NOV. 19 THE IMPROVED LABORATORY SUPER-HETERODYNE 15 Cents

RADIO WORLD

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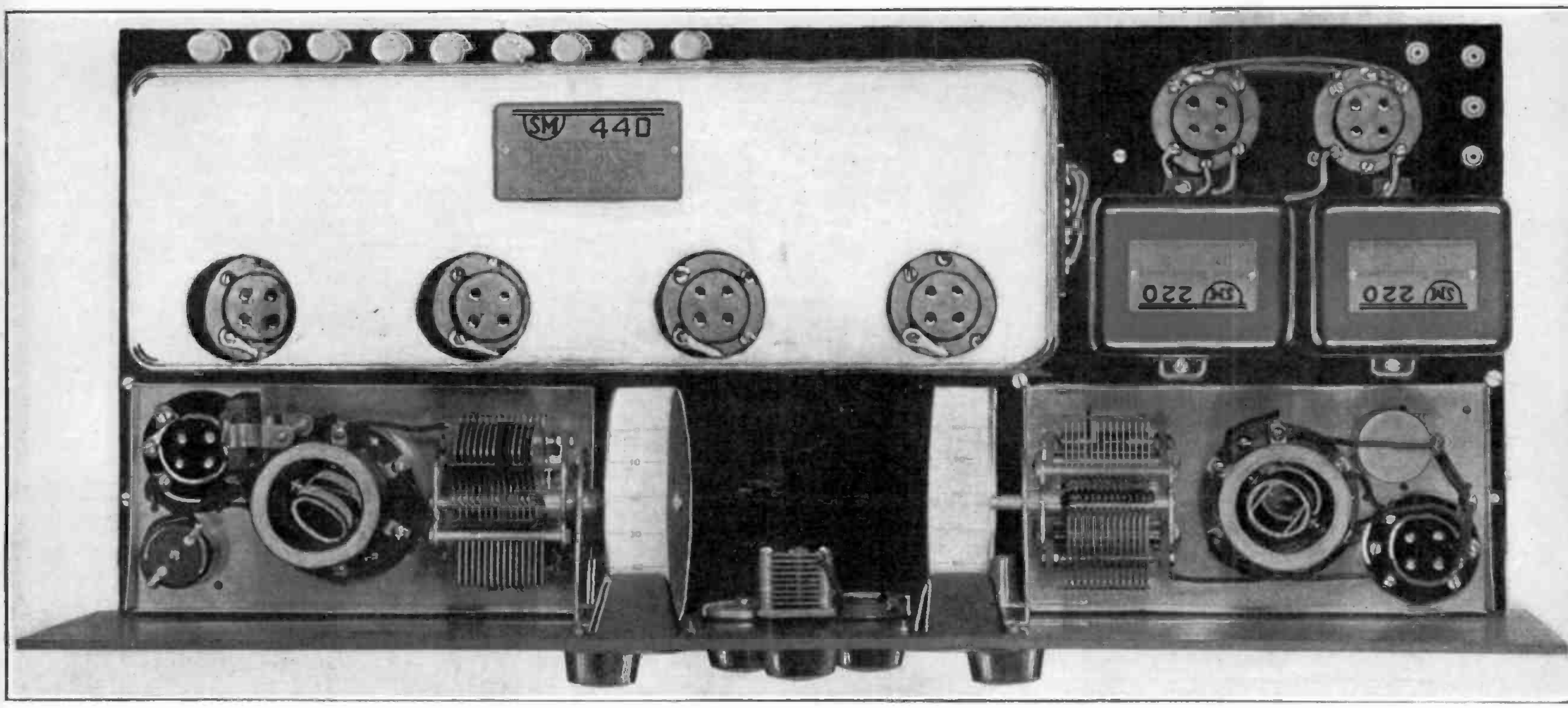
REMARKABLE SENSITIVITY DEVELOPED IN 8-TUBE SET



TOP VIEW OF THE IMPROVED LABORATORY SUPER-HETERODYNE USING JEWELERS TIME SIGNAL AMPLIFIER. SEE PAGE 3.

Diagram of FENWAY Concertrola, Battery Model

See Pages 6 and 7

New Design for a Set Working from DC Light Socket

See page 5

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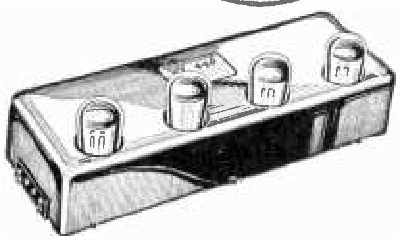
SM



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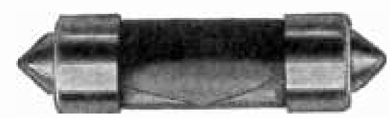

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The Improved Laboratory Model Super-Heterodyne

[Many super-heterodyne circuits have been described in the last few years but it can be said in entire fairness that probably never has a receiver been announced that incorporates the improved principles of construction and design shown in the Improved Laboratory Model Super. Not only does the design in itself—the improvement in the parts that it employs—make the receiver stand out in a class by itself, but the record of its performance in the hands of users is one that is without parallel in the history of radio. Performance in the hands of the users, when all is said and done, is the yardstick by which the worth of the receiver is measured. Such was the measuring rod used.

The Improved Laboratory Model Receiver has been in the eyes of the public but a few short months. In that time thousands have been built and the letters that have poured in about unusual reception are so many that only a few cases can be cited. Regular and consistent reception of KFI in Los Angeles is reported by an owner in Baltimore, even during unseasonable weather conditions. A Novia Scotia owner brings in Boston, Schenectady, Atlantic City, New York and Pittsburgh on one tube—in daylight. A Chicago owner reported a short time ago that through the local congestion—in the city where reception conditions are worse than anywhere else—that he has logged 120 stations over a period of a few nights. These are the reasons why Radio World takes pleasure in presenting this efficient circuit to its readers, feeling sure that the results obtained will be exceptional and satisfactory in every respect.]

By E. R. Pfaff

PART I

IN the Improved Laboratory Super-Heterodyne is at last found a receiver free of the almost age-old bugaboo of individually matched long wave transformers, for the long wave amplifier is a sealed, laboratory-calibrated unit that will not vary one kilocycle in operation with standard tubes.

Almost every builder of a Super-Heterodyne has either been disappointed in his set not possessing the expected knife-like selectivity, or, if he has employed really sharp, efficient transformers, they only too frequently do not function properly. This condition is not always due to the individual transformers not having been properly matched to begin with, but to individual assembly conditions resulting in altered circuit capacities and operating conditions which do not duplicate the laboratory conditions under which the transformers were first matched.

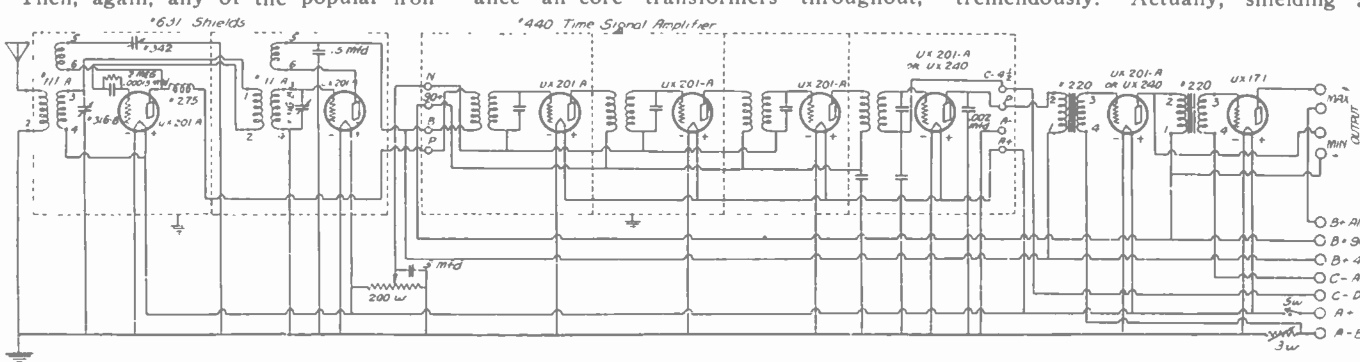
Then, again, any of the popular iron-core 30, 40, 50 or 60 kilocycle transformers have very low winding capacities for operation with low circuit, and low tube capacities. Since the operating frequency of the transformers is largely determined by the total circuit capacity, and since winding capacity is low, it follows that any small variations in wiring, assembly, or tube capacity will represent a large proportionate change of the total capacity, with the result that individual receiver stages built with accurately matched transformers may often be as far as 15 to 20 kilocycles apart. This, of course, means little or no selectivity, even if there still remains fair amplification.

Follows Best Practice

The logical way to build an intermediate amplifier is to use, not iron-core-air-core transformer combinations, but to follow along the lines of best RF amplifier design practice, and use low resistance air-core transformers throughout, tuned with large fixed capacities, so that variations in tube capacities represent such a small percentage change of the whole as to be ineffectual.

Exactly this course has been followed in the Laboratory Super, but it has been carried a step farther by virtue of the use of the S-M Jewelers Time Signal Amplifier, which provides a remarkable intermediate frequency amplifier, the whole amplifier built into a single, carefully tested unit, so that two causes of variation have been eliminated, and the remaining third—tube capacity—rendered so small a percentage as not to affect operation.

On top of this, the whole amplifier is completely shielded, each of the RF stages and detector being housed in individual compartments of a copper-brass catacomb. The amplifier without shielding is remarkably efficient, but when the shielding is added, the amplification jumps tremendously. Actually, shielding adds



THE SCHEMATIC DIAGRAM OF THE IMPROVED LABORATORY MODEL SUPER-HETERODYNE, USING THE TIME SIGNAL AMPLIFIER.

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FRONT PANEL VIEW OF THE LABORATORY SUPER-HETERODYNE

at least 50 to 100 per cent. in volume on weak stations—exactly as it would when intelligently applied to any multi-stage RF amplifier. This is because of the elimination of detrimental feedbacks, invariably present with unshielded amplifier stages.

Functions of the Eight Tubes

Eight tubes are employed in the Improved Laboratory Model Super-Heterodyne—a first detector, an oscillator, three long wave amplifiers, a second detector, and two audio stages.

The first detector circuit is very similar to the conventional short wave regenerative circuits so popular; and, in fact, on short waves the first detector system alone of the new set will bring in European amateur stations on headphones!

The circuit is regenerative, a 75 mmfd. midget condenser controlling regeneration; while a .00035 modified SLW-SLF condenser does the tuning. The coil system is a conventional S-M plug-in coil, so connected that both regeneration and tuning condenser are at ground potential, with consequent total absence of hand-capacity effect.

No provision is made to use a loop, as it has been found that for extreme selectivity the use of an antenna—the coupling to which is variable—provides greater flexibility than a loop.

The oscillator circuit is designed to keep harmonics at a minimum so that stations are heard at but one, or, at the most, two dial points. It is grid-tuned with a .00035 mfd. condenser with consequent absence of hand capacity effect. Its output at different wavelengths is sufficiently constant for practical requirements, as is its calibration; while the coupling to first detector is variable.

Amplifier in Copper Can

The Jewelers Time Signal Amplifier, used in this receiver as IF amplifier and second detector, is a copper can 15 inches long, 5 inches wide, and 3 inches deep. It contains four individual stage compartments, each holding an RF transformer and its tuning capacity, a tube socket, and the necessary wiring and by-pass condensers.

Three RF stages and detector are employed, with the whole unit tuned to exactly 112 kilocycles.

The reason for the selection of this intermediate frequency is that very satisfactory low resistance air-core tuned RF transformers may be built for operation there. If a lower frequency were used, serious cutting of side-bands would result, or poor selectivity, as pointed out. The 112 kilocycle amplifier frequency results in decreased interference possibilities. Normally, in a super employing, say, a 50 kilocycle intermediate frequency, two stations 50 kilocycles apart will heterodyne each other and be received without the use of the local oscillator at all, selectivity being dependent upon the selectivity of the antenna tuner and the local coil pick-up.

As the intermediate frequency is increased, this possibility decreases, since it is far easier for an antenna tuner to discriminate between stations 112 kilocycles apart than between powerful locals 30, 50, or even 60 kilocycles apart. Further, powerful stations are generally spaced on even 10 kilocycle separations, so that the odd 112 kilocycle frequency is a greater aid to selectivity.

5,000 Cycle Cutoff

Coil pick-up is, of course, absent in the shielded amplifier, and wiring pick-up is almost negligible, since all wiring is very close to the grounded metal panel or chassis. Complete shielding of first detector and oscillator sections prevents pick-up of strong local stations on the coil systems themselves, though for receivers to be operated in the country, or in non-congested broadcasting centers, these two shields might be omitted.

The audio amplifier offers a very unusual point of very great value in an ultra-selective receiver. This is the 5,000 cycle cut-off, or decrease in amplification, which aids receiver selectivity. Frequencies above 5,000 cycles do not contribute to realism of reproduction, according to no less an authority than the Bell Telephone Laboratories, while in the range above 5,000 cycles lie practically all parasitic amplifier noises, atmospheric disturbances and the only too prevalent heterodyne squeals. These the 5,000 cycle cut-off tends to decrease very markedly, and almost entirely eliminate.

The amplification of the set is tremendous, due to careful design of every individual circuit. The very sensitive first detector gives an amplification of 200 times or more on a very weak signal when carefully operated. The computed as well as actually measured gain of each RF stage is about 20, while the gain of the audio stages is also about 20.

Computation of Gain

Regarding the over-all amplification in the most conservative light, a gain of 25 is assumed for the first detector—one-eighth that experienced on a weak signal. The gain of the RF amplifier is split in half for the sake of conservatism—to 10 per stage. The audio gain may be considered as 20 per stage. Thus the over-all amplification may be very conservatively taken as 25 x 10 x 10 x 10 x 20 x 20 equals 100,000,000 times. Considering an average eight tube Super employing iron-core transformers and without as careful first detector design, the computed and measured gain of a typical popular set works out about as follows: first detector 5, RF averages 5 per stage including second detector, and audio 20 per stage. Thus,

5 x 5 x 5 x 5 x 5 x 20 x 20 = 1,250,000

times, or only one-eightieth of that of the Laboratory model!

These figures are borne out in practice, for the Laboratory Set will outperform all other eight tube sets against which it has been tried, either tuned RF or Super-Heterodyne. Generally, it will bring in on the loudspeaker stations only rarely heard, or not heard at all, on other sets. Compared against two ten tube Supers, it outperformed them, simply because every tube is worked to the absolute limit of performance.

In the most congested broadcasting districts the set is selective enough to cut through to out-of-town stations within 10, and sometimes 5 or 7, kilocycles of powerful locals—a degree of selectivity duplicated by no other set tested. The wavelength range of the receiver with standard coils is from 30 to 3,000 meters. Regular broadcast range coils cover the range of 200 to 550 meters, but it can be seen that the receiver is adapted to any class of broadcast reception by virtue of its wavelength flexibility.

The parts required to build the 1927 Model Improved Laboratory Super have been most carefully selected for the perfect coordination of the operating characteristics of the receiver. It is imperative that the exact parts specified, be used in building the set if its truly remarkable performance is to be realized to the fullest possible extent. Every item is the product of a well known and reputable manufacturer, and unconditionally guaranteed by him.

Other Photograph on Front Cover.

[Part II, describing the operation of the receiver, will be published next week, issue of November 26.]

LIST OF PARTS

One Van Doorn panel and chassis unit, pierced with hardware	$ 8.50
One Carter .00015 condenser with leak clips	.50
One Frost No. 1922 potentiometer, 200 ohms	1.00
Two Carter ½ mf. condensers @ .90	1.80
One Frost No. 1903 rheostat, 3 ohms	.75
One Yaxley Midget battery switch	.50
Four Frost No. 253 cord tip jacks @ .30 pr.	.60
One Polymet 2 megohm leak	.25
Two S-M 220 audio transformers @ 8.00	16.00
Four S-M 511 tube sockets @ .50	2.00
Two S-M 805 vernier drum dials @ 3.00	6.00
One S-M 275 R. F. choke	.90
One S-M 342 .000075 mf. condenser	1.50
One S-M 440 Time Signal Amplifier	35.00
Two S-M 515 coil sockets @ 1.00	2.00
Two S-M 111A coils @ 2.50	5.00
Two S-M 320 .00035 condensers @ 3.25	6.50
Nine X-L binding posts @ .15	1.35
	$90.15

(If shielded oscillator and first detector are desired, add $4.00 for two S-M type 631 stage shields.)

With each chassis should come the following items of hardware, contained in a small envelope:

Nine sets binding posts insulating washers (1 plain, 1 extruded to a set)

Four sets tipjack insulating washers (1 plain, 1 extruded to a set)

Three sets instrument insulating washers (1 plain, 1 extruded to a set)

Twenty-seven ¾-inch 6-32 RHNP brass screws.

One 1¼-inch 6-32 RHNP brass screw.

Twenty eight 6-32 N. P. brass nuts.

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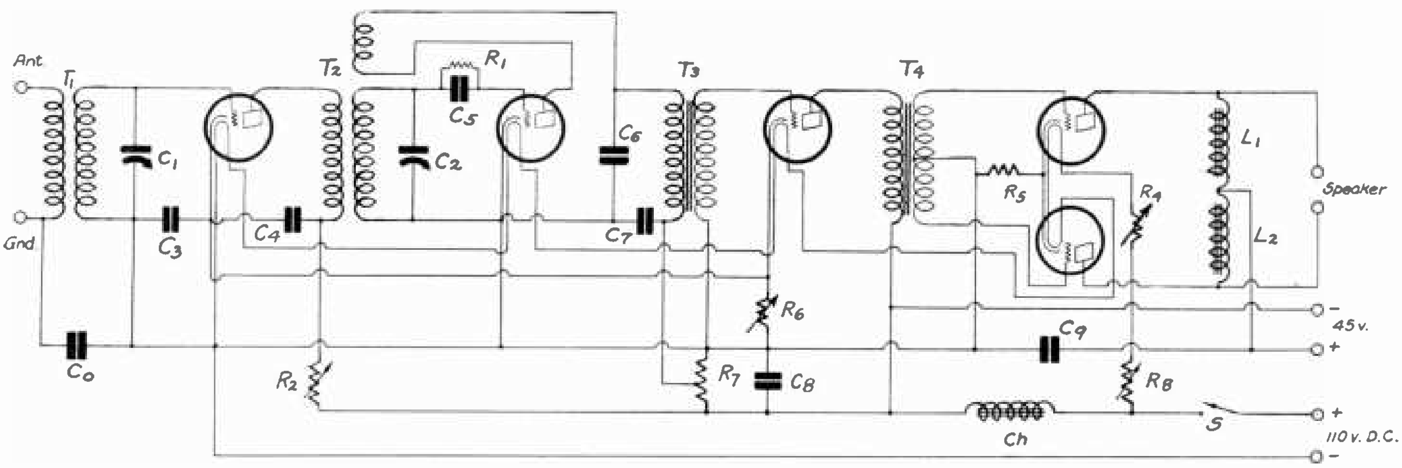
If You Have DC Here's Something for You That's NEW and Very Important

Almost the Entire Line Voltage Available for Plate Supply Yet High Cost Is Averted in Pioneer DC Five Originated by J. E. Anderson—A Long-Awaited Solution of a Real Difficulty

By James H. Carroll



THE SCHEMATIC OF THE NEW DC CIRCUIT

THE so-called electrification of receivers for operating on DC sources has always been a stumbling block to radio engineers.

Various schemes have been suggested for solving the problem. All have been expensive, few satisfactory. When the filaments are connected in series a large and costly filter is required to remove the hum and a large part of the line voltage is used up in the filaments and the filter, leaving only a small part for the plates.

When the filaments are connected in parallel, the plate voltage is saved but only at a very high cost of power supply and filtering.

But here is a new receiver, the Pioneer DC 5, which minimizes these difficulties. It was originated and designed by J. E. Anderson, Technical Editor RADIO WORLD. No filtering of the heating current is necessary and there is no loss in plate voltage to the heater circuit. For example, the line voltage may be 115 volts; and that voltage, less a few volts drop in the plate current filter, is available for the plates.

In previous cases the loss would have been of the order of thirty volts, leaving only 85 volts on the plate. In the new system the heater circuit and the plate circuits are in parallel across the DC line.

Uses New Heater Tubes

This new circuit is made possible by the use of the new heater type of tube, and particularly by the tubes in which the heater element and the cathode are electrically independent. Certain heater tubes are obtainable in which the heater and the cathode are electrically connected at one point. These can not be used in this new receiver.

As can be seen from the circuit diagram of the new receiver, it consists of one stage of TRF, a regenerative detector, one stage of straight audio frequency amplification, and one stage of push-pull audio amplification. There is nothing in the principle which prevents additional stages either ahead or behind the detector. In fact, as far as the cost of operating the heater goes, it is no greater for any practical number of stages than it is for four or five.

This circuit is described because it represents one of the most popular types of receiver and because it has adequate sensitivity, selectivity, and undistorted output. It is a receiver for which none need apologize.

Where It Is New

It is in the arrangement of the heaters and the cathodes that this circuit differs from other receivers. Let us first trace the heater circuit. Starting at the negative end of the DC 110 volt line we first meet the heater of the RF amplifier. Then we come to the heater of the detector, then to that of the first audio amplifier, and then to the heaters of the two push-pull tubes, one after the other. All of these heaters are in series, and the voltage drop across the entire series is 12.5 volts, since the drop across each one is 2.5 volts.

But the voltage of the line may vary from 105 to 120, depending on the locality and on the voltage drop between the power house and the terminals used. Hence it is necessary to insert a "dropper" in series with the heaters. This should preferably consist of two adjustable resistors, one for course adjustment and one for fine adjustment. The heater current will be 1.75 amperes, and therefore the resistors should be able to carry this current continuously without overheating themselves or overheating any other parts of the circuit.

High and Low

The value of the larger of these resistors can be determined on the supposition that the line voltage will never be less than 105 volts and that the current through the resistor will be 1.75 amperes. When the line voltage is the least the smaller of the adjustable resistors should be set at zero. Therefore the voltage drop in the larger resistor should be the difference between 105 and 12.5 volts, or 92.5 volts. This would require a resistance of 53 ohms. The nearest commercial size is 50 ohms, and that should be chosen. It should have a wattage rating of at least 200 watts.

When the voltage has the maximum value of 120 volts the smaller of the two resistors should be set at maximum. Hence the maximum value of the small resistor should be 11.4 ohms. The nearest commercial rheostat is 10 ohms, which may be employed provided that it will carry 1.75 amperes continuously. Should the voltage across the line rise higher than 120 volts, either the large or the small rheostat could be increased as required. The voltage usually does not vary widely at any one place, so that the first adjustment will be the only one necessary.

In view of the large amount of heat that these rheostats will dissipate, it is well to mount them away from the receiver proper, and preferably in such a manner that air has free access to them.

When adjusting the two rheostats an ammeter should be used to measure the heater current to make sure it has the normal value. Or a voltmeter may be used to measure the total voltage across the five heaters to make sure that it is 12.5 volts.

The Grid Returns

All the grid returns in the circuit, with the exception of that of the detector, are connected to the negative terminal of the line, which is the lowest potential point in the entire system. The grid return of the detector is connected to the cathode of that tube, in accordance with the recommendations of the manufacturers of the tubes.

(*Continued on page 22*)

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Fenway—the 4-Tuber for You!

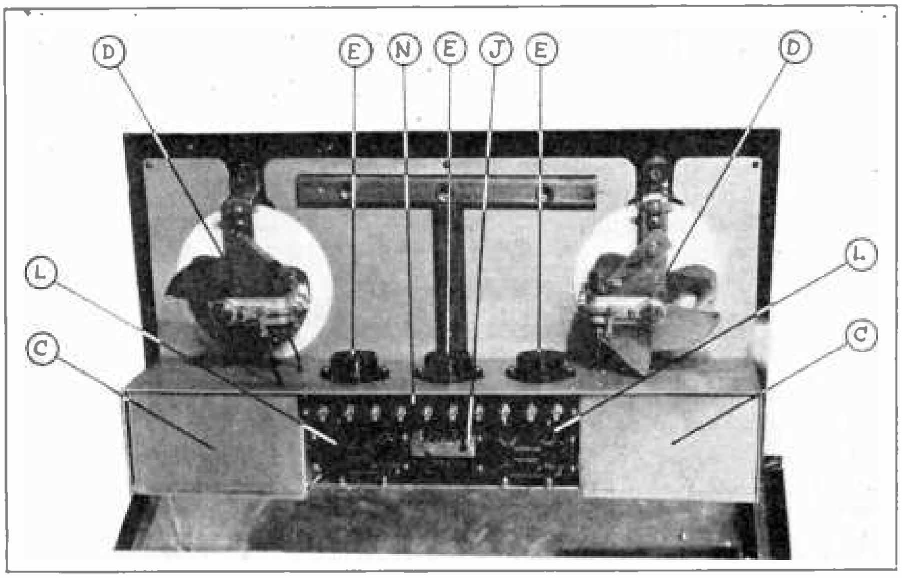


Fig. 7

[The world first was apprised of the Fenway Electric Concertrola in the November 5 issue. Constructional data were published November 12. Now we present Mr. Fenway's description of the battery model. Next week another electric model, using the R.C.A. tubes. The set described November 5 and 12 used Sovereign or McCullough-Kellog tubes. The Concertrola is the 4-tube set for you to build!]

By Leo Fenway

PART III

Copyright 1927

THE Electric Concertrola makes available two fields of enjoyment: radio programs from all parts of the country, reproduced with a fidelity of tone, and phonograph records with the quality of the largest electric amplifiers, made possible by passing the recorded music (or record) through the superlative Ferranti audio system of the Concertola, plus the Pacent Phonovox.

Changing from the radio program to the record program is made easy by means of the Yaxley switch and the connecting wires from this switch to the two phonograph jacks, the phonograph having already been equipped with the Pacent magnetic pick-up device. Thus, a world of music is literally at your finger tips. Parties need no longer be dull. When there seems to be no common interest to hold a family or a party together, you just turn on the radio to a lively dance orchestra, or put a record on the phonograph and the interest of all suddenly converge. When everybody is happy, you sit back and smile—smile because it is the Concertrola that YOU made which is causing all the merriment.

How to Make One Gadget

Last week you discovered the circuit diagram. Perhaps you saw things in that diagram that interested you. Maybe you'd like a little more light thrown upon certain parts of the circuit. Have you wondered how the AC tubes were connected in the filament circuit? Fig. 8 illustrates the connecting plug for these tubes. This little device can be easily made with a piece of bakelite, ½ x 1 x 1/16 inches. Upon this are fastened two ordinary contact springs, such as are used in the average UX socket. Three of these plugs are necesary. The wires which connect these plugs into the circuit come up through the little aluminum pipe (½ inch in diameter) or come through the metal moulding attached to the panel. These wires, of course, start from the Concertrolastat.

It is very important that the 100 ohm

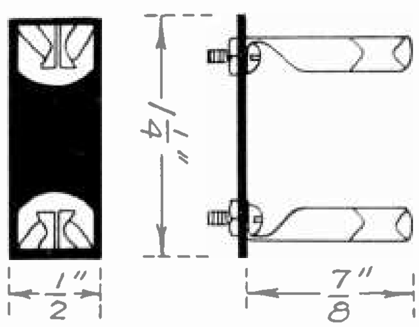


Fig. 8

potentiometer be connected across the AC supply leads, thereby reducing even the slightest trace of hum or buzz; to set the potentiometer, tune the receiver to a position where no incoming signal is heard in the loudspeaker, then make the adjustment, which will generally be found near the center of the potentiometer range for minimum hum. If the adjustment of the potentiometer has no apparent effect upon the hum, reverse the line connections at the lamp socket—reverse the plug.

Only 50 Connections

Because the right start always predetermines a better finish, every man knows that constructional steps must be closely woven, and that the intelligent interlacing of every radio part makes a superfine receiver.

The change-over switch (from radio to phonograph), can be wired without much trouble. The blueprints show all connections numbered. The only trouble that may be experienced with this switch will be in the contact springs, which after a period of a year or more, may become rather weak in spots, but this, of course, depends upon how much the switch is used.

When one has a circuit like the Concertrola to follow, when one knows the exact parts to use and how to use them, as explained in the first two articles, the construction ought to be quite simple. In fact, it is much simpler because there are not more than fifty connections in the whole set, including the eliminator. The kit, as sold, has all the instruments mounted on both the panel and the back panel, so the set builder has merely to follow the wiring instructions to produce a receiver as uniform and efficient as the finest factory job. Even the cabinet, when it comes with the kit, is shielded over all, aluminum being used for the purpose. Thus the construction of the Concertrola is made easy—simple—for home tinkerer, as well as for the professional set builder.

It Pays, Says Fenway

And this answers in the affirmative the question as to whether or not it pays to build your own Concertrola. Of course it pays to wire your own receiver, if for no other reason than the fact if trouble comes you can locate and remedy it without the assistance of a radio doctor and, possibly, a ten dollar bill. Besides, after all, practically all "manufacturers" of radio receivers are nothing more than assemblers. Like you, they purchase kits, or condensers, transformers, coils, sockets, etc., from parts makers who are the manufacturers in reality. Only a few maintain

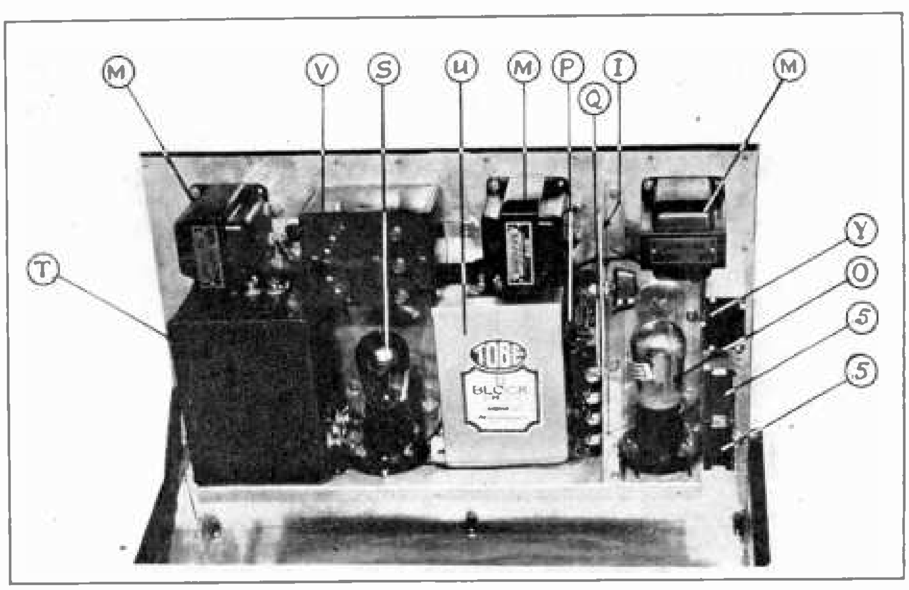


Fig. 9

complete factories, where almost every part of the set is manufactured under one roof. On this basis it has always been comparatively easy to become a radio "manufacturer." It still is.

Every builder of the Concertrola will in a sense become a manufacturer. He will at least manufacture his own set. Nor can he be blamed. The wayside is laden with radio junk. And the home set builder, at least, is fed-up on the idea of paying, say, a hundred dollars, for worthless instruments. He is done with the manufacturer who sells his product today for two hundred dollars, while tomorrow the same instrument is sold for forty dollars.

But the home manufactured set will pay big dividends only when its construction is along well guided lines, with standardized parts, such as is recommended for the Concertrola.

Must Follow Instructions

In the course of long and varied experience in dealing with set builders, the writer has done much satisfactory, successful work—work that pleased him, first of all, and that resulted in the building of receivers that pleased builders, listeners, and others. The writer has, of course, done some work for set builders that did not satisfy him. Most of this was just as unsatisfactory to the set builder. Where he has done his best, most valuable work he has always found one condition present: the set builder was in **earnest.** He wanted to be helped, even if it meant sending some cherished misconceptions of set building into the discard. Where he has been unsuccessful, it has been, **always,** because the set builder would not or could not follow instructions. This leads to the suggestion that if you are willing to receive instruction, are willing to be told that you must build your Concertrola thus and so, you will certainly succeed with this new, new-type of all-electric set.

But you must remember that you learn to build radio sets by building them. There is no other way. Helpful as any reading about the building of sets may be, and necessary and valuable as all thinking about building them is, and priceless as all dreaming of building sets is—you must build.

The Changes Made

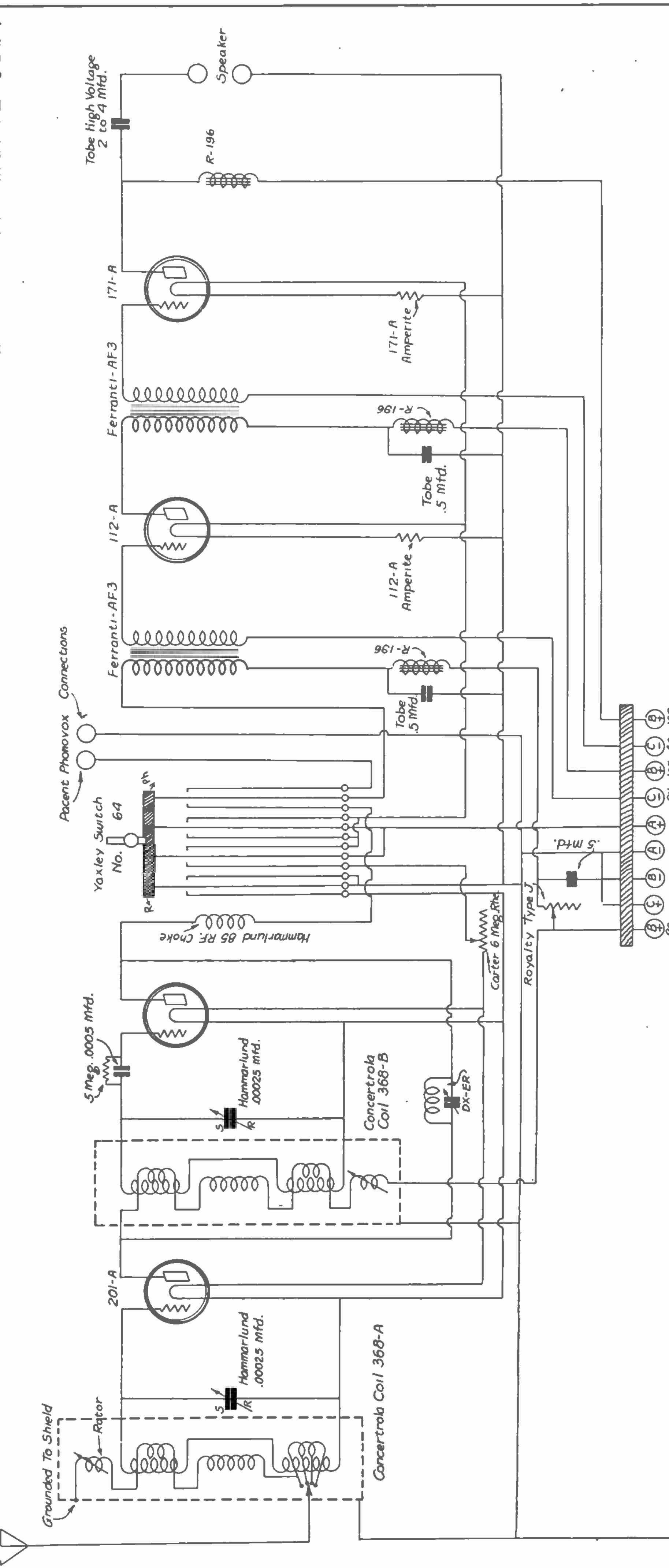
This week the battery model of the Concertrola is presented. Fig. 10 explains the circuit diagram, which is identical to the electric set, except that a rheostat is added for the first two tubes, Amperites for the two audio tubes, standard tubes, and current is supplied by batteries. Naturally, this model can be electrified by means of eliminators.

Construction should be commenced and followed through exactly as suggested for the all-electric set. The same size panel, as shown last week, should be used, the identical instruments, and possibly the same cabinet. The colored wiring scheme, original with the writer as far back as 1924, should be carried out. The performance of the battery set should be on a par with the electric set.

The same care should be taken in the wiring as if the electric outfit was being made. In building any set mechanical strength and security are heeded in all connections. While it makes little difference, electrically, whether you use solder or a paperweight to hold two wires together, it is always best to use Kester rosin core solder.

Useful Hints

In building the electric set, the AC tubes consume one ampere each which is a lot of current these days for ordinary tubes, consequently, heavy wire and well soldered connections are necessary. The same goes for the battery set. If you follow these little things there will be very little likelihood of trouble, when the current is turned on.



THE FENWAY CONCERTROLA, BATTERY MODEL, USING AMPERITES AND A CARTER RHEOSTAT.

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Why Even Churchmen Steal Your Pet Program

By Tim Turkey

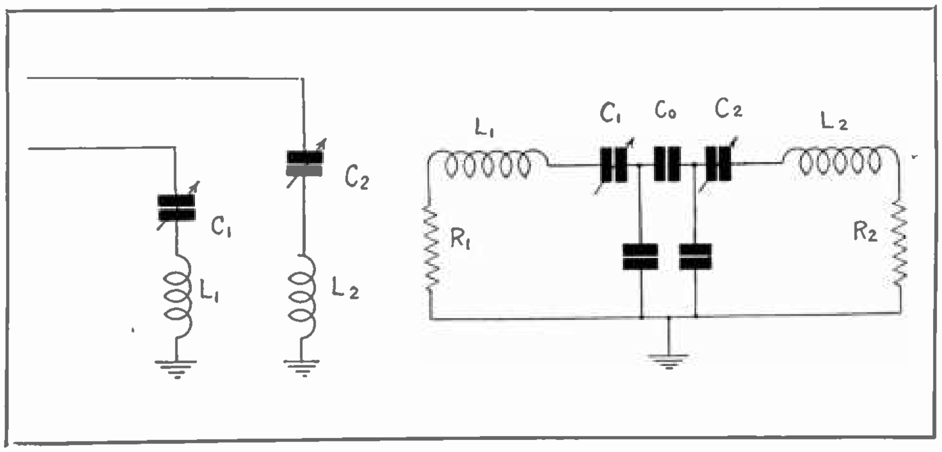


FIG. 1 (LEFT) ILLUSTRATES TWO TUNED ANTENNAS PLACED IN CLOSE PROXIMITY, AS SIDE BY SIDE ON THE SAME ROOF OR ONE UNDER THE OTHER IN THE SAME APARTMENT HOUSE. FIG. 2 SHOWS THE EQUIVALENT ELECTRICAL CIRCUIT FORMED OF THE TWO ANTENNAS. THEY ARE DIRECTLY CONNECTED BY MEANS OF THE CAPACITY CO.

If you are living in a congested neighborhood with radio antennas all around you, be not surprised if your radio receiver behaves in an erratic manner. Rather be surprised if it behaves consistently well all the time.

You should be especially fortified against surprise if the set behaves well when tuned in on a popular station when an unusually good feature is being broadcast from that station. The radio set is temperamentally sympathetic and responds to all the changing moods of all the radio receivers in the vicinity.

When there are other radio sets above it, below it, and all around it, the set has ample opportunity to exercise its temperament.

How may this sympathy affect your own reception? Suppose you are tuned in on a certain station and enjoying the program from that station. Then some one else in the building, say the deacon of your church, takes a notion to tune in on the same station.

He Takes It Away

He turns his dials and takes your program away from you. He may leave you nothing or he may substitute some inferior program. He may steal your operatic aria and give in return a talk on where to buy the best sourkraut. Of course, you are not interested in any phase of sourkraut at the moment so you fish around on the dials for something more in keeping with the occasion. You may stumble on the operatic selection again, at a point on the tuning dials where it had never been before. But your act of retrieving the aria threw your neighbor's set out of tune, and he immediately proceeds to reciprocate. Each retuning, however, brings both sets more into resonance with the same station at the same time, and finally both of you can listen to the operatic performance, provided the tuning has not taken so much time that the station had changed its program to a talk on sourkraut or something equally delectable.

But this case is really a very simple one. There are only two playing the game of "take it and keep it if you can." In a congested district there may be a 100 fans playing the same game at the same time.

Up She Goes, and Down

Up and down goes the volume in your loud speaker without the slightest touch on the tuning and volume controls. In and out go the signals in an equally magic manner. Ninety-nine radio fans are trying to take the signal away from you and each one is trying to take the prize to himself.

In view of this keen competition, is it any wonder that sometimes you have trouble tuning in a given popular station, and that, having captured it, you have still greater difficulty keeping it?

What is the cause of this difficulty? Coupling between the antennas. Place any two circuits close together and tune one of them to a given frequency while the other is off tune as far as possible, or entirely open. The capacity required will have a certain value. Then tune the second circuit also.

When that is in tune the first will be found to be out of tune, and to bring it back a different capacity is required. Having retuned the first the second time, it will be found that the second circuit is out of tune and that a different adjustment is required in that.

Two As One

But each retuning brings the two closer together. Antennas are often nothing but tuned circuits, and two antennas on the same roof, or two antennas in the same building but one above the other, are closely coupled.

This trouble is especially annoying when the antennas are tuned. When the antenna circuit is aperiodic other antennas will not have much effect on it. And if these also are aperiodic there is not much trouble for anybody. But in congested districts the trouble is severe enough.

How to Read Voltage of Grid Battery and Really Get Results

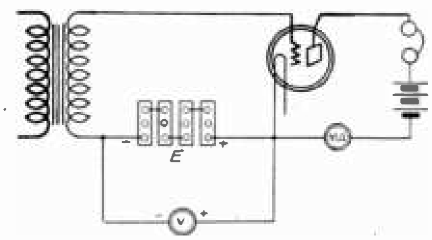


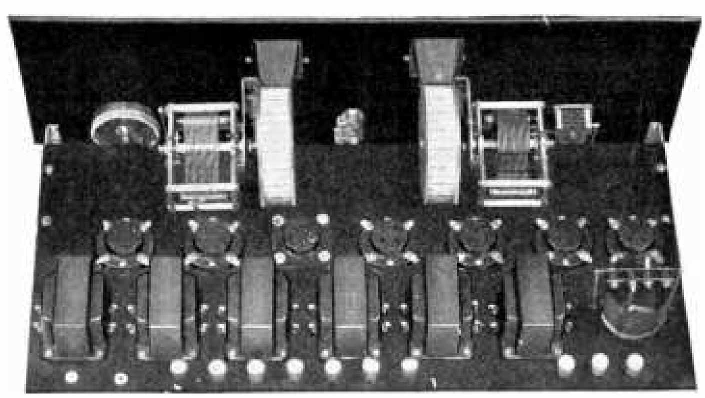
FIG. 1

A CIRCUIT DIAGRAM ILLUSTRATING HOW THE CONDITION OF A GRID BATTERY CAN BE DETERMINED. THE PLATE MILLIAMMETER SHOWS A GREAT CHANGE IN THE CURRENT WHEN THE VOLTMETER IS CONNECTED ACROSS THE GRID BATTERY.

In Fig. 1 is given a simple circuit, which may be the last stage in a receiver, illustrating how erroneous grid voltage may be obtained and how the errors can be detected. Suppose V is a voltmeter which takes considerable current to operate, and further suppose that it is connected across the grid battery E to measure its voltage. If the four units are fresh the meter will give the correct voltage for practical purposes.

If the battery is not in good condition through the exhaustion of one or more cells, the reading on the meter will not be the true value of the bias when the meter is not connected across the battery.

THOMPSON'S SUPER SEVEN



REAR VIEW OF THE THOMPSON SUPER SEVEN, DESCRIBED IN THE NOVEMBER 5 ISSUE. A 10-OHM RHEOSTAT, IT HAS BEEN FOUND, WORKS BETTER THAN A 30-OHM ONE IN SERIES WITH TWO OF THE INTERMEDIATE TUBES AND THE SECOND DETECTOR.

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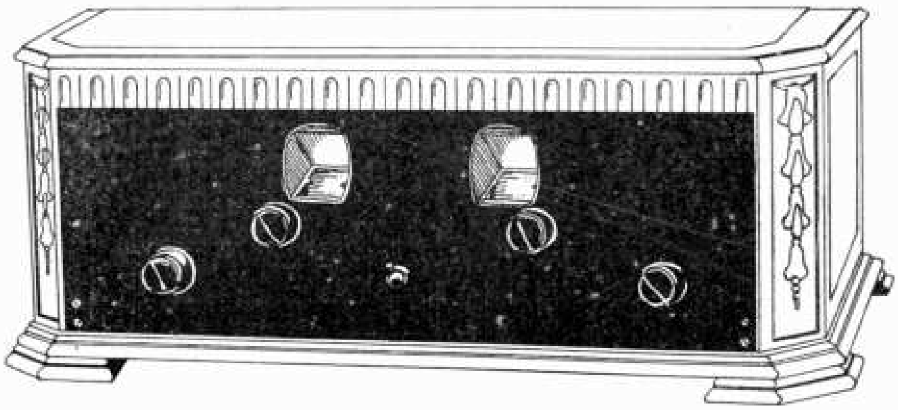
Simplicity Is a Need In a Super-Heterodyne



THE THOMPSON 7-TUBE SET, OF WHICH THE FRONT PANEL IS SHOWN, WAS DESCRIBED IN THE NOVEMBER 5, ISSUE.

Simplicity of control is one of the points on which a Super-Heterodyne is judged. On this point the Thompson Super Seven scores almost 100%. This means that the number of essential controls have been reduced to the lowest possible number. There are two condensers for tuning. No well-appointed Super-Heterodyne can get along with fewer. There is one knob for the regeneration control. Surely that is desirable when it aids the elimination of image interference and when it greatly increases the sensitivity of the circuit. Then there is another knob for the real volume control, the rheostat which controls the filament current in the IF tubes. That is a most effective control and the operator can manipulate it at will without any danger of ruining the quality of the output. The reason is that the tubes are still working with a radio frequency.

The filament switch completes the controls on the panel, and those on the panel are all the controls.

Overload Consideration

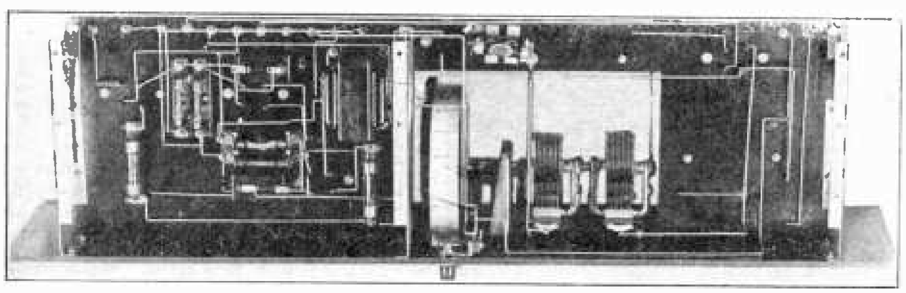
The one thing which prevents a 100% score is that there is no adequate means of preventing the modulator tube from overloading on the very strongest signals. But this does not count much because there will rarely be a station so strong that it will cause overloading when the grid bias method of modulation is employed.

This grid bias leads us to that point. The negative bias used on the modulator is 4½ volts. For the tube used as modulator and the plate voltage, this is just right. The plate voltage on the oscillator is also 45 volts and the bias is zero. That is permissible in an oscillator.

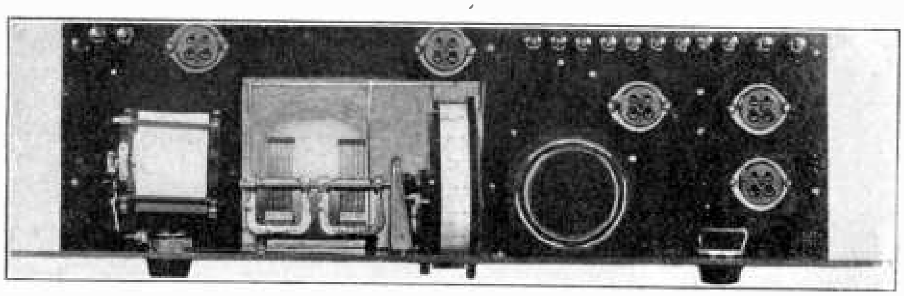
The grid bias on the intermediate frequency amplifier tubes is also 4½ volts, which is just right for the recommended plate voltage of 90 volts when the tubes are used as amplifiers. Pay particular attention to the use of grid bias on the IF tubes. The performance of the set is closely bound up with it.

The bias on the grid of the first audio tube is also 4½ volts and the reason is that the plate voltage is 90 volts. On the last tube the grid and plate voltages should be —40½ and 180 for the tube suggested.

BUS BAR WIRING POPULAR



BUS BAR IS STILL VERY POPULAR WITH THE FANS DUE TO THE ATTRACTIVENESS IT LENDS TO THE SET.



BY PLACING THE COILS AS FAR AWAY FROM EACH OTHER AS POSSIBLE AND AT RIGHT ANGLES FEEDBACK IS REDUCED TO A MINIMUM.

THEY SAY

CAPT. PETER P. ECKERSLEY, chief engineer, British Broadcasting Co.—"Since I was in America last, three years ago, there have been a lot of changes, and I am particularly struck with the way in which broadcasting has developed along commercial lines. The formation of the National Broadcasting Company interests us in England enormously, because we feel that by having a central organization which has some definite public service policy behind it, will mean a real development of radio along the lines of public service. I have been deeply impressed with the way in which sponsored programs can be put over with a minimum of insistence upon their commercial aspect and great concentration upon their artistic value. From conversations with intelligent observers, it would seem that the purely advertising stations will in time be forced out by the chain development, with large resources and a public service viewpoint behind them. This makes the situation in England approximate that in America, the only fundamental difference being that the programs are supplied on the one hand through the initiative of private enterprise; on the other hand by the initiative of a single corporation.

INTERESTING QUERY

ON PAGE 17 of the October 17 issue of RADIO WORLD, there appeared a circuit diagram of a two tube regenerative receiver. I would like to build this set, but since no data appeared with it, I cannot do anything.

WALLACE GEORGE, San Francisco, Calif.

(1) How many turns does L1, L2 and L3 consist of, with what kind of wire are they wound and on what type and size of tubing?

(2) What are the capacities of C1, C2 and C3?

(3) Using 201A tubes, can 1A amperites be used for A1 and A2?

(4) Can a Sangamo type A transformer be used in the audio frequency portion of the circuit?

(5) Does the break in the plus lead indicate a filament switch?

(6) Can a three megohm grid leak be used for R1?—LEONARD LEWIS, Atlantic City, New Jersey.

(1) L1 and L2 are wound on a three inch diameter tubing. No. 22 double cotton covered wire is used. L1 consists of ten turns. Then one quarter inch is left. Forty turns are put on. Another one quarter inch is left and ten more turns are wound. Both these windings constitute L2. Across the ten turn winding, the variable condenser C2 is shunted. L3 is wound on a one and three quarter inch diameter tubing, using No. 26 single silk covered wire. It consist of thirty-six turns.

(2) C1 is a .0001 mfd. condenser. C2 is a .0005 mfd. variable condenser. C3 is a .0005 mfd. fixed condenser.

(3, 4, 5 and 6) Yes.

AMERICAN LEGION FROM WIP

The presentation by radio of announcements and programs of the American Legion, Department of Pennsylvania, has assumed such an important part in the life of Pennsylvania legionaries that the Philadelphia County Committee has designated WIP, the Gimbel Brothers station in Philadelphia, as the official American Legion station.

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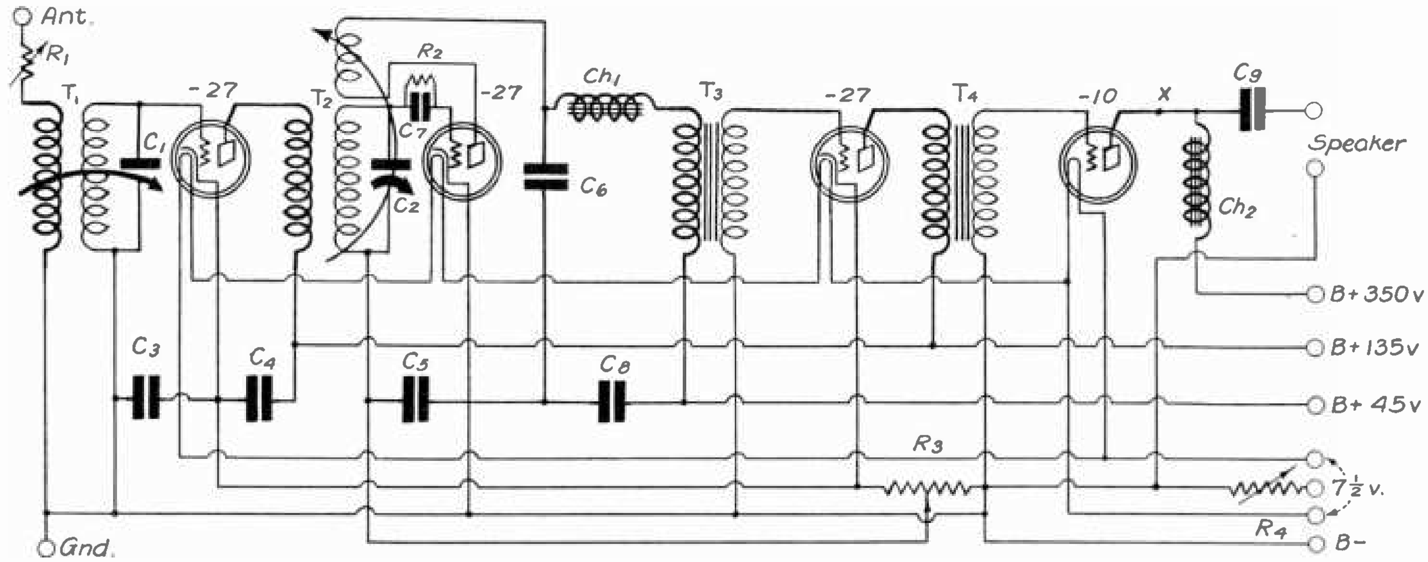
An Outstanding Design

By the Laboratory Staff



A TESTED AND BRAND-NEW AC CIRCUIT, FASHIONED AFTER THE DC MODEL KNICKERBOCKER FOUR. IT MAY BE ADVISABLE TO BY-PASS BOTH OF THE BIASING RESISTORS, R3 AND R4. THE SLIDER OF A POTENTIOMETER, NOT SHOWN, IS TO BE PREFERRED TO THE MIDTAP OF THE FILAMENT SECONDARY WINDING. THE WHOLE SET MAY BE TURNED ON AND OFF BY USING A 110-VOLT SWITCH THROUGH ON THE FRONT PANEL AND INTRODUCING ONE SIDE OF THE LINE THROUGH THIS SWITCH.

FOR easy, trouble-free operation of a receiver from the AC lighting mains, it is a good plan to use heater type tubes, series connected. In a 4-tube receiver, for instance, three such tubes would be heated from a step-down transformer with 7½-volt secondary. The last tube would be a 210 or 310, also heated from the same step-down transformer.

Suppose three heaters, e. g., CeCo N27, be connected in series. The total voltage required would be 7.5 volts. This is the same as that required for heating the filament of a—10 power tube. Many transformers have been developed for the power tube, and therefore one of these can be used to heat the filaments in the three heaters when they are connected in series, without overtaxing the step-down transformer in the least. These transformers are inexpensive.

For a high quality receiver it is essential that a power tube be used in the last stage. Now since a 7.5 volt transformer is used to heat the —27 tubes it is only logical to use a —10 tube in the last stage, since this can be heated from the same transformer. The filament of the —10 tube is connected in parallel with the —27 heater series and all connected across the output of the heating transformer.

The current required to heat the cathode in a —27 is 1.75 amperes. Since the three tubes are connected in series all of them require no more current than one. The current required to heat the filament of the —10 is 1.25 amperes. Therefore, the total current drawn from the heating transformer is 3 amperes. The secondary of the transformer must therefore be designed to carry at least 3 amperes, and its secondary voltage must be 7.5 volts.

The step-down transformer may be center tapped, so that the grid return of the last tube can be made to the tap. Stock transformers are usually tapped at the midpoint of the 7.5 volt secondary. It is better, however, to put a potentiometer across the secondary and connect the grid return of the last tube to the slider.

Note the order in which the three heaters have been connected in series. The heater of the detector tube is in the middle, with the heater of one amplifier on each side. The midpoint of the heater of the detector tube is therefore at zero potential, or at the same potential as the midpoint of the heating transformer. The mean potential of the detector heater is therefore zero with respect to ground, a desirable condition in a tube so sensitive to unbalance as the detector.

A Good Volume Control

In every well-appointed receiver there should be adequate volume control. Tampering with the filament circuit for this purpose is one of the seven deadly sins in radio. Fortunately this cannot be committed in an AC receiver with any chance of immunity from disturbances. Another control has to be found.

It is always practical to use a high resistance potentiometer in the grid circuit of the first audio transformer. This can be used, if desired, but in this particular circuit a simpler and equally effective method has been used. A high variable resistor R1 has been put in the antenna lead. The maximum value of this resistor may be 10,000 ohms. The minimum should in every case be zero so that the maximum signal strength can be obtained on weak stations.

Let us now review the grid bias situation as it applies to this circuit While individual grid batteries are highly desirable in a receiver, few persons will tolerate them in an electric set The grid bias must be obtained in some other manner if it is to be used at all. The designers of this circuit bow to the almost universal clamor. Grid bias is obtained from voltage drops in the plate voltage supply.

Grid Bias Arrangement

In arranging for grid bias we have the choice of using individual resistors for each tube or to lump them and use the plate current from all the tubes. In this circuit we have compromised, using one resistor for the power tube and another for the heater tubes.

For bias on the power tube the voltage drop in resistor R4 is used. Only the plate current of the power tube flows through this resistor and therefore its value must be chosen with that in view. With a plate voltage of 350 volts and a grid bias of 27 volts, the plate current is 18 milliamperes. The required resistance is therefore 1,500 ohms, which is furnished by a 2,000 ohm variable resistor.

The plate voltage on the two heater type amplifiers is 135 volts. The necessary grid bias is 9 volts, and the plate current will be 5 milliamperes in each tube. The total current is therefore 10 milliamperes. The required value of resistance is then 900 ohms. Thus R3, which supplies the grid bias to the two heater type amplifiers, may be a 2,000 ohm variable resistor.

But it is also desirable to have a positive grid bias of 4.5 volts on the detector. This is also obtainable from the same resistor.

Value of Independence

The independence of the heater and the cathode makes it possible to use the same voltage drop to give one grid a negative bias and another grid a positive bias. It is only necessary to invert the cathode and the grid return, as has been done in the circuit diagram. But only half of the 9 volt drop is used on the detector. Hence the grid return is connected to the midpoint on the used portion of R3. Since it is desirable to have the bias on both the amplifiers and the detector variable for adjusting the circuit to maximum sensitivity, it would be well to make R3 a double slider potentiometer having a maximum resistance of 1,000 ohms. It would be used as a rheostat for the higher grid bias and as a potentiometer for the lower, or detector bias. This works out exceptionally well in practice.

The receiver was assembled out of Karas parts, on the order of the Knickerbocker Four. The primary or antenna coil is mounted on the shaft of the first condenser. Hence the coupling between the antenna coil and the secondary of T1 is varied automatically so that the energy transfer remains constant no matter to

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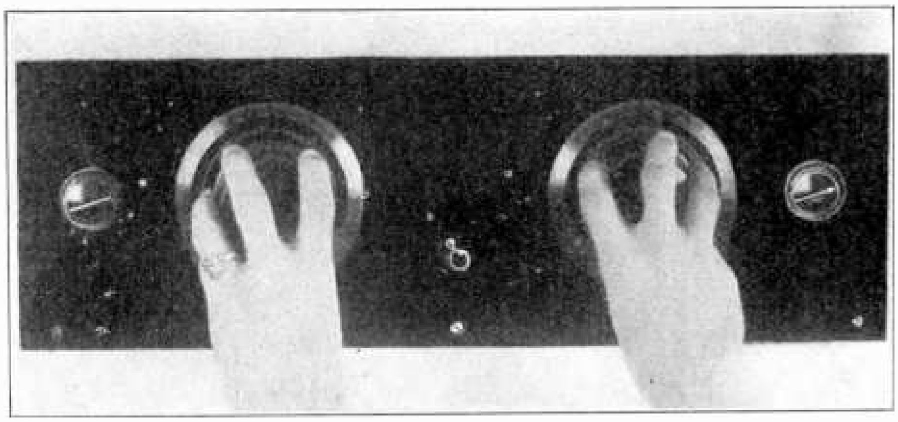
for an AC Set

LIST OF PARTS

C1, C2—Two Karas Orthometric .00037 mfd. condensers
T1—One Karas antenna coupler to match C1
T2—One Karas three circuit coil to match C2
T3, T4—Two Karas Harmonik audio transformers
SpSp—Two Amsco pinjacks
Chl—One Samson 85 millihenry choke coil
C3, 4, 5—Three .001 mfd. condensers
C6—One .0005 mfd. condenser
C8—One Tobe 1 to 4 mfd. by-pass condenser
C7—One Sangamo .00025 mfd. condenser with resistor clips
C9—One Tobe 4 mfd. condenser
R1—One 10,000 ohm Electrad Royalty (type G)
R2—One Amsco 3 megohm grid leak
R3—One 2,000 ohm Centralab two slider potentiometer
R4—One 2,000 ohm variable Electrad Royalty resistor (type F)
One Carter Imp power switch.
Two Karas Micrometric dials
One 7x18x3 16 inch Micarta panel
One wooden baseboard, 9¾x17¼x¼ inch
One Mucher binding post strip containing 7 Fahnestock clips
Three Benjamin five-prong sockets
One four-prong Benjamin socket.
Three Karas subpanel brackets
One Thordarson Heating transformer (7.5 volt, 2 ampere secondary winding)
Three CeCo type N27
One CX-310 power tube



TWO HANDS BRING IN DX EASILY.

what frequency the circuit is tuned. Uniformity of response and freedom from oscillation result from this coupling.

Value of By-Passing

The coupling between the primary of T2 and the secondary of that RF transformer is not varied automatically, but it is adjustable. It can be set so that the first tube is in a regenerative condition but so that it does not oscillate freely.

The automatic variable feature is introduced between the tickler coil and the secondary. That is, the tickler is put on the shaft of the second variable condenser C2. It is adjusted to such an angle that the detector tube is near the oscillating point for all frequencies in the tuning range, yet far enough away from the point to make the circuit stable.

Profuse by-passing is a virtue when the condensers are not put across the line but only across power supply. Therefore, condensers C3 and C4 are used in connection with the first tube. One side of each of these condensers is connected to the cathode. The other side of C3 is connected to the low side of the first tuning condenser. This by-passes the leads and R3. The other side of C4 is connected to the low side of the primary of T2, thus by-passing the plate voltage supply and the leads to it. Each of C3 and C4 should be .001 or more.

Capacities to Use

A by-pass condenser C5, which should be .001 mfd. or more, is connected from the cathode of the detector to the low side of the tuning condenser C2. It by-passes the leads to the grid bias resistor R3 as well as a portion of that resistor.

Condenser C6 is also a by-pass condenser and is used to facilitate detection and regeneration. This is across the line and therefore it should be no longer than absolutely necessary. A value of about .0005 mfd. is about right. It should never be greater than .001 mfd.

Condenser C8 is connected between the cathode of the detector and the low side of the primary of the first audio frequency transformer. Its value should be as large as possible since its purpose is to by-pass audio frequency currents across the 45 volt section of the plate voltage supply. It is of little advantage to use less than 1 mfd. and it should preferably be 4 mfd. or more.

Just as condensers were used in the radio frequency amplifier to by-pass the radio frequency currents, so may condensers be used in the audio frequency amplifier. These are not shown in the diagram. If used, they should be 1 mfd. or higher in value. If C3 and C4 are made 4 mfd. and put as close to the first tube as possible, they will serve the double purpose of by-passing the radio frequency currents in the first tube and the audio frequency currents in the third tube.

The Output

The grid condenser C7 should have the usual value of .00025 mfd. The grid leak R2 across it should have a resistance of about 3 megohm.

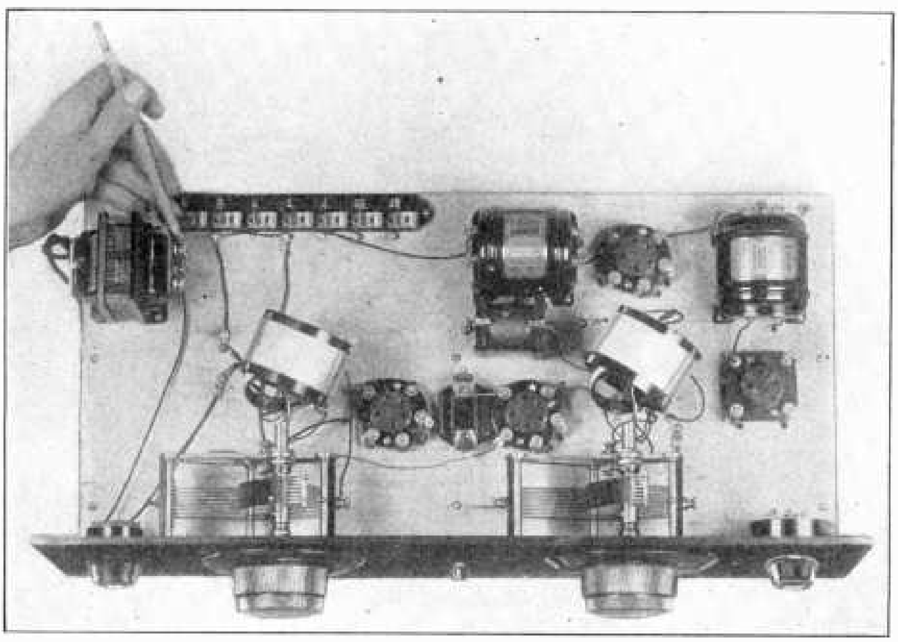
The diagram indicates that the loud speaker is connected to the last tube through a choke coil Ch2 and a stopping condenser C9. This is not built into the receiver as it was constructed in the laboratory, but may be external to the set. A Karas output transformer may well be used for this purpose. An extra binding post is provided at X and another at plus 350 for connecting either the type of output filter shown, or an output transformer. When the choke and condenser method is used the choke should have an inductance of 100 henrys or more and the condenser should not be smaller than 4 microfarads.

The choke coil Chl put in the plate circuit of the detector tube has an inductance of 85 millihenrys. Its purpose is to prevent the passage of radio frequency currents in the audio frequency amplifier. Since this choke is in series with the line its value should not be greater than that specified. Somewhat lower values may be used if desired.

The Front Panel

The panel arrangement is one of extreme simplicity. There are only two dials for tuning and one knob for controlling volume. This is shown in Fig. 2. The subpanel layout can be seen from Fig. 3. There are two condensers with the tuning coils behind them.

At the left rear is the Mucher binding post strip. Between the two condensers and coils are the RF amplifier and the detector. The power tube is at the right of the second tuned circuit. The output pinjacks are in the rear right corner back of the second Karas audio transformer.



THE HEATING TRANSFORMER EVEN MAY BE NEAR THE AERIAL POST.

[Full exposition of operating methods and tuning data next week, November 26 issue]

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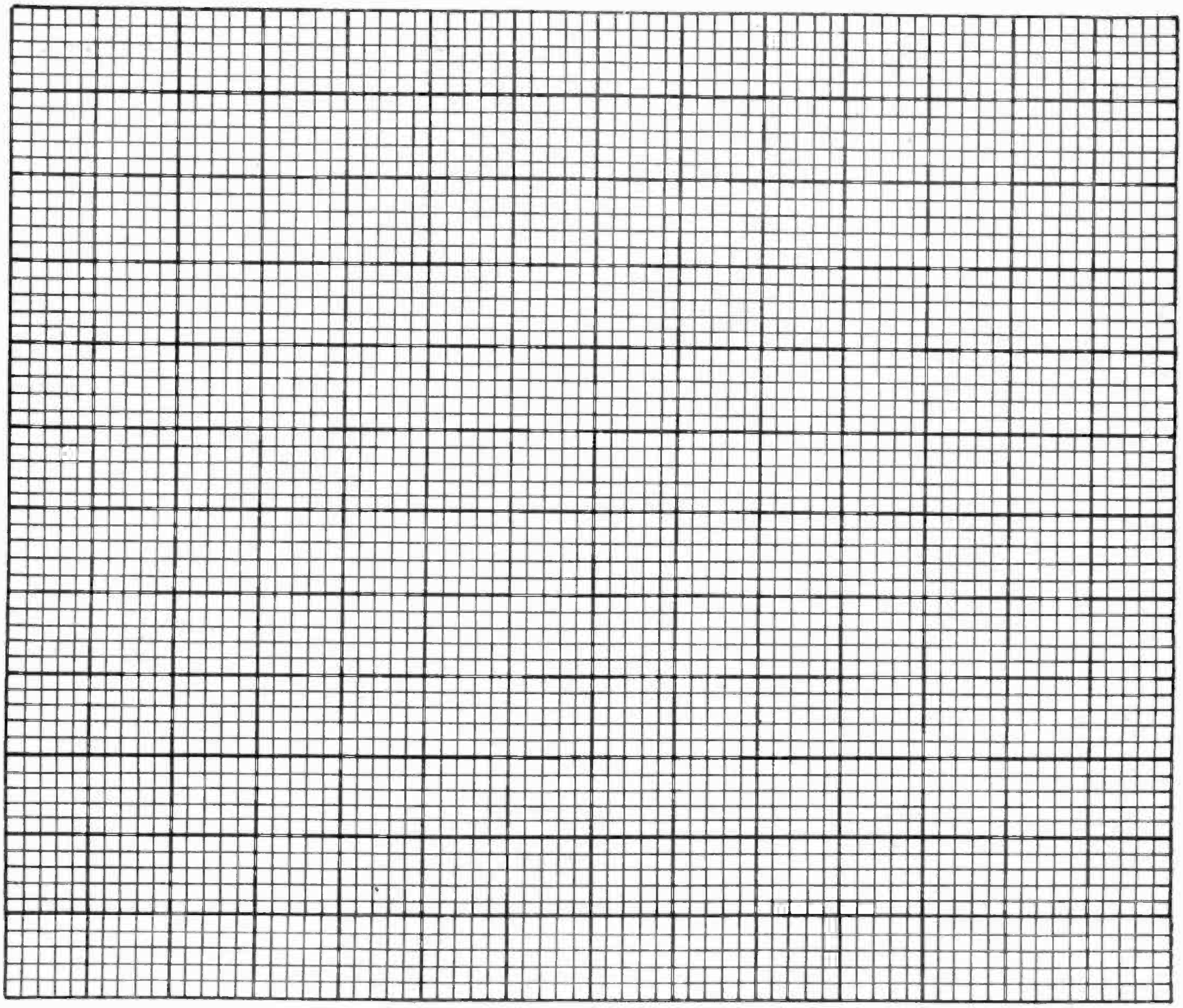
The Incalculable Value



CROSS-SECTION PAPER SERVES INVALUABLE PURPOSES. IT EVEN HELPS YOU TO TUNE IN DX

By Leonardo del Rio

MANY radio experimenters who can use meters with greatest facility are hesitant about cross-section paper. They do not like to transcribe their laboratory findings on such paper if such procedure results in a curve. They are suspicious of curves. But it is practically useless to conduct laboratory experiments unless the data obtained are committed to cross-section paper for interpretation. The results of a long series of experiments can be put on paper in the form of a curve which will show at a glance more about the work than pages of tabular data. In fact, very little is known about the results of the experiments until the data have been expressed in curvelinear form.

The City Plan System

There is nothing complicated about using cross-section paper or about drawing curves. The paper is laid off in equal blocks and numbered just like streets in a well-laid-out city. Any point on the cross sectioned paper can be located by stating how many blocks to the right it is and how many blocks up, or by stating how many blocks it is to the left and south of an arbitrary starting point.

In a city any point, as a house, is located by stating how many blocks it is to the north and to the west, for example, from an arbitrary starting point, usually an important street intersection. The number of the house merely tells the fractional part of a block in one direction.

We can use the city plan for illustrating the plotting of curves. Suppose an airplane flies over the city and the police are interested in knowing what path the plane took.

Policemen on the beat telephone in to headquarters the points above which the plane flew by giving the number of the street in one direction and the number of the avenue in the other. Every report is put on the map in the chief's office.

When all the reports are in the chief draws a smooth pencil line on the map through all the points reported. The curved line thus resulting is the path the plane took over the city, assuming that enough reports were received to include any irregularities in the flight. The plane itself could have drawn the same path over the city itself by letting a stream of sand trickle out.

The Curve Predominates

But the chief's method is that employed mostly in radio research. Isolated observations are taken at suitably selected points and the results are plotted on the "map" or on the cross-section paper. When all the points in that series have been taken and recorded a smooth pencil line is drawn through the points. The result is the "path taken by a moving point" or it is the locus of the moving point. In radio it is more frequently called the characteristic curve of something or other in a selected region. The path of the airplane can also be called the characteristic curve of the airplane flight in the region of the city.

The blocks on the cross-section may represent anything we like. Along the horizontal the distances, or the number of blocks, are called abscissas. They nearly always represent the "independent variable," that is, the thing we vary at will or just as we please. Along the vertical the distances, or the number of

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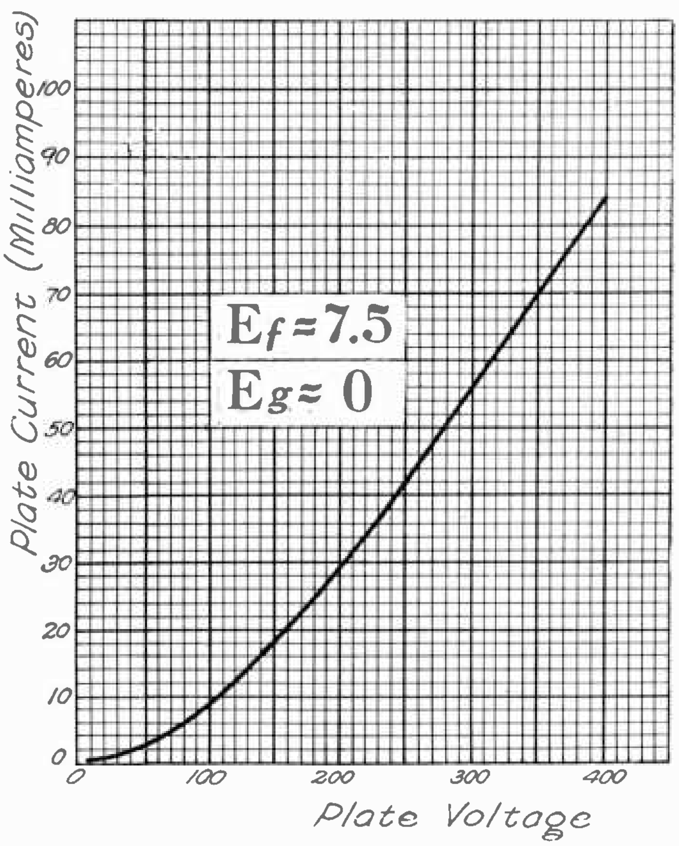
# of Cross-Section Paper

Its Use Enables You to Tune in DX You Might Otherwise Miss, and Even to Use a Vacuum Tube as the Accurate Alternative of a High Resistance Voltmeter.



A CURVE showing the relation between the plate current and plate voltage is a 310 power tube when the grid voltage is zero and the filament voltage is 7.5 volts. When the tube is used as a vacuum tube voltmeter the curve is the calibration curve of the instrument.

blocks, are ordinates. They represent the dependent variable, the values of which depend on the conditions of the problem and on the value of the independent variable. They are the values we are looking for, the unknown before the experiment.

Ip Eg Curve

Suppose we want to find out how the plate current varies with the grid voltage when the plate and filament voltage are held constant at selected values. The plate current is unknown and depends on the grid voltage. Hence it is plotted along the vertical or ordinates. The grid voltage we can choose at will. Hence this is the independent variable and we plot it along the horizontal..

In the experiment we put a milliammeter in the plate circuit and a voltmeter across the grid battery. Some means of varying the grid voltage to any desired value is also included in the circuit. The cross-section paper which is to hold the result is scaled in milliamperes along the vertical and in volts along the horizontal.

For the first observation the grid bias may be adjusted to exactly minus 10 volts. The reading on the plate meter will be low, say 1 milliampere. That gives us the first point, or the first report. The point is 10 volts to the left of zero line and 1 milliampere up. Then the grid bias is changed to minus 9 and the current in the plate circuit is read. It may be 2 milliamperes this time. The second point then is 9 points to the left and 2 up. The bias is successively changed by one volt until it is a few volts positive. The last reading may give the point 4 volts to the right and 50 points up.

Odds and Evens

While the grid bias may always be adjusted to exact integral volts, the current will not often come out even. For example, at minus 1 volt the plate current might be 18.41 milliamperes. When the dependent variable comes out in that manner, which it will nearly every time, the exact location is found as close as possible by estimating the fraction of a block. For example, 18.41 would be located very nearly half way between 18 and 19.

It may be that we wish to study the quality of an amplifier. The dependent variable in this case is the amplification and the independent is the frequency. We can measure the amplification at any frequency we wish, but we cannot make the amplification at that frequency anything but what it is.

Hence we plot the amplification along the vertical and frequency along the horizontal. This procedure gives the characteristic curve of the amplifying system, plotted on a frequency scale.

Everybody knows that such a curve looks like. It has been given thousands of times. In laying out the scale the vertical blocks represent the number of times the system has increased the amplitude and the horizontal blocks represent frequency.

The Octave Scale

It may be desirable to plot the characteristic of the amplifier on an octave scale. In this case the vertical blocks still represent amplification but the horizontal blocks represent musical intervals, such as octaves, or it represents logarithms of the frequency. There are two general ways of doing this. In one observations are taken at 32, 64, 128 and so on, and all of these are placed at equidistant points on the horizontal scale. For example, if there five blocks between 32 and 64 there are also five blocks between 128 and 64 and between 256 and 128, and so on. In the other method the observations are usually taken at frequencies which are multiples of 10. The first might be taken at 50, the next at 100, the next at 500 and the next at 1,000. Then the points are located along the horizontal according to the logarithm of these frequencies to the base of 10. That is, 50 is put at 1.7; 100 is put at 2; 500 at 2.7, and 1,000 is put at 3, and so on.

Still another case where curve plotting is useful to the radio fan is the calibration of tuners. The two variables in question are frequency of the carrier wave and the reading on the dial. In this case either the dial reading or the frequency can be used as the independent variable. It is a question of which is the more convenient. Let us take the frequency as the independent variable and the dial reading as the dependent.

Procedure Outlined

The procedure follows:

The receiver is tuned to the station operating on the lowest frequency within the range of the receiver. Suppose it is 560 kc. The setting of the condenser dial may be 98. The point is located on the cross section paper at 560 kc to the right of zero frequency and 98 points up. Since the broadcast range is from 550 to 1,500 kc the horizontal part of the paper is scaled only between these limits. That is, zero frequency is not represented but the start is made at 550 and the end is made at 1,550 kc, or a little higher in case it is desired to plot the locations of short wave stations.

Having located the 560 kc station on the dial the next highest receivable station is tuned in and the corresponding dial reading is found. The frequency of this station may be 610 kc and the dial reading 87. Hence the point is 610 kc to the right and 87 points up. This is continued until the condenser plates are fully out.

Not all the channels can be located on the dial by tuning in stations. But a large number of points can be found and they will be well distributed over the scale, and over the cross-section paper.

Facilitates Distance

A smooth curve can be drawn through all the points located, and this curve will be the locus of all the missing stations as well as those observed. Having drawn the curve, the points on the dial where distant stations should come in can be foretold very accurately. If the condenser is set at one of these points and the receiver made as sensitive as it can be, the distant station should be audible if it is on the air at the time. If it does not come in, it simply means that the receiver is not sensitive enough to bring it in.

In drawing the smooth curve through the points located it is sometimes advisable to disregard small deviations from regularity. For example, if it is necessary to put a kink in the line in

(Continued on page 16)

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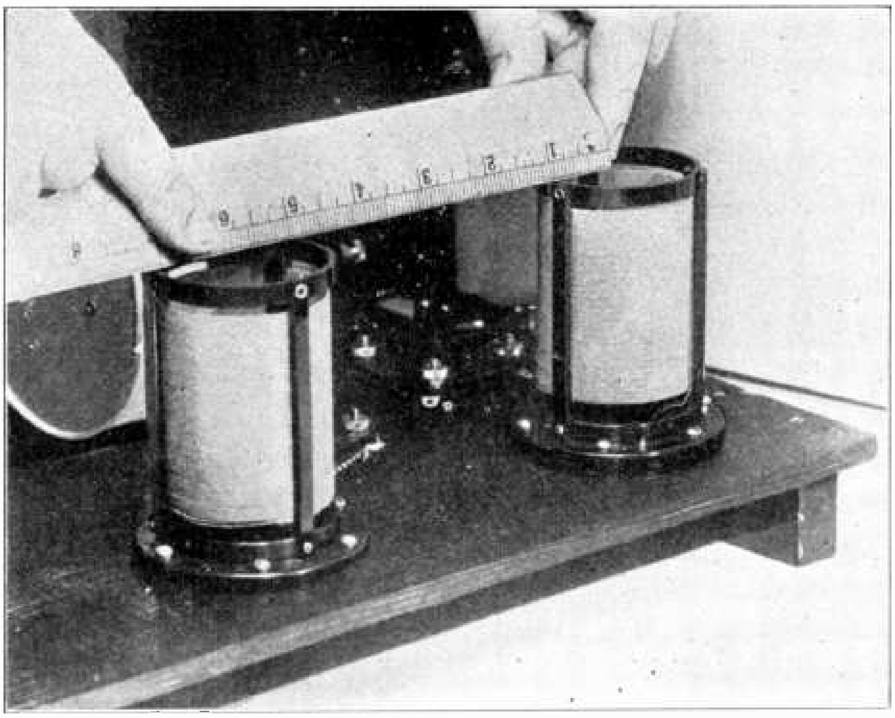
The Cry is for Action

Proper Coil Placement, Capacity Relationship and Shielding Help Stabilize and Standardize Circuit Construction



(Hayden)

FIG. 1
IF SOLENOIDAL COILS ARE PLACED AT LEASE SIX INCHES APART (FROM CENTER TO CENTER) THE INTERACTION BETWEEN TWO ADJACENT COILS CAN BE NEGLECTED. THE PHOTOGRAPH SHOWS THREE AERO UNIVERSAL COILS INSTALLED IN A SUPER-HETERODYNE CIRCUIT

By G. J. M. Bussom

NO two receivers are the same in all particulars. Even two coils made according to the same design will not respond to signals in exactly the same manner.

One of the main sources for irregularity is stray interstage coupling between the various parts of the circuit. Two inductance coils not only have self-inductances but they also have a mutual inductance between them.

Two tuning condensers likewise not only have self-capacity but also mutual capacity. Leads running to and from condensers and coils are really a part of the coils and the condensers and therefore they also have both types of inductance and capacity.

The stray coupling, be it inductive or capacitive, or both, will cause the circuit to behave improperly. It may be too selective at some frequency and not selective enough at other frequencies. It may be exceedingly sensitive at some frequencies while it may be insensitive at other frequencies. The circuit may oscillate over a wide part of the tuning range.

Separation as Remedy

One way of minimizing the coupling between adjacent tuning systems is to separate them. This separation reduces both the mutual capacity and the mutual inductance between the systems. Mutual capacities between two tuning coils or between two condensers or between a coil in one circuit and a condenser in another decreases directly as the distance increases.

The mutual inductance between two coils belonging to two different tuning systems decreases very rapidly as the distance between them increases. Hence in building radio receivers it is of utmost importance to keep the tuned circuits well apart. In an accompanying photograph the tuning coils have been placed 6 inches apart, measuring from center to center, a suitable separation for coils of the size shown, although the particular coil diameter permits closer location. Smaller coils could be placed a little closer and larger coils should be separated still farther.

The same photograph shows a part of the condenser portion of the same circuit. The mutual capacity between the condensers has been greatly reduced by the wide separation, and then has been almost reduced to zero by the shielding effect of the metal portions of the drum dials. This metal is grounded and constitutes a good shield.

Makes All Alike

The elimination of the stray couplings between the various tuned circuits by separating them and by placing shields between them makes all circuits built according to the same plan behave like the laboratory standard or model. Of course, there may be small deviations from standard performance due to unavoidable differences in tubes and other parts. But all such deviations will be so small as to be negligible and usually even imperceptible.

Another important feature is also illustrated in Fig. 2. A vacuum tube with a cap on it is shown. This cap is not a protection against dust and the bright sun. It is a protection against microphonic howls in the set. In what manner does this little cap prevent howls?

The howling often heard in receivers and which is called microphone howl, is due to the mechanical vibration of the elements of a tube. The vibrations are automatically converted into electric vibrations and as such they are amplified.

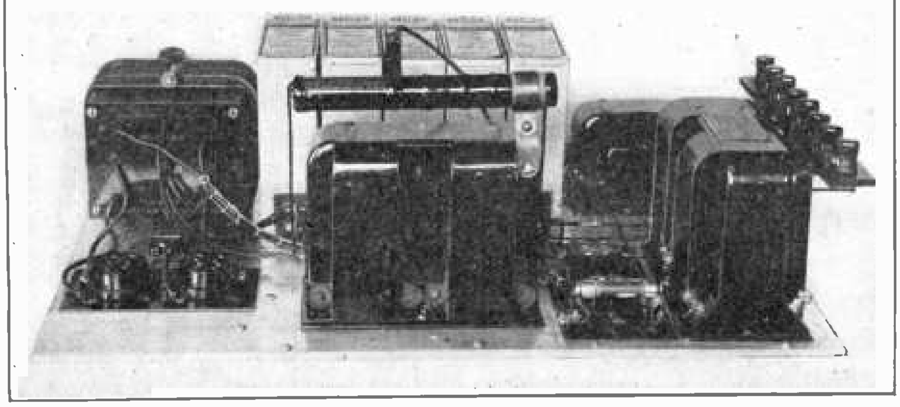
The Horrible Howl

The loudspeaker feeds the vibrations, as sound, back to the sensitive tube, and the sound shakes the tube again. A sustained howl results. A little shock is necessary to start the circuit to oscillate at the natural frequency of the elements of one of the tubes. This shock need not be very great. It may be supplied by a certain frequency in the signal. An instrument, a speaking voice, or a singing voice, may strike the frequency at which the tube is sensitive. It may not hold it more than a fraction of a second, but long enough just the same to start the tube shaking. Then again the starting shock may originate at the receiver. A person talking, singing, or making any kind of noise may start the tube. The tube is so willing to oscillate that the shock required to initiate it is too weak to be heard.

But how does the cap prevent this oscillation we ask again? Well, the tube has a natural frequency of vibration, at which the vibrations will occur. The cap will load the tube so that the natural frequency of vibration will change.

Quick Change

It may change from 1,000 cycles per second down to 100 cycles per second by adding a little weight. At 100 cycles the tube will not be nearly so sensitive to



HIGH REACTANCE BUT LOW DC RESISTANCE CHOKE COILS SHOULD BE USED IN B ELIMINATORS.

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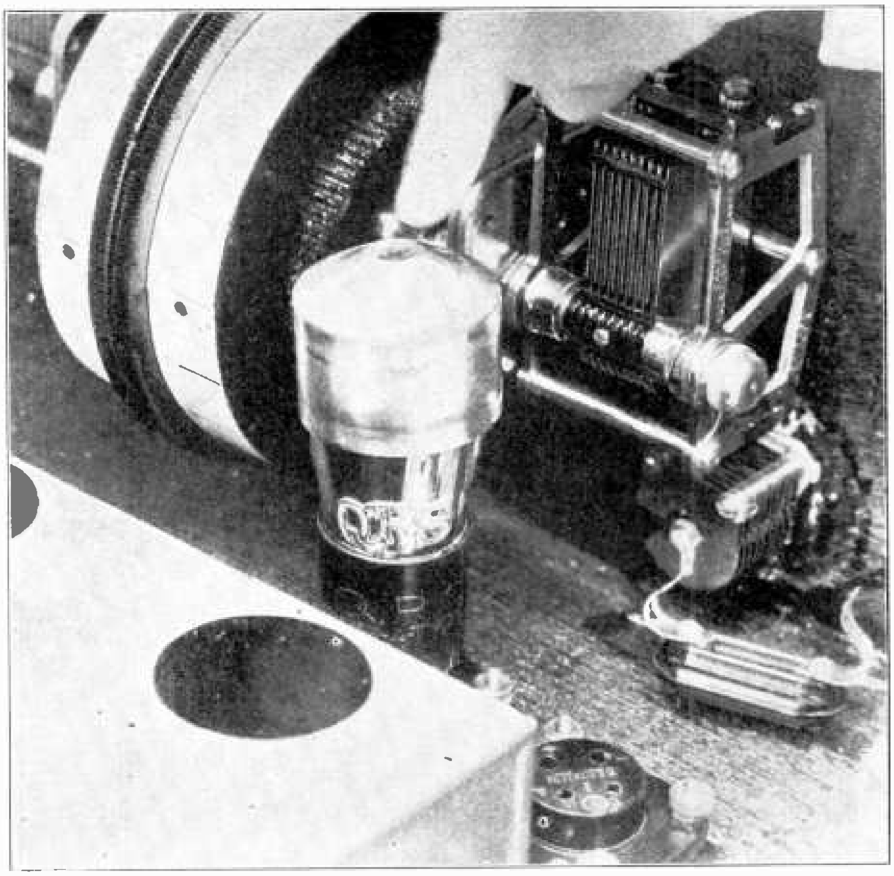
Not Interaction

shock as it is at 1,000 cycles. It may take a shock a thousand times greater to start it vibrating; and what is more important, it may take an amplification in the circuit 1,000 times greater to keep it vibrating. Under those conditions, when the tube is shocked severely a ringing sound is heard, the frequency of which will be that of the new natural frequency of vibration. But the amplification is not enough to sustain the oscillation and the ringing sound dies out after a second, or even less. If the cap is heavy enough the natural frequency of vibration of the tube and the cap is so low as to be below the limit of audibility, and whenever the tube is shocked the vibration will stop instantly. Use of proper tube (indicated by finger) dispenses with the need of a cap.

Microphonism of tubes and detrimental interaction between radio frequency stages are not the only difficulties in a receiver. Interaction between the audio stages is plentiful, and often it is this which determines just how bad and impossible the receiver is. Two general effects may be mentioned. One is the effective capacity of the input circuit of an amplifier; the other is the feedback through the batteries or their substitutes.

It is well known that there is a small capacity between the grid and the plate of an amplifier tube and that this capacity causes oscillation in tuned radio frequency amplifiers unless special precautions have been taken to nullify the effect of the capacity.

It is generally held that this capacity can be disregarded in audio frequency amplifiers And it can when the amplifier operates at one frequency only or when the fidelity of the output of the amplifier is of little importance.



(Hayden)

FIG. 2

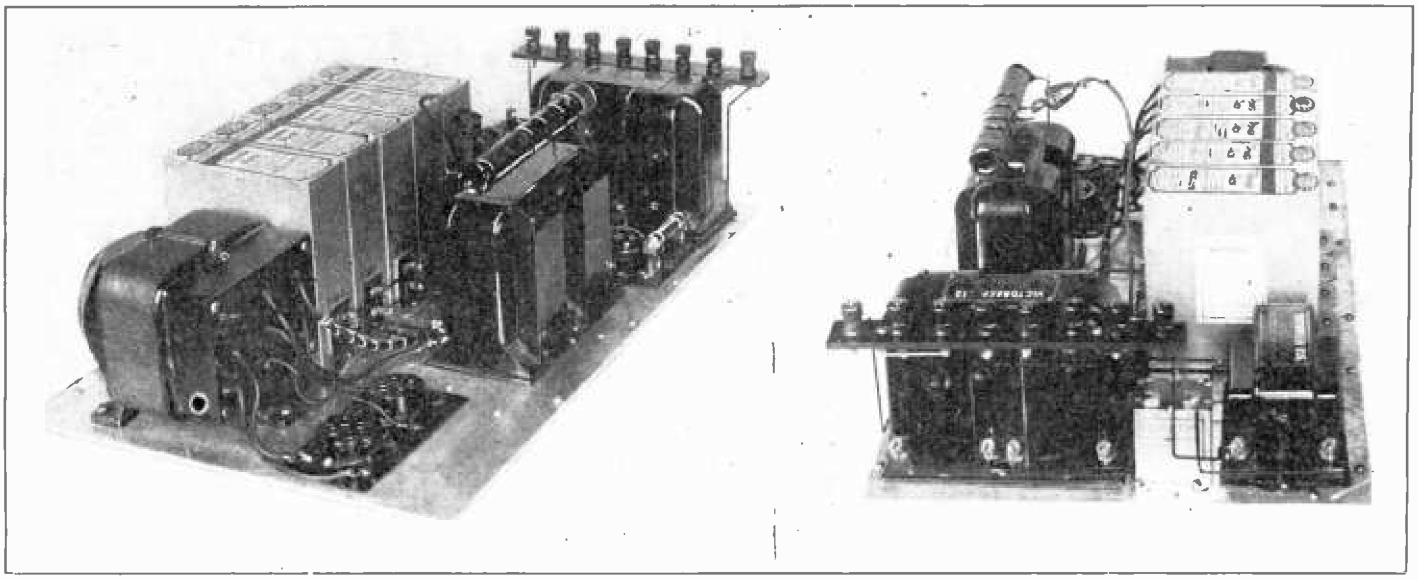
AN ANTI-MICROPHONE CAP IS UNNECESSARY IF ONE USES THE PROPER TUBE. HENCE FAN IS ABOUT TO REMOVE CAP.

When It's Important

In the high quality receivers demanded in broadcast reception the minute capacity between the plate and the grid of a tube becomes of importance. It is directly responsible for the behavior of the amplifier at the upper audio frequencies. It would have been more logical to say, for the misbehavior for that is usually what it is. The small capacity causes a distortion of signal out of all proportion to its value.

The impedance of the load on the tube is reflected into the grid circuit through the grid to plate capacity. If the plate load is a pure resistance of high value the effective capacity of the grid circuit is very great, and the higher the plate load resistance the higher is the effective capacity. This high effective capacity amounts to a partial short circuit at the high audio frequencies, and causes a drop in the input signal voltage. Thus the high notes are not amplified as much as they should, due to the capacity between the grid and the plate elements of the tube.

The interaction between the different stages in the audio amplifier through the batteries or substitutes may be very great. It exists at all frequencies but is easily avoided at radio frequencies by the use of by-pass condensers. At low frequencies the interaction is great and it is not easily removed. It may cause wave form distortion, amplitude distortion, and sometimes oscillation. Motorboating is an example.



THE FIVE TOBE CONDENSERS IN A ROW ARE OF HIGH CAPACITY AND WITHSTAND 1,000 VOLTS, TWO IMPORTANT REQUIREMENTS. THE COUPLING THROUGH THE AUDIO CHANNEL (FOREGROUND) MAY BE CONSIDERABLE IN A POWER PACK.

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Practical Application of Tube as Voltmeter

(*Concluded from page* 13)

order to include an observed point, it may be better to let the point remain on one side of the line. The station in question may be off its frequency a little, or the observation may be in error. If a recheck of the point is made from time to time and averaged, the results will show whether the line should actually go through the point or whether it should pass it by. In determining this question it is also advisable to take other points near the questionable point to find the trend in the curve in the region.

The Ip Ep Curve

As a concrete example of curve plotting let us take the relation between the plate current and the plate voltage in a CX-310 power tube. The filament voltage is held constant at 7.5 volts and the grid bias is held at zero. A milliammeter having a range of 0-100 is put in the plate circuit in series with the plate battery, which is variable is suitable steps between zero and 400 volts.

The plate voltage is the independent variable because we can choose its value at will. Hence this is plotted along the horizontal on the curve. The plate current is the dependent variable since it depends on the value of the plate voltage and the conditions of the tube. Hence the plate current is plotted along the vertical.

The cross section is scaled to include all plate voltage up to 400 volts. The plate current will not exceed 100 milliamperes and therefore the vertical distances are scaled from zero to 100 milliamperes.

Committed to Paper

Suppose the first observation is made with a plate voltage of 50 volts. The corresponding plate current is found to be 2.2 milliamperes. A point is therefore made 2.2 milliamperes up on the 50 volt line on the cross section paper.

The next observation is made with a plate voltage of 100 volts. The plate milliammeter indicates a current of 8.5 milliamperes. The point is put on the 100 volt line 8.5 ma up on the cross section paper. Next an observation is made with a plate voltage of 150 volts. The result is a current of 18.5 milliamperes. The observations are continued every 50 volts until the maximum of 400 volts is reached, and all the points located on the cross section paper.

Having located all the points as accurately as possible, draw freehand a light pencil line through all the points. There should not be any sudden bends or kinks in the line drawn. They would either indicate an error in the observations or lack of constancy in the conditions of the experiment.

An Unexpected Bend

When a point is off a smooth curve running through the majority of the lines, take an other observation at that voltage and reheck on the constancy of the filament and grid potentials. If the point persists in staying on one side of the curve take other observations 25 volts on each side of the questionable point. If these also are off the curve, the bend in the curve is genuine, and the curve should be redrawn to include the points.

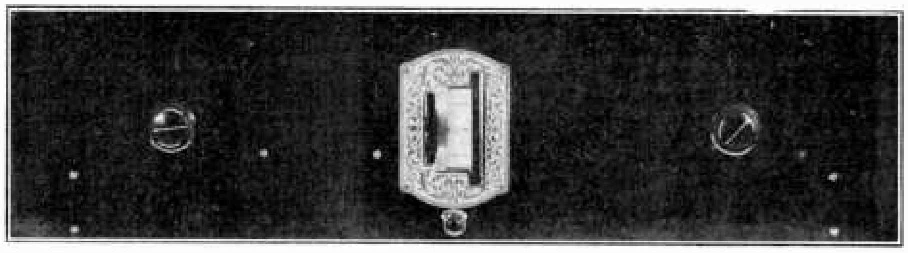
Sometimes it is not easy to determine whether a point is off the smooth curve or not, particularly when the observed points are far apart. A very simple way of judging whether a point is on or to one side of the proper curve is to sight along it. Irregularities show up just as prominently in a curved line as in a straight line, and everybody knows how to tell whether there are any kinks in a supposedly straight line.

When the relation between the plate voltage and the plate current has been plotted as described above the tube can be used as a voltmeter of high resistance. The milliammeter in the plate circuit serves as indicator and the curve gives the calibration.

For example, suppose we wish to know the voltage across the output of a B battery eliminator in which the regulation is so good that the current taken by the tube voltmeter can be neglected. Apply the unknown voltage to the calibrated tube when the grid bias is zero and the filament current is 7.5 volts. The plate current as indicated by the milliammeter will have a certain value.

Suppose that it is 50 milliamperes. On the calibration curve we go up along the left hand scale to 50 milliamperes and then follow the 50 ma horizontal line where it crosses the curve. Dropping down to the horizontal scale we note that the intersection is at 315 volts, which is the voltage sought.

Up or Down, Left, Right, Options in Drum Dials



EXAMPLE OF A PERPENDICULAR MOTION DRUM.

For ages human beings have done things by twisting and turning so that now if anything is done in any other way it seems unnatural. A door is opened by first turning the key, then by turning a knob and finally by turning the entire door. A purse of the old variety is opened by a twisting movement, modern cigarette cases are opened in the same manner. A great many other cases of everyday twisting and turning could be mentioned.

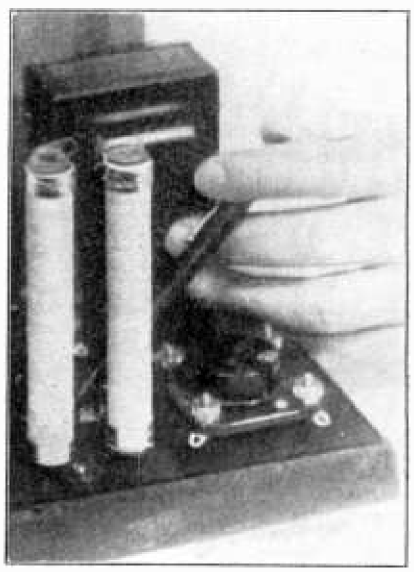
When an adjustable feature was first put into a radio set it operated by turning. When other adjustables were added to the radio set, most of them were twisters. We had tuning condensers which operated by turning, variometers, vario-couplers, rheostats, switches, and many others, all working the same way. This twisting movement persists in radio. It seems the natural thing. Radio is a tortuous world.

But rotation is not the only motion. If it were we would never get anywhere. There is also motion of translation. That is the only kind of motion that takes us anyplace. And we can have motion of translation in a radio set just as well as twisting motion. We can turn a condenser, as is most frequently done, with a twisting movement. But we can also turn the condenser with a motion of translation of the hand which is being done more and more every day. Most of the drum dials are turned that way. Linear motion is converted into rotation. Two schools have grown up in radio, one favoring rotation and the other favoring translation.

The twisters twist and the translators push and pull. In the average modern radio set the twisters show the greatest influence, but in the set of the future, if we are to go by the present trend, the translators will have a greater representation.

In the photograph the drum dial is turned with a motion of translation of the hand in a vertical plane. The drum dial is coupled directly on the shaft of the turning condenser.

LET HEAT OUT



(Hayden)

Heat disposal in B battery eliminators is of utmost importance. A considerable amount of heat is generated in the resistors connected across the output of the eliminator, and this must be removed before it can do any damage. If the resistors are wire wound on insulating tubing like these Electrad wire-wound units, the ventilation can be greatly improved by mounting them upright to take advantage of the chimney effect.

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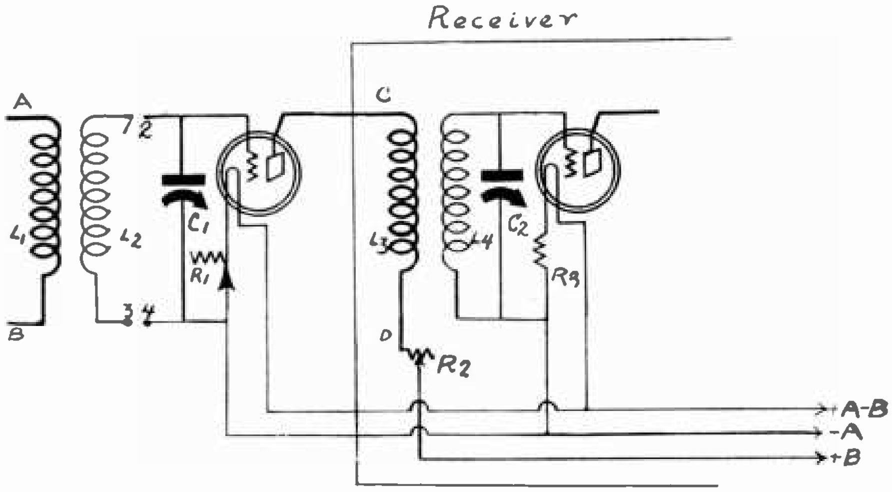

FIG. 578
The extra RF stage and loop hookup.

I BUILT the one-tube receiver described by Wally Frost in the April 16 issue of RADIO WORLD and have had great success with it. The volume and the selectivity is good, I would like, however, to add a stage of tuned radio frequency, so that I could get more distance. I would also like to add two stages of transformer coupled audio, so that I can use a speaker.

(1)—Please give me the necessary data for the coils, condensers, etc., that are necessary for the additions. I am going to use 01A tubes throughout.

(2)—I have a couple of aluminum shields, built for a condenser and coil. Could they be used with success in this receiver?

(3)—I intend building this set on a baseboard, 21 inches long and 10 inches deep. Is this all right?—James Excellont, Port Jervis, N. Y.

(1)—The extra stage of radio frequency and two transformer stages will help materially in increasing the distance getting qualities as well as the volume of the set. The primary of the coil necessary in the RF stage consists of 15 turns, wound on a 3-inch diameter tubing with some No. 22 double cotton covered wire. Separated from this winding ¼ of an inch, the secondary is wound. This consists of 43 turns of the same wire as was used for the primary. The variable condenser now connected in series with the antenna is left in this position, except that the new coil is substituted for the one now in the set. The post of the primary winding of the old coil that went to the condenser, is now brought to the plate post of the socket carrying the radio frequency tube. The end of this winding, which now goes to the ground, is brought to the B plus 45 volt post. The connection between the end of the primary coil and the beginning of the secondary winding of the old coil is broken. This is important, since if it is left in its original postion, you will have a short circuit in the A and B circuit. When inserting the new coil, be sure to connect the end of the primary winding to the beginning of the secondary winding. It is absolutely necessary to install a twenty ohm rheostat in series with the negative leg of the filament. The rheostat in the detector circuit can be used here, with satisfaction. A 1A Amperite can then be used in the rheostat's place in the detector side. When adding audio frequency amplification, just follow a standard diagram. You may install a radio frequency choke coil of the Hammarlund 85 millihenry type in series with the plate post of the detector post. The bypass condenser should be connected after the radio frequency choke. That is, do not connect the bypass condenser to the terminal of the choke that goes to the P post of the transformer. Instead it goes to the tickler terminal. The filaments of the audio tubes should be each controlled by an Amperite of the 1A type. The audio tubes should each have a C bias or 4½ for the first one and 9 for the second. This is at ninety volts for the first audio plate and 135 for the second audio plate. It will also be necessary to install a filament switch in the plus A lead.

(2)—Yes, the shields will help. Don't forget to ground the shields and bring the minus A lead to this ground. This will necessitate a change in the detector grid return. That is, instead of bringing the grid leak across the grid condenser, bring it from the G post of the detector tubes socket to the plus F post on this socket. The grid return of the radio frequency tube should, of course, be brought to the minus A post.

(3)—Yes.

* * *

LAST YEAR, I was given a 4-tube receiver. In it a tuned radio stage, a non regenerative detector and two transformer stages are employed. Until recently the results were great. The recent installations of some stations in and about this vicinity has caused me great grief, for all I can hear are the signals from these stations. I was informed by a friend of mine, that an extra stage of radio frequency amplification in this set, would clear up the trouble. If you would advise this, please give the diagram. The primary of my present coil has 10 turns. The secondary has 45 turns. Both are wound on a 3 inch diameter tubing with No. 22 double covered wire. Each winding is separated ¼ of an inch. The capacity of the condenser across the secondary of the coil is .0005 mfd. I would appreciate you showing this diagram with provision for a loop. The detector filament is controlled by a 1A Amperite. Please give the coil data.—Max Helprin, Bound Brook, N. J.

The diagram illustrating how the extra stage and loop attachment can be made, is shown in Fig. 578. L1, the primary of the new coil, consists of 10 turns. L2, the secondary, contains 45 turns. Both are wound on a 3 inch diameter tubing with No. 22 double cotton covered wire. C1 is a .0005 mfd. variable condenser. R1 is a 20 ohm rheostat used to control the filament temperature of the radio frequency tube. R2 is a 10,000 ohm variable resistance used to control the B voltage applied to the plate of the tube as well as the oscillatory action of the tube. L3 and L4 represent the primary and secondary windings of the radio transformer now in the set. C2 is the variable condenser and R3 is the 1A Amperite. In order to use the loop, connect loop terminals across the posts 2 and 4. In order to use the antenna and ground, connect posts 1 and 2 together and 3 and 4 together. A and B indicate the new antenna and ground connections, respectively. C is the old antenna connection, which now goes to the plate post of the new socket. D, which originally went to the ground goes to the A terminal on the 10,000 ohm variable resistance, through which the B battery voltage flows.

* * *

IS IT necessary that the primaries of the tuned radio frequency coils used in the Winner, described in October 1, 8, 15, 22 and 29 issues of RADIO WORLD, be variable?

(2)—How would a double condenser work out in this set?

(3)—Is it not necessary to use a rheostat in the detector filament circuit?—Harry Williams, Louisville, Ky.

(1)—Yes. The whole idea of the set is based on this system.

(2)—The results would not be satisfactory.

(3)—No.

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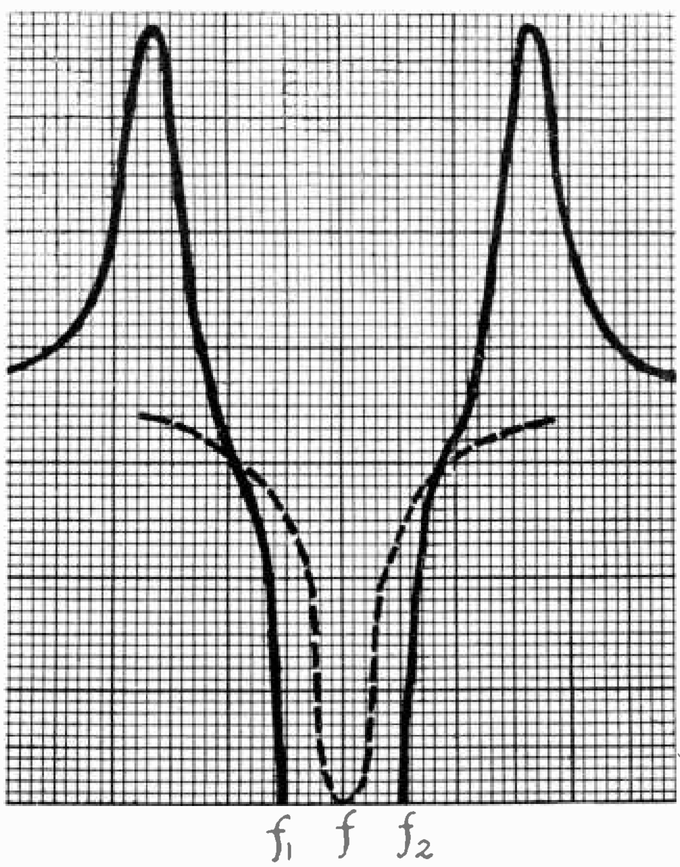
The Greatest Recreation Is Test of a Receiver

By J. E. Anderson

Technical Editor



The full curve shows the attenuation characteristic of a band pass filter having a transmission band f1 f2 and sharp cut-offs at f1 and f2. Outside the cut-off frequencies the attenuation is very high while it is negligible between. If the intermediate frequency f of a super heterodyne is the mean of f1 and f2 and the band is 20,000 cycles wide, the selectivity of the receiver will not suppress the high audio notes. The dotted curve shows the attenuation characteristic of an ordinary tuned radio frequency transformer, or of a series of them tuned to the same frequency, f. The upper side frequencies are cut off (Fig. 1).

THE tug-of-war between quality and selectivity is going on merrily. The rope in this struggle is the purse string of the average fan. It is subjected to a stress. The fan permits this tussle because he is under the illusion that both sides can win at once. He wants both perfect quality and perfect selectivity in his set, and when he is told that he can have both he believes, but when he is told that he can't have both to perfection at the same time he is ready to give argument against the facts. He believes what he wants to believe and reject the truth.

One phase of quality relates to the identity of response at all frequencies. All frequencies in the audible range must be brought out with equal force, provided that they are equal at the source. Selectivity means just the reverse. It means the selection of one frequency and the suppression of all the others. The more selective a circuit is, the more complete is the suppression of all the frequencies not wanted as compared with the frequency desired.

The Sacrifice

Thus if ultra-selectivity is wanted, quality must be sacrificed in proportion to the increase in selectivity. Conversely, if quality of the highest order is wanted, the selectivity must be sacrificed. Both can't win at the same time.

It is not possible to repeal the natural laws which govern this relationship between selectivity and quality. But it is always possible to compromise. As much weight as is necessary can be given to selectivity, let the quality be what it may. Or again, as much weight as desirable can be given to quality, take the selectivity as it is. Much latitude is allowable before a listener can tell whether too much weight has been given to selectivity or to quality. Usually the first noticeable sign of lack of selectivity is the appearance of a background of signals from another station. The first noticeable signs of too much selectivity are hollowness of signal and lack of the hissing sounds in the signal broadcast.

Complete Knowledge By Designer

There is no danger of too high selectivity in most receivers of the tuned radio frequency type. Sometimes when regeneration is used the selectivity can be made too great, but there is always a remedy handy in the tickler. But in the amplification of an intermediate frequency it is very easy to increase the selectivity beyond that which will give good quality. In fact, it is difficult not to exceed the allowable limit of selectivity. It takes a complete knowledge of the frequency-changing receiver and its limitations to enable one to design such a circuit so that it shall have adequate selectivity for all practical purposes and still not sacrifice quality. It takes knowledge acquired by thorough consideration of the theory involved and knowledge acquired by diligent research in the laboratory to do that. It takes intelligent coordination of the facts thus acquired into a harmonious whole. But it takes none of these to build such a circuit from the designer's transparent directions.

An illustration may help to bring out the requirements upon the designer. In Fig. 1 are two curves, one dotted and one full. The full curve is drawn in two sections, one the mirror image of the other. At the bottom of these curves are f1, f, and f2.

What They Represent

The middle f represents a frequency to which the intermediate filter is tuned. That is, it is the frequency employed in the intermediate channel. The other effs for the moment are only two side frequencies.

The dotted line represents the attenuation of a tuned circuit, or of a number of circuits tuned to exactly the same frequency. It is nothing but an ordinary resonance curve plotted upside down on the assumption that the attenuation at the resonant frequency is zero. This can always be regarded as true relatively.

Now suppose that each division on the graph along the horizontal represents 2,000 cycles. Then f1 is a frequency 10,000 cycles lower than f, and f2 is a frequency 10,000 cycles higher than f. If f is a modulated carrier such as the signal in an intermediate amplifier then f1 and f2 are the lower and higher side frequencies in the signal which correspond to an audible frequency of 10,000 cycles after detection. If the two side frequencies f1 and f2 are suppressed by the filter or tuner in comparison with the carrier f, then the 10,000 cycle audio frequency will be suppressed in the same proportion to the lowest audio frequencies. It is in this manner that selectivity causes distortion.

Where Suppression Begins

The closer the two sides of the dotted curve come to the vertical line f, the more selective is the circuit having that characteristic. The greater will also be the suppression of the higher side frequencies. The characteristic as drawn in Fig. 1 shows that the suppression begins to be appreciable at 2,000 cycles, and that the higher audio frequencies, say from 5,000 to 10,000 cycles, are thoroughly suppressed. Very poor quality would be the result in a circuit in which the intermediate frequency filter had that characteristic. And there are many cases in which the selectivity is even greater.

The full line shows the attenuation characteristic of a band pass filter sometimes used for intermediate frequency circuits. Such a filter is a very complicated electrical network which is both expensive and bulky. It is usually not practical for use in receiving. The filter passes all frequencies without much attenuation which lie between f1 and f2. All frequencies lying outside that band are greatly suppressed, particularly frequencies just outside the cut-off frequencies f1 and f2.

Approach the Ideal

The characteristic shown in the full line in Fig. 1 approaches the ideal for perfect quality and perfect selectivity, and is about as good as can be attained in the laboratory with any degree of practicality. The side frequencies corresponding to a 10,000 cycle note are passed freely as well as all the side frequencies closer to the carrier. Thus the selectivity of the filter does not introduce distortion, since frequencies above 10,000 cycles are of no importance.

The very high attenuation just outside the cut-off frequencies f1 and f2 is introduced to reduce any interference from signals of stations operating on channels adjacent to the one desired. The effective selectivity of this arrangement is therefore as great as is ever required, yet the essential frequencies in the desired signal come through without attenuation.

Circuits of this type have been constructed with excellent results. Circuits have also been built in which the two cut-off frequencies were put at 5,000 cycles above and below the intermediate carrier frequency. This was done on the fallacy that the modulation of the carrier only extends 5,000 cycles on each side of

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the carrier and that it was necessary to impose this limitation in order to cut out completely the interference from adjacent channels.

The modulation extends at least up to 10,000 cycles and the signal width is at least 20,000 cycles. If the cut-off is made at 5,000 cycles for radio frequency half of the signal is suppressed and the quality is greatly impaired. And this impairment of quality is effected to cut out an interference largely imaginary. The 5,000 cycle cut-off of an audio transformer is another matter.

The Tuned Transformers

While intermediate amplifiers with filters having sharply defined transmission bands of either 10,000 or 20,000 cycles wide may be constructed in the laboratory, they are not practical for general reception. They are expensive, clumsy and unnecessary. Tuned intermediate transformers having suitable characteristics may be constructed which approach the performance indicated by the full line in Fig. 1. It is only necessary to widen the transmission band so that the steep parts of both curves coincide. This of course will still cut off the upper side frequencies, say above 8,000 cycles, if a high order of selectivity is to be retained; but this suppression can be compensated for by selecting audio frequency transformers for the receiver which have rising characteristics in the region where the filter has a drooping characteristic. It is not necessary to extend this equalization above about 10,0000 cycles.

Of course, this coordination of parts to give a close approximation to the ideal response both as to quality and selectivity cannot be done without adequate equipment. The frequency characteristic of every part must be measured individually as accurately as possible. Then those parts should be chosen which fit most closely into the coordinated whole. The result will be a receiver which has the selectivity required to penetrate space to the farthest transmitting station and bring in the signals strong and free from contamination of signals from other stations, and a receiver which has the quality that the most exacting fan might demand.

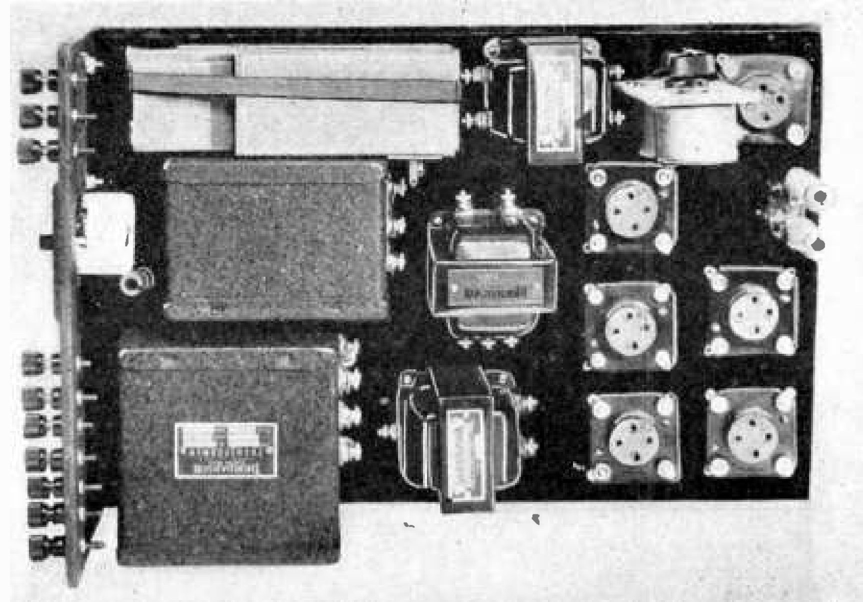
With the present distribution of broadcast channels it is necessary so to design the receiver that the overall characteristic cuts off at 10,000 cycles, and in the interest of quality it is necessary to design it so that all frequencies up to 10,000 cycles be transmitted equally.

A Concrete Example

In studying a concrete example of such a receiver—and such exists in my home—one is forcefully struck by the scientific care exercised in the choice of the co-ordinating parts. Selectivity has been raised to the highest allowable limit, always to remain at that limit, and this by the choice of intermediate frequency transformers accurately tuned to the same frequency, and constructed with such care that mechanical ruggedness lends its reassuring virtue to the ensemble. Sensitivity has been achieved by having these transformers work with high efficiency into standard tubes. Retention of side frequencies results from the use of these coils, and pure quality is preserved by the introduction of audio frequency transformers which compensate for the necessary suppression of the higher frequencies and which cut off immediately above 10,000 cycles. Thus the equalization has been carried on to the point where to increase or decrease the size of any golden link in the charming chain would work only a detriment to the overall result, and make the circuit less than the great recreator that it is.

[To be continued next week]

Some Still Ignore Heat of Resistors and Tubes



AN EXCELLENT LAYOUT FOR A COMBINATION HIGH VOLTAGE ELIMINATOR AND POWER AMPLIFIER.

A correct layout is as important to the success of an eliminator-power amplifier device as the use of the proper parts and diagram.

A frequent cause of trouble is the proximity of the condenser pack to the heavy current carrying resistors as well as proximity to the tubes, all of which get quite warm. The warmth causes the wax or other impregnating material in the too-close condensers to melt and not only change capacity but many times ruin the condensers.

A good layout to follow for amplifier-eliminator device using two rectifier tubes of the 216B type, two 210 power tubes and a voltage regulator tube is shown in the photo. The two rectifier tubes are placed close to the edge of the baseboard towards the right, while right next to them the power amplifier tube sockets are put. In line with these sockets, we have the voltage regulator tube socket. And in the corner a socket for the input audio tube is placed. It will be clearly seen that the heavy current carrying resistors are mounted farthest away from the condensers.

Famous Chronometer of Sea Used by KFI

Los Angeles.

The chronometer which furnishes the correct time for KFI's nightly time signals has a romantic history. It was made in Scotland seventy-five years ago and installed in the famous clipper ship "The Sea Wings." When the ship was recently dismantled, the chronometer was purchased by a yachtsman.

Now reposing alongside of KFI's announcer's microphone it still faithfully and accurately serves its purpose. Its daily loss is less than that established by Government Standard.

Old-timer Pooh-poohs Mere Looks of Wiring

The internal appearance of the wiring of a power device does not cut much ice.

A newcomer in radio visited his friend, who was an old-timer. Old-timer had constructed a power-supply in which was incorporated a B eliminator using a 216 B tube and an amplifier using a 210 power tube. He demonstrated it to newcomer, who revelled in the remarkable volume and tone quality.

Surely, newcomer thought, anything that gives such flawless reproduction must be very neat in internal construction. And so he asked to see the inside. It did not take old-timer long to notice that look was a look of disappointment on newcomer's face. A query from old-timer as to the trouble prompted newcomer to point to the wiring and sadly shake his head.

Old-timer replied:

"I'll admit the wiring looks poor, but looks don't amount to anything when it comes to operation. Do you know the cause of that excellent reproduction? The use of part of impeccable manufacture in a well-designed circuit, which incorporates the use of the 210 power tube, with 400 or more volts applied to the plate. It is this tube which carries the load impressed by the preceding tube, without overloading, and which gives us that true reproduction, due to the high plate voltage and by undistorted power output."

GERMANY WANTS TO BUY

A recent issue of weekly compilation of foreign trade opportunities by the Department of Commerce, shows that Germany is very anxious to buy loudspeakers, sets and parts.

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A THOUGHT FOR THE WEEK

GO into any store and try to buy a B eliminator giving you 475 volts, so you can gain real benefit from 210 tubes.

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Dunlap's New Book "The Story of Radio"

Radio, the lustiest infant of modern science, finds in "The Story of Radio," by Orrin E. Dunlap, Jr., radio editor of the New York "Times," a capable and interesting biographer of its thrilling history. Mr. Dunlap has been behind radio's scenes during all of its development. He is the author of "Dunlap's Radio Manual," was a United States Navy radio operator during the World War, and previously a senior Marconi operator. He was graduated from Colgate University after which he took post graduate work at Harvard.

He vitalizes his radio story by letting radio tell its own history in the first person as if speaking through a microphone.

Hearts of All Ages Won By Beau Broadcasting

Washington.

The work of the Federal Radio Commission since its creation last February was reviewed by Senator James E. Watson of Indiana in an address delivered before the microphone of WRC, Washington. Senator Watson is chairman of the Senate Committee on Interstate Commerce, which handled the Radio Act of 1927 when that measure was before the Senate.

"One of the greatest achievements of the Federal Radio Commission has been the extraordinary improvements in the work being done by the broadcasters themselves," said Senator Watson. "Knowing that the Commission will judge solely on the standard of public service, the broadcasters have made notable changes in the character of their program and the records of the Commission are full of instances in which, as soon as the Commission's policy was made known, broadcasters hastened to replace programs of trashy entertainment by ones of real public value.

Appeals to All Ages

"Radio has become a source of enjoyment to youth, of entertainment and culture to those in middle life and of comfort and consolation to the aged, and has woven itself inextricably into the very fiber of our civilization.

"Radio is a force by means of which the voice of the orator and the prima donna can be heard across the land swifter than the coming light. Certainly it is renewed evidence of the sublime fact that 'God moves in a mysterious way his wonders to perform.'

"Radio, now in its infancy, is destined to become a tremendous importance in the immediate future. There are 2,000 ship stations, 200 experimental stations, 16,000 amateur stations, 340 land communication stations and more than 100 technical and trade school stations as evidence of the importance of radio to the American people. Yet with all these, the great host of people clamoring all the while for a more efficient service and an ever increasing number is demanding opportunity to get on the air.

Eight Months of Chaos

"In reference to the 535 licensed broadcasting stations that were on the air prior to the court decision which brought chaos to broadcasting, there followed nearly eight months of wholesale 'air piracy,' and while public opinion was most vehement against the 'wave jumper' they were not the ones responsible for the greatest trouble.

"Far more numerous, if not individually so troublesome, were the 'power jumpers,' 168 in number, or 31 per cent of the whole. It was not until the Federal Radio Commission was created by Congress," he said, "that this utterly indiscriminate scramble ceased."

Sponsored Programs Win Place By Good Taste

Los Angeles.

The two most important contributions to the broadcasting art of the current year according to Earle C. Anthony, owner of KFI and president of the National Association of Broadcasters, are the formation of the National Network of the National Broadcasting Company and the vindication of the sponsored program.

"It seems safe to state," Mr. Anthony asserts, "that every person owning a receiving set in the United States has heard at least one of the great national programs of 1927. The natural human impulse to be a party to great events is fully satisfied by the National Network. Its scope has been wide this year, embracing sports, music, diversified entertainment, public celebrations, public figures and international relations. A still wider use of the National Network is expected during the coming season.

"The second important contribution of 1927 to the broadcasting field is the vindication of the sponsored program," he continues. "All broadcasting divides itself into two classes—sponsored and sustaining programs. The expense of all sustaining programs is borne by the broadcasters. For the broadcaster to assume the expense of all of his programs would be too heavy a burden. Foreign countries have ameliorated this condition by taxing the receiving set owner. The United States, basically antagonistic to such a system, has solved the problem by the sponsored program.

"The critics of this form of broadcasting feared that excessive commercialism would damage the entire structure, but they failed to take into consideration the desire and ability of the broadcasters themselves to control the situation. While here and there some stations are lax in enforcing the rigid, and in part unwritten rules concerning direct advertising which the leaders of the industry have followed since the beginning, these stations are rapidly being aligned with the majority through public reaction.

"The funds furnished the broadcaster by the sponsors of the country have allowed the radio audience to hear the finest offerings of the musical world, most of which could not have been presented otherwise. On the other hand, the sponsors who made such features have gained an overwhelming amount of good will."

Stations Get Threat of License Revocation

Washington.

Reports to the Federal Radio Commission to the effect that some broadcasting stations are ignoring General Order No. 8 requiring announcement of the call letters, location and frequency of the station before and after each program evoked an official statement as follows:

"The Commission intends to rigidly enforce that order on the ground that it is essential to have the co-operation of the public in keeping check on stations to see that they adhere strictly to their frequencies, which is necessary for good reception. Upon proof of the frequent and flagrant violation of this order, supported by affidavits, the Commission will invoke the penalties provided in the Radio Act of 1927."

License revocation is among these.

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Grid Condenser Plays Vital Part in Set

One of the most important parts in a radio receiver is the grid condenser. Few seem to realize its effect on the quality and sensitivity of the receiver. A poor condenser in the grid lead is worse than no condenser. Leakage in a condenser is one of the chief faults.

The importance of this factor is obvious when one recalls the critical nature of the grid leak. This must be just so or the circuit will not be sensitive and the quality of the output is likely to be mediocre or worse. If the grid condenser leaks considerably it effectively lowers the leakage resistance and the circuit may be a dud as far as sensitivity is concerned. In a grid condenser with mica dielectric moulded in Bakelite and with the grid leak clips mounted directly on the condenser, as in the Sangamo, the leakage is strictly confined to the leak placed in the clips, and the circuit is assured of consistently high sensitivity.

After the grid leak and condenser, in connection with the detector tube, have done their work, the rest is dependent on the audio amplifier. If tubes of adequate power-handling capacity are used the quality of the output is largely a matter of the use of the proper transformers. It is a simple matter to spoil an otherwise good receiver by installing poor transformers. It is an equally simple matter of improving any receiver by replacing the old transformers with a couple of the latest types of transformers such as the Sangamo.

Both the grid condenser and audio transformers of Sangamo are used in the Laboratory AC set, described in the November 12 issue.

Remler's 633 Condenser Preferred for Diamond

The Remler No. 633 three-in-line .00035 mfd. straight line wavelength condenser is officially specified by RADIO WORLD'S Laboratory Staff for the Unified Diamond of the Air. The No. 633 is the one used in models exhibited in retail stores in several cities and is the one the fans prefer for this circuit. The Unified Diamond was described in the September 17, 24, October 1, 8, and 15 issues of RADIO WORLD.

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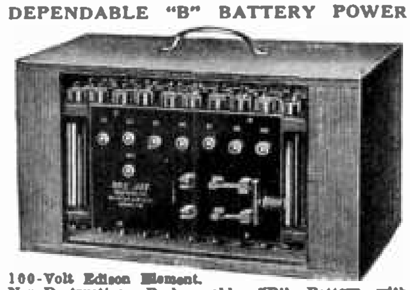

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Everybody who owns a radio set likes to tune in far-distant stations now and then because not only is there a thrill in hearing a voice or instrument thousands of miles away but one verifies the fact that he has a powerful receiver and that it is in good condition, if it is able to pick up these weak signals. Now that the broadcasting stations are more suitably distributed as to wavelength or frequency, fans are in a better position to tune in distance. Besides, the weather is in their favor these days. But what kind of a set shall be used? You know very well that if the set can tune in distance once in a while, you can develop sufficient skill to make it tune in far-distant stations very often, virtually every night. Then when you have visitors you need not boast about the DX qualities of your set but simply tune the receiver and let them listen to stations thousands of miles away. You must be sure to have a receiver capable of responding to your distance-getting desires. You also want this set to have delightful tone quality, so that your own critical ears cannot detect even a single flaw in the reproduction. Indeed, even music lovers who may be guests at your home will comment admiringly upon the bewitching tone of your receiver. Then you know you have something real. The ability to get distance and to reproduce the original music without distortion depends largely on the circuit design, and you will find that the Diamond of the Air, either the 4-tube or the 5-tube model, will live up to your highest expectations. How are you going to know which to build? Carefully inspect the textual data as well as the blueprints that fully expound the theory, operation, characteristics and amplification of these two outstanding receivers that differ principally in the type of audio amplification.

The 5-Tube Diamond

Can be constructed in a couple of hours. The authorized blueprints that make this speed and efficiency possible are just off the press and will be shipped at once, together with the new booklet of full textual exposition of construction, including the winding of coils, how to connect terminals, what values of condensers and resistors to use, etc. The receiver consists of a stage of tuned radio frequency amplification, a specially sensitized detector, first stage of transformer audio and next two stages of resistance audio. It is easily adapted to playing phonograph records through the set and on your speaker. Get acquainted with this new delight.

The 4-Tube Diamond

represents the most that is obtainable from four tubes. A stage of tuned radio frequency amplification, a specially sensitized detector and two stages of transformer coupled audio. Follow the blueprint to amazing success. Build the set from parts you have. Full instructions cover utilization of such apparatus. Thousands are eager to build an economical set of surpassing performance and amazing achievement and this one is the most economical, the most scientific, and the least expensive in cost of parts and upkeep. Works splendidly from batteries, either type 99 or type 1A tubes, and can be used with A and B eliminators, power packs, etc., with great success.

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A New Model DC Set

(*Continued from page 5*)

The plate voltage for the radio frequency and the first audio frequency amplifiers is obtained directly from the 110 volt DC line after it has passed through the filter consisting of the choke coil Ch and condenser C8. The voltage on the plate of the detector is obtained from the drop in half of resistor R7 which is connected across the 110 volt line next to the receiver. Each half of R7 is a 6,000 ohm resistor unit.

The plate voltage on the two push-pull tubes is boosted to 155 by the insertion of a 45 volt dry cell battery where indicated.

Resistor R2, inserted in series with the plate of the first tube, serves as a volume control by limiting the effective plate voltage on the tube.

Resistor R1 is a 3 megohm grid leak.

Condenser Avoids Difficulties

The rotors of the two variable condensers C1 and C2 are connected to the negative side of the line. As they are connected to points of the same potential it is possible to combine the two on the same shaft for unified tuning.

Since the heating and the plate currents are obtained from the same source, there must be at least two points in common between the two systems. They must leave each other and come together again. One of these points is just below the switch S where R8 and Ch join, and the other is the point where the negative terminal of the line is attached to the circuit.

The liaison between the two limits the independence of the two system and puts certain constraints on the design. The rotors of the two tuning condensers cannot be grounded, for example, unless the negative side of the power line is also grounded, which is not often the case. Neither can the cathodes be grounded for the same reason. To avoid any difficulties on this score, condenser

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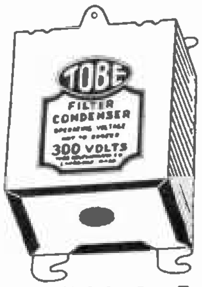

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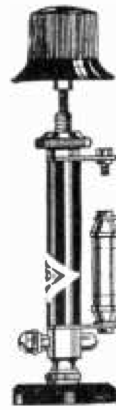

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