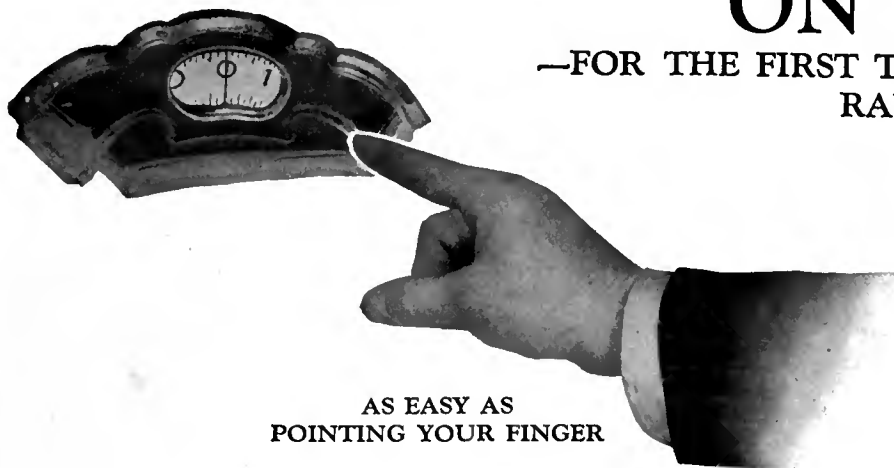
If a 100,000-ohm resistance is used in the plate circuit, the following combinations of grid leaks and coupling condenser may be used to obtain a practically flat characteristic curve down to 50 cycles:

GRID LEAK	COUPLING CONDENSER
0.2 megohm	0.06 mfd.
0.5 megohm	0.025 mfd.
1.0 megohm	0.012 mfd.
2.0 megohms	0.006 mfd.

The greatest trouble with resistance amplifiers is due to the blocking of the tubes which sometimes takes place. It is unlikely, however, that this blocking will occur unless one of the tubes is being overloaded. This makes it essential that the proper C-battery bias be used on the grids of the various tubes. It is possible to calculate the required value of the grid bias if the characteristics of the circuit and the amplification constants of the tubes are known. These calculations indicate that for a 20-mu tube the C battery bias on the first high-mu tube should not be more than 1 volt, and that 4 volts is about right on the grid of the second high-mu tube. These values are high enough to handle a grid swing of 40 volts peak value on a 171 type power tube in the last stage.

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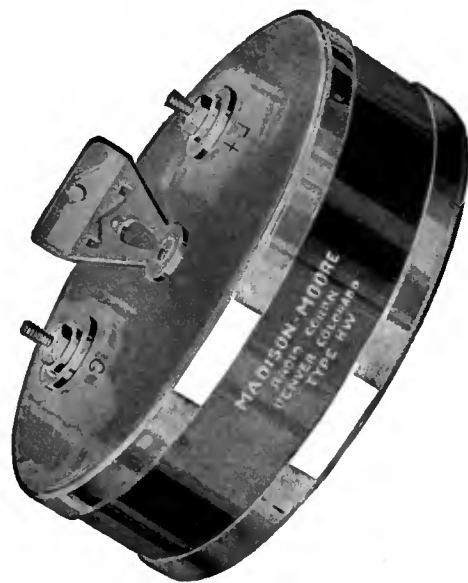
Each instrument carries the following guarantee: "It has been tested with finest apparatus under actual working conditions and is mechanically and electrically perfect. It is guaranteed indefinitely as long as the seal used in closing the case is unbroken, and will be replaced free of charge if found defective."

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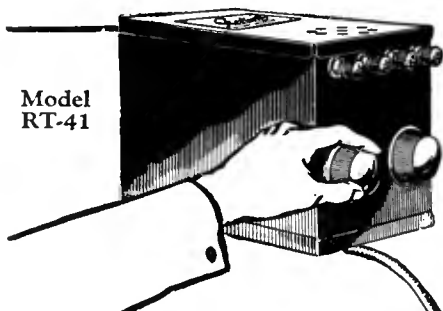
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Model RT-41

Sterling perfected "B" Eliminator control gives this added Advantage

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But with the Sterling "B" Eliminator, there is a tremendous improvement in tone quality too! The secret of this amazing tone quality lies in the extremely fine control of the "B" voltage.

This definite Sterling advantage in tone quality is possible only by using first quality materials, high standards of manufacture, backed by 20 years of Sterling electrical experience.

This Sterling Dependable Light Socket Power Unit RT-41

is the ideal "B" Power supply for sets using as many as 5 tubes. It takes up no more room than a 45 volt dry battery—yet it gives three times the voltage—135 volts.

Just right for Radiolas 25 and 28.

Price complete with CX 313 tube . . . **\$28.00**

Also Raytheon Tube Types for high-powered sets

R-97—"B" and "C" Power . \$55.00

R-99—"B" Power . . . \$45.00

For every set—there's a

Sterling "B" ELIMINATOR

Send for booklet "J" telling about the complete line of Sterling Radio Equipment.

THE STERLING MFG. CO.
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No. 75

RADIO BROADCAST Laboratory Information Sheet

March, 1927

Interference Finder

A PORTABLE RECEIVER

ON LABORATORY Sheet No. 76 is given a circuit diagram of a small portable receiver for use in locating sources of interference. In order to make up this receiver, the following apparatus is necessary:

- L—Any standard loop, tapped at the center.
- C₁—Variable condenser designed for operation with the loop that is used. Any value between 0.00025 mfd. and 0.0005 mfd. is satisfactory.
- R_g—4-megohm grid leak.
- C₂—0.00025-mfd. grid condenser.
- C₃—Midget condenser, 0.00015 mfd. max.
- T₁, T₂—Audio-frequency transformers.
- J—Single-circuit filament control jack.
- R—20-ohm rheostat.
- L₂—Radio-frequency choke coil which may consist of 400 turns of No. 32 or smaller wire wound on an ordinary spool.

To operate this receiver the following accessory equipment is necessary:

Three ordinary dry cells for the filament circuit; one small 45-volt battery for the plate circuits of all three tubes.

Three 199 tubes.
The receiver is of the ordinary regenerative type. The condenser, C₁, controls the tuning, while condenser C₂ controls the amount of regeneration. When C₂ is advanced near to its maximum position the detector tube will oscillate so that stations may be picked up by a heterodyning whistle.

The loop should be mounted so that it can be turned in any direction. It will be found that the loop is very directional and that, therefore, in interference investigations, the interference will be picked up loudest when the loop is pointing toward the source. In this way the actual source of interference can often be located.

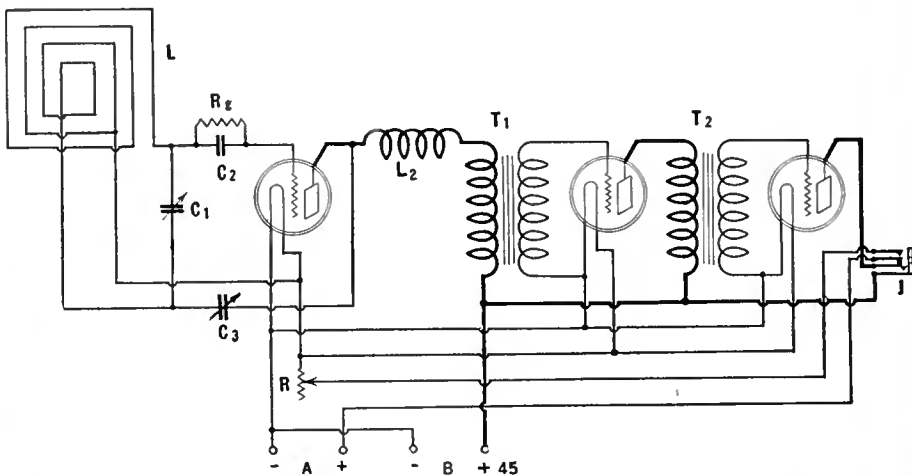
The receiver should be made extremely portable and, for this reason, it is preferable to enclose the batteries and loop, as well as the receiver, in a small carrying case that can be easily handled. The receiver should be equipped with a jack into which a separate loop unit may be plugged, or the loop may be wound inside the case itself. The filament rheostat controlling the tubes should not be advanced further than necessary to obtain satisfactory reception since excessive filament voltage on the 199 tube is very detrimental. It will be found that three ordinary dry cells used for filament lighting will last for many months.

No. 76

RADIO BROADCAST Laboratory Information Sheet

March, 1927

Interference Finder



No. 77

RADIO BROADCAST Laboratory Information Sheet

March, 1927

Interference Elimination

USE OF CONDENSERS AND CHOKES

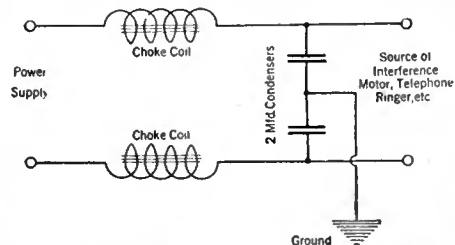
WHEN interference is experienced from motors, telephone ringers, or other similar apparatus, it may frequently be eliminated by using some such circuit arrangement as is illustrated on this Sheet.

This circuit is called a filter, and can easily be connected to practically any piece of apparatus that is causing interference. If, for example, a motor is found to be causing the interference, such may be eliminated by connecting two condensers across the line terminals of the motor with the mid point grounded, as illustrated in the sketch. The values of the condensers should, in general, not be less than 2 mfd., although smaller size condensers will sometimes give satisfactory results.

In extreme cases of interference, where it is found that the condensers shunted across the line with their mid point grounded do not remedy the trouble, the inclusion of choke coils in series with the line is necessary. These choke coils must be fairly large and wound with wire large enough to carry the full current in the line. The shunting condensers and the choke coils, if they are used, should always be placed as close to the source of interference as possible. The source of interference is not always obvious, and, for that reason, it is advisable first to make some simple tests to make certain of the cause. In such an investigation the small portable receiver

described on the Laboratory Sheets Nos. 75 and 76 will be found very useful.

Before installing any condensers, one should make certain that they have a rating sufficiently high enough to withstand the voltages under which they



must operate. There will be little difficulty in obtaining satisfactory condensers for use on direct-current circuits since there are many on the market rated at as high as 1000 volts d.c. Frequently these same condensers are not satisfactory for use on a. c. circuits, however, and consequently, if the device to be shunted is operated from a.c., make sure that the condensers used have a satisfactory a.c. rating.

FEATURING THE NEW GENERAL RADIO DOUBLE IMPEDANCE

A NEW Amplifier Unit

which provides for FAITHFUL REPRODUCTION of

FULL ORCHESTRATION



Type 373
Double
Impedance
Coupler
Price \$6.50
(2 required)



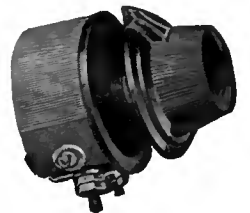
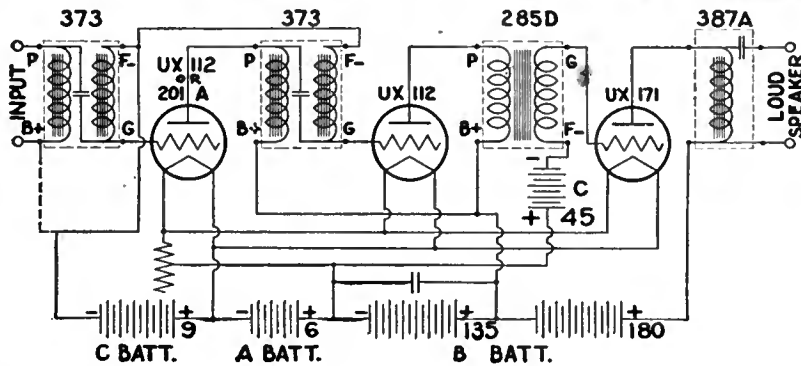
Type 285D
Audio
Transformer
Price \$6.00
(1 required)



Type 387A
Speaker
Filter
Price \$6.00
(1 required)



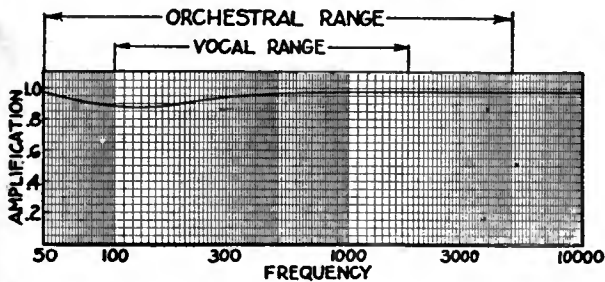
Type 349
UX Tube Socket
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A GRAPHIC REPRESENTATION OF Vocal and Instrumental Tones

as they are amplified by the Type 373 Double Impedance Coupler



The extent of its range of even amplification is from appreciably below 60 cycles to over 10,000 cycles, with a gradual downward deviation of slightly less than 7% between 100 and 400 cycles. This deviation in an otherwise perfect amplification curve is so slight as to be practically negligible, because the ear of the average individual cannot detect a variation of intensity of much less than 25%.

The amplification curve, in fact, compares favorably with that generally obtained with resistance coupled systems which have the disadvantage of large sacrifices of plate voltages.

The above circuit diagram shows a combination of two stages of double impedance coupling and one stage of transformer coupling with speaker filter. While the use of double impedances is not new in principle, the General Radio Type 373 Double Impedance Coupler is unique in design and performance. To facilitate installation, the complete unit, consisting of two impedances and a fixed condenser, is contained within a metal shell. It is connected in an audio amplifier circuit in precisely the same manner as a transformer. The amplifier combination shown above may be readily adapted to any standard manufactured or home constructed receiver, and will produce a very noticeable improvement in tone quality.

Its high and even amplification extends over the range of FULL ORCHESTRATION. The deep bass tones of the tuba are brought out in full timbre as are the shrill notes of the piccolo. The range of the human voice is covered with pleasing clarity.

The above amplifier combination has the further advantage that it may be used with the General Radio Type 405 Raytheon Plate Supply Unit. By substituting two Type 373 Units for the transformers of a two stage transformer coupled amplifier the above combination may be completed and proper plate voltages provided by using the General Radio Type 400 Power Amplifier and Plate Supply.

Ask your dealer or write for folder 373

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as usual-

Whenever a new set or circuit is good you are practically certain to find Centralab Products specified as part of it.

Used in the DAVID GRIMES CIRCUIT



CENTRALAB MODULATOR for volume control

—takes the “rough spots” out of volume—smooths out powerful “locals” as well as “DX”—and provides noiseless control of tone volume without in any way affecting the tuning of the set. Has a maximum resistance of 500,000 ohms, specially tapered to give smooth, even control from a whisper to full volume—or vice versa—without de-tuning.

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Centralab Radiohm

A two terminal variable high resistance that is standard on many leading sets. Gives noiseless control of battery voltages or of regeneration. Furnished in a range of resistances from 2,000 to 500,000 ohms, all variable to zero, and in standard or heavy duty types.



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No. 78

RADIO BROADCAST Laboratory Information Sheet

March, 1927

The Volt, Ampere, and Ohm

DEFINITIONS

WE ARE giving below an explanation and meaning of the common terms, the volt, the ampere, and the ohm. Hydraulic analogies will be used in explaining the first two of these terms.

AMPERE: A current of water in a pipe is measured by the amount of water that flows through the pipe in a second, such as 1 gallon per second, or 10 gallons per second, etc. Electricity is measured by the amount of current that flows along a wire in one second. This quantity is known as the coulomb, and if this term is used we would express the current as 1 coulomb per second or 10 coulombs per second, etc. In electricity, however, we have a special name for the rate of flow of 1 coulomb per second which we call 1 ampere. Thus, 8 amperes is the same as 8 coulombs per second. Ampere, then, is a term defining the quantity of current that is flowing per unit of time.

VOLT: The number of gallons per second of water flowing in a pipe, or the number of amperes flowing in a wire, depends upon the pressure under which it flows. The electrical unit of pressure is the volt.

A volt means the same thing in speaking of a current of electricity that a pound pressure means in speaking of a current of water. It follows then that the greater the pressure (voltage) at the supply, the greater will be the flow of current.

OHM: There is no hydraulic unit which corresponds to the ohm, which is a measure of the resistance of a wire to the flow of current. A wire is said to have 1 ohm of resistance when a pressure of 1 volt will cause a current of 1 ampere to flow through it. If the resistance were doubled, the current would be halved, etc.

According to the definitions given on this Sheet, then, we see that amperes represent the amount of current, volts the pressure causing this current to flow, and ohms the resistance impeding the flow of current. These three units bear a definite relation to each other. This relationship, named after the scientist who discovered it, is known as Ohm's Law, which states that the number of amperes flowing in a circuit is equal to the voltage of the circuit divided by its resistance. An explanation of Ohm's Law is given on Laboratory Sheet No. 81.

No. 79

RADIO BROADCAST Laboratory Information Sheet

March, 1927

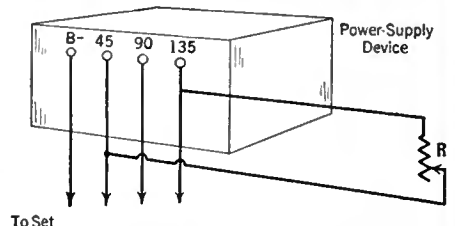
Regulating Voltage on B Power-Supply Device

USE OF RESISTOR

MANY commercial a. c. operated power-supply devices are equipped with taps for supplying different voltages suitable for use in conjunction with the detector, amplifier, etc. The voltage obtained from any tap on such a device is not constant but varies with the amount of current that is drawn from it. If an unusually heavy load is drawn from any one of the taps, it will generally be found that the voltage is somewhat less than the specified amount. In such a case, it is possible to increase the voltage on the particular tap which is low by connecting an external resistance between the tap whose voltage is low and the maximum voltage tap on the device. The proper connections for this resistance are indicated in the diagram, and, by the proper variation of this resistance unit, it will be found possible to obtain any value of voltage that might be required. This method of increasing the voltage on any tap is very simple, since it does not require that the power-supply device be opened and the internal resistances varied.

It should be noted that the resistance does not connect between the two adjacent taps but that it is

connected between the 45-volt tap and 135-volt tap which, in this particular case, is supposed to be the maximum voltage tap on the device. This method of increasing the voltage on any tap was suggested



in the December issue of the *General Radio Experimenter*.

The resistance should be variable between 5000 and 50,000 ohms, and must be of a type satisfactory for use in power-supply devices.

No. 80

RADIO BROADCAST Laboratory Information Sheet

March, 1927

Characteristics of Tubes

MEASURING THE AMPLIFICATION CONSTANT

LABORATORY Sheet No. 68 (February, 1927) gave some characteristic curves of the 171 type tube, and Sheet No. 67 explained how the plate impedance of the tube might be calculated using these curves. The present Sheet will explain how to calculate the amplification constant.

The amplification constant is the measure of the effect of the grid voltage on the plate voltage. Stated as a formula, the amplification constant equals:

$$\frac{\text{CHANGE IN PLATE VOLTAGE}}{\text{CORRESPONDING CHANGE IN GRID VOLTAGE}}$$

We are giving two examples below which will make simple the calculation of the amplification constant of any tube provided its characteristic curves are available.

EXAMPLE 1: Calculate the amplification constant of a 171 using the curves given on Laboratory Sheet No. 68. In this example we shall use curves Nos. 2 and 3. Locate some point on curve No. 2; in this example we are taking the point corresponding to 100 volts, although any point might be taken provided we stay on the straight portion of the curve. We find that at this point, corresponding to 100 volts, the plate current is 12.5 milliamperes. Following across the horizontal line corresponding to this plate current until we come to curve

No. 3, we find that the corresponding plate voltage on this curve is 128. We now have two voltages, 100 and 128, corresponding to two different grid biases, 16.5 and 27. Both of these values are for the same value of plate current. These values can be substituted in the above formula as follows:

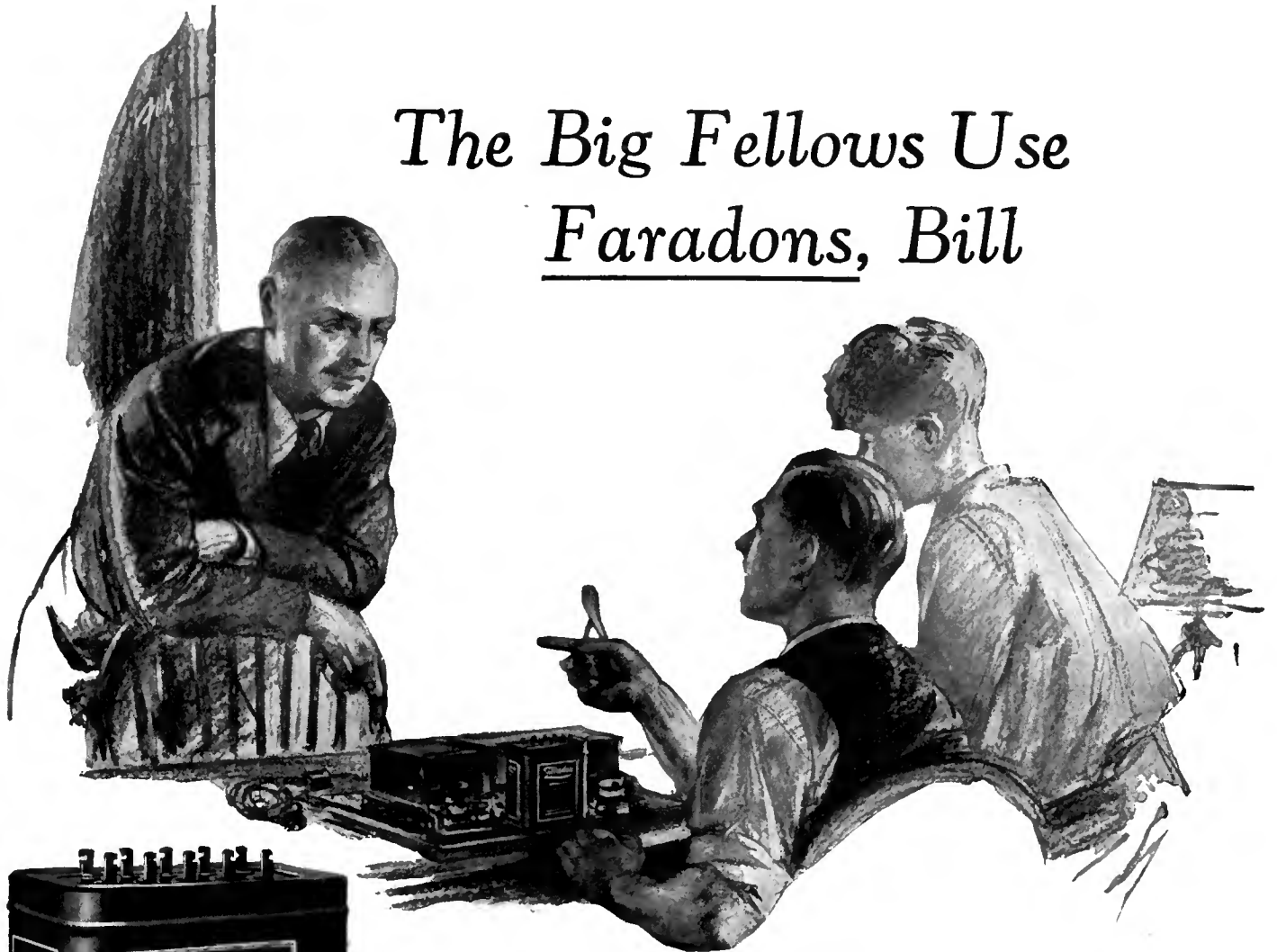
$$\frac{128 - 100}{27 - 16.5} = \frac{28}{10.5}$$

Solving this formula, we get a value of 2.67, which is the amplification constant of this particular 171 type.

EXAMPLE 2: Find some point on curve No. 4, taking that point corresponding to 160 volts as an example. In this case a plate current of 20.3 milliamperes is obtained. Following across to the corresponding plate current on curve No. 5 we find that the plate voltage is 179. The difference in plate voltage between these two points is 19 and the difference in grid bias is 40.5 minus 33, or 7.5. Dividing these two, we obtain a value of 2.54, the amplification constant of the 171.

It should be noted that this latter result is somewhat different from that given in the preceding example due to the fact that the tube was considered to be operating under different voltages. The amplification constant varies slightly for different plate voltages, but the variation over the operating range of plate and grid voltages is not usually more than 10 per cent.

The Big Fellows Use Faradons, Bill



Complete block assemblies for usual eliminator requirements.



Model T. The high efficiency, all metal mica receiving set type unit in desired capacities with convenient terminals. Very compact.



Convenient units for assembly or replacement in special filter hook-ups.



In 1/2, 1 and 2 Mfd.

"Believe me, I'm using 'em wherever I need a condenser.

"We can't do better than follow the lead of the Navy, R.C.A., General Radio Corp., General Electric, Westinghouse, Bell Telephone and many other quality equipment manufacturers when it comes to condensers. They all use Faradons!"

Dependability, convenience, and long life are built into Faradon condensers with the accuracy that comes only from years of experience, finest

materials and rigid inspection of the finished product.

Since 1907 Faradon experts have met condenser needs. There is a Faradon specially designed for each particular purpose. Get the Faradon unit or block having the capacitance desired in the operating voltage class to meet your requirements.

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Faradon

Electrostatic condensers for all purposes

Reception as it should be

If you think that you are getting 100% reproduction—just listen to a set equipped with Ferranti Transformers. You'll note the difference. *Every tone—every note reproduced with living reality!* That is something worth having. And that is exactly what you can get by the simple process of modernizing *your* set with Ferranti Transformers.

Some Good Reasons—

High amplification ratio with flat curve.

Ferranti brings out the fundamental frequency of low tones—none are heard merely by inference from higher harmonics.

Every transformer tested ten times—all short circuited turns eliminated.

Tested to 1000 volts between primary and secondary and between primary and secondary and ground. Therefore specially suited for use with power tubes requiring high plate voltages.

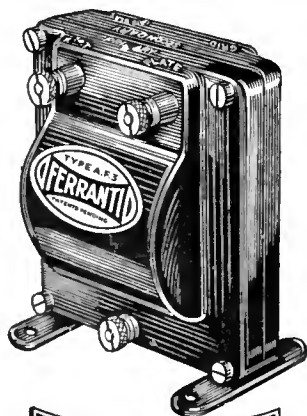
Primary shunted with built-in condensers of correct capacity. Built by an established manufacturing company with forty years experience in the winding of coils of fine wire for electrical instruments and meters.

For the best results—use two Ferranti Audio Frequency Transformers type A. F. 3—ratio $3\frac{1}{2}$ to 1—\$12.00 each.

For results far superior to the average, use two Ferranti Transformers type A. F. 4—ratio $3\frac{1}{2}$ to 1—\$8.50 each.

FERRANTI, Inc.

130 West 42nd Street, New York, N. Y.



FERRANTI

Manufacturers' Booklets Available

A Varied List of Books Pertaining to Radio
and Allied Subjects Which May Be Obtained
Free by Using the Accompanying Coupon

AS AN additional service to RADIO BROADCAST readers, we print below a list of booklets on radio subjects issued by various manufacturers. With this list appear many additions to the lists printed in this magazine for January, and February, 1927. This information supplements the other departments, such as the "Lab," data sheets, and the Periodical surveys, all of which have proved most popular with our readers. The publications listed below cover a wide range of subjects, and offer interesting reading to the radio enthusiast. The manufacturers issuing these publications have made great effort to collect interesting and accurate information. RADIO BROADCAST hopes, by listing these publications regularly, to keep its readers in touch with what the manufacturers are doing. Every publication listed below is supplied free. In ordering, the coupon printed on page 512 must be used. Order by number only.—THE EDITOR.



PARTS

1. FILAMENT CONTROL—Problems of filament supply, voltage, regulation, and effect on various circuits. RADIALL COMPANY.
2. HARD RUBBER PANELS—Characteristics and properties of hard rubber as used in radio, with suggestions on how to "work" it. B. F. GOODRICH RUBBER COMPANY.
3. AUDIO TRANSFORMERS—A booklet giving data on input and output transformers. PACENT ELECTRIC COMPANY.
4. RESISTANCE-COUPLED AMPLIFIERS—A general discussion of resistance coupling with curves and circuit diagrams. COLE RADIO MANUFACTURING COMPANY.
5. CARBORUNDUM IN RADIO—A book giving pertinent data on the crystal as used for detection, with hook-ups, and a section giving information on the use of resistors. THE CARBORUNDUM COMPANY.
6. B-ELIMINATOR CONSTRUCTION—Complete constructional data on how to build. AMERICAN ELECTRIC COMPANY.
7. TRANSFORMER AND CHOKE-COUPLED AMPLIFICATION—Circuit diagrams and discussion. ALL-AMERICAN RADIO CORPORATION.
8. RESISTANCE UNITS—A data sheet of resistance units and their application. WARD-LEONARD ELECTRIC COMPANY.
9. VOLUME CONTROL—A leaflet showing circuits for distortionless control of volume. CENTRAL RADIO LABORATORIES.
10. VARIABLE RESISTANCES—As used in various circuits. CENTRAL RADIO LABORATORIES.
11. RESISTANCE COUPLING—Resistors and their application to audio amplification, with circuit diagrams. DEJUR PRODUCTS COMPANY.
12. DISTORTION AND WHAT CAUSES IT—Hook-ups of resistance-coupled amplifiers with standard circuits. ALLEN-BRADLEY COMPANY.
13. MATERIALS FOR SCREW MACHINE PRODUCTS—Comparative costs of steel and brass with data and actual examples of how to specify. BRIDGEPORT BRASS COMPANY.
14. ORDERING THE RIGHT KIND OF SHEET BRASS—How to specify the proper grades for various purposes. BRIDGEPORT BRASS COMPANY.
15. B-ELIMINATOR AND POWER AMPLIFIER—Instructions for assembly and operation using Raytheon tube. GENERAL RADIO COMPANY.
- 15a. B-ELIMINATOR AND POWER AMPLIFIER—Instructions for assembly and operation using an R. C. A. rectifier. GENERAL RADIO COMPANY.
16. VARIABLE CONDENSERS—An ambitious description of the functions and characteristics of variable condensers with curves and specifications for their application to complete receivers. ALLEN D. CARDWELL MANUFACTURING COMPANY.
17. BAKELITE—A description of various uses of bakelite in radio, its manufacture, and its properties. BAKELITE CORPORATION.
18. BRASS RODS—Details of manufacture together with tests and specifications. BRIDGEPORT BRASS COMPANY.
19. POWER SUPPLY—A discussion on power supply with particular reference to lamp-socket operation. Theory and constructional data for building power supply devices. ACME APPARATUS COMPANY.
20. AUDIO AMPLIFICATION—A booklet containing data on audio amplification together with hints to the constructor; also some general radio information. ALL-AMERICAN RADIO CORPORATION.
21. HIGH-FREQUENCY DRIVER AND SHORT-WAVE WAVEMETER—Constructional data and application. BURGESS BATTERY 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 radio frequency 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 in the circuit. SAMSON ELECTRIC COMPANY.
49. BYPASS CONDENSERS—A description of the manufacture of bypass and filter condensers. LESLIE F. MUTER COMPANY.
50. AUDIO MANUAL—Fifty questions which are often asked regarding audio amplification, and their answers. AMERTRAN SALES COMPANY, INCORPORATED.
51. SHORT-WAVE RECEIVER—Constructional data on a receiver which, by the substitution of various coils, may be made to tune from a frequency of 16,660 kc. (18 meters) to 1999 kc. (150 meters). SILVER-MARSHALL, INCORPORATED.
52. AUDIO QUALITY—A booklet dealing with audio-frequency amplification of various kinds and the application to well-known circuits. SILVER-MARSHALL, INCORPORATED.
56. VARIABLE CONDENSERS—A bulletin giving an analysis of various condensers together with their characteristics. GENERAL RADIO COMPANY.
57. FILTER DATA—Facts about the filtering of direct current supplied by means of motor-generator outfits used with transmitters. ELECTRIC SPECIALTY COMPANY.
59. RESISTANCE COUPLING—A booklet giving some general information on the subject of radio and the application of resistors to a circuit. DAVEN RADIO CORPORATION.
60. RESISTORS—A pamphlet giving some technical data on resistors which are capable of dissipating considerable energy; also data on the ordinary resistors used in resistance-coupled amplification. THE CRESCENT RADIO SUPPLY COMPANY.
62. RADIO-FREQUENCY AMPLIFICATION—Constructional details of a five-tube receiver using a special design of radio-frequency transformer. CAMFIELD RADIO MANUFACTURING COMPANY.

AMRAD



AMRAD CORPORATION Harold J. Power, Pres. Medford Hillside, Mass.

Here's a "B" Eliminator Equals fresh new "B" batteries



B ELIMINATORS usually fail to give reproduction qualities to your radio that come from fresh new B batteries. First class B eliminators are usually quiet in operation and supply proper voltage and current but the reproduction in the loud speaker is faulty because the capacity of the eliminator is not sufficient for the tremendous drain of current accessible loud or low notes demand. Such eliminators must draw the current all the way from the lamp socket through the filter choke into the receiver. The time element is appreciable so that the peaks of many notes are chopped off which causes distortion.

The Amrad B eliminator employs the famous Mershon Condenser as the principal capacity unit. This famous condenser has many times the capacity of any other eliminator condenser and constantly provides you with a sufficient supply of energy for the correct reproduction of any sounds that may come through your radio

Free from Break-downs

Paper condensers now used in B eliminators frequently break down. Here the Mershon has such a large capacity that any excessive voltage surge is eliminated, the charge being instantly absorbed. This also protects the receiver set against punctured parts or insulation break-down.

Won't get Noisy

Nor are there any variable adjustments to get out of order. All parts are readily accessible as no compound or other filler is used in its manufacture. The Amrad B power unit is mounted on a metal base and incased in steel box, black enamel finish.

This as well as the other products of the Amrad Corporation are a tribute to the engineering skill of the Amrad laboratories and the influence of mass production methods of Powel Crosley, Jr.

Write Dept. 2C7, for descriptive literature.

\$35.

including the celebrated

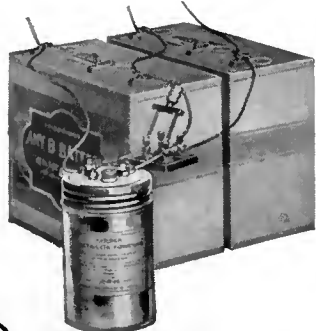
Amrad S-1 tube

The Mershon Condenser freshens up old B eliminators and prolongs life in "B" batteries



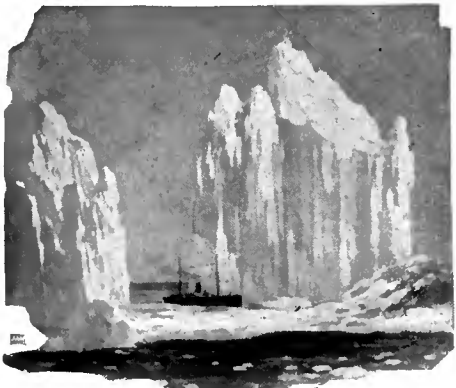
The Mershon Condenser assists in more perfect filtering (straining) of the uneven current supplied by a lamp socket. It also acts as a reservoir to store a large amount of energy which is necessary for the continuous smooth flow demanded by incoming broadcasts. This energy such as fresh B batteries deliver must be on tap instantaneously for large substantial musical notes. The improvement in tone quality is particularly noticeable on low notes.

Mershon Condenser connected across B batteries (with a disconnecting switch) greatly prolongs useful life of these dry cells. It in itself does not wear out—can be used continuously.



\$8.

ASK... ANY... RADIO... ENGINEER



With the
"Trouble-Shooters"
 of the
North Atlantic

ICE-BERGS—towering, ponderous, deadly mountains of ice drift southward from the ice fields of the Arctic into the traffic lane of trans-Atlantic steamers. Locating and destroying them is the perilous and never-ending duty of the United States Coast Guard Cutters.

Shell fire and high explosives, however, often fail to blow the bergs from the sea, and warnings are then broadcasted by radio to every ship whose course lies through the danger zone.

Smooth power, unfailing dependability over long periods and under all conditions of service are qualities demanded in the radio batteries used in this dangerous naval service.

The fact that Burgess Batteries meet those requirements recommends them to you for your own receiving set.

Ask Any Radio Engineer

BURGESS BATTERY COMPANY

GENERAL SALES OFFICE: CHICAGO

Canadian Factories and Offices:
 Niagara Falls and Winnipeg



**BURGESS
 RADIO BATTERIES**

63. FIVE-TUBE RECEIVER—Constructional data on building a receiver. AERO PRODUCTS, INCORPORATED.

64. AMPLIFICATION WITHOUT DISTORTION—Data and curves illustrating the use of various methods of amplification. Also data on how to build. ACME APPARATUS COMPANY.

65. RADIO HANDBOOK—A helpful booklet on the functions, selection, and use of radio apparatus for better reception. BENJAMIN ELECTRIC MANUFACTURING COMPANY.

66. SUPER-HETERODYNE—Constructional details of a seven-tube set. G. C. EVANS COMPANY.

70. IMPROVING THE AUDIO AMPLIFIER—Data on the characteristics of audio transformers, with a circuit diagram showing where chokes, resistors, and condensers can be used in an amplifying unit. AMERICAN TRANSFORMER COMPANY.

71. DISTORTIONLESS AMPLIFICATION—A discussion of the resistance-coupled amplifier used in conjunction with a transformer, impedance, or resistance input stage. Amplifier circuit diagrams and constants are given in detail for the constructor. AMSCO PRODUCTS INCORPORATED.

ACCESSORIES

22. A PRIMER OF ELECTRICITY—Fundamentals of electricity with special reference to the application of dry cells to radio and other uses. 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.

24. DETECTOR TUBES—A brief outline of tube operation. C. E. MANUFACTURING COMPANY.

25. ELECTROLYTIC RECTIFIER—Technical data on a new type of rectifier with operating curves. KODEL RADIO CORPORATION.

26. DRY CELLS FOR TRANSMITTERS—Actual tests given, well illustrated with curves showing exactly what may be expected of this type of B power. BURGESS BATTERY COMPANY.

27. DRY-CELL BATTERY CAPACITIES FOR RADIO TRANSMITTERS—Characteristic curves and data on discharge tests. BURGESS BATTERY COMPANY.

28. B BATTERY LIFE—Battery life curves with general curves on tube characteristics. BURGESS BATTERY COMPANY.

29. HOW TO MAKE YOUR SET WORK BETTER—A non-technical discussion of general radio subjects with hints on how reception may be bettered by using the right tubes. UNITED RADIO AND ELECTRIC CORPORATION.

30. TUBE CHARACTERISTICS—A data sheet giving constants of tubes. C. E. MANUFACTURING COMPANY.

31. FUNCTIONS OF THE LOUD SPEAKER—A short, non-technical general article on loud speakers. AMPLION CORPORATION OF AMERICA.

32. METERS FOR RADIO—A catalogue of meters used in radio with connecting diagrams. BURTON-ROGERS COMPANY.

33. SWITCHBOARD AND PORTABLE METERS—A booklet giving dimensions, specifications, and shunts used with various meters. BURTON-ROGERS COMPANY.

34. COST OF B BATTERIES—An interesting discussion of the relative merits of various sources of B supply. HARTFORD BATTERY MANUFACTURING COMPANY.

35. STORAGE BATTERY OPERATION—An illustrated booklet on the care and operation of the storage battery. GENERAL LEAD BATTERIES COMPANY.

36. CHARGING A AND B BATTERIES—Various ways of connecting up batteries for charging purposes. WESTINGHOUSE UNION BATTERY COMPANY.

37. CHOOSING THE RIGHT RADIO BATTERY—Advice on what dry cell battery to use; their application to radio, with wiring diagrams. NATIONAL CARBON COMPANY.

53. TUBE REACTIVATOR—Information on the care of vacuum tubes, with notes on how and when they should be reactivated. THE STERLING MANUFACTURING COMPANY.

54. ARRESTERS—Mechanical details and principles of the vacuum type of arrester. NATIONAL ELECTRIC SPECIALTY COMPANY.

55. CAPACITY CONNECTOR—Description of a new device for connecting up the various parts of a receiving set, and at the same time providing bypass condensers between the leads. KURZ-KASCH COMPANY.

61. DRY CELLS—Information on the construction and operation of dry cells with a description of the methods used in testing them. THE CARBON PRODUCTS COMPANY.

68. CHEMICAL RECTIFIER—Details of assembly, with wiring diagrams, showing how to use a chemical rectifier for charging batteries. CLEVELAND ENGINEERING LABORATORIES COMPANY.

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. RADIO CORPORATION OF AMERICA.

MISCELLANEOUS

38. LOG SHEET—A list of broadcasting stations with columns for marking down dial settings. U. S. L. RADIO, INCORPORATED.

39. BEHIND THE SCENES IN A BROADCASTING STATION—Operation in general, and specific facts about WKRC. KODEL RADIO CORPORATION.

40. STATIC—A brief discussion of the disturbances which may cause trouble in a receiver. SUN MANUFACTURING COMPANY.

41. BABY RADIO TRANSMITTER OF 9XH-9EK—Description and circuit diagrams of dry-cell operated transmitter. BURGESS BATTERY COMPANY.

42. ARCTIC RADIO EQUIPMENT—Description and circuit details of short-wave receiver and transmitter used in Arctic exploration. BURGESS BATTERY COMPANY.

43. SHORT-WAVE RECEIVER OF 9XII-9EK—Complete directions for assembly and operation of the receiver. BURGESS BATTERY COMPANY.

44. ALUMINUM FOR RADIO—A booklet containing much radio information with hook-ups of basic circuits, with inductance-capacity tables and other pertinent data. ALUMINUM COMPANY OF AMERICA.

45. SHIELDING—A discussion on the application of shielding in radio circuits with special data on aluminum shields. ALUMINUM COMPANY OF AMERICA.

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 any one 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.

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 RADIO BROADCAST, Garden City, New York.
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Volume
With
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DOUBLE ENJOYMENT
From Any Set With

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LOUD SPEAKER

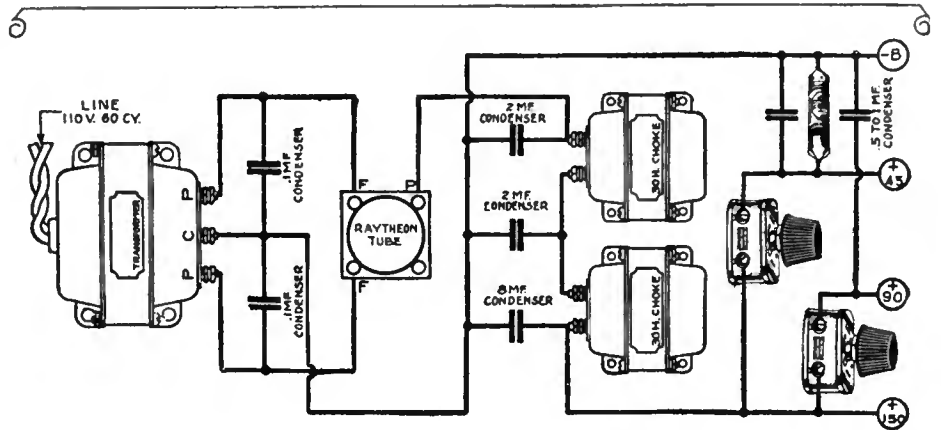
Why sacrifice the excellent reproducing qualities of a set by the use of an inferior speaker. With a BURNS it is possible to reproduce with amazing exactness every note of music and inflection of voice that the set can pick up. A trial will convince.

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American Electric
COMPANY

State and 64th Sts. Chicago, U. S. A.

Ask About BURNS B-Eliminator



Improve Your B-Eliminator with Allen-Bradley Resistors

WHEN you build a B-Eliminator, be sure that your kit contains Bradleyohm-E for plate voltage control and Bradleyunit-A for the fixed resistors. Then you will be assured of perfect plate voltage control.

Bradleyunit-A

PERFECT FIXED RESISTOR

This solid, molded fixed resistor has no glass or hermetic sealing in its construction. It is a solid unit, molded and heat-treated under



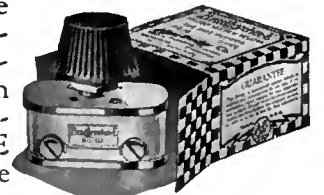
high pressure, that is not affected by temperature, moisture and age. The end caps are silver-plated, and can be soldered without affecting the accuracy of the Bradleyunit.

By all means, use Bradleyunit-A when you need a fixed resistor in your radio hookup.

Bradleyohm-E

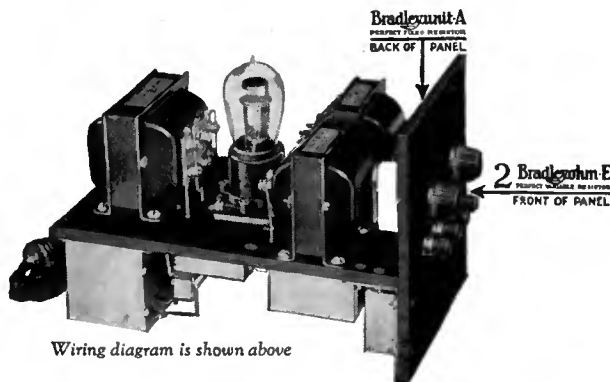
PERFECT VARIABLE RESISTOR

This oversize variable resistor is used as standard equipment for accurate plate voltage control by leading B-Eliminator manufacturers. The scientifically treated discs in Bradleyohm-E provide stepless, noiseless, plate voltage control, and the setting will be maintained indefinitely. Ask for Bradleyohm-E.



Always insist that Bradleyohm-E and Bradleyunit-A are included with your B-Eliminator kit. You then will be assured of perfect voltage control.

ALLEN-BRADLEY COMPANY
278 Greenfield Ave. :: Milwaukee, Wis.



Wiring diagram is shown above

Write for
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Giving Seven
B-Eliminator
Hookups.

Use Allen-Bradley Perfect Radio Devices



A Message

to

Manufacturers

Today, buyers of radio—receivers, battery eliminators and power amplifiers—insist upon the latest of approved designs and finest quality of performance. To you, the manufacturer, much depends upon your source of supply on parts.

For audio amplification, power amplification and battery elimination the very latest designs are found in Dongan Transformers. Exclusively a manufacturer of high-grade parts Dongan offers the newest improvements in engineering ideas and the extreme quality in construction—at a price within your purchasing requirements.

Allow us to help you to improve your product.

DONGAN ELECTRIC MFG. CO.
2991-3001 Franklin St. Detroit, Mich.

TRANSFORMERS of MERIT for FIFTEEN YEARS

New 32-Page Booklet Giving Information Usually Known Only To Expert Set Builders



Just off the press!

Every radio set contains from one to a dozen fixed condensers. Do you know what they are for? Do you know how to test them to see whether they are working properly? Do you know that there is a way of changing the range of your tuning condensers?—of getting greater selectivity—of improving the tone? All through simple applications of fixed condensers.

The Dobilier Condenser Corporation is now supplying radio fans with a complete and authoritative explanation of the correct use of fixed condensers.

You have often envied the man who could look over your set and by inserting a small fixed condenser somewhere, greatly improve its tone and operation. Do this yourself. Perhaps some defect in reception that you have always thought could not be helped is due to an imperfect condenser.

This new booklet will also give you the most recent information on power amplifiers, filters and battery eliminators. Send 10 cents in stamps or coin for your copy.

Dobilier
CONDENSER CORPORATION
4377 BRONX BLVD. NEW YORK, N. Y.

Press, Weather, and Time Signals

Times and Wavelengths of Stations in All Parts of the World Transmitting the Above Signals

IN THE accompanying corrected table of transmissions of time, weather, and press intelligence, the scheduled times of transmission are given in Greenwich Mean Time, Eastern Standard Time, and Pacific Standard Time. This list, we feel sure, is as accurate as it is humanly possi-

ble to make it, but minor changes are often made at the stations concerned with little or no notice. PX in the last column stands for "Press"; WX for "Weather"; TFC for "Traffic Transmissions." This list supersedes that published in the December, 1926, RADIO BROADCAST.

TIME G. M. T.	TIME E. S. T.	TIME P. S. T.	CALL	LOCATION	WAVE IN METERS	FREQUENCY KCS.	REMARKS
00:30	7:30 P. M.	4:30 P. M.	YN	Lyons	15,100	19.86	Arc; Press.
02:00	9:00 P. M.	6:00 P. M.	NAH	Brooklyn	1500	199.9	Spark; WX, PX.*
02:15	9:15 P. M.	6:15 P. M.	VCE	Cape Race	600	499.7	Spark; Ice Reports, etc.
02:55	9:55 P. M.	6:55 P. M.	NAA	Arlington	2655	112.9	I. C. W.; WX, Time.
02:55	9:55 P. M.	6:55 P. M.	NAR	Key West	1463	205.0	I. C. W.; WX, Time.*
02:55	9:55 P. M.	6:55 P. M.	NSS	Annapolis	16,900	17.74	Arc; WX, Time.
03:00	10:00 P. M.	7:00 P. M.	NPM	Pearl Harbor	1500	199.9	Spark; Press.
03:05	10:05 P. M.	7:05 P. M.	VBT	Cape Race	2700	111.0	C. W.; Press.
03:30	10:30 P. M.	7:30 P. M.	UA	Nantes, Fr.	2400	124.9	Spark; Press.*
03:48	10:48 P. M.	7:48 P. M.	GBR	Rugby	18,740	15.98	C. W.; Press.
03:50	10:50 P. M.	7:50 P. M.	WSH	New York	2478	120.9	Arc; Press.
04:30	11:30 P. M.	8:30 P. M.	WNU	New Orleans	3331	90.04	C. W.; WX, TFC, and PX.
05:15	12:15 A. M.	9:15 P. M.	WRQ	Marion	12,500	23.09	C. W.; Press.
05:40	12:40 A. M.	9:40 P. M.	NPL	San Diego	13,300	22.54	Arc; Press.
06:00	1:00 A. M.	10:00 P. M.	BZL	Demerra	1300	230.6	Spark; Press.†
07:00	2:00 A. M.	11:00 P. M.	GPH	Guayaquil	750	399.8	Spark; Press.†
07:30	2:30 A. M.	11:30 P. M.	BZM	St. Johns, Nfd.	1500	199.9	Spark; Press.
08:00	3:00 A. M.	12 Mid.	YN	Lyons, Fr.	5000	59.96	Arc; Press.
08:00	3:00 A. M.	12 Mid.	VCU	Barrington	1500	199.9	Spark; Press.
08:00	3:00 A. M.	12 Mid.	NPL	San Diego	13,300	22.54	Arc; Press.
08:00	3:00 A. M.	12 Mid.	NAH	Brooklyn	1500	199.9	Spark; Press.*
08:00	3:00 A. M.	12 Mid.	NBD	Bar Harbor	1900	157.8	Spark; Press.
08:00	3:00 A. M.	12 Mid.	KPH	San Francisco	2300	130.4	C. W.; Press.
09:00	4:00 A. M.	1:00 A. M.	GFA	London	4200	71.39	C. W.; WX.
09:30	4:30 A. M.	1:30 A. M.	FL	Eiffel Tower	2700	111.0	Spark; Time.†
09:45	4:45 A. M.	1:45 A. M.	GCK	Valentia	600	499.7	Spark; WX.
09:55	4:55 A. M.	1:55 A. M.	NAX	Colon	1800	166.6	I. C. W.; Time.*
09:55	4:55 A. M.	1:55 A. M.	NBA	Balboa	7000	42.83	Arc; Time, PX.†
10:30	5:30 A. M.	2:30 A. M.	NBA	Balboa	7000	42.83	Arc; Press.†
11:00	6:00 A. M.	3:00 A. M.	GPH	Guayaquil	750	399.8	Spark; Press.
11:18	6:18 A. M.	3:18 A. M.	GBR	Rugby	18,740	15.98	C. W.; Press.
11:30	6:30 A. M.	3:30 A. M.	VMG	Apia, Samoa	2000	149.9	Spark; Press.
12 Nn.	7:00 A. M.	4:00 A. M.	POZ	Nauen	18,500	16.21	Arc; Time.
12 Nn.	7:00 A. M.	4:00 A. M.	GBR	Rugby	18,740	15.98	C. W.; Press.
14:15	9:15 A. M.	6:15 A. M.	VCE	Cape Race	600	499.7	Spark; Ice Reports, etc.
15:15	10:15 A. M.	7:15 A. M.	BZI	Durban, S. A.	2000	149.9	Spark; Press.
15:30	10:30 A. M.	7:30 A. M.	VIS	Sydney, Aus.	2000	149.9	Spark; Press.
16:00	11:00 A. M.	8:00 A. M.	FL	Eiffel Tower	2500	119.9	Spark; WX.
16:30	11:30 A. M.	8:30 A. M.	VIP	Perth, Aus.	1500	199.9	Spark; Press.
16:30	11:30 A. M.	8:30 A. M.	WNU	New Orleans	3331	90.04	C. W.; WX, TFC, and PX.
16:55	11:55 A. M.	8:55 A. M.	NAA	Arlington	2400	124.9	C. W.; Time etc.
16:55	11:55 A. M.	8:55 A. M.	NAR	Key West	1463	205.0	I. C. W.; Time.
16:55	11:55 A. M.	8:55 A. M.	NSS	Annapolis	16,900	17.74	Arc; Time.
16:55	11:55 A. M.	8:55 A. M.	NAT	New Orleans	2700	111.0	I. C. W.; Time.
17:00	12 Nn.	9:00 A. M.	NPL	San Diego	13,300	22.54	Arc; Press.
17:55	12:55 P. M.	9:55 A. M.	NAX	Colon	1800	166.6	I. C. W.; Time.*
17:55	12:55 P. M.	9:55 A. M.	NBA	Balboa	6663	45.02	Arc; Time.
18:00	1:00 P. M.	10:00 A. M.	VAS	Louisburg	2700	111.0	C. W.; Press.
18:00	1:00 P. M.	10:00 A. M.	VJZ	Rabaul, Aus.	2900	103.4	Spark; Press.
18:30	1:30 P. M.	10:30 A. M.	VID	Darwin, Aus.	850	352.7	Spark; Press.
19:00	2:00 P. M.	11:00 A. M.	XDA	Mexico City	2700	111.0	C. W.; Time, WX.
19:55	2:55 P. M.	11:55 A. M.	NPL	San Diego	9800	30.59	Arc; Time.
20:00	3:00 P. M.	12 Nn.	BYZ	Rinella	4200	71.39	Arc; Press.
20:00	3:00 P. M.	12 Nn.	NBA	Balboa	2400	124.9	Spark; Press.
20:00	3:00 P. M.	12 Nn.	LY	Bordeaux	18,600	16.12	C. W.; Time.
20:00	3:00 P. M.	12 Nn.	GFA	London	4200	71.39	C. W.; WX.
20:00	3:00 P. M.	12 Nn.	KAV	Norddeich	1800	166.6	Spark; Press (German).
20:00	3:00 P. M.	12 Nn.	GBR	Rugby	18,740	15.98	C. W.; Press.
20:48	3:48 P. M.	12:48 P. M.	GCK	Valentia	600	499.7	Spark; WX.
21:45	4:15 P. M.	1:15 P. M.	BXW	Singapore	2000	149.9	Spark; Press.
21:45	4:15 P. M.	1:15 P. M.	BYX	Hong Kong	2000	149.9	Spark; Press.
22:15	5:15 P. M.	2:15 P. M.	IDO	Rome	10,000	29.98	Arc; Press.
22:30	5:30 P. M.	2:30 P. M.	BZG	Mauritius	2000	149.9	Spark; Press.
22:45	5:45 P. M.	2:45 P. M.	FL	Eiffel Tower	2700	111.0	Spark; Time.
24:00	7:00 P. M.	4:00 P. M.	NPM	Pearl Harbor	11,200	26.77	Arc; Time.
24:00	7:00 P. M.	4:00 P. M.	PRG	Prague	9300	32.24	Arc; Press.‡
24:00	7:00 P. M.	4:00 P. M.	POZ	Nauen	18,500	16.21	C. W.; Time.
24:00	7:00 P. M.	4:00 P. M.	GBR	Rugby	18,740	15.98	C. W.; Press.

*Possibly changed to c.w. May have been discontinued, or details uncertain.
†Uncertain of wavelength.
‡This weather sent in code form. Useless unless you have reference code book.
§English press sent on 4100 meters (73.13 kc.).

Practically all of the above stations, it will be seen, transmit on wavelengths too long to be covered by the ordinary broadcast receiver. Experimenters desirous of listening to the above signals might very well employ a simple regenerative circuit for this purpose. RADIO BROADCAST Laboratory Information Sheet No. 19, which was printed in the August, 1926, issue, gives a suitable circuit, together with data for the coils.



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Prevents corrosion and con-
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The Problems of A. C. Filament Lighting

Why It Is Simpler to Obtain B Supply than A Current from the A. C. Mains—Series Connection of 199 Tubes Offered as Remedy

By C. T. BURKE

Engineering Dept., General Radio Company

THE problem of filament supply from alternating current is essentially different from that of plate supply. It is not a question of the power supplied, but the voltage at which it is supplied. The power required for filament supply ranges from 0.18 watt for the dry-cell tubes to 9.5 watts for the UX-210, while the plate power for these tubes is 0.2 watt and 9 watts, respectively. The average set draws a filament load of about 7 watts and a plate load of perhaps 4 watts. There is not enough difference between the wattage requirements of plate and filament to involve great difficulty.

The essential difference between the plate and filament requirements is the supply voltage, which is about 100 for the plate as compared to 5 for the filament. As power in watts is equal to the current supplied times the supply voltage, roughly twenty times the current is required to supply a given number of watts to the filament as would be required at the plate. The great difference then, between the demands of filament and plate supplies is not of power, but of current. Plate current supply devices are not called on to deliver more than about 50 milliamperes, while the filament may draw two or more amperes.

Direct-current power differs from alternating in that power at high voltage and low current cannot be transferred into power at low voltage and high current without the use of rather expensive equipment. It is, therefore, necessary to use the d. c. power at the current and voltage supplied by the rectifier.

Rectification and filtering is generally necessary in order to use alternating current for filament supply. The last stage of audio amplification can be run with alternating current on the filament with excellent results. When the slight hum resulting from a. c. on the filament is amplified through successive tubes, it reaches an objectionable magnitude. Thus, the use of raw a. c. is confined to the last tube. This is generally a power tube, and requires a greater filament supply than the others. Under certain conditions, where some hum is not objectionable, it may be possible to operate two stages of audio amplification on alternating current. The detector tube must, however, have a supply of well-filtered direct current.

The maximum current available from a single rectifier tube of the kind popularly used in plate supply devices, is about 85 milliamperes. This is the current required by a one-tube set, employing an UX-199 type tube. It is delivered at high voltage. If the set is so wired that the tubes are in series, any number (up to 50) UX-199 type tubes, may be operated from such a rectifier tube when supplied with a suitable transformer and filter. As the same unit is generally used for both A and B supply, it would be necessary to design transformers and chokes to deliver this current at about 220 volts in order to take care of the plate and grid voltage of the UX-171 type tube. This is somewhat expensive, but by no means impossible. A rheostat of sufficient resistance and current carrying capacity is also required.

It will be seen that A elimination for UX-199 type tubes is feasible. So far as the writer

knows, however, there is no commercial eliminator for this service available. The field for such a device would be very limited, first because of the comparatively few sets using 60-mil. tubes, and secondly, because rewiring of the set is generally required. The making of individual installations of this kind, however, including building the unit, and rewiring the set, should prove a source of considerable profit to those dealers and service stations who undertake it. The same type of installation would not be entirely beyond the bounds of practicability with 201-A type tubes if a rectifier tube were available supplying 250 milliamperes. The chokes and resistances for this arrangement would present considerable difficulty. This would result in greater bulk, and materially greater expense than would the equipment for 199 type tubes.

There are a number of low-voltage rectifiers available which are used to charge batteries. The output of these units is ample to supply the filament current drain of any set, and they would be suitable for a general purpose filament supply. The great obstacle in this case is filtering. The condensers in the filter act as reservoirs, storing surplus current during one part of the cycle and feeding it to the load at another. The large current required by the filament supply would require condensers of many times the capacity now required on plate supply units. The filter inductances also present a serious problem. The low voltage available from high-current rectifying devices permits a very small drop in the filter system. This requires chokes having very large wire and few turns. In order to get the proper inductances, and avoid saturation, the cores would have to be of very large cross section, and would require air gaps. Fortunately, as the current drain increases, the amount of inductance required for a given degree of smoothing decreases somewhat. Even allowing for this, the filter choke for a filament power supply to furnish 2 amperes would cost much more than do those for a plate supply. The condenser cost would be multiplied by an even greater proportion unless electrolytic condensers were used.

The cost of a storage battery is, of course, many times less than that of such a filter. This brings us to the trickle charger-battery combinations, which, while not battery substitutes, do provide a reliable filament source from the alternating-current line. The trickle charger combination is probably at present, and likely to remain for some time, the most satisfactory general purpose filament supply. The use of UX-199 type tubes in series will, however, prove interesting to the experimenter and to the service man.

Another type of A device, in which dry batteries are used as filter condensers, is appearing this year. In this type a tungar rectifier is generally used. The filter consists of a choke of small inductance which can, therefore, be made with low resistance and dry cells in place of the filter condensers. A number of these devices will be on the market this year, and they offer interesting possibilities. Meanwhile, tube manufacturers are at work on the problem of developing tubes which will not require A batteries.

RADIO BROADCAST



LABORATORY RECEIVER

Radio Broadcast Laboratory Staff

Coast to Coast

able home-constructors, that claims of this nature may be true only in isolated cases.

The "Lab" Receiver employs an unusually well-designed radio frequency amplifier circuit and is, in addition, perfectly neutralized. From rather elaborate experiments and tests, it would appear that the four-tube "Lab" Receiver delivers a stronger signal than many Receivers employing many more than four tubes. It is a decidedly inexpensive Receiver both from a constructional and operation standpoint. Several innovations in design amplify the construction and present a departure from what has come to be regarded as the conventional method of set building.

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In order to facilitate your building of the "Lab" Receiver, actual size blue prints along with reprinted constructional data has been prepared. This material may be had free of charge by writing to any of the manufacturers listed, to the business offices of Radio Broadcast, or to Allen-Rogers Company, 118 East 28th Street, N. Y. C.

(Write Radio Broadcast, 285 Madison Avenue, N. Y., for Constructional Data)

Complete Kits from Allen-Rogers, 128 E. 18th St., New York City



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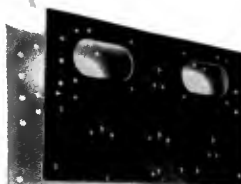
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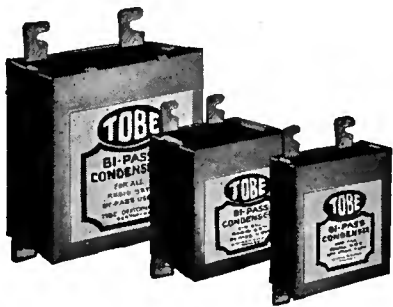


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A KEY TO RECENT RADIO ARTICLES

By E. G. SHALKHAUSER

THIS is the seven-teen'h installment of references to articles which have appeared recently in various radio periodicals. Each separate reference should be cut out and pasted on cards for filing, or pasted in a scrap book either alphabetically or numerically. An outline of the Dewey Decimal System (employed here) appeared last in the January, RADIO BROADCAST, and will be reprinted in an early number.



R582. TRANSMISSION OF PHOTOGRAPHS. TELEVISION. *Radio News*. Nov., 1926. Pp. 466ff. "Television Enroute," P. J. G. Fischel.

A new principle of photo-telegraphy, known as the Telefunken system, and discovered by a German, Count Arco, is described. It is said that the transmission is practically independent of atmospheric disturbances and that photographs may be used for reproduction without retouching. A new ring-shaped photo-electric cell is used. A light relay, called the Karolus Cell, makes possible the high speed and good quality of reception. The operation, circuit diagrams, and photographs of the apparatus are explained.

R592. BRITISH EMPIRE; RADIO DEVELOPMENTS. BRITISH *Radio News*. Nov., 1926. Pp. 474ff. BROADCASTING Co. "The B. B. C. in the Melting Pot," A. Dinsdale.

Present conditions concerning the broadcasting situation in Great Britain are related. In view of the fact that the arrangements, under which broadcasting stations are operated at present, terminate on December, 31st, 1926, and the suggested appointment of a commission to control matters has been delayed, the situation seems to be very much in the air. Conditions at present are related.

R800 (621-354) BATTERIES. BATTERIES.

Radio News. Nov., 1926. Pp. 476ff.

"Radio Batteries and Their Care," M. L. Muhleman. It is the purpose of the article to present simple and intelligent information on dry cells and secondary batteries their common ills and their prevention. Such information as time of recharge, size and type to choose for various sets, use and importance of the battery, test of specific gravity, etc., are considered.

343. ELECTRON-TUBE RECEIVING SETS. RECEIVER.

Radio News. Nov., 1926. Pp. 500 ff. *Browning-Drake*. "A Lamp-Socket Operated Browning-Drake Receiver," A. H. Lynch.

The receiver described uses the Browning-Drake circuit in connection with a battery substitute. The audio amplifier is of the resistance-capacity-coupled type with one stage of power amplification. Construction and operation data are given, together with a list of parts required.

R342. 15. AMPLIFIER TRANSFORMER. TRANSFORMERS, Audio.

Radio News. Nov., 1926. Pp. 511ff.

"Transformer-Coupled Amplifiers," S. Harris. In analyzing the action of audio transformer-coupling in vacuum-tube circuits, the author shows how the theory of primary to secondary coupling applies, how the primary to secondary flux determines the "degree of coupling," how the primary impedance affects amplification and reproduction, and the relation between frequency and amplification functions (plotted graphically). He also gives the relations between frequency, plate current, and amplification.

R142. COUPLED CIRCUITS. COUPLING.

Proc. I. R. E., Oct. 1926. Pp. 605-611. *Cap. and Ind.*

"Combined Electromagnetic and Electrostatic Coupling and Some Uses of the Combination," E. H. Loftin and S. Y. White.

The paper presents a method of combining electromagnetic and electrostatic coupling in radio-frequency amplifier circuits of vacuum-tube receivers for the purpose of increasing the efficiency and reducing the objectionable effects of oscillation in these circuits. The elementary principle of reactance in a simple circuit, and its application to the circuits in question, is explained.

R281. 71. QUARTZ. QUARTZ

RADIO BROADCAST. Jan., 1927. Pp. 263-265. CRYSTALS.

"Piezo-Electric Crystals," M. T. Dow.

The general properties of quartz crystals, their structure, and their application to radio, are discussed. A crystal is said to act as an impedance (coil and condenser combination) when connected into its usual place in a tube circuit. Its elongation and contraction when potentials are applied on opposite sides occur at a very definite frequency. It is difficult to produce changes as large as one cycle in a thousand per second without stopping oscillations. A temperature difference of one degree will change the frequency only about one cycle in 30,000 per second.

Crystals oscillate at various frequencies, these points of oscillation being related in accordance with complicated laws. Since oscillating circuits have a good many harmonics it is possible to determine many frequencies with one crystal.

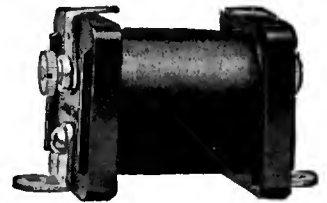
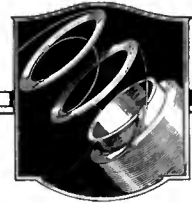
R330. ELECTRON TUBES. CATHODE

RADIO BROADCAST. Jan., 1927. Pp. 251-254. RAY, New.

"The Hundred-Billion-Dollar Vacuum Tube," J. Stockley.

A new Cathode ray tube has been developed by Doctor Coolidge which shoots electrons into the outside atmosphere through a thin nickel window. A potential of 350,000 volts is used on the tube. It is stated that its electron emission is equivalent to that given out by more than one ton of radium. The many peculiar and startling experiments, such as crystals being made to glow for some period after exposure to these electrons, the electrification of wax, the solidification of gas, and the effects on bacteria, indicate its many future possibilities.

(Continued on page 522)



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"All sense of listening ceases—you are in the great artist's presence."

say the musically critical who have simply added

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to their radio receiving sets to eliminate howling, "motorboating" and other disturbing noises—for at all times these chokes keep radio and audio frequency currents where they belong.

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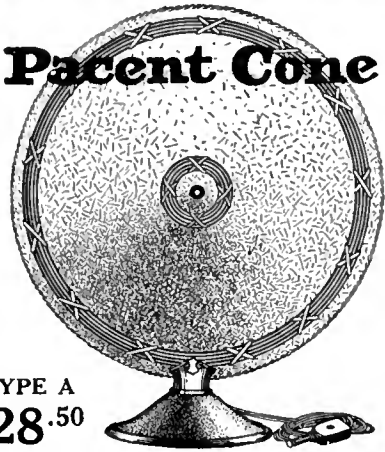
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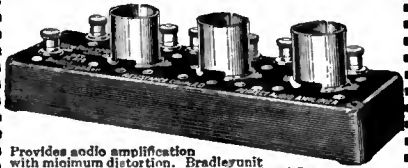
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This set of supersensitive Aero Tuned Radio Frequency Coils has never failed to improve the performance of any radio receiver. Tremendously increased power, extreme selectivity, and improved tone quality are sure to result from their use.

This kit of Aero Coils have a much lower high frequency resistance than other types of inductances. You should use them in any circuit, if you want the best possible results.

FREE Big 8-page 4-colored layout system (actual size blue prints) and complete instructions for building the 5-tube Aero-Dyne Receiver free with each kit. Also insert showing how to wire for a power tube if desired. Extra copies, 75c each.

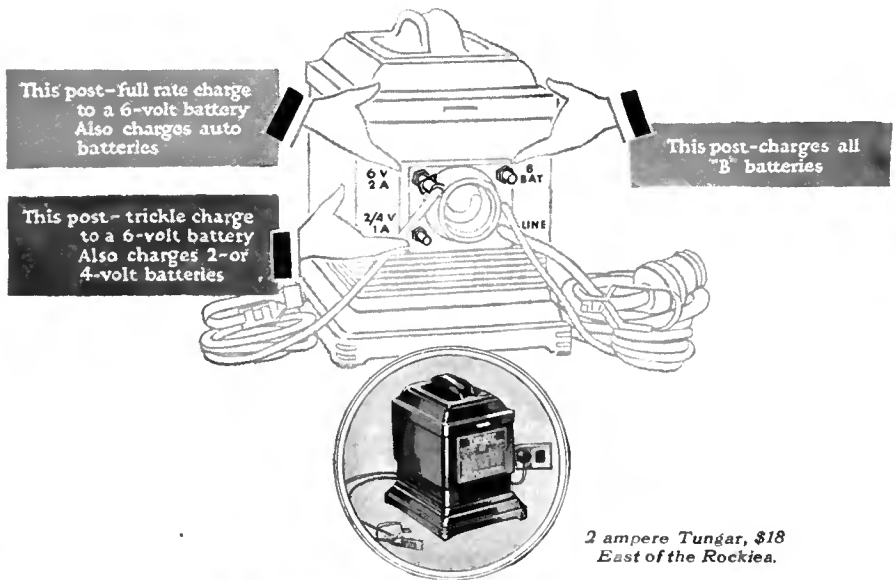
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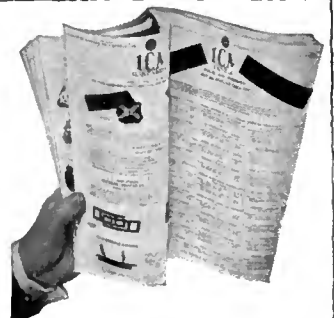
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Panel size, 36" x 9" x 1" Super 10-tube Standard Admiralty Model Weight: 55 lbs.

A SUPER-10 has been installed on board the "U. S. S. Wright," now sailing for Asiatic waters with the U. S. Aircraft squadrons. This receiver will also be used for entertaining civilian representatives at various ports of call.

A New and Advanced Model Highest Class Receiver in the World

THE NORDEN-HAUCK SUPER-10 is an entirely new and advanced design of Receiver, representing what we believe to be the finest expression of Modern Radio Research Engineering. It is the product of years of experience devoted exclusively to the attainment of an ideal Broadcast Receiver—regardless of cost.

Results obtained in every respect will upset all your previous ideas of good radio reception. The unusually large number of unsolicited testimonials constantly being received from users—concerns and individuals of international repute—indicates the absolute superiority of the NORDEN-HAUCK SUPER-10.

You, too, may enjoy the advantages of this wonderful receiver at a surprisingly moderate cost. Here are only a few of the host of features that place the NORDEN-HAUCK SUPER-10 far in advance of competition.

- 10 tubes employed to give perfect reproduction with unlimited range and volume power.
- Super selectivity on all wave lengths.
- Built to Navy Standards.
- Wide wave length range without change of coils, 200-550 meters full. (Adaptable 35 meters to 3600 meters if desired.)
- Use Loop or Antenna.
- Simple to operate, having only two major tuning controls.
- No Harmonics. Signals are received only at one Point.
- Special Power Audio Amplifier, operating any loudspeaker and eliminates necessity of external amplifier.
- Can be operated directly from house current with socket power devices.
- Thoroughly shielded at all necessary points.

Complete Price List for Socket Power Operation

1 Norden-Hauck SUPER-10, completely constructed and laboratory tested.....	\$307.00
*1 Heavy-Duty 200 V. "B" Eliminator and Tube, 50-60 cycle A/C 110 V.....	42.50
1 Automatic "A" Power Supply, complete.....	29.50
10 Tested Tubes, including Power Tube.....	22.50
1 Western Electric Cone Speaker, 540AW or Farrand Sr., and Plug.....	32.60
1 Set Antenna Equipment, complete.....	5.00
2 "C" Batteries.....	2.00
TOTAL COST OF ALL ITEMS—NOTHING ELSE REQUIRED.....	\$441.10
* 25/30 cycle A/C current, \$47.50.	

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381. CONDENSERS. CONDENSERS, Fixed.
Radio News, Nov., 1926. Pp. 481ff.
"A Visit to a Condenser Factory."
Details relating to the manufacture of fixed condensers are given. Photographs are shown of the vacuum tanks used for impregnating with paraffin, power winding machines, vacuum dryer container, and testing apparatus.

R343.5. HETEROODYNE SETS. SUPER-HETERODYNE.
RADIO BROADCAST, Jan., 1927. Pp. 260-262.
"A Six-Tube Super-Heterodyne," K. Clough.
This six-tube super-heterodyne, consisting of regenerative detector, oscillator, two stages intermediate, second detector, and one stage audio amplification, has its detector and oscillator shielded. Detailed constructional data are given with a list of the parts required.

R140. RADIO CIRCUITS. GRIMES, Inverse Duplex.
RADIO BROADCAST, Jan., 1927. Pp. 266-268.
"The New Inverse Duplex System," David Grimes.
A new inverse duplex system features the following advantages over the old circuit known by the same name: (1) Excellent radio-frequency selectivity at all wavelengths. (2) Substantially equal radio-frequency amplification at all wavelengths. (3) Several special arrangements to secure real tone quality in the audio-amplifying circuits. (4) Means for preventing detector-tube overload, thus retaining the bass notes on local stations. (5) Elimination of direct current from the loud speaker windings, reducing burn-out tendencies. (6) Straight line volume control for smooth and gradual adjustment from a whisper up to the choking point of the tubes. (7) Long tube life because of the negative C battery bias on all amplifying tubes, radio frequency as well as audio frequency. (8) Small B-battery drain due to the reasonable number of tubes used and the fact that all amplifying tubes are operated with the standard negative C bias on the grids. (9) Unique grid arrangement on first audio tube to overcome hand hum, prevent the audio whistling caused by the A type tubes, and to permit the second and third condensers to be run on the same grounded shaft, if desired. (10) Certain circuit designs to permit the use of the new 1X-171 type power tube and the new 1X-200-A detector. (11) Determination of audio phases for reducing the radio frequency modulating effect on excessive signal strengths.
It is shown how the problem of equal amplification over the present broadcast band is accomplished through the use of a correct radio-frequency filter circuit. Greater selectivity on the lower frequencies is obtained through a feedback arrangement, equivalent to a reduction in resistance. Body capacity and other squealing noises have been eliminated by proper separation of radio and audio frequency currents in the circuit. Succeeding articles on the Inverse Duplex receiver will appear in the February and March issues of RADIO BROADCAST.

R343. ELECTRON-TUBE RECEIVING SETS. RECEIVER, Hammarlund-Roberts.
RADIO BROADCAST, Jan., 1927. Pp. 274-276.
"The 'Hi-Q' Receiver," L. G. Biles.
An improved Hammarlund-Roberts receiver, having two tuned radio frequency stages instead of one, incorporates the following features: (1) Dual tuning whereby three tuned radio-frequency circuits are controlled by only two dials. (2) Complete shielding of the radio-frequency circuits so as to prevent direct pickup by the coils, and unwanted inter-stage coupling. (3) Automatic variation of the coupling between the primary and secondary coils of the radio-frequency transformers so as to obtain high efficiency. (4) A high-efficiency detector circuit which permits the use of the new type 200-A detector tube. (5) Arrangement of the circuit so as to permit the use of a semi-power tube in the output.
These points are discussed and data are presented on the construction and assembly.

R344.5. ALTERNATING CURRENT SUPPLY. A. C. POWER.
RADIO BROADCAST, Jan., 1927. Pp. 284-288.
"A Combined Amplifier and A. C. Operated Power-Supply Unit," J. Millen.
A unit is described consisting of three stages of audio amplification, the first impedance-coupled, and the other two resistance-coupled. The plate potential is obtained from a Raytheon rectifier tube. A description of the layout and the unit's operation are outlined, with the necessary photographs for details.

R140. RADIO CIRCUITS. HARTLEY, CIRCUIT.
QST, Dec., 1926. Pp. 9-13.
"How Our Tube Circuits Work. No. 1—The Hartley Circuit," R. S. Kruse.
It is the purpose of this series of articles to explain in simple terms some of the few standard circuits, such as the Hartley, the Colpitts, and others. The development of the Hartley circuit into other arrangements is explained, and a series of other circuits are shown. In the final analysis, it is said all come from the same source, and operate on the same principle as the Hartley. The development of practical receiving and transmitting circuits from the Hartley, the difference between series and shunt feed, and the operation of the hook-ups, is discussed.

R134. DETECTOR ACTION. DETECTOR ACTION.
QST, Dec., 1926. Pp. 14-17.
"Detector Action in High-Vacuum Tubes," L. P. Smith.
Detector action in vacuum tubes is taken up from the standpoint of the grid and its potential, relative to the filament. Two common methods of detection are discussed, namely the grid leak—condenser method and the battery bias method. Curves of grid voltage and grid current for the 201-A type tube and detection characteristics for the 201-A type as well as the 200-A type tubes are given and explained.

R144. HIGH-FREQUENCY RESISTANCE. LOSSES.
QST, Dec., 1926. Pp. 21-24.
"The Relative Importance of Losses in Radio Receiving Systems," W. W. Harper.
A discussion of the desirability of having some standards for transformers, from which operating results may be predicted, is presented. The conclusion seems to be that standards cannot be determined so long as other component parts have not been standardized. The question of losses in coils is discussed at some length, the natural and the operational power factors being quite different, thus leading to wrong conclusions as to the operation of receivers.

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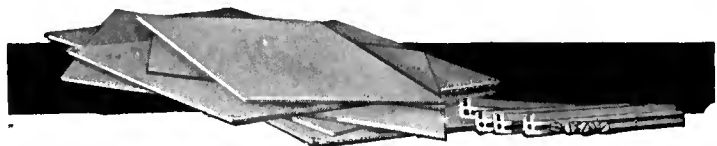
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R343. ELECTRON-TUBE RECEIVING SET. RECEIVER, Short-Wave.
QST, Dec., 1926. Pp. 37-40.
"A Shielded Short-Wave Receiver," F. J. Marco.
The desirability of using shielding on short-wave receivers is explained, especially where troubles such as power-leaks, local broadcast station fields, sixty-cycle induction from lighting lines, and body capacity, are experienced. Possible antenna, shield connections, and trap circuits for eliminating broadcast transmitter troubles are discussed.

R343. ELECTRON-TUBE RECEIVING SETS. RECEIVER, Counterphase.
Radio, Dec., 1926. Pp. 35ff.
"The Counterphase Power Six," G. M. Best.
The Bremer-Tully Counterphase Six is described, with illustrations, circuit diagrams, constructional details, and operating data.

R132. AMPLIFYING ACTION. AMPLIFIER, Infradyne.
Radio, Dec., 1926. Pp. 39ff.
"The Infradyne Amplifier," E. M. Sargent.
In the infradyne receiver the main consideration is given to the three stages of tuned radio-frequency amplification operating on 3486 kc. (86 meters). The development of intermediate stages from the first experiments using a Hazeltine neutralizing circuit down to the present circuit is described.

R800 (347.7) PATENT PRACTICE. PATENTS.
Radio, Dec., 1926. Pp. 41ff.
"The Maze of Radio Patents," John Flamm.
The radio patent situation is discussed in general, such patents as those pertaining to tuned radio frequency, the grid leak, regeneration, the super-heterodyne, the tube, and others, being mentioned. The author, in taking up this subject of patents, states that the patent office issues many invalid and baseless patents and many are won or lost only through court action. He mentions the DeForest and the Armstrong regenerative patents as examples.

R382. INDUCTORS. TOROIDS.
Radio, Dec., 1926. Pp. 43ff.
"The Mindector," O. C. Roos.
A constructional article is presented concerning the design and overall efficiency of toroidal coils. In order to have a coil with a given inductance and the least wire, a definite coil dimension must be used. Such a coil has been designed and called the "Minimum Decrement Toroid" or, for short, "Mindector." Data on construction are given for coils having 1.66, 16.6, and 166 microhenries inductance.

R351. SIMPLE OSCILLATORS. OSCILLATORS.
Radio, Dec., 1926. Pp. 46.
"An Oscillator That Holds Calibration," L. W. Hatry.
An oscillator, illustrated and described, is said to have such advantages as: (1) Controllable pickup; (2) Range covering entire waveband; (3) portable and flexible; (4) permanent in calibration. Uses for the instrument are suggested.

R201. GENERAL METHODS AND APPARATUS RADIO MEASUREMENTS FOR MEASUREMENTS.
Radio, Dec., 1926. Pp. 47-48.
"An 'LCR' Measuring Box," S. Harris.
The author describes the construction and use of a measuring instrument for determining wavelength, capacity, inductance, coupling coefficient, high-frequency resistance, and measurements which are commonly made in every experimental laboratory. Typical set-ups in making such measurements are shown and explained. A simple means of determining the coupling coefficient is mathematically outlined.

R113.5 METEOROLOGICAL PHENOMENA. METEOROLOGY.
Popular Radio, Dec., 1926. Pp. 76ff.
"The Effect of Temperature on Signal Strength," E. E. Free.
The discussion pertains to the relation of signal strength to variations in temperature throughout the year. An explanation is offered based on the possible variation of warm and cold waves and the relative ionic content of the atmosphere during such temperature changes. In cold weather the number of ions present per unit area is less than in warm weather, and therefore the friction between them is decreased. This may account for less static.

The "Lightning Jerker"

COMPLAINTS of non-delivery of correspondence addressed to our excellent contemporary the *Lightning Jerker* have been recorded by several correspondents. This was due to a change of address of the editorial offices of that publication, of which the post office apparently was not cognizant. Letters, instead of being addressed to the old Avers Avenue location, should be sent to 1110 Capitol Building, Chicago, Illinois. The *Lightning Jerker* has a Pacific Coast address at Seattle, Washington—P. O. Box 2123.

Erratum

ON PAGE 261 of the January RADIO BROADCAST there appeared a diagram of a super-heterodyne designed by Mr. Kendall Clough. In error, a single-circuit jack, J, was shown in the plate circuit of the oscillator tube; the jack should have been of the closed circuit type so that the plate circuit is completed through the jack when the plug is removed. Also, the rotor of the oscillator tuning condenser C₃ should connect directly to the shield and not to terminal four of the socket as indicated.



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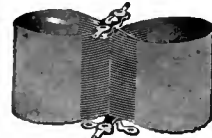
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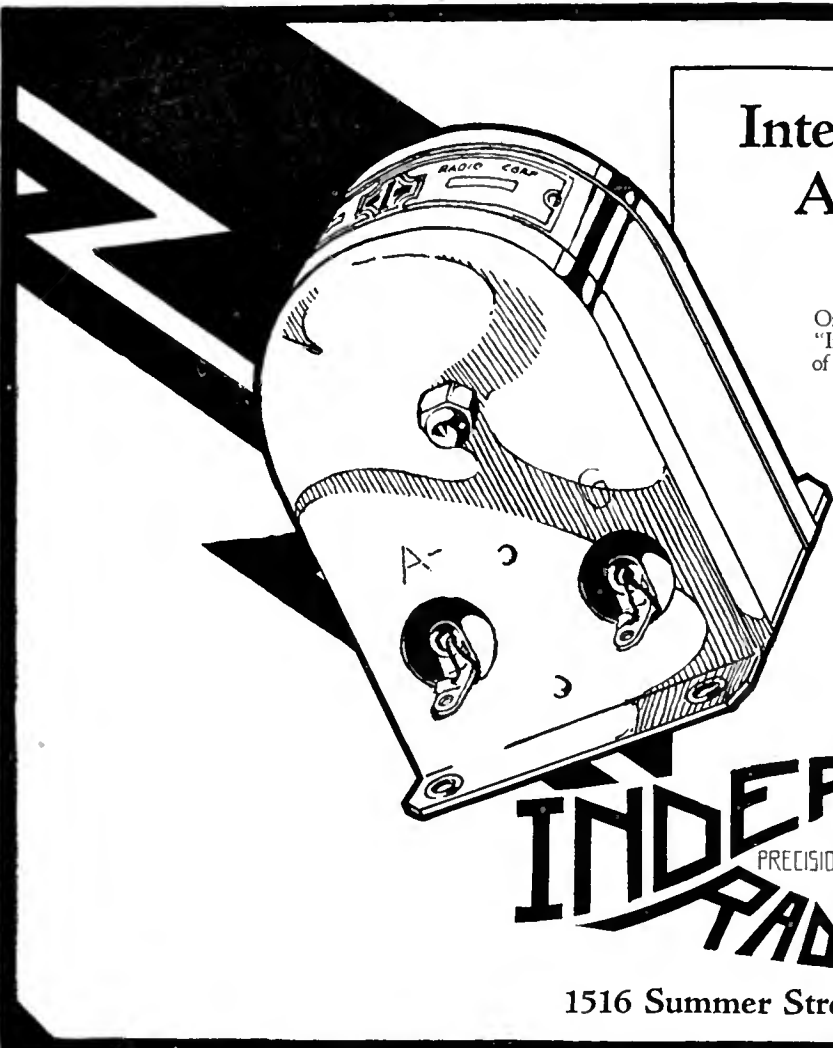
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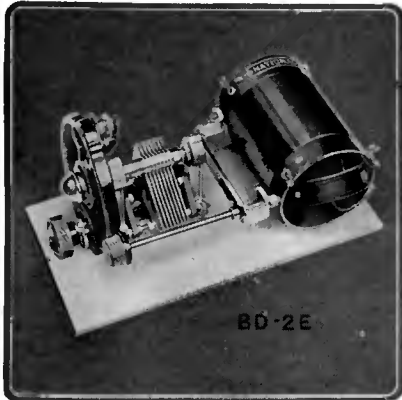
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