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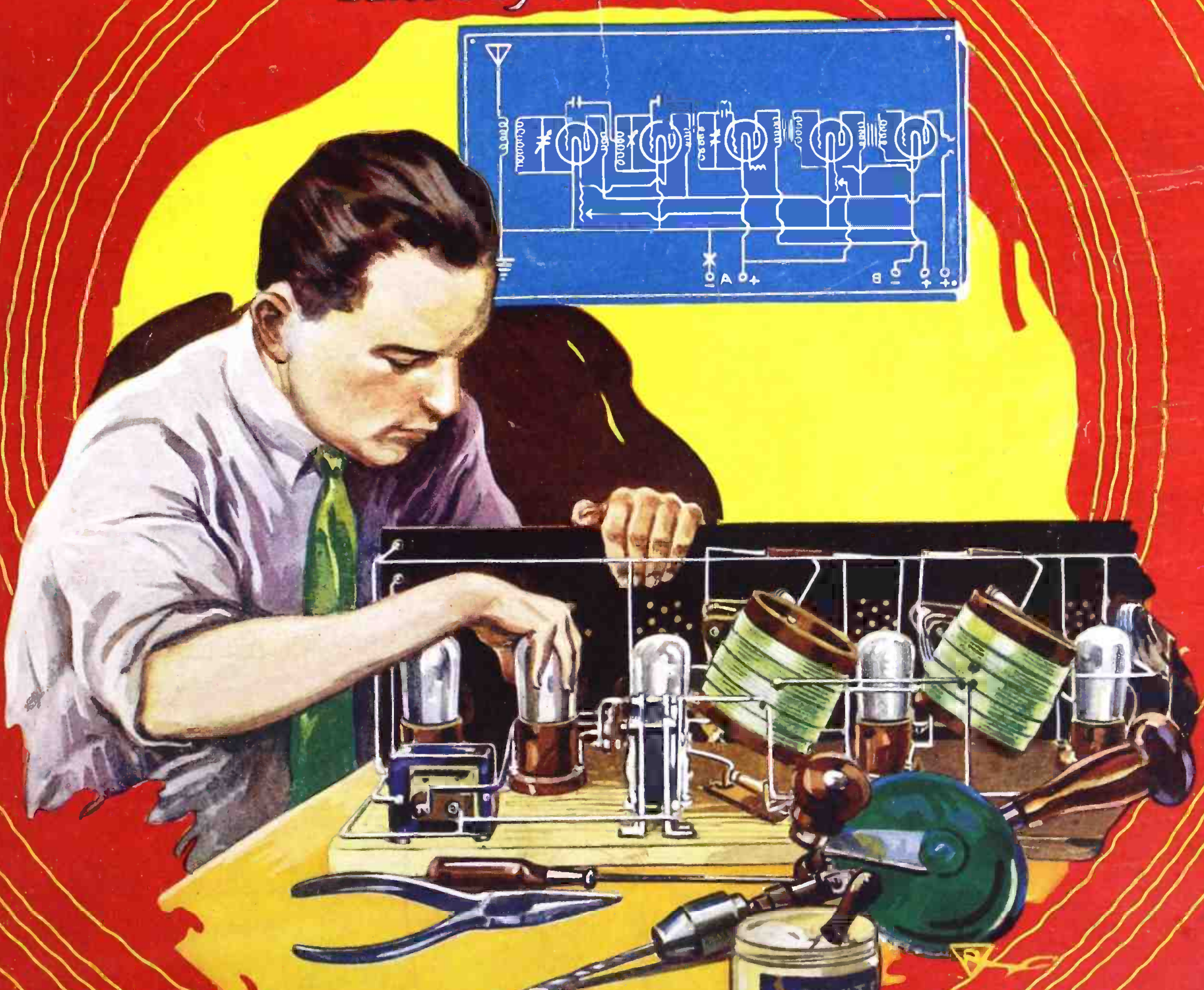
RADIO REVIEW

Reg. U.S. Pat. Off.

A Digest of the Latest Radio Hookups

Edited by S. Gernsback



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RADIO REVIEW

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A Digest
of the
Latest Radio Hookups
from the Radio Press of the World

Special Supplement beginning in this issue
S. GERNSBACK'S RADIO ENCYCLOPEDIA
First Installment

THIS issue of RADIO REVIEW marks the beginning of a publication inaugurated for the sole purpose of giving data and instructions for building radio sets of all kinds with hints and practical ideas concerning the installation, operation and maintenance of radio outfits.

¶ Heretofore, the radio set builder has found it difficult to obtain information on various new and popular types of sets, due to the reason that details of construction appear in more than a dozen different magazines, newspaper radio sections, etc.

¶ This magazine will serve as a review for all novel and most popular types of sets; an agency to which the constructor can readily refer in obtaining details for building or assembling any particular receiver.

¶ We shall appreciate suggestions from our readers recommending circuits and data on receiving sets they would like to see published in coming issues of RADIO REVIEW.

¶ RADIO REVIEW will contain each month, as a supplement, a section of the most complete Radio Encyclopedia ever published. This work is not a dictionary giving only definitions, but a complete Encyclopedia of every term used in radio, with diagrams, photos and tables, explaining and defining them. The first installment will be found in the back of this issue.

The Consrad Co., Inc.
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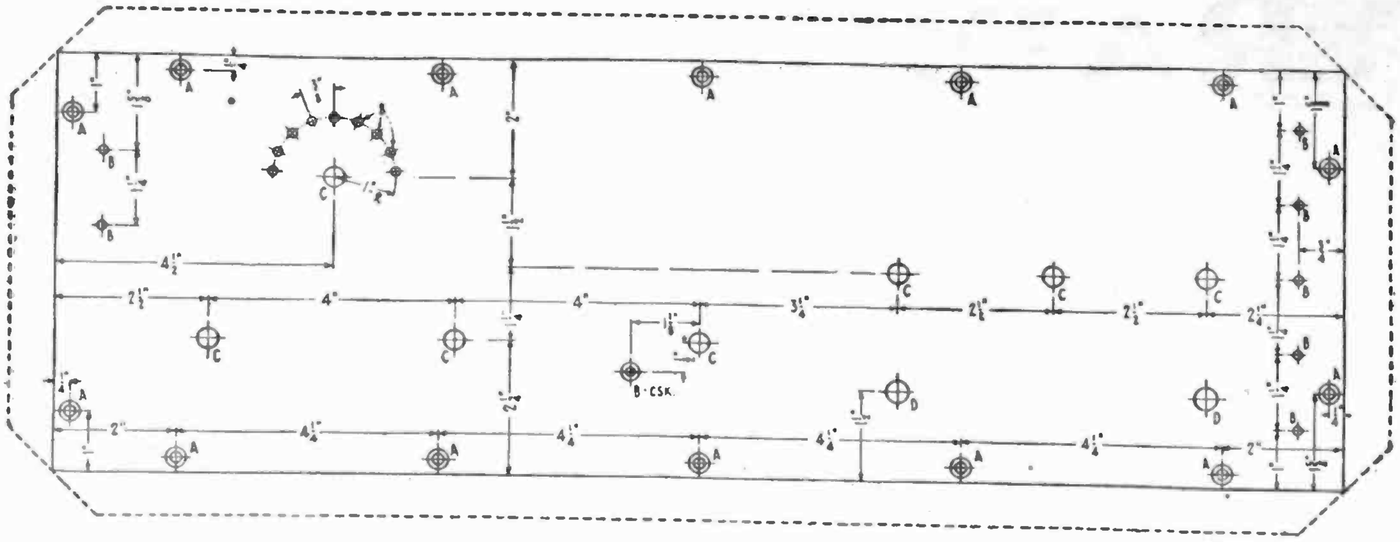


Fig. 3. The panel layout shows the mounting holes in the panel on a small scale, the actual location with dimensions.

grids, a split primary delivering the sum of the output of the two tubes in pulsating direct current, and the secondary delivering alternating current to the loud speaker. Each one of these features helps in its own way to prevent the possibilities of distortion and overloading.

The value of the C battery varies with the value of the B battery used as the following table shows:

B Battery Voltage	C Battery
80	3.0 to 4.5
100	4.5 to 6.0
120	6.0 to 9.0
150	9.0 to 12.0

It follows that if the ordinary type of amplifier be added to the Roberts Two-Tube receiver, the resultant signal produced will be greatly distorted unless special corrective measures are incorporated in the general layout. Due to the loud speaker volume produced by the two-tube set, these corrective controls are frequently ineffective because of the subsequent excessive overloading of the extra stage of amplification and the peculiarities of various transformers.

Taking these obstacles into consideration, it was evident that some means of effectually surmounting them would have to be provided. After a series of elaborate tests the push-pull type of amplifier proved entirely satisfactory.

Fig. 2 and the several photos show the general appearance and layout of the Four-Tube Roberts receiver.

Materials

The parts used, with the approximate cost, are listed as follows:

1	Panel 7 x 21 x 3-16	$2.00
1	Base-board	$0.50
1	Set Turney Coils	8.00
2	Variable Condensers .0005 mfd. $2.50 ea.	5.00
3	Vernier Dials, $2.00 ea.	6.00
1	Switch Arm	.25
7	Switch Points	.10
2	Switch Stops	.05
4	Sockets, $1.00 ea.	4.00
1	Transformer (ratio approximately 5-1)	7.00
2	Push-Pull Transformers (set)	12.50
3	Rheostats, $1.00 ea.	3.00
2	Jacks (Open and double circuit)	1.25
7	Binding Posts $.20 ea.	1.40
1	Neutralizing Condenser	1.50
1	Grid Leak (3 to 7 megohms)	.60
1	Grid Condenser .00025 mfd.	.40
2	Micadons .005 and .0025 mfd. $.40 ea.	.80
2	C Batteries 4½ volts $.40 ea.	.80

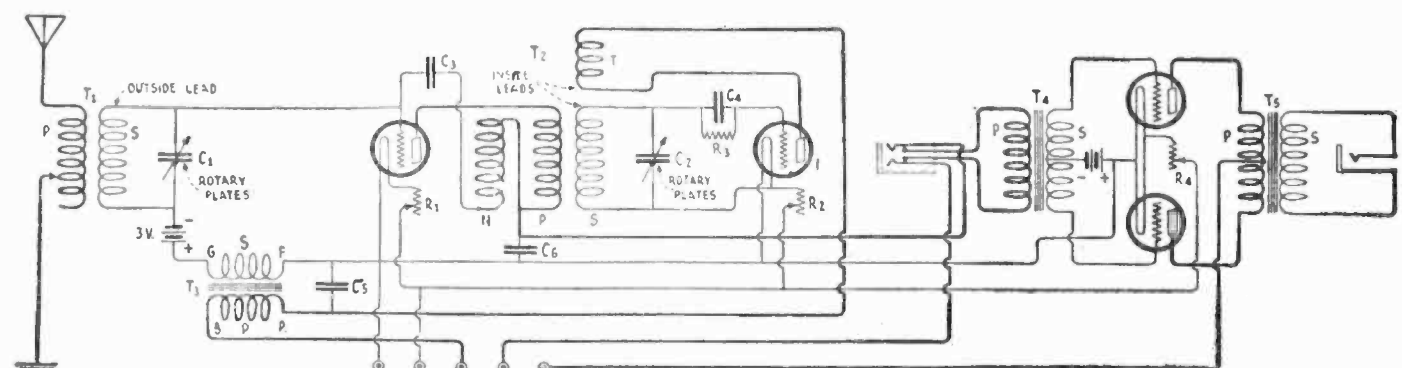


Fig. 4. In this schematic circuit diagram the original Roberts circuit may easily be identified and the push-pull amplifier is also strikingly evident.

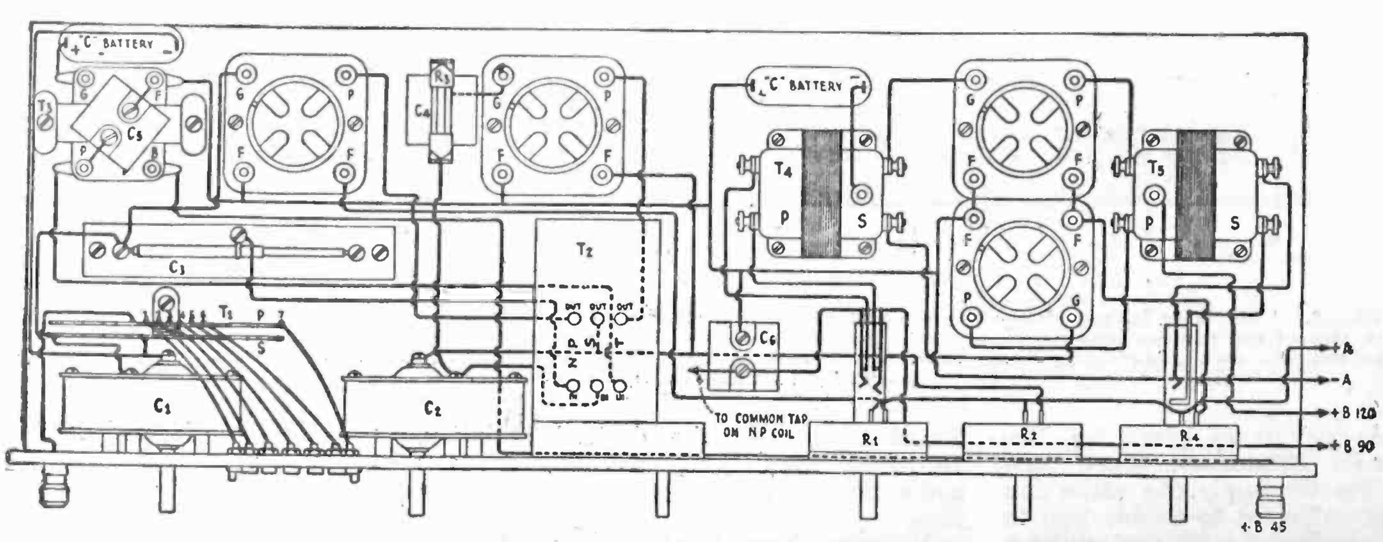


Fig. 5. Showing the actual diagram of the receiver as applied to the base layout shown in Fig. 2. In wiring the set, it is advisable to make frequent references to Figs. 4, 5 and 8.

—Miscellaneous bus wire—spaghetti — screws — bolts — nuts — lugs, etc. . . $2.00

Total $57.15

The prices given here are high enough to admit of the purchase of parts of good quality.

Preparation of Parts

In preparing the various parts for assembly, the tri-coil unit and the neutralizing condenser require alterations.

That part of the wooden section of the coil mounting protuding at the left (looking at it from the front) and containing the bearing for the shaft of the NP coil control is sawed off flush with the bakelite base. This is shown in Fig. 6. The dial control for this coil is discarded and the separation between the NP and S coils is maintained by the bolt and not as shown. The coupling between these coils is varied to the correct value by means of this screw and is quite sharp in adjustment, affecting the tone quality and quantity to a marked degree.

The neutralizing condenser must be taken apart and the two lengths of bus wire replaced with one continuous piece. Great care must be exercised in performing this operation so as not to break the glass insulating tubing. If, however, the tubing is broken, a length of spaghetti tubing will serve as a substitute.

Tighten all the bolts and nuts on the sockets to insure a positive contact. This is done by first removing the round knurled thumb-nut and tightening the nut and bolt with a screw-driver and pliers. In doing this be sure that the contact blade of the socket does not move out of place.

Lugs are placed at all connection points wherever possible.

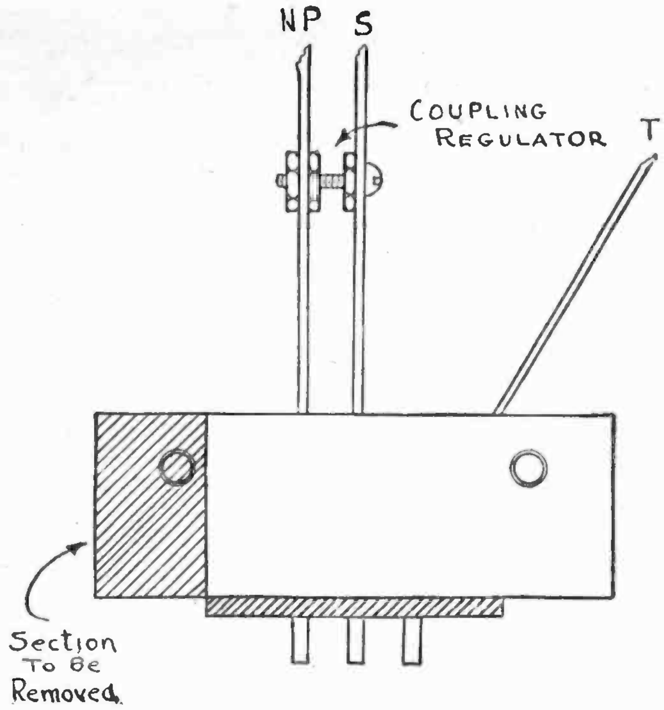


Fig. 6. The alterations of the three-coil mounting are clearly indicated. The manufacturer of this type of coil has since produced a unit in which similar features have been permanently included, as may be seen by referring to Fig. 9.

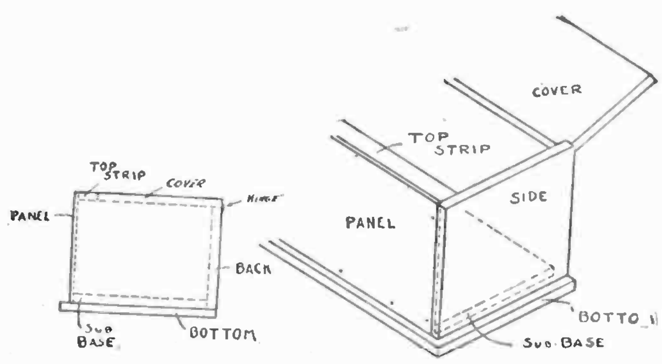


Fig. 7. Although there are many cabinets of standard panel size procurable, the builder may construct his own from the details shown here.

Drilling the Panel

To prepare the panel for drilling, lay out the various center points by direct reference to Fig. 3. With a light hammer and centerpunch mark these points and after securing the panel substantially, drill all the holes first with a No. 28 drill. Once drilled, the holes may be enlarged to their proper size. All the holes for mounting the parts on the panel should be countersunk.

The screw holes around the edge of the panel for fastening it to the cabinet are drilled with a No. 18 drill and countersunk. A No. 28 drill is used for the binding post, switch points, coil mount, and rheostat holes. The latter two are countersunk. All center holes such as condenser shaft, rheostat and switch arm holes are drilled with a 5-16 inch drill. The jack bushings take a 3-8 inch hole. The holes for the condenser mountings obviously differ with the type of condenser used, but for the duplex condensers a countersunk No. 28 hole is drilled.

Graining the Panel

A very fine panel appearance is obtained by adopting the commercial practice of graining. Firmly fix the panel on a bench or table and with a sheet of No. 00 emery cloth wrapped around a block of wood, rub down the panel, removing all the "high lights." The direction of graining is parallel with the long side rather than with the width of the panel. When all surface marks have been removed a few drops of machine oil may be rubbed in by the same graining process. A finely grained, highly finished panel surface results.

Countersink the heads of screws slightly under the surface of the panel so that they will offer no ob-

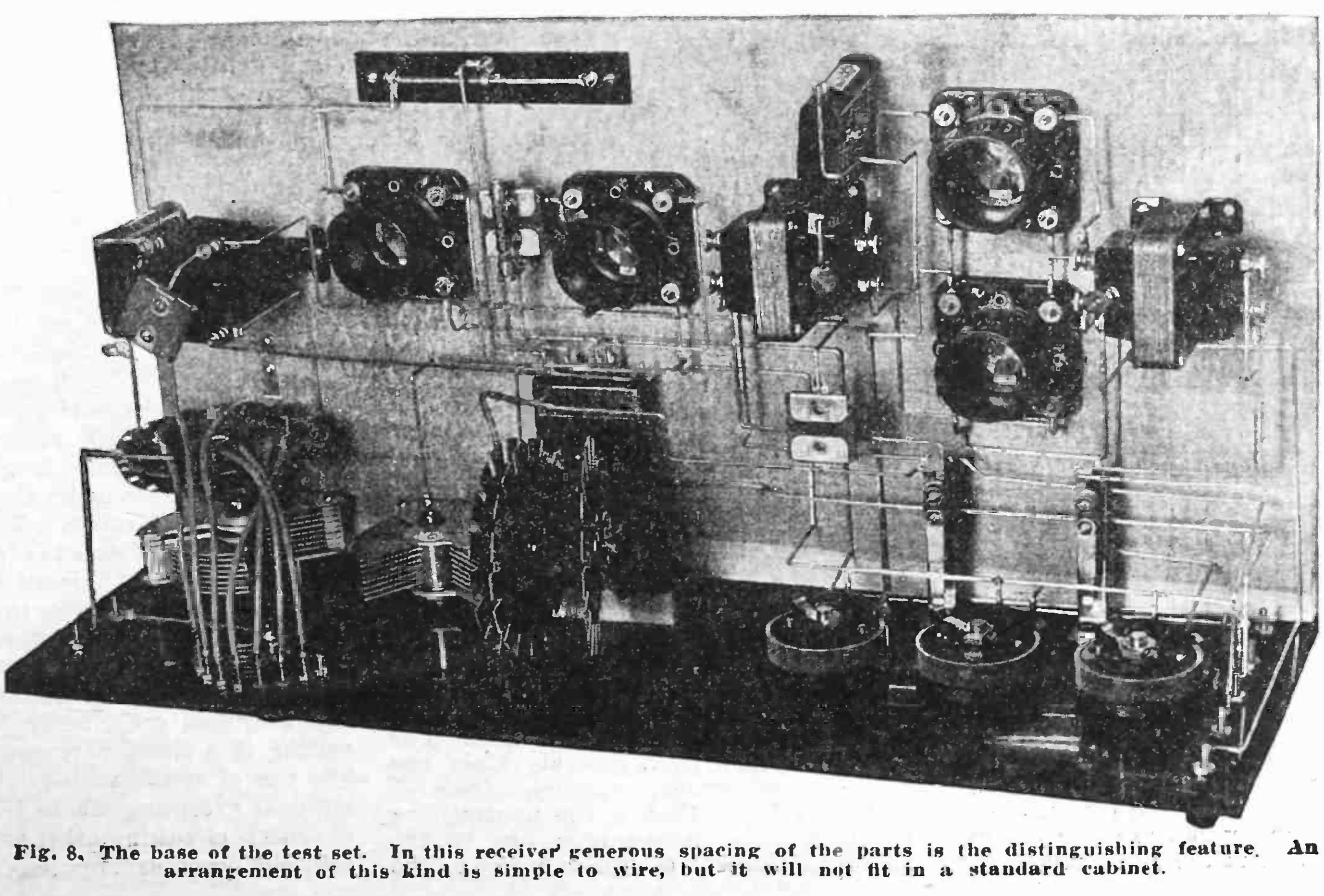


Fig. 8. The base of the test set. In this receiver generous spacing of the parts is the distinguishing feature. An arrangement of this kind is simple to wire, but it will not fit in a standard cabinet.

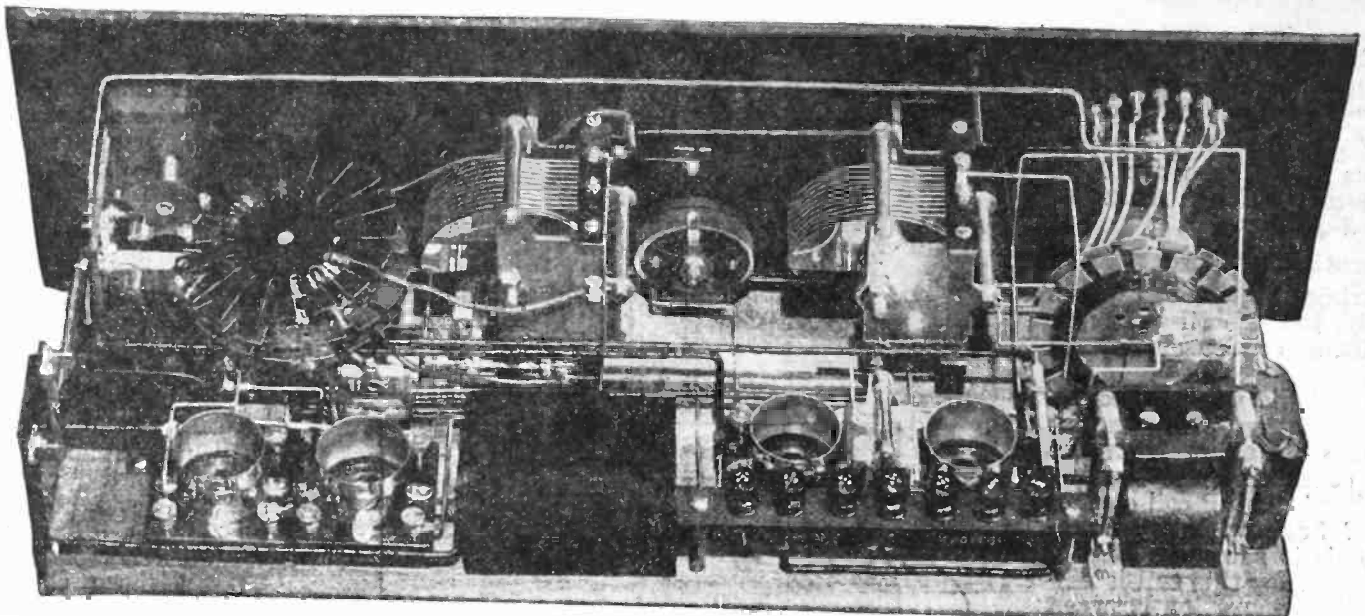


Fig. 9. Another view showing more compact placement and construction where a standard panel and cabinet have been used.

struction to the turning of dials or knobs.

Assembly

The next operation is in assembling the parts upon the panel. The switch points, stops, and arm are first mounted so that there is no interference to the hand motion which might be caused by the proximity of the other units. Before mounting the remainder of the units, attach the panel to the base. This supports the panel in a rigid manner, facilitating the assembling of the condensers, tri-coil unit, jacks, rheostats and binding posts in the order named.

The base layout is shown in detail in Fig. 2. It will be noticed that no dimensions are given. This allows the use of other types of apparatus with the same layout scheme. Round head wood screws, 1-2 inch, No. 5, are used to fasten the parts to the base. Where the base of the sockets is thicker than 1-4 inch, longer screws are necessary for the purpose.

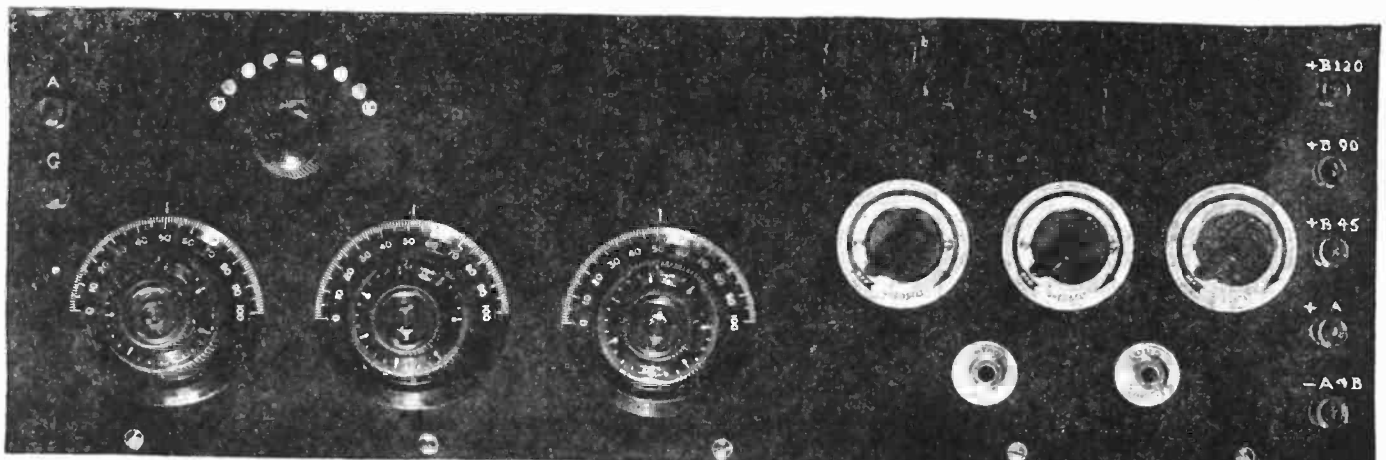


Fig. 10. The panel view of the set shown in Fig. 8. The vernier dials greatly facilitate sharp tuning.

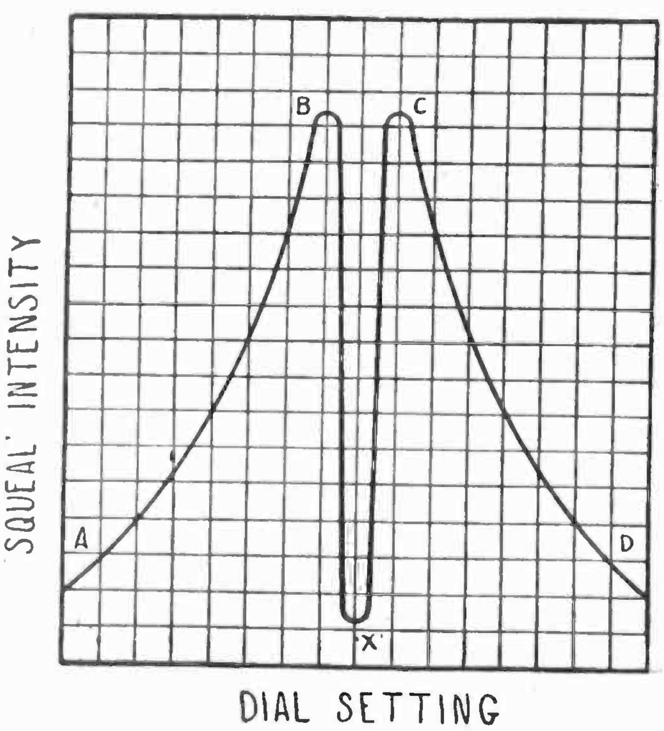


Fig. 11. Graphically explains the system and theory of proper neutralization in the Roberts circuit.

In a receiver of this type, the electro-magnetic and electrostatic fields set up by the several units unquestionably have their effects on the successful operation of the receiver. Whether this is detrimental or not depends largely upon the crowding or generous spacing of the various parts. Naturally there is a safe medium at which both crowding on one hand and the possibility of extra long leads on the other are reduced to a minimum. Fig. 5 shows such a layout with the actual wiring circuit. Both variable condensers C1 and C2 are of .0005 mfd., while the fixed condensers C5 and C6 are of .0025 and .005 mfd. respectively. The grid leak condenser C4 is .00025 mfd. For the grid leak, several values are recommended ranging from 3 to 7 megohms. CD3 is the neutralizing capacity. The inductances are of the standard Roberts design and are of the manufactured type. The filament circuit of the first tube is controlled by a 20 ohm rheostat as is the detector. The two push-pull amplifier tubes have their filaments in parallel with a 15 ohm rheostat in series with the supply.

The photograph Fig. 8 shows the first laboratory model built and strongly indicates the generous spacing of the elements. The photograph Fig. 9 is a revised layout showing the more compact construction.

In following the panel template of Fig. 3 it will be noted that the position of the jacks is slightly altered so that the socket may be brought nearer to the panel.

Wiring the Set

The actual wiring of the receiver is shown in Fig. 5. The schematic circuit is shown in Fig. 4. Together with the base photos these wiring layouts clearly indicate the attempt to keep the wires short, parallel to the length and width of the base, and to make all turns at right angles to each other. The observance of these few rules adds to the workmanlike appearance of the finished job. Soldered connections were made to the lugs attached to the various parts. Half-and-half strip solder and a solution of resin mixed with carbona or alcohol to the desired liquid consistency, was used, resulting in a clean, permanent connection. The use of spaghetti insulating tubing is optional excepting where there is danger of short circuiting, then its use is absolutely necessary.

Operating Notes

We used UV-201-A tubes throughout, but any standard tube may be substituted providing the necessary changes in value of the filament rheostats are made. The tickler and the secondary until all the squeal vanishes and the music or speech is clear. The quality and quantity of the reception can be increased by clearing up the tuning with a further adjustment would appear, if visualized. When the cylindrical tubing on the neutralizing condenser has been adjusted so that at a certain point on the dial of the first condenser there is a comparatively quiet

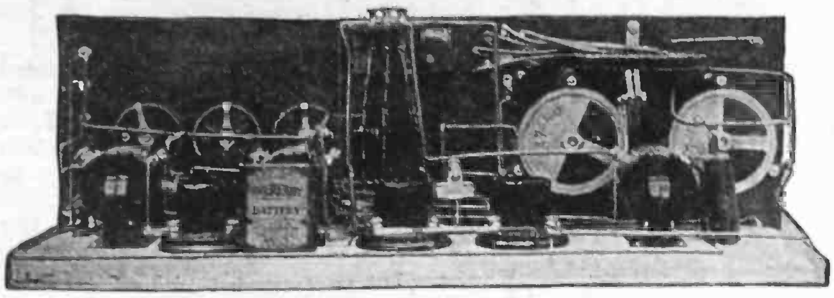


Fig. 12. A rear view of another Roberts experimental model.

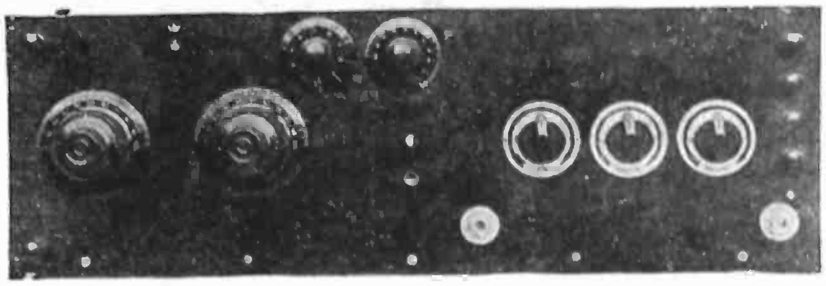


Fig. 13. A front panel view of the set shown in Fig. 12.

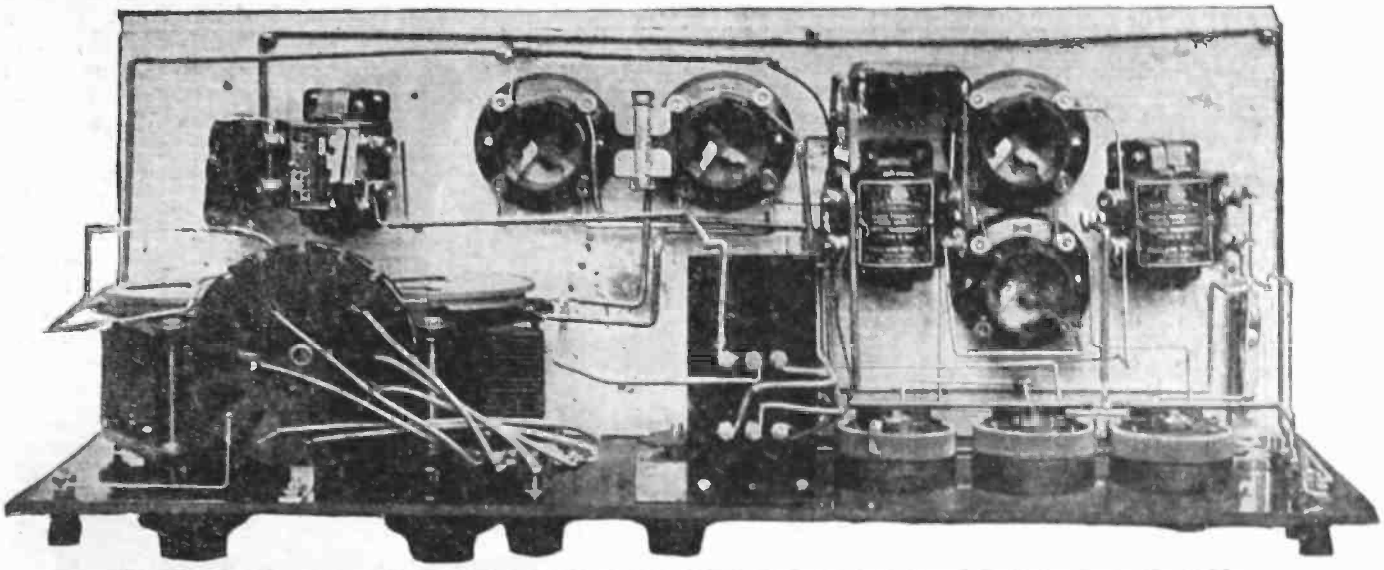


Fig. 14. Another base view. Other parts and a different base and panel layout prove the wide flexibility of design.

grid leak resistance of the detector tube controls to a large degree the volume output of the receiver. The value of this resistance will vary according to the tube used, from about 2 to 7 megohms.

If all the batteries, etc., have been connected and the set is otherwise ready to operate, the following procedure of tuning is followed: Turn the tubes on to normal brilliancy and listen-in on the first of the rheostats and the switch taps.

The operation of the push-pull amplifier is entirely controlled by its filament rheostat. It is important to observe that a loud speaker be used that is capable of handling the large output volume without distorting the tone quality. Signals from this receiver are so loud that some loud speakers cannot carry them when the set is turned on full. Undue oscilla- spot a few parts of a degree either side of this point, but gradually and equally increasing then decreasing in a whistle as the dial approaches and passes this point, it may be assumed that the correct location of the tube has been determined. But, if it so happens that the squeal first increases gradually, then quickly slumps down, then quickly increases and quickly decreases, it is evident that the proper

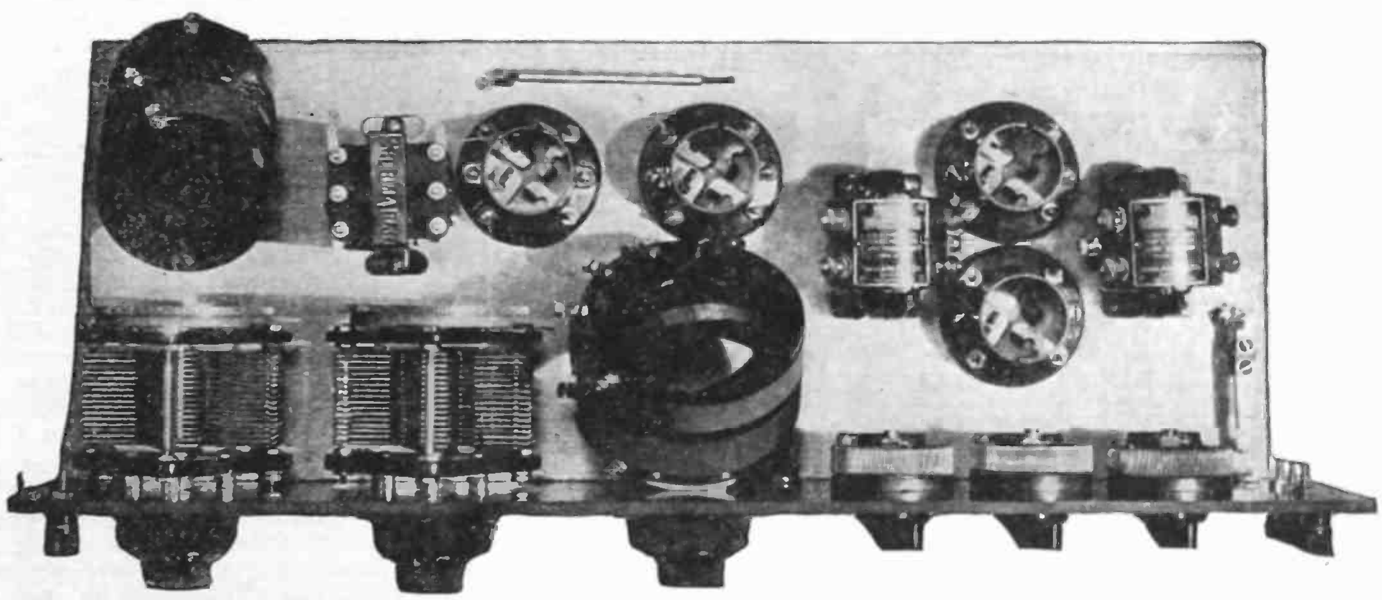
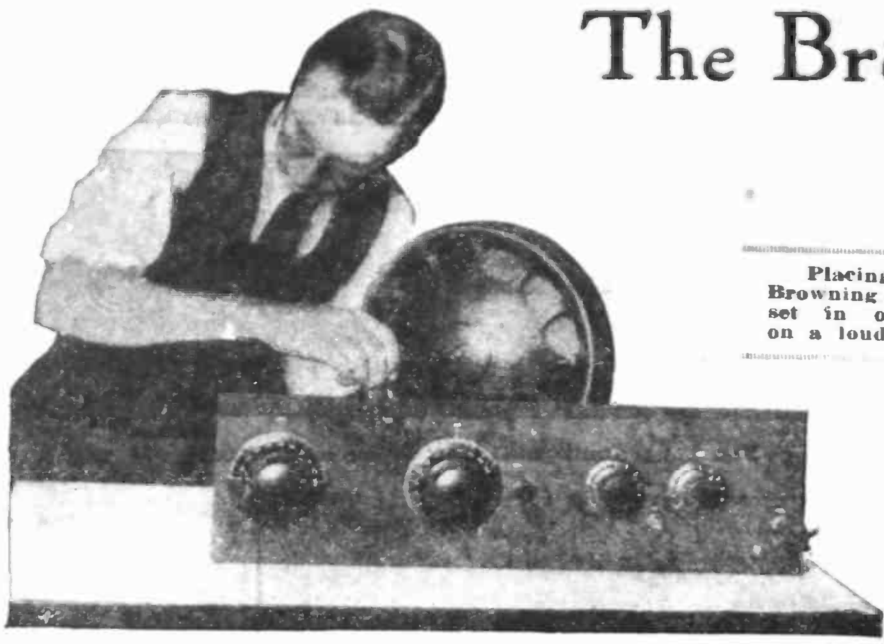


Fig. 15. Adapting the circuit to tuning units of a more standard nature. A 180 deg. coupler is rewound to take the place of the spiderweb NP-S-T coils and the antenna inductance is wound on a cylindrical form mounted at right angles to the coupler. No matter what type of apparatus is used, it is well to make a permanent, complete layout of this character before doing any of the wiring.

jack. Turn up the tickler control so that the coupling between the secondary and the tickler is quite close. Now, set the tap switch on the middle point and simultaneously rotate the two condenser dials slowly. Gradually the squeal of a station will be tuned-in until it reaches its loudest point. Let these controls remain at this setting and then slowly reduce the coupling between the tion or howling that seemingly cannot be controlled by any of the tuning units may be eliminated (providing the correct connections to the coils have been made) by reversing the leads to the primary of the audio frequency transformer used for reflexing. It is also necessary to vary the detector B voltage to its proper value, depending upon the individual tube used.

Fig. 11 shows how the tuning squeal balance has not been obtained. Try sliding the tube in the opposite direction of its original position for only a short distance and repeat the variation of squeal intensity. In Fig. 11, X shows the silent point extending from B to C, while A-B indicates a gradual increase in intensity and C-D indicates a gradual decrease in squeal intensity. This constitutes the proper squeal adjustment.

The Browning-Drake Set



Placing the Browning - Drake set in operation on a loudspeaker.

Illustrations by Courtesy of Radio Engineering (New York)

THE Browning-Drake receiver illustrated in the accompanying photographs and drawings is not only interesting and unusual in its design and operation but almost unique in the method by which the circuit and the constants were worked out. Messrs. G. H. Browning and F. H. Drake, who are responsible for this outfit, undertook to develop at Harvard University a receiver equivalent to the super-heterodyne in selectivity and sensitiveness, operating on not more than four tubes. Constructional details of this set as given herewith by *M. B. Sleeper* appeared in *Radio Engineering* magazine and the excellent design worked out by the publishers is to be commended.

Comparisons are so dangerous to make that comparisons with the super-heterodyne would be left to those who built this set. It is certainly true that the outfit is unusually sensitive and selective, simple to operate and construct, and an all-around good receiver which will be appreciated equally by experimenters and broadcast listeners.

In the special notes which appear farther on, a more detailed account of the development of the circuit is given. At this point it is sufficient to say that the possible amplification from a tuned radio frequency transformer was determined mathematically, and curves plotted to take into account the value of the primary inductance in the R. F. transformer and the coupling between the primary and secondary coils. The curves showed that maximum amplification was obtained when a particular relation existed between the primary inductance and the coupler.

On the basis of the data thus obtained, a transformer was assembled and tested under actual operating conditions. In practice, the calculations did not seem to hold good for the amplification was far below that indicated by the curves. It was only after several months of experimenting and testing that the source of the difficulty was located—the capacity between the primary and secondary coils, which is responsible for the rather low amplification obtained from R. F. transformers, was introducing losses. Accordingly, the construction of the transformer was changed as indicated by the sketch in Fig. 7. Thereupon an actual amplification equal to 90 per cent of the theoretical value was obtained.

A very interesting fact was brought out in this experimental work. It was found that the UV-199 tube was equivalent to the UV-201-A as an R. F. amplifier, which accounts for its use in this receiving set.

Subsequent development work showed that the high R. F. amplification obtained could be increased three or four times by using a regenerative detector, altering the constants of the circuits to take account of the decrease in resistance of the secondary as a result of the feed-back action.

For neatness and simplicity of design, the arrangement of the Browning-Drake Receiver is hard to improve upon. To be sure, this is largely a matter of good luck, for some types of circuits come out in such a way that it is practically impossible to work out an orderly design and to get the leads as short as they should be while keeping them properly spaced apart.

There are several excellent features in this outfit. The National condensers are equipped with angle brackets so that the condenser can be set up on a table or baseboard. These are employed to support the tube panel at one end, while a mounting pillar holds the panel in place at the other extremity. The new Benjamin sockets are used for this outfit, as you will see from the illustrations. They are exceedingly well designed, both electrically and mechanically, and have the advantage of a spring mounting to absorb vibrations without making the construction clumsy. General Instrument rheostats, with their fixed moulded dials, improve the appearance of the controls on the front panel. Their action is particularly smooth and the design of the shaft lock makes them easy to install. Another feature is the vernier dials. In appearance, they are exactly like solid bakelite dials. By means of a very clever reducing arrangement under the knob, a reduction of 6 to 1 is obtained.

The panels for this set are of mahogany celeron. This is a perfect reproduction of mahogany grain, for the outer sheets of paper of which the panels are formed are primed with the real grain, obtained by photographing a mahogany board. As a matter of fact, it is difficult to tell without examining the edges of the panel, whether the material is wood or celeron.

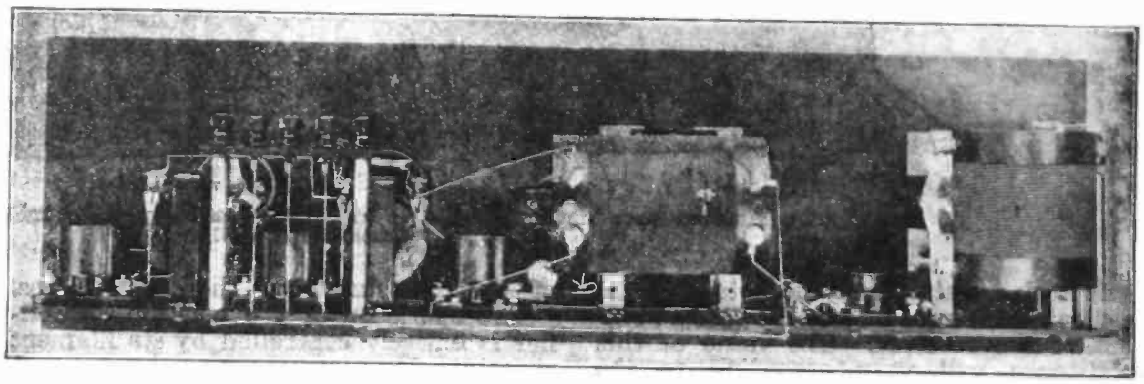


Fig. 1. One reason for the high efficiency of this set is that the parts are arranged in the exact sequence as they come into the circuit, making possible the use of short leads well separated.

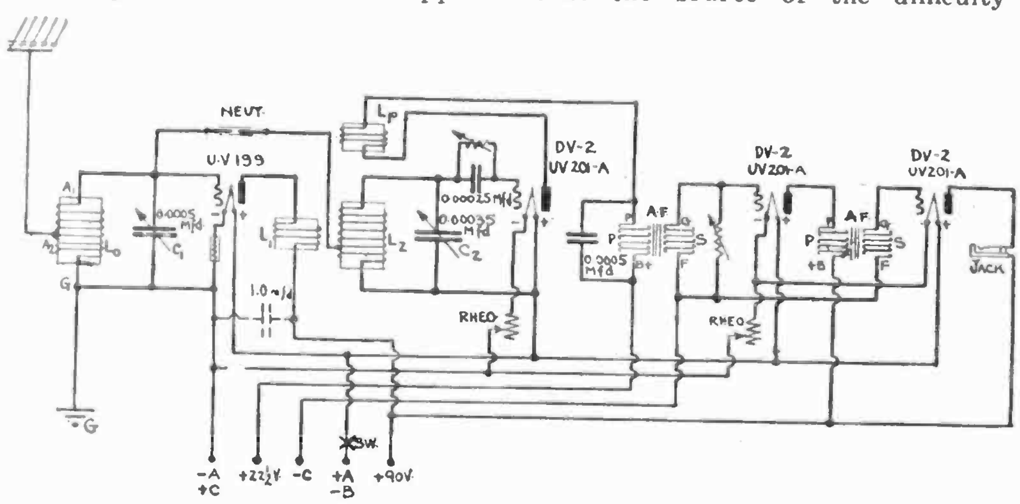


Fig. 2. This diagram shows the circuit system of the Browning-Drake set. It is advisable to follow the picture wiring diagram in making connections.

How the Tuning Controls Are Used

On the front of the panel there are five adjustments, two condenser dials, two rheostats, and a Walbert filament lock switch. With the lock switch at the middle position, which lights the filaments, the detector and A. F. amplifier rheostats are adjusted properly. No control is needed for the UV-199 as that is regulated automatically by an Amperite.

Then the two dials are set at about 30 divisions and the tickler coil rotated until a slight roaring sound is heard in the phones. To bring in a station, tuning is done roughly with the R. F.

You will notice that, while the adjustment of the secondary condenser seems rather broad while a transmitting station is being located with the R. F. dial, when the R. F. dial is set exactly, the secondary control becomes very sharp. This is a little trick in the

is made in the parts or layout, it may be necessary to use a neutralizing condenser, as shown in Fig. 2, the schematic wiring diagram.

Two panels are required, of mahogany celeron if you prefer this finish or of Formica or Bakelite if you favor the

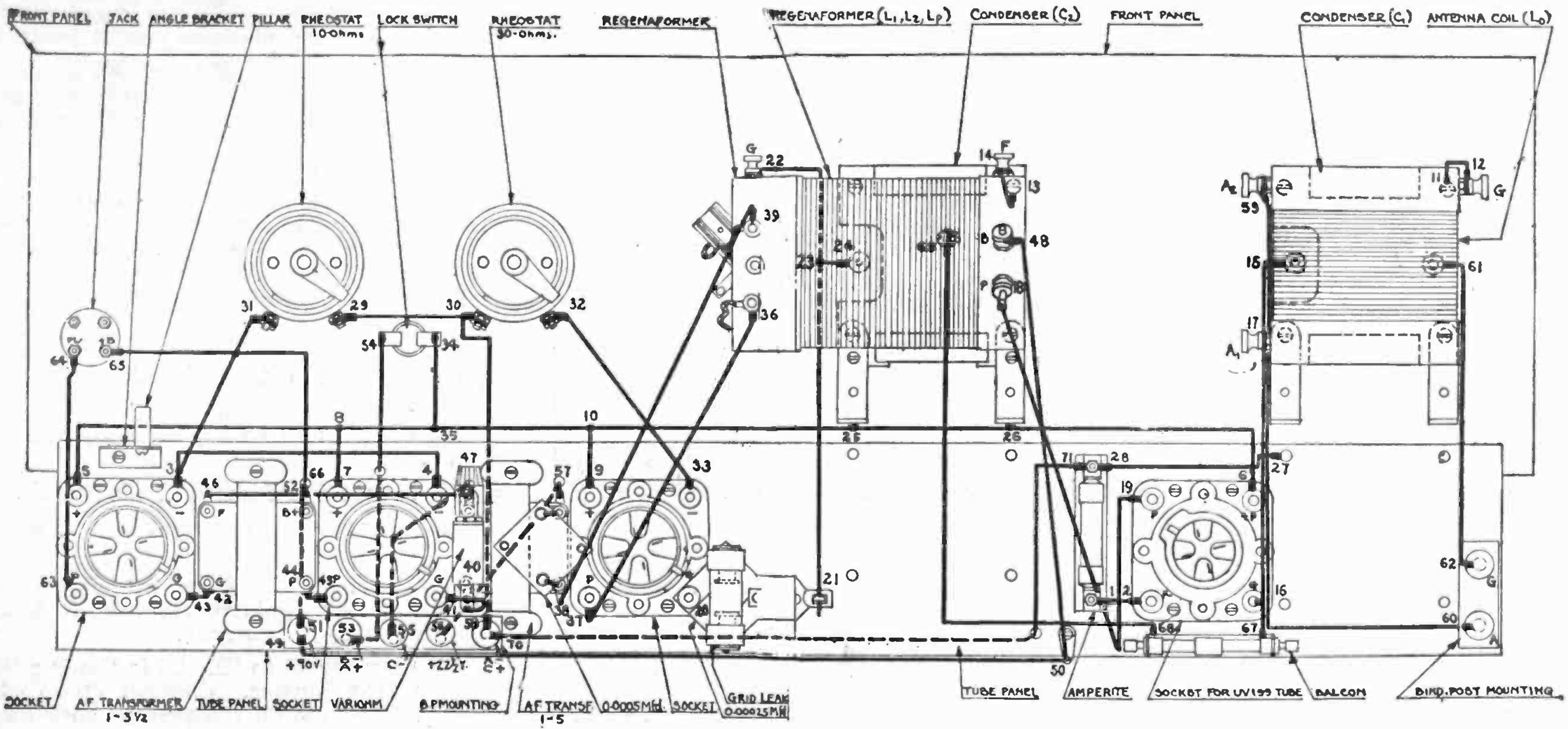


Fig. 3. Picture wiring diagram, showing connections as they are actually made. The tube panel is tipped down so that you see the rear of the front panel and the top of the tube panel.

condenser, although the secondary condenser should be kept at about the same setting as the other dial. As soon as a station is heard, the R. F. condenser should be left alone and the secondary condenser adjusted for maximum sig-

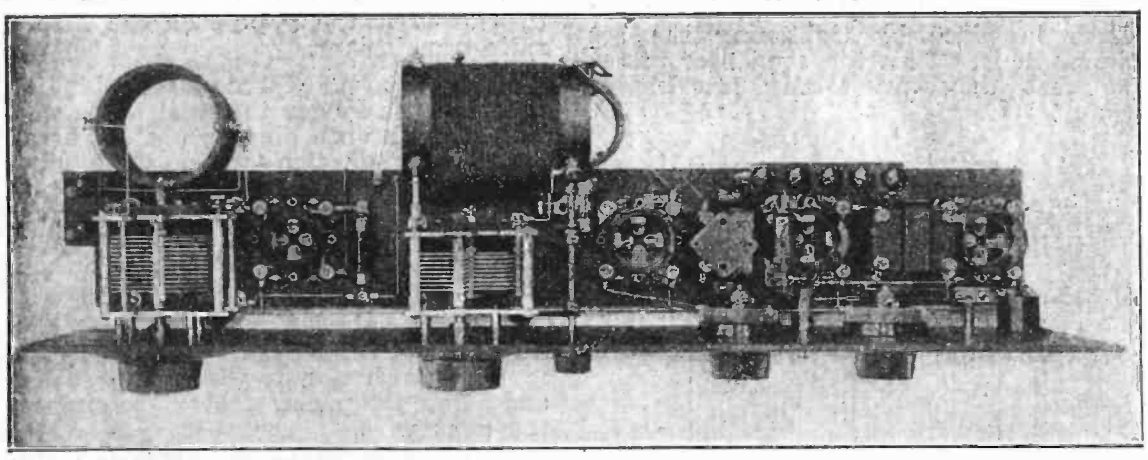


Fig. 4. Looking down on the top of the set. Check your assembly with the illustrations as you put the parts together and make connections.

nal strength. Then the R. F. dial is set accurately and, if necessary, the tickler coupling increased slightly.

When the set is tuned in this way, it does not oscillate or radiate. Consequently, there are no objectionable squeals in the loudspeaker nor is any interference caused with other receiving sets in the neighborhood. There is very little tendency to put the set into oscillation by using too much tickler feedback, as is the case with ordinary regenerative receivers, because, just before the tickler is turned enough to make the set oscillate the signals become fainter. Turning the tickler farther makes the signals strong again but badly distorted. The exact way to handle the tickler control is easily understood when the set is in actual operation.

operation of the outfit that helps greatly in tuning in one station after another.

Standard Parts Required

Following is a list of the parts actually used in this set. While other things equally good can be substituted, it is not advisable to change the mechanical

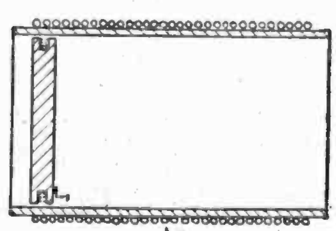


Fig. 5. Sectional view of the R. F. transformer showing the primary and secondary windings.

design of this set for the reason that, as the original model was actually built, it is self-neutralizing. If any change

black color. The front panel measures 7 by 24 ins., and the tube panel, 3½ by 33 ins. It is well to get the base panel 24½ ins. long so that the two strips for mounting the binding posts can be cut from it. The longer strip measures 3½ by ¾ in. and the other 1¾ by ¾ in. All are 3/16 in. thick.

The key instruments are the National secondary condenser and coupling unit, and the R. F. condenser and transformer unit. These condensers are supplied with vernier dials 4 ins. in diameter. The other parts required are three Benjamin sockets for standard-base tubes, one Benjamin UV-199 socket, a UV-199 Amperite, one Amertran of the 1 to 5 ratio, one 1 to 3½ ratio, a 30-ohm General Instrument rheostat, and another of 10-ohms, an Electrad vari-

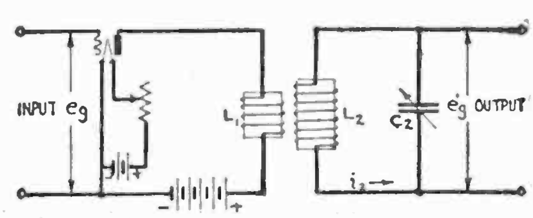


Fig. 6. Theoretical circuit of the R. F. amplifier as it was considered in the mathematical development.

ohm, a B. M. S. Tri-jack, a Walbert filament lock switch, one New York Coil condenser of 0.0005 mfd., and another of 0.00025 mfd. with grid leak clips, a Turn-it variable grid leak and seven binding posts of the Eby or Marshall-Gerken type. Since there is not enough room on the binding post mounting strips for engraving the terminal markings, it is well to use engraved posts.

For hardware, four panel support pillars, 3⅜ ins. long by ⅜ in. diameter, threaded 6/32 at each end, are needed, one coil mounting pillar, 11/16 in. long threaded 6/32, and one angle bracket

Drilling the Panels

The drawing, Fig. 3, gives the panel layout. The panel is furnished with a high polish. If, however, you prefer to have it dull, the polish can be taken off by rubbing the panels with No. O sandpaper. Be very careful not to rub too hard or you will go through the outer layers on which the grain is printed. After sandpapering, a little oil will make the grain show up again. If the set is to be used in a mahogany cabinet, it is well to finish the panel to match the finish of the cabinet.

Engraving adds greatly to the appearance of the set. It is not expensive, and the cost is well worth the professional touch that it gives to the panel. If you are going to send the panel out to be engraved, drill your holes first.

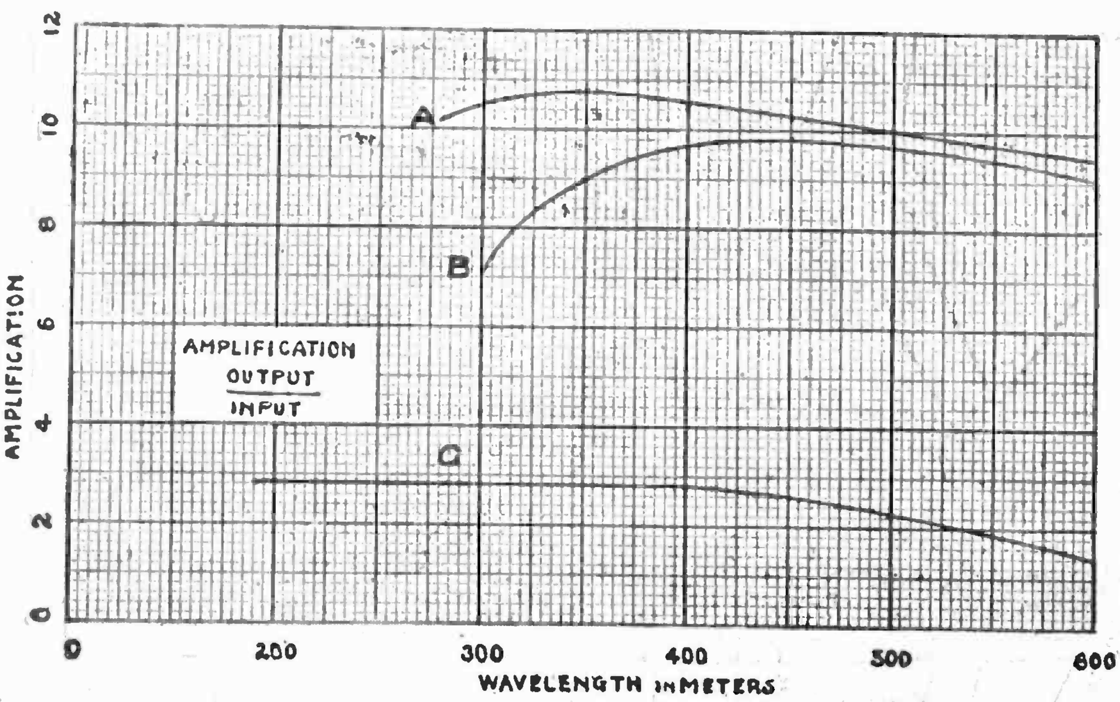


Fig. 7. A most unusual set of curves, showing A at the theoretical amplification, at C. the actual amplification just obtained by applying the mathematics to practice, and at B. the amplification obtained after the kinks had been ironed out.

Assembly and Wiring

The following step-by-step assembly instructions have been worked out very carefully so that, as the parts are put together, it will not be found necessary to take off something already put together in order to get at a difficult connection. You will save yourself much time and trouble, and assure yourself of the success of the final results if you follow each step in order.

Do the soldering with a good electric iron, if you can get one. For the joints use either Kester rosin core solder or soft solder and Nokorode paste. Be sure to apply enough heat so that the solder flows freely. Much trouble can be saved by tinning each lug thoroughly before it is put in place. The directions in which the lugs should point are indicated by the heavy lines on the picture wiring diagram in Fig. 3.

1. Mount the four sockets on the tube panel, putting the terminals in the positions shown in the picture wiring diagram. Use ½-in. 6-32 R. H. screws and nuts. Mount the Amperite next to the 199 socket, fastening it with a ½-in. 6-32 R. H. screw and nut.

2. Connect 1 to 2, 3 to 4, and 5 to 6. Keep this wire on the level with the upper surface of the tube panel and about ⅛-in. away from the edge. Connect 7 to 8, and 9 to 10.

3. Mount the secondary and R. F. transformer condensers, with their respective coils, on the front panel. It is necessary to remove the dials from the condensers. First loosen the set screw which holds the knob to the shaft. Then take out the three R. H. screws which fasten the dial to the gear box, remove the four screws which hold the gear box to the condenser mounting posts, and undo the set screw on the collar which fits over the condenser shaft. You will find three washers on each condenser mounting post. Take off all but one from each post. Put the condenser behind the panel and put in the screws which go through the gear box and thread into the mounting pillars, put back the three screws holding the dial to the gear box, and, finally, fasten the knob in place by tightening the set screw in it. Turn the condenser plates so that they are totally interleaved,

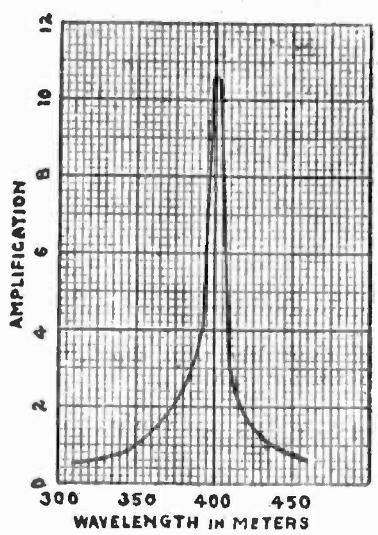


Fig. 8. Resonance curve, indicating the sharpness of tuning at 400 meters.

loosen the set screw on the collar over the condenser shaft, set the dial so that the 100 division line coincides with the line on the panel and tighten the set screw again.

4. Connect 11 to 12. 11 is a lug on the screw fastening the condenser end plate to lug on the screw which holds the condenser end plate to the post.

5. Turn the mounting feet on the variable condensers so that the feet point to the rear. Fasten these feet to the tube panel with ½-in. 6-32 R. H. screws and nuts.

6. Connect 15 to 16. 15 is the binding post of the fixed plates and 16 the grid contact on the socket. Connect this wire also to 17, the bottom binding post on the coil. Connect 18 to 19. It is well to insulate this wire with M-R varnished tubing so that it will not accidentally touch one of the filament circuit leads.

7. Remove one of the Fahnestock binding posts on the fixed condenser, and put the condenser terminal over binding post 20.

8. Connect 21 to 22, and connect this wire at 23 to 24, the binding post on the fixed plates. Solder wire 5 to 6 to the mounting feet of the R. F. condenser at 25 and 26. Put a lug under the screw holding the left hand forward leg of the secondary condenser and connect 27 to 28.

9. Fasten the two rheostats to the front panel.

10. Connect 29 to 30, 31 to 3, and 32 to 33.

11. Mount the filament lock switch.

12. Connect 34 to 35, and 36 to 37.

13. Mount the 1-5 A. F. transformer using ½-in. 6-32 R. H. screws. Have the secondary terminals to the left, looking at the set from the rear.

14. Connect 38 to 39. 38 is the P post on the transformer. Connect 40 to 41. 40 is the G post on the transformer and 41 the G post on the socket.

15. Turn the terminals of the 0.0005 mfd. condenser to the side and bend them around so that they can be slipped over the P and B+ binding post of the transformer. Mount the 1 to 3½ ratio transformer.

16. Connect 42 to 43, and 44 to 45. 44 is the P post on the transformer and 45 the P post on the socket. Connect 46 to 47. 47 is the F post on the 1 to 5 ratio transformer.

17. Mount the three inside binding posts on the longer terminal strip, putting lugs on each binding post. Thread the shanks of the two outer binding posts into the ends of panel support pillars. Fasten the pillars to the tube panel with ½-in. 6-32 R. H. screws, putting two lugs under each one of these screws.

18. At terminal 50 you will see that a screw is put through the tube panel, held in place with a nut, with a lug above and below the panel. This is to support the next wire.

19. Connect 48 to 49, soldering this wire at 50 to hold it in place. 49 is one of the lugs under the tube panel on the terminal support pillar. Connect 51 to 52. This wire is run from the other lug on the support pillar underneath the tube panel and up through a hole to the B+ binding post on the transformer. Connect 53 to 54. This wire is run from the lug on the binding post down through a hole in the tube panel and up through another hole to the lock switch. Connect 55 to 47. Connect 56 to 57, and 58 to 30. This wire should be insulated with M-R varnished tubing where it passes along the underside of the tube panel. Connect 59 to 60, and 61 to 62.

20. Fasten the angle bracket to the tube panel, and fasten the angle bracket to the front panel by means of a coil support pillar. ½-in. 6-32 screws should be used. Mount the tri-jack on the front panel with the binding posts in the positions shown.

21. Connect 63 to 64, and 65 to 66, a

connection made to the wire, running from 51 to 52. Connect 70 to 71. 70 is the other lug on the panel support pillar.

22. If you use a Balcon for neutralizing, mount it directly behind the UV-199 socket and connect 67 to 16, and 68 to 69, a lug put on a screw passing through the small loop in the secondary winding.

This completes the wiring of the set.

Testing and Operating

The picture wiring diagram shows the connections for the batteries. Looking at the set from the rear, the left-hand binding post is for the + terminal of a 90-volt B battery, while the next binding post to the right is for the — terminal. This same terminal takes the — post of a 22½-volt battery with the + going to the next to the last binding post to the right. With a UV-199 Amperite, 6 volts can be put on the filament of the R. F. amplifier tube. Therefore a 6-volt storage battery should be used, connected on the — side to the right-hand binding post and on the + side of the first binding post to the right. The C battery is connected from the right-hand to the center binding post, the positive terminal going to the right. With this combination of A and B batteries, two 4½-volt Eveready 3's are required. This not only reduces the plate current to a minimum but prevents distortion. For the detector and A. F. amplifier tubes UV 201A's, DV 2's, or C 301A tubes can be used. In tests made on this outfit, excellent results were obtained with 3 DV 3's for the detector and A. F. amplifier stages, but the ¼ ampere tubes made the volume.

You will note that an Audiohm is connected across the secondary terminals of the first A. F. transformer. It is advisable to use this control to cut down the volume on powerful stations. During the tests made at the Darian Laboratory, the tubes were overloaded, in spite of the fact that 9 volts of C battery were used, on the New York stations, Springfield, and the A. H. Grebe Co. station, WAHG. However, the Audiohm used had a tendency to reduce the strength of weak signals even when it was set for maximum resistance. Therefore the spring connection was not fastened securely on the transformer binding post but merely hooked around it so it could be disconnected easily. The resistance of the grid leak is important. For that reason, a Turn-it is suggested, although some experimenters prefer to try different values of fixed grid leaks. The grid leak is exceedingly important in this set. If you hear disturbing noises, test the grid leak at once, for it exercises a very important control. A faulty grid leak will entirely spoil the results.

If, for any reason, signals do not come in properly, test the coils for open circuits, test the transformers for opens or shorts between the windings, test the fixed condenser across the primary of the first transformer for short circuit, and test the jack for open circuit. At one of these points you will find your trouble unless you have made a mistake in the connections.

Notes About Neutralizing

It was not found necessary to neutralize this receiver for, as is often the case, the peculiar arrangement causes the circuit to neutralize itself. If, however, you find that the set is radiating, as indicated by whistles at various points when the secondary condenser dial is rotated, a neutralizing condenser can be mounted on the set and adjusted in the following manner:

Turn the tickler to a point where placing a moistened finger on the grid side of the condenser C_2 gives a pluck in the phones. Of course, the antenna and ground must be connected, as well as A and B batteries, and the tubes lighted at their proper brilliancy. Turn back the tickler until this pluck just disappears. Then rotate condenser C_1, and if, at any setting of C_1 touching, the grid side of C_2 should give a pluck, the set is not neutralized. Change the capacity of the neutralizing condenser until this test is satisfactory. If no value of capacity is found, reverse the leads to coil L_1 and repeat the test.

Mathematics of the Tuned R. F. Transformer

For those who are technically inclined, it is thought advisable to give some of the mathematics of the radio frequency transformer. A paper has already been presented before the Northeastern District Convention of Electrical Engineers, in which the theory and experimental data have been completely taken up, so that this is merely a summary of that paper.

Referring to Fig. 6, the radio frequency voltage impressed on the grid of the amplifier tube is e g, while the radio voltage impressed on the detector tube é g. Therefore, as we desire to find the amplification of the system we must solve the circuit for é g/e g with these abbreviations:

L_1 inductance of the primary.

L_2 inductance of the secondary.

$W=2\pi f$ where f is impressed frequency.

i_2=current in secondary circuit.

M mutual inductance between L_1 and L_2.

R_n plate resistance of the tube.

C_2 capacity of condenser.

μ Amplification of the tube.

$$W_0=\frac{1}{\sqrt{L_2 C_2}} \qquad \tau=\frac{M}{\sqrt{L_1 L_2}}$$

$$\eta_1=\frac{R_p}{L_1 W} \qquad \eta_2=\frac{R_2}{L_2 W}$$

$$\frac{W_0}{W}=\theta$$

The equation for the amplication of the system is:

Equation 1:

$$\frac{e'_g}{e_g}=\frac{\mu\sqrt{L_2/L_1}}{\sqrt{\eta_2^2+(1-\theta^2)^2}\sqrt{\left[\eta_1+\frac{\tau^2\eta_2}{\eta_2^2+(1-\theta^2)^2}\right]^2+\left[1-\frac{\tau^2(1-\theta^2)}{\eta_2^2+(1-\theta^2)^2}\right]^2}}$$

When C_2 is tuned for maximum signal, equation becomes:

Equation 2:

$$\frac{e'_g}{e_g}=\frac{\mu\tau\sqrt{L_2/L_1}\sqrt{\eta_1^2+1}}{\eta_2(\eta_1^2+1)+\tau^2\eta_1}$$

It is seen that equation 2 has a maximum with respect to t. This maximum occurs when

Equation 3:

$$t^2=\frac{\eta_2}{\eta_1}\left(\eta_1^2+1\right)$$

With equation 3 substituted in 2, we obtain:

Equation 4:

$$\frac{e'_g}{e_g}=\frac{\mu\sqrt{L_2/L_1}}{2\sqrt{\eta_1\eta_2}}$$

This at once shows that L_2 should be made as large as possible consistent with tuning to the lowest wavelength desired. Therefore, L_2 was at first made a .4 millihenrys, but later reduced to .3 millihenrys, in order to bring in lower wavelengths with great volume.

An experimental curve was taken to find what value of n_2 could be easily obtained, and the average value to be .008. R of the UV 199 tube was found to be about 20,000 ohms so that with 1=.52 which was a value which could be obtained, L_1 must be .13 millihenrys. With these constants, and the form of winding shown in Fig. 5, the theoretical curve, A, shown in Fig. 7, was plotted and the measured curve shown at B was taken.

With regeneration n_1 was found to be reduced by one-third and consequently the other constants of the transformer were changed accordingly.

In the original papers, the tendency of the input tuning system to break into oscillation, when the transformer was tuned, was taken up and several interesting facts brought out which will not be considered here.

The reader may see that this equipment was not made up by a cut and dried proposition, but was carefully designed on the basis of theoretical and experimental data which was collected during a year's work.

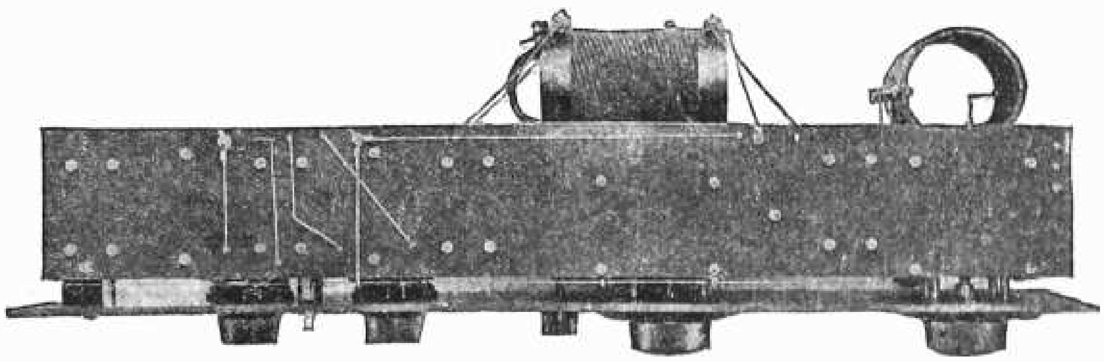


Fig. 9. Showing the wiring as it appears on the underside of the tube panel.

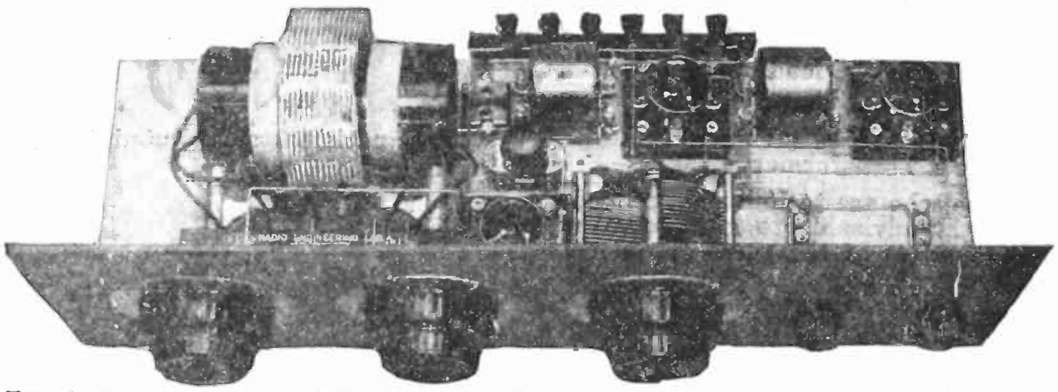
Wavelength Calibration for the R. F. Tuning Condenser Dial

230	10.0	440	47.5
240	11.5	460	52.25
280	17.25	480	57.5
300	20.5	500	62.5
320	24.0	520	67.5
350	38.5	540	73.5
370	29.0	560	80.0
400	32.7	580	85.6
420	43.0	600	92.0

How to Build a Low Loss Set

WHEREVER you go or wherever you are, at the present time, you hear "low loss" this and "low loss" that.

When you look back over the receiver you used a few years ago you cannot help but wonder how the poor little micro-volt of signal energy ever reached your headphones.



By placing the detector tube socket as shown between the tuner and variable condenser, the shortest leads are possible. The Bradleyleak together with the grid condenser connected directly across its terminals is placed directly behind the detector tube socket.

The reduction of losses in receiving apparatus marks one of the outstanding developments in radio in the past ten years.

What does the reduction of losses accomplish? It sharpens tuning; it increases signal strength; reduces set and tube noises; and in these ways the reduction of losses means a more efficient receiver.

One of the most effective types of low loss receivers is that of the three-circuit variety, a splendid design of which is described herewith by *R. A. Bradley* in *Wireless Age* magazine.

This receiver has been used for only a month, yet in that time it has certainly proved what low loss design, construction, and assembly will accomplish in a receiver.

The main tuning unit is manufactured complete and includes a basket weave fixed secondary, a tickler coil and a primary coil. The latter two are wound solenoid fashion on bakelite tubes. Perhaps you wonder why low loss design is not carried into effect in these instances. Why?—because there is absolutely no advantage to be had from the reduction of resistance in the plate circuit of a regenerative detector tube. Did you know that the average fan's antenna has comparatively high resistance and that the removal of one ohm from the primary coil will have no effect on the operation of the set? Such is the actual truth of the matter.

The variable condenser tuning the secondary further carries out the low loss practice. It is a grounded rotor condenser of superior construction insulated with Isolantite which needs no introduction.

The sockets are those which have excellent side-wiping contacts with real honest-to-goodness springs in them. When you put the tube in the socket—you know it's hitting "on all four" contacts.

You see now what we meant by low loss in construction and assembly when it is carried even to contact springs on sockets, and the results speak volumes and these results are more convincing than ever printed words could be.

How to Build It

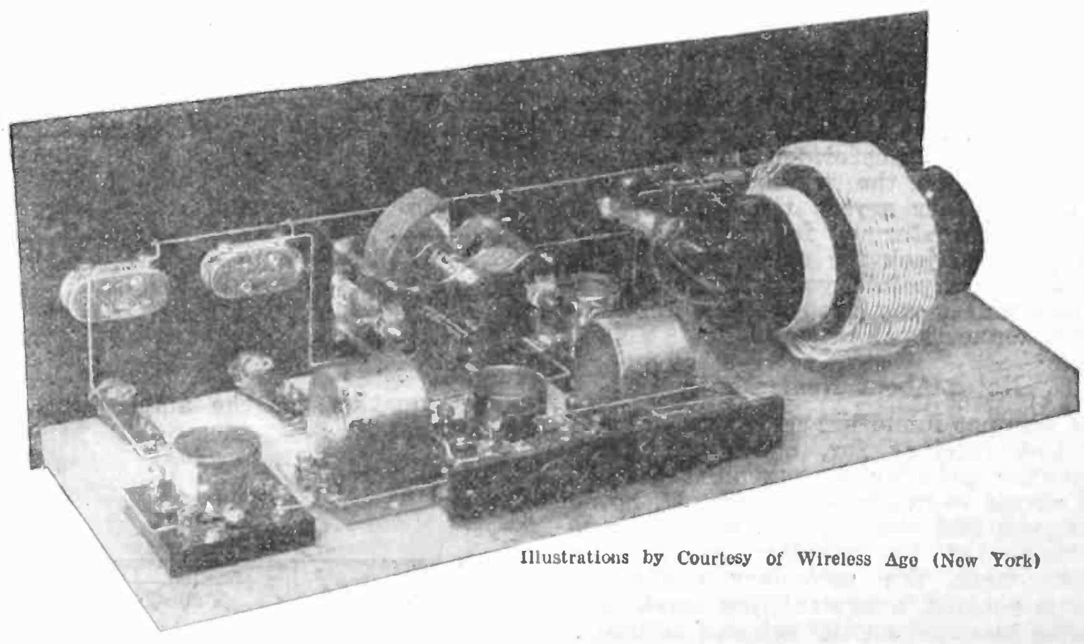
The main consideration in the first stages of the receiver's construction is the panel layout. You must have a 7" x 21" panel and on this panel must go three tuning dials, two rheostats and two jacks. The best arrangement is as follows: The hole for the shaft of the primary coil is drilled 3½" from the left end of the panel and centered, up and down. The template furnished with the tuner will indicate the proper drillings for the tickler shaft and supporting screws. The distance between shaft centers is given on the template. Measure off an equal distance to the right of the tickler shaft and center punch this for the shaft of the tuning condenser.

LISTS OF MATERIALS

- One Low Loss tuner (Radio Engineering Laboratories)
- One .0005 mfd. variable condenser (General Instrument Co.)
- Three Standard sockets (Howard)
- Two Audio transformers (Pacent)
- Two Single closed circuit filament lighting jacks (Pacent)
- Two Bradleystats
- Three Micro-Dials (Jewett)
- One 7x21 Panel (Pyradiolin)
- Six Eby Binding Posts
- One .002 mfd. fixed condenser (Dubilier)
- One Bradleyleak and .00025 mfd. Condenser

When this is accomplished the position of the rheostats will be simple to locate. The two jacks are placed in a line 1¾" from the base of the panel. This completes the panel layout. Attention is next directed to the baseboard and to the instruments mounted thereon. Particular attention was paid to the layout of the transformers and sockets for most efficient operation, shortest leads and simplest connections. By placing the detector tube socket between the low loss coil and the variable condenser it is possible to secure very short leads. The audio frequency unit is then laid out along the rear edge of the baseboard in as compact a manner as possible. We wish to call your attention particularly to the method of making connections to these excellent audio frequency transformers. The leads are brought out in such a way that it permits mounting the transformers slightly to the rear of the sockets, and the plate and grid connections come out directly to the tube socket binding posts. The B plus and A minus are to the rear of the transformer and go directly to their respective binding posts. This is the ideal method of making transformer connections and greatly simplifies the wiring. The lead running along the top of the low loss tuner terminal strip to the Bradleystat as shown in the accompanying illustrations is the A minus lead and all returns are made to this lead, and it is finally grounded by a strap connection to the ground binding post wherever convenient. In making this connection, run one piece of bus wire from the farthest Bradleystat to the ground terminal on the low loss tuner. Then take all connections which should go to this minus A line, off from this one main lead.

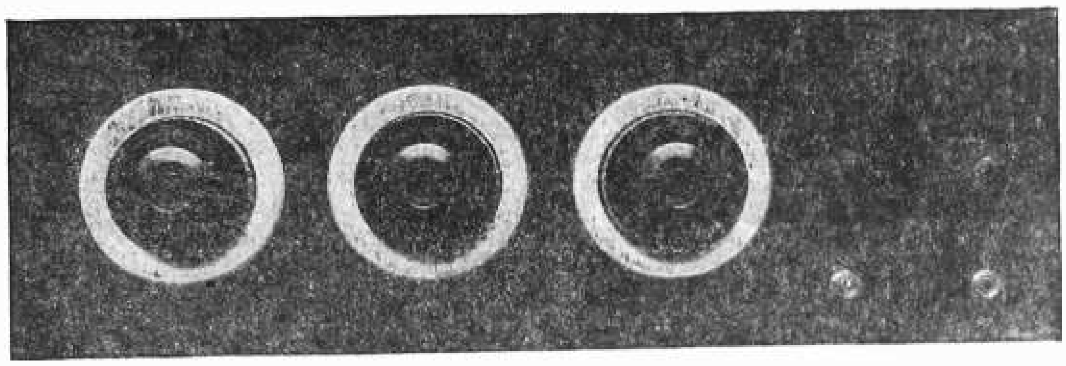
We prefer to use in an audio frequency amplifier single closed circuit jacks for cutting in the phones at various stations. If wired according to the diagram, they work just as well as double circuit jacks and are much easier to connect up. When the phones are plugged in the jack, the transformer of the following stage is automatically disconnected. We always make a practice of connecting the framework of the jack to the positive of the B battery in every instance and likewise the top contact of the jack to the plate of the preceding tube. This provides a standard and it is



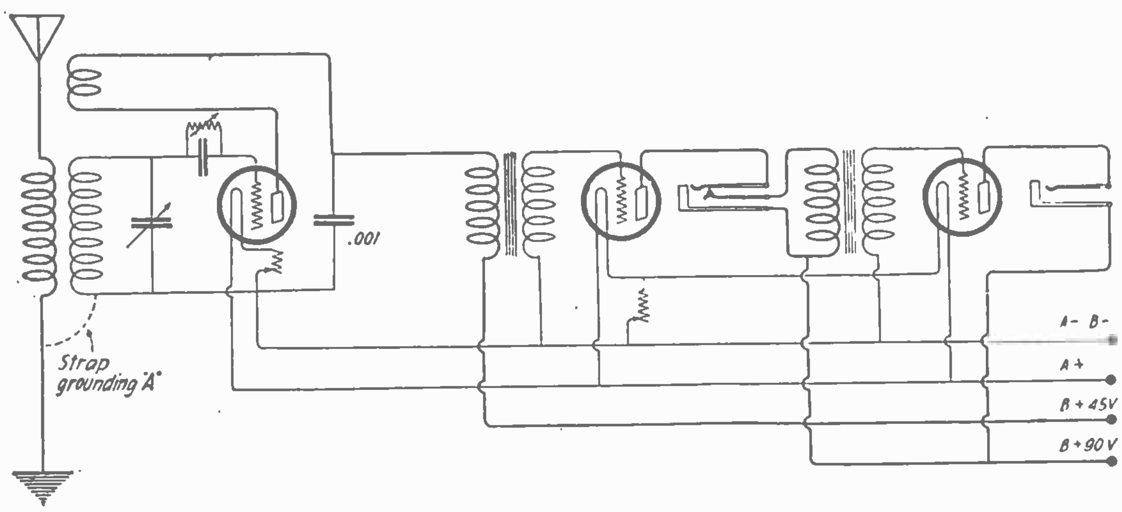
Illustrations by Courtesy of Wireless Age (New York)

The realtive position of all instruments is clearly shown in this illustration. The long piece of bus-bar running along the panel is the common negatve return lead.

just as well to make as many things as possible standard in your set. By connecting the jack in this manner you have a ready means of testing your B battery voltage by placing one contact of the voltmeter on the jack and the other on the filament switch. This is a more correct method of testing batteries than by taking a reading directly across the batteries themselves as it indicates exactly what the working voltage of your battery is at the set itself. You may have 45 volts in the B battery under the table, but after passing through some high resistance lead connections and contacts it may be anything from 38 to 40 volts by the time it reaches your tubes. If you stop to realize how many connections the battery current must go through in order to reach your tube, you will exercise more care in making clean-cut connections, soldering where possible, and eliminating all useless resistance. Notice the location of the Bradleyleak fastened to the baseboard of the set near the grid terminal of the detector tube socket. This excellent gridleak is now being supplied with a



A front panel view of the completed low-loss set showing the convenient arrangement of tuning controls.



The circuit diagram of the low-loss receiver is essentially the same as the common three-circuit regenerative set.

.00025 mfd. Dubilier Micadon condenser which fits directly across its terminals. This makes the unit complete, for one need only use this variable gridleak with a stubborn detector tube in order to appreciate the value of a good variable gridleak. This leak should be turned all the way out, and the tickler rotated until the set goes into oscillation. Now turn the gridleak "in" which decreases its resistance until the set goes into oscillation smoothly without a click and with no hangover. When this is obtained it should be left in the position.

Operation

Many of the fans seem to be scared of a three control regenerative receiver and seem to shun them as something fearful. The addition of one more tuning control—the variable primary should be looked upon as a convenience and a distinct aid in tuning rather than "just one more knob."

If you set this dial at 100, that is with the windings of the primary parallel to the windings of the secondary coil and rotate the variable condenser slowly over the entire scale it will be found that with the average antenna there is a spot somewhere between 200 and 300 meters where the set will not oscillate readily and regeneration is almost impossible. Nine times out of ten this is the fundamental wave-length for your antenna and at this point your antenna system is absorbing too much energy from your tube circuit to permit its action as generator of continuous oscillations. Keep the condenser at this spot and the tickler setting the same and rotate the primary coupling dial slightly and it will be found that the set will now oscillate at the point where it did not, a moment before. Now this is not the only use which the variable coupling has. If it should happen that your receiver tunes broadly which is possible (but hardly probable) with this combination then the rotation of the primary coil 15 or 20 degrees off the parallel will greatly increase the selectivity of your receiver. On a well-designed tuner such as the one used in this receiver, loosening of your antenna coupling will not materially affect the wavelength of the secondary circuit. However, it does to a very slight extent. If you reduce the coupling or rotate the coil away from the parallel it will be found that it is necessary to slightly increase the dial reading on the tuning condenser to compensate. For this reason all three dials should be calibrated for a given station so that you may return to the exact setting.

In conclusion we would like to again bring up the subject of choice of parts. We make a practice of specifying a given part for your guidance in building the featured receiver each month. Many have a wrong idea of what this list is for. It is perfectly possible to build up this receiver using apparatus other than that specified in every single instance from the tuner to the panel itself and have it work well providing good material is used, but for the benefit of the many fans who cannot readily recognize efficient apparatus from apparatus which is otherwise, we print a list of materials to be used in building the set.

Where Short Leads Are Important

Too much cannot be said about the advisability of obtaining short leads from the various pieces of apparatus. In laying out a set the best plan would be to lay all the apparatus on a temporary baseboard. Space them so that the shortest piece of wire is necessary to make the connection. This especially holds true of the grid and plate leads. Mount the transformers between the tubes so that P post on the transformer is right next to the plate terminal of the tube socket, the following socket being so spaced that its G or grid post is but a half inch from the G post of the same transformer. With some transformers, in order to do this, it will be necessary to mount the sockets on a separate piece of wood to raise them up to the height of the binding posts on the transformers.

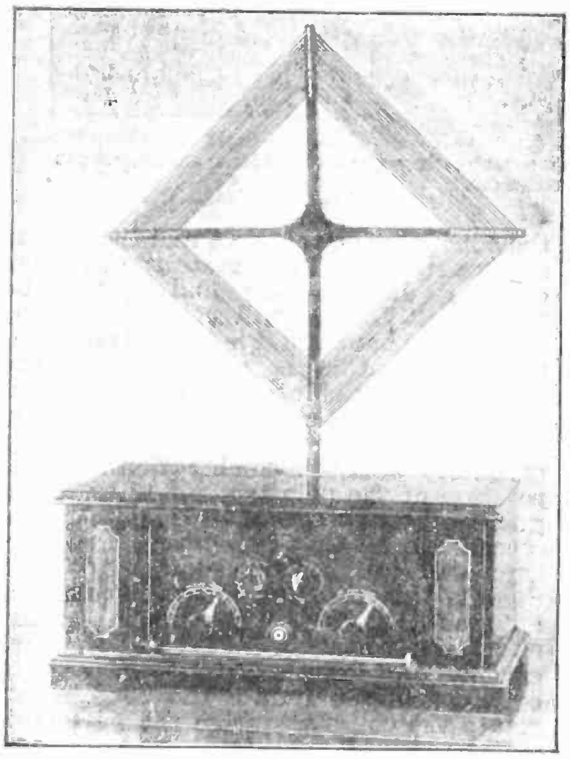
A battery leads may be longer without bad results. It is better to sacrifice length in the filament circuit than any other circuit in the set. Considerable time and thought should be given to the laying out and positioning of the secondary and its tuning condenser. The coil itself should be so arranged that it has an air space of at least two inches, all around, therefore do not try to mount the variable tuning condenser too close to this coil or within the field of it. Run the leads from this coil without bends direct to the condenser, which should be located close to the first tube socket.

The grid condenser should of course be mounted directly on the G terminal post of the socket.—*New York Evening World.*

How to Build the New Priess Reflex

Technical Details of New Five Tube Receiver

FEW of us realize the rapidity with which our desires for material things stimulate and infect our neighbors and swell into a lusty but unorganized movement which creates a powerful demand upon the resources of the country to meet and satisfy it. The American public today is asking itself, "What kind of a set shall I buy?" and has passed the stage of its former question: "Shall I buy a radio set?"



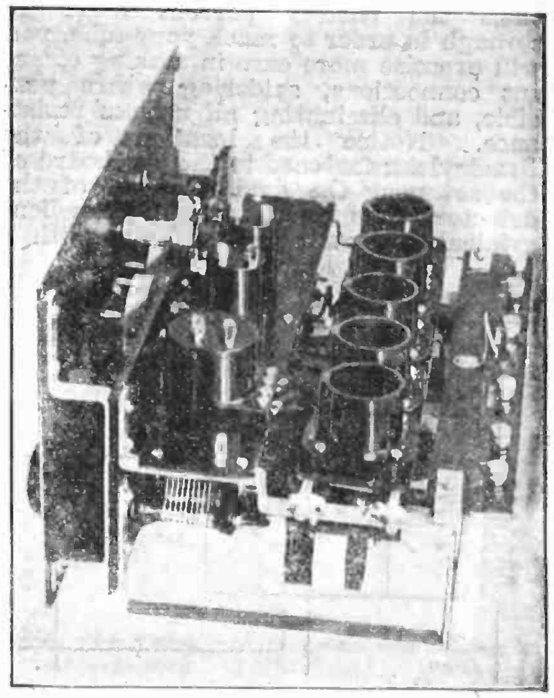
The completed receiver, showing panel and loop location.

A radio set is a combined receiver or collector of radio waves, a selecting or tuning device to enable the choice of the desired wave, a radio amplifying device to strengthen the waves to a value sufficient to operate the detector which gives them an audible character, the detector itself, an audible frequency amplifying device to build up the detected output to loud speaker volume, and finally the loud speaker, which translates the electrical output of the set into sound waves. All of these parts and functions must harmonize, otherwise neither stability nor the other essential, receptive and reproductive qualities will be obtained. In addition the set must be mechanically constructed to support the parts properly, with materials of such electrical nature that they will perform their function of conducting current or insulating parts without deterioration for years to come.

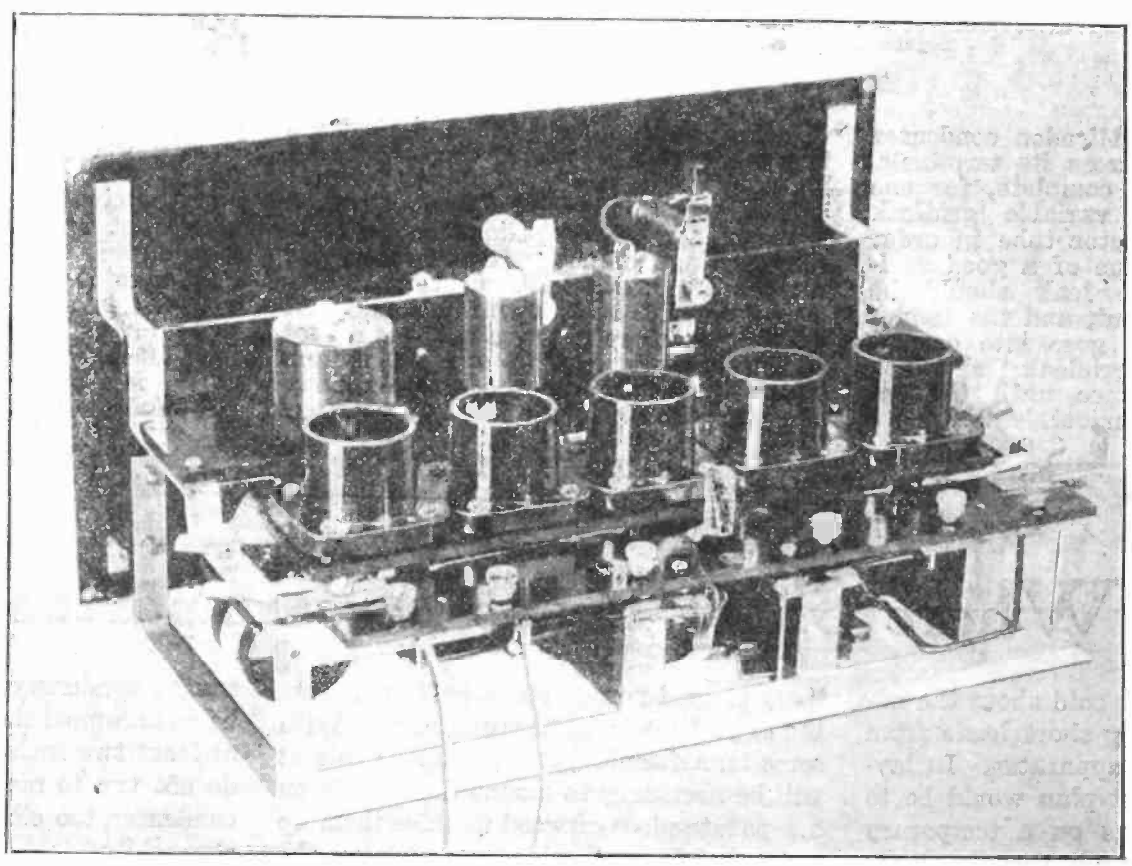
The Priess set as recently described by *William H. Priess* in the *Boston Transcript Radio Section* and reprinted in the following, is a five tube device employing reflex principles. Its reception is from a loop. The set is contained in a two tone mahogany case, with compartments for batteries.

It has a sensitivity determined by utilizing three stages of radio amplification, one of which is tuned to give the set a very high degree of selectivity. This selectivity is further enhanced by the use of a sharp wave collection system comprising a low loss loop terminating in a low loss contracting system instead of the usual telephone plug and jack, and the use of low loss variable condensers for tuning both the loop and the amplifier systems. The set has a wave length range of 220 to 560 meters without requiring switches or other circuit alterations.

The collector system comprises a sharply tuned loop system. Provision has been made for the addition of the usual antenna and ground connections for the purpose of providing additional distance range for that portion of the public that demands of their set an occasional transcontinental or transoceanic performance. A mica condenser is connected in the antenna lead and a second in the ground lead, so that the set and its tubes are always protected from any danger of burnout that would follow the use of either a battery charger or B battery substitute operating from a grounded lighting circuit. I believe this is the only set on the market that contains this form of insurance for ripe old age for both the set and the tubes.



End view, showing transformers and sockets.



Illustrations by Courtesy of Boston Transcript

Rear view of the Priess Receiver. Note the arrangement of parts on panel and shelves.

A loop set has a large number of advantages. The set can be installed quickly and moved to various locations without entailing the services of a steeplejack. It is the ideal set to take in the car on a day's outing, or to the country on a week-end. It can be installed in places where the connection of antenna is forbidden or impossible. In addition to its inherent mobility, the loop receiver has the remarkable property of directional reception and freedom from certain types of "static" disturbance. Two interfering signals of approximately the same strength and wave length, but coming from different directions, cannot be separated by the ordinary antenna set. However, with the loop receiver this separation can be made complete by turning the loop so that one of the stations disappears and tuning in sharply on the other station.

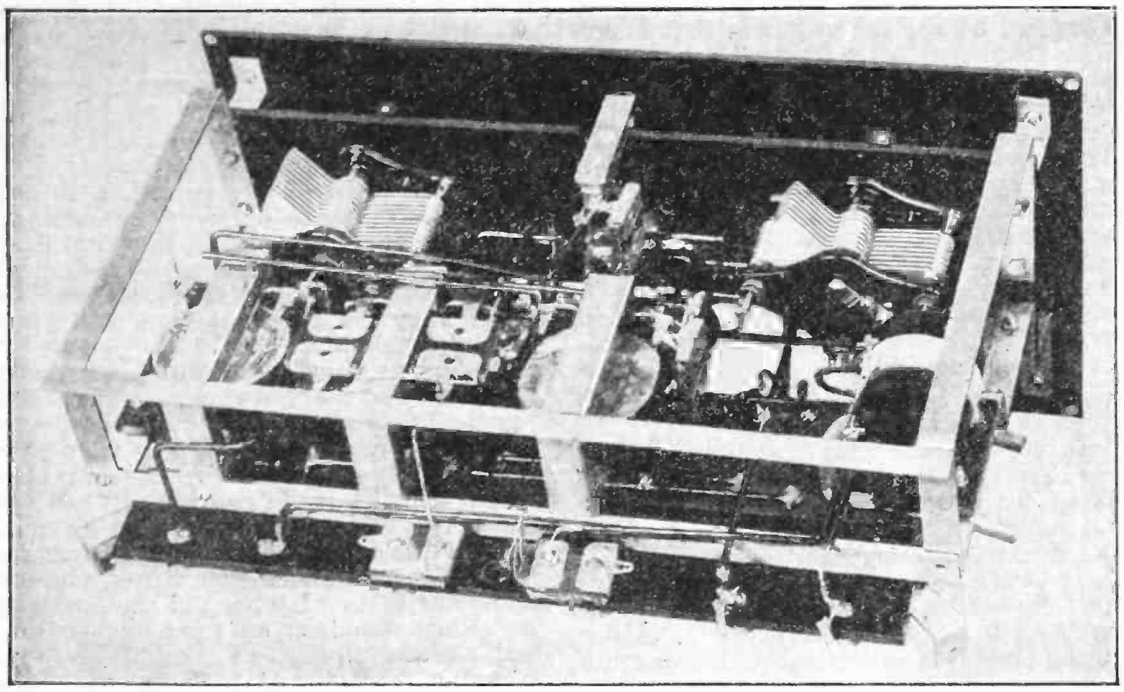
The loop should pivot in the set and turn freely without play. The loop wire must be an exceptionally good conductor for radio frequency currents and must be mechanically both flexible and elastic in the sense that it will stretch but without permanently deforming its length. The loop wire in the receiver described on this page is composed of twisted strands of fine copper wire about which has been lightly coiled several fine strands of phosphor bronze wire. As the wire is stretched and released the phosphor bronze strands uncoil and recoil over this distortion range. The loop wire is fastened to the loop arms by a screw at each cross of wire and arm. There is a slight depression molded under each loop screw to provide a take-up, and separate adjustment at the factory of the tension of each quarter turn of the entire loop winding.

There has been a strong agitation recently in radio circles promoting the use of low loss coils and condensers to secure sharp tuning. Little if any attention has been paid to the losses of the contracting system of the loop. Telephone plugs and jacks are in wide use for this purpose, despite the fact that a telephone plug and jack represent a very large radio frequency loss and loading which flattens out the tuning and decreases the sensitivity or distance range of the set. The telephone plug and jack act efficiently in telephone circuits, but must not be used to conduct radio frequency currents. Low cost of this standard part is the only excuse for this unsuitable use.

The radio amplifying system determines both the selectivity and the sensitivity or distance range of the set. The Priess system is operated with a maximum of both, and is radical in its design in that it entirely dispenses with neutralizing condensers and neutralizing windings, whose effect is to broaden the tuning and decrease the range by providing parasitic paths for the signal and shunting the useful signal energy off the grids of the tubes. In this set there is but one path for the radio currents and that path flows undivided into the grids of the tubes and undivided out of the plates of the tubes.

After the radio signal has been amplified by three stages it is fed to a detector. The detector is the main device in a radio set for determining the quality of the reproduction from both angles—namely, stray noises generated by the receiver itself and the angle of fidelity of duplication of the original program. The only detecting device known today that is entirely free from self-generated noise and at the same time has the property of detecting with absolute fidelity is the crystal detector. It eliminates the fog or feltlike background of noise present in most radio sets, and due to the hiss of a detector tube, and detects with the brilliant reproduction that is its inherent property. I discovered that a crystal detector coupled to a radio frequency amplifier is an entirely different problem from coupling a crystal to an antenna similar to the way it is used in the so-called crystal sets. A new phenomenon is introduced. The tube cancels out effective resistance present in the crystal contact and produces a result that may be described as amplifying detection action. Furthermore, the crystal is cushioned electrically so that its input is limited to the power output of the tube to which it is coupled. This value is below burnout or paralyzation value. Therefore, a crystal connected as it is in the PR-3 cannot burn out, or, what is more important, be paralyzed, through a heavy signal or static pulse. A tube detector will paralyze under these conditions and cause the set to either distort or howl with a clucking sound. To successfully couple a crystal to a radio amplifier the following factors must be correctly proportioned: Coupling, damping, period and ratio of the coupling transformer; resistance of the crystal and constancy of this resistance either through selection of crystal and contact materials or their contracting mechanism; tank capacity of the crystal system, and finally the design of the low frequency power absorbing system, which starts at the first audio trans-

(Continued on Page 33)

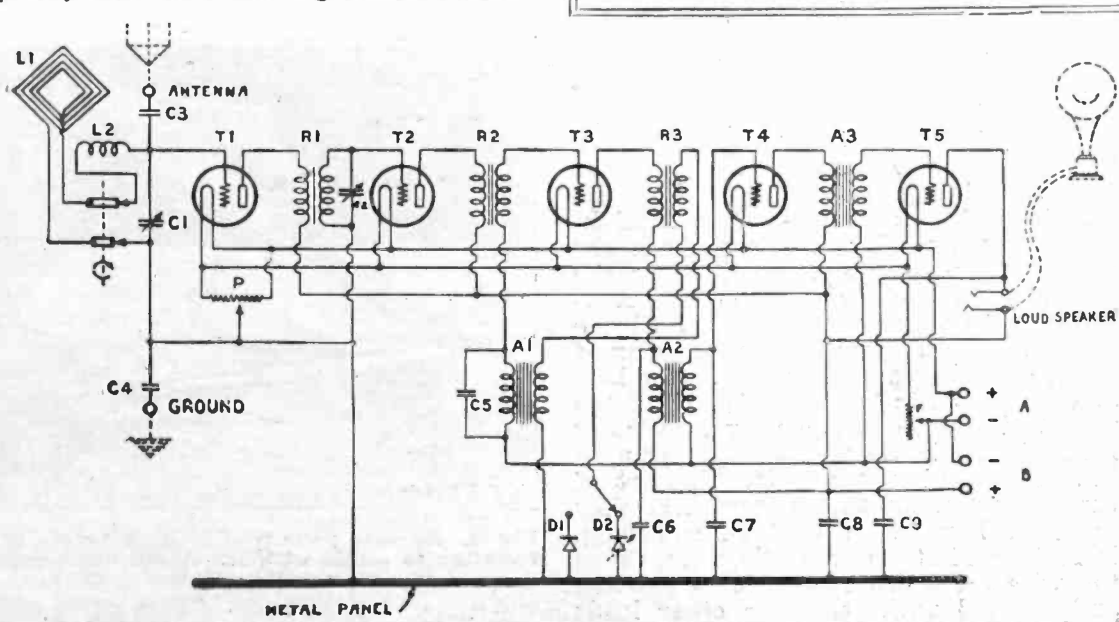


Rear view of the underside of tube and transformer shelves.

Table of Values for Parts in Priess Reflex

C1—.0005	C6—.001 mica
C2—.00035	C7—.001 mica
C3—.0001 mica	C8—.002 mica
C4—.002 mica	C9—.002 mica
C5—.0005 mica	Load Coil—28 turns No. 26 wire 1 5-8 inch diam.
Loop has 16 turns	

R. F. Transformer R1, wound with No. 26 wire.
Primary, 33 turns. Secondary, 105 turns. Mean diameter of pie winding, 1¼ inches.
Two pies in primary and three in secondary. R1 contains a little iron.
R2 has 75 turns on primary, 400 on secondary. Wound with No. 34 wire. Mean diameter ¾ inch. Contains more iron than R1.
R3 has 225 turns primary, 330 turns secondary. Wound with No. 34 wire. Mean diameter ¾ inch.
Audio frequency transformer A1 has 2850 turns primary, 10,000 turns secondary.
A2 has 2850 turns primary, 14,200 turns secondary. A3 is same as A1.
D1 (crystal detector) described in text.
D2 (detector) is a steel galena button with phosphor bronze cat-whisker.
Panel is 14¼ inches long and 7½ inches high. The depth of the cabinet is 7 3-8 inches. Potentiometer has resistance of 400 ohms.
Rheostats F has resistance of 10 ohms.

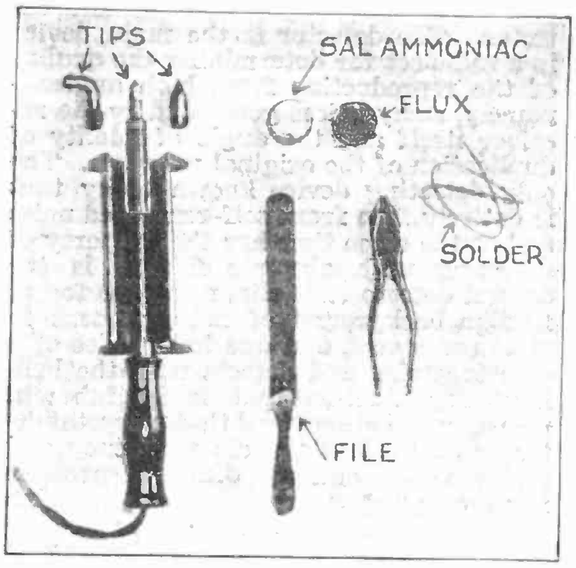


This is the circuit as developed by the author for the five-tube reflex. The values of the parts are given above.

Hints to Radio Constructors

THE radio constructor who builds his own set always values suggestions as to methods of making a better job of his work. *A. P. Peck* writes in *Radio News* on this subject as follows:

In this article the writer is not going to give directions for building any particular set, but is rather going to describe, for the benefit of the readers, the proper method of going about the assembling of sets, stressing particularly the tools needed and the methods of handling them. One who has been contemplating building a radio receiving set will undoubtedly find below some hints that will be of value in the work. Whether you are thinking of building a simple crystal receiving set or a multi-tube Super-Heterodyne, you will have to know certain fundamental principles of construction. These will be outlined in the paragraphs below in as simple and concise a manner as possible.



Illustrations by Courtesy of Radio News (New York)

Fig. 1. The implements necessary for executing a good soldering job. Different size tips for the iron are handy to have.

Soldering Tools

Probably the most important point in the construction of radio sets is the soldering of the connections. It may seem very simple when you watch someone else doing it, but when you get the necessary implements together and try to do it yourself, you will usually find it to be a different proposition unless you follow certain definite rules that are very necessary for success. First of all, you must have the correct tools. We have illustrated in Fig. 1 those tools most essential in making a good job of soldering. The tools illustrated are a soldering iron, which may either be of the electrically heated type or one heated over an open flame, two extra tips of different shapes for the iron, a small box of sal ammoniac and one of soldering paste, a medium file, a pair of pliers and some wire solder. Many constructors prefer the use of what is known as resin core solder in which resin or flux is contained within the wire. This form, however, is rather difficult to use until one is proficient in the art of soldering and, therefore, it is recommended that a non-corrosive soldering flux or paste, as it is called, be used. The flux is employed in order to make a perfect union between the solder and the metals to be soldered together. Its use will be explained below. Without it, ordinary soldering would be impossible.

The purpose of the various tips for the soldering iron is that by the use of them heat can be applied to points that otherwise could not be reached with the standard tip. These accessories are not absolutely necessary, but are desired as they are often found to be quite convenient. The small box of sal ammoniac is for the purpose of cleaning the iron. Rub the iron on the salt occasionally when in use, to keep it clean. The file is for this purpose also and the pliers are used for holding the materials to be soldered. Of course, one can elaborate upon this list of tools, and we will mention this fact later in another connection.

Bending Wire

In most of the radio receiving sets in use today, either solid copper wire of about No. 14 gauge, or what is known as bus bar wire, is employed for connecting the instruments together. This material finds favor because of the fact that very neat connections and solid joints can be made with it. In order properly to use this material it is desirable that certain points in working it be learned. The most important one of these is the method of turning an eye in the end of the wire. This can be accomplished readily after a few trials by using a pair of round nose pliers as illustrated in Fig. 2.

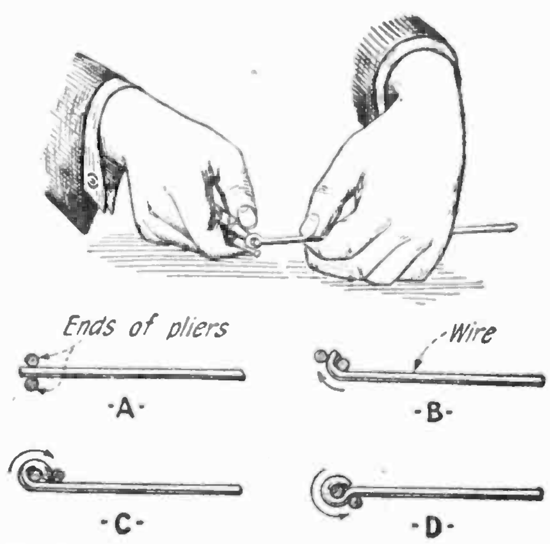


Fig. 2. Above shows how the pliers and wire should be held, and Fig. 3 how the pliers are twisted to loop the wire.

This illustration shows the completion of a loop. The exact method of obtaining this loop is illustrated in Fig. 3. First, the end of the wire is gripped between the pliers as at A, and while the wire is held still the pliers are turned in the direction of the arrow, B. This rotation is continued until the pliers reach the position C, whereupon, still holding the wire in position, the direction of the rotation of the pliers is reversed until the eye is formed as at D. The diameter of the eye can be varied by making the loop at various points along the length of the pliers. These loops are very convenient for fastening heavy wire of the type used in sets under binding posts. The art of bending wire, as shown herewith, goes hand in hand with that of soldering. Make bends in the ends of the wire, shape the wire as desired, place it in position and proceed with soldering other leads to it, following the hook-up of the circuit being used.

Soldering

We will now consider the subject of soldering. The first and most important point to remember is that cleanliness must be observed throughout the process. We will take up the steps in order. First, if an electric soldering iron is used, connect it to the source of current, or if the other type is used, place it over an open flame. For small irons, an alcohol torch can be employed as illustrated in Fig. 5. While the iron is heating, carefully clean the wires to be soldered together. Sandpaper will accomplish this very easily. Then remove all traces of sand, place the wires together in the position in which they are to be soldered, and place a small amount of flux at the joint. As little flux as possible should be used as it then tends to make a cleaner and neater joint. The right amount must be determined by experiment. By this time your iron probably will be heated, but take care not to let it get red hot. When the heating is being done with an open flame, you will find that the iron is at a right temperature a short time after a green flame starts to play around the edges of it. Place the iron on some non-inflammable material, such as a holder as illustrated in Fig. 4, and with the file clean all four sides of the iron until they are bright and free from all foreign material. Place a little flux on the point and immediately apply solder. The solder will, if the iron is clean, spread out over the point and form a thin film which adheres to the iron. You are now ready to solder the joint that you prepared. It will probably be found necessary to hold the wires in position with a pair of pliers, as illustrated in Figs. 7 and 8. This is in order to prevent them from moving out of place while the iron is applied and while the solder is cooling. By placing a little excess solder on the iron, and applying it to the point to be soldered, you will find that the solder will run on to the joint and will "sweat" into the wires, making a tight, rigid joint. This sweating is absolutely necessary and it will be found that sometimes it is necessary to hold the iron at the joint for a few seconds until the sweating starts. The point being soldered in Fig. 7 is indicated by A.

Very often it is necessary to solder to lugs or projecting metallic points with which some instruments are equipped. In this case, the method is illustrated in

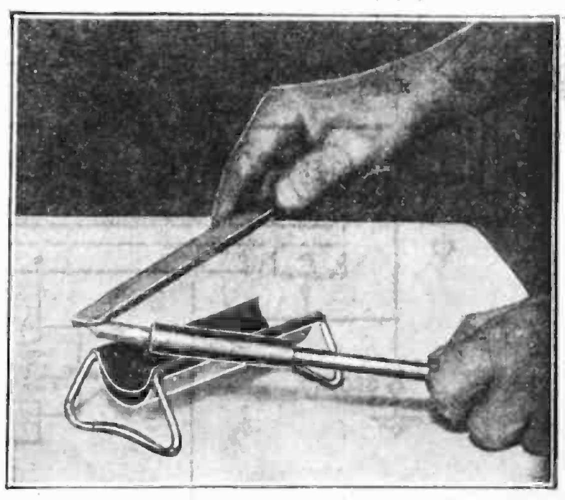


Fig. 4. Be sure your iron is clean before attempting to solder with it. A file will scrape the dirt off.

Fig. 8. The wire, after it has been cleaned, is laid on top of the lug which has also been cleaned and the flux applied. A small quantity of solder is then picked up or placed on the heated iron and applied to the joint until it sweats in.

Three types of joints are illustrated in

Fig. 6. A is what is known as a butt joint and is accomplished by placing the wires in position so that they are at right angles to each other as shown. Flux is applied and then, when the iron

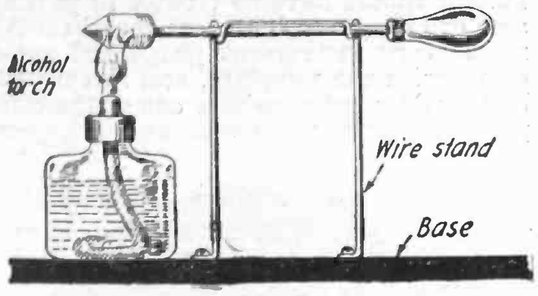


Fig. 5

Fig. 5. An alcohol lamp will produce sufficient heat for heating a small soldering iron, in absence of better means.

with a small amount of solder upon it is placed under the joint with the solder in contact with the wire, the solder will sweat in and form a perfect joint. This method of making a connection is some-

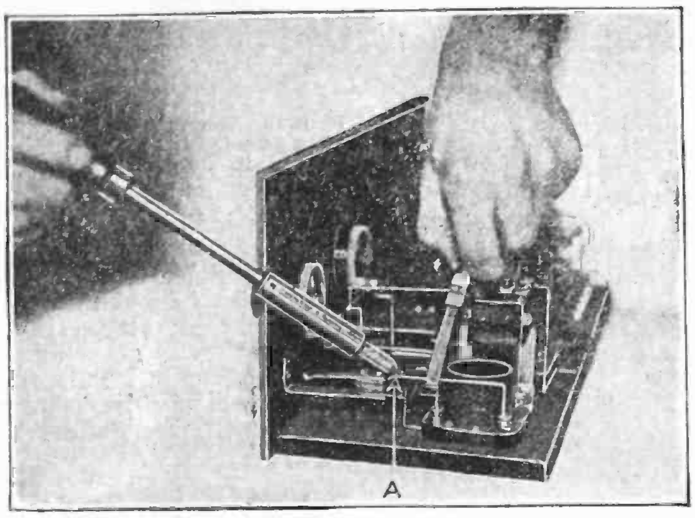


Fig. 7. The correct way to solder the end of a bus-bar wire to a terminal. Grip it with the pliers to hold it steady.

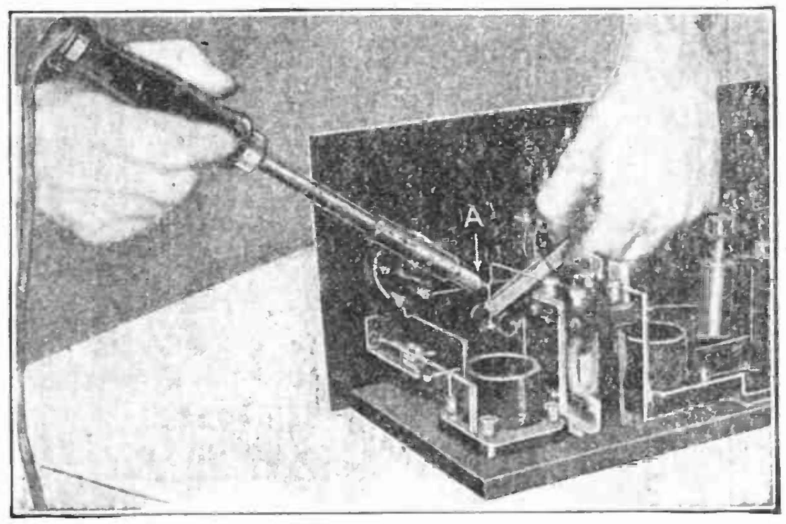


Fig. 8. Pliers are essential when soldering a joint like this. The bus-bar must be held steady until the soldered connection cools.

times not to be desired, as it is not as mechanically strong as it could be. To overcome this difficulty the method shown in B may be used. The wire to be soldered to another at right angles is turned into a loop at the end and the loop placed over the second wire. The loop is then closed up tightly with a pair of pliers and soldering is carried through in the same manner as in making the joint A.

When soldering to lugs, such as shown at C, the wire is placed between the two prongs of the lug, flux applied and the soldering carried through. The prongs of the lug may then be bent down over the wire, making an electrically perfect and mechanically strong joint.

Another method of soldering wires that are not close to instruments or near the panel is illustrated in Fig. 9. The wires are cleaned, twisted together and flux applied to the point to be soldered. The twist is then placed in the flame of an alcohol torch as shown and solder applied. It will promptly sweat into the joint if the wires are clean and flux has been applied properly.

Before we leave the subject of soldering, let us emphasize and review several points. First—keep the iron clean and sufficiently hot to immediately melt solder. Second—have all wires perfectly clean and apply only a small amount of flux. Third—use only a good grade of solder, preferably that known as half-and-half. Fourth—never use anything but non-corrosive flux. Flux containing any acid that corrodes metals will cause joints to become weakened in time and will always result in trouble. Avoid acid content fluxes. Fifth—always apply heat to the point long enough to enable the solder to sweat into place. Remember that the metals to be joined must be heated to a point above the melting point of solder before perfect union results. Sixth—if a plain soldering iron is used, which must be heated with a flame, always apply the flame to the base of the iron as shown in Fig. 5. Allowing the flame to play upon the tip of the iron will get that point dirty to the detriment of the work. Seventh—always have the wires in position by the time the iron becomes heated so that the process of soldering can be immediately carried through. Ninth—never try to solder with an iron that will not immediately melt wire solder. Attempting to do this will only result in a few crude looking slugs of solder being placed on the connection which will do no good. A smooth joint into which the solder has thoroughly sweated is the only efficient one.

The question always arises in the mind of the amateur as to just what a soldering iron really is. It is not made of iron, although that term has been applied to

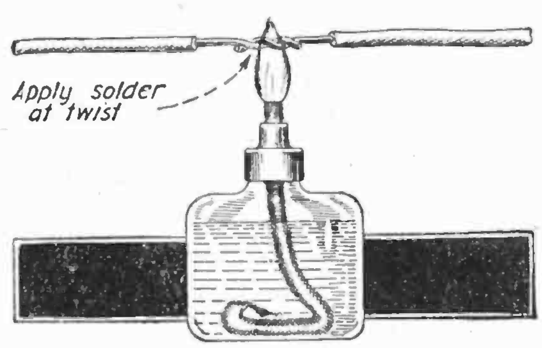


Fig. 9

Fig. 9. Wires that are not close to instruments can be soldered together by heating the ends over an alcohol lamp and applying solder.

the tool for so long that it has become accepted. Soldering irons are always made of copper, the reason being that copper holds its heat for a much longer time than iron. Furthermore, the copper can be heated more quickly and more thoroughly, resulting in an all-around greater efficiency.

Placement of Instruments

Hand in hand with the proper soldering of connections goes the laying out of the various instruments comprising a complete receiving set. The first thing to watch is that the instruments be laid out so that the shortest possible leads can be run from one instrument to another and so that there will be as few crossings of wires as is possible. The most important short lead is that from the grid

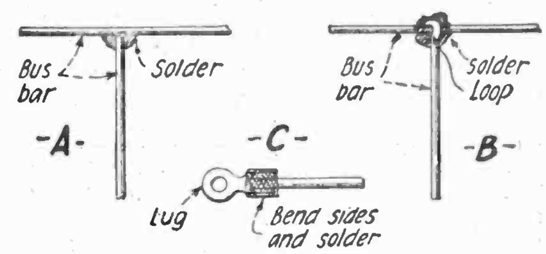


Fig. 6

Fig. 6. It is bad practice to solder two wires together in the manner shown at A. The B method is the best. C shows how a lug should be soldered to a wire.

binding post of the detector tube to the grid condenser and leak. Preferably one end of each of the latter two instruments should be mounted directly on the grid binding post, although if it is necessary to do otherwise, the grid lead should be kept as short as possible. It should never be over two inches long. Attention to this one little point may save considerable worry over troubles that would otherwise develop later on.

Another point to watch is the placement of the various coils and transformers, if the set is of the multi-tube type. Never arrange the instruments so that the grid and plate leads run parallel for any appreciable distance. Such procedure would result in an interaction between the leads which would probably make the set noisy in operation. Also if it should happen that you are building a radio frequency amplifier take care that the coils comprising the radio frequency transformers are placed far enough apart to prevent magnetic coupling between them. Six inches distances will usually be found sufficient and a larger space will not give any better results. In fact, it will be detrimental because of the longer leads required.

Regarding the audio frequency amplifying transformers, the writer would advise that builders always lay out the instruments so the coils of the transformers will be at right angles to each other. This is particularly true if the transformers are placed close to each other. If, however, they are kept at quite a distance which, by the way, is not usually done, there will be little need for this step. However, be on the safe side and place them in the manner mentioned. Coupling produced by placing the cores parallel to each other will result in distortion of the amplified sounds making the amplifier very unsatisfactory in operation.

Other Tools

In order properly to go about the construction of a radio receiving set, a certain number of tools should be at hand. A very good stock consists of those illustrated in Fig. 10 with one addition—a hand drill and a set of bits. Even all of the tools illustrated in Fig. 10 are not necessary. The amateur can usually get along without the hacksaw, the metal snips, and the set of small socket wrenches, although all of them often come in handy. The other tools are almost essential. Without them imperfect work will result, and the finished set, while it be perfectly satisfactory electrically, will not present a pleasing or symmetrical appearance. With the tools illustrated in Fig. 10 and those used in connection with soldering and illustrated in Fig. 1, the amateur will have a very complete assortment which will enable him to do practically any ordinary work on receiving sets.

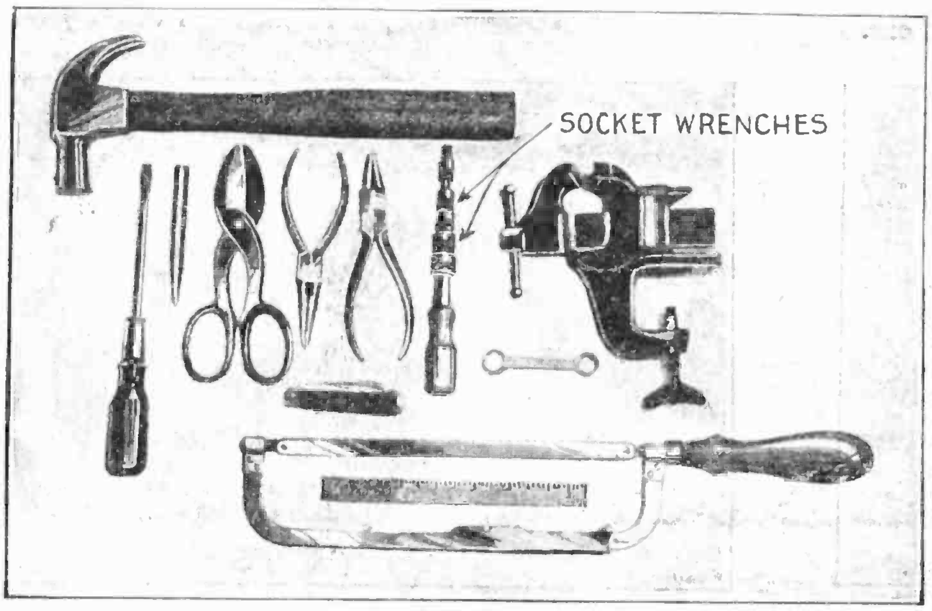


Fig. 10. If you expect to do a real good job in constructing a radio set, the tools shown in this photo are essential. It takes more than the hands and a pair of pliers to do such work well.

Miscellaneous Notes

Probably more panels are spoiled than any other particular part of radio receiving sets because of inefficient methods used in working with them. Panels today can be obtained in a variety of standard sizes so that it very seldom becomes necessary to cut the panel material. If you do have to do so, however, use a hacksaw with a fine toothed blade for the purpose and saw slowly, not forcing the work. Drilling the panel is about the only work that will usually have to be done upon it. In order to do this properly, the holes should first be located and an indentation made in the panel at the correct point with a center punch, as illustrated. Here we show a template for the mounting of a variable condenser being used for properly locating the shaft hole of that instrument and the mounting holes. The latter are indicated by B and the former by A, Fig. 11. The method of using the template, as the sheet of paper upon which the location of the necessary holes are indicated is called, is to place the paper over the panel in the desired place and preferably paste it in position. Then place the point of the center punch on the intersecting lines which indicate the exact center of the hole to be drilled and tap the punch lightly with a hammer. Do this at all points where holes are indicated on the template and then with the hand drill and a bit of the correct size cut the holes in the panel. When the drill has nearly passed through, exert very little pressure on it, for if you do the panel material will split out, giving a very unsightly result.

Certain companies today are supplying complete descriptions for building radio receiving sets in which they include templates made the full size of the panel. These can be placed in position as described above and all of the necessary holes be drilled in the panel definitely located. The slight indentation made by the center punch through the template and into a panel not only provides correct indication of the location of the hole, but also enables the builder to start to drill quickly and in exactly the right place without allowing the drill to slip and scratch the panel.

It often happens that after a hole is drilled it is found to be slightly smaller than it should be. Here is a little kink that should enable you to overcome this without trying to run a large drill through the hole. In fact, this kink is most useful when no larger drill is at hand. The idea is to use the tang of a file as a reamer. This is illustrated in Fig 12. Grasp the file as shown, and holding the panel rigidly, place the tang in the hole to be enlarged and twist it back and forth. The tang will act as an excellent reamer and by working first from one side of the panel and then from the other, the desired size can be quickly reached.

Following the above hints on soldering and other points in construction, the builder should have no trouble in putting any ordinary receiving set together. Almost every instrument purchased today comes with the template, and in case the builder does not purchase one of the complete templates mentioned above, he can,

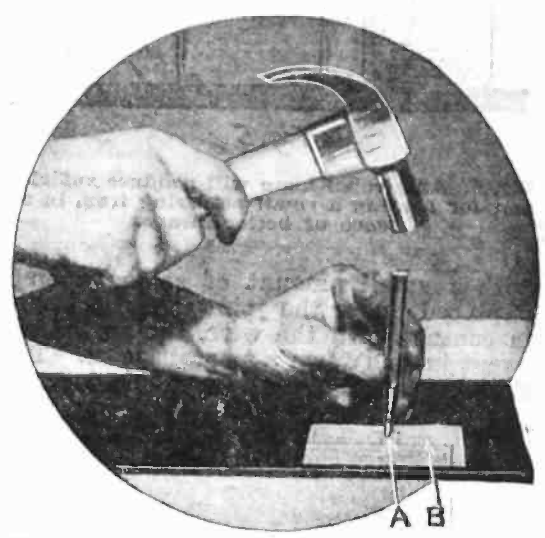


Fig. 11. Showing how a center punch is used for marking a panel, through a template, prior to drilling.

by laying these individual templates out on the panel, accurately locate and drill each and every hole. The instruments need then only be fastened to the panel, the connecting wires placed in position and each joint that is not clamped in a binding post, soldered. This procedure will almost invariably be conducive to good results, unless the builder makes a mistake in his wiring, which, of course, involves that human element which can only be controlled by one person; in this case, the builder. Always be sure to check and recheck every wire and connection before putting the set into service to prevent accident and disappointment later on.

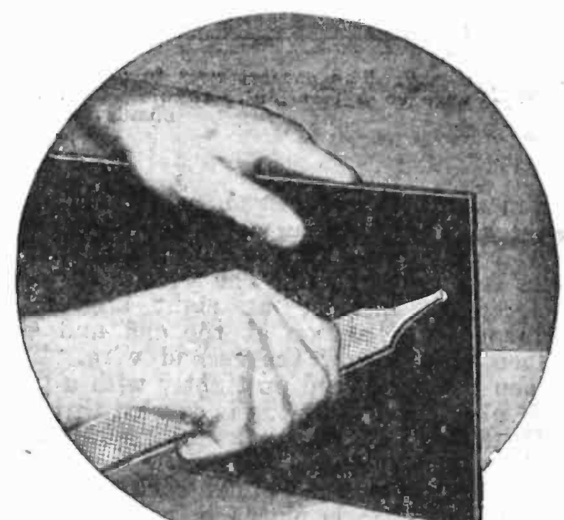


Fig. 12. Holes in panels can be enlarged by using the end of the file as a reamer.

More Helpful Hints

Holes in the cabinet for ground, aerial and battery leads can be dressed up by inserting hard rubber bushings like those used in the top of electric light sockets.

If you need a good light when repairing a broken connection in the dark corner of a set, use a flashlight and a piece of mirror to reflect the rays where you want them.

Mark your panel, fill the crease with acetone, dust aluminum paint powder over it, wipe excess away with a toothpick and you have a good panel mark as soon as the acetone dries.

The temperature of the filaments in the vacuum tubes has much to do with many sets, and so the filament rheostats must be carefully adjusted.—*Milwaukee Journal.*

The Freshman Masterpiece Set

THE Freshman Masterpiece receiver has won great popularity in radio circles both from a standpoint of efficiency and ease of control. This set employs five tubes, two radio frequency amplifiers, detector and two audio frequency amplifiers.

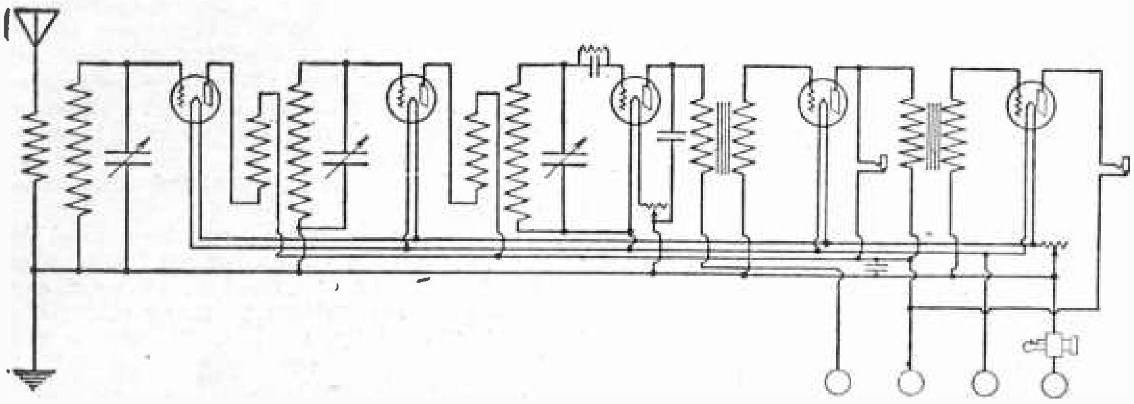
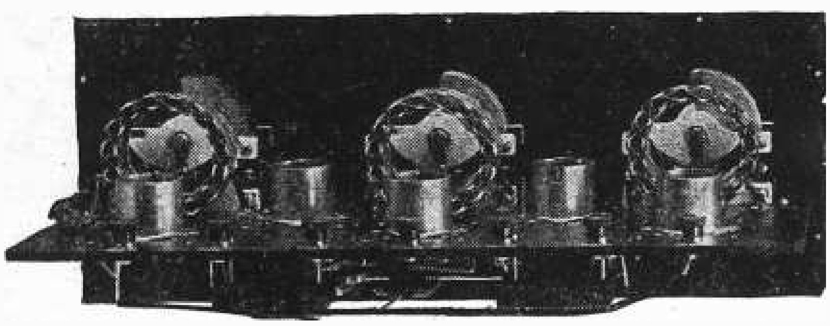


Fig. 1. Circuit of the Freshman Masterpiece receiver. Low-loss coils and low-loss condensers are an outstanding feature of this inexpensive, efficient set. The primaries of the radio-frequency coils are reversed, to prevent oscillation. These coils have a 7-turn primary and a 60-turn secondary, of No. 24 DSC wire, including the coil in the detector circuit, the detector coil not having a reversed primary, however.

Complete description of the set has been given by *A. W. Franklin* in *Radio World*, New York, as follows:

With the splendid co-operation of my associate engineers the development of a 5-tube tuned radio-frequency set using efficient low-loss apparatus was accomplished in compact form and at very low cost, but very high efficiency.



Illustrations by Courtesy of Radio World (New York)

Fig. 2. The arrangement of parts on the panel and top of sub-panel.

A minimum amount of labor is necessary in assembling the complete set.

List of Parts Required

3—Tuned radio frequency units.

1—Front panel, bakelite, size 7" x 18".

1—Sub-panel with sockets and binding posts attached (see photos, Figs. 5, 6, 7, 8).

1—Variable grid leak and .00025 M.F. condenser.

1—5 to 1 audio transformer.

1—3 to 1 audio transformer.

1—.002 fixed mica condenser.

4—No. 6/32x1⅝ in. screws for mounting transformers.

1—Filament control switch.

1—30 ohm rheostat.

1—6 ohm rheostat.

2—Brass angle brackets for rheostat mounting.

4—No. 6/32x1⅝ in. screws for mounting transformers.

4—¾ in. long brass bushings for mounting transformers.

7—No. 4/36 x 5/16 in. screws round head.

4—No. 4/36 x ⅝ in. screws round head.

6—No. 6/32 x ½ in. screws for mounting variable condenser.

2—No. 6/32 x ½ in. screws for mounting grid condenser.

1—Assortment of necessary nuts and lock washers.

The circuit (Fig. 1) shows the two stages of tuned radio-frequency, detector and two stages of audio-frequency. There is one tuning unit in the aerial circuit and one on each of the tuned radio-frequency stages, evenly matched, so that all three dials read practically alike. Once the stations are logged the same station always may be brought in on the same dial setting.

The only apparatus visible when the cabinet is opened are the three tuned radio-frequency units, the variable grid leak and the tubes. (Fig. 2.) All other parts are mounted below a hard rubber sub-panel (Fig. 6), this panel also serving as the base of all five sockets and the base of the three tuned radio-frequency units. Therefore, the first part to make secure is the sub-panel, the sockets being riveted or eyeleted thereto. All of the wiring, transformers and rheostats are mounted directly under the sub-panel, being thus entirely hidden from view. (See Figs. 6 and 7.) This permits the use of short straight line connections between the different points and keeps the resistance of the circuit the lowest possible, thus increasing the efficiency.

Most persons, especially when the wiring is open to view, try to make a beautiful right angle bend and lose sight of the fact that in making a set pleasing to the eye they sacrifice the most essential features, low loss and efficiency. By using the sub-panel method entirely, we not only had efficiency but believe that the appearance is also improved.

The coils do not have to be set at an angle and do not have to be spaced a great distance apart. This is because the magnetic field of this particular winding is concentrated very close to the winding and there is no stray magnetic field which would cause interference between the coils. Due to this concentration of the magnetic field it was possible to eliminate all neutralizing capacities.

A variable grid leak is recommended as it was found that all tubes vary to such an extent that a fixed leak will not permit the tube used to work at its maximum efficiency and distance could always be brought in louder by adjusting the leak to a proper value for the tube. However, it was also found that once the variable grid leak was set at its maximum efficiency for any one station that that point was the best operating point for all stations and that the variable grid leak could then be left set for the particular detector tube being used.

In tuning a set of this type it is best to set the two dials in the radio-frequency circuit to the highest point usually used, which may be on 90, and then try to tune in a station by slowly turning the first dial, which is in the aerial circuit, until the station is heard. If there is no station radiocasting on that particular wavelength, the two dials should then be turned down to divisions and the antenna dial turned again approximately within ten divisions of the same setting as the other dials. This should be continued, setting the dials two divisions lower each time until all the stations on the various wavelengths are logged, after which it is a very simple matter to tune in the same stations by simply referring to the previous log.

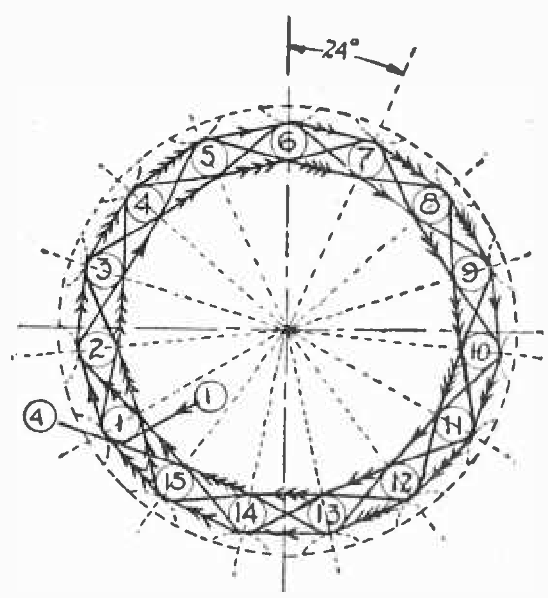


Fig. 3. How to wind the coils.

As shown in Fig. 1, the primaries of the radio-frequency coils are reversed. This is very essential, as it prevents the set from oscillating. This circuit is self-balancing when using these special tuned radio-frequency units and does not require any stabilizer, such as a potentiometer or neutralizing condensers.

How the Coils are Made

The demand for compactness and simplicity, together with far greater efficiency and selectivity of radio receiving apparatus, made it necessary to evolve radical changes in the design of an inductance. Conforming with the policy of using low-loss apparatus, a special inductance coil was made which would fit in back of the 17 plate variable condenser in such a manner as to make a very compact tuned radio-frequency unit.

To give the reader a clear conception of this coil which seems to be the most efficient method of winding, Fig. 3 shows

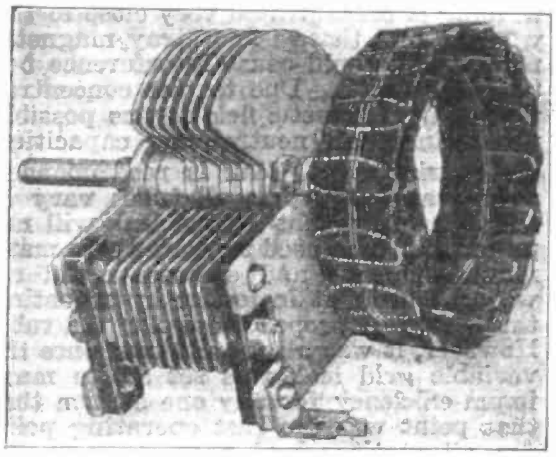


Fig. 4. How the coil is mounted on the variable condenser.

how this coil may be wound at home. First procure wooden discs 3⅛" in diameter and ¼" thick. Draw a circle 5-16" in diameter. On the circumference of this circle drill 15 holes evenly spaced. These holes provide a snug fit for ¼" wooden dowels. Cut wooden dowels into pieces 1¾" long, rounding off the free end with sandpaper. These pegs should be glued into the holes. The recess on the peripheries of the disc are to facilitate the interlacing on the outside of the coil.

After the form is finished proceed with winding the coil as follows: Hold the form in your left hand with the pegs pointing toward you and lay the wire over peg 1 and 2, then inside of 3 and 4 over 5 and 8, then under two pegs and over two pegs until you come back inside of 15 and 1, after which the second turn is started which is over two pegs and then under two and so forth until the third turn is completed over 15 and 1, then the fourth turn is wound in similarly. We now have a complete cycle of four turns. You will now note by studying Fig. 3 and following the arrows, one arrow for the first turn, two for the second, and so on, that no two wires are parallel to each other and that they are a considerable distance apart. This is why distributed capacity is so very low. In winding the second circle of four turns, the fifth turn is laid over and inside of the same pegs as the first turn. The sixth turn is laid the same way as turn No. 2. Seven follows the same path as turn No. 3, while turn No. 8 goes over the same pins as the fourth turn. This cycle of turns again creates a magnetic field which is staggered from the field made by the first four turns.

The coils of wire are each separated by a space equivalent to the thickness of the wire and its insulation, thereby suffering practically no absorption losses through the adjacent wire. Hence, the maximum amount of inductance is obtained in this form of winding.

Proceed winding the required number of turns as above and after the winding process is completed cut the wire, leaving slack for a suitable lead. To interlace the inductance so as to be able to slide it off the form without collapsing, obtain a medium-sized binding needle and a spool of white thread and guide the needle through the corner next to peg 1 from the top of the coil. Recess A on the bottom of the form will enable you to go past the form with needle and thread. Now pass the needle from the bottom of the coil through the other corner next to pin 1, hold the end of the thread with one hand and pull the thread tight with the other hand. Next guide the needle from top of coil through the further corner next to pin 15. Come back from the bottom of coil through the inside corner next to pin 15, thereby bringing the needle again to top of coil. Next bring the needle through the furthest corner to pin 14 and then from bottom through other ends to pin 14 and so on until you are around the entire coil. When the interlacing is done up to peg 2, lace the thread a second time through the corner next to peg 1. This loops the turn around peg 1 twice and after the ends of threads are tied with double knot there is no chance of the winding ever becoming loose. The coil is now ready to be taken off the form, and to accomplish this without mishap hold the form in left hand and grip the coil with thumb and forefinger of right at the point where a pin is located and pull the coil off the pin about ⅛", and then go to the next pin and again pull the coil off the same distance. Repeat this procedure until you have the coil off the pegs entirely. The coil interlaced on one side is now rigid enough so as not to lose its shape. However, if you want to make it absolutely rigid, the inside of the coil should be interlaced the same way as the outside. This coil can be used in any circuit that requires an inductance coil and will be far superior to so-called spider-web inductance coils.

Although these coils can be wound for any circuit that requires an inductance, the particular coil used in this set consists of a seven-turn primary and sixty-turn secondary of No. 24 single silk wire.

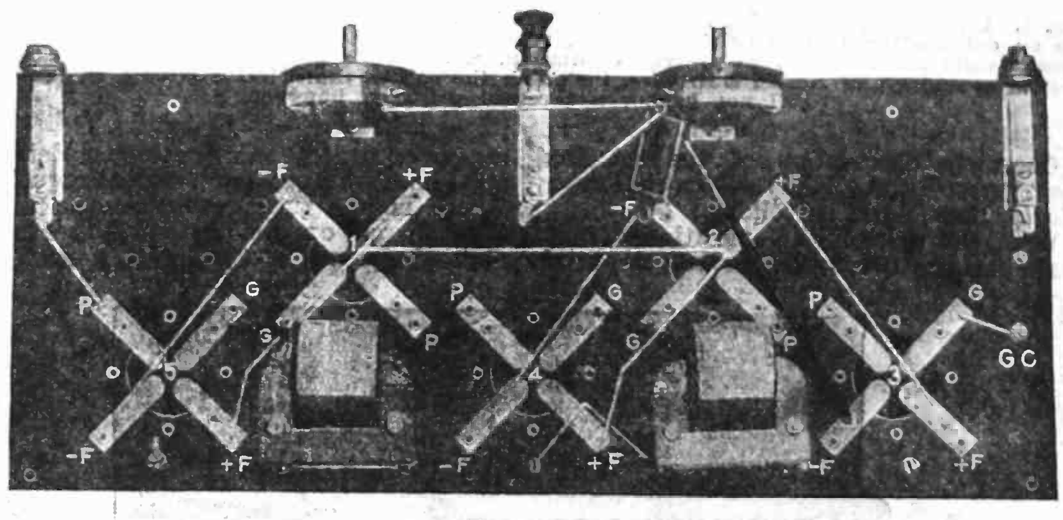


Fig. 5. The arrangement of parts and first step in wiring.

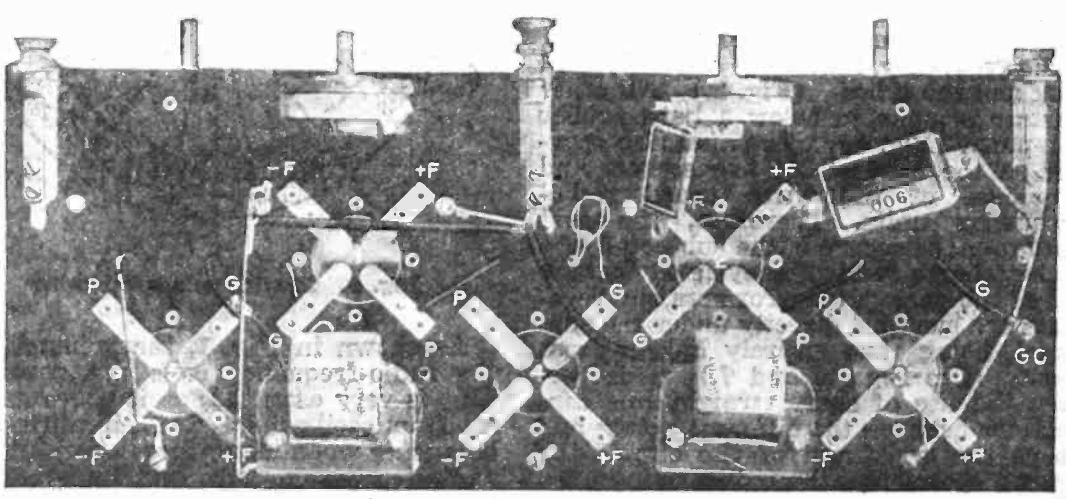


Fig. 6. The second step in the wiring process. Care must be taken to place these wires so that they do not touch the wires already connected.

Wiring the Set, 1st Step

Figs. 5, 6, 7 and 8 show the step by step wiring of the Freshman set in order that the constructor may see exactly how it is done while we carry him on through the various details. The directions are as follows:

Place the sub-panel in front of you on a table, with the underside up and the edge carrying the binding posts nearest you, in the position shown in Figs. 5, 6 and 7. Referring to Fig. 5, connect a wire from the ground binding post to the —A binding post. Wire from the bottom contact on the left hand (speaker) jack to prong P on socket No. 5. Wire from prong —F on socket No. 5 to prong —F on socket No. 1. Wire from prong +F on socket No. 5 to prong +F on socket No. 1, to prong +F on socket No. 2, to prong +F on socket No. 4. Wire from +A binding post to prong +F on socket No. 4, to —B binding post. Wire from prong +F on socket No. 2 to prong +F on socket No. 3. Wire from prong —F on socket No. 4 to prong —F on socket No. 2. Connect the lower left hand (Grid) wire on the left hand (3 to 1 ratio) audio transformer to prong G on socket No. 5. Connect the lower right hand (plate) wire on the left hand (3 to 1 ratio) audio transformer to prong P on socket No. 4. Connect the lower left hand (Grid) wire on the right hand (5 to 1 ratio) audio transformer to prong G on socket No. 4. Connect the lower right hand (plate) wire on the right hand (5 to 1 ratio) audio transformer to prong P on socket No. 3.

Connect the upper right hand (B Battery) wire on the right hand (5 to 1 ratio) audio transformer to the +B Det. binding post. Connect prong G on socket No. 3 to bolt G. C. Connect a wire from the top post on the left hand

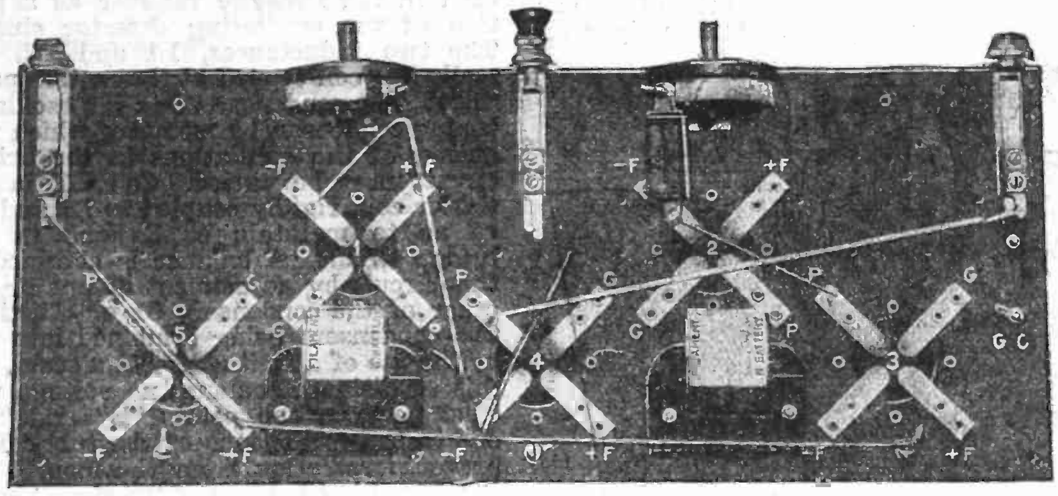


Fig. 7. This is the third step in wiring the set.

(6 ohm) rheostat to the top post on the right hand (30 ohm) rheostat, (one side of .002 condenser also attached thereon) to the top contact prong on the filament switch. Connect the bottom post of the right hand (30 ohm) rheostat to prong —F on socket N0. 3.

Mounting the R. F. Units

Now, before we go on with the remainder of the wiring, let us mount the three radio frequency units. (See Fig. 2.) Three brackets will be found eyeleted to the front top of the sub-panel. Place the units so that the front plates on the condensers are immediately in front of the brackets and push the primary wires (on bottom of coil) through the holes provided in the sub-panel. Insert a screw through the hole directly below the shaft in the front of the condensers and tighten securely to the brackets. Next insert a screw in each of the brackets that are fastened to the rear of the condensers, starting with unit on the left (front of condenser towards you). Underneath the right hand screw of the first R. F. unit, place a soldering lug and lock washer. Next fasten the rear screws on the second and third R. F. units, placing a

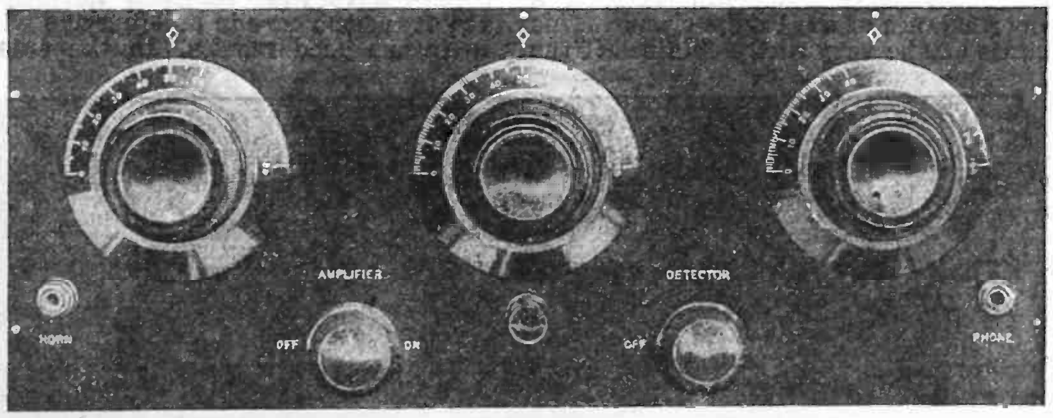


Fig. 9. After all the wiring is completed, the dials and knobs are fastened to the condensers and rheostat shafts.

soldering lug and lock washer under the left hand screw of both units. Be sure all six screws are tightened securely.

Wiring, 2nd Step

Referring to Fig. 6, wire from the aerial binding post screw to left hand primary wire on Radio Frequency unit No. 1. Wire from the ground binding post screw fastening the right hand side (secondary) of Radio Frequency unit No. 1. To this same ground wire, connect the right hand primary wire of Radio Frequency unit No. 1, the upper

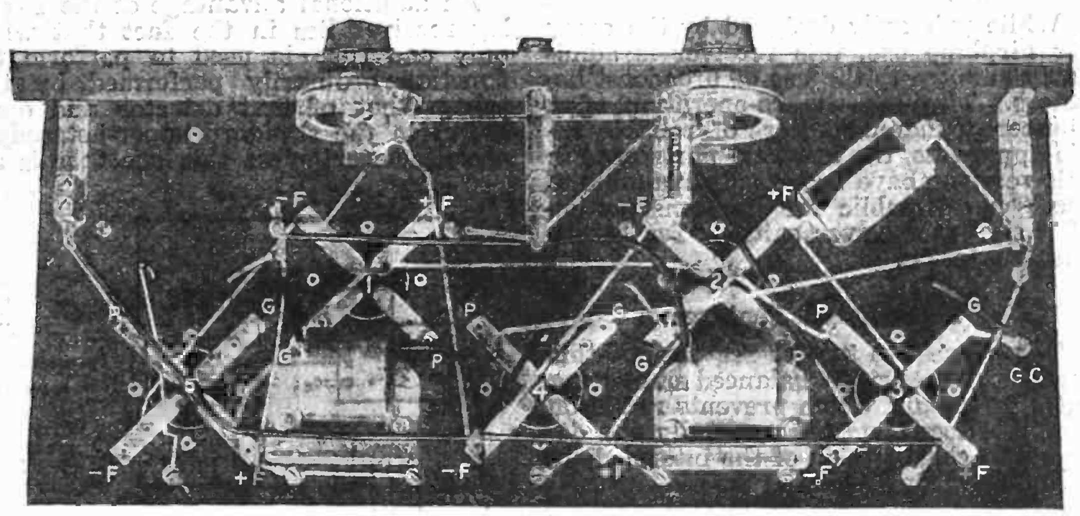


Fig. 8. This shows the parts completely wired.

left hand (Filament) wire on the left hand (3 to 1 ratio) audio transformer and run a wire to the bottom contact prong on the filament switch. Connect a wire from the left hand screw fastening Radio Frequency unit No. 2 (secondary) to the bottom contact prong on the filament switch. Also connect the upper left hand wire (filament) on the right hand (5 to 1 ratio) audio transformer to the bottom contact prong on the filament switch. Wire from the left hand primary wire on Radio Frequency unit No. 2 to prong P on socket No. 1. Wire from the right hand secondary wire of Radio Frequency unit No. 2 to prong G on socket No. 2. Wire from the left hand primary wire on Radio Frequency unit No. 3 to prong P on socket No. 2. Wire from one side of the .006 fixed condenser to prong +F on socket No. 2, to the left hand screw fastening Radio Frequency unit No. 3 (secondary). Wire from the other side of the .006 fixed condenser to the top prong on the right hand (phone) jack, to the +B amp. binding post screw. To this same wire, connect the right hand primary wire on Radio Frequency unit No. 3.

Wiring, 3rd Step

Referring to Fig. 7, wire from prong —F on socket No. 1 to the lower contact on the left hand (6 ohm) rheostat, to prong —F on socket No. 4. Wire from the +B amp. binding post screw to the top contact prong on the left hand (speaker) jack. Join to this same wire the top right hand (B. Battery) wire of left hand (3 to 1 ratio) audio transformer and the right hand (primary) wire of Radio Frequency unit No. 2. Wire from prong P on socket No. 4 to the lower contact prong on the right hand (phone) jack. Wire from prong P on socket No. 3 to the other side of the .002 fixed condenser.

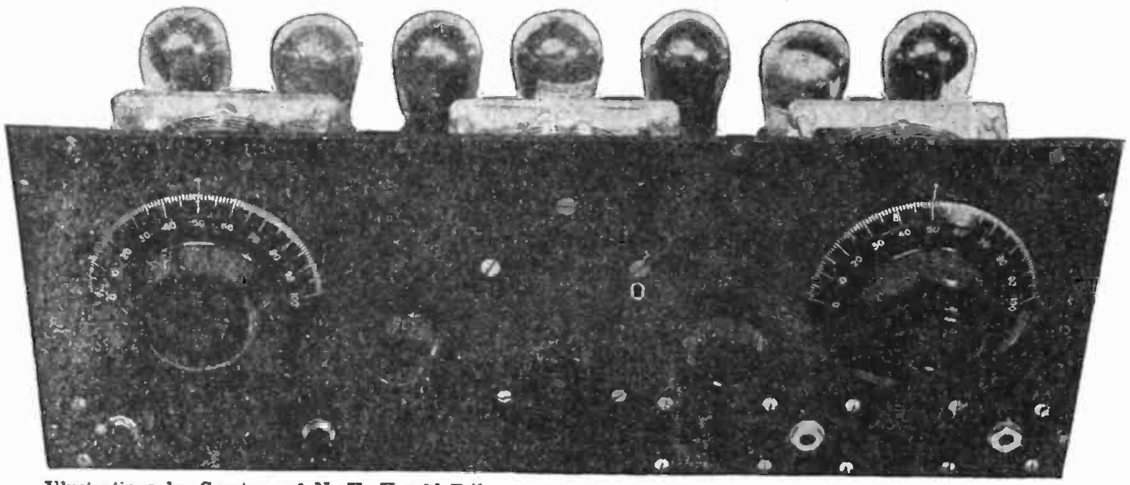
Run a wire from the right hand soldering lug on the condenser of Radio Frequency unit No. 3 to the side of the .00025 grid condenser nearest the Radio Frequency unit.

The wiring is now completed. (See Fig. 8). Check back very carefully, assuring yourself that each wire is in its proper place. After you are thoroughly convinced, proceed to mount the front panel by taking off the hard rubber knob on the filament switch and the tightening screws and spacers on the filament switch and jacks. Place the front panel over the rheostats, condenser shafts, filament switch and jack bushings and screw the filament switch, jack spacers and tightening screws down tightly. Fasten the dials and rheostat knobs by tightening the set screws on the side of the knobs. (See Fig 9.)

The Set can now be placed in a 7" x 18" cabinet and is ready for installation and operation.

Data on the New Pressley Super-Heterodyne

SINCE the introduction of the new seven-tube, non-radiating receiver developed by Mr. Jackson H. Pressley, chief engineer of the Radio Laboratory at Camp Alfred Vail, N. J., so much interest has been aroused in this circuit that it would not be out of place to give complete information regarding the construction and balancing of this receiver.



Illustrations by Courtesy of N. Y. Herald-Tribune

A front view of the Pressley Super-Heterodyne showing the new arrangement of controls.

In a recent issue of *The New York Herald-Tribune Radio Magazine*, this data was given by *Frank W. McDonell* as follows:

While primarily designed by the army for airplane use, this receiver is admirably adapted to the use of broadcast listeners. Through the co-operation of a number of manufacturers of reliable radio apparatus, the essential parts used in this receiver have been made available to the general public for the construction of a similar receiver suitable for broadcast reception.

Two Salient Features

There are two salient features of this receiver: the bridge balanced oscillating detector circuit, which prevents radiation from the loop, and the unusually fine design and construction of the intermediate frequency transformers.

The first of these features is based upon the principle of the Wheatstone bridge, well known among most radio experimenters. For a theoretical discussion of the application of this scheme to the Pressley circuit the reader is referred to the article by Captain Paul S. Edwards in *The New York Herald-Tribune* of November 23, 1924.

The other salient feature of the Pressley receiver is the design of the intermediate frequency transformer. In most super-heterodyne receivers the efficiency of the intermediate frequency amplifier depends upon the use of a certain amount of regeneration in the amplifying circuits. This regeneration is ordinarily controlled by a potentiometer, and unless the operator has acquired a certain amount of skill in using the receiver the background of noise in the loud speaker will be extremely objectionable because of the presence of regeneration in the intermediate frequency amplifier.

In the Pressley circuit the intermediate frequency transformers have been so cleverly designed that they do not depend upon regeneration for amplification. No potentiometer or other control is necessary to adjust the amplifier for maximum efficiency. The rheostat controlling the intermediate frequency amplifier tubes is used solely as a volume control, and the adjustment of this rheostat is in no way critical.

These features make the tuning of the Pressley receiver a pleasure rather than a constant annoyance. When the receiver has been properly balanced it will tune as quietly as a well balanced neutrodyne receiver, and no squeals or howls can be heard except those due to outside causes. For the same reason the quality is excellent, and the background of objectionable noises is reduced to a minimum.

An additional advantage of the Pressley receiver lies in the fact that while only one tube is used to perform the function ordinarily performed by two tubes (that of first detector and oscillator) in the standard super-heterodyne circuit, nevertheless this one tube is ac-

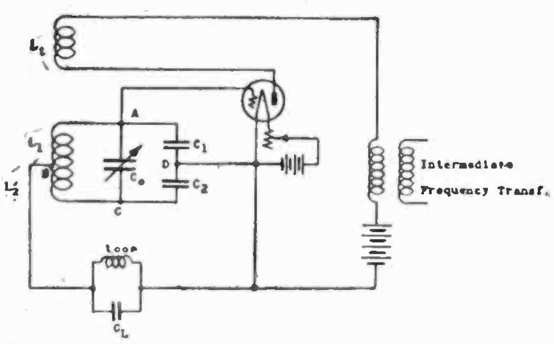


Fig. 1. Diagram of the bridge scheme used in the Pressley Super-Heterodyne.

tually more efficient than the two tubes as used in the standard super-heterodyne circuit.

Many builders of this receiver seem to have experienced trouble in securing a proper balance of the bridge circuit. This balance can be very easily obtained if the builder follows the circuit specifications implicitly.

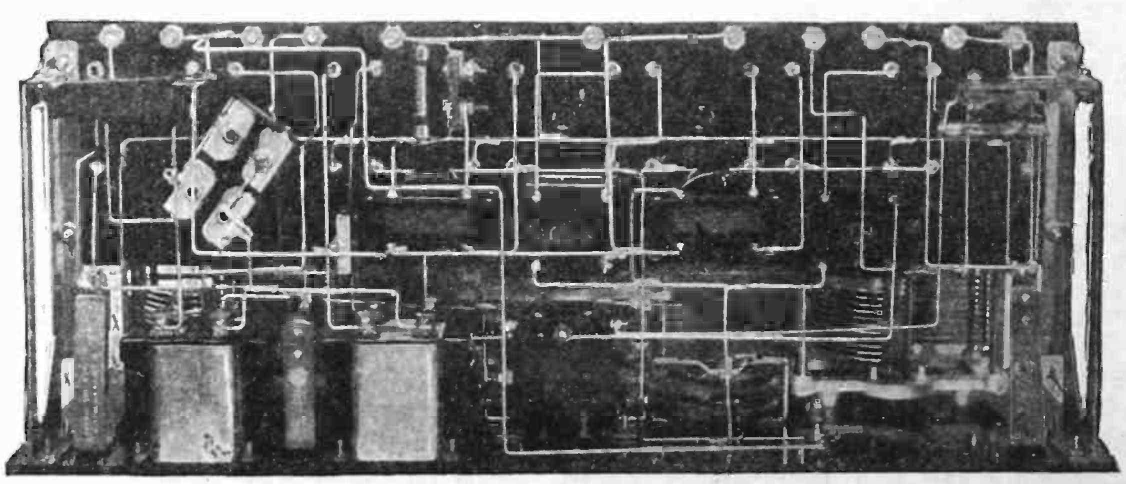
The Bridge System

Fig. 1 shows how the bridge scheme is used in the Pressley receiver as a portion of the oscillating detector circuit. The two inductances, L1 and L2, are really one coil tapped at the center (point "B"). The condenser C0 is the oscillator tuning condenser, by means of which frequency of the oscillations in the bridge circuit may be varied. Coil LT is the tickler coil, rigidly coupled to L1 and L2 so as to maintain oscillations in the bridge circuit. A balance is obtained in this circuit by adjustment of one or the other of the condensers C1 or C2, these two condensers being combined into one by the use of a split stator condenser. At this condition of balance no voltage will exist between the points "B" and "D," due to the oscillations of the tube. This prevents radiation from the loop.

If a perfect balance of the circuit could be obtained there would be absolutely no current in the loop circuit due to the oscillations of the tube. This, however, is not exactly the case. In wiring a receiver of this sort there is always a certain amount of coupling between the wires leading to the loop circuit and the wires connecting the different apparatus used in the bridge circuit, and the two circuits are thereby coupled together, however slightly, even when the bridge itself has been balanced. There might also be a certain amount of coupling between the loop and the oscillator coil, although this coupling is extremely small because the dimensions of the oscillator coil are as small as possible.

For these reasons the voltage across the points "B" and "D" can never be reduced to zero. In spite of the fact that the bridge can never be perfectly balanced, it can always be sufficiently balanced to prevent any appreciable amount of radiation from the loop, and also to prevent the presence of squeals and howls due to heterodyne action when receiving a station.

If the lay-out of the apparatus is exactly the same as that described in this article, an almost perfect balance can be obtained in the bridge circuit. The author wishes to point out the fact that it is important for the man who builds his own receiver to follow precisely the lay-out of apparatus, the selection of parts and the wiring diagram specified. This type of receiver, while very much less critical than the ordinary type of super-heterodyne receiver, nevertheless requires some care in building and wiring to insure good results. In the author's



How the Pressley set appears from a bottom view. Neatness in the wiring of parts is an outstanding factor.

experience more trouble has resulted by arranging the parts of a receiver to suit the builder's own fancy than from any other cause. Some builders never stop to realize that the arrangement of the apparatus is just as important in such circuits as the use of the correct wiring diagram, and very often they throw away months of careful development along these line by prominent engineers simply to satisfy their own idea of panel lay-out, etc. The photographs accompanying this article show the arrangement suggested.

the loop circuit. If the bridge is properly balanced there will be no such transfer of current from one circuit to the other and we will hear no such click. To balance the bridge continue to rotate the loop tuning condenser back and forth rather rapidly over that portion of the dial at which the clicks are heard in the telephones. At the same time vary slightly the position of the rotor of the split condenser until the clicks entirely disappear, or at least become as faint as possible. The loudness of the clicks heard

Parts Required

One 7x18-inch Bakelite panel, drilled and engraved.

One Sangamo kit, consisting of one oscillator coil, two iron core and two air core transformers.

One "X" Laboratories, .00007-mf. balancing condenser.

One "X" Laboratories .0005-mfd. Vernier condenser.

One "X" Laboratories .0005-mfd. plain condenser.

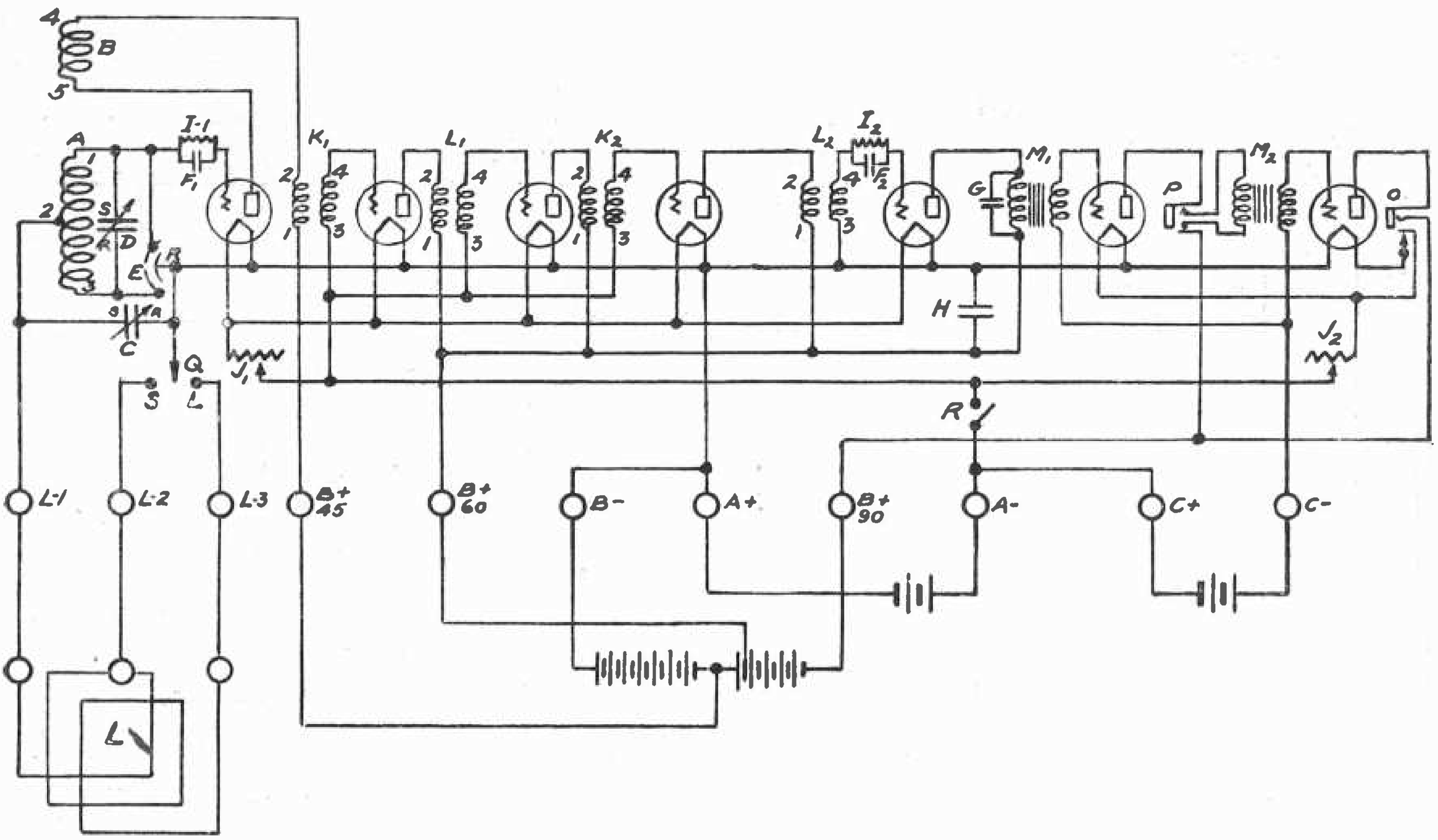


Fig. 2. The wiring diagram of the new Pressley Super-Heterodyne.

Balancing the Detector

To balance the detector circuit connect a pair of telephones in the B battery lead to the first or oscillating detector tube. The loop should remain connected to the receiver, with the wave change switch thrown to the short-wave side, and all batteries should be connected. It is not necessary, however, that any except the first tube be placed in the sockets. Test the circuit to make sure that it is oscillating by wetting your finger and putting it on the grid binding post of the socket. If a click is heard in the telephones as you touch the grid binding post, and another as you remove your finger from the grid binding post, the tube is oscillating. This test may be repeated with the oscillator condenser dial placed at different points over the scale to make sure that the tube oscillates equally well at any position of the tuning condenser dial. When you are sure the oscillator functions properly set the oscillator dial at about forty divisions of the scale or at some point near forty divisions where you cannot hear any whistles or signals which might be received from a powerful local broadcasting station. Then, leaving the oscillator dial set at this point, move the left hand or loop condenser dial over the scale.

If the dial is moved over the scale rather rapidly a click will be heard in the phones. This click is due to a transfer of current from the oscillator circuit to will depend largely on how rapidly the loop tuner dial is moved back and forth. Even if the loop condenser dial is moved quite rapidly there should be no more than a very dull thud in the telephones when the circuit is properly balanced. Having once achieved this condition of balance, the split condenser may be locked in position by the set screw provided for that purpose, and thereafter need not be changed.

Of all the Pressley receivers which have been sent to the author's laboratory with the complaint that they could not be balanced, there has not yet been one case in which the receiver could not be balanced if the circuit was correctly wired and if there were no open circuits or short circuits present. If it is apparently impossible to balance the circuit by the method outlined above there must be some trouble in the wiring of the bridge circuit and the connections in this circuit should be checked very carefully.

The complete parts for this receiver may be purchased from any reliable radio dealer. All of these parts listed below have been selected with a view of increasing the efficiency of the receiver as far as possible, as well as providing smooth mechanical controls for the moving parts, such as the condensers and rheostats. The list of parts in the receiver shown in the photograph is as follows:

One "X" Laboratories dial to match.
One "X" Laboratories 6-ohm rheostat.
One "X" Laboratories 15-ohm rheostat.
One Benjamin seven-tube gang shelf.
One Benjamin grid leak panel.
One Benjamin battery switch.
One pair Benjamin brackets.

One Thordarson 6:1 audio transformer, first step.

One Thordarson 2:1 audio transformer, second step.

One Pacent double circuit jack, No. 63, first step.

One Pacent single circuit fil. control, No. 65, second step.

Two Dubilier .00015-mfd. micadons, type 601-G.

One Dubilier .005-mfd. micadons, type 601.

One Dubilier .5-mfd. micadons, type 656.

One ¼ megohm grid leak (first tube detector and oscillator).

One two megohm grid leak (second detector).

One jack switch Carter No. 3 or Yaxley No. 30).

One loop (Portena or Marion).

The following directions, if followed in the assembly and wiring of this circuit, will be found extremely helpful:

1. Attach brackets to socket shelf.
2. Attach iron and air core transformers to bottom of socket shelf, as

(*Continued on Page* 33)

How to Make a Battery Charger

CONSTRUCTIONAL details of a transformer to be used in conjunction with a 5-ampere-hour capacity Tungar rectifier tube were given in the *Radio Oracle* column of *Science and Invention* magazine as follows:

type, having three different windings on it. The core is made of laminated silicon steel, "L" shaped, in two sections, which are butted together and securely fixed after the coils have been put in place.

One hundred and twenty-five lamina- turns of No. 6 B. & S. D.D.C. wire are wound on and serve as the filament winding. Directly over this are wound 73 turns of No. 10 B. & S. D.C.C. wire, which furnishes the current for charging the "A" battery. It will be noted that

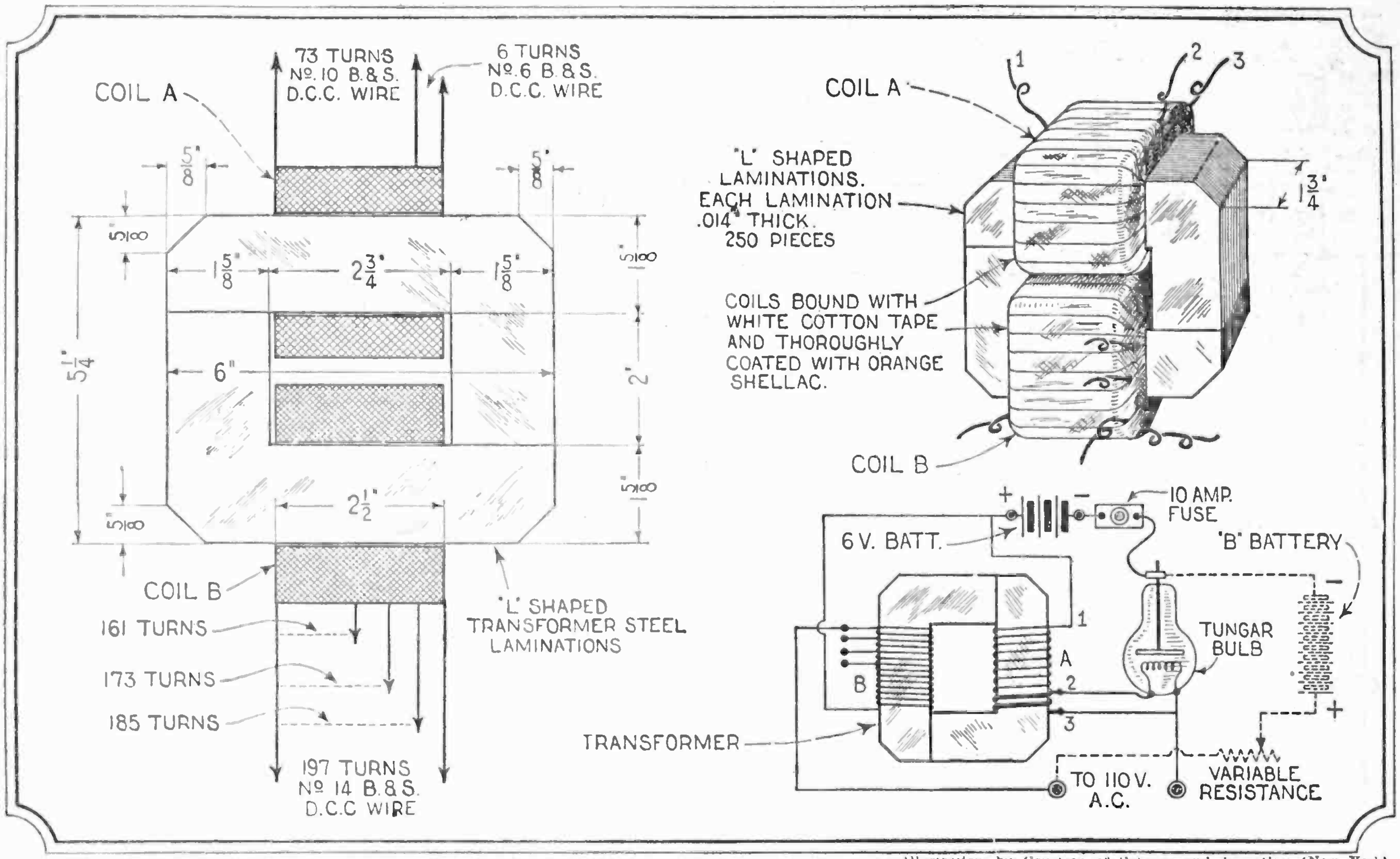


Illustration by Courtesy of Science and Invention (New York)

A transformer for the purpose of charging both the "A" and "B" batteries is detailed clearly above. It is well worth the trouble to construct. It is designed for operation on 110 volt, 60 cycle alternating current, and if carefully built will last indefinitely.

The time has come when the recharging of storage batteries, both "A" and "B" types, necessitates a much more convenient way than the carrying of them several blocks to the nearest battery station, with, perhaps, the dire results accruing from spilling the acid over one's clothes. The best means of overcoming this difficulty is to charge them at home. A transformer for that purpose has been designed along the lines given in the above diagram and will meet all requirements. It is of the auto-transformer tions are placed in a pile 1¾ inches high and constitute one leg of the core. Two or three layers of tape are wound tightly over it, after the laminations have been squeezed together as tightly as possible. On this are wound 197 turns of No. 14 B. & S. D.C.C. wire, taps being taken off at the 161st, 173rd and 185th turns. The winding must be confined within a space of 2½ inches wide. This is shown as coil "B" in the diagram.

After having prepared the second leg of the transformer as outlined above, six the two coils are connected in series with the winding on leg "B."

Having finished the windings, they are carefully taped and shellaced. The legs are then butted together and securely held together with wooden cleats. The variable resistance shown is a bank of five 40-watt lamps which are used to regulate the charging current. A 10-ampere fuse is connected in series with the battery and prevents overcharging. The transformer should be mounted on a slate or asbestos base.

Select the Proper Grid Leak

The resistance of the grid leak will often be the factor which determines whether or not a distant station that is slightly below the point of audibility may be logged.

For the dry cell tubes, from two to three megohms will generally be satisfactory. The 199 type of tube requires a leak from two to nine megohms, the exact value to depend on the individual characteristics of the tube. The 200 type of tube works best with a grid leak from one-half of two megohms. The 201A type will operate with a leak from two to nine megohms. Regardless of what tube is being used, best results can be obtained only by trying different leaks to ascertain which will allow the tube to work at greatest efficiency. A leak of high value will be better for weak signals.

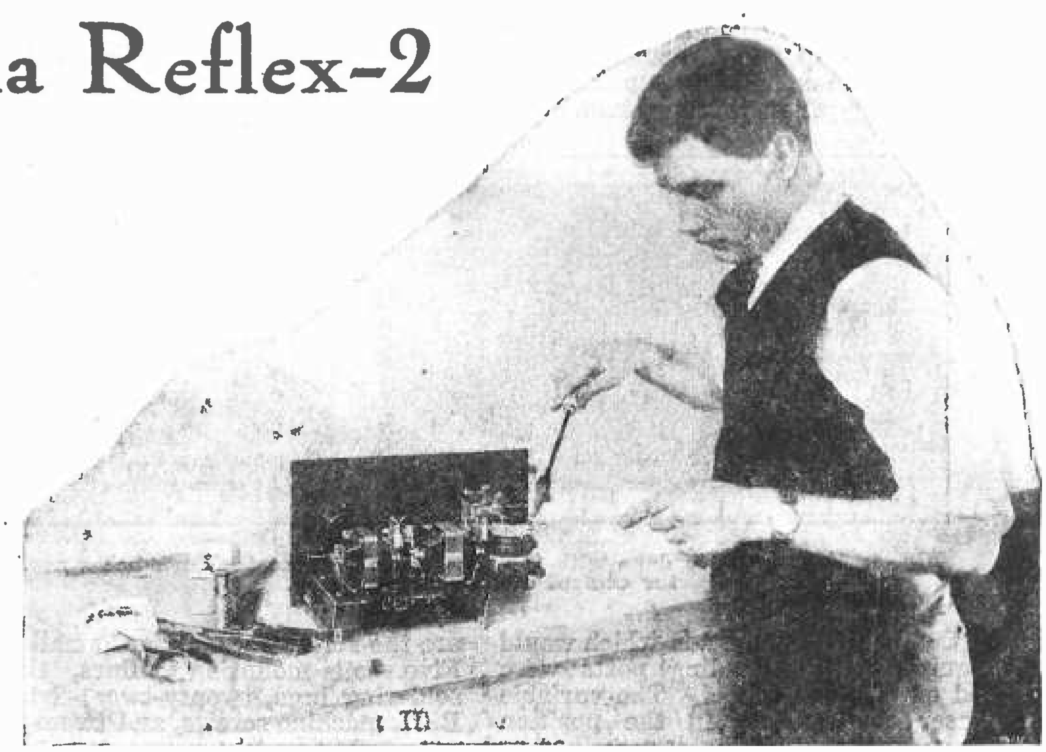
Grid leaks which consist of a carbon pencil mark in the bakelite covering are inefficient, as are all leaks which are apt to change their value with usage or become affected by changes of temperature.

The grid leak condenser should have a capacity of .00025 mfd. for all tubes excepting the 200 type, which works best with a condenser from .00025 to .0005 mfd. capacity. Condensers that are composed of sheets of tinfoil and waxed paper are unsatisfactory, as their capacity will vary with changes in temperature. —*The State Journal, Lansing, Mich.*

Making the Rasla Reflex-2

THE popular two-tube Rasla Reflex receiver makes a powerful, compact and attractive set capable of operating a loud speaker. Constructional details for building this set as recently described by *M. B. Sleeper* in *Radio Engineering*, follows:

We had read and heard so much about the new Rasla type two-tube receiver that we had to make up one for ourselves. After testing out the circuit thoroughly and making little changes here and there the problem resolved itself into the construction of a compact unit which could be easily built and used as a portable set if desired. The hardest job was to arrange the parts so that the wiring would be short and simple and yet preserve the high efficiency of the receiver. In presenting this receiver we feel that all of the obstacles have been surmounted. The set is small, measuring 7 by 12 inches, by 7 inches deep. At the Darien laboratory we brought in all of the broadcasting stations around New York City as well as many DX stations on the loud speaker. The set is extremely selective when used with an aerial about 60 feet long.



Illustrations by Courtesy of Radio Engineering (New York)

Fig. 1. Putting the finishing touches on the Rasla set.

The Rasla Reflex Circuit

The circuit employed in this set is not of the trick variety, but rather depends for its high efficiency on the correct design of the various parts. Referring to the schematic wiring diagram, Fig. 2, you will notice that the Rasla tuning unit consists of an untuned primary with a tap for use with long aerials, and a secondary coil tuned by a 0.0003 mfd. Cardwell variable condenser. The condenser tunes the entire secondary winding, but only part of the coil is included in the grid circuit. This increases the selectivity. Oscillations are controlled by a small two plate Rasla balancing condenser used in conjunction with the remainder of the secondary winding. This condenser also serves as a volume control. The first tube is reflexed to provide both radio and audio frequency amplification. The interstage Rasla radio frequency transformer is designed so that its impedance matches that of the fixed Rasla crystal detector, giving efficient coupling. The high ratio Modern A. F. transformer used in the first stage has a low primary impedance to match that of the crystal detector and provides the unusual kick peculiar to this circuit. A .00025 mfd. Micadon bypasses the radio frequency current around the secondary. The second stage of straight A. F. amplification uses a low ratio Modern transformer to prevent distortion. After very careful experimenting it was found that a 0.00025 mfd. Micadon connected across the primary of this transformer not only cleared up the reception greatly but also increased the volume. The filament current of the first tube is controlled by a 30-ohm Cico rheostat. An Amperite is used on the second tube. A filament control jack is employed as it does not complicate the wiring.

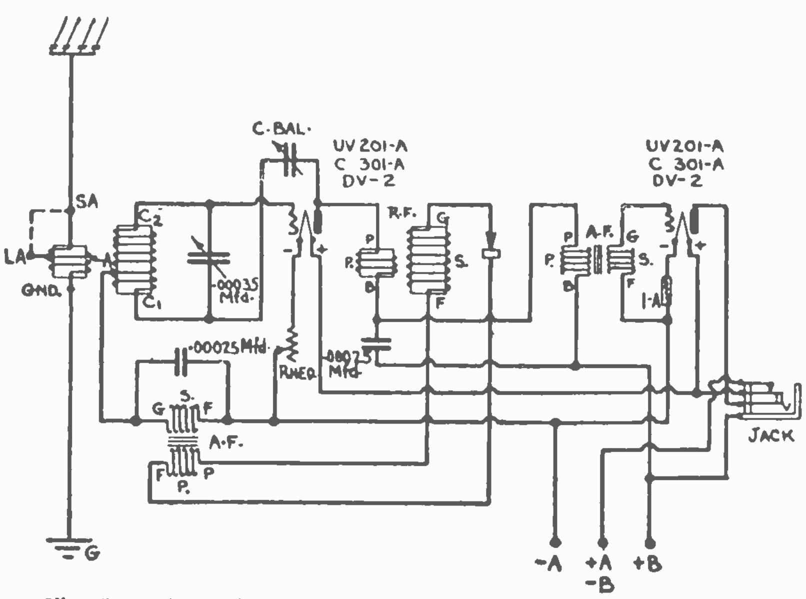


Fig. 2. Schematic wiring diagram of the Rasla Reflex No. 2.

Design of the Receiver

Much thought was given to the design of the set in an effort to make it compact and easy to construct without decreasing its efficiency. The front panel layout balances very well and is hard to improve upon. The tube panel is supported by two Benjamin panel support brackets. These brackets are essential in this set as the weight of the two A. F. transformers concentrated at the back of the panel is too great to permit of the use of the conventional angle brackets. The tube sockets are hung under the panel with coil mounting pillars and screws so that most of the wiring is below. These sockets are of white Isolantite and have sterling silver contacts. Aside from their high electrical efficiency, they present a very pleasing appearance when contrasted against the black panel material. The base of the R. F. transformer is also fastened under the tube panel. The mounting of the Amperite has been worked out so that it is fastened directly to the panel, and the terminal which goes to the socket is under the coil mounting pillar which supports the socket, thus utilizing it to convey the filament current to the contact spring. The right hand panel support bracket, looking at the set from the front, is used as part of the filament lead from the —A binding post to the rheostat

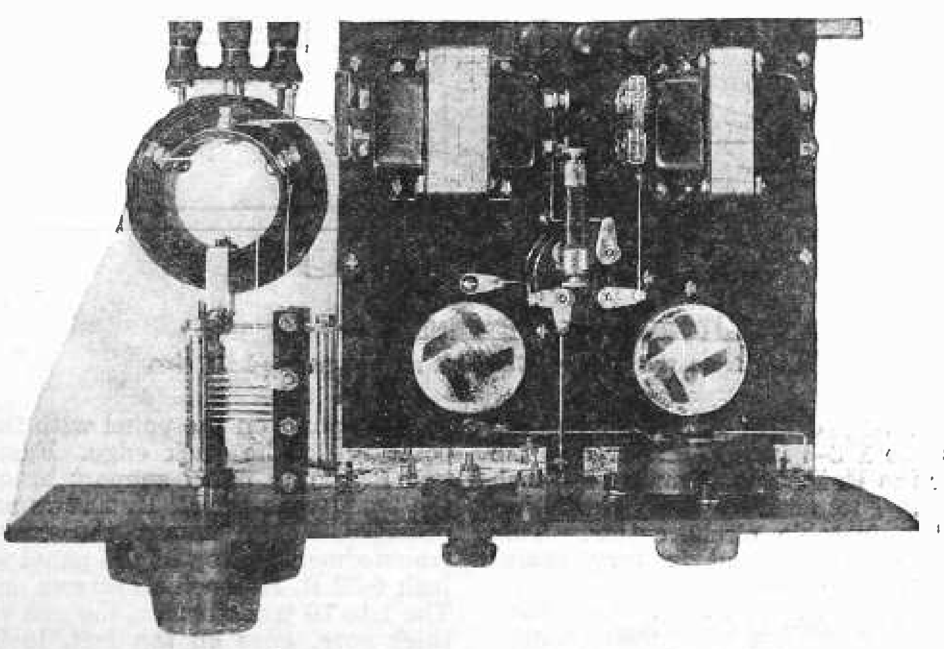


Fig. 3. The Benjamin mounting brackets are used to make a rigid mechanical construction as well as convenience in the arrangement of parts.

The antenna coupling coil has a separate binding post strip for the antenna and ground connections. This is supported on a coil mounting pillar. This scheme eliminates the long parallel leads which would be required if the binding posts were located on the tube panel. The variable condenser is fastened in the position shown so as to make the connections as simple as possible.

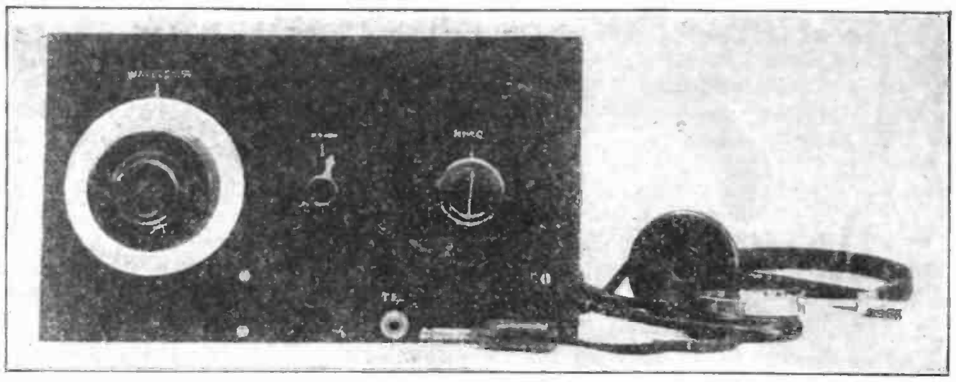


Fig. 4. All tuning is done with the vernier dial, the center knob being used for control of regeneration only.

Standard Parts Required

The panels may be either of Formica or Celoron. The front panel measures 7 by 12 inches, 3-16 inch thick, the tube panel is 7 by 6 3-8 inches, 3-16 inch thick, and the binding post strip is 2 by 5-8 inch, 3-16 inch thick. The instruments required are a Rasla tuner, fixed crystal detector, compensating condenser and knob, and type CR radio frequency transformer, a Modern 1 to 10 and 1 to 4 ratio A. F. transformer, two General Instrument Isolantite sockets, one Cico 30-ohm rheostat and knob, a pair of Benjamin panel support brackets, 1-A Amperite, Carter 3-spring filament control jack, six Eby or Marshall-Gerken binding posts, Cardwell 0.0003 mfd. variable condenser, two 0.00025 mfd. type 601G Micadons with grid leak clips, and one 4-inch Accuratune vernier dial. In addition there are the following standard small fittings: Five coil mounting pillars, thirty-five soldering lugs, twenty-two 1-2 inch 6-32 R. H. machine screws, and twenty nuts.

Drilling the Panels

If you desire, you can scale off the location of the holes in the tube panel from the picture wiring diagram, as it is shown at exactly one-half size here. All of the screw holes in the tube panel are made with a No. 18 drill, and the holes through which the wires pass are made with a No. 27 drill. The holes for the sockets are 1 3-4 inch diameter and the hole for the R. F. transformer 1 5-8 inch diameter. These can be easily cut with a Pawood adjustable circle cutter. This tool is inexpensive and is very useful around the laboratory.

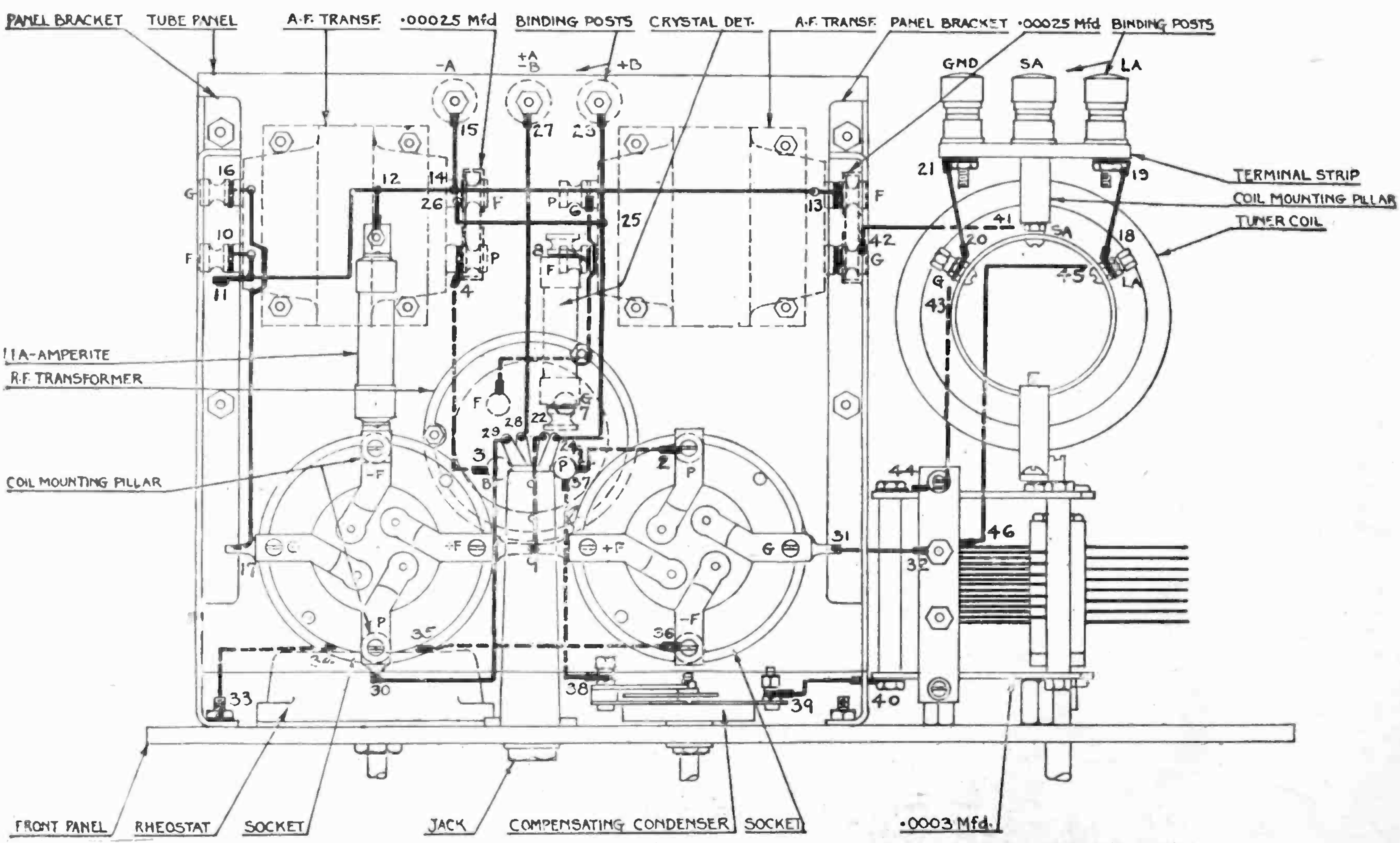


Fig. 5. This picture wiring diagram shows the set from the under side. All parts are one-half size.

Assembly and Wiring

Fig. 5 shows a picture wiring diagram of the set, in which the connections have been drawn exactly as they were arranged in the original receiver. The diagram is drawn looking up at the bottom of the set.

Place the lugs on the instruments as they are mounted, having them pointing in the directions shown by the short heavy lines in the picture wiring diagram and have nuts tightened securely. Spintite wrenches are very good for this work.

1. Put the R. F. transformer through the middle large hole in the tube panel and fasten its base to the panel with three 1-2 inch 6-32 R. H. machine screws and nuts. Be sure that the terminals are located correctly. Remove the two nuts from the P and —F terminals of each socket and put a coil mounting pillar on each screw instead. Now fasten the sockets to the underside of the tube panel by means of a 1-2 inch 6-32 R. H. screw threading into the coil mounting pillars from the top of the panel. Before fastening the left hand socket, remove the mounting clips from the base of the Amperite, and cut off the clips where they bend over the ends of the base. Mount one of these clips under the coil mounting pillar on the —F terminal of this socket so that when the screw is put in from the top of the panel the whole unit is clamped tightly together. Mount the other Amperite clip on the panel with one of the R. H. screws from the Amperite base. Snap the Amperite in place between the clips. Mount the three binding posts on the panel with the holes pointing to the back edge. Fasten the two Benjamin panel support brackets to the panel with the R. H. screws and nuts provided. Now mount the two A. F. transformers on top of the panel with 1-2 inch 6-32 R. H. machine screws and nuts. The 1 to 10 transformer, the one with the thick core, goes on the left, looking at the panel from the top-front. Flatten out the grid-leak clips on the two Mica-

dons and mount one on the secondary of the 1 to 10 transformer and one on the primary of the 1 to 4 A. F. transformer. Fasten a soldering lug to the Micadon on the 1 to 10 transformer with a 1-2 inch 6-32 R. H. screw put through the front eyelet hole.

2. On top of the panel, connect 1, the P. terminal of the R. F. transformer, to 2, the lug which is fastened to the P. terminal of the left hand socket, looking at the panel from the front. Connect 3, the B terminal of this transformer to 4, the P terminal of the 1 to 4 A. F. transformer. Connect 5, the F. terminal F terminal of the 1 to 10 transformer. Connect 14, a point on this wire, to 15, the —A binding post. Connect 16, the G terminal of the 1 to 4 transformer, to 17. Keep this wire clear of connection 11.

5. Mount the jack on the front panel, keeping the frame toward the bottom. Loosen the set screw in the knob of the compensating condenser, and take off the knob, pointer, lock nut, and washer. Fasten the condenser to the panel with the lock nut and washer, keeping the rotor plate terminal facing the side of the panel where the Cardwell condenser

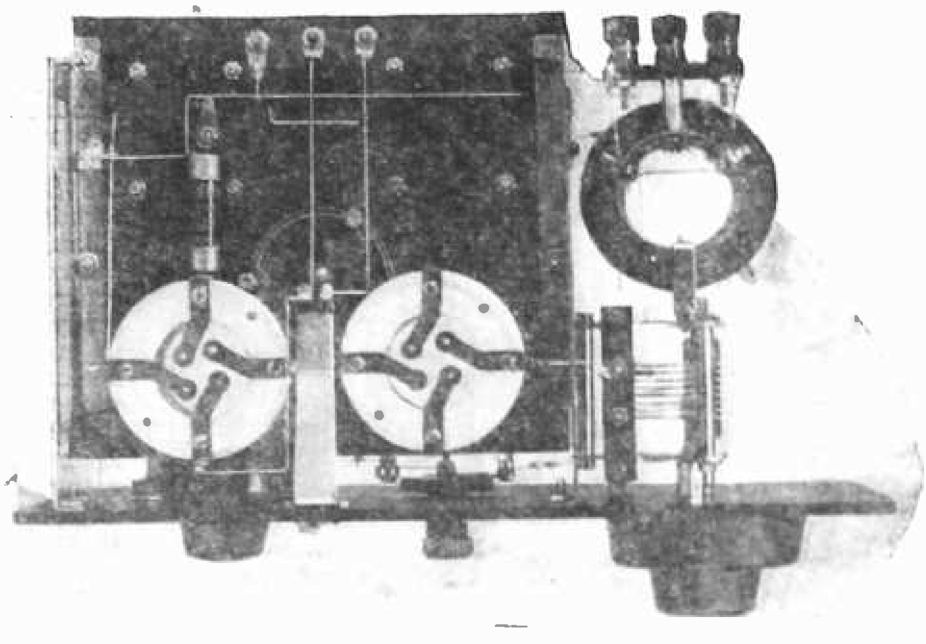


Fig. 6. The under-side view of the Rasla-2 is quite as neat as the top.

of the R. F. transformer to 6, the P terminal of the 1 to 10 transformer.

3. Put a lug on each terminal of the Rasla crystal detector.

4. Solder one lug, 7, to the lug on the G terminal of the R. F. transformer. Solder the other lug, 8, to that on the primary F terminal of the 1 to 10 transformer. These lugs may have to be twisted slightly in order to get the crystal detector straight. Now turn the tube panel upside-down and connect the two +F. lugs on the tube sockets together. This is connection 9. Connect 10, the secondary F terminal of the 1 to 4 transformer, to 11, a point on the panel support bracket. This wire runs through the small hole in the panel. Connect this same point, 11, to 12 and through the small hole in the panel to 13. Connection 12 is made to the lug on the Amperite terminal and 13 is the secondary is to be mounted. Put on the knob and dial so that the dial is vertical when the rotor plates are halfway interleaved with the stator. Mount the rheostat on the panel, and fasten the knob so that the arrow points to the line on the panel when it is turned all the way to the left. Mount the two outside binding posts on the small terminal strip, putting a lug under each nut. Remove the outer nut from the SA terminal of the Rasla tuner and screw a coil mounting pillar on it. Now put the middle binding post through the terminal strip and screw this into the free end of the coil mounting pillar, keeping the strip parallel to the tuner coils. Mount the two legs of the tuner unit to the end plate of the Cardwell condenser, fastening them with 1-2 inch 6-32 R. H. machine screws threaded into the two holes which you will find in the end plate. It so happens that these holes in the end plate are spaced correctly for the mounting.

6. Connect the LA terminal, 18, of the tuner to the LA binding post, 19. Connect the GND terminal, 20, to the GND binding post, 21.

7. Mount the condenser and tuner unit on the front panel with the three flat head screws. Put the Accuratune dial on the shaft so that the 100 division line coincides with the line engraved on the panel when the condenser plates are totally interleaved. If you use the old style Accuratune you will find it necessary to cut off the shaft of the condenser just a little bit, so that the dial will fit flush up against the panel. Make sure that you press the dial on firmly before tightening the set screw for, otherwise, the cork friction disc will not hold. Remove the two binding posts from the rheostat and put on lugs and ordinary nuts instead. Fasten the front panel to the brackets on the tube panel with the four flat head machine screws provided. Make sure that the nut on the top screw on the right hand bracket has a tinned lug under it.

8. Turn the set so you are facing the bottom of the tube panel and connect 9 the junction of the F+ terminals of the sockets, to 22, the lower right hand tab of the jack. Connect 23, the +B binding post, to 24, the right hand tab next to the frame. Connect 25, a point on this wire, to 26, the primary F terminal of the 1 to 4 transformer. Connect 27, the +A —B binding post, to 28, the lower left hand tab of the jack. Connect 29, the remaining tab on the jack, to 30, the P terminal of the left hand socket. Connect 31, the G terminal of the right hand socket, to 32, the stator terminal of the Cardwell condenser. Keep this lead clear of F.the bracket. Turn the set right-side up again and connect 33, the lug under the nut on the bracket, to 34, the outer terminal of the rheostat. Connect 35, the other rheostat terminal, to 36. Connect 37, the P terminal of the R. F. transformer, to 38 on the compensating condenser. Connect 39 to 40. 40 is a lug under the spacer rod of the Cardwell condenser. Connect 41, the —A terminal of the tuner, to 42 on the .00025 Micadon. 41 is shown as a free dotted line in the picture wiring diagram. Connect 43, the C1 terminal of the tuner, to 44 on the rear end plate of the condenser. Connect 45, the C2 terminal, to 46 the top stator terminal of the condenser.

This completes the assembling and wiring of the set. It will be well to check over every connection against the picture wiring and schematic diagrams as well as the illustrations.

Enameled Wire for the Aerial

The resistance of an outside aerial increases rapidly a few days after the wire is exposed to the air because of the corrosion of the metal surface. When the aerial is first installed it brings loud signals to the set, which decrease steadily as the accumulation of oxide increases on the wire.

To prevent this effect it is necessary to use enameled antenna wire, the covering of which keeps the air from reaching the metal, eliminating the corrosive action and making the signal efficiency permanent, without any bad effect from the enamel itself.

Why this accumulation of oxide interferes with the passage of the radio currents is explained by what is called the "skin effect" of high-frequency currents. The outer layer, or surface, of the wire is called the skin, and the effective thickness of the skin is different according to the wave length, or frequency, of the signal, for these currents do not penetrate the wire, traveling only on or near the surface.

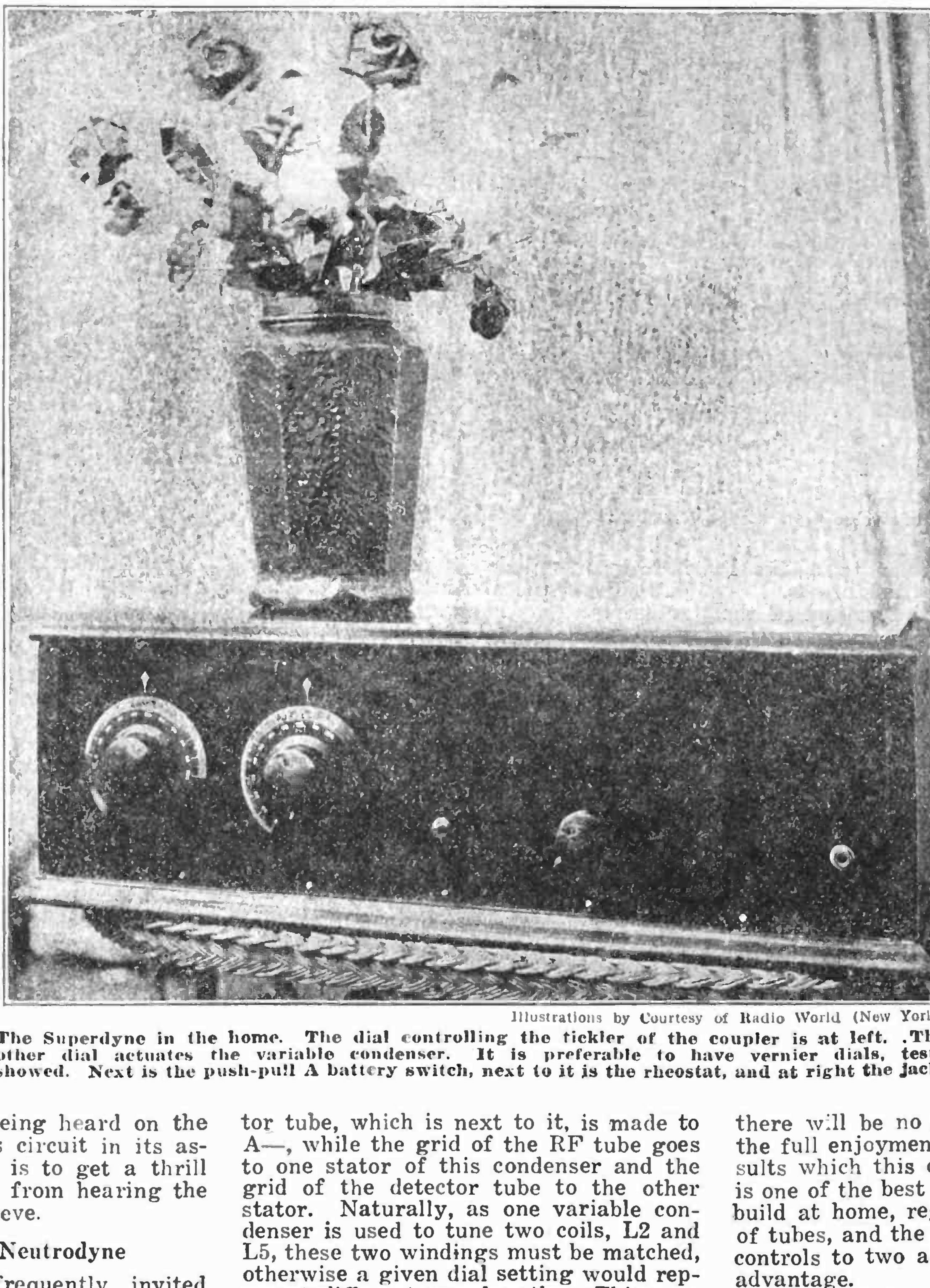
Penetration of the current below the surface of the aerial wire is so little that it is almost negligible. If the wire were hollow it would serve the purpose of a radio conductor perfectly well, because the inside, or core, is of no value as the current never penetrates that deeply.

It is important, therefore, to provide a shell, or skin, conductor for the current of the highest possible efficiency. If the skin of pure cooper turns to a crystalline mixture of oxide and dirt, it follows that but little radio energy will be passed through it.—*N. Y. Evening Journal.*

How to Make the 4-Tube Superdyne

SIMPLIFIED tuning by the reduction of the number of controls to two, the preservation of tone quality and distance reception are some of the outstanding features of the 1925 model 4-tube Superdyne. This set was designed and subject to test for several months in the *Radio World's* laboratories and described by Herman Bernard in three parts in that magazine. The complete description and constructional details for the set follow:

A set with a thrill in it is something that every radio fan is seeking. That thrill is amply provided by the Superdyne. It is impossible for the home constructor to achieve a more entrancing result than is obtainable from building *Radio World's* 4-Tube Superdyne. It embodies a stage of radio-frequency amplification in which reversely fed-back regeneration is utilized and a strong amplification of weak signals afforded. A radio-frequency transformer, tuned by a variable condenser, couples the radio-frequency side of the circuit to the detector tube. The two stages of transformer-coupled audio-frequency amplification give powerful signals on the loud speaker. Distant stations are thus brought in with an astonishing clearness, 1,200-mile distances being not uncommon under good conditions on a winter's night. Often you might imagine you are listening to some powerful local station when in fact some broadcaster 1,000 miles away is being heard on the speaker. To hear this circuit in its astounding performance is to get a thrill like that which comes from hearing the song of the thrush at eve.



Illustrations by Courtesy of Radio World (New York)

The Superdyne in the home. The dial controlling the tickler of the coupler is at left. The other dial actuates the variable condenser. It is preferable to have vernier dials, tests showed. Next is the push-pull A battery switch, next to it is the rheostat, and at right the jack.

Superdyne vs. Neutrodyne

Comparisons are frequently invited between the Superdyne and the Neutrodyne. While one must remember that different circuits have different eccentricities, it is nevertheless true that for tonal quality the Superdyne is better than the Neutrodyne; for volume, the Superdyne is at least as powerful as the Neutrodyne; for quietness of operation and ease of tuning the Neutrodyne is better than the Superdyne. But the Superdyne, with only four tubes, will about equal, often exceed the Neutrodyne in DX possibilities. Moreover, with the Superdyne stations may be tuned in with consistent selectivity over the entire broadcast wavelength band.

Uses Only Two Controls

Like the Super-Heterodyne set, the 4-Tube Superdyne has only two controls. The elimination of one control is not achieved at a sacrifice, but a variable condenser is used that has a common rotor joined to the A—. Hence the grid return of both the RF tube, the one at extreme left in Fig. 1, and of the detector tube, which is next to it, is made to A—, while the grid of the RF tube goes to one stator of this condenser and the grid of the detector tube to the other stator. Naturally, as one variable condenser is used to tune two coils, L2 and L5, these two windings must be matched, otherwise a given dial setting would represent different wavelengths. This synchronizing of the coils, however, is not difficult.

The Variable Condenser

The condenser, known as the Bruno Ultra-Vario, has four separate stators of .00025 mfd. maximum capacity each, but these stators are joined in pairs, so that each combined stator represents the desired maximum capacity of .0005 mfd., in this case 22 plates. Where these stators are united and the common rotor connection made is shown in Fig. 2.

The Coils

As for the coils, there are quite a few excellent Superdyne variocouplers on the market, all of which work splendidly in this circuit. Instead of an impedance plate coil an aperiodic primary of a radio-frequency transformer is used (L4). The beginning of this primary goes to the plate of the RF tube, while the end of the winding is connected to the end of L3, the tickler or rotary coil of the coupler. The beginning of L3 is joined to the B+ amplifier voltage, usually 90. In this way, by connecting the plate coil in standard fashion, but reversing the leads to the tickler, the Superdyne effect is gained. Oscillations are suppressed and this control of the heterodyning common to regenerative hookups enables the utilization of the strong radio-frequency amplification to its fullest extent and serves to block the emission of the heterodyned note through the antenna.

The set is not difficult to construct, especially as the important item of placing the parts is fully set forth in Fig. 3, showing the combined panel layout and assembly plan, with each instrument in perpendicular alignment in both sections of this illustration.

Under no circumstances must the coils L4L5 be in inductive relationship to the coupler. Almost always if the L4L5 coil is mounted as shown (Fig. 3) at right angles to the coupler and safely distant from the variable condenser, there will be no stray coupling to spoil the full enjoyment of the astonishing results which this circuit can produce. It is one of the best circuits it is possible to build at home, regardless of the number of tubes, and the reduction of the tuning controls to two adds considerably to the advantage.

Only One Rheostat

Only one rheostat, R1, is shown. This is connected in the negative lead of the detector tube socket so that advantage may be taken of the voltage drop in the rheostat for negatively biasing the grid of the detector to the extent of that drop. For that reason, too, it is advisable to put the rheostat in the negative lead in any hookup for any stage, radio, detector or audio. An Amperite or 4-ohm rheostat controls the three amplifier tubes.

A 6-ohm rheostat should be used for controlling the 200 or 300 detector tube, while an amperite controls the three other tubes.

If any rheostat were used to control the three amplifier tubes it should be 2 or 3 ohms. A little finer control is afforded by the inclusion of the rheostat, and for those who desire to include it they should mount the amplifier rheostat just to the left of the jack in Fig. 3. But it is not a vital adjunct.

The grid leak, R1, should be variable for best results. It is shown in Fig. 1 connected from the grid post of the detector tube socket to the F+, but it may be mounted in conventional fashion across the grid condenser C2.

A Loudspeaker Set

Only one jack is included, because the set is designed for loud speaker operation whenever possible. Nearly all distant stations that will be heard will come in with enough volume to be audible on the loudspeaker, but to cover the exceptional cases a pair of earphones come in handy. These would be plugged into the jack instead of the loudspeaker cord tips.

The C Battery

A C battery is included in the two audio stages to avoid possible distortion and to reduce the drain on the B batteries. There is room for the C battery right behind the panel, in front of the audio transformers. If the B battery voltage on the audio stages is 90 and the 201A or equal are used, the C battery voltage should be about 4½.

The Coils

The coils must be matched, otherwise the set will not work properly. If they are not matched the same dial setting of the only variable condenser used in the set will represent different wavelengths, hence a station will come in at two different settings of this dial, and not perfectly in either case. But once the coils are matched the difficulty is solved.

Varied Choice of Coils

In the choice of coils there is quite a variety. Almost any 3-circuit tuning coil may be used for L1 L2 L3 (Fig. 1) and the coupling transformer (L4 L5) must be wound just as the stator of the variocoupler is wound. For simplicity and the preservation of inductance values the primaries and secondaries of both inductances should be identical, except the RFT secondary (L5) is tapped and later connected to one of the condenser stators at that tap which gives the desired perfection of result.

No. 20 double silk covered wire may be used for making both inductances. If a 4" outside diameter tubing is used for making the variocoupler, L1, L2, L3, it should be 2" high. Thirty-one turns are put on for the secondary. The primary should consist of four or five turns of the same wire wound directly over the secondary and for the entire length of the secondary winding, that is, the primary turns are spaced wide apart. All windings of all coils used in this circuit are in the same direction. The Superdyne effect is obtained by reversing the leads, rather than by the more complicated method of reversing the windings and connecting the leads in standard fashion. That will be discussed later. The rotor may be of the former type, that is shaped like the sides of a ship, and on it 36 turns of the same kind of wire are wound. Eighteen turns are placed on one side of the centre of the rotor and eighteen on the other, to leave unobstructed space for inserting the shaft. The forms for making one's own coupler are not easily obtainable and often a home-made coupler is not mechanically strong. If you have an old variocoupler you may convert it into one for use in this circuit, but otherwise it is preferable to purchase a commercial model specially suitable for this circuit.

Taps on RFT Secondary

The specifications given are those of the special coupler manufactured by Wallace for this circuit. However, the Globe low-loss variocoupler also is excellent for use in this circuit, but it is futile to give instructions for constructing one just like it, since that requires factory facilities. One additional turn is required on the secondary of the standard Globe coupler for use in this circuit, and a special coil is now manufactured to meet this need. If Litz wire or its equivalent is preferred by the constructor, he should wind a 16-turn primary on a 3" outside diameter tubing, terminate, leave ¼" space and wind 40 turns for the secondary. The rotor may consist of 36 turns. These are the specifications for the ARC Tri-Tuner as adapted to this circuit.

These concerns also make correspondings RFT for L4, L5. The primary of the RFT is wound just like the primary of the variocoupler and the secondary likewise matches exactly the secondary of the coupler, except for the taps. It is just barely possible that trivial stray magnetic coupling and capacities built up within the tubes may require an adjustment of the secondary of the RFT. That is why, in winding the RFT secondary, a tap should be taken at every quarter turn on the last turn of this secondary. For double safety the extra-cautious may tap the last two turns at every quarter turn. Once the correct inductance is determined for this secondary, the lead to one of the stators of the special variable condenser is connected permanently. No tapswitch is used.

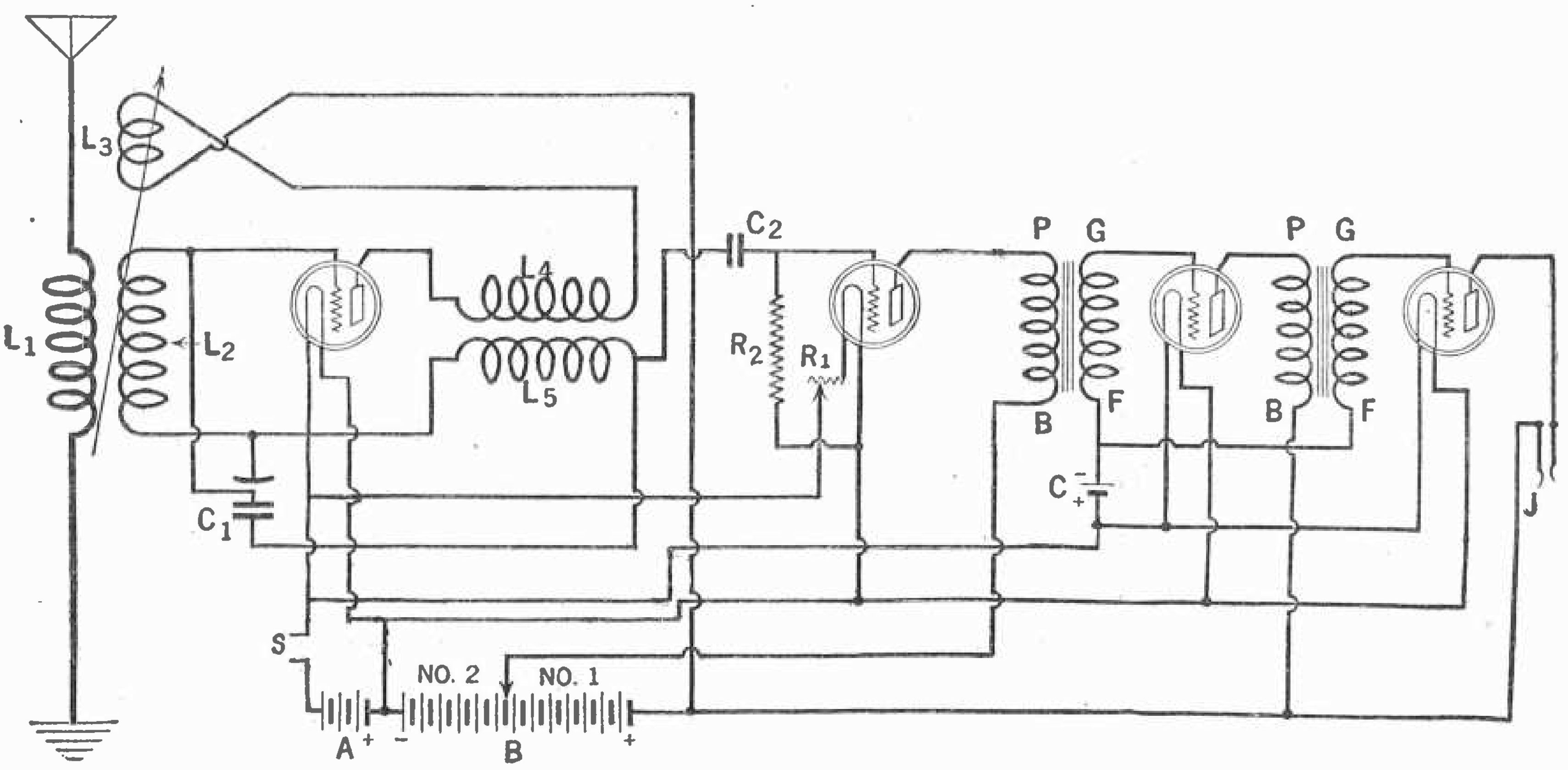


Fig. 1. The 4-tube Superdyne, which uses only two controls instead of three. The elimination of one control is accomplished without any sacrifice by employing variable condenser, C1, which has a common rotor connection, with separate stators. The R.F. tube grid return is to the minus, as is that of the detector tube, second from left, the common rotor of the variable condenser being connected to A—. Look at the grid of the first tube. Follow the lead through L2. The heavy dot shows where this grid return end of the coil is connected to the common rotor of the condenser, represented by the arc. Continuing, you will see that this lead makes connection with A—, just below the F— on the R.F. tube socket, then joins to the grid return side of the L5, the secondary of a radio-frequency transformer. The grid end of these two coils, L2 and L5, connect to the separate stators, represented by the parallel lines in C1, C2 is the grid condenser, .00025 mfd., and R4 the grid leak, preferably variable. The set works best with a UV-200 or C-300 detector tube, the other tubes UV-201A or 301A. One rheostat, R1, is shown. It controls the detector tube and is vital. For sake of simplicity, A— is connected to one side of a push-pull battery switch, the other side of the switch to a 6-ohm rheostat or an Amperite, controlling the three amplifier tubes.

The windings as specified above are correct, despite the disparity in the number of turns on the primaries as between one type of coupler and another. The commercial products were taken as they existed, and then adapted to this circuit by adjustment of the secondaries. All three models were fully tested.

The tickler dial need not be charted, especially as slight variation of the setting of this dial for a given station may arise from week to week.

LIST OF PARTS FOR SUPERDYNE

One certified Superdyne coupler (L1L2L3).
One certified matched radio-frequency transformer (L4L5).
One Bruno Ultra Vario Condenser, No. 19 (C1).
Two Federal (Nos. 65 and 65A) or two No. 3-A Stromberg-Carlson audio-frequency transformers.
Three UV201A tubes.
One UV200 tube.
Four Federal sockets.
One .00025 mfd. Dubilier grid condenser (C2).
One variable Bradleyleak (R2).
One Bradleystat (R1).
One Amperite No. D-11.
One Bradley push-pull battery switch (S).
One Tri-Jack or single-circuit jack (J).
One 120-ampere-hour Exide storage battery.
Two 45-volt Eveready B batteries (No. 1 and No. 2 in Fig. 1).
One 4½-volt Eveready C battery.
One 7x24 black Radion panel.
One mahogany cabinet, size to match.
Two silver Eureka dial pointers.
Two 1½ diameter hard rubber bushings.
Ten feet of vari-colored battery cable.
Two lengths of spaghetti.
No. 20 double cotton covered wire or round bus bar for internal set wiring.
One pair of Tower's earphones.
One Western Electric loudspeaker.
One Eby terminal block.
100 feet 7-strand aerial wire, 50 feet No. 14 insulated lead-in wire, ground clamp, one double Fahnestock clip, screws, U-angle, two dozen solderless lugs, half-dozen Morse solderless union joints, hardware.

Drilling the Panel

The dimensions given in Fig. 3 should be followed for panel drilling. The respective drill holes were given, except for the screws mounting the variocoupler and the rheostat.

From left to right on the panel front are (1) the coupler shaft, (2) the condenser shaft, (3) the push-pull A battery switch, (4) the rheostat and (5) the single-circuit jack. The panel is 7 x 24" black Radion, which is excellent for radio purposes and easy to drill. The minimum distance between dial circumferences is 1", the same distance being preserved between the circumference of the first dial and the left-hand end of the panel, and between the jack and the right-hand end of the panel. All this is clearly set forth in the dimensions given in Fig. 3.

The Baseboard

Next tackle the 6½ x 23" baseboard. With a hacksaw cut the terminal block, separating the aerial and ground binding posts, as one unit, from the rest. This is to afford a separate block for the aerial and ground leads, which are thereby shortened. The aerial-ground block is mounted on the left-handed rear of the baseboard, parallel to it, two small blocks of wood or washers, being used to keep the lugs under the terminal block from touching the baseboard. It is well to solder two 6" leads to No. 18 double cotton covered wire, or round bus bar, each to one of the two lugs, so that this connection does not prove an irritating job, which it might, if the soldering were attempted after the block was mounted. The block may be flush with the left-hand rear corner of the baseboard.

The coupler, variable condenser, push-pull switch and rheostat and jack being mounted on the panel, it is well to hold the baseboard in position, as if it were fastened to the panel. This may be done by placing a few newspapers flat under the baseboard, thus elevating the baseboard about ½" from the bottom of the panel, which is held upright, flat on the table itself, unelevated by the newspapers. Following Fig. 3, the assembly plan, mark where the sockets are to go. The placement of the radio-frequency socket is automatically determined by the position of the coupler and the variable condenser. Remember that the tube must be unobstructed for insertion in and removal from this socket, hence do not set this socket too far forward. If the rear of the socket is an inch or so from the rear of the baseboard correct placement will result. Draw a square with a pencil, so you will know just where this socket must go, and take care that the F— post of the socket is at left, front. This automatically places F+ at front, right, grid at left, rear, and plate at right, rear. The next socket to tackle is that for the detector tube. This is placed directly behind the rheostat. This socket is also placed conventionally, as was the other one. The position of the socket posts is confirmed in Fig. 3.

The Audio Stages

The last audio socket, extreme right, Fig. 3, should be allowed for next. It is placed at the rear on the right-hand side of the baseboard and mounted in conventional fashion. To the left of it goes the second audio-frequency transformer, with its G and F posts directly in line with the G and F— posts of the fourth or last socket previously discussed. The third socket, or last socket to allow for, is the first audio stage, and that socket alone is mounted sideways, so to speak. The P post of this socket is at left, rear, which brings the G post to left, front, the F— to right, front, and the F+ at right, rear. The location of the first audio transformer is predetermined by the position of the first audio socket, since this transformer is mounted in front of the first audio socket and in alignment in two directions with this socket and the detector socket. The primary of the first audio transformer is in front, the P post at left. This primary is sometimes designated P1 and P2, sometimes P and B. The secondary is marked either G and F or S1 and S2. These corresponding designations are for identical posts.

Behind the detector socket the terminal block for battery connections should be placed at right angles to the baseboard and supported by a brass, copper or iron right angle, about 1 x 1" or 1½ x 1½". This manner of mounting is recommended because it renders the binding posts easy of access after the set is completed and battery connections may be changed without one's hand getting cramped in between the terminal block and the back of the cabinet, or between parts of the set and the rear cabinet wall.

The location of the radio-frequency transformer also is predetermined, since it is to be between the detector socket and the variable condenser. Note that this inductance is mounted at right angles to the variocoupler mounting. That is, windings on the coupler are parallel to the baseboard, windings on the RFT at right-angles to the baseboard. This is to minimize stray magnetic coupling between the two inductance units, for such action causes losses. The RFT should be mounted at least 1½" from the variable condenser, so as to keep the RFT out of the electrostatic field of the condenser.

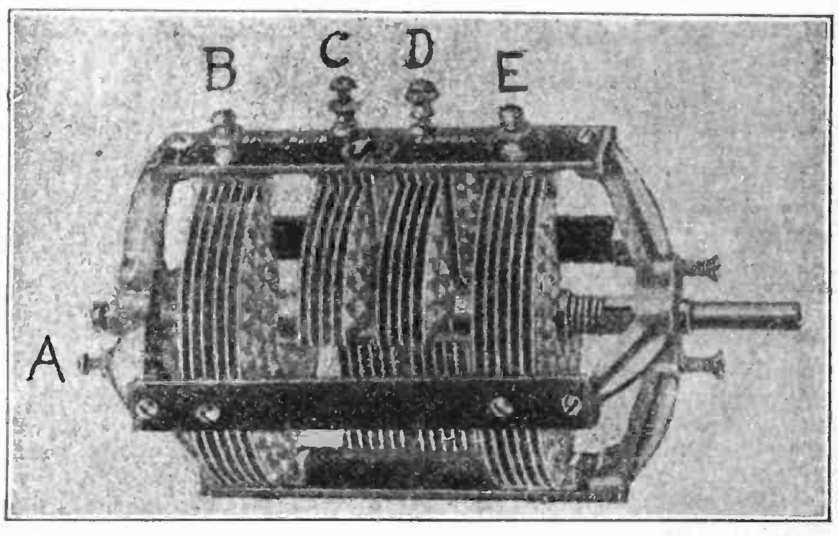


Fig. 2. The variable condenser used in the 4-tube Superdyne. A designates the binding post connecting to the common rotor. B, C, D and E are binding posts connecting to separate stators, each having 11 plates (.00025 mfd.). As the capacity desired is .0005 mfd., the two binding posts marked B and C are joined with a wired connection, and D and E likewise are combined. Thus BC represents the stator of a .0005 mfd. variable condenser and DE the stator of another .0005 mfd. variable. No connection is made between C and D.

Mount the Parts

After the positions for these parts have been allowed for, with the comfortable assurance that there will be no collision of panel-mounted parts with baseboard mounted instruments, a safeguard which fans readily appreciate, the parts are permanently mounted to the baseboard. A brass, copper or iron U-angle should be used to mount the RFT, to obtain the right-angle position. If such an angle is not handy two right angles may be screwed together to form a U-angle, but this method does not afford any too great security. If the connecting screw loosens the coil form sags.

The parts have been permanently mounted on the baseboard, up to this point, except the battery terminal block. That will require some soldered connections, a task more comfortably performed when one is free to move the

through the center. This phenomenon is known as the skin effect. Be sure in all your wiring to run the leads in as straight a line as possible. While angular wiring looks prettier and has an imposing effect on the unitiated, it is not as efficient as the bee line method, for it simply compels the inclusion of unnecessary wire in the circuit, thus building up harmful resistance and causing condenser effects and eddy current losses.

The three amplifier sockets referred to above are Nos. 1, 3 and 4. They are the radio-frequency amplifier tube socket and the two audio tube sockets. As shown in the assembly plan, Fig. 3, the F post of the first audio socket, next to

look as well as busbar but it is equally efficient.

Placing Coupler and Condenser

Now notice how the coupler is made. If the coupler terminals are at left, mount the coupler upside down, to bring them at right. Some couplers have left-handed leads because manufacturers had in view the placement of the coupler in another circuit to the right of the variable condenser, but the opposite method is used in the present case. With the coupler properly adjusted—if such adjustment is necessary—see to it that the variable condenser is mounted upside down. This precaution, as well as that

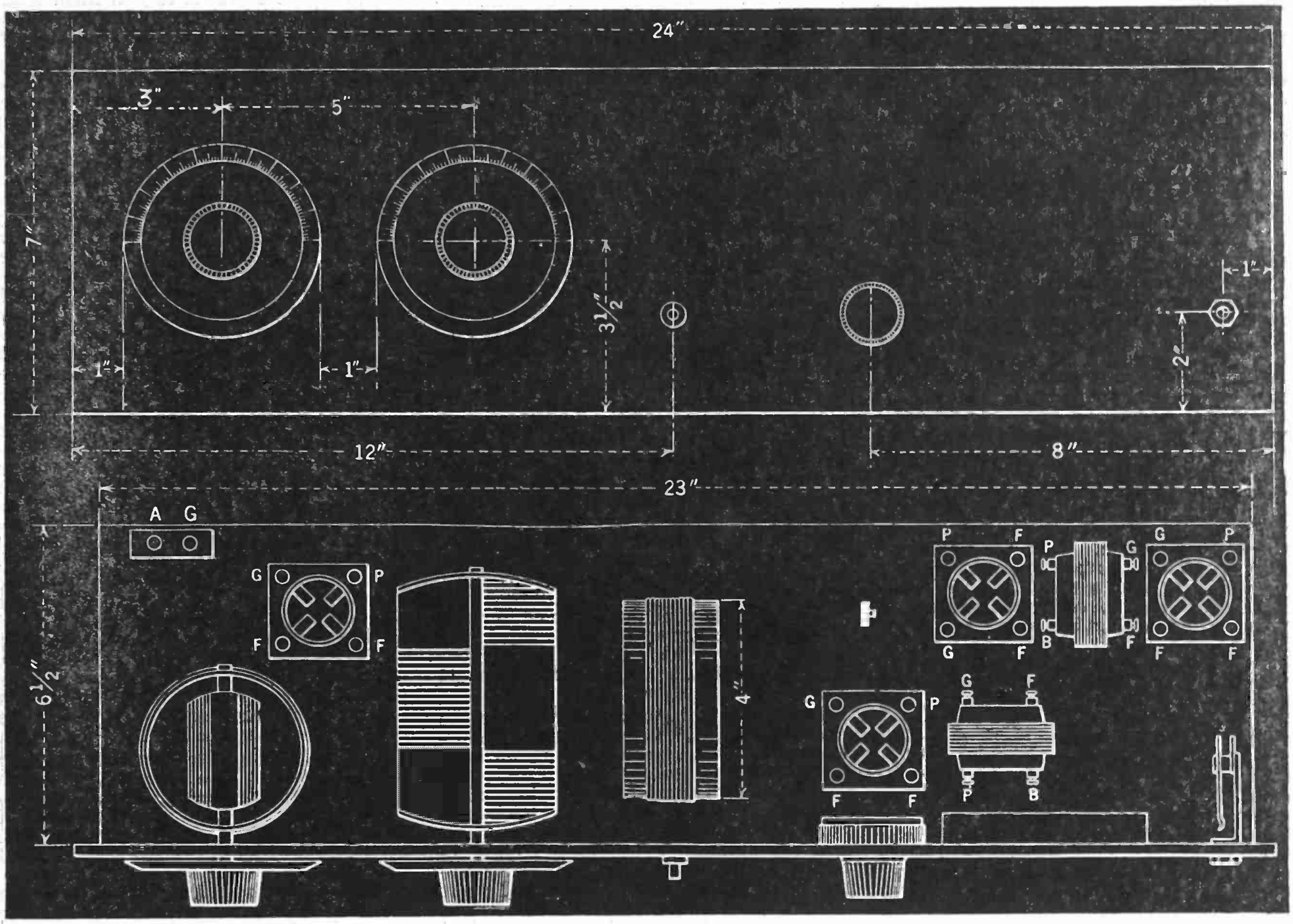


Fig. 3. Blackprint of the combined panel lay-out and assembly plan for 4-tube Superdyne. The relative positions of the instruments are preserved in both diagrams. In the panel lay-out the dial at left is for the tickler, while the next one to it actuates this Ultra-Vario condenser, which tunes two coils with one motion. The dials are 4 ins. The center of the left-hand dial is 3 ins. from the left-hand side of the panel, on a central horizontal line. The only other instruments on the panel are the switch, the rheostat and the jack. The assembly plan above shows the Superdyne coupler at left, the R.F. socket behind it, then the variable condenser, which has a coil-like appearance in the diagram, then the plate coil. Note how the detector tube, audio tubes and audio transformers are placed. The white mark behind the detector socket shows where the terminal block is.

block into the most convenient position.

The panel and baseboard have not been joined yet, because it is handier to wire the filament leads when the baseboard is free.

Before the baseboard is fastened to the panel it is well to connect together the F+ posts of all four sockets. The F— posts of the three amplifier sockets also are connected together, but not to the F+ leads. A minus goes to these three F— posts after passing through the amperite. In wiring, if you like bus bar, select the round kind, as it offers an easier path for the high-frequency currents, due to the larger surface. Radio currents travel virtually on the surface of the wire, not

the P post of the second audio transformer, is in the rear, near the back of the baseboard. Thus it will appear on your assembly. As the other F+ posts are in front, slip a Morsing busbar union joint on the lead connecting the F+ posts of detector and last audio tube sockets, for this facilitates a right-angle soldered connection to the lead that parallels the panel. If busbar is used, it may be bent with round-nosed pliers, the end in the form of a loop for connection at the socket posts, or lugs may be soldered to the connecting ends and the lugs fastened to the socket posts by screwing down the nuts. No. 18 double cotton covered wire may be used for this wiring all the way through. It doesn't

concerning the coupler, while having nothing to do with the wiring being done on the baseboard parts, completes the correct preparation of the panel, so that difficulties will not be encountered later. The connecting leads are made shorter by the upside-down method of mounting the condenser, although the connections to the condenser stator posts are thus made a little difficult, because there isn't room between the lower part of the condenser and the baseboard to get your fingers through. If the condenser posts have not been connected as shown in Fig. 2, this work should be done now. Viewing the condenser with the shaft at right and the stator posts on top, you will see four such posts.

Left to right these may be regarded as B, C, D and E. With a wired lead join B and C. Also join D and E, but not to B and C. As there are 44 stator plates (four sets of 11), two sets of 11 plates are thus joined, making two 22-plate condensers, each slightly in excess of .0005 mfd. maximum capacity. If a lead is wired to B, the lefthand post, and another to D, the post second from right, with 6" of slack, there will be no cramped efforts at making connections later from these stators, and the nuts will be securely fastened. If lugs are used and it is thus necessary to remove these binding post nuts, hand pressure will suffice to get them off. The screws are purposely slightly distended at top to keep the nuts on, but they may be forced off without injury and easily replaced. The post at extreme left, on a line with the shaft, and regarded as A, is the connecting point to the common rotor, which goes to battery A—and thus enables the tuning of two coils—the secondaries of the coupler and of the RF transformer—with one motion.

Which Is Beginning and End

Now look at the RF transformer, the inductance mounted at right angles to the panel length, about in the middle of the baseboard. Look at the terminals. See which way they point. Draw the direction as an arrow on a piece of paper. Thus at top of the sheet will be an arrow pointing to the left, let us suppose, designating the terminal wire whose end-piece points in that direction. Of course the other and lower arrow you will draw will point in the opposite direction. Lest there be a mistake, mark the word "top" at the top of the sheet. Now look at the coupler (not the RFT). See how the terminals point there. In all the couplers for this circuit all windings are in the same direction. Turn the tickler so that its winding is parallel with that of the stator windings of the coupler. Using the stator, either secondary of primary, as your guide, mark two more arrows on the same sheet of paper. Be sure to remember which arrow refers to which terminal. Pick out two terminals of the coupler and the RFT that point in the same direction. Tie a piece of thread around both terminals, temporarily, for these will be regarded each as the beginning of the particular coil. It does not make an difference which are selected, so long as both terminals selected from the two coils point in the same direction. Now, inspect the tickler or rotary coil in the coupler. Find the terminal which is the beginning. This is the terminal which points in the same direction as does the beginning of the stator, either primary or secondary. Some care may be necessary here, for a few couplers have pigtail connections not easy to follow. However, if you will push the pigtail inside a fraction of an inch it will cause a movement inside that makes this pigtail or flexible wire lead readily discernible. Now follow the lead through, seeking the point where that pigtail is soldered to the winding. At this stage you will not find it difficult to determine the direction of the winding. Once it is found, pick out the beginning of the tickler, identify its external lead or binding post on the coil—depending on the type of coupler used—and then tie a piece of thread on the OTHER tickler terminal. In other words, the beginning of this tickler is not to be identified, but the end of the tickler is. This is because the primary of the RFT is to be connected to the end of the tickler and the beginning of the tickler to the B+ high voltage (amplifier) post on the second terminal block.

The Superdyne Principle

This method of reversing the connections, rather than reversing the windings and making connections in standard fashion, is an easier way of gaining the superdyne effect of reversely fedback current. If a coupler is being used that rotates completely around a circle, that is, has an actual 180-degree variation, no attention need be paid to these directions for determining the beginning and the end of the tickler, as the Superdyne effect is obtained then by rotating the coupler until the magnetic fields oppose, and the manner of connections is therefore immaterial.

The action of the magnetic fields when the Superdyne method is used is shown in Fig. 15. Take the stator coil, L2, secondary of the variocoupler. The field AB moves up the inside of the tubing and down the outside, then up the inside again, etc., round and round. But the tickler field CD moves up the outside and down the inside. Thus the two fields oppose each other. This is called counter-electromotive force (counter E. M. F.). The result of the reverse feedback is a suppression of oscillations within the set, although not a prevention of radiation. The lettered designations may also be regarded as showing the terminal connections of the windings, C and A being the beginnings, D and B the ends.

Now to resume the wiring. The P post of the detector tube socket, the one behind the rheostat, is joined to the P or P1 post of the audio transformer beside it. The G or S1 post of that audio transformer, which is for the first stage, by the way, goes to the G post of the first audio tube, the one right behind the transformer under discussion. The P post or plate of the first audio socket, the one second from the right, at rear, goes to the P or P1 post of the other audio transformer, whose G or S1 post is then connected to the G post on the last socket, extreme right.

Now, on the panel, one side of the battery switch may be wired at this point to one side of the rheostat, usually the right-hand side, looking from the panel front.

Before fastening the baseboard to the panel, drill a ½" hole for the introduction of the battery cable and also a hole, somewhat smaller, if you prefer, for bringing in the aerial and ground leads; these holes are drilled in the back wall of the cabinet. The position of the holes is easily determined by placing the baseboard in the cabinet and marking the points nearest the two blocks, and right behind them, preferably equi-distant from top and bottom of the rear cabinet wall. In drilling, start from the inside, until the drillpoint just emerges through the back; this can easily be determined by the "feel" of it when working. Then do the rest of the drilling from the back or outside toward the inside. In this way the wood will not be torn off in jagged fashion.

Stain may be applied to the holes to improve the appearance of the cabinet, otherwise the holes would show up in violent contrast with the mahogany or walnut finish. A better way, however, is to insert a ½" hard rubber, bushing in each hole. This gives the added advantage of an insulated protection.

Completing the Wiring

Now fasten the baseboard to the panel. The screwholes are 4" apart, ½" from bottom, thus providing four points for fastening, which are sufficient. Countersink the holes so that the screw heads do not protrude above the panel surface.

Coupler Wiring

The rest of the wiring will be done from left to right. The aerial post on the first terminal block is connected to the beginning of the primary or small winding on the stator of the coupler (L1 in Fig. 1). This terminal corresponds to the one on the stator that has a thread tied to it. The ground binding post on the block is connected to the other terminal of the primary. If previous advice was followed(wires already were affixed to the block and need only be connected to the corresponding leads on the coupler. In some cases these coil leads are so long that the slack wire previously connected to the block lugs will now be cut to a length of perhaps only 1". Anyway, the sole object is to join them without duplicated leads or including unnecessary wire lengths being in the circuit.

The beginning of the stator secondary, (L2) with the thread on it, is connected to the lead already joined to the rearmost post of the condenser stator, (BC) and is joined also to the grid or G post of the first tube, extreme left. The P post of this socket, representing the RF tube plate, goes to the beginning of the primary of the RFT. The end of the primary (small winding on the RFT) goes to the END of the tickler on the variocoupler, the lead previously identified with tie-string. If a 180-degree coupler is used, at either tickler terminal may be joined to the end of the RFT primary. The tie-strings are removed. The remaining free terminal of the tickler goes to B+ high voltage (amplifier). This is B+ No. 1 in Fig. 1. This post is on the still unmounted terminal block which later is to be fastened upright. But before fastening it finish the soldered connections to the lugs thereon. Therefore solder this lead from the beginning of the tickler to B+ amp. on the block and carry the lead right on, past the terminal block, joining it to the B or P2 post of the second audio transformer, second from right, and to the right-angle of the single-circuit jack. The battery side of the rheostat is now connected to the end of the coupler secondary (L2), still free, and to the rotor of the condenser, the accessible post at rear of the condenser, in line with the shaft, and to the end of the secondary or large coil of the RFT, (L5).

The remaining free terminal of the RFT secondary, L5, is connected to the other free stator binding post of the variable condenser C1 and to one side of the grid condenser (C2). The other side of the grid condenser connects to the G post of the detector tube socket. A variable grid-leak (R2) is mounted on a special leak clip mounting clip and the two ends of this mounting are connected respectively to the G post of this same detector tube and the F+ post of the socket. Do not connect one side of the leak to the coil side of the grid condenser. Be sure to connect it to the socket side. This has proven the best way of connecting the leak for this circuit, although the leak may also be mounted right across the grid condenser, especially if a grid condenser with mounting clips attached is the kind used.

This open side of the switch S is now joined to the A— post of the terminal block, the lead being soldered to the lug on this block. The other side of the rheostat (R1), still unconnected, goes to the F— post of the detector tube socket right behind the rheostat. The A+ lead is now connected from the most convenient point to the lug on the A+ post of the terminal block. This completes the A battery wiring; in fact, nearly all the wiring.

The F or S2 posts of the two audio transformers are joined and this lead is brought to the minus post of the 4½-volt C battery, the plus post of this C battery going to A— at the most convenient place. The B+ post of the first AFT goes to the B+ low voltage (B+ det.) post of the terminal block No. 2 in Fig. 1). Now join the P post of the last socket to the remaining unconnected side of the jack.

Connect the battery cable from batteries to binding posts on the terminal block. Connect aerial and ground to their posts.

Ready to Tune In

Before attempting to tune in, however, turn on the rheostat, pull out or push in the filament switch, depending on how you wired it, and see if the tubes light. One of them may not. That will be the detector. Turn up the rheostat and that tube ought to light. If you find that the rheostat makes the tube burn brighter at first, and the more you keep turning the rheostat the dimmer the light becomes, reverse the leads at the rheostat terminals. Rheostats should be wired so that maximum resistance is in use when the first contact is made between the arm and the resistance and the resistance is lowered the more the rheostat is turned. If none of the tubes lights, check back for wiring errors. Consult the wiring diagrams.

After you have the satisfaction of seeing your tubes light, then connect aerial and ground to their respective posts and join the A+ and B—. Provision for this joining is made on the terminal block, and a lead may be soldered between the two, but it is perhaps preferable to make this connection from B— to A+ on the batteries themselves.

Tubes to Use

The tubes to use are UV200, C200 or Sodion D21 for the detector, and UV201A or C301A for the amplifiers. The UV and C tubes are the same. The detector plate voltage should be from 20 to 40. The amplifier voltage may be from 45 to 90 or even 110. Try the different voltages for best results, as the particular tubes you have may work remarkably better at certain plate voltages. These tubes require a storage A battery.

How to Build the New Priess Reflex

(Continued from page 15)

former and ends at the loud speaker. In the PR-3 each set is separately adjusted for crystal tank capacity. Two detectors are provided—one adjustable, the second fixed. A flexible lead terminating in a spring slip provides a means for plugging in either type of crystal at will. The adjustable detector is a steel galena button with phosphor bronze catswhisker. The catswhisker is connected electrically to the metal front panel or shield so that no disturbance follows the touching of its adjustment knob. The crystal and catswhisker are inclosed in a glass tube to render adjustment visible and at the same time shield them from dust. The adjustable detector is included in the set because of the ill repute in which a fixed detector has been held in the past. I am certain that the demonstration of the new form of fixed detector that was devised and is built by ourselves will justify us in eliminating the adjustable detector in future models. This new fixed detector, which we call "Teloflex," comprises two minerals pressed over a broad era by a heavy spring at a pressure of over two tons per square inch. The detector cannot be destroyed by severe jar or by any form of electrical pulse that can be impressed upon it through any form of abuse of the set. All other forms of fixed crystal detectors I have tested in the past are destroyed by an abuse such as a repeated opening and closing of the B battery circuit while the tubes are lighted.

From the detector the power is returned back through an audio frequency transformer to the third tube in its transformed form of audio frequency power. It is then further amplified by two more stages of voice frequency amplification and the total output impressed upon the loud speaker telephone jack.

Three stages of voice frequency amplification are necessary to produce voice frequency output of a value sufficient to generate an output that will actuate a loud speaker to a volume as great as that which we obtain using the loud needle of a phonograph. It is difficult to make three cascade stages of voice frequency operate stably. It is likewise difficult to make them operate without distortion. In the PR-3 both of these results, namely, stability and non-distorted amplification, are secured by designing the transformers with staggered characteristics, due to different turn ratios and capacity loadings, and by balancing and opposing the stray fields of the transformer systems.

The set gives a good seven tube output and utilizes only five tubes to produce its result.

The tubes are shock mounted to protect them from vibration in sympathy with the loud speaker and from recording room and building vibrations.

The parts of the set are mounted on brass strap and angle members bolted together to form strong and light beam structures.

The electrical parts that require insulation are all of bakelite and are attached to bakelite dilecto panels.

Shielding of the various parts is accomplished by the use of a heavy black and gold metal front panel, the metal framework of which cuts off external radio fields from the set, and an aluminum transverse shield, which fixes the path of the fields of the variable condensers, and the fields of the radio transformers and their leads.

All of the set wiring should be done with a rosin flux. The wires are first clamped to form a mechanical joint. This joint is then soldered to secure it electrically.

Data on the New Pressley Super-Heterodyne

(Continued from page 23)

shown in the accompanying photograph. The air core transformers should be mounted so that the terminals 1 and 3 are nearest the front panel; the iron core transformers so that the terminals 1 and 2 are nearest the front panel.

3. Mount grid condenser panel on left socket shelf bracket (see photograph).

4. Run a solid bus as close to the shelf as possible, connecting the positive filaments of the first six tubes.

(The seventh tube is connected through the filament control jacket).

5. Run a solid bus connecting the negative filaments of the first five tubes together (later to be carried to the six-ohm rheostat).

6. Connect the negative filaments of the last two tubes together (later to be carried to the 15-ohm rheostat).

7. Wire plate and grid leads of the second, third and fourth tubes and the grid lead of the fifth tube to the four Sangamo transformers.

8. Mount the .0005 plain condenser at the left-hand side of the panel; split condenser in middle of panel; .0005 vernier condenser right side of panel; oscillator coil directly beneath balancing condenser (tap No. 4 toward the bottom of the panel); Thordarson audio transformer 2:1 ratio right-hand lower (second step), Thordarson 6:1 ratio right-bottom center (on both of these transformers the secondary binding posts should be up, primary binding posts down); jack switch lower-left corner frame down; Benjamin battery switch just to the right of this; single circuit filament control jack bottom right; double circuit jack between the audio-frequency transformers.

9. Wire all possible leads of instruments connected to the front panel before the socket shelf is attached.

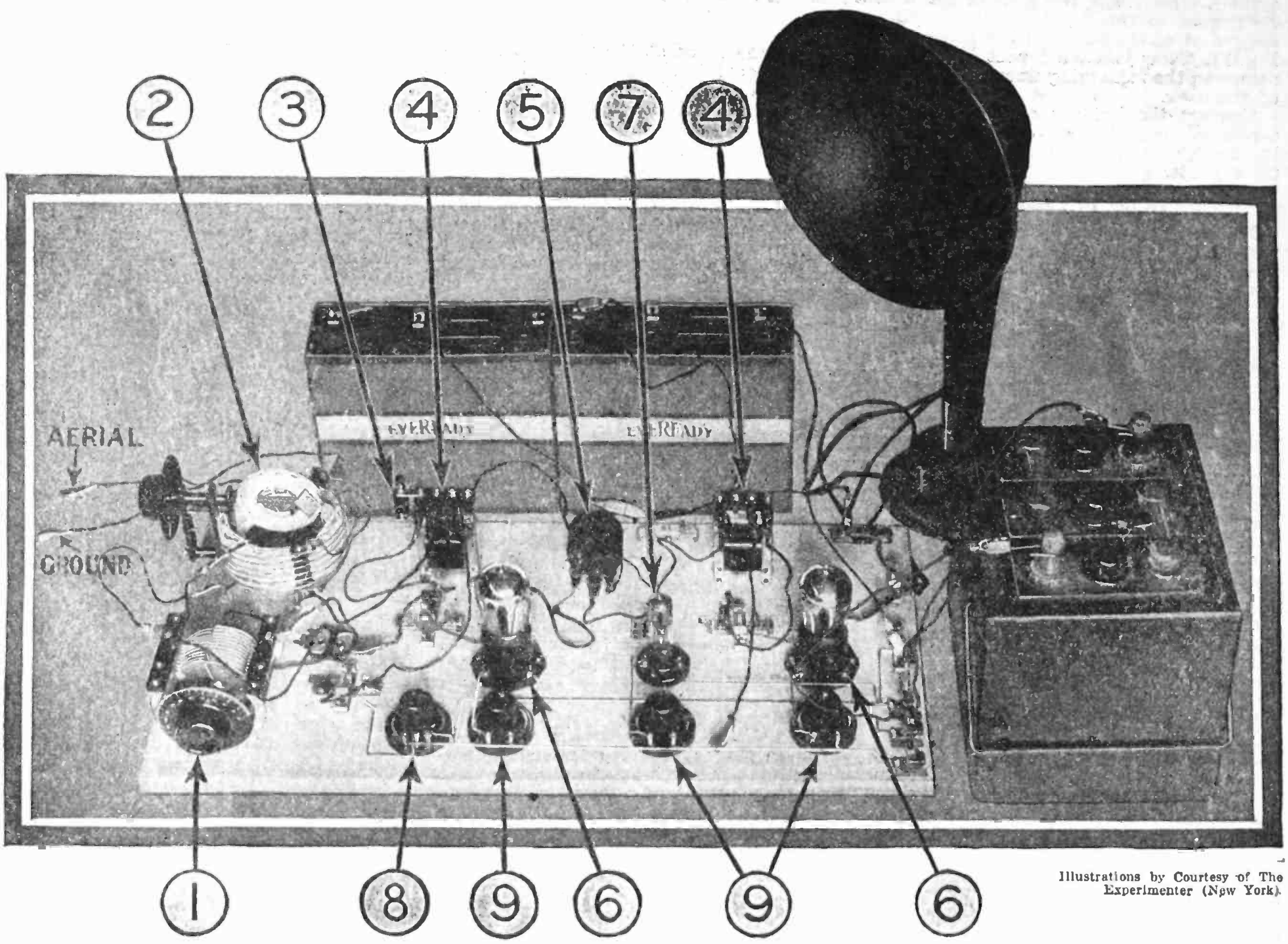
10. Attach socket shelf and complete wiring as per diagram.

11. The jack switch connections are to be made as follows: Connect middle leaf of jack switch to the rotors of the balancing condenser and the loop condenser, and then to the positive filament bus. Connect the upper leaf to the third from the left binding post on the rear of the socket shelf, and the bottom leaf (nearest frame of the switch), to the second from the left binding post.

After these operations have been completed check all wiring in order to see that proper connections have been made, and also make sure that no B and A battery wires touch each other.

In attaching the loop, if the Portena, Marion or similar loop is used, it should be tapped on the eighth complete turn counting from the inside. In connecting the loop to the set the very outside turn should be connected to the left-hand binding post on the back of the socket shelf, in connection with diagram, Fig. 2. The center tap of the loop should be connected to the second binding post to the right, L2, and the inside of the loop to the third from the left binding post, L3.

Reflex Experiments with Two Tubes



Illustrations by Courtesy of The Experimenter (New York).

The two tube hook-up board with circuit No. 5 on the opposite page connected. The numbers designate the following instruments: 1. Variable condenser; 2. Low loss tuner; 3. Crystal detector; 4. Audio transformer; 5. Radio transformer; 6. Vacuum tube socket; 7. Diobe tube; 8. Potentiometer; 9. Filament rheostats.

FOR the radio enthusiast who is interested in trying different circuits, the various forms of reflex hook-ups offers a very interesting study.

Clyde J. Fitch describes in *The Experimenter* a number of the reflex circuits which can be tested on a special experimental board. The author's explanation follows:

Although there are thousands of circuit combinations possible with a single tube and a crystal very few if any of these give real worth while results. What we require is a receiving set that will give loud speaker volume on distant stations when used with either an outdoor aerial or a loop, but in order to do this two or more tubes are usually required.

We all understand of course that in a multi-tube receiving set the first tube receives little of the load, whereas the last tube is usually overloaded. If the first tube could be worked to its full output the other tubes would be unnecessary and we would have a single tube set equal in results to many of the multi-tube sets. By reflexing, the tube is worked at both radio and audio frequency and the load is more evenly distributed. In this way we save in the number of tubes required. But even reflexing does not give us ideal conditions. At least two tubes are required for good results. Of course super-regeneration solves the problem in a different manner, but this comes under a heading by itself and will not be described in this series.

The following list of parts will be required for making the two tube reflex experiments:

- 2 *Flewelling* 23-plate condensers.
- 1 *Flewelling* 43-plate condenser.
- 1 *Gen-Win* low loss tuner.
- 1 Set of *Gen-Win* reflex coils.
- 2 *National Airphone* calibrated transformers.
- 1 *Rasco* radio frequency transformer.
- 1 *Rasco* Neutroformer.
- 2 Standard V. T. sockets.
- 3 30-ohm rheostats.
- 1 1200-ohm potentiometer.
- 1 *Electrad* diode tube with socket.
- 1 *Erla* reflex crystal.
- 1 Set 50-, 75-, and 100-turn honeycomb coils.

With two tubes and a crystal at our disposal the field of experimenting is practically unlimited. There are all kinds of combinations possible. It is up to the experimenter to try out the various combinations and develop something really useful in the line of an ideal two tube receiver. In order to try the two tube circuits, it is best to build a new experimental hook-up board similar to the one shown in the accompany illustrations. This board is 12"x24"x⅝" thick. It should be made of soft wood so that instruments can be easily mounted upon it. An ordinary drafting board with rubber feet on the bottom is ideal for this purpose.

Fig. 11 shows the constructional details of the board. On it are mounted two standard vacuum tube sockets and a socket for a two electrode valve. The filament rheostats, potentiometer and binding posts are permanently mounted and wired, as the filament circuits of the tubes will probably be the same regardless of the type of hook-up used. The other instruments shown in the photographic views and those that will be required for making the various hook-ups in the illustrations are given in the list.

By using a crystal detector, we eliminate one tube, but unless a fixed crystal detector is used the circuit will be very noisy when adjusting the crystal. By using a fixed crystal the noise is eliminated but it is very difficult to obtain a sensitive fixed crystal detector and sometimes if the set does not work it is difficult to determine whether the trouble is in the crystal detector or in some other part of the circuit. Therefore, it

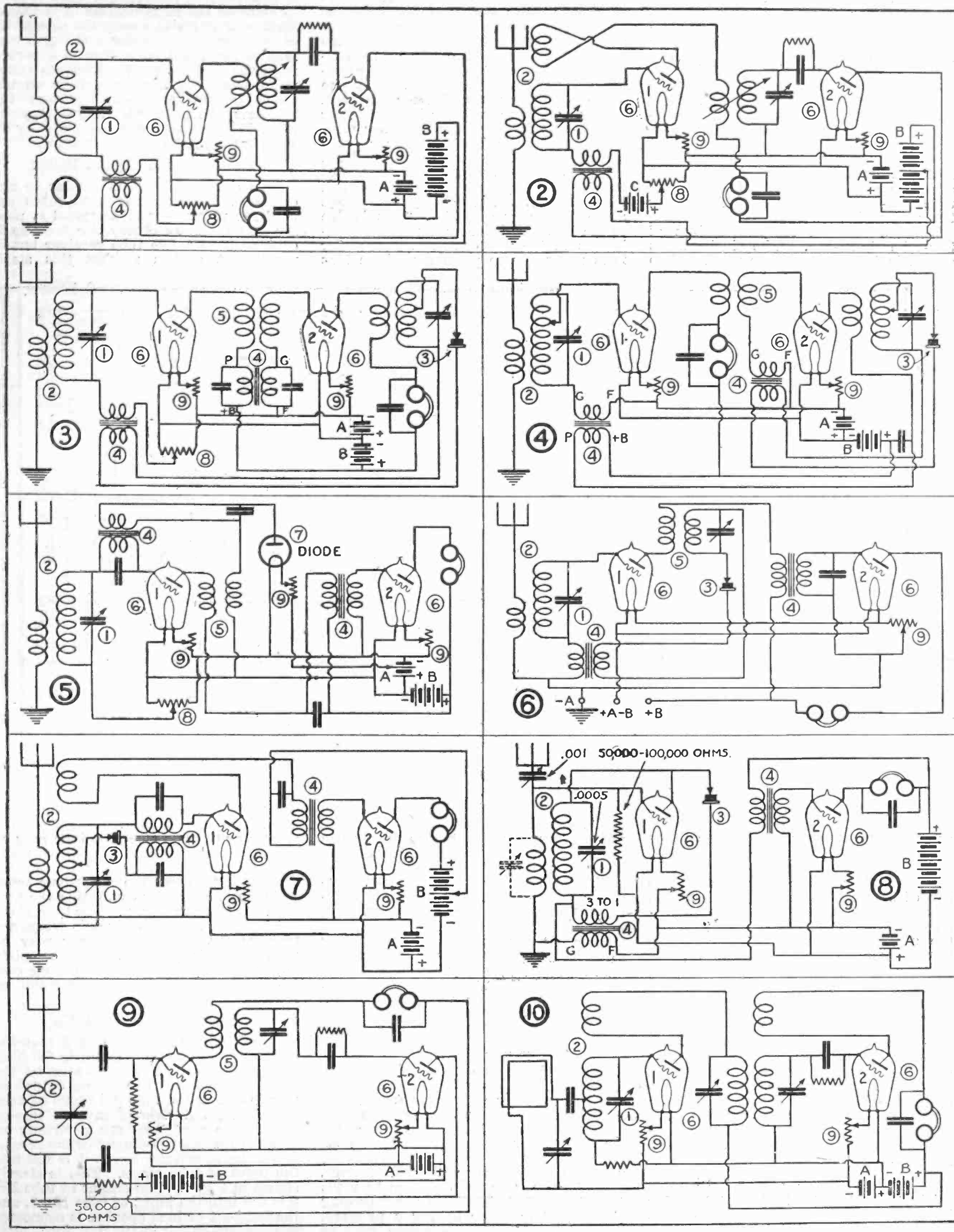


Fig. 1. Standard reflex circuit employing a vacuum tube detector. Fig. 2. The same circuit with reverse feed-back added to control oscillations. Fig. 3. Standard two tube reflex circuit with crystal detector. Fig. 4. The Grimes inverse duplex circuit. Fig. 5. A two tube reflex circuit employing a two electrode valve for the detector. Fig. 6. The Harkness two tube reflex. Fig. 7. A two tube circuit employing regeneration and a crystal detector. Fig. 8. The ST 100 two tube circuit. Fig. 9. The resistoflex, a reflex circuit employing resistance coupled audio amplification. Fig. 10. A two tube super-heterodyne.

is well to make use of a two electrode vacuum tube rectifier for detection. Once a circuit is working with this detector it is a simple matter to substitute the crystal.

As almost all two electrode tubes require 1½ volts for the filament it will be necessary to tap on to one cell of the six volt storage battery and consequently three A battery binding posts are required. A 30-ohm rheostat is used for controlling the current through the filament. If a two electrode tube is not available any dry cell tube such as the type WD-12 may be used by connecting the grid and plate together.

We are showing ten illustrations of two-tube hook-ups. The instruments shown in the diagrams are numbered to use in this case. A suitable radio frequency transformer, preferably of the tuned type, should be used in the plate circuit. In order to control oscillations a potentiometer is required. The connections of the detector tube are standard and need no explanation. Only one audio frequency transformer is used. This couples the output of the detector tube to the input of the amplifier tube. The head-set or loud speaker is connected in the plate circuit of tube No. 1.

This circuit is equivalent to a one stage radio frequency amplifier, vacuum tube detector, and practically a one stage audio frequency amplifier. This is due to the fact that in order to prevent oscillations in the radio frequency amplifier it is necessary to place a positive bias A C battery of about three volts is used to increase the amplification of the tube. Incidentally this increases the selectivity of the circuit as it reduces the grid current to zero, and no energy is absorbed from the aerial circuit. Either a tuned radio frequency transformer or an untuned transformer, which covers the broadcast wave-length range, may be used. This circuit was described by R. Washburne in the December issue.

Two Tube and Crystal Reflex

This circuit, Fig. 3, is similar to circuit Fig. 1 except that both tubes are used for reflexing and a crystal is used for detecting. In theory this hook-up is equivalent to a five tube receiver but in practice it seldom reaches this state.

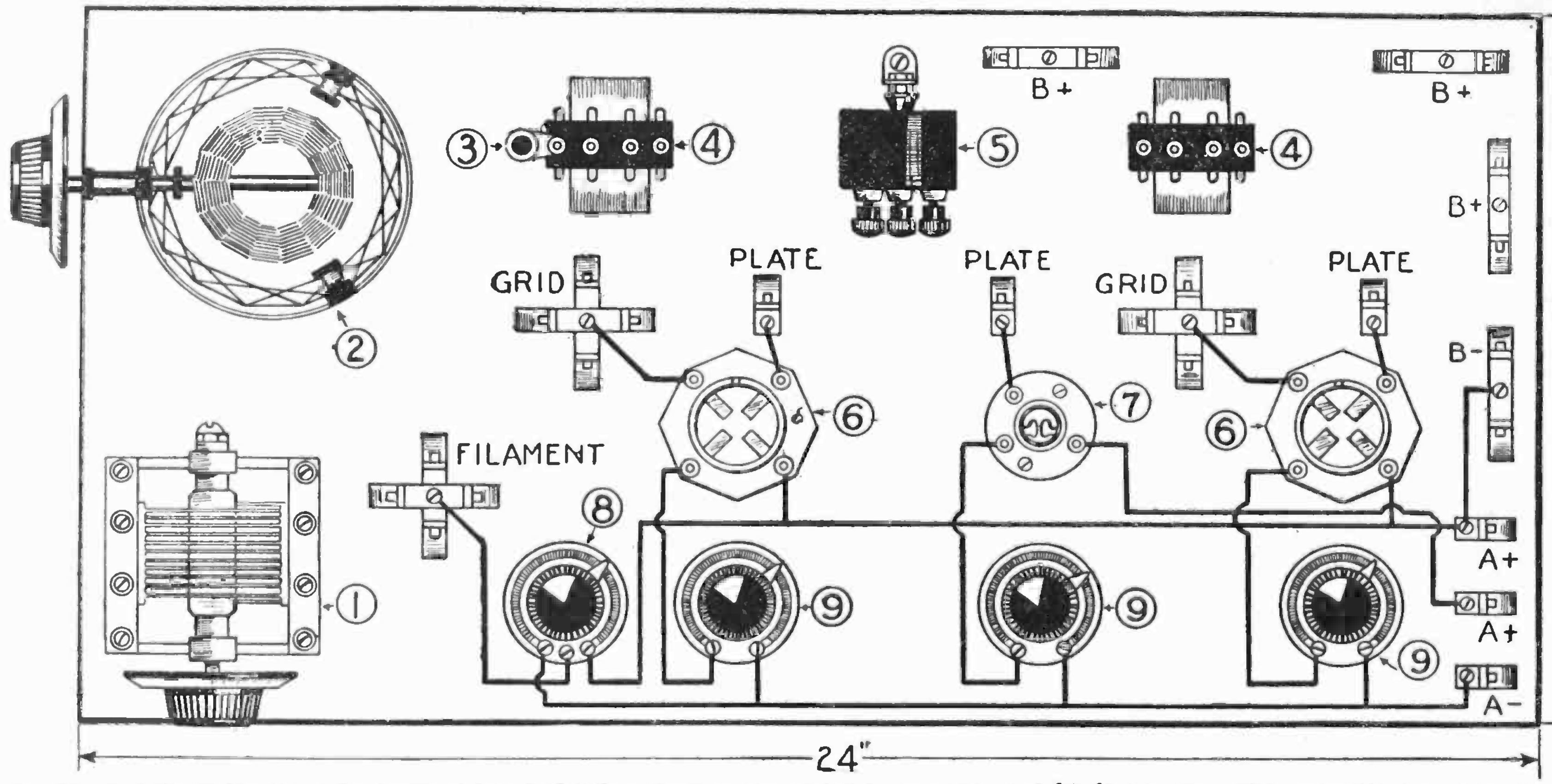


Fig. 11. Details of the two tube hook-up board showing the location of the instruments and binding posts. The connections of the filament circuit are also clearly shown.

correspond with the numbers given in the other illustrations of the hook-up board. One of the photographic views shows the hook-up board complete with circuit No. 5 connected.

In our other issues we showed a number of single tube and crystal circuits. The experimenter may try these circuits on the two-tube hook-up board and use the second tube as a one-stage audio frequency amplifier. This will increase the signal strength considerably and in most cases loud speaker volume will result. In making the connections a large number of clip leads and tip leads will be required. It is well to use type UV-201A tubes in all cases although very good results may be obtained with dry cell tubes. After a circuit has been connected that gives good results the instruments used in it and the exact connections should be copied, so that if it is desired to build a complete set in a cabinet the same conditions can be duplicated.

Standard Two Tube Reflex

Fig. 1 shows a standard two tube reflex hook-up using a vacuum tube for the detector. In this case tube No. 1 acts as both radio and audio frequency amplifier and tube No. 2 is the detector. This circuit requires a suitable tuner for the aerial in which case a low loss tuner such as the one shown in the photograph is preferable. The tickler winding is not in on the grid of this tube. This bias is determined by the potentiometer setting and of course prevents the tube from working at its maximum efficiency as an audio amplifier. For best results as an audio amplifier a negative potential is required on the grid; this is usually obtained by the use of a C battery. But in order to use a C battery some other method must be employed for preventing oscillations. The best method so far evolved makes use of a tickler coil with reverse feed-back superdyne principle. We can easily make use of the tickler coil on the tuner for this purpose in which case we will have circuit No. 2.

Superdyned Reflex

The superdyned reflex is clearly shown in Fig. 2. Although this circuit shows one tube used as a detector there is no reason why this tube cannot be used as an audio amplifier by using a crystal for the detector. We are giving this circuit merely to show how well the superdyned principle works out in a reflex receiver, and of course this principle can be made use of in practically all of the following circuits. Any tuner having a primary, secondary, and tickler windings may be used, preferably one of the low loss type in order to gain in sensitivity and selectivity. A low loss condenser is also recommended. The tickler coil is used for obtaining negative feed-back. This coil prevents the circuit from oscillating. The instruments used may be the same as those used in Fig. 1. Either the crystal or the two electrode tube may be used for the detector. The Rasco radio frequency transformer works well in this circuit. Of course the superdyne principle may be used by connecting the first tube as shown in Fig. 2. For tube No. 2 it is best to use a tuned radio frequency transformer. A neutroformer may be used for this purpose. The complete hook-up will then have two tuning controls and one potentiometer or stabilizer control.

Inverse Duplex Hook-Up

It will be noted from Fig. 3 that the output of the crystal detector is fed back through the audio transformer to the input of tube No. 1, and the output of tube No. 1 is fed into the input of tube No. 2. In the Grimes Inverse Duplex Circuit the conditions are reversed; instead of feeding the output of the crystal to the input of tube No. 1, it is fed into the input of tube No. 2. This is clearly shown in Fig. 4. The output of tube No. 2 is fed into the input of tube No. 1, and the head-set or loud speaker is connected in the plate circuit of the first tube. For controlling oscillations the grid of the first tube is connected to a tap on the tuning coil. A number of taps are required as the correct one depends upon the wave length of the circuit.

The inverse duplex system is supposed

to give a more equal distribution of the load on the tubes. Tube No. 2 receives the greatest radio frequency load, as it is in the second stage of the radio amplifier and it receives the least audio frequency load as it is in the first stage of the audio amplifier. The same conditions hold true with tube No. 1, which operates as the first stage of the radio amplifier and the second stage of the audio amplifier.

Diode Coupled Reflex

Fig. 5 shows a standard reflex circuit with a two electrode tube as the detector. This circuit is given merely to show the connections of the diode tube. Tube No. 1 is used as both a radio and an audio frequency amplifier, and tube No. 2 is used only as an audio amplifier. It is this circuit that is shown in the photograph of the hook-up board. A Rasco radio frequency transformer is used. Note that one side of the secondary winding of the radio transformer connects to the positive side of the filament. This gives a slight positive potential on the plate of the diode, and improves its action as a detector.

Harkness Reflex

The Harkness reflex has become very popular among the broadcast enthusiasts. There are no new principles involved in the circuit. The results obtained from it are due mainly to improved design of the parts. It is very difficult to use one stage of tuned radio frequency amplification and a crystal detector and obtain good amplification throughout the entire tuning range without oscillation. But this has been accomplished in the Harkness two tube set by proper design of the coils. The experimenter should obtain a set of Gen-Win reflex coils or wind a set of them himself. Otherwise the circuit is easily followed and requires no special comment. All the connections are clearly indicated in Fig. 6.

Regenerative Crystal Hook-Up

Fig. 7 shows one of the most simple and stable crystal-tube hook-ups so far evolved. This circuit gives loud speaker volume on distance stations and is comparatively selective. On account of the crystal detector the quality of music received is excellent. In the circuit, tube No. 2 is simply a one-stage audio amplifier. Its connections are standard. If the crystal detector and the audio amplifying transformer were removed from the circuit, tube No. 1 would be connected as a regenerative detector. By adding the crystal and transformer, the coupling between the plate coil and the grid coil may be increased and the extra energy fed back from the plate circuit is rectified by the crystal and applied in the form of audio frequency current to the grid of the same tube through the step-up transformer. In this way the signals are amplified enormously. It will be noted that with the plate coil set at zero inductive relation to the grid coil the circuit acts as a crystal detector and two stage audio frequency amplifier.

By using a low loss tuner and condenser the circuit is made very selective. By connecting the crystal to a tap on the secondary of the tuner the selectivity is further increased. Usually the tap should be about at the center turn. The experimenter should try tapping to several parts of the coil until best results are obtained.

S. T. 100 Circuit

The S. T. 100 circuit was developed by John Scott-Taggart and is very popular in Europe. This circuit is shown in Fig. 8. Honeycomb coils are used for the primary and secondary of the tuner. although any standard variocoupler should give good results. Both the aerial circuit and the secondary circuit are tuned. A .001 mfd. variable condenser is used for tuning the aerial circuit. A 50-turn honeycomb coil shunted by a .0005 mfd. condenser is sufficient for the secondary circuit as it will cover the broadcast wave-length range. Between the grid and filament is connected a 50,000- to 100,000-ohm variable resistance. A Bradleyohm No. 50 is suitable for this purpose. The remaining connections are clearly indicated in the diagram. Tube No. 2 is connected as a one stage audio frequency amplifier. This circuit gives sufficient amplification to operate a loud speaker. A B battery of 90 to 100 volts should be used.

Resistoflex Circuit

The resistoflex circuit was recently developed in England by John Scott-Taggart. This circuit is shown in Fig. 9. It differs from the usual form of reflex in that it employs resistance coupling for the audio frequency amplifier instead of transformer coupling. As a resistance has no natural period of vibration of its own it will not cause howling so common in transformer coupled reflex circuits. In the circuit shown, tube No. 1 acts as a radio frequency amplifier and tube No. 2 acts as the detector. In the plate circuit of the detector is a resistance of about 50,000 ohms. A by-pass condenser of about .00025 mfd. is connected across the resistance. A Bradleyohm No. 50 is suitable for the resistance. This resistance couples the audio frequency output of the detector tube to the input of the amplifier tube.

A grid condenser and leak is required in the grid circuit of the amplifier tube. The grid condenser is not used for the purpose of operating the tube as a detector but is used merely to block the high voltage of the B battery from the grid of the tube. The grid condenser should have a capacity of about .005 mfd. A ¼-megohm grid leak should be used. The head-set or loud speaker is connected in the plate circuit of the amplifier tube in series with the primary of the radio frequency transformer. This transformer is preferably of the tuned type. It should be designed so that the circuit will not oscillate at any setting. A neutroformer may be used. Of course reverse feedback such as is used in circuit number 2 may be used for preventing oscillations. In the hook-up of Fig. 9 a single circuit tuner is used. This works very well with a short aerial but if a long aerial is to be used a 43-plate variable condenser should be connected in series.

Super-Heterodyne

Although the usual form of super-heterodyne requires 6 or 8 tubes it is not generally known that very good results may be obtained with only two tubes. Fig. 10 shows such a circuit. In this hook-up tube No. 1 acts as both oscillator and first detector by using the tropadyne principle. Coils suitable for this circuit were described in detail in the December issue. The second tube acts as a detector. For the second tube, three 1000-turn honeycomb coils should be used. A triple coil mounting will be found convenient for adjusting the coupling between the coils. This circuit works very well with a head-set and loop aerial. Amplification is obtained both from the heterodyne action of tube No. 1 and from regeneration of tube No. 2.

Cleanliness of Set Important

Clean parts are as important as good parts in a radio set. The most expensive materinal may cause serious trouble if it is dirty. Some parts must be looked over and cleaned when they are first purchased and all should be cared for frequently.

In order to build good radio receivers, manufacturers have sought metals and insulators which have been rigidly tested by the Bureau of Standards as well as by many commercial laboratories, but even such good material loses its qualities when it collects a few small particles of dust at a critical point, or otherwise becomes dirty.

Good insulation is used in making fixed condensers, but it is no better than cheap insulation when it is dusty. Such a condenser is usually held together by two metal pieces, which are separated only a small distance by insulation, and dirt here may cause losses. A small brush can be used to clean such parts inside a receiver. It is used dry, as moisture may accumulate dust.

A dry cloth which does not leave lint should be used often wherever possible. It will help to remove dust between binding posts, on the baseboard and on the various instruments used. Because it is necessary to dust the set frequently, it is a good plan to leave plenty of space between parts when building the set.

When it is considered that a grid leak, an essential part of a radio set, can be made of a single pencil mark on a piece of paper, the dust problem may be better understood. Through such a pencil mark enough energy will leak away from the grid of a vacuum tube to keep it stable, and if the mark is too heavy, volume or sound will decrease.

In order to make the grid leak effective all other insulation must be nearly perfect. If enough dust should collect between two binding posts to correspond to the current path offered by a pencil mark, an otherwise good set might by a failure.

Even the front of the panel should be wiped with a cloth to remove finger marks and other foreign matter which might cause leakage. In choosing panel material manufacturers have carefully considered surface leakage and have given us material which is not porous enough to take up water or to accumulate dirt. A light oil used sparingly on a cloth will improve the insulating qualities of a panel, but it must be renewed frequently, as it picks up dust. A dry cloth is good enough.

The small space between plates of a variable condenser must be clean, because a particle of dust or lint here may serve the same purpose as a grid leak. A condenser usually occupies the same position in the circuit as the grid leak, and if it becomes "short circuited" by small particles of foreign matter, the efficiency of the circuit is greatly decreased. A pipe cleaner is handy for dusting the condenser. It should be drawn through the flanges a number of times first to make sure that no loose fibres will remain in the condenser.—*N. Y. Evening Journal.*

A Cascade Regenerative Receiver

A NEW idea in radio frequency amplification is applied to the set described herewith from *Radio News*. In practical form it has been tried and has given excellent results. The two tubes used as radio frequency amplifiers and the regenerative detector give approximately the same results as four stages of radio frequency amplification. The set is no more difficult to tune or control than an ordinary receiver and at the same time is exceptionally stable.

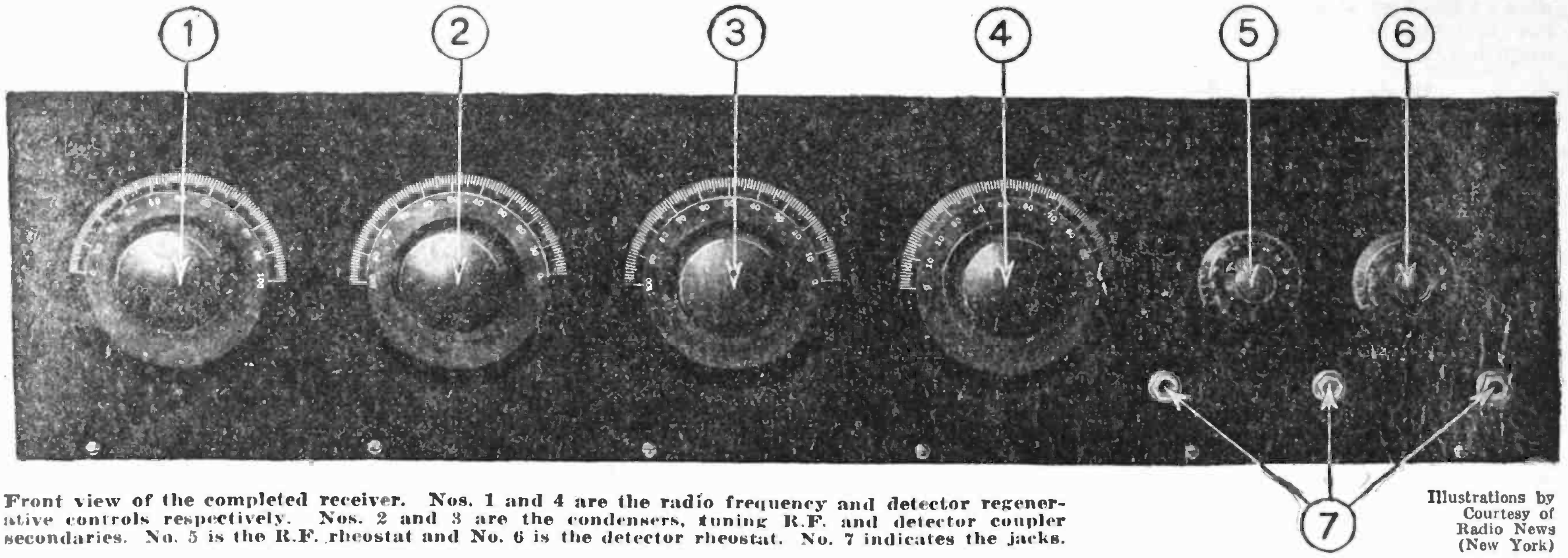
The idea is comparatively simple. The plate current of the first tube is fed back through the tickler, giving regeneration in the antenna circuit. The output of this first tube is passed to a second tube which is used as a resistance coupled radio frequency amplifier of the ordinary type and acts also as a blocking tube, keeping the first and second regenerative circuits entirely separated. The output of this second radio frequency amplifier is passed, in the regular manner, to the detector, which also is regenerative.

In the present instance, two stages of audio frequency are added to the set in the regular manner.

Following is the list of apparatus necessary to construct the cascade regenerative receiver.

The secret of the set's success lies in the blocking tube used between the first and second regenerative circuits. Oscillations are controlled entirely by the two ticklers, there being no potentiometer which adds greatly to simplicity of control. Coupling between the aerial and first radio frequency circuit is made through an aperiodic primary system, the aerial coil consisting of seven turns wound directly over the grid coil of the coupler and not tuned.

The second radio frequency amplifier tube is connected to the first through resistance coupling. The output of this tube is passed to the detector by coupling through seven turns of wire wound directly over the grid coil of the second coupler. This second coupler is identical with the first.



Front view of the completed receiver. Nos. 1 and 4 are the radio frequency and detector regenerative controls respectively. Nos. 2 and 3 are the condensers, tuning R.F. and detector coupler secondaries. No. 5 is the R.F. rheostat and No. 6 is the detector rheostat. No. 7 indicates the jacks.

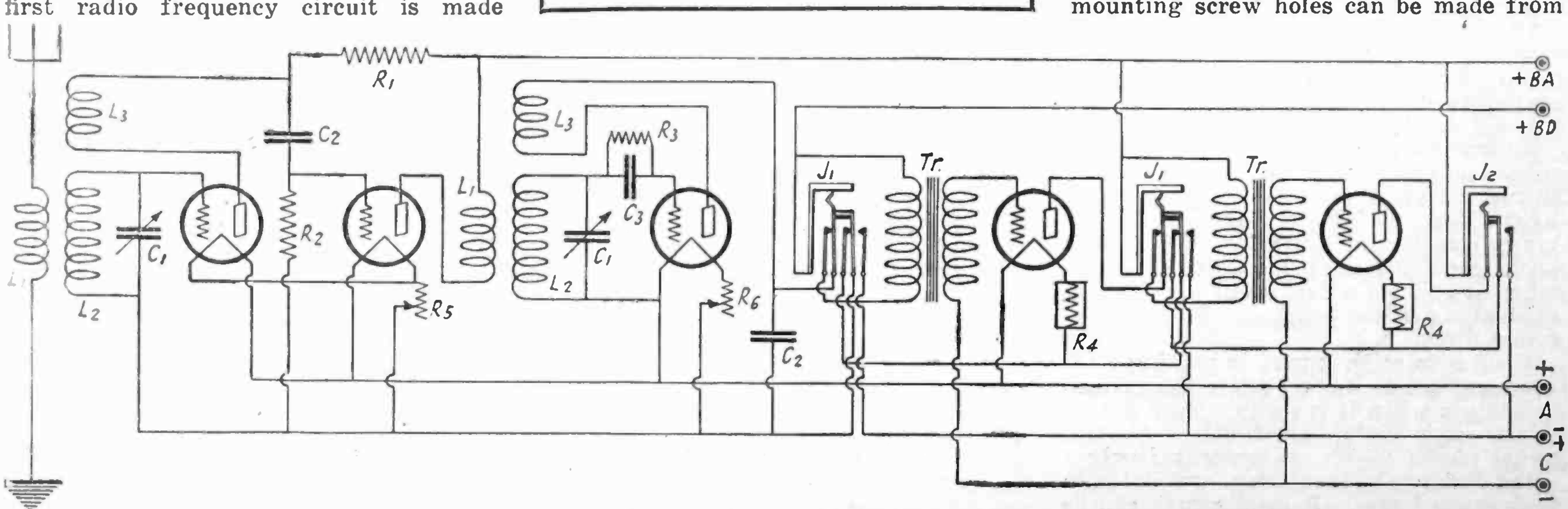
Illustrations by Courtesy of Radio News (New York)

- 1—7 x 28 inch panel.
- 1—7 x 27¼ inch wood baseboard.
- 2—.0005 mfd. variable condensers.
- 2—special variocouplers.
- 1—variable resistance 10,000—100,000 ohms.
- 2—2 megohm grid leaks.
- 1—.00025 mfd. fixed condenser with leak clips.
- 2—.0005 mfd. fixed condensers.
- 1—6 ohm rheostat.
- 1—20 ohm rheostat.
- 2—automatic filament adjustors for U.V.-201A type tubes.
- 2—medium ratio audio frequency transformers.
- 2—double circuit filament control jacks.
- 1—single circuit filament control jack.
- 4—four inch dials.
- 8—binding posts.
- 5—standard sockets.
- Various wood screws for fastening apparatus to baseboard.
- 1—strip of insulating material 5 x 2 inches for binding posts.
- 1—strip of insulating material 2 x 2 inches for binding posts.

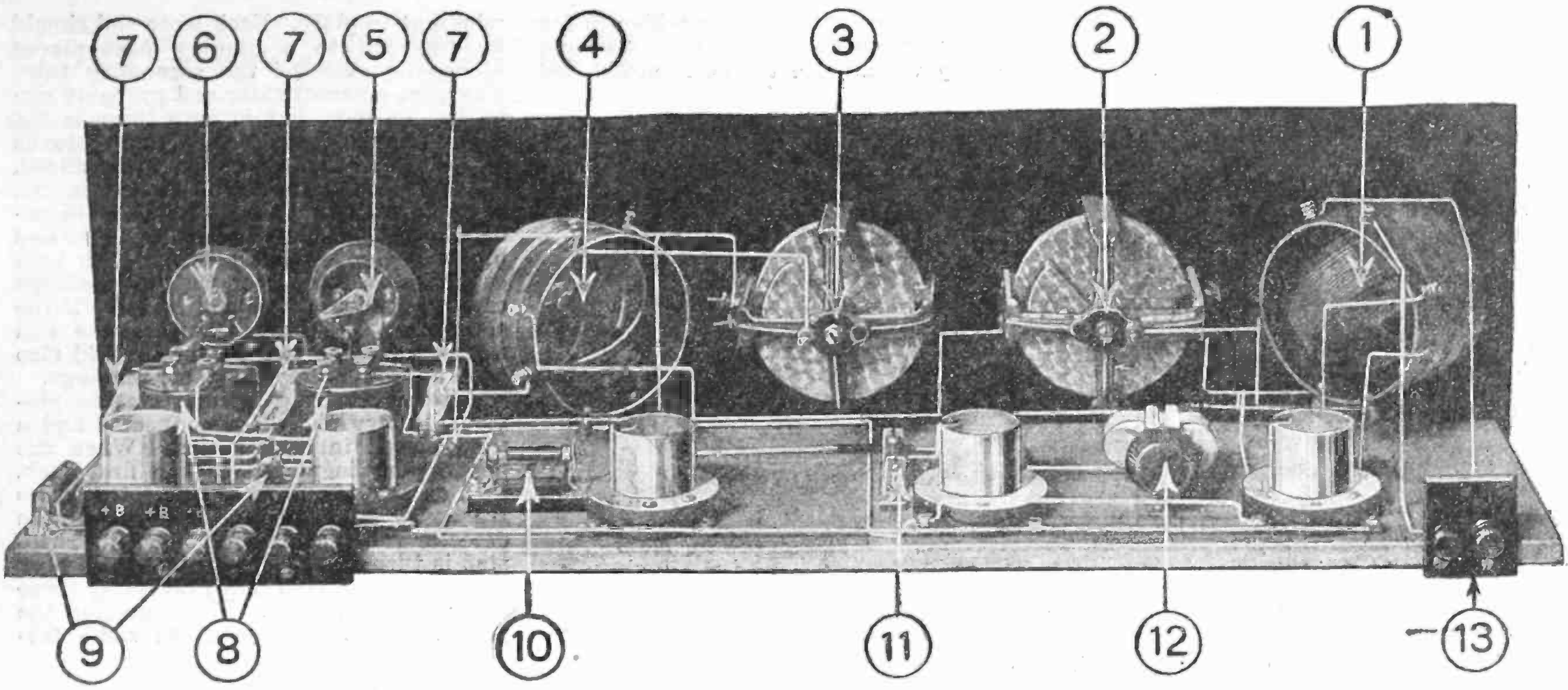
Results will be obtained with either loop or outside antenna as a collecting agency, although a good outdoor aerial is preferable.

The quality of the apparatus will in most cases depend upon the pocketbook, the same as the results will depend upon the quality of the material used. The best parts are always cheaper in the end and they can be taken out of one set and used again and again in more efficient hook-ups. One learns to pick out the good parts after a little experience, but while he is acquiring the experience he had better buy from the dealer who guarantees merchandise.

After all the parts have been secured, the first thing to be done is to mark and drill the panel. The parts used in the model set are all of standard size and manufacture which allows the reader to place his apparatus in the same position, if desired. There are two ways of marking the panel. One is to secure a piece of heavy paper and cut to the exact size of the panel, and then draw a line across the paper exactly in the center. The center holes for all instruments, with the exception of the jacks, will be made on this line. The measurements for the mounting screw holes can be made from



Schematic diagram of the circuit employed. The numbers designate the following parts: L1, L2, L3 are the primary, secondary and tickler of the couplers; R1, variable resistance; R2, R3, two-megohm grid leaks; R4, amperites; R5, six-ohm rheostat; R6, 20-ohm rheostat; C1, .0005 mfd. variable condensers; C2, .0005 mfd. fixed condensers; J1, double circuit filament control jacks; J2, single circuit filament control jack.



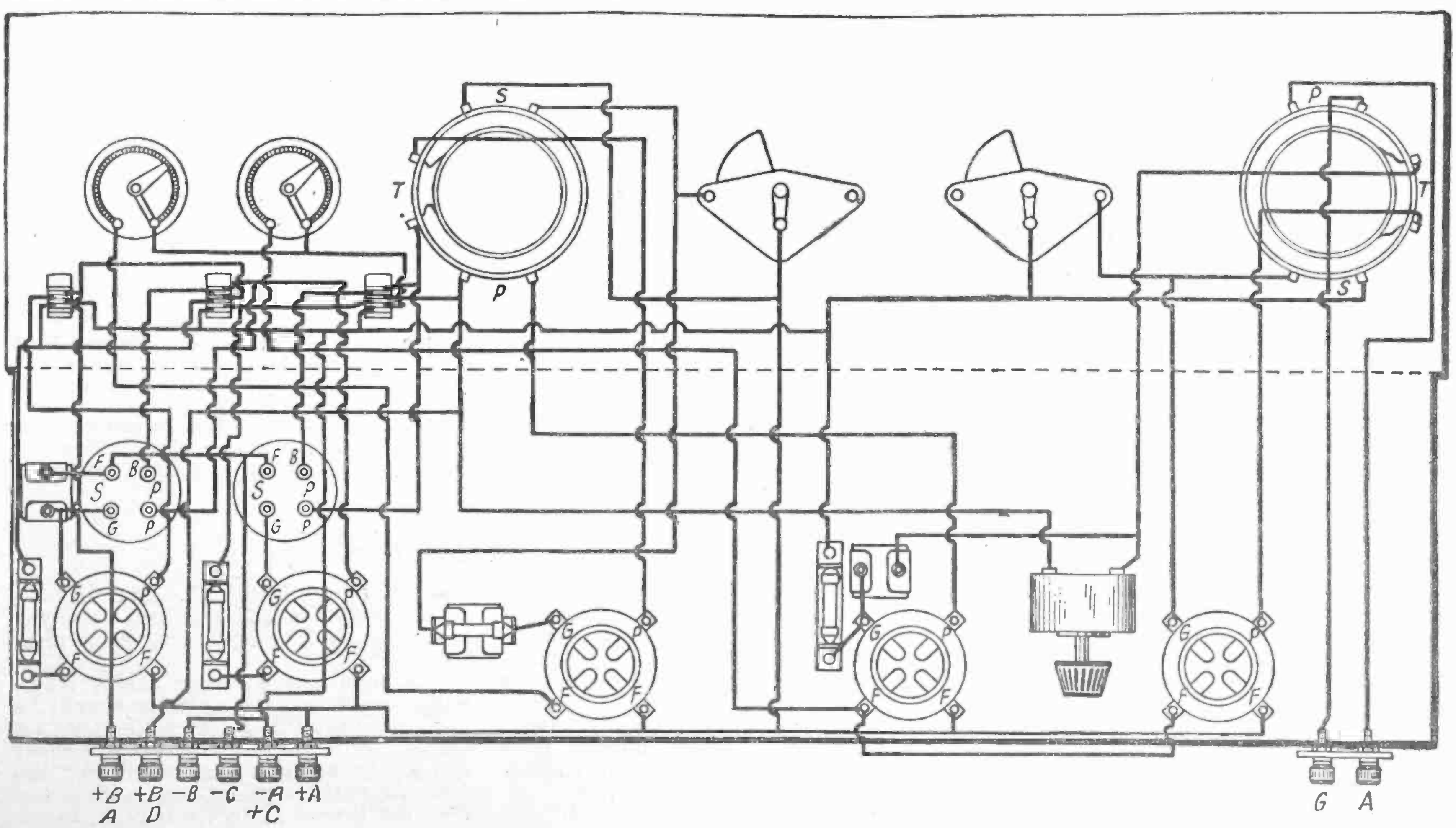
Rear view of the receiver. The numbers designate the following parts: 1 and 4, variocouplers; 2 and 3, .0005 mfd. variable condensers; 5, six-ohm rheostat; 6, detector rheostat; 7, filament control jacks; 8, A.F. transformers; 9, amperites; 10, grid condenser and leak; 11, two-megohm grid leak; 12, variable resistance; 13, antenna and ground connections.

the instruments themselves or the templates may be used. Another line is drawn 1½ inches from the right lower corner of the panel, on which the three jack holes will be drilled. After the centers of all the holes are marked the paper is pasted on the panel and an impression is made on the surface of the panel with a center punch and hammer. After drilling all of the holes with the proper size drill, a countersink should be used on all holes through which a machine screw is to pass so that the dials can be set close to the panel. The paper template can be removed before drilling is started and used over again if desired. The second method of operating the panel is to measure off the instruments on the panel and mark each hole with a center punch as it is measured.

Finished Panel

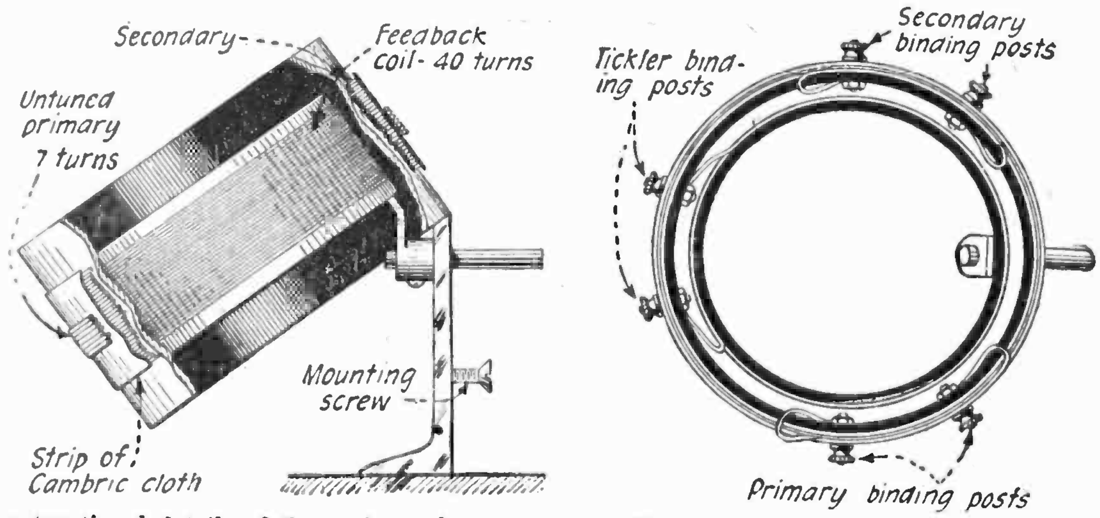
In some cases it may be desired to have a grained finish on the panel. The requisites are some pumice powder, thin lubricating oil or linseed oil and some rags. The panel should be made fast to the workbench by fastening a thin brace to the table on all four sides of the panel. A little oil should be spread on the panel and a small amount of the powder sprinkled on. Care should be taken that the surface is rubbed either lengthwise or crosswise, but not both, as this will do anything but improve the looks of the finished product. When the desired finish is procured, a little oil should be spread on the surface and rubbed with a clean cloth until it is perfectly dry. This can be done either before or after the panel is drilled, preferably before.

The baseboard should be about three-fourths inch shorter than the panel so that it will fit into the cabinet. It should be the first thing to be fastened. The condensers, variocouplers, rheostats and jacks should be fastened to the panel before the sockets, transformers and other apparatus are fastened to the baseboard. The sockets and other parts should be so placed that the leads are as short as possible at the same time the plate and grid leads should be placed as far apart as possible to avoid unneces-



Layout of the receiver showing the arrangement of the apparatus on the panel and the baseboard. With the instruments arranged as shown, short leads are obtained and the wiring is greatly simplified. Only by careful wiring, well soldered joints and short leads can maximum results be obtained.

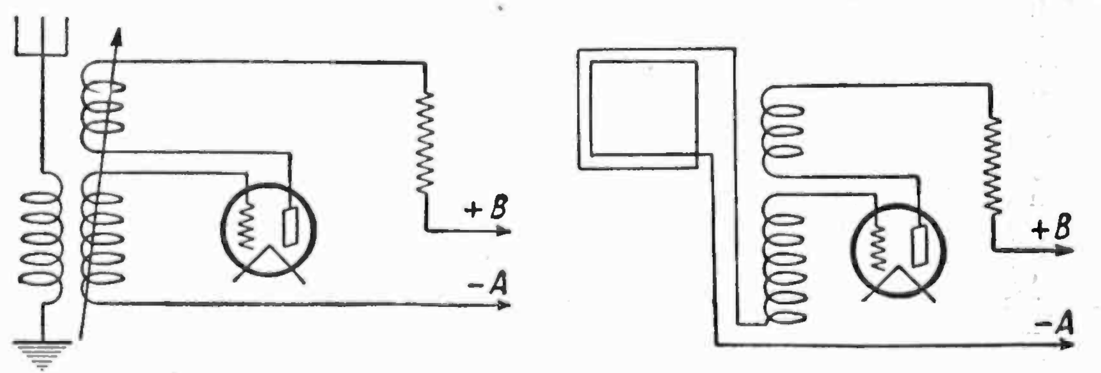
sary feed-back. Where it is possible, have wires cross at right angles. If two leads come very close together, a short length of cambric tubing should be used. All contacts which are not made with machine screws should be soldered. All excess flux should be scraped or washed off with alcohol to avoid corrosion. Filament control jacks are used throughout so as to have the least number of controls possible. The filament of the audio frequency amplifying tubes are controlled by automatic resistances made for use with any particular type of tube. The kind used in this set allows one-fourth ampere to pass to a five-volt tube from a six-volt storage battery, thus only UV-201A tubes or others with a similar current rating can be used. The six ohm rheostat is for use with the two radio frequency tubes while the 20 ohm rheostat supplies the current for the detector tube.



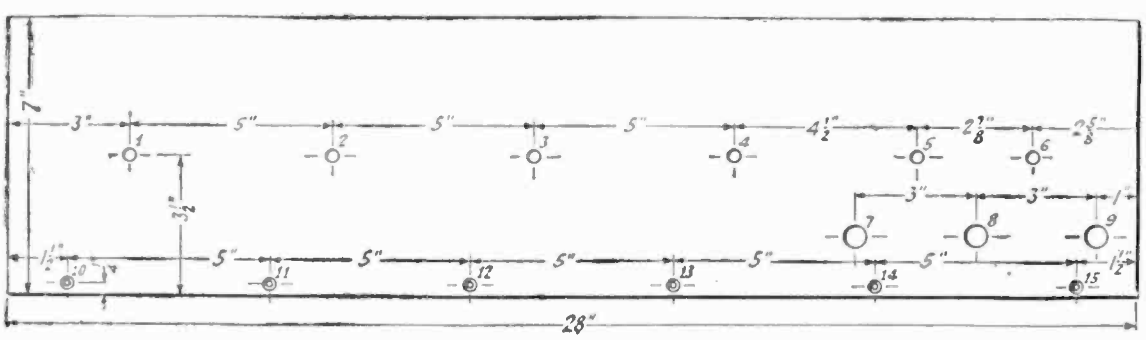
Constructional details of the variocouplers employed. The primary is wound directly over the secondary, separated from it by a layer of cambric cloth. It is best to purchase a variocoupler similar to the type shown and rewind it as specified.

The couplers are both alike as to size and windings. They may be made with any 180 degree variocoupler form. It will usually be much more efficient to buy a form than to make one. Perhaps there are two couplers which are similar in size and shape around the workbench for which there is no further use. The old primary winding should be removed and in its place 40 turns of No. 24 D. S. C. wire should be wound. Directly on top of this winding a strip of cambric cloth should be wound, over which 7 turns of the same size wire is placed. A light coating of radio cement will hold these windings in place. Each loose end should be fastened to a binding post placed along the edge of the secondary tube. The wire on the tickler coil probably can be left as it is, but in case there is not enough for regeneration, about 40 turns of No. 24 S. S. C. wire should be added. All three coils should be wound in the same direction. If care is taken in securing two couplers of the same size and provided the respective winding on both couplers are alike, then the dial readings of both condensers should be alike if the condensers are of the same make and same size. The two ticklers should also have approximately the same readings.

After the wiring is complete the filament battery should be connected and a tube placed in each socket. When the phone plug is placed in the first jack, turn on the left rheostat. The two radio frequency tubes should light while the detector tube should light when its rheostat is turned on. When the phone plug is withdrawn from the first jack, these tubes should go out. When putting the plug in the middle jack the radio frequency tubes, the detector tube and the first audio frequency tube should light while the third jack should light all five tubes. As the filament wiring is quite complicated it is fairly easy to make a mistake wiring the jacks, so be careful. The aerial and ground wires as well as the "B" batteries should now be connected. When the phone plug is thrust into any jack, a click should be heard in the phones. Set the two variocoupler dials at about 40 degrees and move the two condenser dials slowly with approximately the same reading for each. A whistle should be heard as a carried wave is picked up. If no whistle is heard, but a station is heard, try turning the ticklers and if the signal becomes louder as the coupling is decreased then the connections of the tickler which acts in this manner should be reversed. If a buzzing sound is heard there is probably some grid connection open or the variable resistance is open. If the former are perfect, try tightening up the latter.



The receiver may be used with an outside antenna and ground or, as shown at the right, a loop may be employed by connecting it in series with the secondary. Both arrangements work exceedingly well. The use of an outdoor aerial of fair dimensions will, of course, produce the best results.



Panel layout of the Cascade regenerative receiver giving the correct position of all parts. Holes 1, 2, 3, 4, 5 and 6 are ¼ inch; 7, 8, 9 are ½ inch and 10, 11, 12, 13, 14, 15, are ⅛ inch and countersunk.

Proper Height and Length of Aerial

It is a known fact, which has been backed up by countless thousands of observations by trained observers, that the higher and longer the antenna, the more difficult it is to eliminate undesired signals. You may pick up broadcast signals louder on the high, long antenna, but you won't hear as many because the loud stations are so "spread out" on the dial that you can't get a chance to listen to the weaker stations.

Where there is any static disturbance the static is much stronger in proportion to the signal on a high and long antenna than it is on the low short one. This means that with a low and short antenna it is more desirable to increase the signal strength by adding audio and radio amplification, which does not amplify the static all out of proportion to the signal, than it would be to get the louder signal on a higher and longer antenna with more static which cannot be eliminated.

It is a significant fact that all the trans-Atlantic commercial radio telegraph stations employ receiving antennas which are strung on telephone poles not over 25 or 30 feet high. And the antennas are made long only because of the tremendously long wave-lengths used in this work.

For broadcast reception a safe maximum length for the antenna should be one whose total length from the antenna connection at the receiving set to the far end of the antenna does not exceed 125 feet. An antenna whose maximum height does not exceed 40 feet will bring in ten times as much distance as the 70 and 80-foot antennas. — *The Evening Bulletin, Philadelphia, Pa.*

How to Build a Two-Tube Loudspeaker Set

Illustrations by Courtesy of Popular Science Monthly (New York)

Mr. Lane tuning the remarkable loudspeaker set that he tells you how to build in the accompanying article. For local stations this set will give ample loudspeaker volume to fill a room on a single tube.

HERE is a radio receiver designed to give plenty of volume on the loudspeaker with the minimum number of tubes. It has been described by *Alfred P. Lane* in a recent issue of *Popular Science Monthly* and suggests itself as being a very practical outfit for broadcast reception.

If you are located near several powerful broadcasting stations, this receiver will give volume enough for dancing from any of them on just one vacuum tube. And if you are a bit too far away for one tube, the design of the receiver is such that you can add another stage of audio amplification without changing a single wire already in the set.

The receiver is both selective and easy to tune. If the coils are carefully wound and the two condensers are alike, the two tuning dials will read within a few degrees of each other from the lowest to the highest of the broadcasting wave lengths, and the readings of these dials may be logged for the different stations heard.

With the receiver shown in the illustrations, I have found it easy to tune in any one of the 11 different broadcasting stations in the vicinity of New York City on one tube with loudspeaker strength, using a 100-foot antenna strung up the side of an apartment house. The selectivity can be adjusted to suit local conditions and various lengths of antenna by changing the number of turns in coil A.

Another feature that certainly will appeal to radio fans is the elimination from the circuit of any special parts not easily obtained. The tuning inductances AB and CD take the place of the fancy coupling units often recommended for reflex sets and these inductances are so simple that any one can wind them. And it is an easy matter to change the number of turns of wire in any of the coils in order to compensate for the peculiarities of the particular instruments you use in building the receiver.

The reflex principle is employed because it reduces the number of tubes required to obtain the desired degree of volume, a factor of considerable importance when the receiver is to be operated on dry cells, or on a storage battery if the latter must be carried some distance to have it recharged. With two storage-battery tubes, it will overload most loudspeakers on local stations. It will operate perfectly on storage-battery tubes or either type of dry-cell tube, but the latter will not give as much volume.

The crystal detector helps to keep the quality of the reproduction high, although this is governed to a large extent by the characteristics of the audio-frequency transformers used in the circuit.

Here are the parts you will need:

A and B—Tube tuning unit
C and D—Crystal tuning unit
E and F—Variable condensers, .00025 mfd. maximum capacity
G—Mica fixed condenser, .001 mfd.
H—Mica fixed condenser, .00025 mfd.
I—Audio-frequency transformer, high ratio
J—Audio-frequency transformer, medium ratio
K—Rheostat
L and M—Vacuum-tube sockets
N—Crystal detector
O—Double-circuit jack
P—Open-circuit jack
Q—Panel, 7 by 14 inches
R—Wooden base board, 6½ by 13½ inches
S—Binding-post panel, 1 by 6 inches
Six binding posts, two dials, two vacuum tubes, brass right-angle brackets, bus wire, etc.

The variable condensers E and F do not have to be of .00025 capacity. If you already have a couple of .0005 condensers, they can be used. It is desirable, however, if larger condensers are used, to cut down the number of turns in coils B and D to 50 turns apiece so as to spread out the broadcasting stations over a greater portion of the dials.

The audio-frequency transformer I has a ratio of 5 to 1; transformer J has a ratio of 4½ to 1. Almost any standard types of transformers can be used, although it may be necessary to alter the number of turns in coil C if the characteristics of the transformer used at I are different from the one used in the model set. How to do this will be explained later.

If preferred, the crystal detector N can be of the fixed type, but one can never be sure that a fixed crystal is really sensitive unless means are at hand to make comparative tests.

The jacks O and P in this receiver are of the type that have holes drilled and tapped in the frame, and the wooden baseboard is screwed directly to the jacks as shown in Figs. 4 and 5. If you have standard jacks on hand, you can drill and tap the holes yourself; or if you prefer, the wooden base can be fastened to the panel in the usual way with screws through the panel.

The rheostat, of course, should have a resistance suitable for the tubes you expect to use. Generally speaking, any rheostat that is right for one particular tube will also handle two tubes in parallel without enough overheating to make it a serious matter.

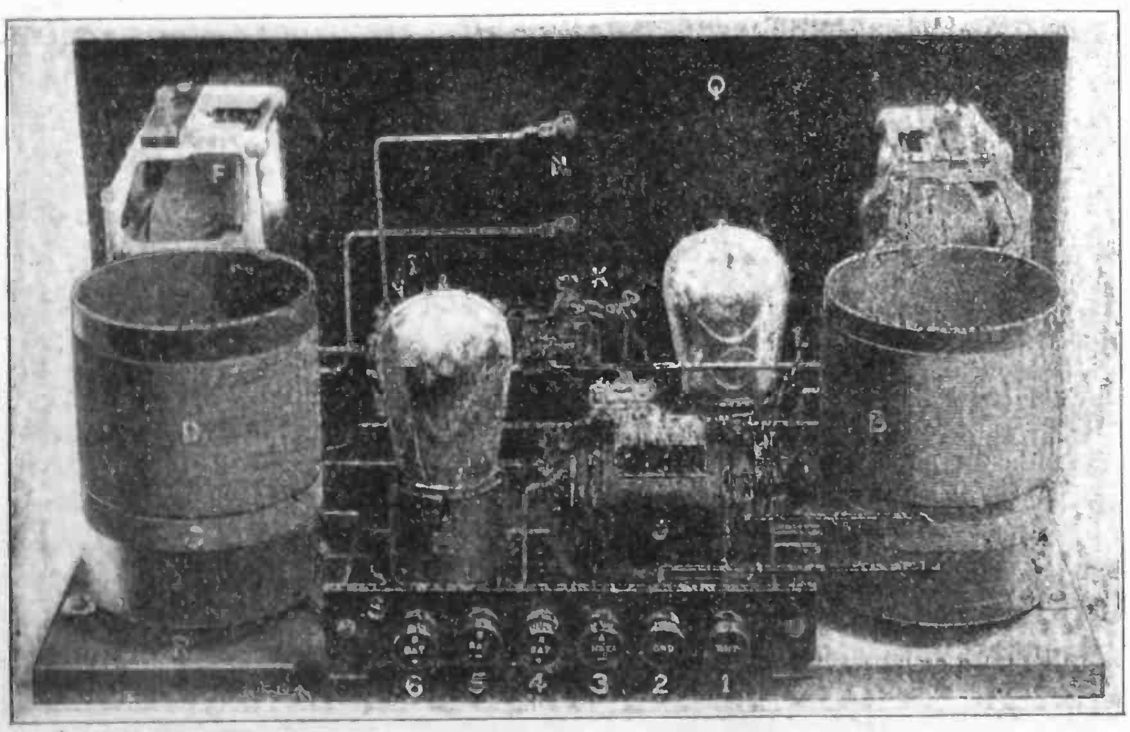


Fig. 1. Rear view of the set, showing layout of parts and wiring. Notice particularly how the ends of the wires are fastened on coil A.

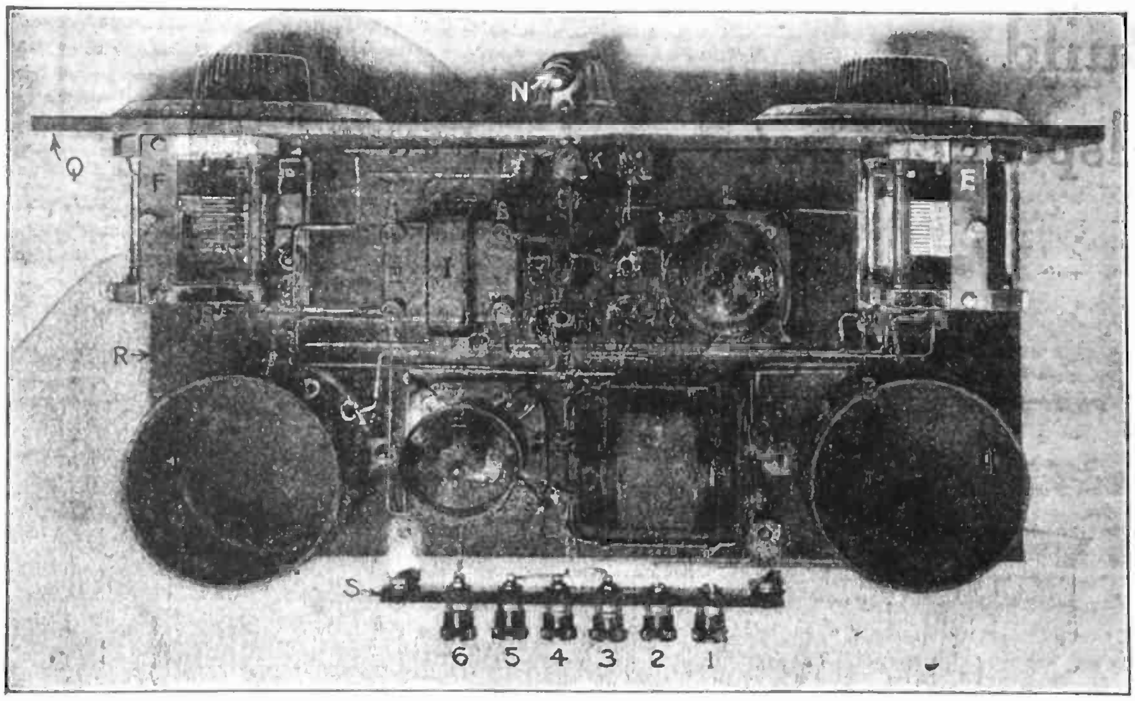


Fig. 2. View of the set from above. The layout of parts is symmetrical, whether you use one or two tubes. For a one-tube set, leave out tube socket M and audio transformer J.

The rest of the apparatus needs no comment. Any standard parts will give excellent results.

After you have purchased all the parts, including two pieces of bakelite tubing 4 inches long and 3 inches in diameter, and a half-pound spool of No. 22 double silk-covered wire for the inductances AB and CD, the first step is to lay out the holes in the panel as shown in Fig. 7. Only the shaft holes for the instruments are indicated, since there is so much variation in the spacing of the holes for the screw used to mount the instruments, and so many of them are now made single mounting anyway.

The easiest way to do this job is to mark off the holes on a piece of paper the exact size of the panel and paste the paper on the panel with library paste. Then center punch the holes through the paper and after you have drilled them, the paper can be washed off. This method will prevent scratches on the panel.

The tuning inductances should be wound next, after the holes have been drilled in the bakelite tubing for the brass angle brackets that support them, as shown in Figs. 1, 2, 4, and 5. Small holes also should be drilled so that the ends of the wire can be passed through and back to hold them in place. The way this is done is shown on coil A in Fig. 1.

The number of turns of wire in each coil is as follows: Coil A, 14 turns; coil B, 72 turns; coil C, 15 turns; coil D, 72 turns. Coils A and C take up slightly less than a half inch of space on the bakelite tubing, and coils B and D are a shade over 2 inches long.

Now arrange all the instruments as shown in Figs. 1, 2, 4, and 5 after you have mounted the panel on the wooden baseboard. Mark where the holding screws belong and fasten all the instruments in place except the tuning inductances AB and CD. It is best to leave these off until the wires in back of them have been soldered in place. This will save accidental scorching of the coil wire and will give more space to work.

Be sure to place socket L with the grid and plate binding posts toward condenser E, and fasten socket M with grid and plate binding posts toward the rear, so that the filament binding posts on this socket will be nearest the panel Q. The audio-frequency transformer I should be placed with the secondary binding posts toward socket L and the secondary binding posts on transformer J should be toward socket M.

You will note that in the wiring diagram given in Fig. 6, all the wires that go to make up a one-tube receiver are marked in solid lines, while dotted lines are used to indicate the additional wires necessary if two tubes are to be used. The following description of the wiring will cover the necessary connections for two tubes. If you want to build the receiver as a one-tube outfit, just disregard the instructions specifying wires that are indicated by dotted lines in Fig. 1. Incidentally, this is a good plan if you live near several broadcasting stations, since one dry-cell tube will operate a loudspeaker with good volume.

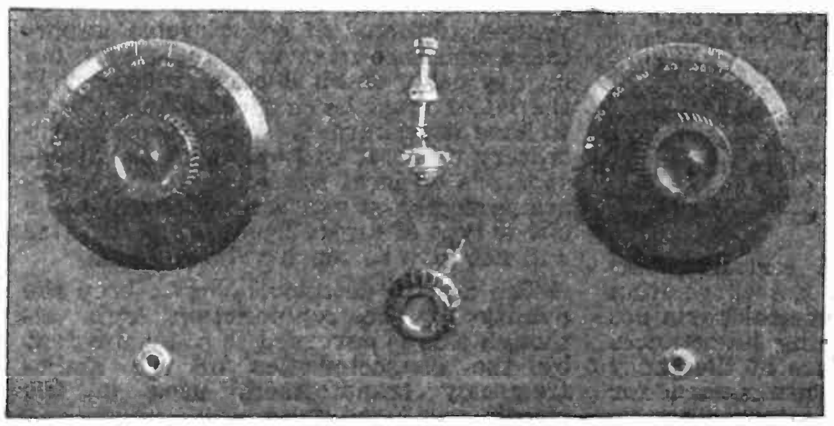


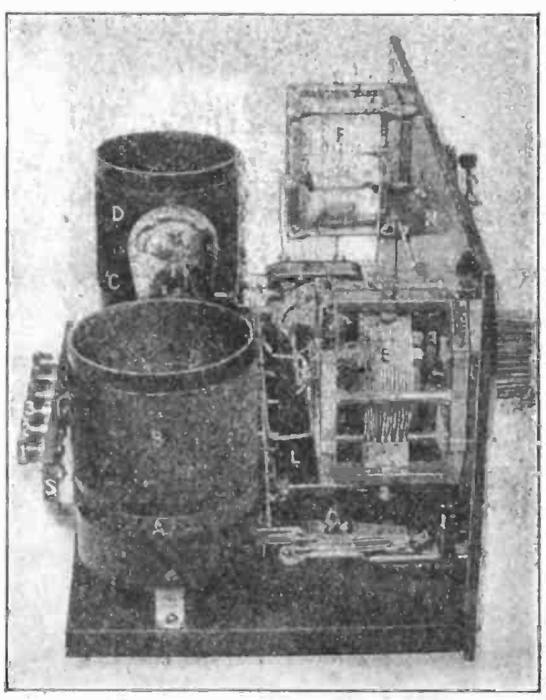
Fig. 3. The well-balanced panel lay-out.

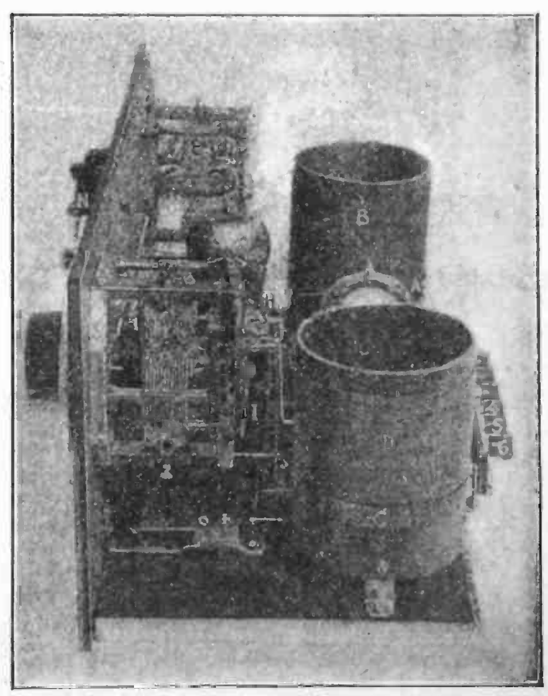
As each wire is soldered in place, go over the line that indicates the wire in Fig. 1 with a blue or red pencil. This will enable you to note any wire that you may accidentally have missed. Do not forget the positions of tuning inductances AB and CD, and be sure to bend the wires so that they will not interfere with them.

The filament circuit should be wired first. Run a wire from binding post No. 3 to one binding post on the rheostat K. From the other binding post on the rheostat run a wire to the nearest filament terminal of socket L and continue it around to the left-hand (as seen from the rear in Fig. 1) binding post on socket M nearest panel Q. Next, run a wire from the binding post No. 4 to the remaining filament terminals of both sockets L and M.

Now connect a wire from the stator plates of condenser E to the grid terminal of socket L, and another from the rotary plates of the same condenser to one of the secondary terminals of transformer I. Connect the other secondary terminal of the same transformer with the wire that runsthat runs form binding post No. 3 to the rheostat. Fixed condenser H can be soldered between these two wires at any convenient point. See Fig. 6. Binding post No. 5 can be connected directly with binding post No. 4. Binding post No. 6 is next connected with the top soldering lugs of jacks O and P. Running a wire from the other lug of jack P to the plate terminal of socket M. completes the connections with this jack.

(Continued on page 46)





Figs. 4 and 5. Right and left end view, showing the position of parts, and particularly how the wooden baseboard is screwed to the jacks; also how the tuning inductances are mounted by brass right-angle brackets.

The Duotrol Tuned R. F. Circuit

IN this article from *The Evening World Radio Section, James S. Caulfield* describes a circuit devised by him called the "Duotrol," which is said to be exceedingly selective and has, as its main feature, only two tuning controls instead of three as found in most conventional types of tuned radio frequency sets.

The description and constructional details for building this receiver in two different forms are as follows:

Every radio fan who owns, intends to build or buy a tuned radio frequency receiver should read this article, for it deals with the reduction in the number of controls on this type of receiver, which at present is one of the most popular.

Let us see why it has become popular before we discuss the fine points of the receiver illustrated. There are three forms of radio frequency amplification which are really practical. They are the transformer coupled, the tuned impedance coupled and the resistance coupled. Of these three types, the tuned impedance has come to the front because this type of radio frequency amplification amplifies fairly uniform over the entire broadcast range, whereas the other types amplify certain wave lengths more than others. The resistance coupled type is very rarely used. In the tuned impedance type it also has been possible to eliminate the use of a potentiometer to stabilize the circuit which therefore reduces the number of controls.

Every two-stage tuned radio frequency receiver has three controls. These are variable condensers which are used to tune the coils. One condenser is used to tune the antenna and the other two tune the radio frequency circuits.

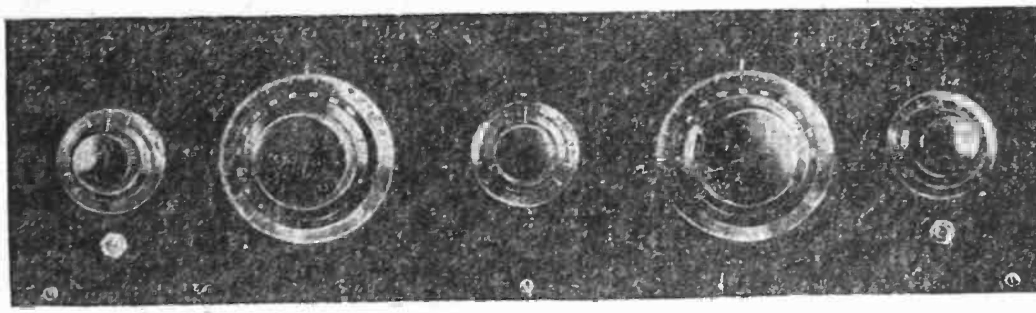
The circuit described herewith was named the "Duotrol" circuit by reason of the two controls. Samuel Cohen, chief engineer of the General Instrument Corporation, designed the duo variable condenser which is shown in the left hand side of the illustration above. This condenser tunes the two radio frequency circuits. It took many weeks to bring out this condenser, but the result is a double variable condenser that is well matched, with even spacing between the plates, is rigidly built and with losses that literally cannot be measured. As a matter of fact this condenser is called the "No Loss," one of a series of such products made by the General Instrument Company of New York City.

The duo condenser is the heart of the circuit and must be properly made. Because the duo condenser is a scientifically perfect condenser it is necessary for the losses in the circuit to be kept at a minimum to appreciate the effect of the efficient tuning elements.

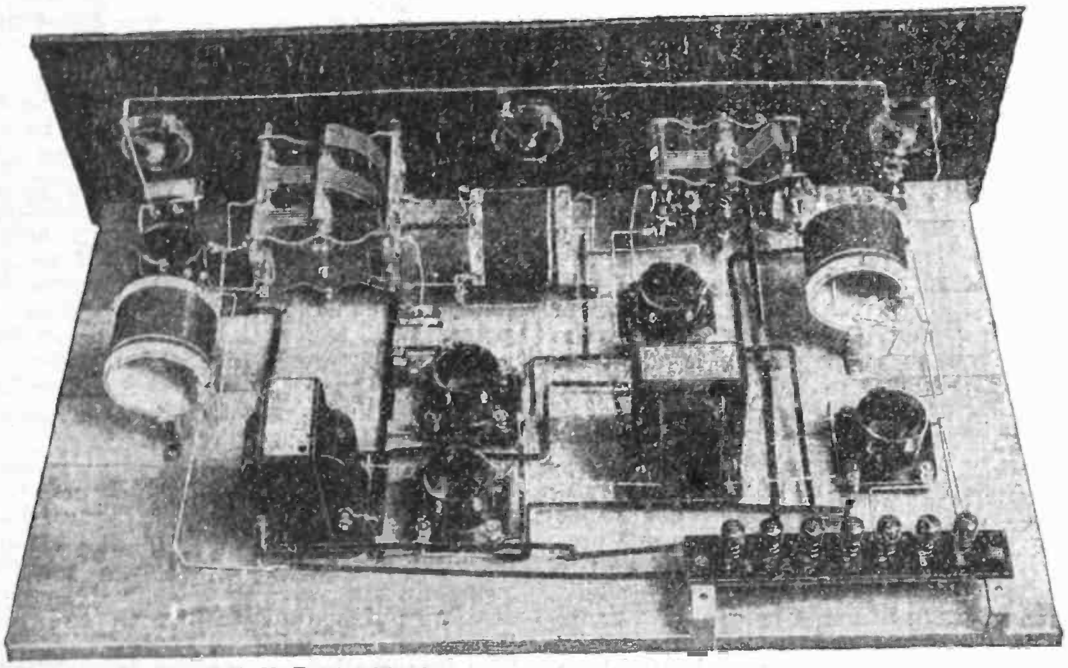
The baseboard layout of the Duotrol circuit is shown herewith. As this layout was set up purely for experimental purposes, the reader may be able to arrange the instruments more compactly.

The parts used in the Duotrol model illustrated are as follows:

1 General Instrument Corporation Duo Condenser .0003 mfd.



A front panel view of the experimental set showing the layout of the tuning controls and rheostats.



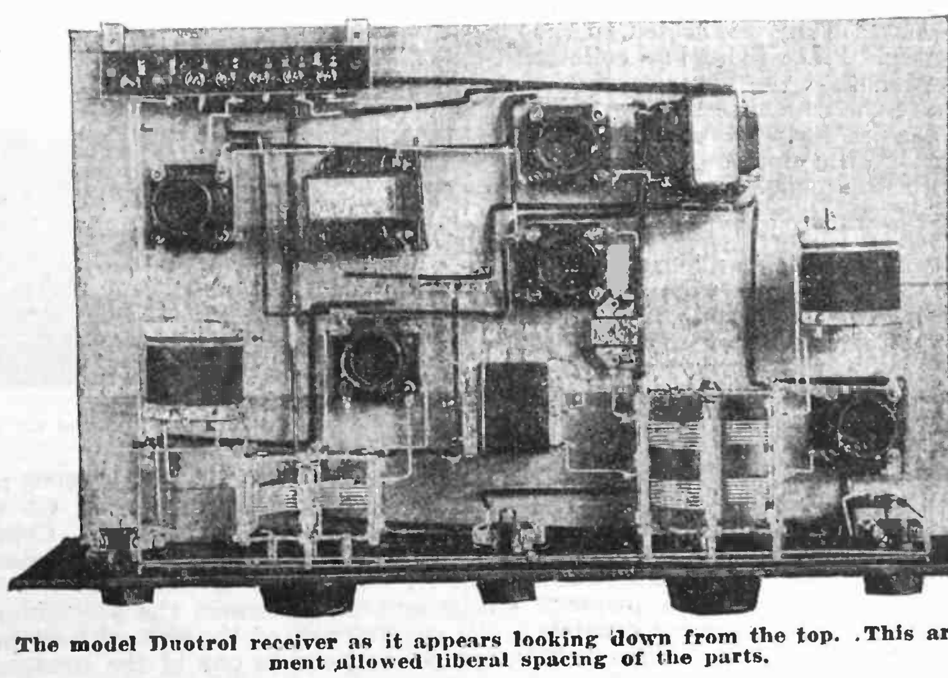
Photos by Courtesy of N. Y. Evening World

Panel and baseboard assembly of the Duotrol receiver as built for experimental purposes. (This arrangement can be made more compact to fit in a standard cabinet.

1 General Instrument .0003 mfd. variable condenser.
3 radio frequency coils.
5 Rauland sockets.
2 Rauland lyric transformers.
2 General Instrument 20-ohm rheostats.
1 General Instrument 10-ohm rheostat.
1 Cutler-Hammer radioloc.
1 Single circuit jack
1 Dubilier .00025 mfd. grid condenser.
1 Dubilier .00025 mfd. fixed condenser.
1 .006 mfd. bypass condenser.
7 Binding posts.
1 Terminal strip.
1 Panel 7x24 inches.
1 Baseboard 13x23 inches.

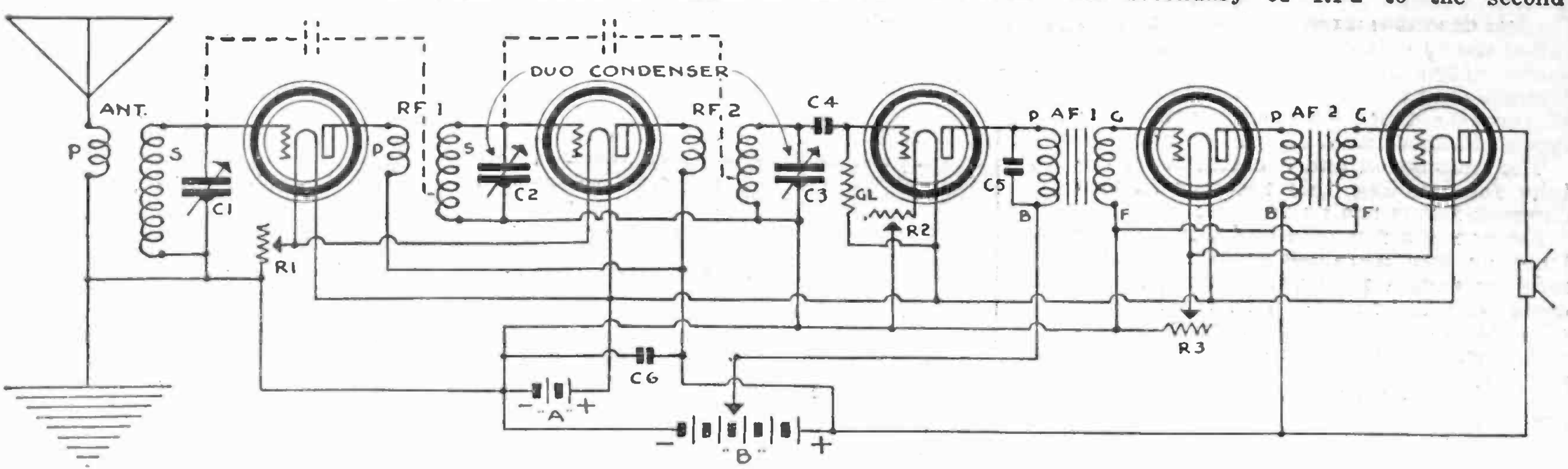
The Duotrol circuit, with few exceptions, is the standard five-tube radio frequency circuit. The two tube sockets mounted near the panel are for the radio frequency amplifiers; the socket in the center of the baseboard is for the detector and the two sockets in the foreground are for the audio frequency amplifiers. The details of the radio frequency coils will be described later.

An extra wide baseboard was used on the original layout to get good spacing between the parts and to make wiring changes if necessary. With a little care, the average home builder will be able to get all of the equipment in a much smaller baseboard. On the 7x24-inch

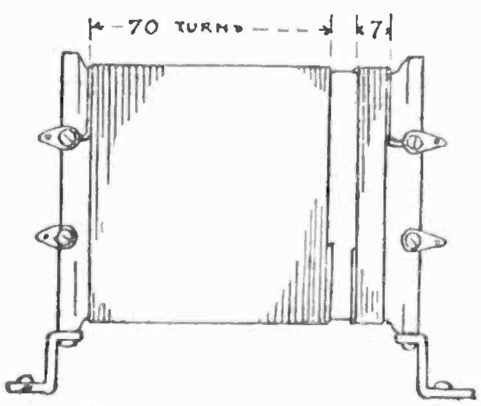


The model Duotrol receiver as it appears looking down from the top. This arrangement allowed liberal spacing of the parts.

panel mount the General Instrument condensers and rheostats. Looking at the panel, the Duo condenser should be mounted to the right or the left from the rear of the panel. After the instruments have been mounted on the panel fasten the panel to the baseboard. When this is done place the instruments on the sub-base and fasten them. The parts on the sub-base should be placed with a view to compactness and with sufficient room between the parts to facilitate the wiring. If you have the parts too close together the wiring will be cramped and you will have difficulty in reaching some of the places. Note the position of the coils with respect to one another. The coils should be mounted at right angles to each other to prevent interaction between the inductances. There is one caution in placing the two radio frequency coils which are connected to the Duo condenser. Place these two coils in such a position that the wires from the secondaries to the condensers are exactly the same; that is, have the wiring to the Duo condenser an equal length from the condenser to the coils. In the wiring diagram these coils are lettered RF1 and RF2.



Wiring diagram of the Duotrol receiver. Note the method of connecting the Duo-condensers and the location of the grid leak. The dotted lines represent neutralizing condensers which may be added to the circuit if necessary.



The radio frequency coils are wound on an insulating form. The primary consists of seven turns and the secondary of seventy turns of No. 28 B. & S. gauge wire.

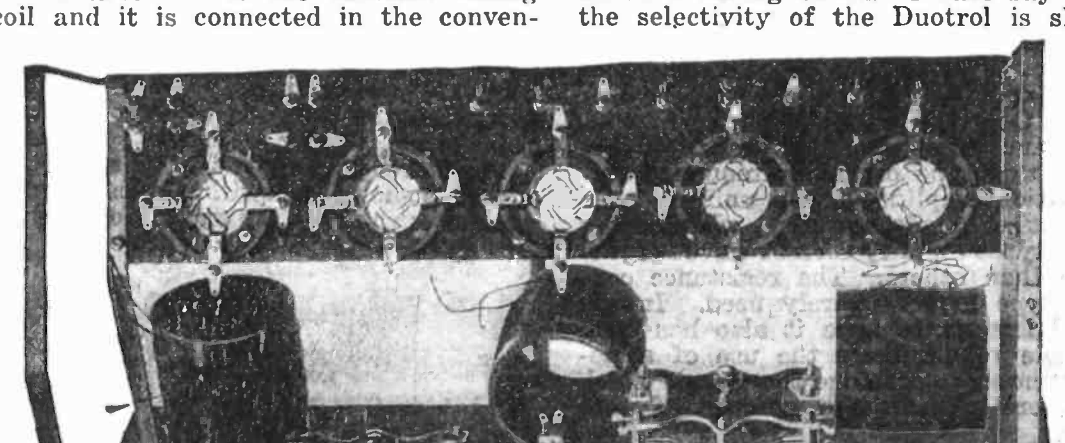
If the reader desires to make the coils it will be necessary to take extreme pains in winding the coils identical. Should any variation occur in the coils it will show up in the tuning and it will be impossible to get on the peak of the station for the maximum and best results.

The three coils used in the set shown are made as follows: The tubing is Isolantite, one of the most efficient forms of insulation made at the present time. The diameter is three inches. There are two windings on this tube, a primary and a secondary. The primary consists of seven turns of 10-38 Litzendraht wire or No. 28 B&S solid copper wire. The secondary is wound with the same size wire for seventy turns. If one desires to insert standard neutralizing condensers in the circuit the secondary should be tapped in the fifteenth turn from the filament end of the wiring (see wiring diagram above). Both the primary and secondary are wound in the same direction. Should one desire to leave out stabilizing methods the primary should be wound in the opposite direction onto that of the secondary. The three coils are wound the same.

When following the wiring diagram the reader should carefully observe the connections to the variable condensers. The rotary plates of the condensers are shown by the small black dots placed by the symbol. In all cases the rotary plates are connected to the filament return, which in this circuit is the negative bus. The Duo variable condenser made by the General Instrument Company has the two rotary plates of the condenser connected together. This means that he filament end of the radio frequency transformers RF1 and RF2 are connected together and brought to the rotary plates of the double condenser.

The first coil is the antenna tuning coil and it is connected in the conventional manner with the single .0003 mfd. General Instrument condenser C1 connected across the secondary. Connect the primary of the first radio frequency coil RF1 in the plate circuit of the first tube and then connect the secondary to the grid circuit of the second tube making connections to one of the condensers in the Duo condenser unit. The primary of RF2 is connected in the plate circuit of the second tube and the secondary is connected to the grid circuit of the detector tube. The connections from the secondary of RF2 to the second condenser in the Duo unit should be the same length as the connections to the first condenser in the unit. The Duo condenser as shown in the wiring diagram consists of the variable condensers C2 and C3. The audio frequency amplifier in the circuit is connected as per standard practice. A .00025 mfd. bypass condenser is connected across the primary of the first transformer. This condenser is shown at C5. A bypass condenser (C6) is connected across the batteries. This condenser should have a capacity of .006 mfd. or larger.

The selectivity of the Duotrol is really remarkable and at the same time permitting ease of tuning. As an indication of the selectivity of this circuit, it was placed in a location five blocks from station WEAF and tuned out this station by two degrees with one dial. This was done with an outdoor antenna. The impulse being received from WEAF was so strong that touching the grid of the detector tube with the finger produced a strong shock. I dare say that the selectivity of the Duotrol is sharp enough to enable the fan situated in close proximity to a broadcast station to tune out the nearby station and bring in distance. This was proven by test. The fine selectivity may be attributed to the efficient condensers and coils.



A bottom view of the Duotrol set as assembled to fit in the slope-panel cabinet.

In passing, it is well to point out that the Duo condenser is made under a license agreement which does not cover the use of the production of the Duotrol circuit with the duo condenser. Should one desire to make this circuit for commercial purposes it will be necessary to obtain a license from the patentee.

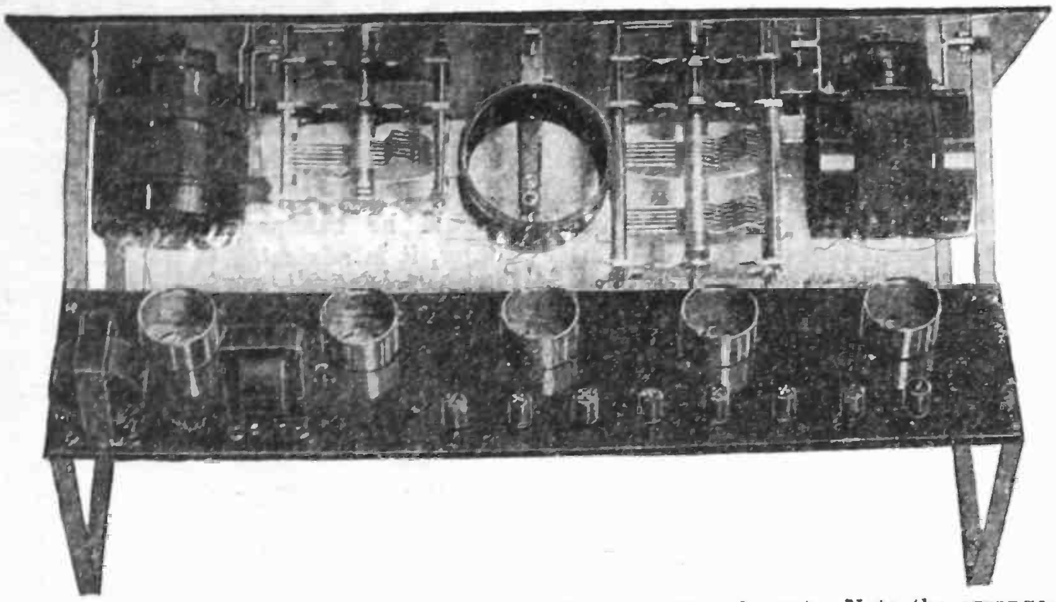
diameter and about 3 inches long. The wire should be number 24 double silk covered. About a half pound of wire will be sufficient. If you are going to neutralize the circuit the primary and secondary should be wound in the same

latter should have seventy-seven turns. It is necessary to make three coils for the circuit.

The brass brackets for mounting the sockets and transformers are made from strip material about thirty inches long, one-quarter inch wide and one-quarter inch thick. Before bending the brass it is necessary to lay out the dimensions to scale and then place in a vise and bend as sharply as possible. The strip for mounting the sub-panel for the sockets and transformers should be of rubber or bakelite, the thickness being a matter of choice. This strip should be eighteen and a half inches long and four inches wide. This sub-panel should be used for mounting the sockets, audio frequency transformers and the binding posts.

Make three small brackets for mounting the radio frequency coils on the main panel. The main panel should be nine by twenty inches. On this panel mount the General Instrument Duo condenser and the single condenser. All of the condensers should have a capacity of .0003 mfd.

Also mounted on the main panel are the Carter switch, the Frost jack and the General Instrument rheostats.



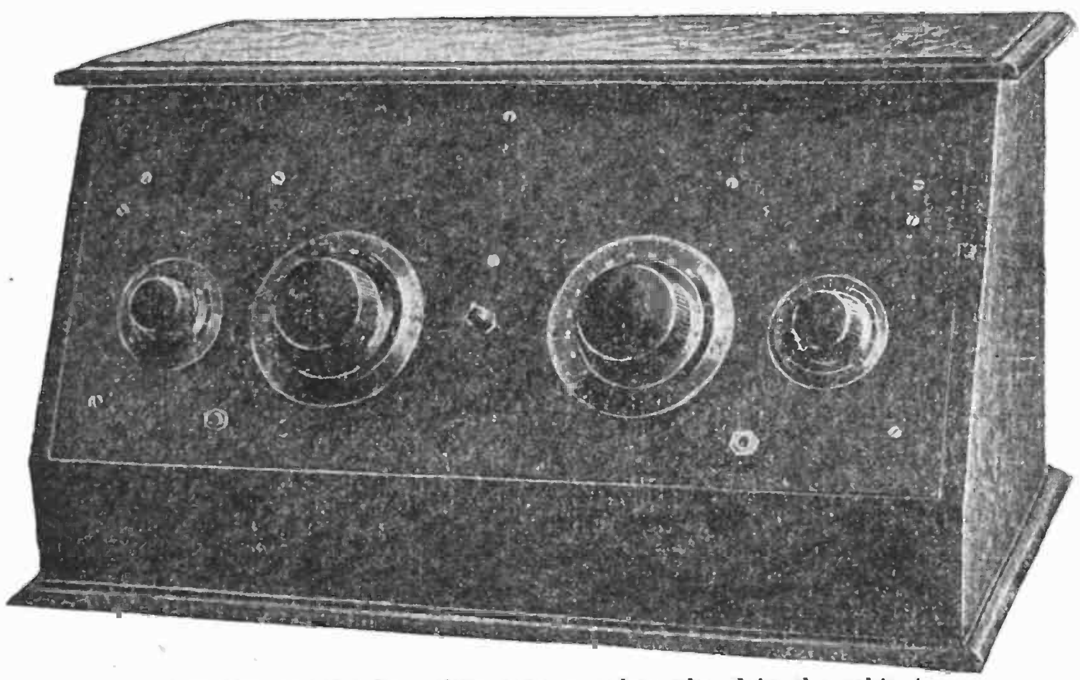
A top view of the receiver showing the general construction layout. Note the arrangement of the coils. The coils in this set were wound on bakelite tubing.

The tone quality of the Duotrol circuit will please the most critical music lover, and speech and music are produced with remarkable fidelity. The Rauland Lyric audio frequency transformers work particularly well in this circuit. They are efficiently designed and amplify all the tones in the musical scale.

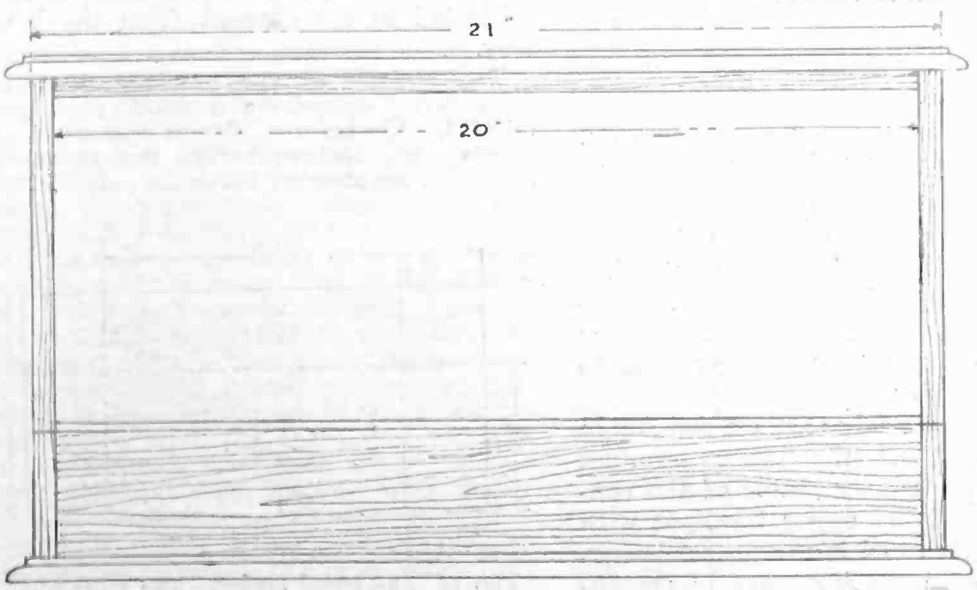
Building the Duotrol in a Slope-Panel Cabinet

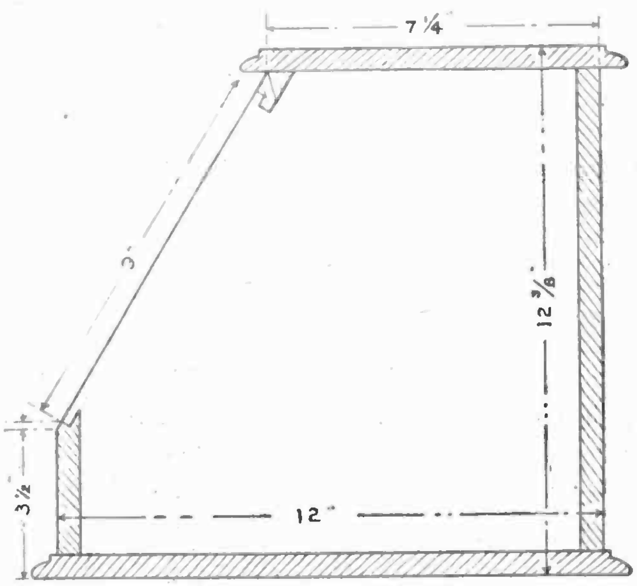
In the foregoing description constructional details of this circuit have been described in full. However, the layout was made laboratory style on an exceptionally wide baseboard and it is doubtful if many readers would care to build a set with such a large sub-base and one which would not fit into a standard cabinet.

It will be observed from the photos accompanying that several changes are made in the parts, particularly in additions. Now let us first consider the radio frequency coils. If one desires to



How the completed receiver appears when placed in the cabinet.





Front and side elevation views of the slope-panel cabinet giving dimensions for building. The front view shows space allowed for the panel.

neutralize this circuit the standard neutrodyne coils may be used successfully. Should the reader desire to build the coils as shown in the photos of the slope-panel set, the following are the specifications: Three pieces of tubing 3 inches in

direction and if the set is not to be neutralized then the primary and secondary should be wound in the reverse direction. The primary should have nine turns, then leave about one-sixteenth of an inch and start the secondary. The

One rheostat is used to control the amplifier tubes and a separate rheostat control is used for the detector.

The reader will note that one of the illustrations shows the General Instrument Duo condenser is mounted to the left in place of to the right as in our first receiver. This is done in order to get short leads to the radio frequency tubes. The antenna tuning condenser is then mounted to the right and we need not worry much about the length of these leads. However, under all conditions avoid parallel leads and make them as short and direct as is possible.

When the completed assembly is placed in the cabinet one will find that the brass supports are within about a half inch from touching the floor of the cabinet. This half inch has been allowed so that a small board about the size of the sub-panel can be screwed to the bottom of the brace supports so that it will have some extra support and make the mounting very much more solid.

If one assembles this receiver with care the finished job will be one that is fit to grace any home and aside from being good looking in appearance it will give satisfaction in operation. Should the reader desire good equality, above all means select the best in audio frequency amplifying transformer, and I advise that one try a C battery for the best results. The C battery will aid greatly in preventing the overloading of your tubes and will round out the quality of the music and voice.

Making the Cabinet.

A working drawing of the Duotrol slope-panel cabinet is illustrated herewith. The fluting and beads are not shown in detail because the reader's taste will vary on this subject. The wood for the cabinet should be of mahogany, walnut or some other hard wood. One should avoid the use of soft or gum woods, because they not only will crack but will warp. The measurements shown in the illustration are over all and on the smaller details the reader will have to use his own judgment. Before assembling the cabinet the pieces should be sandpapered. After assembling, it is advisable to go over the cabinet with pumice stone to get a smooth finish. Then put on the stain and when the stain has dried thoroughly the cabinet should be gone over with wax.

How to Build a Two-Tube Loudspeaker Set

(Continued from page 42)

The crystal detector N now can be wired. The lower terminal of it is connected with the stator plates of condenser F and the other terminal goes to the nearest primary binding post of transformer I. The remaining primary terminal of transformer I goes to the rotary plates of condenser F.

If you are building the complete two-tube set, the next wiring is to connect up transformer J. The grid terminal of this transformer goes to the grid terminal of socket M; the filament terminal of J is connected with the wire from binding post No. 3. Now screw coil CD in place and run a wire from the upper terminal of coil C to the lower lug on jack O. After this you can connect the second from the bottom lug of jack O with the plate terminal of transformer J, and the next to the top lug of jack O with the plus B terminal of the transformer J.

Now run a wire from the plate binding post of socket L to the other terminal of coil C, and from the wire running from the jack to this coil, connect the fixed condenser G over to the wire from binding post No. 3 at any convenient point. See Fig. 6. Be sure that the condenser G is connected with the jack side of the coil, for if you connect it with the plate side, the receiver will not work at all.

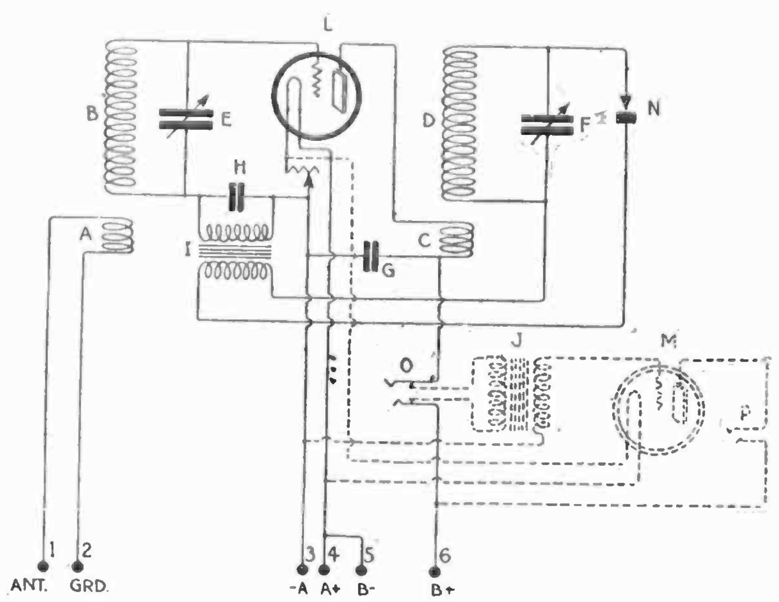


Fig. 6. The wiring diagram. The solid lines indicate all the connections for a one-tube set. The dotted lines show the additional wires necessary for two tubes.

Coil D can be connected with condenser F, the lower terminal going to the stator plates, and the upper terminal to the rotary plates.

Now you are ready to place coil AB in position. Connect the lower terminal of B with the rotary plates of the condenser E, and the upper terminal with the stator plates of the same condenser. The last two connections are to the antenna and ground binding posts, Nos. 1 and 2, from the terminals of coil A.

You will note that no instructions have been given as to the direction of the winding of the coils with relation to each other. It makes no difference which way they are wound. Likewise, the specific terminal connections to transformer I have not been given, for it is well, in this circuit, to try reversing the primary connections to this transformer.

In many reflex circuits there are a number of factors that may spoil its operation. In this set there is just one point to watch out for, and that is the number of turns in coil C. Too many turns will cause the receiver to squeal on the lower wave lengths. Too few turns will make the receiver not sensitive.

With an adjustable crystal at N it is easy to tell when you have everything right, for the receiver should squeal continuously when the catwhisker is not in contact with the crystal, and should disappear when the whisker makes contact.

It might be well to point out here that any type of crystal suitable for use in a plain crystal circuit will work perfectly in this receiver, since the crystal is not subjected to the current from the battery.

The success of the receiver depends to a large extent on a good, sensitive crystal. Therefore, if you use a fixed crystal, try several before you start to alter the number of turns in coil C.

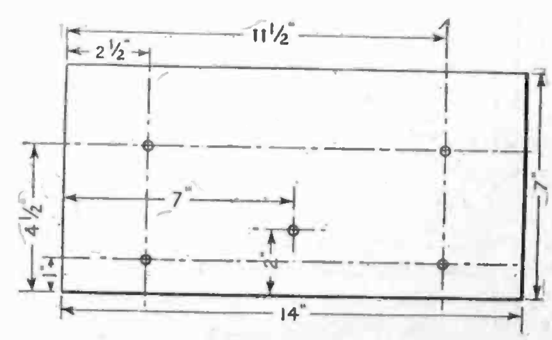


Fig. 7. The panel layout. The holes are for the rheostat and for the jacks. If screws are needed to support the condensers, use the templates furnished with them.

Ninety volts is about right for the B battery, but in actual test, excellent signal loudspeaker strength was obtained with two 1½-volt dry-battery tubes and only 48 volts of B battery.

Tuned Radio Frequency Circuits

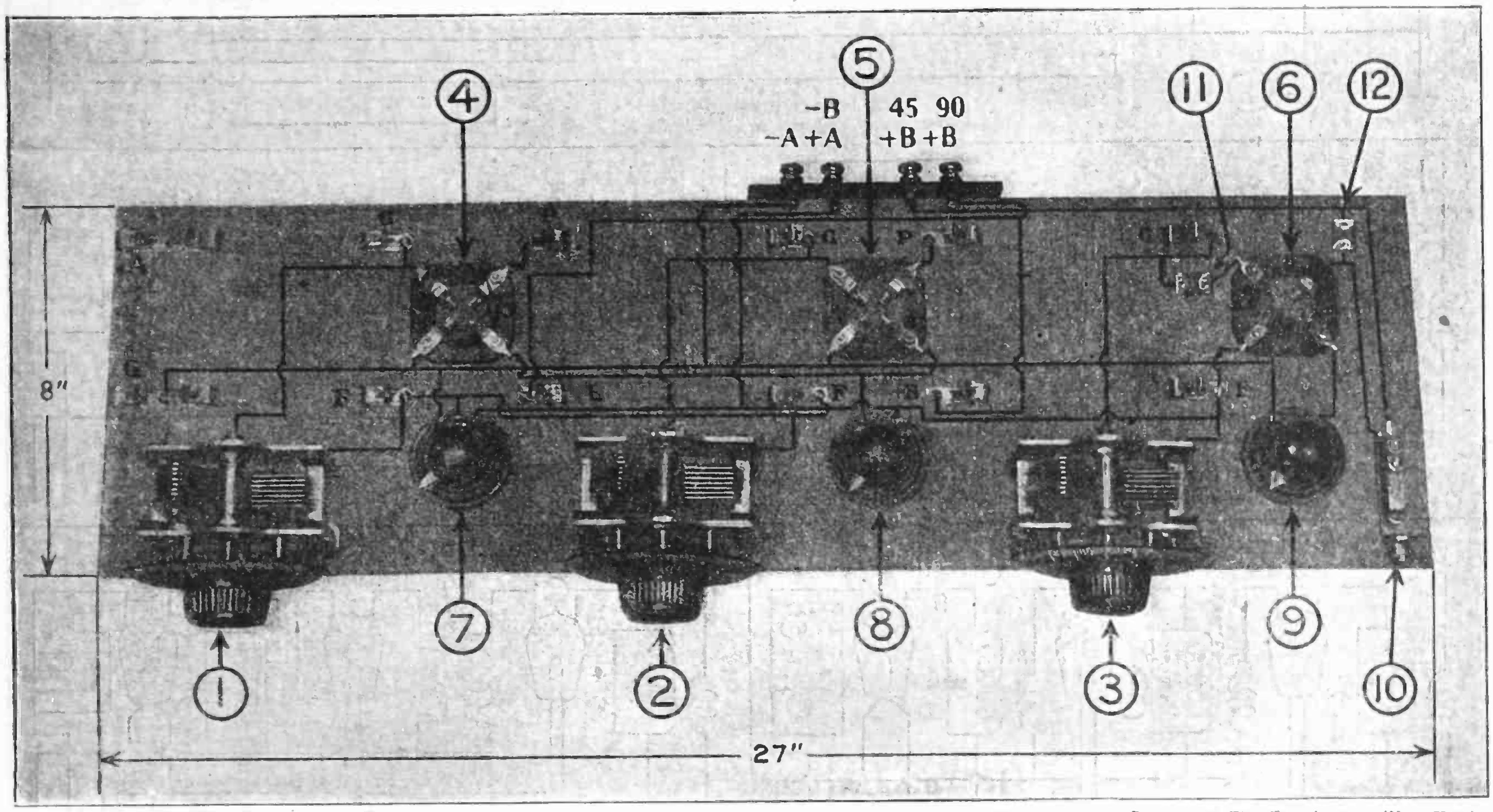
THE popularity of five-tube tuned radio frequency receivers was caused by a very peculiar patent situation. Heretofore regenerative receivers have been considered the most efficient and practical for broadcast reception, but the majority of manufacturers were unable to obtain licenses for manufacturing these sets, and fortunately for the public they were forced to turn their attention to other ideas. The only loop hole seemed to be in tuned radio frequency amplifier circuits.

In *The Experimenter, Clyde J. Fitch* explains a number of tuned radio frequency circuits, giving experimental construction details for trying the circuits.

While this type of circuit employs five tubes and is no more sensitive than a three-tube regenerative circuit, it has many advantages that make it ideal for broadcast reception. The main advantage is non-radiation. If all the five-tube receivers in use today were changed over to three-tube regenerative sets, it would be virtually impossible to receive radio concerts. The noises from these small receivers would drown out everything. Another ideal advantage of the tuned RF receiver is that the three dial settings are practically the same, within one or two degrees, and stations are easily logged. Tuning is also simplified. Thus we see that due to monopoly caused by the patent situation the radio public has benefited considerably and the small set manufacturers have profited.

In order to interest the experimenter in working along these lines, we are giving complete details of a simple experimental hook-up board for testing different transformers and circuits. A number of radio frequency transformers that have made their appearance on the market together with several RF circuits are also shown.

The illustrations clearly indicate the construction of the test board. The experimenter will note that only three sockets are used. With this arrangement we obtain two stages of radio frequency amplification and detector. By plugging the phones in the detector jack, comparisons of different circuits and transformers can easily be made. The filament connections of the circuit are wired permanently. Four Fahnestock clips are provided for each socket for connecting the coils. All wiring is made with No. 20 D.C.C. wire underneath the board. The illustration shows the connections in full for clearness.



Illustrations by Courtesy of The Experimenter (New York)

An experimental hook-up board for testing tuned radio frequency circuits and transformers. The transformers to be tested are connected to the spring terminals lettered P, +B, G and F. The numbers designate the following instruments: 1, 2, 3, tuning condensers; 4, 5, 6, sockets; 7, potentiometer; 8, 9, rheostats; 10 Jack; 11, grid condenser and leak; 12, by-pass condenser.

The following parts were used:
- **1 Soft wood board, 8 x 21 x ⅝".**
- **3 Freshman 15-plate condensers.**
- **3 Cutler Hammer tube sockets.**
- **2 Rasco 30-ohm filament rheostats.**
- **1 Rasco potentiometer.**
- **1 Single circuit jack.**
- **1 Binding post strip with 4 binding posts.**

The main trouble in all receivers of this class is due to coupling between the circuits causing oscillations. In order to obtain amplification it is necessary to prevent the circuits from oscillating. Several methods have been used for doing this, but only a few are satisfactory. In order to prevent feed-back coupling between the circuits, we must first understand where the feed-back occurs. Feed-back in the electrodes of the vacuum tube cause the most trouble. The grid and plate electrodes form a small condenser which couples the plate circuit to the grid circuit and causes oscillations. By means of a bridge connection it has been possible to neutralize this tube capacity, and the circuit is successfully used in neutrodyne receivers.

Feed-back also occurs between the coils themselves. The magnetic and electrostatic fields of the coils extend far out into the surrounding space, and energy is fed from the plate circuits to the grid circuits and oscillations are produced. In the neutrodyne type of receiver, feedback between the coils has been reduced by mounting the coils at such an angle that their fields have no effect. The type of coil used in neutrodyne is shown at A in Fig. 10. The details of the coil are given so that the experimenter may construct them. B shows a similar coil except that it is of the low-loss construction. The wire is supported by thin strips of insulating material instead of being wound on bakelite tubes. The coil shown at C is also of the low-loss construction. It is stagger wound. The experimenter may wind these coils on a suitable form, after which they may be removed, tied with a string and the wire cut in two places at the center so as to form the primary winding.

Spider-web coils may be used also. This type of coil is shown at D. It may be wound in the same manner as the stagger wound coil with the winding cut in the center in two places so as to form the primary. Coils C and D being smaller in size than coils A and B, have a smaller external field and consequently do not have as great a tendency to cause oscillations. Coil E is of interest in that electrostatic coupling between primary

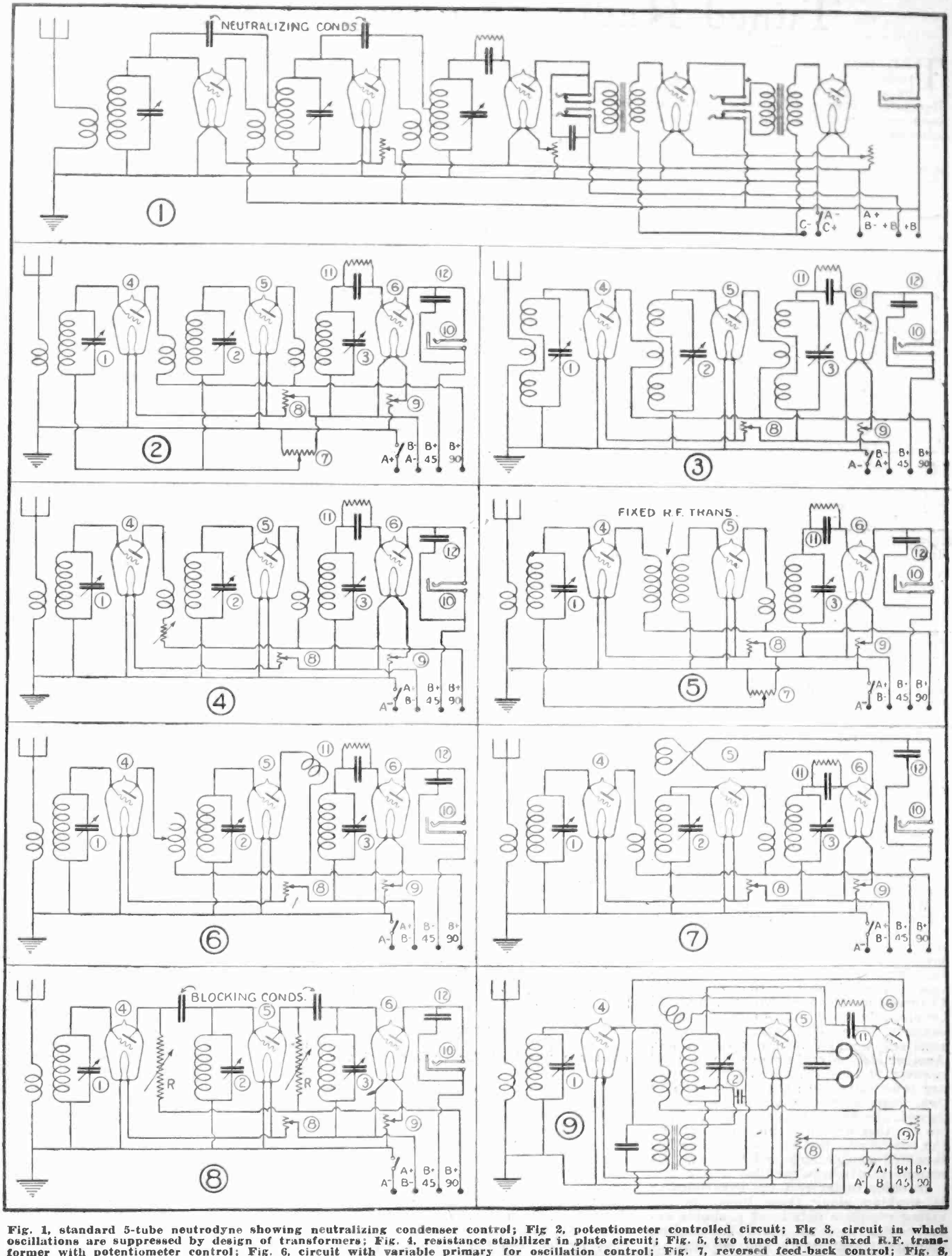


Fig. 1, standard 5-tube neutrodyne showing neutralizing condenser control; Fig 2, potentiometer controlled circuit; Fig 3, circuit in which oscillations are suppressed by design of transformers; Fig. 4, resistance stabilizer in plate circuit; Fig. 5, two tuned and one fixed R.F. transformer with potentiometer control; Fig. 6, circuit with variable primary for oscillation control; Fig. 7, reversed feed-back control; Fig. 8, resistance coupled circuit; Fig. 9, tuned reflex circuit.

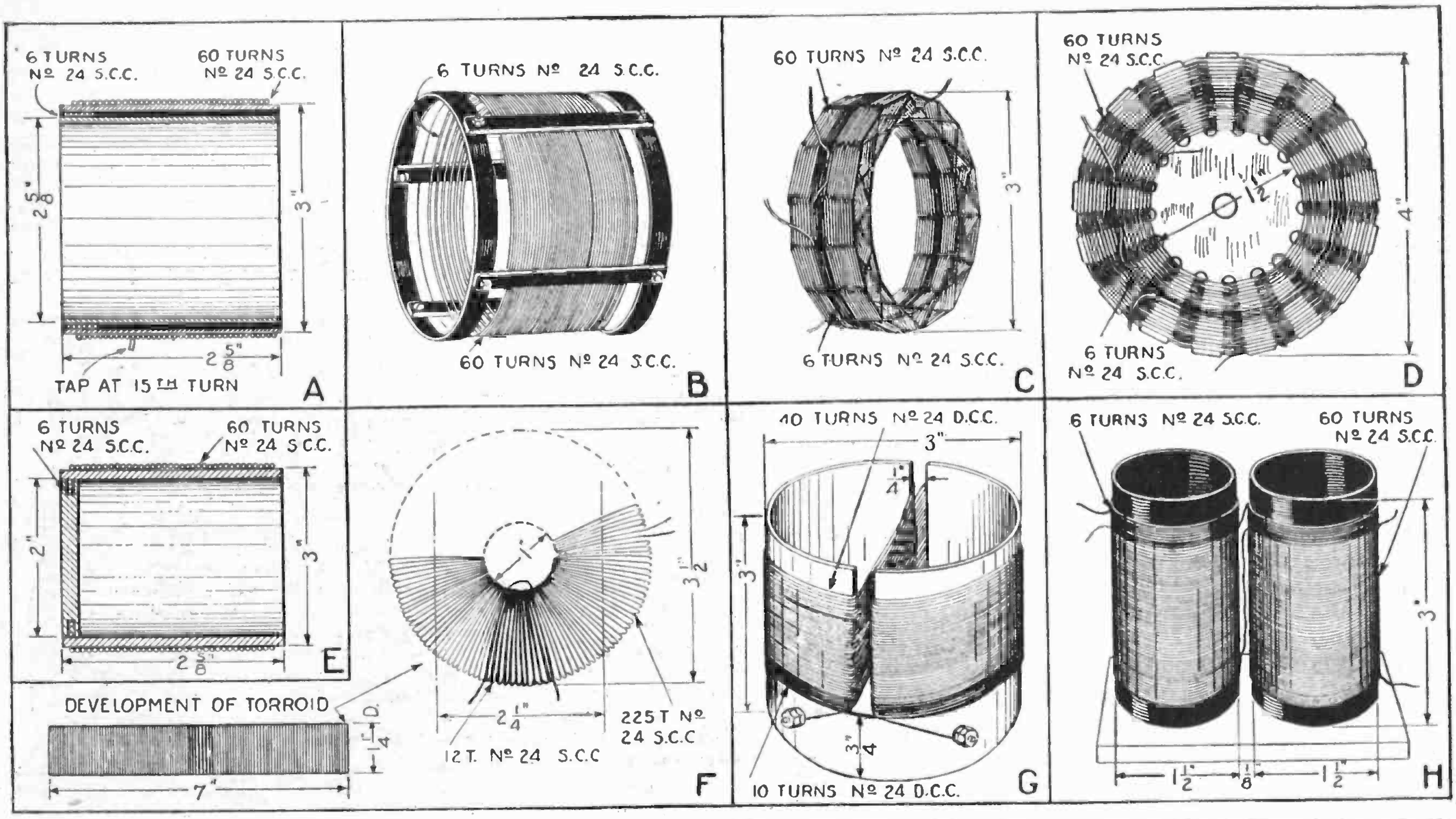
and secondary winding is considerably reduced by winding the primary in the form shown. Greater amplification is obtained because more primary turns can be used without oscillations. The coil shown at F has no external field at all. It is wound torroidal shape so that the entire magnetic field is inside. This type of coil looks like a doughnut. It may be placed in any position or in the vicinity of metal objects without causing any noticeable effects in the circuit. The experimenter may make these coils by winding the wire in one layer on a tube.

Neutrodyne Circuit

The full page of diagrams shows a number of radio frequency circuits. Fig. 1 shows the complete five-tube neutrodyne circuit. This comprises two stages of radio frequency amplification, detector, and two stages of audio frequency amplification. In the other circuits only three tubes are shown, as the connections of the two-stage audio amplifier are the same in each case and have been omitted. Coils A, B and E may be used successfully in the neutrodyne circuit. These works comparatively well throughout the entire range without oscillating. The design of the coils, therefore, must be such that they do not feed back energy from one circuit to the other. The coils shown at C, D, F, G and H have been successfully used in the circuit.

Plate Circuit Stabilizer

Fig. 4 shows the circuit used in the Deresnadyne receiver. This circuit is the same as the one shown in Fig. 3 except that a variable resistance is connected in the plate circuit of the first



Various designs of radio frequency transformers coils that are now used in many commercial receivers. Note that the tendency is towards the use of low loss self-supporting windings with low external mganetic fie'ds. The experimenter can easily try the various coils on the hook-up board.

Gummed paper is then stuck along one side of the coil and it is removed. The winding is then bent around in the shape shown and securely fastened. In this case a few of the turns are cut out for the primary. The "D" coil shown at G gives a similar effect. The wire is wound figure 8 fashion on a tube having two slots. Thus the magnetic field goes through one-half of the tube and back the other and does not extend far out into space. H represents a similar coil except that it is wound on two separate tubes placed close together.

A study of these coil designs shows that the object is to produce a coil that will not cause feed-back between the circuits. If we have much feed-back the circuits will oscillate, and in order to prevent them from oscillating, we have to decrease the number of turns in the primaries of the transformers and this, of course, decreases the amplification. By designing our coils and mounting them so that very little feed-back occurs, we can use a greater number of primary turns and obtain greater amplification. As amplification without oscillation is required, extreme care should be taken in constructing the coils. The experimenter should try various sizes and shapes of windings, and in that way he may produce a coil that will allow the use of the entire amplification factor of the tube.

coils are tapped at the first 15 turns for neutralizing purposes. The neutralizing condensers are shown in this diagram. When properly neutralized, this circuit gives very high amplification.

RF Amplifier With Potentiometer Control

Fig. 2 shows one of the first tuned RF amplifier circuits that has ever been used. To prevent oscillations, a potentiometer is used. This changes the grid potential of the amplifier tubes, and with its use they may be operated on any portion of their characteristic curves. This is a very poor method of control, as in order to prevent oscillations, the potentiometer must be adjusted so that the amplification factor of the tubes is reduced sufficiently. While this method controls oscillations, it reduces the amplification considerably and results are comparatively poor.

Tuned RF Without Control

The circuit shown in Fig. 3 is used in many of the five-tube sets now on the market. No control is provided for stabilizing the circuit. The design of the transformers is such that as many turns as possible are used in the primaries so that the circuit does not oscillate on the lower settings of the condenser dials. In this way the set tube. Assuming that the circuit oscillates with the resistance shorted, we can easily understand that by adding the resistance a certain value will be reached where oscillations cease. This resistance may be in the order of 4,000 or 5,000 ohms. A Bradleyohm No. 10 may be used.

Tuned RF Circuit With Fixed Transformer

In order to reduce the number of tuning controls, a fixed transformer that covers the entire broadcast range may be used for one of the amplifiers. A Rasco transformer works very well. The connections are shown in Fig. 5. Any of the above methods of stabilizing the circuit may be used. Although the selectivity is not quite as great as when using three tuned circuits, the amplification is about the same and tuning is simplified.

Tuned RF Circuit With Variable Primary

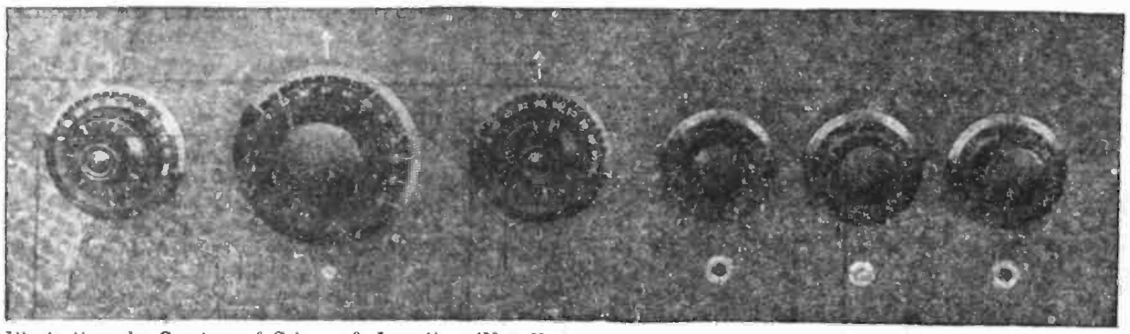
Another idea that works very well for controlling oscillations is shown in Fig. 6. Two of the RF transformers may be any of those shown in Fig. 10. The other transformer connected to the detector tube has variable coupling between the primary and secondary. Therefore, instead of reducing the number of turns of the primary until oscillations cease, the coupling between primary and sec-

(*Continued on page* 57)

A Four-Tube Distance Getter

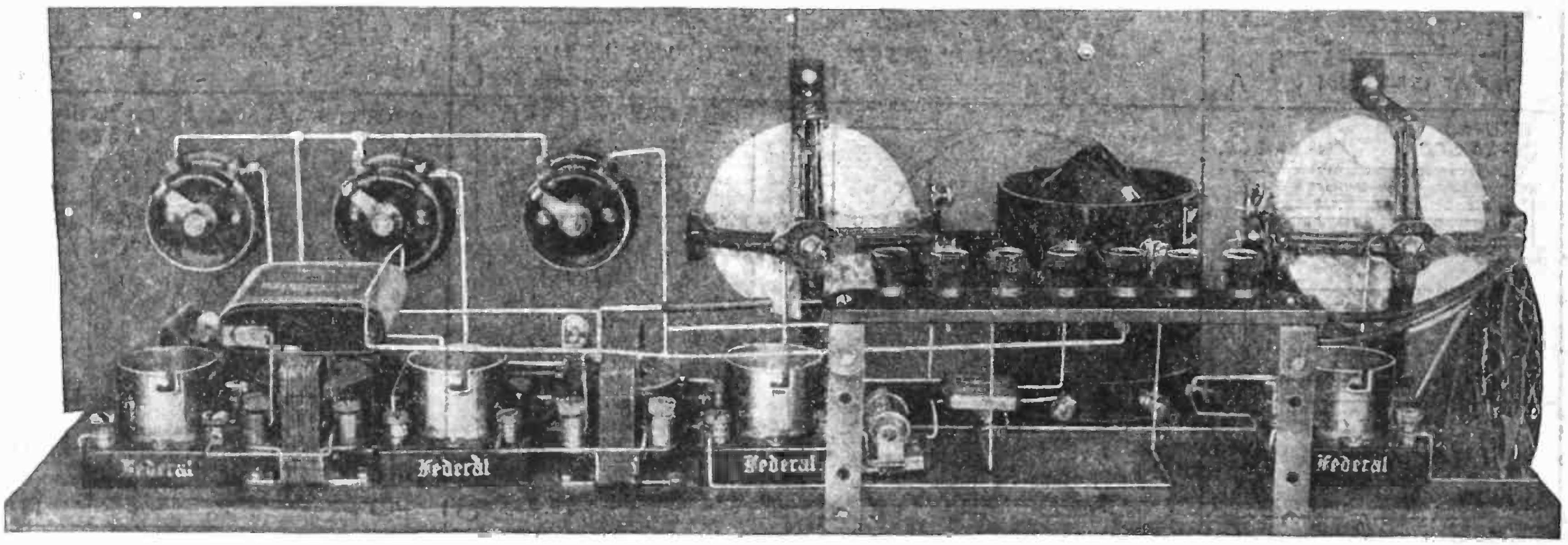
THE set illustrated herewith consists of one stage of tuned radio frequency, regenerative detector and a two-stage audio frequency amplifier. *Sidney E. Finkelstein* described this set in a recent issue of *Science and Invention* as follows:

The one who has completed his first single tube regenerative receiver and who wishes to add to its distance-getting ability and volume, will do well to follow the suggestions incorporated in this article. A 7 x 24 in. panel accommodates all the instruments without crowding and allows vation. Two .0005 mfd. variable condensers, four standard sockets, three rheostats, one vario-coupler and spider-web coil, three fixed condensers, one grid leak, two audio frequency transformers, two jacks, one filament switch and the necessary binding posts complete this receiver. As will be seen in photo, most of the connections go to binding posts, thus requiring a very minimum of soldered connections, as soldering goes to make the assembling of a radio set a disagreeable job. Material of recognized quality is used in its construction. This has much to do with the production of really satisfactory sets. The first step to take is to lay out the panel and mount all the instruments. The filament circuit is then wired completely; this is clearly depicted in the diagram. Consistent good work in wiring the rest of the circuit, keeping in mind the importance of making the connections as short as possible yet spacing

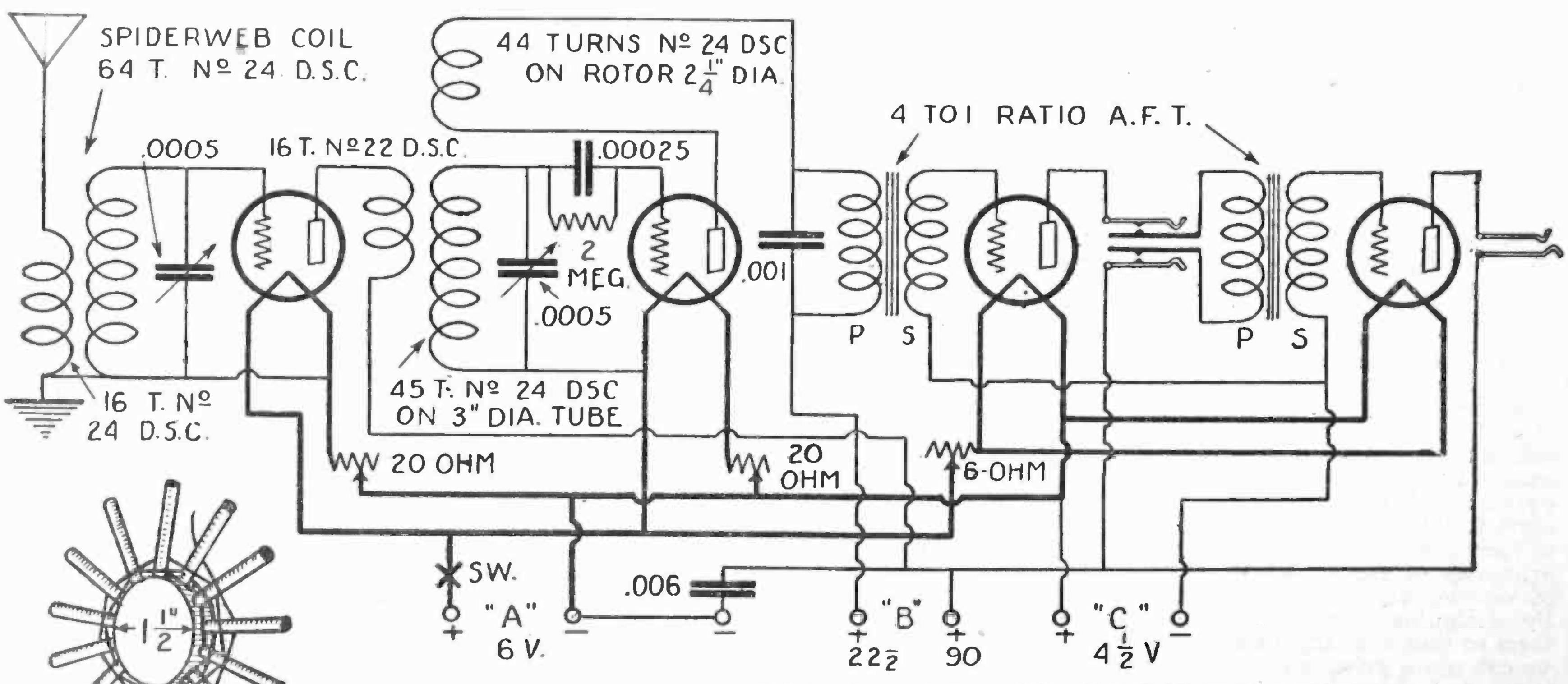


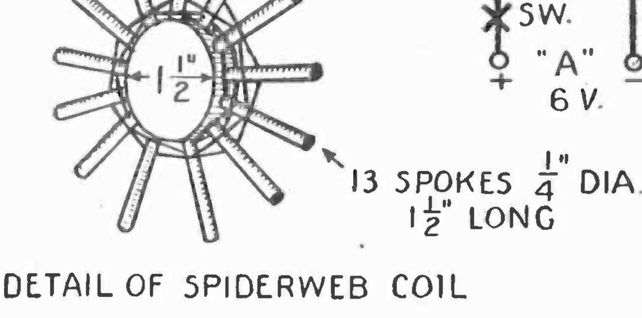
Illustrations by Courtesy of Science & Invention (New York)

Note the pleasing appearance of the grained panel and the symmetrical lay-out of the apparatus. While six controls are shown, only two are required for tuning, with an optional dial for regeneration.



Panel and baseboard layout of the set described herewith. Most all the connections are made to screw binding posts, thus avoiding soldered contacts.





Wiring diagram and details of the spider web coil.

room for doing a neat wiring job, which is necessary for good results. Vernier dials are used with the two tuning condensers. Simplicity is the keynote of this set. The list of parts becomes apparent upon casual observation. them apart so as not to introduce undesirable losses, will, when one's work is completed, give the results to be desired. If wanted, although it is not necessary, a double circuit jack can be placed in the detector circuit.

The Three-Tube Graphodyne

How to Build It

THE three-tube Graphodyne receiver, the photographs of which appear herewith, is the result of many weeks of experimenting by the staff of the *N. Y. Evening Graphic* Radio Laboratories. The description of the set as given herewith by *William M. Henderson* appeared in the radio section of that newspaper. The set combines the acme of selectivity, distance reception, good volume and tone qualities. Therefore every desire a radio fan may have will be satisfied by this receiver.

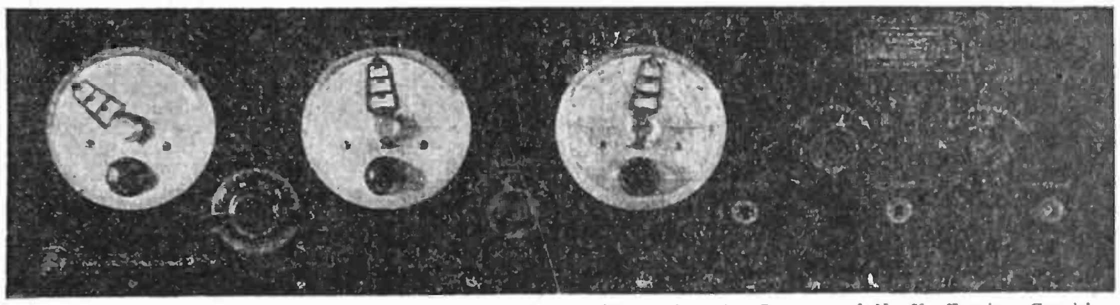
A schematic diagram of the one-tube set is shown in Fig. 1. This is without the addition of two stages of audio frequency amplification.

For the readers' convenience a complete list of parts for the three-tube set is given as follows:

List of Parts Required

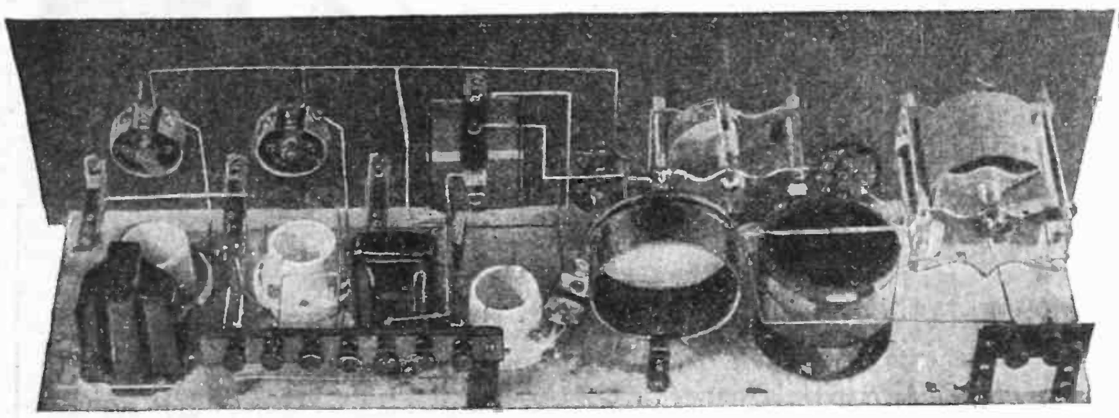
The list of parts necessary for the construction of a three-tube Graphodyne is as follows:

One 7 by 26-inch panel.
One 7 by 25-inch baseboard.
One composition tube, 3¼ inches in diameter by 2½ inches long.
One composition tube, 3¼ inches in diameter by 1⅝ inches long.
One composition tube 2¾ inches in diameter by 2¼ inches long.
One composition tube 1¾ inches in diameter by 1 7/16 inches long.
One brass rod ¼ inch in diameter and 2½ inches long, threaded at one end for a distance of ¾ of an inch.
One brass rod ¼ inch in diameter and 1¼ inches long, threaded at one end for a distance of ½ inch.
Two brass angles for mounting coupler to panel, shown in Fig. 4.
Three Vernier dials.
One rheostat, resistance to fit tube used.
Two double circuit jacks.
One single circuit jack.
One .00038 mfd. variable condenser.
One .001 mfd. variable condenser.
One panel mounting inductance switch.
Seven binding posts.
One battery binding post strip.
One aerial and ground binding post strip.
Three sockets.
Three tubes, either UV-201A, UV-199, UV-200, C-301 A, C-299, C-300, C-12, WD-12 or Sodion D-21. Soft tubes and Sodion for detector only.
One .0005 mfd. fixed condenser.
One .00025 mfd. grid condenser with leak mounting.
One .002 mfd. fixed condenser.
Two brass angles for coil mounting.
Miscellaneous screws and bolts, batteries, phones, aerial, ground, six nuts to fit threaded brass rods and one ½ pound spool of No. 26 s. s. wire.



Illustrations by Courtesy of N. Y. Evening Graphic

Front panel layout of the Graphodyne receiver. Vernier dials are used in order to obtain careful adjustment of the tuning controls.



Rear view of the set showing the position of parts on the panel. The binding post strip is mounted directly on the back of the baseboard.

Coil Construction

The first step in the construction of this receiver is the winding of the coils. Two of these coils are easy to make; the coupler is slightly more difficult. It is possible for those who would rather buy the coupler than make it to do this, providing the wire on the stator coil is made right to cover the wave length band with the condenser. This may be done by either removing or adding wire to that on the coupler.

The first coil to wind is the large antenna coil. This is wound on the largest composition or cardboard tube. If cardboard is used be sure that it is thoroughly dried out before winding. Start winding the coil with No. 26 single silk covered wire at the very edge of tube and wind on eighty turns of wire, tapping at the thirty-fifth, fiftieth and sixty-fifth turns, as shown in Fig. 2. When the winding is finished mount one of the brass angles on the bottom of the tube for fastening the tube to the baseboard.

The next coils to be wound are the two coupling coils, as shown in Fig. 3. These are wound on the smaller 3¼-inch tube. The first coil is started on five-eighths of an inch from one end of the tubing. Seven turns of No. 24 wire comprise the first coil.

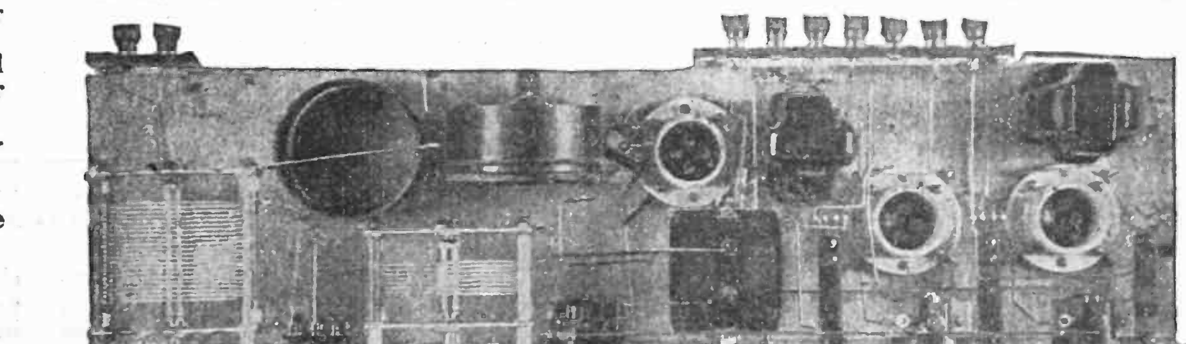
In the original model it was found advantageous to make the coupling between the first and second coils semi-variable, so that the coupling could be adjusted for the location and left set in that position. Those who do not wish to do this can make the second coil of seven turns permanently on the tube three-sixteenths of an inch from the first coil.

Making Semi-Variable Coil

For the semi-variable coil construction some court plaster will be necessary. First a strip of plaster three-quarters of an inch long is cut and laid on the tube with the sticky side up. Then the wire is started on the tube three-sixteenths of an inch from the edge of the court plaster nearest the first coil.

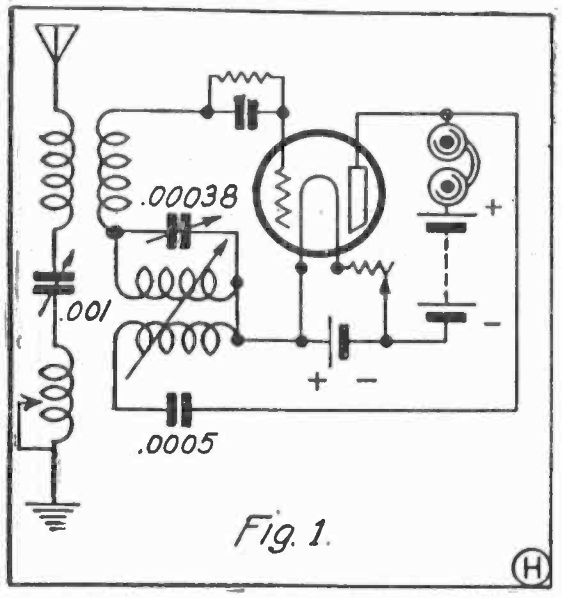
The end of the plaster is then bent over the wire and the first turn of wire is carried around the tube and laid over the end of the plaster where it folds over the start of the first turn.

Continue winding the coil until seven turns have been wound on the form. Then bend the end of the plaster strip over the entire coil. Further fastening is done by cutting three more strips of court plaster and slipping one end of it under the coil, by sticking that end onto a piece of paper and forcing the paper under the first, and then bending the plaster over the coil. These strips should be placed at four equi-distant points on the coil circumference.



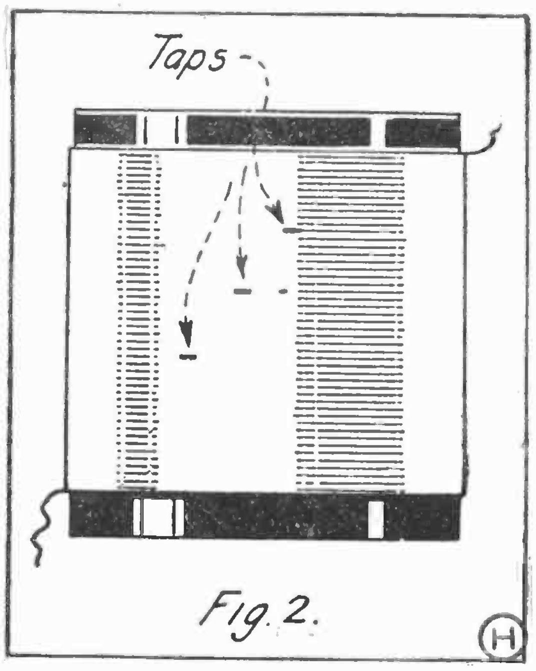
Baseboard layout of the Graphodyne set. Note the relative location of the coils and other parts.

The coupler construction had best be taken from the picture given in Fig. 4, which will give the fan a better insight



A schematic wiring diagram of a one-tube Graphodyne set.

into the assembly of this unit than a word picture would. The larger tube is wound with 35 turns of No. 26 wire on each side of the rotor coil shaft, starting the winding three-sixteenths of an inch from one edge and finishing three-sixteenths of an inch from the other.



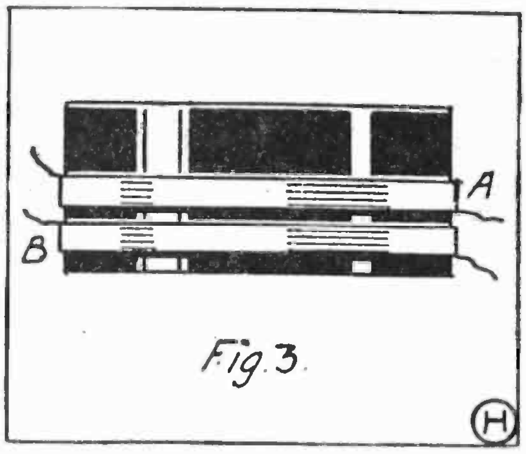
Taps are made on this coil at the 34th, 50th and 60th turns as shown.

The rotor coil consists of twenty-five turns of the same size wire wound on each side of the rotor shaft. The tubing used is the smallest tube in the list of parts. This winding is started three thirty-seconds of an inch from the edge of the tube and ends the same distance from the other edge.

These shaft holes are four inches from the bottom of the panel. The antenna condenser is three inches from the left edge of the panel. The secondary condenser is nine inches from the left edge of the panel and the coupler is mounted three inches from the right edge of the panel.

The inductance switch detector rheostat and jacks are mounted in the same line across the panel, which is two inches from the bottom. The inductance switch is centered between the first and second condensers, the rheostat centered between the second condenser and the coupler, while the jack is one and one-half inches from the left hand edge of the panel.

The first amplifier rheostat is six and one-half inches from the right hand edge of the panel, the second rheostat three inches from this panel edge. Both are three and one-half inches from the bottom. The first stage jack is three



Coupling coils used in the Graphodyne receiver.

and five-eighths inches from the detector jack and the second stage jack is three and five-eighths inches from the first stage jack.

The baseboard layout is also given in the photographs of the back and top views of the receiver. The antenna coil

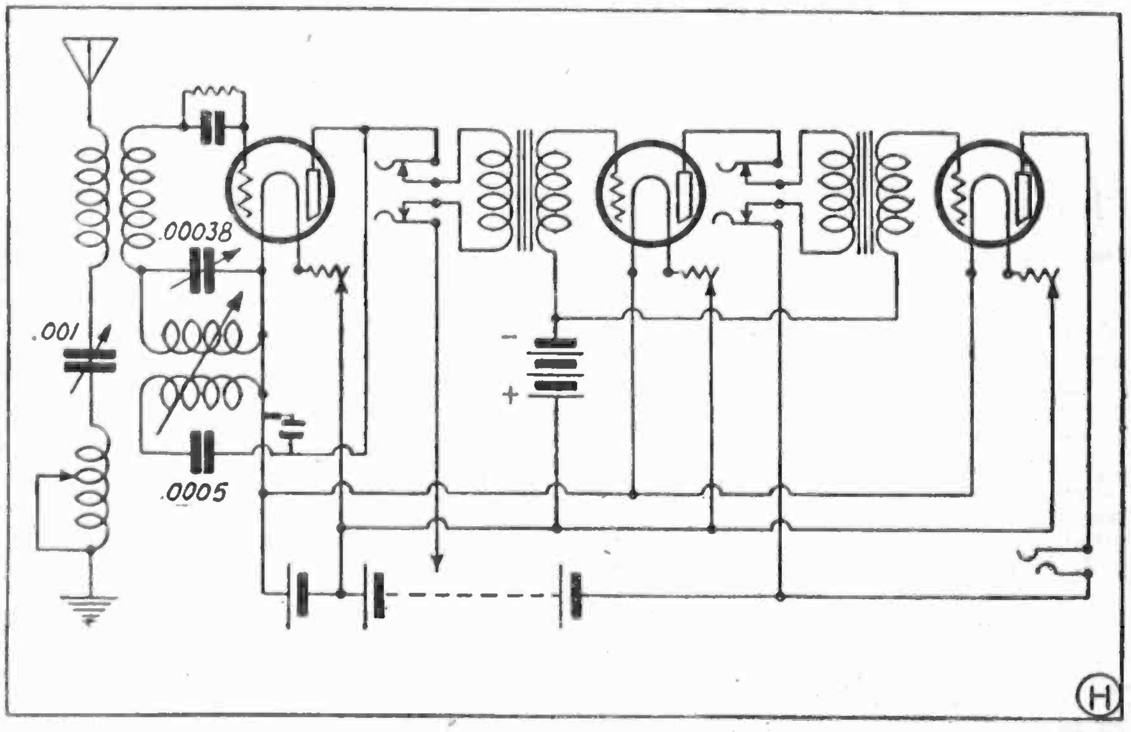


Fig. 5. Wiring diagram of the set. When making connections, follow each wire carefully according to this plan, also refer to photos of the completed receiver.

is mounted between the antenna condenser and the secondary condenser, with the taps and coil ends facing the panel. The coupling coils are mounted behind the second condenser and the tube socket behind the coupler.

It is essential that all the coils be mounted at right angles to each other, so that there will be no coupling between them to decrease the selectivity. That is why such a large panel is used.

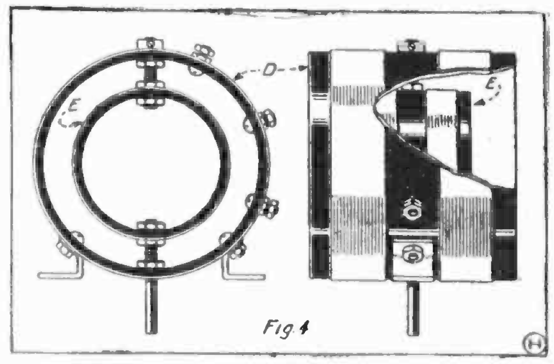
Wiring Diagram

With the parts all laid out and mounted the set should be wired according to the diagram in Fig. 5. Approximate wiring can be obtained from the back of panel photographs given on this page.

The tuning of this receiver is simplicity itself. When the batteries have all been connected and the phones plugged in, set both condensers at about fifty on the dials. Turn up the detector tube and turn the tickler dial until the tube oscillates. Be sure and set the antenna inductance switch on the last tap, thereby throwing all the inductance into the circuit. Turn the secondary condenser slowly up, following with a greater increase in the antenna condenser. A whistle will designate the approach to a station.

Using the Tickler

Then decrease the tickler coupling until the whistle ceases and retune the secondary and primary condensers until the station is brought in loudest. Then the coupling between the two coupling coils should be varied until they are as



Details of the coupler.

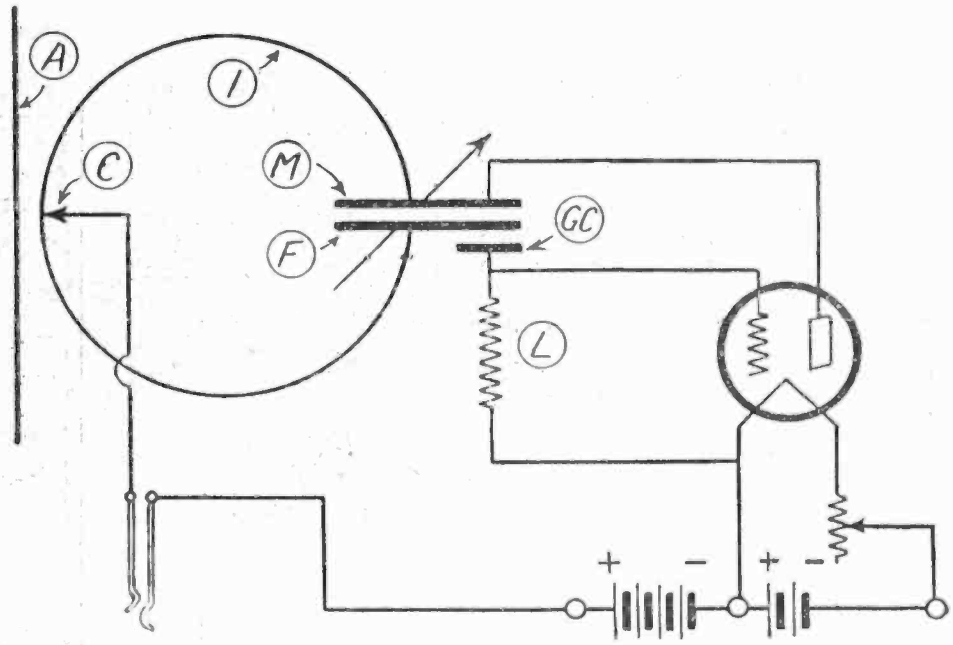
close together as they can be with good selectivity for the location and lock them in this position.

Then tune in the other local stations and make a log of the dial settings. This will greatly facilitate the finding of both local and distant stations. In tuning the set after once the local station settings have been obtained, do not force the detector tube to oscillate; that is, instead of tuning the set into station by whistles, operate the set just below the whistle and bring in the voice or music direct. The volume can then be increased by slight adjustment of the tickler coil.

How to Build an Ultra-Short Wave Receiver

THE new wave bands given to the amateurs by the last Commission present very great possibilities for experimentation and research, and it is to encourage the keen experimenters to work along these lines that we reproduce herewith some data on very short wave apparatus, as published in a recent issue of *Radio News* magazine.

The receiver shown in the various photographs covers a range of about 4.5 to 5.5 meters. This wave band may seem extremely small as compared to that of most broadcast receivers, but it should be remembered that this one meter of variation represents a band of 15,000 kilocycles. In such a band of frequencies 1,500 broadcast stations could operate; that is, more than are actually in operation in the whole world.

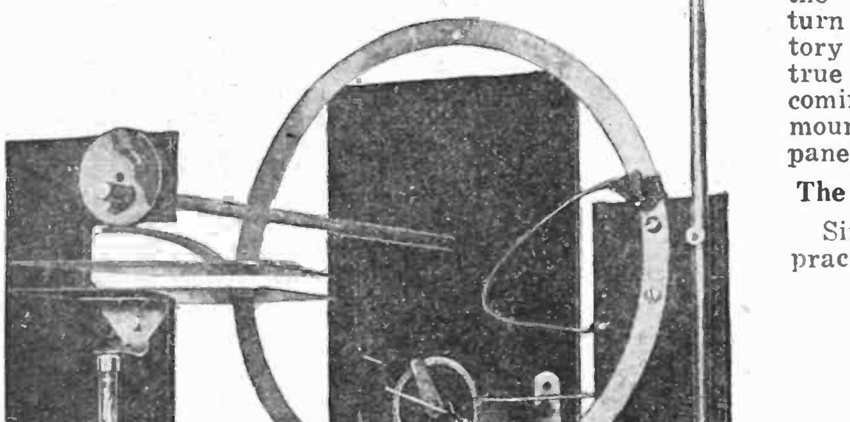


Illustrations by Courtesy of Radio News (New York)

The wiring diagram of the set. A is the antenna, C the sliding contact for controlling regeneration, I the inductance, M-F the variable condenser, GC the grid condenser and L the grid leak.

The Circuit

The circuit used in the receiver is the regular Hartley type. It is composed of a single turn with a center tap, which may be varied in order to produce regeneration or oscillations. If we consider this single turn as a coil, the grid and plate circuits are composed of one-half turn each. Shunted across this turn is a variable condenser with a minimum of dielectric in its field. It may not seem to be of very good mechanical construction, but it is simple and of good electrical design. In order to vary the capacity between the two plates forming this variable condenser a cam system mounted at the end of a long insulating rod presses on the upper plate varying the distance between the plates of the condenser.



A rear view of the short-wave receiver. Note that the two plates of the variable condenser are attached to the ends of the inductance. The cam moves the upper plate. The grid condenser can be seen directly below the stationary plate.

The Detector

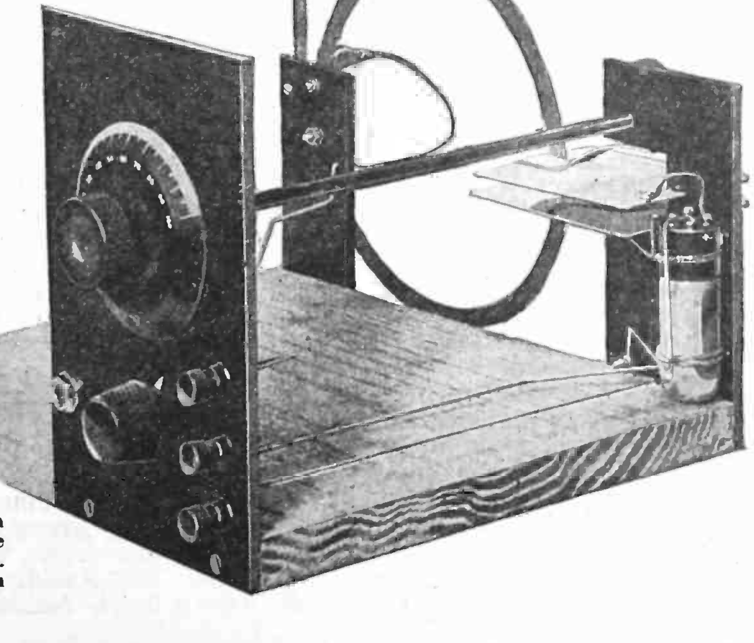
The detector tube used with this very short wave receiver should have very low internal capacity and it would be advisable to remove the base, especially if it is a metallic one. The tube shown in the picture is a UV-199 or a C-299 mounted upside-down with the leads connected directly to the plates of the condenser. The grid condenser is composed of another small plate mounted directly under and very close to the fixed plate of the variable condenser and constructed in such a way that the same piece of metal acts as one plate of the grid condenser and as the upper mounting of the grid leak. This construction provides extremely short leads, a feature which is very important in designing all short wave receivers. The filament leads are connected directly to the battery through a rheostat and should be wired so as to be at right angles with the plane of the single turn forming the oscillatory circuit. The same is true of the center tap lead coming directly to the jack mounted on the control panel.

The Antenna and Ground

Since it would not be practicable to use an antenna and ground of the ordinary type on account of their natural wave length, a single rod acting as an antenna and counterpoise is used. The center of this rod should be on the horizontal diameter line of the single turn circuit so that the upper half of the rod acts as the antenna and the lower one as the counterpoise. The coupling is provided by the proximity of the rod to the single turn circuit and may be varied by moving the rod away from the single turn to copper strip, but in the same plane. The rod should be one-half a wave length long.

The Central Panel

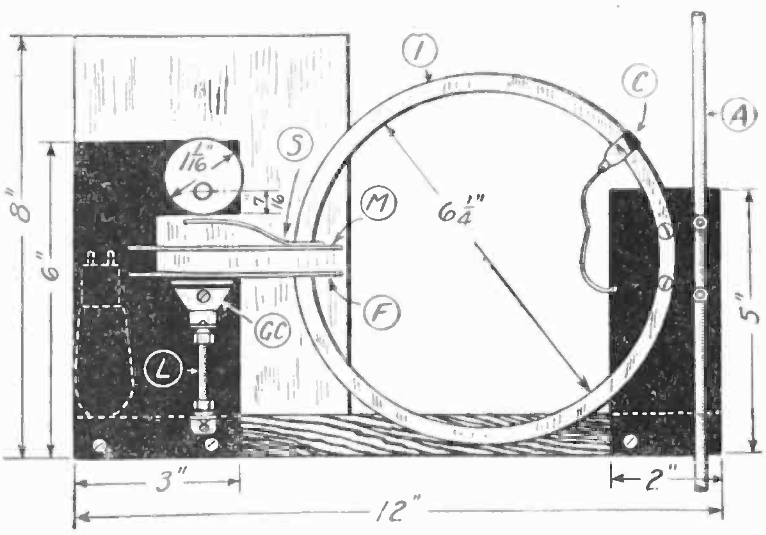
All the controls are mounted on a small panel, which is about 10 inches away from the circuit itself in order to avoid capacity effects when tuning. Since the

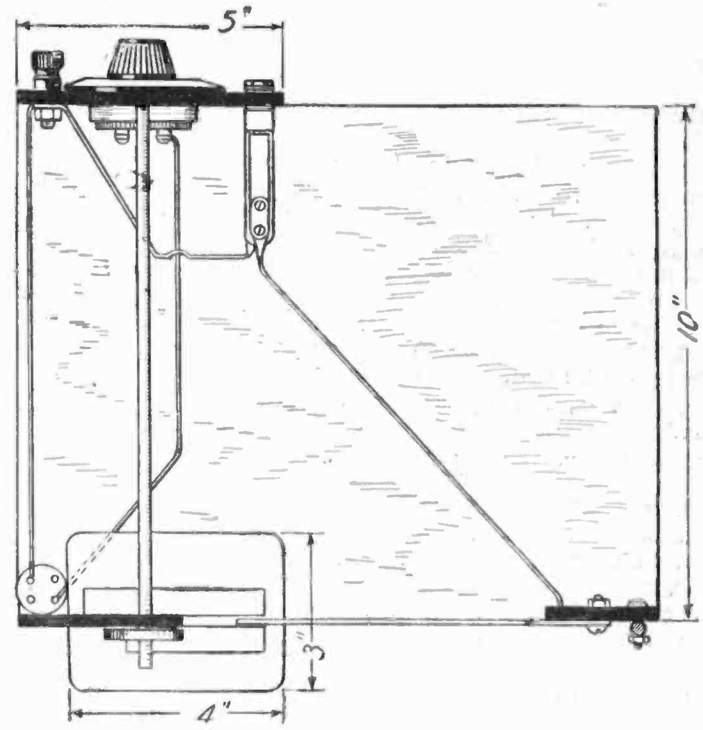


A front view of the receiver. The long shaft on the variable condenser control eliminates any possibility of body capacity effects. The UV-199 tube can be seen mounted just to the right of the variable condenser. It is inverted in order to shorten the leads to the condenser.

adjustment of the variable condenser is extremely critical, it would be best to use some form of vernier dial providing a very slow motion of the shaft when the knob is turned. There are now on the market several types of vernier controls with high ratios which would be suitable for such a short wave receiver. On the panel are also mounted the filament rheostat, the telephone jack and the binding posts necessary for the connections. The photographs and drawings clearly show the arrangement of the various parts and should make it clear for the poise rod may be a piece of small copper tubing or rod which should be stiff enough not to vibrate.

The cam and the rod used to vary the distance between the condenser plates may be of formica, hard rubber or other good insulating material. Three pieces of insulating material supporting the controls and the various parts of the circuit are screwed against the edge of a baseboard and scribed in the January and February issues of *Radio News* by Mr. Bruno for communication over short distances. The exact range of such apparatus is not yet accurately known, but it should prove very interesting to try in some good loca-





The sketch at the right shows the manner in which the instruments and the variable condenser control are placed on the baseboard. The sketch to the left gives further constructional details. The figures are the same as those used as keys in the circuit diagram of the set.

experimenters interested in the construction of such a set how to assemble the whole outfit.

Constructional Details

The single turn of the oscillating circuit should be made of fairly stiff copper ribbon such as is used in transmitting oscillation transformers. The two plates of the condenser, which are 3 by 4 inches, are made of springy copper 1-50 inch thick. The small plate used as one armature of the grid condenser is made of the same material and cut as shown in the drawing. The antenna and counter- should be of the highest grade of insulating material obtainable. As may be seen in one of the sketches the small panel supporting the vacuum tube is used also as a guide for the condenser plates which are notched so as to fit against the edge. This prevents the plates from vibrating horizontally, which would change the capacity.

Transmitting at Ultra-Short Wave Lengths

The receiver described above may be used with the short wave transmitter de- tion how far signals sent by a short wave transmitter using 5 watts of power could be heard. Short wave transmitting apparatus for use with this receiver is the "Bruno" transmitter for the purpose of experimenting.

It is absolutely essential that a Government license be obtained in order to operate a transmitter of any type. Amateurs desiring a license for a short wave transmitter for use with the receiver described in the foregoing can obtain full particulars by communicating with their local radio inspector. If *only* the receiver is used, of course no license is required.

Shielding Sensitive Receiving Sets

It seems strange that the average radio fan appears to hesitate in making use of metal shielding when building sets. Examine the more popular and most efficient manufactured receiving sets and it will be found that proper shielding is incorporated in the majority of them. Surely if the manufacturers with their expert engineering staff find it essential it behooves the fan who constructs his own set to seriously consider its advantages.

Possibly the real reason for its lack of general use is in the difficulty of purchasing sheet metal in small pieces. It is only the large hardware supply houses that carry a stock of sheet metal, and these firms are limited to the large cities. Radio stores, except in rare cases, are not handling shielding material. Fortunately, this demand is now being taken care of and standard size sheets in envelopes like panel stock are now available.

Aluminum, copper and tinfoil have been placed on the market for shielding. Unfortunately, tin foil stock does not readily adapt itself for fastening to panel stock. Sheet metal having some degree of stiffness is more convenient. This can be held in place behind the apparatus.

The question arises, *which* metal should be used? Copper is decidedly expensive and corrosion makes it turn green after a time, especially where soldering is done. Aluminum has a habit of collecting an oxide coat which detroys the good electrical contact. Furthermore aluminum does not lend itself to soldering within the limits of the fans' equipment. Magnetic metals such as iron cannot be used.

During the war nickel zinc was used to a large extent for trench mirrors. This is a pure zinc sheet metal which has been given a nickel coating, giving it a mirrorlike finish. It lends itself readily for shielding purposes, and the nickel finish decidedly enriches the appearance of the inside of the set. Connections can be readily soldered to it. The metal can be purchased in convenient sizes and is very inexpensive.

For the average use behind a variable condenser the circular shield serves the purpose. In cases where some protection between stages is desirable the shield with a flap is recommended.

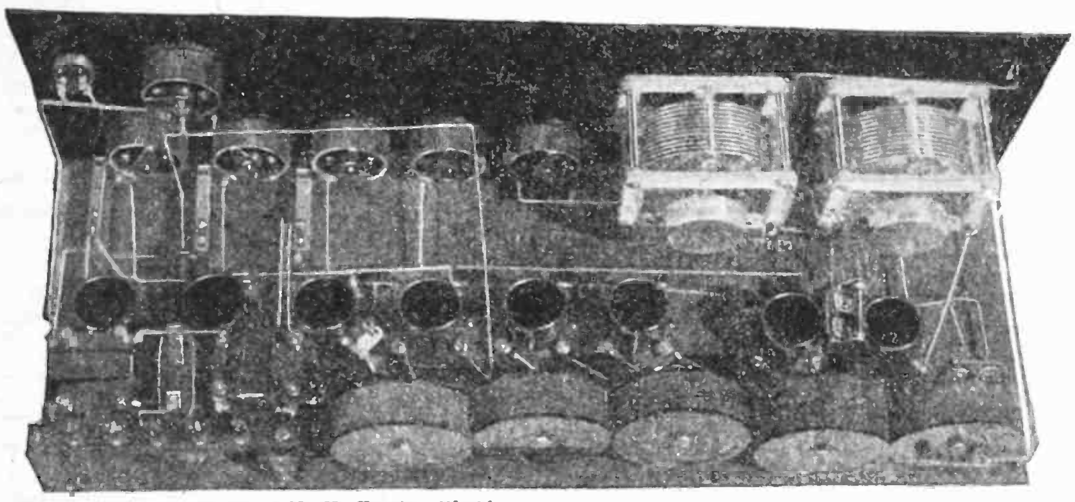
Where shielding of this sort is used it should be electrically connected to the rotor plates and on the ground side of the circuit.

A little more general use of shielding will do much toward solving the body capacity problem which is characteristic of home constructed sets. Some manufacturers are going to the extent of completely lining the inside of the cabinets in order to entirely eliminate any possible external interference. Where a cabinet is lined in this manner the shielding is as a rule directly connected to the ground terminal.—*The Sun, New York.*

The Victoreen Super-Heterodyne

A Super That Does Not Require Matching of Tubes

THE Victoreen Super-Heterodyne receiver is one of the most sensitive types of super-heterodyne sets that has been offered to the radio public. This will be fully confirmed by one who has given this



Illustrations by Courtesy of N. Y. Evening World

A top view of the assembled receiver showing compact assembly on a 7x24 in. panel.

set a thorough trial. The intermediate frequency transformers are matched within one-third of one per cent for accuracy and give ideal selectivity. Complete instructions for building this set has been given by *H. G. Silbersdorff* in *The N. Y. Evening World's Radio Section* as follows:

The numerous broadcasting stations in and around New York City cause a congested condition in the air which can only be solved with the aid of what might well be called a super-selective receiver, and this super-selectivity can only be obtained with the addition of tubes in accurately designed circuits.

The day is past for the three or four-tube receiver, retailing between $75 and $125, which is selective only in cases where a great difference exists in wavelengths. For the most part the public is willing to double upon the number of tubes if they can only get what they want—that is, knife-like selectivity and long distant stations with volume sufficient for loudspeaker operation.

Knowing that much has been written on the virtues of the super-heterodyne receiver and the extreme distances which it is said to be able to cover, there are many of us who have invested in this type of receiver, spent considerable time in its assembly and still more in learning how to operate it and, after all is said and done, many of us wonder what it was all about. Results, in many cases, showed that the set was not selective, we had trouble with harmonics, we were troubled with noise, but our main disappointment lay in the fact that the distance range of the set did not increase in anything like fair proportion to the number of tubes used, nor the drain on our pocketbooks, when comparison is made with a really good four or five-tube receiver.

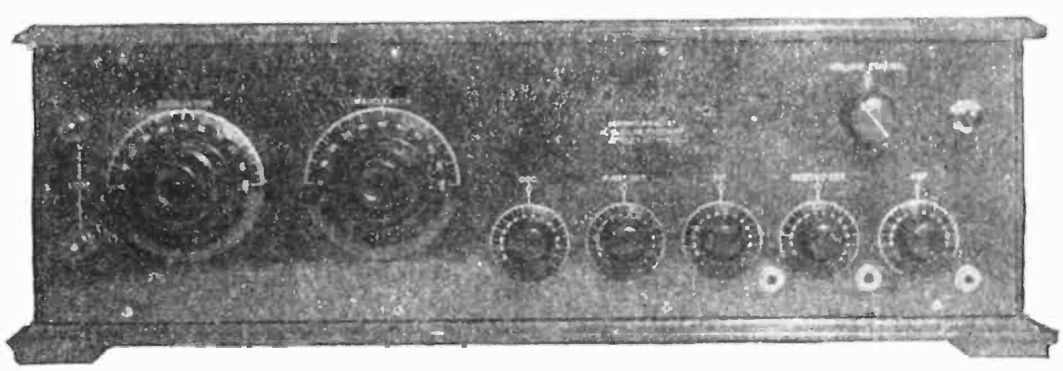
The above results were typical and from it the super-heterodyne received in general a very bad black eye.

Those who are supposed to know when asked what they think of the super-heterodyne usually answer:

"Well, I haven't seen a really good one that was constructed at home and those which can be bought completely assembled have the drawback in the matching of the tubes."

This latter remark surely is true and a big drawback, especially after matching a number of tubes and then have one of them go "West."

For the time being let us forget the matching of tubes question and get to the reason why we need so many tubes in the super, and what is gained by their use, as compared with the average four or five-tube receiver. First, we mention the oscillator tube and the two detectors; here we have three tubes already, none of which amplify. Then we require two stages of audio, which are needed in any



Showing how the receiver appears when placed in the cabinet. The panel lay-out design of this particular set shown here was made by the author.

set for loudspeaker operation, although in the case of this receiver it can be conveniently cut down to one stage of audio and the result will be a signal quite suitable for the average home. This simmers down to three tubes which are used in the intermediate frequency amplifier and, when figured numerically, it is this balance of three tubes, by which we gain selectivity, which is so important for distant reception, and an absolute necessity in congested radio centers.

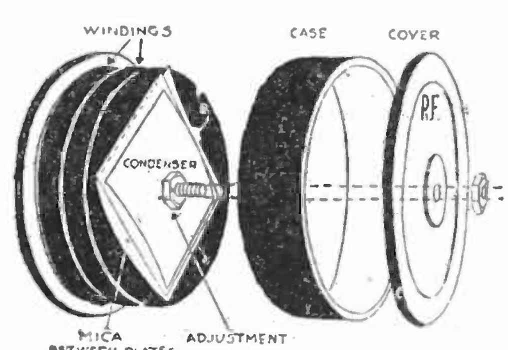
As has been said before, there are many types of super-heterodyne kits which can be purchased but when assembled, with manufacturers' instructions carried out to the last detail, will not give the results claimed for them.

It has been my good fortune to be able to try out a number of these receivers and all have been found lacking in some detail, but the one which made the nearest approach to the ideal, and therefore is deserving of special mention, is that manufactured by the Victoreen Radio, Inc., of Cleveland, Ohio.

Vast claims were made by the manufacturers of the kit as to what could be accomplished with it, together with a statement that it could be completely wired in three-quarters of an hour. Taking them to task on the matter, I was later firmly convinced that it could be done, and in a period of forty minutes after the wiring was started I was listening to signals from all the local stations on a set having nothing short of remarkable selectivity and twelve minutes later the signals from a station in Omaha and another in Texas came in on the loudspeaker while all local stations were in the midst of their operations. As for the time of the year this happened on the night of September 12 and in a location that might be termed fair. Additional experimenting with the set proved it was capable of good long distance reception, even with the makeshift connections which were made in haste; and, I dare say, if pains are taken in properly constructing this set, with soldered connections throughout, the California stations can be tuned in occasionally.

One frequently sees advertising matter in which a map of the United States is gaily covered with ribbons starting at New York City and extending to all remote points of the United States showing at a glance what stations have been heard with a certain type of set, but when looking at such maps bear in mind that these extreme distances may have been covered but once, and as for receiving them consistently or even occasionally, is quite another story.

Now there is a reason for the good work produced by this receiver, which the manufacturer claims is due to three things. First, they claim to have a 100



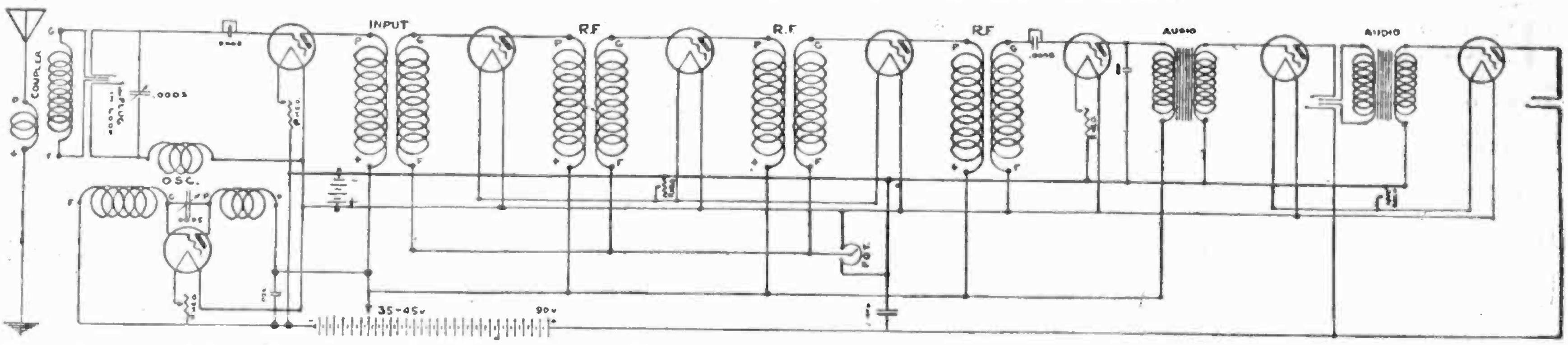
Sectional view of the Hetroformer showing the leaf tuning condenser.

per cent. sharper curve on the intermediate frequency transformer than other transformers of the same type. The reader will at once say: "Oh, I have heard that before"; but read on; the other two points follow, and then we shall explain the whereof in their claims. Second, each one of the resonance curves has a guaranteed precision of 1-3 of 1 per cent. Third, only air core transformers are used, which prevents interstage oscillation.

tory it is sealed to prevent tampering with.

Still another big feature with this receiver is the fact that it is not necessary to match the tubes, because of the capacity across the secondary. The variation in tube capacity in comparison with and will match the remaining ones in the set.

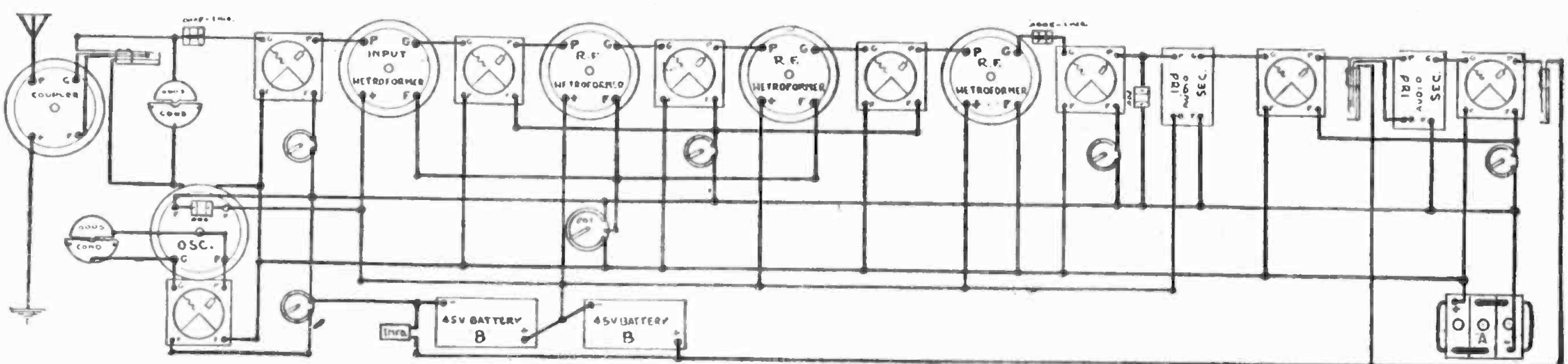
The peak of these hetroformers has been so designed that 12,000 cycles have been allowed, so that any variation in the voice frequency will not cause distortion.



The schematic wiring diagram of the Victoreen Super-Heterodyne. Note that connections to cross wires are represented by black spots. Other crossings are not connections.

Now as for the first point. The transformers have a curve that is 100 per cent. sharper because of the fact that the secondary is tuned by means of a small capacity in the neighborhood of .00025, which reduces the radio frequency resistance of the circuit, thus increasing the sharpness of resonance or decrement. This is possible because each that of the shunt condenser is so small as to become negligible. This same holds good in the variation of systems of wiring; no special care need be taken as far as capacity of wires or position of instruments are concerned, as this, with body capacity, is relatively small, as compared to the capacity of the shunt condenser.

Usually transformers for the intermediate stages in a super-heterodyne are tuned between 1,600 and 10,000 meters. On this latter wavelength an iron core transformer is necessary, which in itself brings up the possibility of distortion. On the 1,600 meters the amplification is hindered because of interstage oscillation and it is necessary



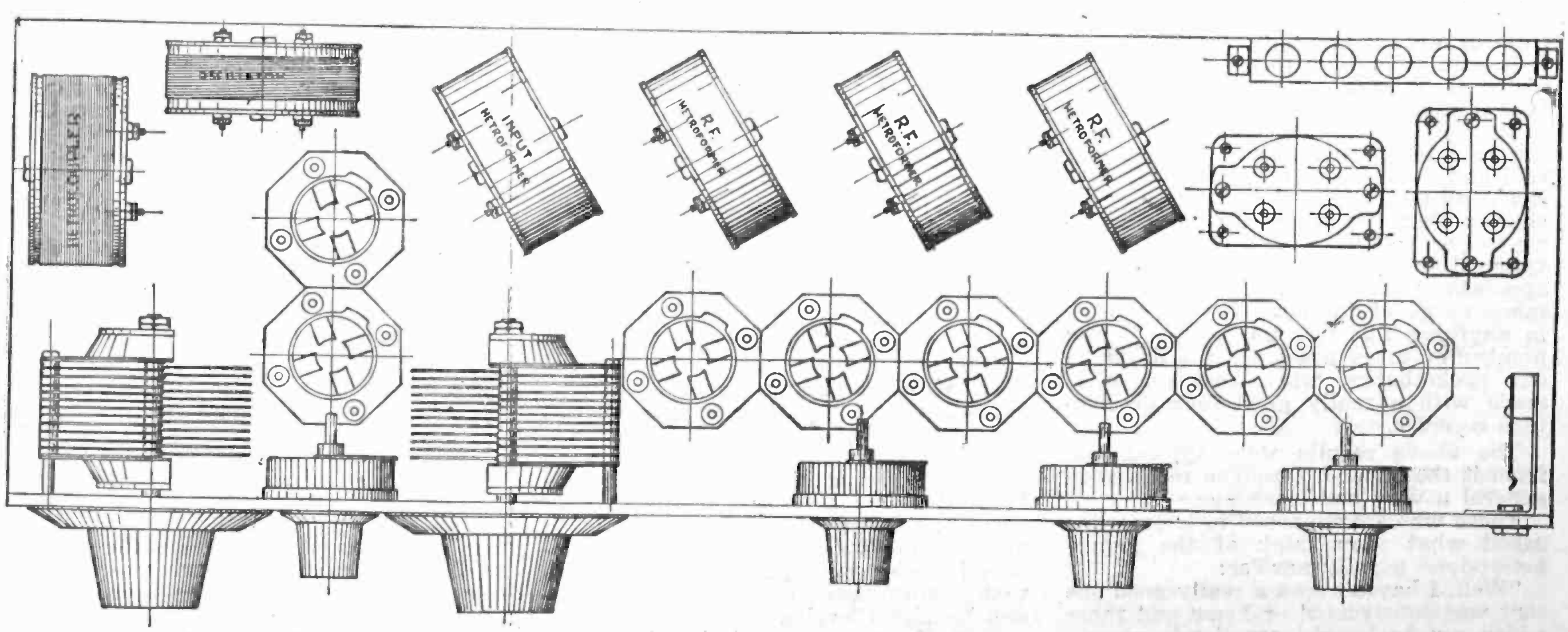
A picture wiring hookup of the Victoreen Super-Heterodyne. Carefully observe that connections are shown as black spots

transformer is tuned individually at the factory in the process of manufacture by means of a separate oscillator and two radio frequency tubes. From this accurate means the reader can easily see how the statement of 1-3 of 1 per cent. in sharpness is arrived at. The sectional view of the transformer clearly shows the method of mounting this small variable capacity inside the casing. After adjustment is made at the factory it is sealed to prevent tampering with.

The fact that an aperiodic primary is used in these transformers permits the transformers to be used with any type of tubes of any reasonable plate impedance. These hetroformers, as they are called, are all tuned to the same wave length, namely 3,400 metres, which affords an added feature: in case one of the hetroformers is damaged the manufacturer can easily replace it with another which is tuned exactly the same

to use a potentiometer to decrease sensitiveness of the tube and prevent oscillation.

Thirty-four hundred meters was selected by the engineers who designed the hetroformer as a happy medium and was selected because 88,000 cycles, which is 3,400 meters, offers the least trouble from harmonics which will be experienced in any receiver of this nature.



Diagrammatic view from the top of the set showing the positions of the Hetroformers for compact arrangement.

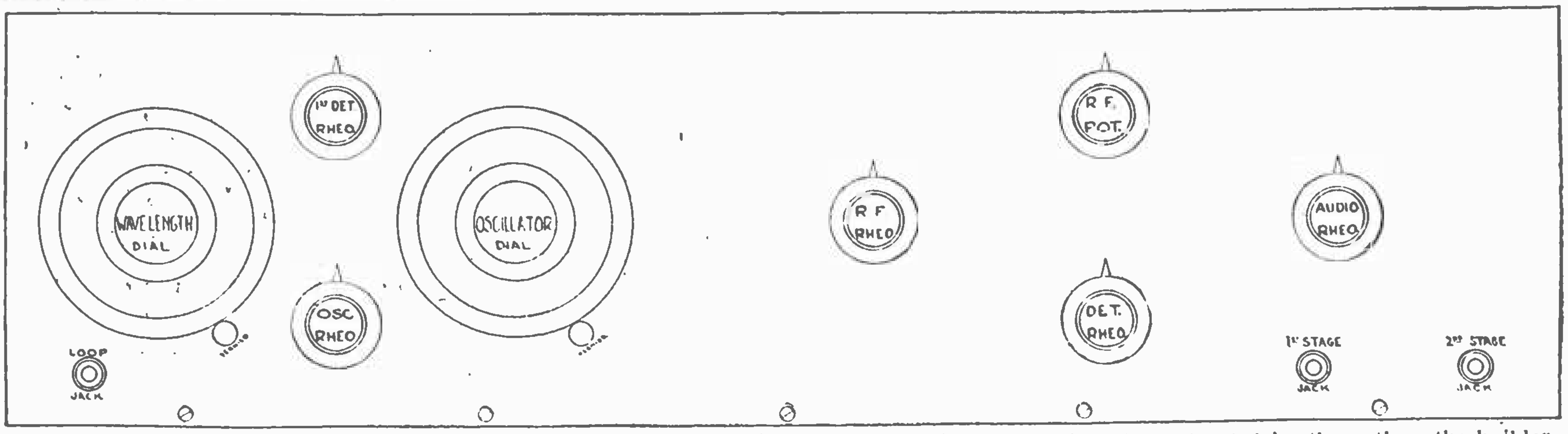
The potentiometer, or losser, as it is sometimes called in the language of the experimenter, in this set does not act as a losser but as a useful and desirable control over the grid voltage for the R. F. tubes, consequently affording a control over the volume on the signal. The set will not oscillate, regardless of the position of the arm on the potentiometer.

Greater clarity and much less tube noise are also obtained, and together with the fact that the grid voltage can be controlled conveniently to a point on wants something that will not only work well, but look good.

The photographs show about as well as possible a suggested arrangement of parts. The entire set can be assembled on a 22 or 24 inch panel, but it is recommended that a 26 inch panel be used for convenience for the average enthusiast in assembly and wiring. It is unnecessary to shield the cabinet or baseboard at any point, eliminating another point which heretofore was considered an absolute necessity in receivers of this character.

cycles, as mentioned above. The primary has a resistance of 50 ohms and the secondary 100 ohms.

When wiring up the assembled receiver, use No. 14 bus wire and Empire tubing and keep the leads as short as possible, especially those running to the grid and plates of the tubes. The angle for mounting the R. F. transformers is not important. The negative B should be connected to the negative A, as this will protect your tubes from burning out should any shorts ever occur. But five rheostats are necessary for the best re-



A suggested panel lay-out for the Super-Heterodyne set. Although this arrangement differs from the set constructed by the author, the builder may perfer this lay-out for convenience of the parts used.

the negative side, which gives best results, a greater reduction in B battery consumption is obtained, which can be appreciated only by those who already have had experience in feeding B batteries to super-heterodyne types of receivers.

The usual input transformer is used and is tuned to the same wavelength as that of the hetroformers, namely 3,400 meters. As a matter of fact and interest, the hetroformers are so sharply tuned in themselves that an input transformer is really unnecessary, the set can be built with just the four intermediate frequency transformers and the results will be so nearly the same that it is next to impossible to tell when it is or when it isn't used.

In the average super-heterodyne kit the transformers have no resonant peak. To offset this defect they have to provide an input transformer, which must be tuned with matched condensers, etc.

The hetrocoupler, more commonly called the antenna coupler, the hetro-oscillator or oscillator coil, and the input hetroformer all match, as far as outward appearances are concerned, their brother members, the R. F. hetroformers. Because of this they can be compactly arranged and laid out on the baseboard in a manner that pleases the man who takes pride in his work and

It will be of interest to those who desire to build such a set to know the construction of the various units. Starting with the hetrocoupler it has an aperiodic primary and consists of six turns of No. 21 silk covered wire, space wound. The secondary, which is wound on first under the primary, consists of forty-eight turns of No. 24 silk covered. The secondary has an inductance value of 300 microhenries.

The hetro-oscillator is designed to cover a wave length variation between 440 K. C. and 1,400 K. C. when connected to the usual .0005 variable condenser which covers the upper side band of a 550 metre station and the lower side band of a 225 metre station. Its secondary has an inductance value of 330 microhenries.

The input transformer has a primary of 350 turns of No. 38 B & S enameled wire and will tune to resonance with a .00025 mfd. condenser if desired, but it has been found usually not desirable. Its secondary consists of 400 turns of the same size wire. Its internal construction is similar to the cut of the hetroformers shown above.

The hetroformers are wound to a 2 to 1 ratio, the primary having 200 turns of No. 38 enameled wire and the secondary 400 turns of the same size wire and is shunted by the small variable capacity which is accurately tuned to 88,000

sults. The three R. F. tubes may be on one 6 ohm rheostat and the two audio on another, the two detectors and the oscillator having individual rheostats. Nothing but standard tubes should be used throughout.

The polarity of the connection to the pick-up coil on the back of the oscillator is not important. A .00025 mfd. fixed condenser may be found advantageous across the primary of the input transformer.

A plate voltage of 45 volts will be found about right for the UV 201A type on all tubes with the exception of the audio amplifier, which voltage should be higher.

The schematic diagram shows a jack in the head end which enables one to quickly insert a loop in place of the antenna. For convenience this acts very well, but it is suggested that two extra binding posts, separated about 2½ inches, be mounted on the panel or elsewhere for the loop connections.

The set will operate on outdoor antenna and ground, loop or for all local stations and even some stations up to 250 to 300 miles without either antenna and ground or loop. When used in this manner the tuning becomes exceptionally sharp, as is natural, and a good vernier dial attachment on both the oscillator and tuning condenser will be appreciated.

Tuned Radio Frequency Circuits

(Continued from page 49)

ondary can be reduced instead, and it can be set at a value that gives best results throughout the entire tuning range. Any standard variocoupler may be used for this transformer.

Tuned RF Circuit With Reverse Feed-Back

Fig. 7 shows a circuit in which reversed feed-back is used to prevent oscillations. This principle is used in the superdyne receiver. Reverse feed-back is obtained by connecting a coil in the plate circuit of the detector tube and coupling it to the first or second RF transformer. Any one of the above circuits except the neutrodyne with any of the coils shown in Fig. 10 may be stabilized by this method. Very good amplification is obtained.

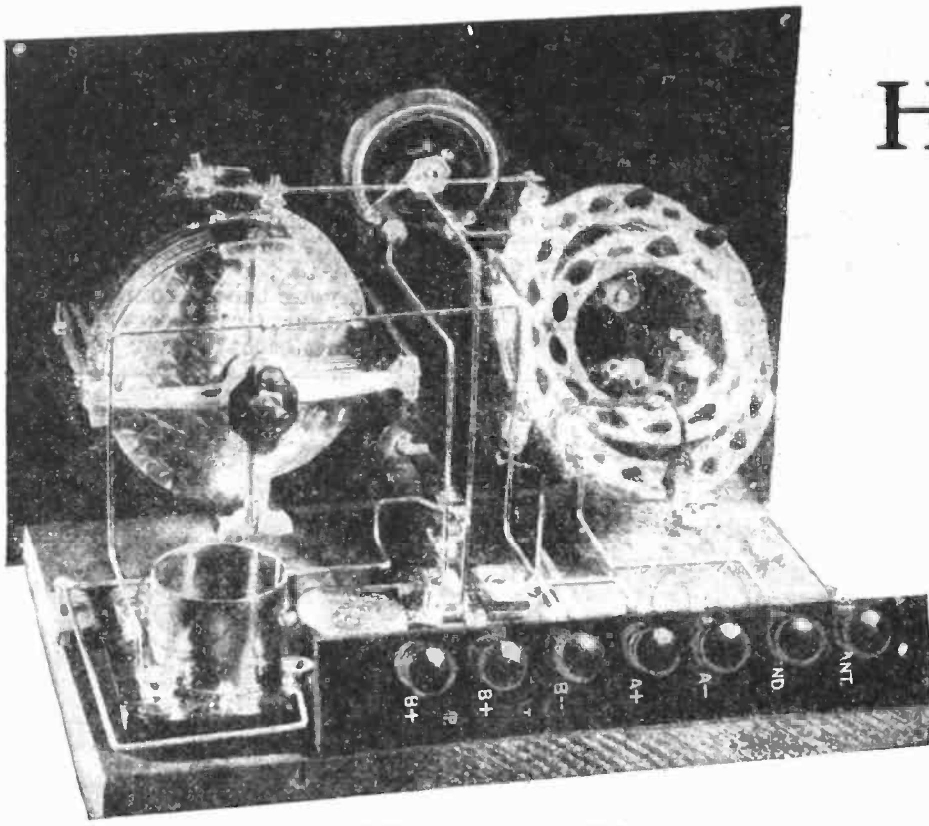
Resistance Coupled Tuned RF Circuit

Resistance coupled amplifiers at wavelengths below 600 meters give very poor results, but if we use a tuned circuit in place of the usual grid leaks, much better results are obtained. Such a circuit is depicted at Fig. 8. The variable resistances may be variable grid leaks. They should be adjusted so that the circuit does not oscillate at any wave-length. This circuit has not been fully developed as yet, but it has promising possibilities.

Tuned Reflex Circuit

Fig. 9 shows an experimental circuit that combines tuned radio frequency amplification, regeneration, detection and audio amplification. The first RF transformer may be the one shown at B, Fig. 10. The second one may be any standard low-loss three-circuit tuner having primary, secondary and tickler windings. The secondary is tapped as shown. An audio transformer is used for reflexing the audio currents into the second tube. Loud speaker results are obtained from this circuit.

How to Make a Short Wave Set



Illustrations by Courtesy of N. Y. Telegram & Eve. Mail

A photo showing a rear panel view of the short wave set especially designed for amateur reception.

OF late we hear quite a lot of gossip of the possibilities of the shorter wave lengths. One time we read of an amateur here communicating with another in Australia. Again, we read of great distances being covered by broadcasting stations using the short wave lengths. For instance, KDKA, operating somewhere around sixty or seventy meters, is easily heard in Europe and with great volume.

Even with all this publicity, how many have concrete ideas of how to receive these low wave length stations? At the present time amateurs are principally interested in the frequencies between 35 and 150 meters, since most of the high frequency experimenting is done between these wave bands.

Those interested in code reception have great radio thrills awaiting them if they decide to listen in on the ultra-short waves. Think of being able to listen to from three to five continents in one night. That is real DX! One may consider this exaggerated or, to use ham slang, "applesauce," but it is being done nightly by thousands of amateurs. Of course, the one drawback is the fact that one must first acquaint himself with the international Morse code before he can receive this great DX. Once the code is mastered, however, you can sit back in your chair and listen to the world in the true sense of the word.

Plenty of Thrills

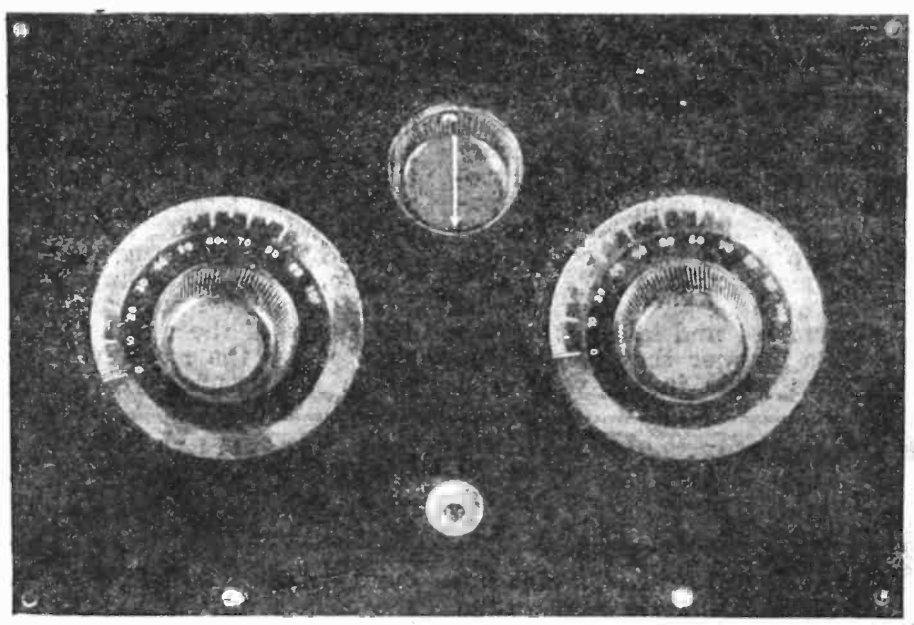
For the man who does not care to learn the code there are plenty of thrills in listening to the few broadcasting stations operating on the low wave lengths. As time goes on there are bound to be many more broadcasting stations operating on the high frequencies. In fact, many prominent radio experimenters claim that the ultra-short wave lengths will be used exclusively by all types of radio stations.

Many people who read that the amateurs have been assigned the wave band from four to five meters laugh and think it to be one grand joke. But it is not. The wave length band from four to five meters is broad enough to contain all naval, commercial, broadcasting, amateur and transatlantic radio stations without one station interfering with the other. If this small band is figured out in kilocycles it will run up into the thousands.

There are many types of circuits and apparatus that can be successfully used for the reception of these frequencies, yet all are not able to bring in the DX signals consistently.

A very efficient and practical set which the amateur will find to be well worth his while building is that described by *W. A. Schudt, Jr.*, in the *N. Y. Telegram and Evening Mail Radio Section.*

The short wave tuner we are about to describe is one that has been carefully selected from several really good sets as one of the best. This set, the model of which contains only one tube, has been given a very severe operating test and has proven its worth in gold.



A front view of the short wave set.

One of the tests was constructed by E. M. Glaser, owner and operator of station 2BRB, and is in use there. It is on this receiver that he listens to Europe and New Zealand every night. He used this set when he first communicated with Australia.

Parts List

A list of apparatus for the construction of a one-tube low-loss short wave length set follows:

One Bruno special low loss wave tuner.
One .00025 low loss variable condenser.
One tube socket (low loss design).
One 30-ohm rheostat.
Four Dubilier .0005 mfd. fixed condensers and 1 meg. grid leak.
One hard rubber panel, 7x10 inches, with suitable baseboard.
One binding post strip with six posts mounted.
Two dials three inches in diameter.
Miscellaneous screws, bus bar and lugs.

A special tuner was designed for use in this set and can be constructed as follows:—Primary coil consists of six turns of No. 16 DCC magnet wire wound in low loss fashion, with a diameter of three inches. This primary coil is fastened to a shaft which protrudes through the panel and becomes one of the controls. The secondary coil is wound in the same manner with the same size wire except it is wound on a larger form. A form of about four inches or a little less will fill the bill nicely. A total number of eighteen turns is wound on the secondary with a tap taken at the centre, or ninth, turn of the coil. This coil is then mounted so that the primary coil can rotate freely within the secondary coil.

Mounting

The panel should be fastened by means of two wood screws to the wooden baseboard. Then drill all holes for the various instruments. The inductance coil is mounted on the left side of the set with the variable condenser on the right and on the same plane with the inductance.

Next mount the rheostat in the middle of the panel and slightly above the plane of the condenser and inductance. Directly below the rheostat and near the baseboard is mounted the single circuit jack.

The tube socket is mounted on the baseboard and directly behind the variable condenser. The binding posts, mounted on the rubber strip, are placed at the back and left hand side of the set as you face the back of it. We are now ready to hook it up.

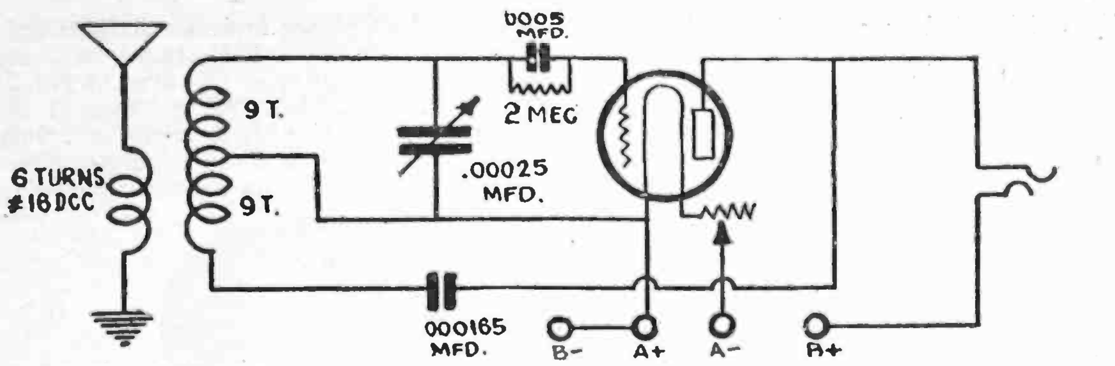


Fig. 1. A schematic diagram of the set described with only one tube.

Wiring Hints

One end of the primary coil is connected to the antenna and the other end is connected to the ground binding post.

Starting from the top end of the secondary coil run a wire to one end of the grid condenser. This same wire is connected to the fixed plates of the variable condenser. The other side of the variable condenser is connected to the midtap of the secondary inductance and also to the positive filament terminal on the tube socket, our positive filament being in turn connected to both the "A plus" and "B minus" binding posts.

Take the three fixed condensers and connect them all in series. Thus we obtain a capacity of about .000165. These condensers are connected in series with the lead running from the bottom of the secondary inductance to the plate. Exact connections follow:—From bottom or end of secondary coil connect a lead to one end of the fixed capacity. The other end of the condenser goes directly to the plate terminal of the tube socket. From this same plate terminal a lead is connected to the top prong of the phone jack, the bottom prong of this jack going to the binding post marked "B plus."

One of the .0005 mfd. fixed condensers is used in the grid circuit with a 1 meg. grid leak as shown in the diagram, Figs. 1 and 2.

It may be easier for the builder to follow the schematic diagram found elsewhere on this page than the word description, but the latter will be very

Audio Circuit

So much for the one tube set. Since the average amateur station wants a two tube set consisting of detector and one stage of audio frequency amplification a few changes must be made to convert this into a two or three tube receiver. For simplicity's sake we show the schematic diagram of the two tube set. After the first stage of audio any number of stages (within reason) can be added in the usual manner.

A larger panel will also be necessary. One about 7x12 inches will do. The addition of a radio frequency choke coil is also necessary. This choke is constructed as follows:—Wind 250 turns of No. 30 DCC magnet wire on a cardboard tube having a diameter of 1¾ inches. This choke is connected in series with the lead running from the plate to the primary of the first audio frequency transformer. Our single circuit jack perforce is substituted by a double circuit jack and the conventional audio frequency circuit followed.

We are now ready to test the set out. Connect the antenna and ground to the posts marked for them, then the "A" battery and last of all the "B" battery to their respective binding posts.

U. V. 201-A tubes were used in the writer's set and it was found of advantage to use forty-five volts on the plate of the detector tube. Some tubes even worked better as detectors with as high as ninety volts on the plate. (This, of course, is for code work.)

Transformers of very high ratio can be used to good advantage in the audio stages of this set if only code signals are to be received.

If the set does not oscillate at first try increasing the plate voltage. If still it does not oscillate try increasing and decreasing the condensers in series with the plate lead.

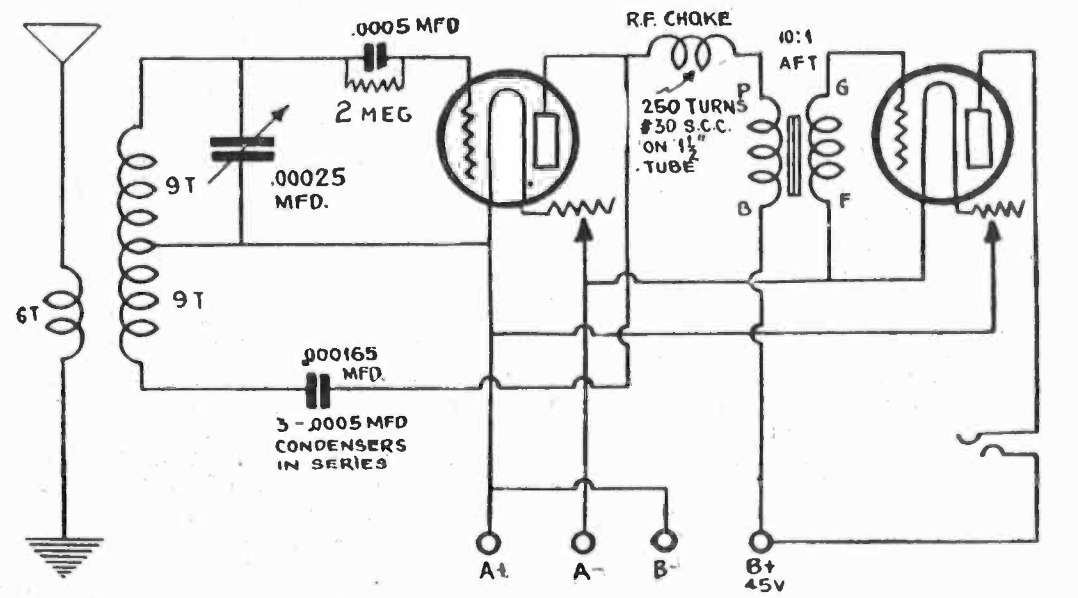


Fig. 2. Hook-up of the short-wave set with one stage of audio frequency amplification.

This set has a wave length range of from forty meters to 130 meters, thus covering two amateur bands (the bands used most extensively) and many other bands of equal importance. The European amateur stations will be found around the wave lengths of 80 to 107 meters. Most American stations are using the 75-80 meter band.

The writer believes that the receiver will prove a worth while experiment in short waves, especially to amateur radio operators. The one that is the subject of this article is now furnishing thrills for the editor of this magazine, who is, by the way, a code lover and an expert in both Morse and international telegraphy.

Better Tone Quality with C Battery

Nowadays the critical radio listener is after good quality. Audio frequency transformers have been improved and loud speakers are nearing perfection. However, if one desires good quality it is advisable to use a C battery. The C battery does not directly improve the quality, but it does prevent distortion by preventing the tubes from overloading, and when we prevent our audio frequency amplifier from overloading we will get good quality. Local stations will overload any receiver located in New York City.

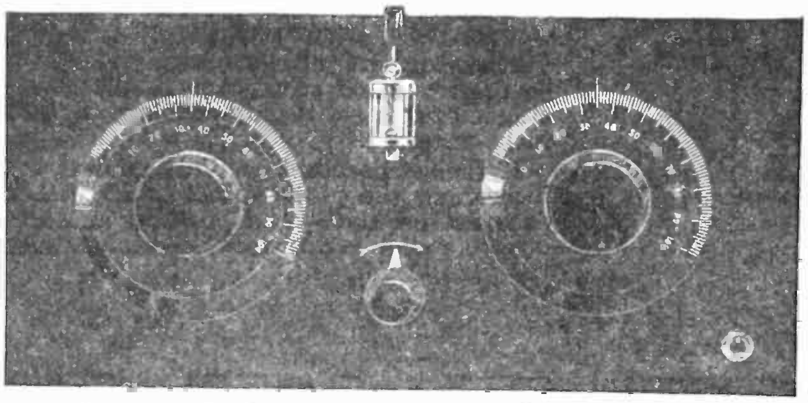
The C battery is connected between the negative filament wire and the filament return terminal on the audio frequency transformer. That is, the positive side of the C battery is connected to the negative side of the filament and the minus side of the C battery is connected to the terminal marked F on the audio frequency transformers. The voltage of the C battery to be used changes with the B battery voltage. For the best results the following C battery voltages should be used with the specified B battery voltages. If your B battery is 40 volts for the amplifier, the C battery should be .5 or a half a volt; when the B battery voltage is 60 volts the C battery should be one volt. When using an 80-volt B battery the C battery should be three volts, and if you are using 90 volts the C battery should be four and a half volts.

The reader will find that exceptional results will be obtained with the 199 tubes when a C battery is used on the audio frequency amplifier. This also applies to other dry battery tubes.—*Boston Traveler.*

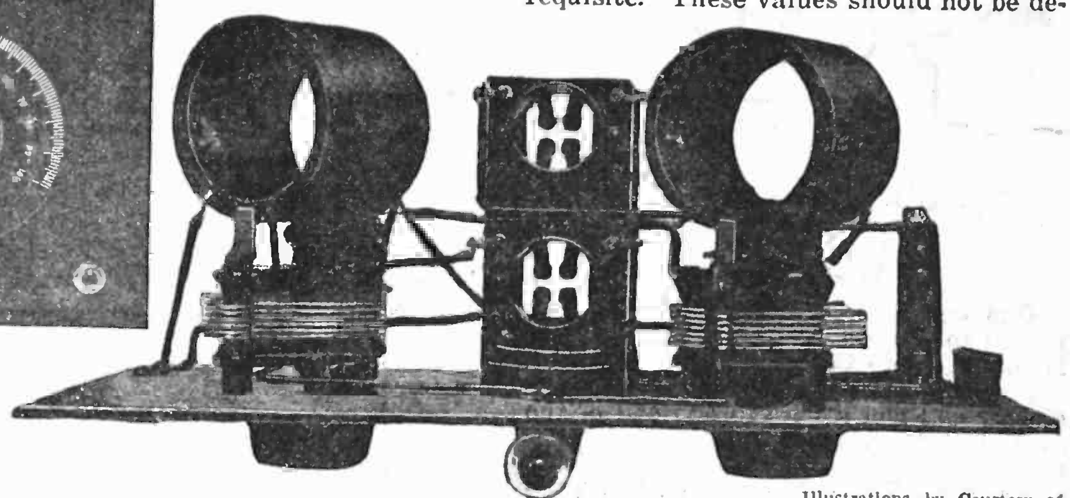
A Two-Tube Reflex Circuit

THE reflex circuit is well known for its simplicity of control, clarity of reproduction and volume. The set described herewith by *Alfred R. Macy* in a recent issue of *Science and Invention* is one which will give these results.

Using but two 201A tubes, such stations as KDKA, WDAP, WGY, WBZ, WSAI, WTAM and many of the other large broadcasting stations within a radius of 1,000 miles are heard regularly with loud speaker volume. Distant stations such as WDAF, WOAW, KFKX and WFAA come in very nicely on the headphones. To secure such good results necessitated the selection of reliable parts and great care was used in the construction. Mounted on a panel 7 x 14 are two neutroformers, a glass enclosed sensitive crystal detector and a six-ohm rheostat. A single circuit jack is also incorporated as well as four binding posts. Behind the panel are placed two audio frequency transformers and two standard sockets. The neutroformers are mounted at an angle of 54.7°. The neutroformers are composed of a variable condenser of 13 plates and two inductances, one the primary of 15 turns and the other the secondary of 65 turns of No. 26 D. S. C. wire. Besides the rest of the apparatus mentioned, a .0005, a .00025 and two .006 mfd. fixed condensers are requisite. These values should not be deviated from since the successful operation of the set is controlled in a great measure by them. It must be remembered, however, that the entire operation of the set depends upon the sensitiveness of the crystal detector.

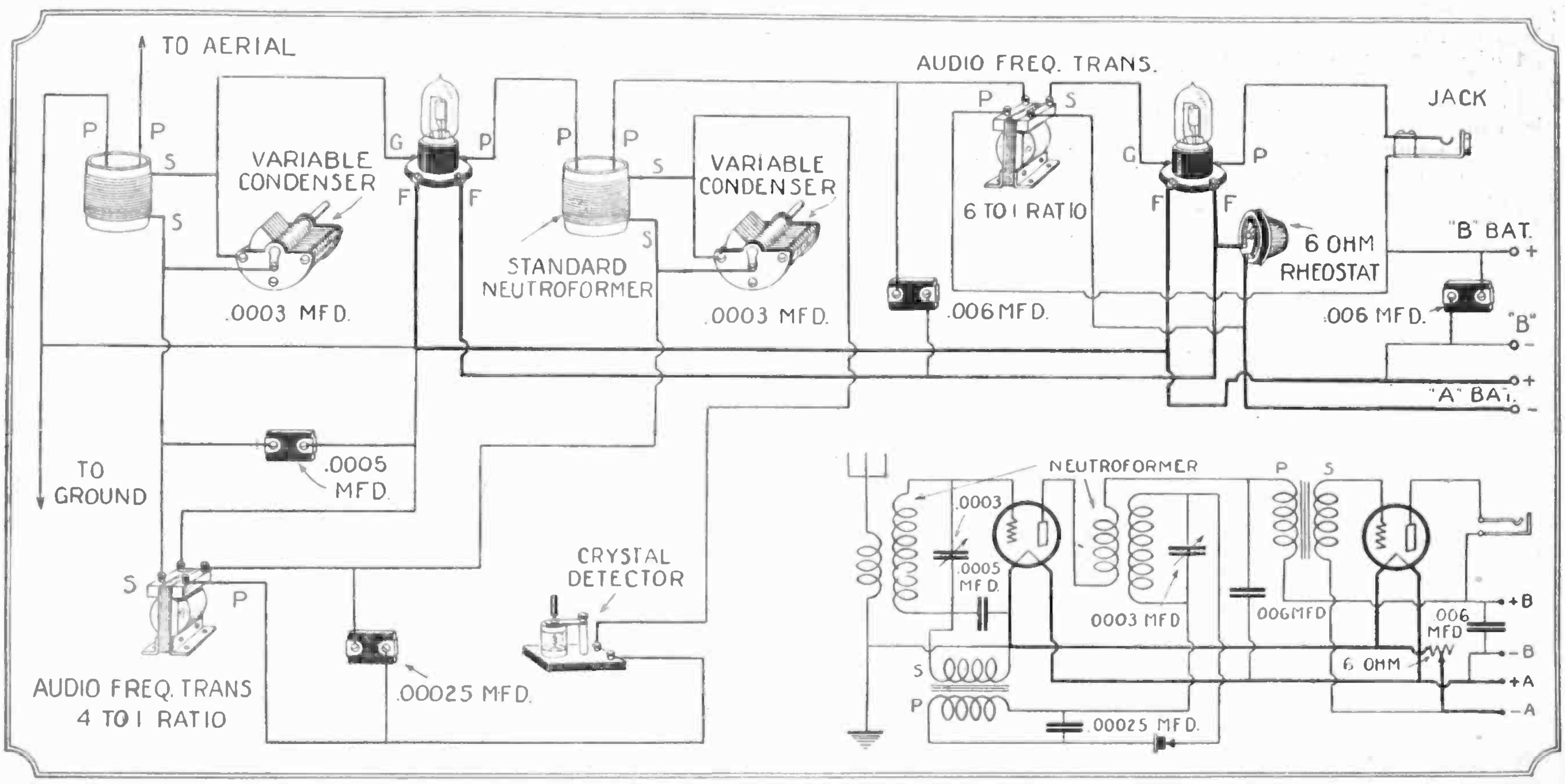


A front panel view of the two-tube reflex set.



Illustrations by Courtesy of Science & Invention (New York)

Looking down on the set from the top. Note the proper angle of the neutroformers.



Stabilizing R. F. Amplifiers

The most common method of stabilization is with a potentiometer which is connected across the filament battery, and the centre post, connecting to the arm, being connected to the grid through the secondary of the transformer, or inductance, as the case may be. A small condenser acting as a by-pass is used with advantage between the arm of the potentiometer and the negative side of the A battery. The placing of a positive charge on the grid of a tube prevents that tube from breaking into oscillation, as this is done, we find, by means of meters. We are drawing a much heavier drain on the B battery, the reverse condition becoming more pronounced as we advance the potentiometer to the negative side.

This disadvantage can be eliminated by changing the connections somewhat, with the results that in every way equal those of the described before and now nearly obsolete method. But two terminals of the potentiometer are used. The wire from the potentiometer is connected to the lower side of the transformer or inductance and the arm connected directly into the negative side of the A battery. This method affords a variable resistance in the grid circuit of the tube, which will prevent oscillation. —*Boston Traveler.*

An Efficient Three-Tube Reflex Receiver

AN efficient three tube reflex circuit employing a tube for a detector instead of a crystal, which will give selectivity and volume enough to bring in the real DX stations on the loud speaker, has been recently featured by the *N. Y. Telegram and Evening Mail* Radio Section. The description of this set as given by *L. R. Barbley* follows:

While the idea of reflexing one or more tubes in a receiver is not new and the theory of regeneration has had full sway, reflex receivers of one sort and another are going to become more and more popular both with the manufacturers of radio sets and "home builders."

The object of the engineers was to make the three tubes of this new reflex hook-up do double duty or, in other words, come as near as possible to making the three tubes do the work of five. No three tube receiver will ever achieve this aim at 100 per cent., probably, but the set described by the writer comes as near to it as appears possible now for the amateur radio receiver builder.

This new circuit employs first a stage of radio frequency, a detector tube and then one stage of audio frequency. The tube detector is employed rather than a crystal because for additional sensativeness it was necessary to provide for a feed-back in the detector circuit. The principles of both regeneration and reflex are comparatively old, but little has been done either by amateur experimenters or in the laboratories of concerns marketing radio products toward the development of a receiver combining both of these principles. There have been, however, several "kits" put on the market for reflex receivers, but the more successful ones used a crystal for detection.

The receiver described here is reflex in principle, pure and simple, although regeneration is developed to a slight extent, and the two principles of radio signal reception are thus combined. The receiver described herein is not an easy one to build nor to properly stabilize after it is built. None but advanced "home builders" had better try it, although a fan who has built a three tube set should be able to put this reflex together and synchronize it properly. When the receiver has been completed, however, the fan will be amply rewarded for his pains and will be highly amazed at the remarkable results obtainable as to selectivity and its ability to yank in truly distant stations.

Selectivity a Strong Point

Selectivity is this reflex receiver's strong point. One-half a point on the dials is sufficient to tune out one station and bring in another one, sharp and clear. A half turn of the knob of the vernier condenser mounted on the panel will itself frequently serve to tune out a station and bring in another without disturbing the condenser dials at all. The receiver does not possess enormous volume. It will not produce a signal that will tear the plaster off the walls, but it will bring in medium distant stations such as KYW and WLS, Chicago; CNRO and CKAC, Canada; WOC, Davenport, etc., on the loud speaker sufficiently loud to be heard all over a seven room apartment—and through the walls into the next apartment, too, if the neighbors' kick counts for anything.

For the locals and the not too distant stations an indoor aerial from twenty to thirty feet long is ample to give satisfactory reception, but this receiver is so selective that the fan can use an outdoor aerial without any real interference even from the locals. Even with an outdoor antenna the locals may be tuned out by moving the dials one degree in either direction. The outdoor aerial gives greater volume on distance, and the writer has both and can change from one to the other by merely throwing a switch.

New Coils Set's Heart

The basis of this reflex receiver is the new low-loss Ambassador and the antenna coil, which actually is the stator of the low-loss coil. The wiring of these two coils, especially made of "litz," represents months of experimentation and research work.

The parts needed for this newly developed reflex receiver are:

One Ambassador tuning coil, low-loss type.
One Ambassador antenna coil.
Two 23-plate variable condensers, low-loss type.
Two baby variable condensers.
Two 4 to 1 audio transformers.
Three sockets.
Two rheostats—one 6-ohm; one 30-ohm.
One automatic filament adjuster.
One open circuit jack.
One double circuit jack.
Two .00025 fixed condensers.
Two .001 fixed condensers.
One two-meg. grid leak.
One variable grid leak.
Six binding posts.
One panel 7x21 inches.
One black panel, 2¼x20¼ inches.
One cabinet, 7x21 inches.
Bus wire, screws, soldering lugs, etc.

In this reflex set the radio frequency tube is used also as an amplifier, as is the detector to some extent. In order to achieve the reflex amplification the secondary of the first audio frequency transformer is introduced into the grid circuit of the radio frequency tube, between the condenser and the filament of the tube. The secondary of the first audio frequency transformer then becomes a part of the radio frequency unit. As the capacity of this winding is usually not large enough to provide an efficient by-pass for the radio frequency currents, a small by-pass condenser, one of the two baby variable condensers mentioned, is placed across the terminals of the secondary winding.

In starting your set, drill the panel first, following the layout as much as possible from the accompanying illustration. The illustration shows a top view of the panel, although one can judge the relative position of the various parts.

Mount the condensers, two rheostats, coil, switch, baby variable condenser and jacks on the panel and lightly screw the

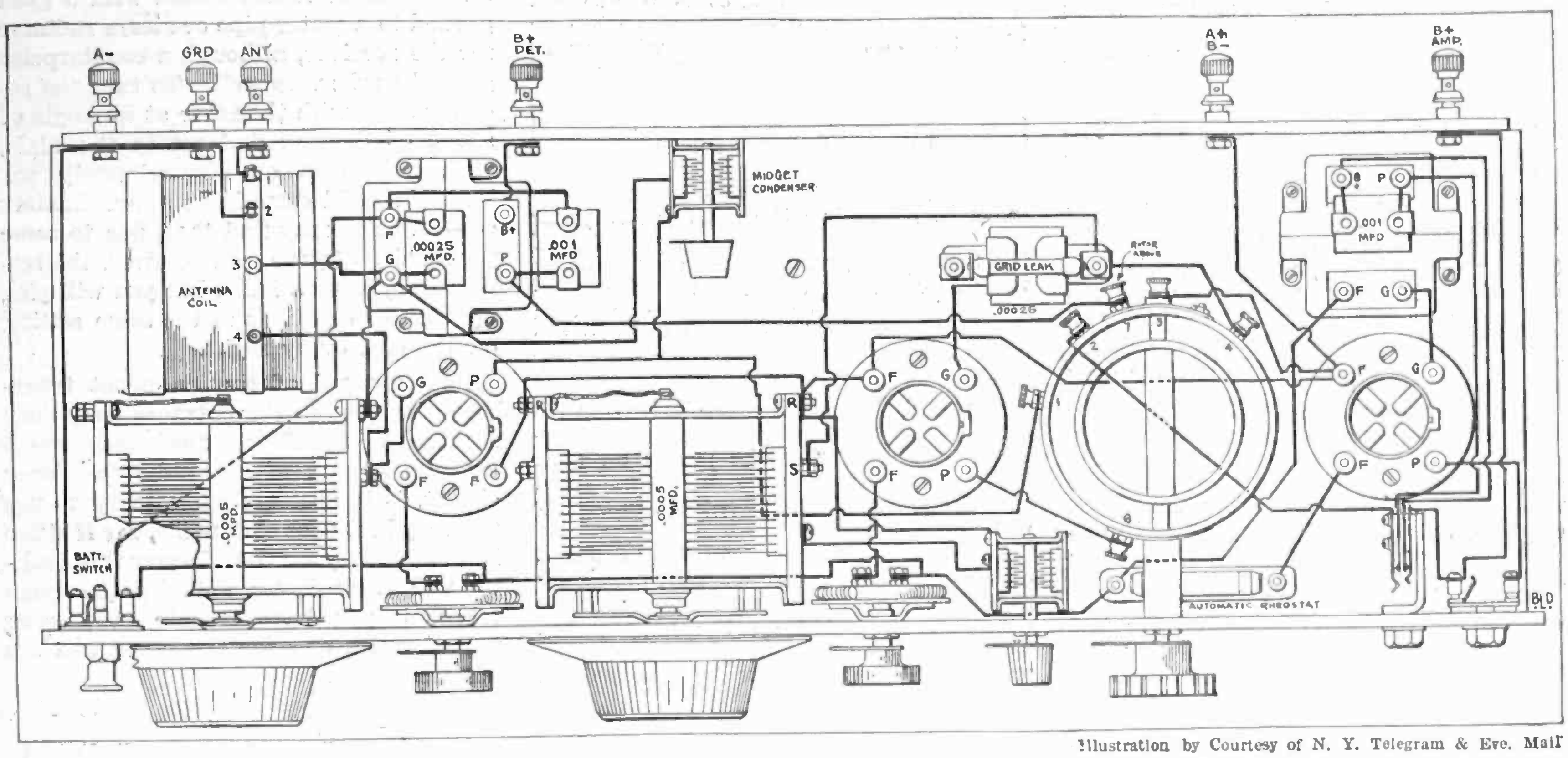


Illustration by Courtesy of N. Y. Telegram & Eve. Mail

The above drawing shows the location of the parts of the three-tube reflex receiver as well as the circuit. It can be used as a mounting lay-out if the relative spacing is followed.

baseboard to the panel. After marking the positions of the other parts on the baseboard, following the diagram as nearly as possible, take the baseboard off and fasten the parts in place.

Construction

The antenna coil should be fastened to the baseboard just behind the condenser of the radio frequency unit. You may also attach the coil to the condenser.

After drilling the back panel and mounting the neutralizing or by-pass condenser, proceed with the wiring. Follow the diagram as closely as possible as to spacing of the wires and your results will be better. This receiver was designed with a view to the greatest efficiency possible and the spacing of wires is of paramount consideration. Under no circumstances use any spaghetti; none is needed. Use soldering lugs for all connections between bus wire and parts.

If you prefer a different panel arrangement you may put the tuning coil in the center of the panel and the two 23-plate variable condensers at either end. The accompanying photograph shows this arrangement as opposed to the diagram, which is the more efficient receiver of the two.

The set which the writer built proved to be more efficient, when the negative side of the A battery was grounded between the negative side of the switch and the No. 2 connection on the primary of the radio frequency, or antenna, coil. This is shown in the diagram.

The writer assumes that the amateur has had experience enough in the matter of wiring to proceed as indicated by the diagram, but the writer will explain the method of stabilization after the set is completed and indicate a few little things to do to bring it to its highest state of efficiency.

If you wish, you can provide for a third rheostat on the panel to control the last audio frequency tube, which the writer took care of by using an automatic filament control. This proved thoroughly satisfactory. If an automatic filament control is used it should be provided with grid leak clips. When stabilizing your receiver you must rely on experience to decide whether to use a grid leak there or not.

It will be noticed that there are two fixed condensers on the first audio frequency transformer. The first one (a .00025) is shunted across the primary and the second (a .001) is put between the plate terminal of the secondary winding of the transformer and the filament terminal of the primary. This may seem an unusual arrangement of fixed condensers, but the writer found that it was the proper combination to produce results. The placing of fixed condensers frequently must be different in receivers that look exactly alike because of different values of the transformers and other parts used. A second .001 fixed condenser should be placed across the secondary winding of the second audio frequency transformer.

A fourth fixed condenser and a variable grid leak are placed between the grid terminal of the detector tube and one of the terminals of the secondary winding of the tuning coil. In the event of difficulty in balancing the set try reversing the leads from the secondary winding of the tuning coil, putting the condenser on the other terminal and the lead to filament of the audio and detector tubes on the other. The hook-up as shown in the diagram proved the more successful way for the writer, however.

If you follow these directions your receiver should bring in broadcasting stations at about the same points on both dials and should cover a range from something less than 200 meters to nearly 600 meters.

In balancing the receiver there are several methods of arriving at the proper setting of the balancing or neutralizing condenser mounted on the back panel. The best way of all is trial and experimentation. Get it where it gives the best results and let it alone. Once it is properly set there is no need of touching it again no matter what wave length you are working on.

If you are bothered by howls, which sometimes occur because of peculiar characteristics of the audio frequency transformer which causes oscillations in the amplifier circuit, try swapping the leads to the primary terminals of the transformer. This will clear up 90 per cent. of any trouble you may have in this part of the circuit.

Aerials

It is recommended that you use either an outdoor or indoor aerial with a good ground to a water pipe or steam radiator for the receiver, although a counterpoise ground works very well. To tune the receiver start with the rotor at an angle of about 45 degrees and rotate the dials, always in step or approximately so. WEAF should come in at approximately 65—65. You may find that, due to some peculiarity of your own receiver, the settings may vary a little, but you will pick up the same stations at the same setting on the dial every night.

Just a word of caution about transformers. Due to the extraordinary duty required of the first transformer which becomes a part of the radio frequency circuit, it is absolutely necessary to use the very best ones obtainable, for if there is a defect in your transformer this hook-up will show it up and, by the same token, if you have trouble swap your transformers one for the other and see what happens.

Lightning Arrester a Necessity

A lightning arrester is a necessary part of any well designed antenna system. Its purpose is to shunt to ground and dissipate high voltage charges which accumulate on the antenna; these charges are the result generally of static accumulations or are induced by charged thunder clouds or lightning flashes and the lightning arrester in leading them harmlessly off to ground not only protects valuable receiving apparatus, but as well guards against the possibility of property damage from lightning disturbance.

An unprotective radio antenna on the home may represent a hazard from these and other viewpoints; an antenna properly protected is really a protection to your property, your person and your receiving apparatus.

The National Board of Fire Underwriters has wisely incorporated into the "National Electrical Code" a ruling that each antenna lead-in conductor must be provided with an approved lightning arrester; the average owner of a receiving set, or for that matter the more advanced technician in the radio field, has accepted this ruling, has purchased "an approved lightning arrester," has installed it on his antenna lead-in and grounded it; this done, the matter has promptly been forgotten.

In selecting a radio lightning arrester, all too frequently the purchaser is influenced either by a cheap price or by the recommendation of a salesman who, though conscientious and honest in his recommendation, has not the technical knowledge of lightning protection necessary to weigh the qualities of one arrester against the other and choose on merit alone.

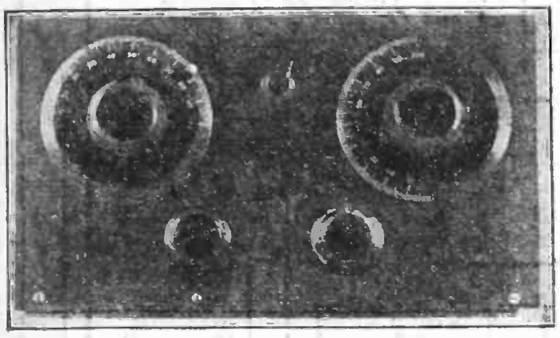
If the lightning arrester is of poor design, or is constructed of poor inefficient material it will allow a greater or less amount of this antenna energy to leak through or over it to ground and all of this leaking energy is subtracted from that which would otherwise flow into the receiver to be detected and amplified to audibility.

No part of an antenna or receiving system is 100 per cent. efficient; the energy collected by an antenna is so infinitely small, particularly in DX work, that to secure efficient operation it is absolutely necessary to conserve and actually utilize in the receiver the greatest possible percentage of this collected energy. Great care is now given to low loss coils, low loss condensers, sockets, etc., but little attention on the part of the purchaser has been given to the necessity for a low loss lightning arrester which should absolutely and unquestionably be the starting point for low loss apparatus; for, as before stated, a poor and inefficient lightning arrester may actually leak off the received antenna energy in quantities far in excess of that which generally will be conserved through the use of low loss receiving apparatus as compared with older non-low-loss designs.—*Chicago Herald and Examiner.*

How to Make the Graphlex Set

Regeneration by New Method Saves Losses

THE Graphlex set as described in the *New York Evening Graphic* and presented herewith has achieved remarkable success for its simplicity in construction and efficiency in operation. One of the best features of the set is the elimination of the outside aerial and



Front panel view of the Graphlex set.

the use of the loop antenna. This in itself is one of the strongest points of the set, because in some apartment houses in the city districts the erection of an aerial is prohibited by the owner or is impractical because of the number of aerials already upon the roof. Radio fans have also realized that loop reception is best for both local and distant stations, on account of the increased selectivity and absence of static and power line interference.

Besides the use of the loop antenna this receiver owes its popularity to the low cost of construction and operation and the results obtained from two tubes.

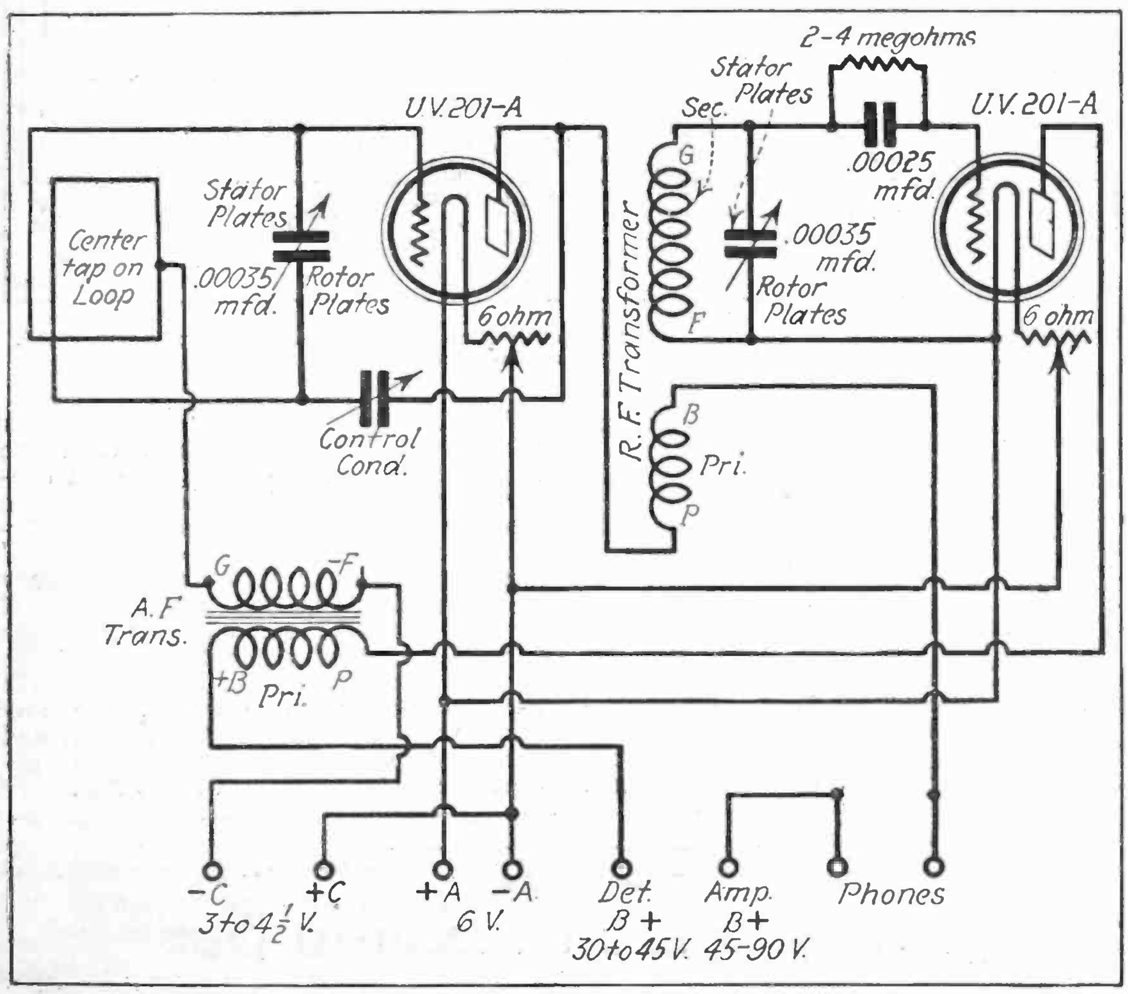
It will be noticed in looking at the diagram that one stage of radio frequency amplification is used with a tuned output to the detector tube. The radio frequency amplified tube is reflexed so that the two tubes are doing the work of three. This reflexing of the first tube would not, however, give sufficient sensitiveness to the circuit to enable it to do the wonderful things that it does if regeneration were not employed in the correct manner.

Using Regeneration

Regeneration in the set is accomplished by a method that is new to most fans and yet is the simplest method of all and does not introduce unwarranted losses in the circuit. The small condenser connecting the plate with the loop is the regeneration control.

This condenser is a very small variable one having a capacity of .00002 mfd., and may be procured from a radio store having an assortment of vernier condensers. One having two plates or several very small plates will have the correct capacity range. If upon completion of the set it is found that the condenser is too large, then the plates may be cut down in either number or size.

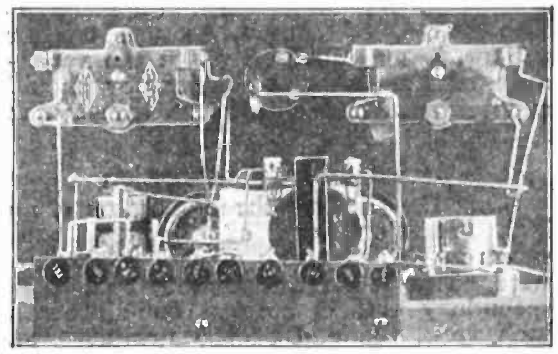
For further efficiency and selectivity the radio frequency transformer is of the tuned type. The variable condenser connected across the secondary of the transformer, while it adds another tuning control to the set, is not critical in adjustment, thereby bringing the receiver almost into the one control class, the regeneration condenser being set for a certain wavelength band and used as a volume control.



Illustrations by Courtesy of N. Y. Eve. Graphic

Schematic wiring diagram of the Graphlex two-tube receiver.

Though it would be possible to use a crystal detector in this circuit, a vacuum tube was chosen because it is less difficult to use than the crystal and also gives greater signal strength.

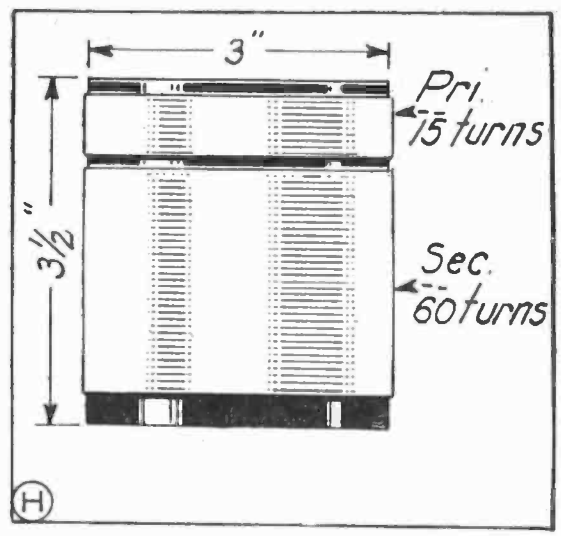


The rear of the set showing placement of parts on the panel.

A one-stage audio frequency amplifier may be added to this set in order to give loud-speaker volume on distant stations. As the circuit stands, it is capable of operating a sensitive loud speaker on local stations.

List of Parts

One loop antenna of sufficient inductance to cover a wavelength range of



Constructional details of the R. F. Coil used in this set.

200 to 600 meters with a 0.00035 mfd. tuning condenser. A tap should be provided at the center turn of the loop.

Two variable tuning condensers, 0.00035 mfd. each max.

Two standard vacuum tube sockets.

Two rheostats, 6 ohms. each.

One mica grid condenser, fixed 0.00025 mfd.

One Durham grid leak resistance, two megohms to four megohms, or it may be a good variable leak.

Eleven binding posts.

One front panel, 12x7x3/16 inches, hard rubber or bakelite.

One binding post strip, 11x1½x3/16 inches, hard rubber.

One baseboard, 11x7x½ inches, soft wood.

One hard rubber tube, thin walled, 3-inch diameter and 3½ inches long.

Sixty-five feet No. 26 D.C.C. wire for winding r.f. transformer.

In addition to the above, sufficient busbar should be provided for wiring, screws for mounting parts and fastening front panel and battery connection strip to the baseboard.

The radio frequency transformer may be wound in the conventional low loss design if the constructor has had any experience with these coils; if not, then the instructions for making the transformer, as given herein, should be followed. The primary and secondary coils of the transformer are wound on a hard rubber tube three inches in diameter and three and one-half inches long. The wall of this tube should be thin, not more than one-sixteenth of an inch. It is possible, of course, to use thicker tubing, but as this increases the resistance of the coil the constructor should shop around and obtain the thin-walled material.

Transformer Construction

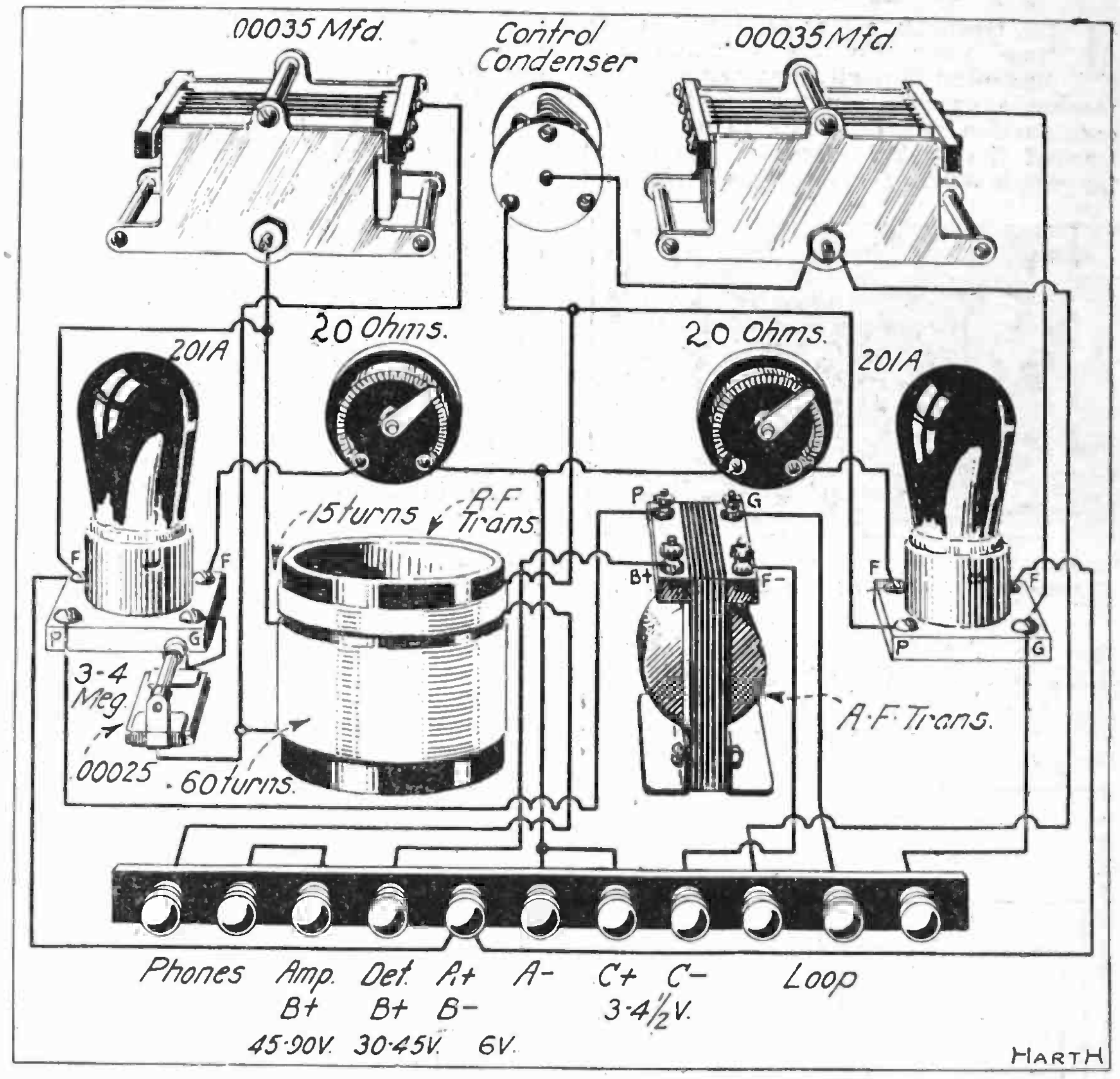
Start the winding three-quarters of an inch from one end of the tube and wind on fifteen turns of No. 26 D.C.C. wire. This is for the primary coil. The secondary coil is started one-sixteenth inch from the end of the primary coil and is wound with sixty turns of the same size wire, in the same direction as the primary. The start of the primary coil is connected to the plate of the radio frequency amplifier tube, the end of the primary coil is connected to the "B" battery positive. The start of the secondary coil is connected to the positive filament of the detector tube and the end of the secondary coil is soldered to the grid condenser and leak.

Brass brackets for mounting the transformer may be made from brass one-thirty-second of an inch thick and three-eighths of an inch in width. A hole should be drilled in each end of the brackets, one for fastening them to the transformer and the other for screwing the brackets to the baseboard. These brackets must be made so that the transformer will be at least three-quarters of an inch from the baseboard.

The panel layout for this set is shown in the diagram given herewith and should be closely followed. It is possible in some cases that the construction of the condensers that have been bought will not permit the measurements given in the drawing to be followed, but no radical deviations should be made under any circumstance. If it is necessary, simply move the condensers further apart.

The baseboard layout for the set can be determined from the accompanying photos and diagram. This is possible, because the audio frequency transformer is the only instrument that will vary enough in size to cause a change, and enough space has been allowed for this emergency. The battery terminals should preferably be mounted on a hard rubber strip 11 inches long by 1½ inches wide. Eleven holes should be drilled in this strip for the binding posts, and then another set of brass brackets may be made for supporters.

All leads should be kept as short as possible, and no two wires should be run parallel to each other. The grid condenser had best be mounted and connected directly on the grid terminal of the detector tube socket.



Perspective wiring diagram of the Graphlex receiver showing the arrangement of parts which should be followed as near as possible.

Wiring Circuit

In wiring the circuit it is always advisable to first connect the filaments of the tubes to the battery and rheostats. The tubes can then be inserted in their sockets and the filament battery connected to test for completed circuit. In wiring this part of the set, be sure to keep the filament leads close together and down on the baseboard. After the filaments have been wired and tested the rest of the circuit can be carefully done.

When the circuit has been completely wired and been tested out, then the slight individual changes that each constructor likes to make in his set may be made. Only two things are suggested—these are: adding a phone condenser and a small condenser across the secondary of the audio frequency transformer. If the insertion of the condensers improves the operation of the set they may be left permanently in the circuit. It will not be necessary, however, for any changes to be made in the circuit, and experimenting with it is not advised except for the experienced radio fan.

Rheostat An Important Part of Radio Set

The neglected part of a radio receiver is the rheostat. It is a device which is used to control the current from the A battery. As this current is controlled, so is the brilliancy of the filaments of the tube controlled. The A battery is a low voltage device which supplies current for lighting the vacuum tube used in a radio receiver.

This small device plays an important part in a receiver. The purpose of the rheostat is to reduce the current from the A battery to the tube filament to that point at which the tube will work most efficiently. In every vacuum tube there is a point of temperature at which the tube will operate most efficiently as a detector or as an amplifier. This means that the current flow must be so regulated that this temperature is established and maintained.

One will find that the adjustment of the rheostat is critical on some tubes, particularly those of the low vacuum type. These tubes are generally called soft tubes. To feed a heavier current than is needed means to shorten the life of the tube and a weaker current will prevent the proper volume being obtained. In some tubes an A battery voltage of too high a value will cause the signals to become mushy in much the same manner as in regeneration.

When purchasing a rheostat for making up your set be sure to select one that has the wire wound firmly on the form and not likely to become loosened. Some types of carbon rheostats are efficient and will give a fair amount of satisfaction. The ordinary wire wound rheostat requires little attention except to see that the contact arm is free to move over the entire surface of the wire without scraping too hard or making too light a contact.—*World-Herald, Omaha, Neb.*

Construction of the Ultradyne, L-2

Incorporates New Features in Design

REGENERATION plus modulation is the keystone of the new Model L-2 Ultradyne receiver designed by Robert E. Lacault, formerly radio research engineer with the French Signal Corps. This combination is going to prove as valuable to the level minded radio fan as four wheel brakes and balloon tires have to the level minded autoist. There is a strong comparison here, for both the autoist and radio fan seek the same thing—namely, smooth operation and reliable and instant control.

Illustrations by Courtesy of Telegram and Evening Mail (New York)

Fig. 1.—A front view of the new Ultradyne, L-2. Note the convenient arrangement of controls.

The *N. Y. Telegram and Evening Mail* Radio Section recently gave account of the constructional details in a most complete way. The article by *Hogart S. Sweet* read:

Regeneration plus modulation—you can theorize until you are blue in the face, you can draw conclusions on such a combination from experience with regeneration in conjunction with the usual form of Super-Heterodyne, but until you experience the performance of the new Ultradyne you don't know the half of it.

But thinking it over from the theoretical standpoint—anyway we know the advantages of the Super-Heterodyne—maximum amplification for each radio frequency stage for one thing and ease of control for another. Add to this the modulation system, and we make the first detector or frequency changer perform a real service by modulating the oscillations produced by the oscillator tube and thus enormously boost the amplitude of the incoming signal before it ever reaches the long wave radio frequency amplifiers. Now suppose we add the most sensitive and efficient system of amplification known to the radio art: regeneration. To be more exact, suppose we include regeneration in the modulator tube circuit. What is the result? We boost the already boosted incoming signal! There we have it—all the advantages of regeneration. That alone, incorporated in the circuit of a single tube set, puts shades over more elaborate receivers—all the advantages of the modulation system and the Super-Heterodyne—all in one. Still eight tubes, "but what a whale of a difference," as a cigarette ad. states.

As any radio technician will tell you, it is easy enough to think up any number of combinations and draw them into an intelligible circuit, but to get the combination to work, and work satisfactorily, is another story and one that is not without its note of despair. Mr. Lacault met up with numerous difficulties in his attempts to make the combination of regeneration and modulation work to his complete satisfaction, but he was successful in the end.

Specifications

But listen to the specifications of Mr. Lacault's new design—his model L-2—before we cover the constructional details:

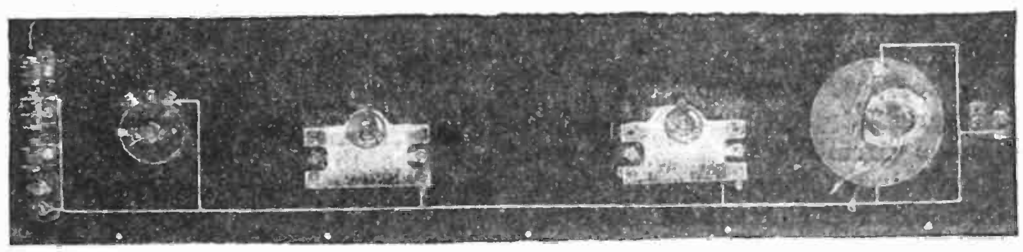


Fig 2.—The arrangement of condensers, coupler, rheostat and jacks on the rear of the panel.

There are no rheostats. The filaments of all the vacuum tubes are controlled by automatic filament regulating devices. Filament control jacks are employed for the two stages of audio frequency amplification so that it is not necessary to play around with one or a couple of rheostats every time you shift. If you are using both stages of audio and wish to shift to the detector, out comes the plug with your own hands and out go the two audio frequency amplifier tubes without saying boo. Likewise on one or both go when the plug is inserted in one or the other jack.

All binding posts have been moved to the rear, where they rightfully belong, for there should be no wires in front or on the side of the receiver, but behind, where they are out of sight and out of the way. The two variable condensers, of the low loss type, are both of the same capacity, whereas before, one was twice the capacity of the other. Making them both of a capacity of .0005 M. F. provides a more even adjustment than was possible with the original type of Ultradyne.

Naturally, the old type single layer cylindrical coils have been replaced by coils of the low loss type. These are the basket weave form and are more compact than the single layer type and decidedly more efficient.

It will be noted from the photo of Fig. 1 that there is a radical change in the position of the controls. Both the tuning dials are situated in the center of the panel, really the most convenient position for them—right where your hands normally rest. The regeneration control and the potentiometer control are out to either side, being the less important adjusting mediums.

The Layout

The layout is a work of art. Though the size of the panel is the same as in the former model, the instruments are not at all crowded and the leads from instrument to instrument are considerably shorter. It is a fact that it is much easier to wire this set than the old one or sets of similar design. A study of the accompanying photographs will assure one of this.

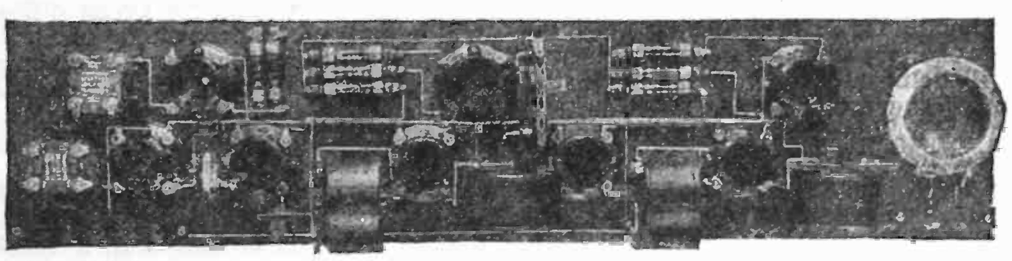


Fig. 3—View of the parts as they are mounted on the baseboard.

The panel layout is shown in the photo of Fig. 1. The loop aerial jack is at the extreme left followed by the regeneration control knob, the tuner dial, the oscillator dial and the potentiometer control. The three phone jacks and the "A" battery switch are lined up on the extreme right of the panel.

The circuit diagram is shown in Fig. 4. The units employed from left to right are:—the phone jacks and "A" battery switch, the potentiometer, the 23 plate oscillator condenser, the 23 plate tuning condenser, the regeneration coupler and its copper shield, and the loop aerial jack.

Fig. 3 shows a view of the instruments mounted on the baseboard. The devices similar in appearance to grid leaks are the automatic filament regulators. The oscillator coupler is seen just to the right of the second rear tube socket. The tuning coil is situated to the extreme right of the baseboard. The Ultraformers are seen lined along the front portion of the baseboard, in the photo, though this is actually the rear. The "A," "B" and "C" battery binding posts are all mounted on a single strip of bakelite which is supported by two brass columns, and are at the extreme left of the baseboard in the photo. The aerial and ground binding posts are mounted in the same manner and are seen to the extreme right.

The Parts Required

Below is given the complete list of parts required for the construction:—

1—7x30 inch cabinet with baseboard.
1—7x30 inch panel.
2—.0005 M. F. low loss variable condensers.
2—Vernier knobs and dials.
1—Low loss tuning coil.
1—Low loss oscillator coil.

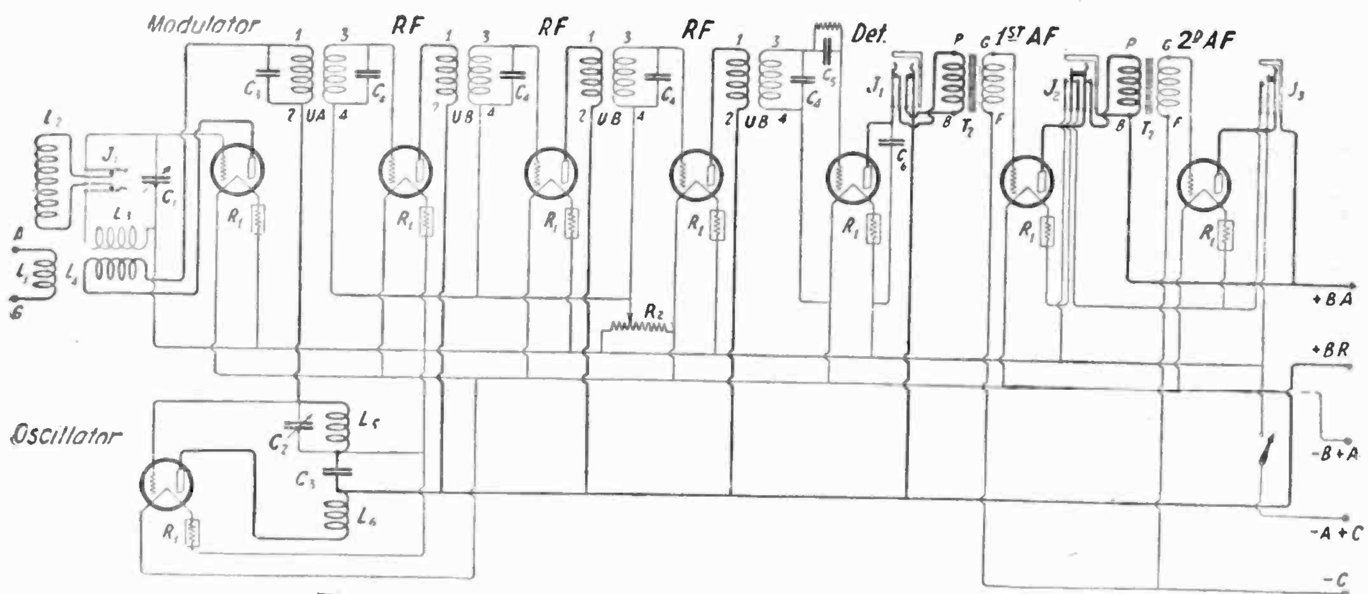


Fig. 4. The complete wiring diagram of the Ultradyne, L-2.

1—Ultraformer, type A.
3—Ultraformers, type B.
1—Low loss 180 degrees coupler with shield.
1—Dial for coupler.
8—Vacuum tube sockets.
1—Dial for potentiometer.
8—Amperites, type A.
2—Double circuit jacks.
1—Single circuit filament control jack.
1—Double circuit filament control jack.
1—"A" battery switch.
2—Audio frequency transformers.
1—Variable grid leak.
7—Binding posts.
2—Bakelite binding post mounting strips.
1—.0005 M. F. condenser with grid leak mounting.
4—.00025 M. F. fixed condensers.
2—.001 M. F. fixed condensers.
1—.005 M. F. fixed condenser.
No. 14 tinned copper bus bar wire.
Assortment of screws and nuts.
1—400 ohm potentiometer.

Above all means purchase the best of materials. The L-2 Ultradyne is worthy of the best, and if full service is to be expected, do not use any inferior parts.

Assembling the Receiver

The first job to be done is the panel drilling and the mounting of the phone jacks, "A" battery switch, the two 23-plate variable condensers, the potentiometer and the coupler and shield, Fig. 2. Lay out the baseboard next, placing each instrument in its proper position as shown in the photo of Fig. 3. The complete circuit diagram is shown in Fig. 4. Wire the instruments mounted on the panel first, then the instruments on the baseboard. Be sure and solder all connections and take your time about it to insure a good job. Be sparing with the soldering flux and use a hot iron. After both the panel and baseboard instruments have been wired, attach the baseboard to the panel and complete the wiring between the instruments on each.

Be sure and check all the connections when you have completed the wiring and as a final check-up test each soldered joint with the battery and headphones to insure perfect electrical contact. As a precaution before operating the set, connect your "A" battery to the "B" battery binding posts and with one tube test each and every tube socket to be positive that there is no short between the "B" and "A" battery connection. If the tube lights in any one or all of the sockets, it is proof that the set has either been incorrectly wired or the "B" battery wires are touching the "A" battery wires at some point.

After all instruments and connections have been tested, insert the tubes in the sockets, connect up the "A," "B" and "C" batteries to the proper binding posts, plug in the loop aerial or attach the aerial and ground and, with the phones or loud speaker plugged in, pull the filament switch.

The following is the correct procedure for tuning in:—Turn the oscillator dial one degree at a time and for each setting of this dial turn the tuning dial slowly through its whole range. If nothing is heard at any setting, move the oscillator dial one more degree and repeat the process with the tuning dial. At some point one should hear a station, and it will be noticed that a slight hissing noise is heard when the station is transmitting, but no speaking or singing into the microphone. This slight hissing noise indicates the presence of a carrier wave and will help materially in tuning in the various broadcast stations. All this tuning should be done with the potentiometer adjusted to a point where no whistles are heard. If whistling noises are present, the potentiometer should be turned toward the positive side until the whistling stops, at which point the amplifier operates at its maximum sensitiveness.

When tuning in distant stations it may be necessary to readjust the potentiometer slightly. This should be done only after the station is heard faintly, but clearly enough to increase the amplification. When tuning in very weak signals the feedback or regenerative coupler should be turned slowly until a point is reached where a whistle is heard, then moved back just below this point. A slight readjustment of the two condensers will then bring the signal to maximum audibility. When tuning in another station, turn the feed back coupler to zero (coils at right angle) and tune first with the two condensers, as explained above, then adjust the coupler once the station is tuned in.

If the same antenna or loop be used at all times, the set may be calibrated and a curve made giving the proper settings of the two condensers for any station. A somewhat similar procedure which will also prove useful is to keep a record of the two dial settings for each station heard. This permits the operator to tune any station which has been already heard by tuning the two condensers to the proper settings.

It should be pointed out that the regeneration feature incorporated in the new Model L-2 is a form of radio frequency amplification and consequently plays its most important part when you are receiving a long distance station. Its use does not increase the volume of the signals received from the local stations to any appreciable extent, this not being the object. Greater volume can always be obtained by the addition of audio frequency amplification; but it does increase the volume of stations at a distance for the reason that the weak signals are boosted in amplitude before they pass through the long wave radio frequency amplifier. Since the object of the regeneration feature is to make the Ultradyne more sensitive to weak signals, it should be evident that it will increase the volume of signals from distant stations that could not be heard on an Ultradyne without regeneration.

As has been said, no great difference will be noticed in the volume of local stations, but it is surprising what the regenerative feature does in connection with the reception of long distance stations. Probably the most advantageous point is that it insures reliable and consistent reception from stations that heretofore faded or swung badly, and this is exactly what is desirable in a receiving set.

With the addition of regeneration, it will be found that the second stage of audio frequency amplification is of real use only when receiving from a very distant station. All the volume desired is had with one stage of audio frequency amplification when receiving local or semi-local stations. The second stage of audio frequency amplification, however, is quite desirable for long distance work and may be likened to a high powered car when, under normal conditions, the surplus power is not used, but it is there for use in case of emergency. It is always nice to know that you have it to use when you wish.

A Practical Four-Tube Receiver

ALTHOUGH the manufacturers of radio receivers claim that they have sold many millions of dollars' worth of radio sets during the last year there still persists that type of fan who likes to buy his parts and build the set himself. He is the experimenter—the man who has discovered the fact that while a ready-made receiver works to perfection for some people, he cannot get the necessary "kick" out of it to make it enjoyable. To him it is like owning a car and having a highly paid chauffeur to drive it for him. In other words, any one can turn dials, but it takes a little more than that to build a receiver and make it work right.

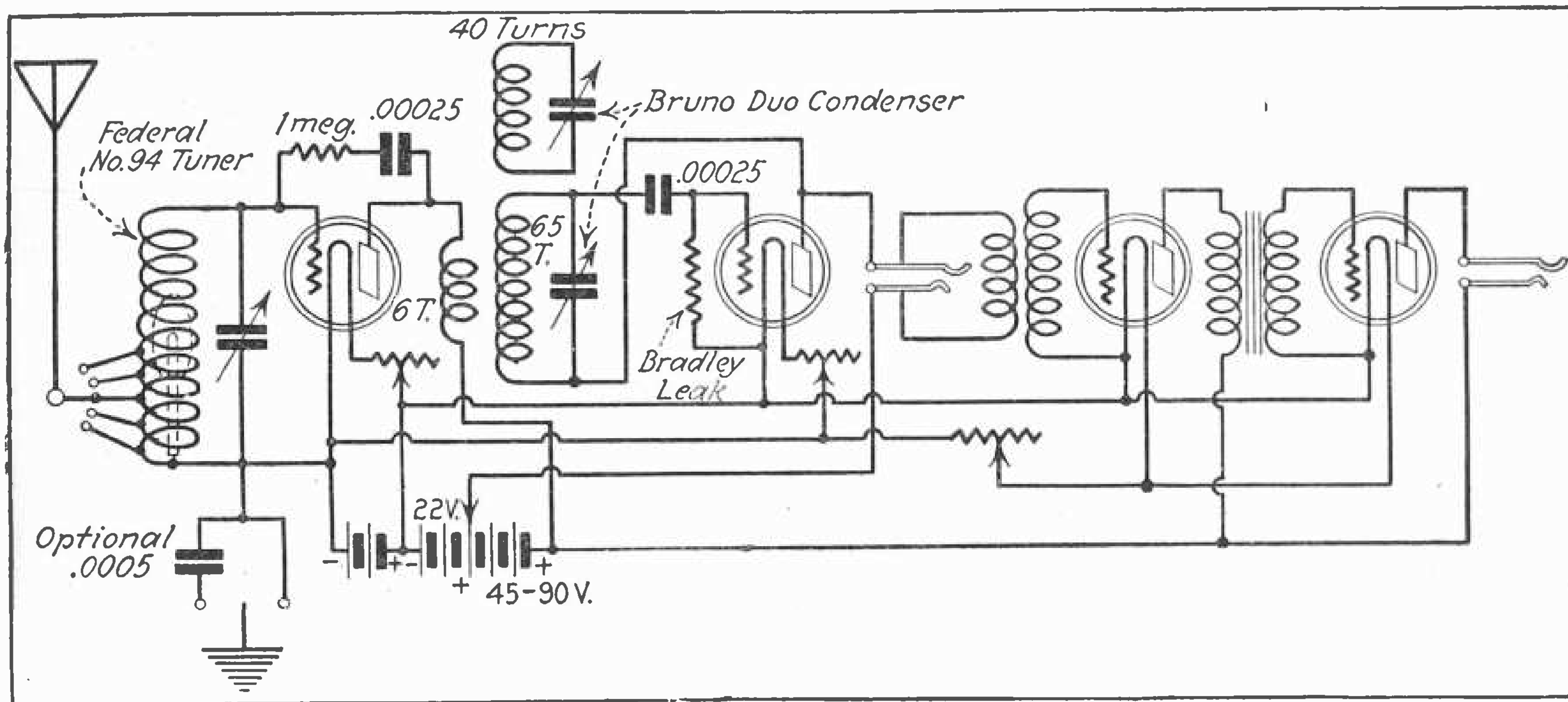
Were it not for the activities of this type of radio enthusiast it is quite probable that the vast improvements that have been made in apparatus would not have reached anywhere near their present perfection. Inasmuch as this is a technical article and not a thesis on the improvements on radio apparatus, it would perhaps be better to "start going."

The receiver, the diagramatic circuit of which is shown here, is in reality several receivers chopped down and made into one. It consists primarily of a stage of neutralized radio frequency, a regenerative detector (ultra-audion detector), with synchronized wave trap and two stages of plain audio frequency. Simple enough to build and remarkably simple to operate.

Directions for building this receiver as described herewith by *Robert L. Dougherty* appeared in *The N. Y. Herald and Tribune Radio Magazine Section.*

As the parts used are all of standard manufacture, with the exception of the wave trap, which is wound over the secondary of the second tube circuit, an estimate on the cost of the parts required can easily be obtained from any radio shop. The parts needed are as follows: One Federal 94 "metal vane vernier" auto transformer, 1 neutroformer (any good standard make), 1 Bruno 45 plate condenser, 1 Bruno duo condenser (two condensers on one shaft), 2 audio-frequency transformers, 4 sockets, 3 Bradley stats, 1 Bradley leak, 1 .00025 mica fixed condenser, 1 .0005 mica fixed condenser, 1 double circuit jack, 1 single circuit jack, one-fourth pound of DCC 22 gauge wire, 1 24x7-inch panel, with cabinet to match.

The first piece of apparatus mentioned is a new departure in tuning couplers and is manufactured by the Federal Telephone and Telegraph Company. It consists of a 4-inch tube, wound with one layer of wire, tapped at the lower end, at the first, third, sixth and fifteenth turns. The rest of the turns form an untuned secondary, and the theory is that a greater step up, and consequent smaller step down, ratio is obtained, with a sharper tuned circuit resulting. In the center of this coupler is a copper vane about one inch and a half in diameter, which is capable of being turned on its axis from a parallel position with the windings to a right-angled position. This copper vane, being in the center of the magnetic field, has the effect of adding remarkable selectivity and giving a tuning control finer than any vernier control on the market today.



Illustrations by Courtesy N. Y. Herald-Tribune

A schematic wiring diagram of the four-tube receiver described herein. This set will be found very efficient both for selectivity and distance reception.

The first step in the building of the receiver is to wind the absorption coil (wave trap) on top of the secondary of the neutroformer. Look at the neutroformer and find out which end of the primary is nearest. Then, beginning at the opposite end wind on top of the secondary in the same direction forty turns of the wire. This wire should be wound directly on top and between the turns of the present secondary. The loose end is fastened by laying a strip of tape on the wire, looped under several of the last turns and running the last turn through it, and then pulling it tight. A light coat of insulating compound may then be given it to hold it tight.

In the radio-frequency tube a method of neutralization is used which has proved itself efficacious during the last few months. It is the Farrand pliodyne method, and consists of a grid leak in series with a small .0005 condenser shunted across the plates and grid of the tube. This prevents oscillation of the radio-frequency tube, and allows the use of a regenerative detector without any chance of squeals or howls radiating from the set. Therefore it performs two functions, one bringing in distance and one allowing the use of regeneration, making a sensitive and quiet receiver.

It has often been said that one stage of radio frequency ahead of a regenerative detector was worth three tubes of radio frequency, and this receiver fully proves that theory. Furthermore, there is an absence of interference and other troubles generally experienced by the use of a regenerative set alone.

In hooking up the receiver taps are shown for the auto transformer. These, however, may be arranged inside the cabinet, as once the correct position for the antenna used is found it is not necessary to move them. On an antenna 120 feet long and 45 feet high it was found that the best results for selectivity and distance existed when the tap using six turns was used. However, the small dial for the vane vernier is used constantly when turning through locals, and therefore must be placed outside of the cabinet. The small dial necessary is furnished with the tuner.

Assemble the set with care, taking precaution that the wires do not cross at anything but right angles, and that the tuner and the radio-frequency transformer (neutroformer) are placed at right angles to reduce any chance of feedback through coupling. Attach one set of the condenser plates of the duo condenser to the secondary of the neutroformer and the other set of plates to the wave trap. As the turn ratio is calibrated no trouble will be found with the double tuning of this unit, and if a good tube detector is used, it will be found that the numbers on the dial will read within five of those of the condenser used to tune the first tube. Furthermore these numbers will always bring in the same station, provided that

(*Continued on page* 70)

How to Make an Audio Frequency Transformer

EVERY man knows that most experiments are just experiments and gives it up after becoming disgusted. But on the other hand, some of our most useful appliances were once experimental. However, the audio frequency transformer described herewith by *Meyer Rabinowitz* in *The Experimenter* will be found efficient and practicable both in design and operation.

As an audio frequency transformer requires a few thousand turns in the primary coil, the secondary will require several times that number according to the ratio, so the making of such a transformer seems rather complicated to the average layman. But, as the saying goes, "Where there's a will, there's a way," so I have thought out the following: We all know that a spark coil is composed of the iron wire core, the primary winding, and the coils of very thin wire for the secondary. We will first get an old Ford spark coil, which can be procured at any garage for the asking. The vibrating part is removed and the case broken open, but, as the coil is incased in pitch, great care must be taken in removing it.

The two secondary coils are connected in series near the core (Fig. 1a). The intervening space between the coils is filled with pitch which should be carefully removed by the following process: Heat the blade of a knife, first putting some grease on it. When it is very hot, cut into the pitch at the end of one coil and slice that coil off (Fig. 2). Through the core of the other coil locate the end of the thin wire and carefully bring it out to the inside of the core by cutting the paper (Fig. 3). When this is done, heat the knife again and slice off the pitch, but be careful not to cut the thin wire. This coil will be used for the primary, but a number of turns must be removed. As it is thoroughly solid, having been soaked in oil and pitch, it is impossible to separate the windings and make two coils (primary and secondary) out of one large coil. It will, therefore, be necessary to use both coils. The one just described will be the primary. Either unwind each layer or cut the layers off until there is about one-fifth of the original coil left.

Take the brown paper that insulated the primary from the secondary of the spark coil and paste it with shellac to the outside of the coil. The primary winding is now finished (Fig. 4).

The next step is the secondary. Beginning at the inside of the other coil the wire is carefully unraveled until the primary coil slides into it tightly. The ends of both coils are brought out. The complete coil is shown in Fig. 5.

The next important step is the core which is composed of strips of ordinary sheet iron. The size of the window opening for the coil should be 1⅝" x ½" (Fig. 6). Allowing one-half inch for overlapping (Fig. 7), the dimensions of the strips would be 2⅛" by ½" and 1" x ½", piled ½" high. Three legs of the core are built up, the coil slipped on, and then the remaining leg is put on. The problem now is to bring out the wires to binding posts and make the whole transformer firm and compact. Procure four sandpapered and smooth strips of wood 2½" long and ½" x ½" in cross section. Chisel out a piece from each a trifle less than ½" from both ends (Fig. 8). The four blocks are then put on each end of the transformer and holes drilled through the ends for bolts (Fig. 9).

(*Continued on page* 70)

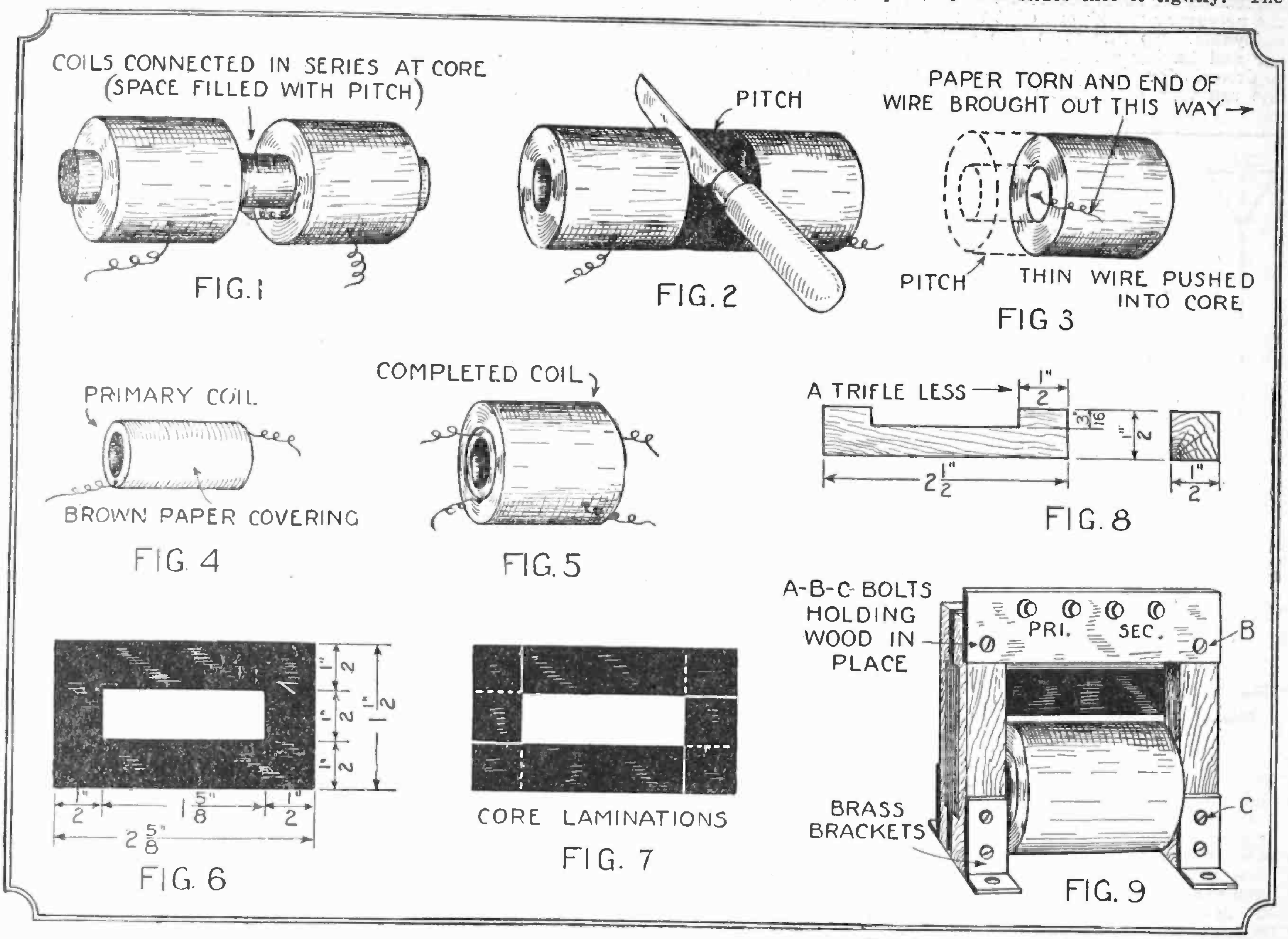


Illustration by Courtesy of The Experimenter (New York)

Constructional details of an audio frequency amplifying transformer the coils of which are obtained from an old Ford spark coil. Note that the inside of one of the spark coil secondaries forms the primary, and the outside of the other coil forms the secondary. The completed transformer is shown at Fig. 9.

Construction of a Simple Auxiliary Set

THE large set with its many tubes and a loud speaker is prying its way into many homes and taking the place that it justly deserves. But, still, the time often comes when a little single tube set would meet every requirement with complete satisfaction. The big set may need repairing, or its battery need recharging. A lone member of the household may want to listen quietly through an evening without disturbing the rest. The children may want a hand in the game, but find the operation of the big set too difficult.

For all these reasons, and more in addition, a little auxiliary set would prove to be a great boon. This simple set as described by *Kenneth M. Swezey* in the *New York Telegram and Evening Mail* Radio Section follows:

This particular outfit was selected because it is easy to build, the parts cost little, it is compact, and wonderful control can be secured by manipulating a single dial. Once constructed, there is nothing to get out of order, and the youngest child can operate it. Fans who have built similar sets have written eloquent endorsements.

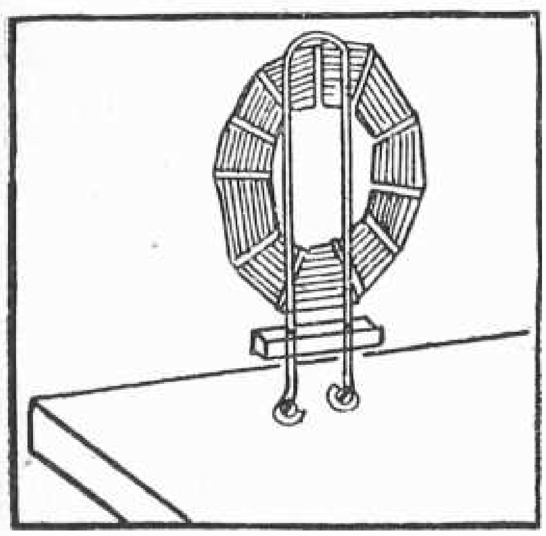


Fig. 2. Method of mounting the coil on the baseboard.

Circuit Very Simple

It is regenerative, and the circuit is so simple, the wiring so short, that resonant amplification is obtainable to the highest degree. Regeneration can be controlled to a nicety by the rheostat.

Although it cannot be classed with non-radiating sets, the tuning can be accomplished so rapidly, because of the single dial to adjust, that very little interference would be caused in the neighborhood, and those living in the country or suburbs could be perfectly conscience-free. Regenerative sets with three or four dials and that must be brought to resonance before a station can be accurately tuned are apt to cause much more trouble than this little one.

Volume and Distance

The comparative volume and distance that can be obtained with a single tube set depends chiefly upon two factors, tuning quality and resistance. Cautions have been repeated again and again, but never can they be sounded too often. A regenerative set is limited only by the ratio of its tuning qualities to its losses.

In our particular set the leads are all short, and the only things that can be improved upon are the condenser and the coils. By having both of these of low-loss types a result equal to that of any regenerative set that exists can be obtained.

Vacuum tubes are voltage operated devices, and in order to get the greatest response the inductance in the set should be kept as high as possible within the required wave length range—for the difference of potential is higher across a coil than across a condenser.

For waves from about 320 to 600 meters the variable condenser need not have a capacity above .0003 mfd. By using such a small condenser much more accurate tuning can be obtained, for the capacity variation for each degree is smaller. The fewer the plates a condenser has the nearer it becomes a vernier.

It is hard to describe just what points a condenser must have in order to have the minimum of loss, for the way it is put together determines the efficiency just as much as do the materials of which it is made. Conductor loss will generally be slight, for the plates and the binding bushings are of sufficient area and thickness to permit the free flow of any current that is encountered in a radio set, and anything from brass to aluminum will perform satisfactorily. But it is the insulation that must be watched, for high frequency currents swash around aimlesssly in dielectric materials as readily as magnetic flux permeates pieces of iron. In this way much energy is converted into heat and wasted. Therefore, a good condenser has as little dielectric between oppositely charged portions as it is possible to construct one with.

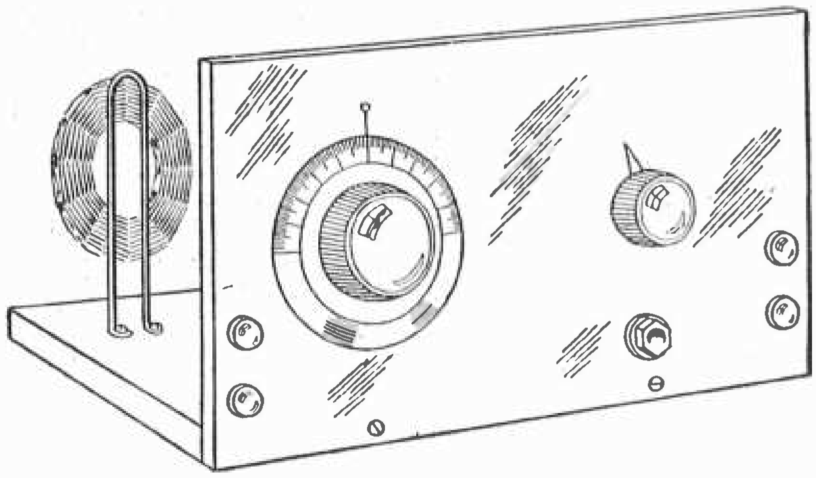
Coil Constants

The coils must be wound expressly for the set, and are wound in the modern low-loss fashion, with threads or thin wires as the supporting members. The primary takes the place of both primary and tickler and consists of fourteen turns of No. 18 or 20 double cotton covered wire, wound into a coil with a 2¾-inch inside diameter. The double cotton covering reduces the distributed capacity by giving the wires a little greater spacing.

With No. 24 cotton covered or enameled wire, wind a coil of forty-eight turns, to serve as the secondary. Be sure that it is wound in the same direction as the primary.

Each of these coils is mounted separately on a support made of a heavy wire bent as shown. These wires may be either passed through the coil between the meshes or else the coils may be securely tied to them with threads. The bottom ends of the wire supports are bent into loops with round-nosed pliers, so that they may be fastened to the baseboard with screws.

Next the panel may be drilled to suit the apparatus which it must hold. This comprises the variable condenser, a rheostat, a jack and four binding posts—two toward the lower edge of each end. It need in no instance be larger than 7x10x 3-16 inches. If a tube that lights brightly is to be used, it may be advisable to cut a hole or a series of holes, through which to ascertain the intensity of brilliance. The coated filament tubes, such as the 12 and the 199, do not need these holes.



Illustrations by Courtesy N. Y. Telegram and Eve. Mail

Fig. 1. Panel lay-out of the auxiliary receiver, showing the extreme simplicity in design.

Materials Needed

Any standard tube will serve satisfactorily, but probably the two mentioned would be in best keeping with the purpose of the set. The 11 and 12 tubes make the best detectors, but the 199 follows as a close second.

The rheostat should be suited to the tube. Some of the carbon-pile compression rheostats can cover the entire resistance range of all the tubes in common use, and the incorporation of one of these into the set might prove a valuable feature.

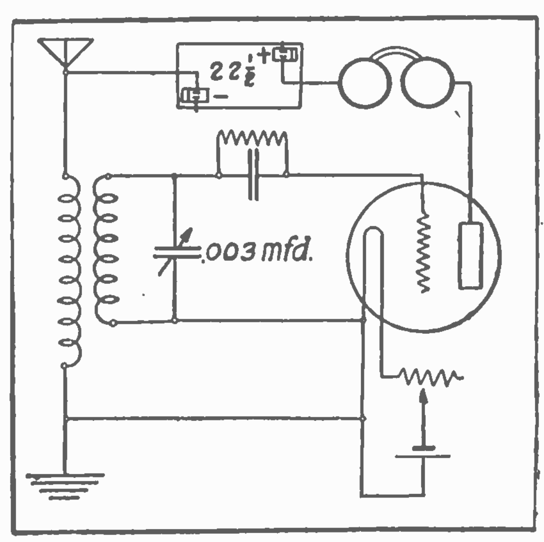


Fig. 3. Circuit of the set which can be built by a novice.

Secure a good mica grid condenser of .00025 mfd. capacity. By "good" is meant one whose capacity cannot be varied by squeezing. There are a few good fixed condensers with paper insulation, but they are so scarce that one cannot be too careful in making a choice. A grid leak to suit the particular tube should be mounted upon the condenser. The correct value is given on tube boxes, or on the circular which accompanies them.

A sub-base, about an inch shorter than the panel and about seven inches deep, is fastened to the panel by means of small brackets, or simply screws.

Next, the condenser, the rheostat, the jack and four binding posts are put into the permanent places on the panel. Then a socket is screwed to the sub-base, directly behind the rheostat. If it is possible, one terminal of the grid condenser and leak can be fastened directly to the binding post that leads from the stationary plates of the variable condenser.

The coils are mounted facing each other, and spaced about one-quarter inch. They should be at least two inches behind the rear end of the condenser. The secondary should be mounted on the side toward the panel.

Four Fahnestock clips should be screwed to the rear edge of the base to serve as the A and B battery connecting posts. The two binding posts on the left side of the front of the panel are for the aerial and ground, and the two at the right are connected directly across the terminals of the jack, so that an amplifier can afterward be conveniently attached, if desired, without disturbing any of the wiring.

As the low potential terminals of both coils, one side of the tube filament and the rotary plates of the variable condenser are connected to the ground post, no hand capacity effect will be observed, even though there be absolutely no shielding.

Heavy Wire Used

When wiring, use heavy wire, make connections as short as possible and do not neglect to carefully solder all joints. Soldering is more difficult than merely twisting wires together, but it means secure insurance against loads of troubles that might develop from imperfect contacts that make themselves by jarring or corrosion.

The connections of the coils are of utmost importance, for if they are not correctly wired the set will not regenerate. The inside end of the primary coil should be connected to the minus B battery post and to the aerial post. The

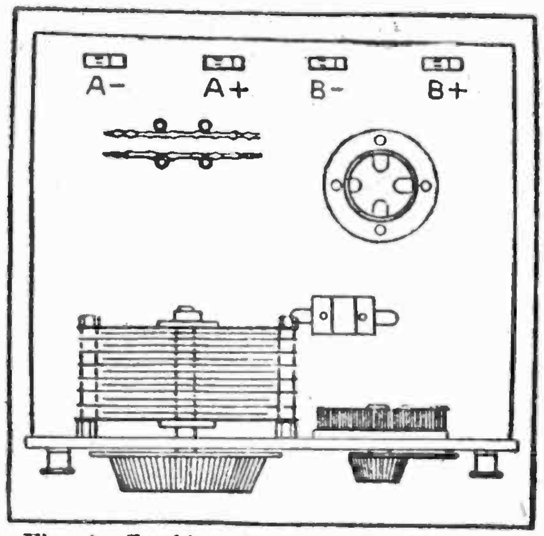


Fig. 4. Looking down on the placement of parts.

outside turn should be connected to the ground post, the rotary plates of the condenser, the minus A battery post and the inside turn of the secondary. The outside wire of the secondary connects with the stationary plates of the variable condenser and with the grid condenser.

If the set does not readily oscillate when connected this way, some experimenting will have to be done with the connections to the coils. They probably have been wound differently.

It is desirable that the variable condenser be fitted with a vernier attachment or a vernier dial, for the tuning is very sharp and critical. Often six stations can be brought in in succession at intervals of but about a quarter inch apart on the dial—each one distinct and free from interference by the others.

For local stations the filament rheostat may be turned down below the oscillation point, and perfectly satisfactory results obtained. When such conditions exist the set will not whistle, but stations will come in, rise to maximum and fade out again as the dial is turned.

Getting DX

When oscillating, DX stations are easily located, for between two squeals can always be found a station. The squeals can be entirely eliminated by accurate tuning. Turning down the rheostat will also cut it out, but at the same time this procedure will cut down the regeneration, and hence the volume.

When the set is complete on the panel and base it may be either left as it is or fitted into a suitable cabinet. Possibly a cabinet with a detachable front and a handle to make it readily portable would be ideal.

If a UV-199 tube is used, a small C battery and a small 22 1-2 volt B battery could be installed directly in compartments within the cabinet.

A regular outside or inside open aerial should be used. A loop is not practicable.

A Simple Four-Tube Receiver

(Continued from page 67)

the wave length of the station does not deviate.

Due to the fact that the ultra-audion method of regeneration, discovered by Dr. Lee De Forest, is used, the detector is constantly in a state of oscillation, unless controlled by the rheostat. The stations can be found by the "squeal" method, yet with the realization that such a method is not causing any trouble for the neighbors.

It is not a difficult set either to construct or to manipulate, and the writer believes that if a little care is taken in following out the diagram there should be no questions regarding its construction.

Now as to the tuning after the set is wired. After the tubes are turned up insert the plug in the detector jack and light the tubes. Turn the first tube up to normal brilliancy and the second tube until a slithering sound is heard. This denotes oscillation of the detector. Then place the antenna lead on the tenth turn and beginning at zero with both condensers rotate them almost in step. The first time that the set is tuned it would perhaps be advantageous to set the second condenser at a given point and then "wiggle" the first dial over 10 degrees.

When a station is found, leave the second condenser where it is and change the tuning tap around until the best point is found. Then turn the vernier until the minimum signal is heard, and carefully retune the second set of condensers until the loudest signal is heard. Then by retuning the vernier on the transformer the maximum signal will be heard. If there is any interference at all, it is only necessary to adjust this vernier.

I do not claim that this receiver will get KGO every night in the week, through the locals, and have not myself been able to get it as yet. However, logging such stations as CKCO, WBAP and KFKX so that if they are on the air they may be brought in, is a pretty fair record for a four-tube receiver using DV3 (dry cell tubes). With the larger DV2 tubes more volume is obtained, but the writer believes in the conservation of energy and therefore used the smaller tubes operated on three dry cells.

How to Make an Audio Frequency Transformer

(Continued from page 68)

The panel for the binding posts is a strip of bakelite ¾" x 2⅝" with four holes drilled in it and posts inserted. It is fastened on the top of the transformer by the clamping bolts. This is shown in the illustration of the completed transformer.

I use four brass L-shaped brackets ¾" x ½" to hold the transformer upright. Two holes are drilled or punched out on the ¾" side and one hole on the ½" side. The top hole on the ¾" side securely fastens each bracket to one block of wood by a screw. The other hole is for the brass bolt. The wood should be given a coat of varnish and the completed transformer is then ready for use.

When connecting the wires to the binding posts be sure to connect them as follows: The outside turn of the secondary or outer winding connects to the grid terminal. The inside turn of the outer winding connects to the filament terminal. The outside turn of the inner coil connects to the plate terminal, and the inside turn of this coil connects to the B terminal. The coils should be placed on the core in such a way that the windings are in the same direction. The transformer may be tested by connecting it in series with a dry cell and headset.

A Home-Made Storage B-Battery

CONSTRUCTIONAL details for making a practical storage B-battery which can easily be made by the home radio constructor were given by *J. W. Conzelman*, M. E., in a recent edition of *Wireless Age* magazine. The complete article reads as follows:

There comes a time in the experience of every radio fan with his set when the question of a better B-battery is paramount. If the average one of us were to trace our radio development we would find that tuning coils and condensers supplied our first worries, then suitable detectors followed in quick order and probably the A-battery was the next weak link in the set.

As the radio "bug" adds to the set, a storage A-battery must be used and thus the item is disposed of for a time, at least. You are just about to relax, thinking that all your problems are settled when the dry B-battery starts acting up and the question arises: "Shall I buy two more 45-volt dry batteries, or shall I invest in a storage B-battery?" The first solution offers temporary relief for six or eight months. The second represents an investment that is considerable and it sometimes seems questionable whether or not the extra trouble involved in looking after the storage cells does not offset the advantages gained in the operation of the set.

Why not make a simple, high voltage, small capacity source of power? It sounds easy, and if one follows the scent through the various types of primary cells, the voltaic pile, thermo-couple generators and all, he finds that each one offers disadvantages, either due to internal or local action. Friction machines have been tried out and small motor-generator sets, but have been discarded as unsuitable.

In the storage battery field the non-acid battery was eliminated because it offered no particular advantages over the lead-acid cell, and the unit cell voltage is considerably lower than that of the lead-acid cell. The lead-acid battery gives slightly better than two volts per cell and anyone familiar with regular storage batteries for automobile work, or for filament lighting, knows how to keep the cells in good operating condition.

To make the lead-acid cell there are required two lead plates and a dilute solution of sulphuric acid. If the lead peroxide plate and a plain lead plate are put into a dilute sulphuric acid solution a cell is formed with the peroxide plate at the higher potential. As the cell discharges, both plates are converted into lead sulphate ($PbSO_4$) at the expense of the acid radical in the sulphuric acid solution (H_2SO_4). The action reversible and lead peroxide is reformed on the positive plate with pure spongy lead on the negative upon charging. The reactions are very complicated in nature, but the results may be expressed thus:

Equation expressing action during discharging $PbO_2 + H_2SO_4 - PbSO_4 + H_2O + O$ at the + plate and $Pb + H_2SO_4 - PbSO_4 + H_2$ at the negative plate.

Since the reactions are reversible, reading the equations from right to left shows the reactions during charging conditions.

How to Make the 100-Volt Battery

Glass test tubes are recommended for the cell containers. They are cheaper than anything else, are acid resisting, and take up a small amount of space. The main objection to their use is the fact that they are so fragile. ¾" x 6" test tubes of plain glass cost about $2.50 per gross in Chicago. Only 50 tubes will be used, but a few extra should be kept on hand to replace any accidentally broken.

These tubes should be placed in a rack made as shown in figure 1. This arrangement of 10 tubes per row, and 5 rows, makes a rack of convenient shape, and it will be seen that it is convenient to charge the 5 rows in multiple, if a 25 or 30 volt B-battery charger is available.

Eleven pounds of ¼" round lead wire will be needed for electrodes. Cut this, after straightening, into forty-five 11½" lengths and ten pieces 7" long. Drill or punch with a sharp tool five small holes in each end of the 11½" lengths, as indicated in figure 2. Punching is recommended, as it is faster and requires less care. Do not go clear

(*Continued on page 74*)

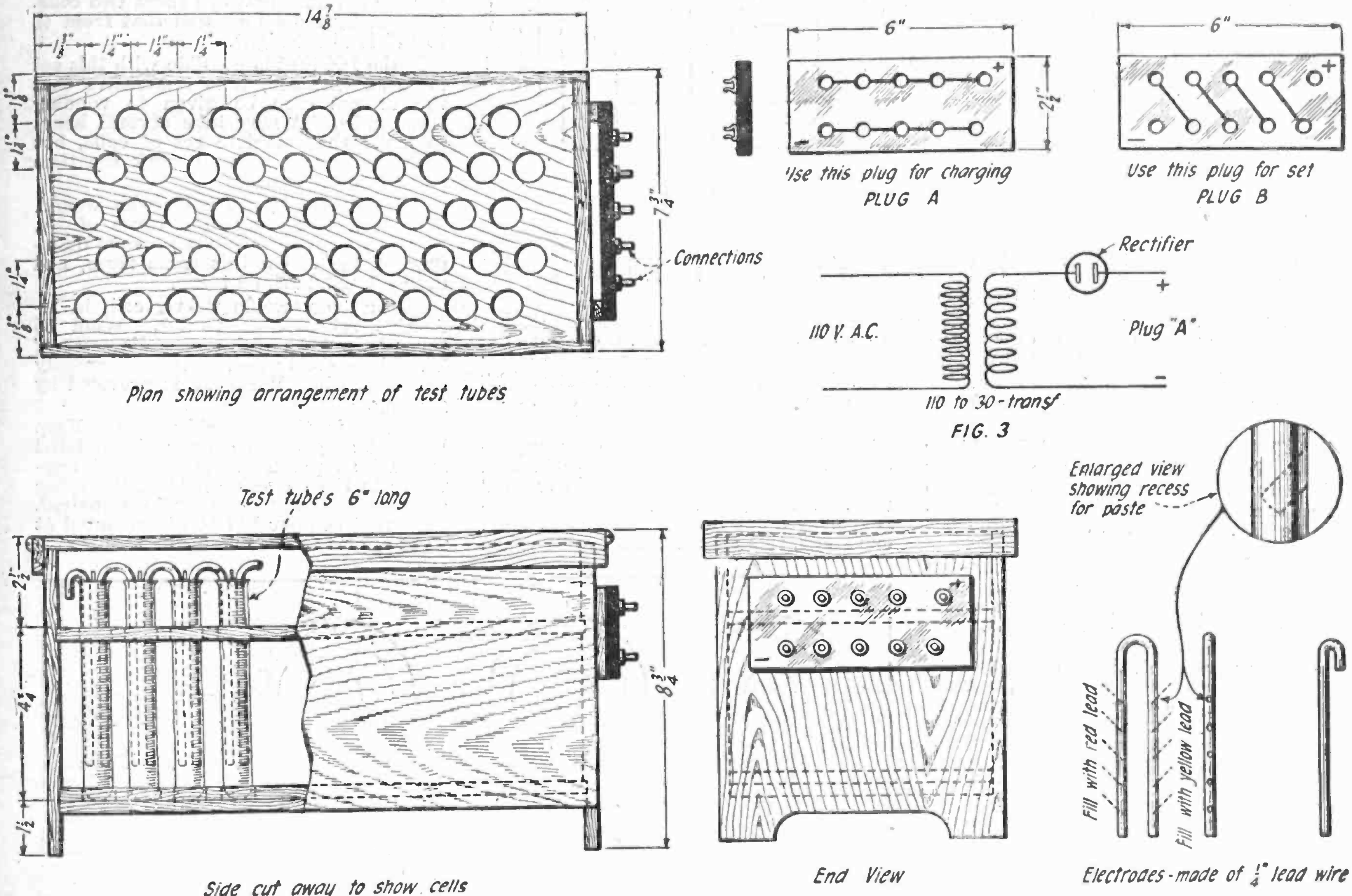
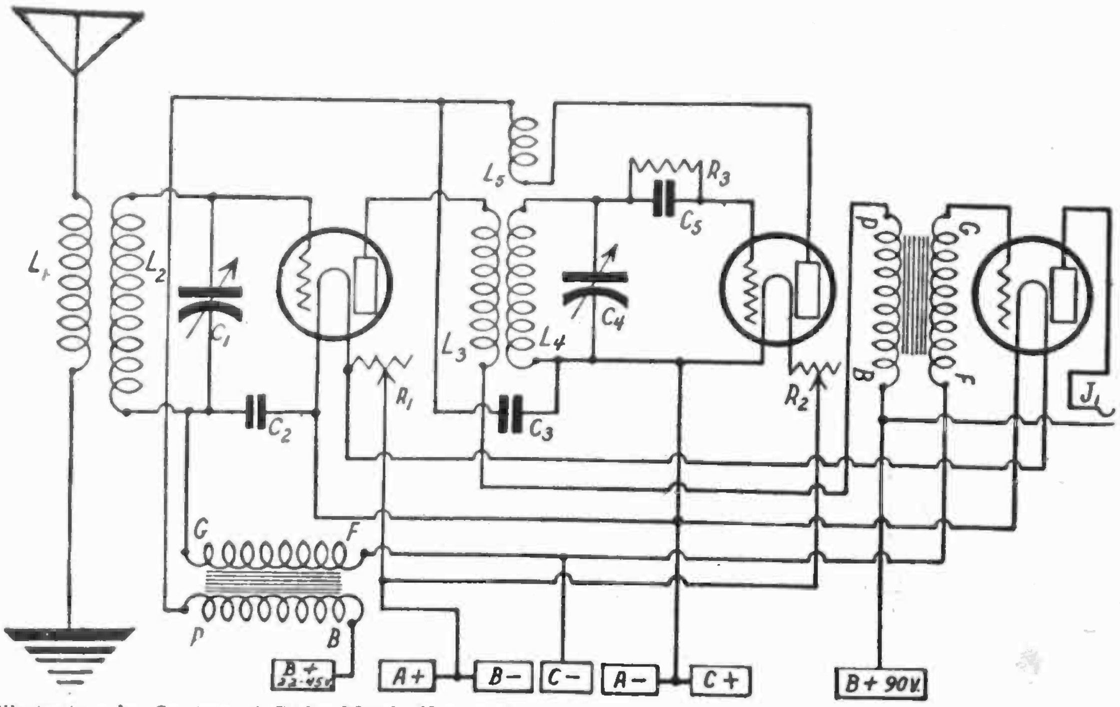


FIG. 1

Illustrations by Courtesy of Wireless Age (New York)

Showing the constructional details and hook-up of the home-made storage B battery.

How to Make a 3-Tube Superflex



Illustrations by Courtesy of Radio World (New York)

Fig. 1. The Superflex. The advantages of a 5-tube set are obtained from the Superflex, because the first audio stage is reflexed in the radio-frequency tube, and regeneration, equivalent to at least an extra stage of RF, is used in the detector tube. L1L2 are two separate coils, but inductively related. L3L4L5 constitute a 3-circuit tuning coil. The two variable condensers (one C1, the other regarded as C4) are .0005 mfd. low-loss, normally 23 plates. Both must have venier. A C battery is included to cut the B battery drain and eliminate any distortion.

THE Superflex, developed by *Abner J. Gelula* and recently described by him in *Radio World*, is claimed to rank among the most successful receivers of the day. This set is described as follows:

The public appetite for receiving distant stations is growing all the time, hence it was decided to design a receiver that would be a "bearcat" for DX and still would cover the prospective new waveband, 200 to 545 meters, without tapswitches. For satisfying the demand for DX performance the receiver was so designed as to be super-selective and extremely sensitive. The wide waveband was covered by employing compensated tuning. In this way the inductances and capacities of coils and variable condensers may be combined to reach the highest wavelength station.

List of Parts

One 3-circuit tuner, as described, or Pfanstiehl 3-circuit coupler.

One 50-turn coil; one, 10-turn coil.

Two Erla AF transformers, 6-to-1 and 3½-to-1 ratios.

Two General Radio .0005 mfd. vernier condensers.

Three Cardwell sockets.

Two Carter rheostats, 6 ohms each.

One 7x21" American Hard Rubber panel (Radion).

One cabinet and one baseboard (7x20") to match.

One Bradleyleak.

One Bradley filament switch, push-pull.

One Pair Towers phones.

Two 45-volt Bright Star B batteries.

One World 6-volt storage battery.

One roll talking tape.

One Federal single-circuit jack.

One Federal plug.

One Tungar 5-ampere charger.

Twenty-five solderless lugs.

One Eby terminal block.

One Western Electric loud speaker.

Three 201A tubes.

Lead-in wire, connecting wire, screws, insulators, aerial masts.

The circuit (Fig. 1) embodies a stage of radio-frequency amplification regenerative detector and two stages of audio, the first audio stage reflexed in the RF tube. As regeneration supplies radio-frequency amplification equal to at least one stage, this circuit has a 5-tube value.

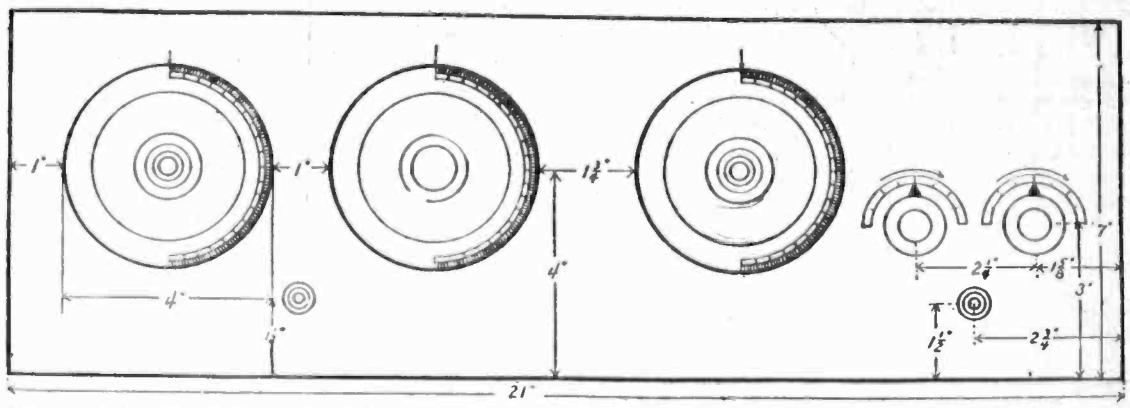


Fig. 2. The panel lay-out. There are three controls. Two rheostats are shown. The jack at the left is for plugging in a loop. When the plug is inserted, the serial, ground, primary and secondary coils are automatically disconnected from the set, placing the 23-plate condenser (left dial) across the loop. The two condensers are mounted on each end of the panel, the variable inductance in the center.

Many a Neutrodyne will not bring in as much DX as this 3-tube set. Although this is a reflex it is not difficult to construct or operate.

The Coils Used

The primary and secondary coils are fixed. All coils are of the spiderweb type. The primary is 15 turns wound on a spiderweb form having a core of 1" in diameter; the secondary, 35 turns, on a spiderweb form having a core diameter of 1½". No 2 double silk covered wire is used.

When the coils are to be mounted, it would be well to experiment in adjusting the distance between these two coils. Laboratory tests indicated that from ¼ to ⅜" is about right.

If the DX that is possible with this set is to be obtained, it is imperative that the utmost care be given to winding these coils. It may take several hours to make the complete set of coils, but the results will be well work the time and energy spent.

All three coils are spiderweb wound. Wind L3, consisting of 8 turns of No. 22 DSC, on a form having a core diameter of 1½". On this same form, and over L3, wind L4, 50 turns.

L5 is the variable tickler coil, in inductive relationship to L3. Wind 35 turns on a form with a core diameter of 1". These coils are known commercially as Phanstiehl. Variation is provided by gearing.

Fig. 3 is the assembly plan. Keep L1L2 at as great a distance from L3L4 and L5 as possible. If L1L2 is anywhere in the inductive field of the other coils results will be greatly impaired. Note that coupler L3L4L5 is mounted at right angles to the tuning unit.

As to the condensers, C1 and C4 are low loss .0005 mfd. variable condensers (normally 23 plates) with vernier at-

(*Continued on page* 78)

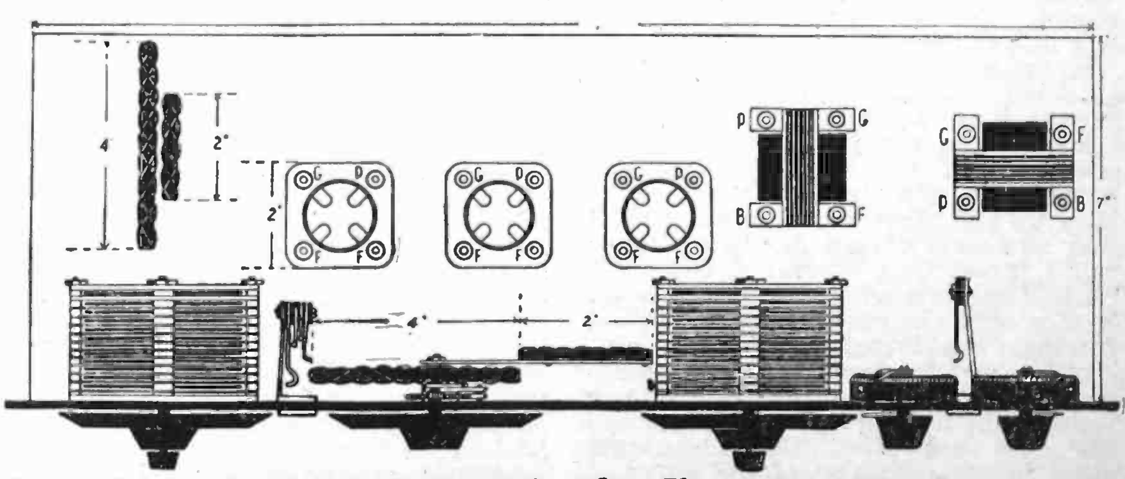


Fig. 3. The assembly plan for the 3-tube Superflex. The two spiderweb coils, representing primary and secondary, are shown at the left, directly behind the condenser. The smaller coil is the primary. The variable inductance is mounted between the two transformers. The loop jack is placed between the coil and the variable condenser.

An Experimental Receiver

A Set Consisting of Units Adaptable to Any Circuit

WHEN a promising new wiring diagram appears in a paper or magazine, and its virtues are described in glowing terms, how does it make one feel when he realizes his panel set can never be changed to try the new circuit? *R. C. Hitchcock* describes the solution in *The Cincinnati Enquirer* as follows:

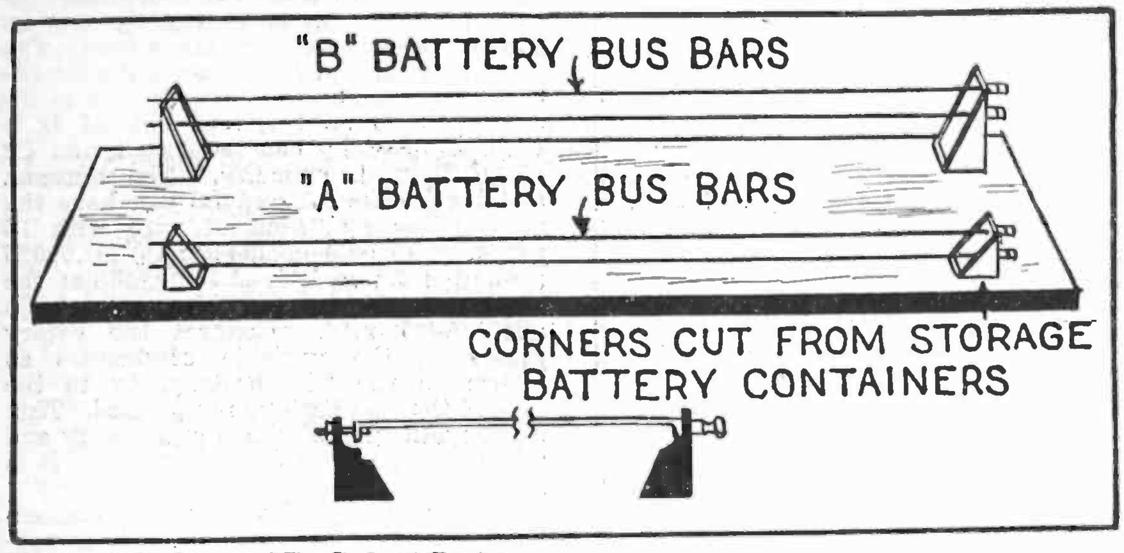
A radio fan who likes to experiment will probably feel, as the writer has felt, that everything is not just right. Why shouldn't every one be allowed to try all kinds of wiring schemes? Of course, if unlimited money is available, it might be possible to build a new set every time a new type circuit made its appearance. That would be fine; but the majority of radio fans will have to content themselves with one set, or perhaps, after seeing how easy that set is to build, one regular set and one experimental receiver.

Without dismantling the regular set it is possible to use the same tubes, batteries, antenna—everything but the smaller parts, which are comparatively inexpensive. The set to be described is for those who want to keep up with the latest in radio at a reasonable cost.

It is called the "experimental set" because it is never completely finished; something may be added to it if it is thought to be an improvement, or dispensed with if not. In short, anything may be done, and the fun of doing original work, of trying new ideas, is twice that of merely operating a set some one else has built. Try it and see.

The idea on which this experimental set is based is this: The modern tube uses "A," "B" and "C" batteries; almost every well-known circuit has three batteries. Some people prefer to use only the "A" and "B" batteries, and for those the set can be simplified to that extent. Now, if every set must have connections to batteries, regardless of the other differences in circuits, why not provide permanent wires to these batteries? Much time used in trying various schemes led to the adoption of the one here shown, namely, in stringing permanent busbars to which the batteries are connected.

By proper placing it is possible to avoid most of the feedback and capacity effects, and the accessibility of connections will commend itself as a great advantage. So, instead of having to bend a lot of wires, insulate them with tubing and figure out the best positions of instruments, all one has to do is to fix heavy bare copper wires in place above the baseboard, and the instruments may be hooked to them with a minimum of time and effort. (See Fig. 1.) In this figure note that the "A" battery leads are in front, where the operator's hand will be in operating the set, while the "B" battery leads are in back.



Illustrations by Courtesy of The Cincinnati Enquirer

Fig. 1. Showing how the busbars are supported on insulating brackets made from the corners of storage battery containers.

The busbars are screwed to hard rubber corners cut from an old storage battery container. These containers are cheap and may usually be obtained by merely asking for them at a battery service station. They are cut with an old wood saw; in fact, they are more easily cut with a wood saw than with a hack saw, as the teeth of the former are coarser and do not clog. The particular containers used for the busbar supports are best taken from the smaller jars of a 12-volt battery, and are sawed diagonally as seen in Fig. 1. Binding posts on the hard rubber corners are used to connect the busbars to their respective batteries. The "C" battery bus is omitted in this figure. If the high voltage "B" battery is less than 45 volts a "C" battery is not necessary, but if the utmost is wanted for your tubes the "C" battery and a high voltage "B" battery are recommended. The proper voltage for "B" and "C" batteries are generally given on the sheet supplied with the tube. For a 201A tube use 3 to 4½ volts "C" battery, with a 90-volt "B" battery.

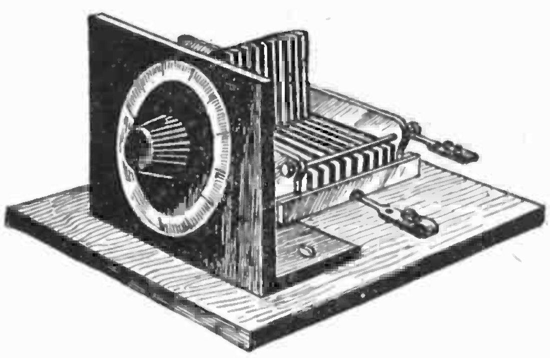


Fig. 2. The condenser unit is mounted on a small panel and baseboard.

Can Be Any Length

The busbar can be any length that the experimenter decides to make it. If a five-tube set is to be used make the bus long enough to accommodate it. If very long it will probably be necessary to support it at the middle, or brass rods could be used. No. 12 hard drawn antenna wire was used for a stretch of over three feet in the writer's set and gave good results.

Without a doubt there are other ways to fasten the busbars; the one shown is simply the one the writer has tried and found satisfactory. If another scheme is decided upon, still using the overhead bus wires, be sure the supporting material is a good insulator. Ordinary glass would be very good and pyrex glass would be ideal, but it would be a question whether or not it would be easy to get the glass into the shape necessary to use for this purpose.

The second feature of the experimental set is that every unit that goes into the set can be moved—can be used in another part of the set if it proves to be desirable to do so later. Tube sockets are mounted on wood bases to prevent tipping and the filament posts are equipped with short, flexible wires terminating in clips, so they may be attached to the "A" battery busbars at any point. Condensers may be of the panel type and are mounted on wood bases which have hard rubber "I" pieces also cut from battery containers. (See Fig. 2 for a drawing of the condenser mounted.) These condenser units have separate panels, and variometers and variocouplers may also be mounted in the same way.

Coils may be any of a variety of kinds. If they are of commercial type wires may be attached to the binding posts provided. If home-built coils are used simply leave the leads long enough to make connections. It will be found by the use of clips a very quick change is possible. Or, if one prefers to use the still simpler method of winding the wire several times around the proper wire, it will be satisfactory, at least for a temporary connection. It will be found a good plan to put a form of spring clip on instruments often used, such as condensers, so that coils may be connected across them easily. Small lengths of wire with clips on one or both ends will prove handy in making connections to various units of the set.

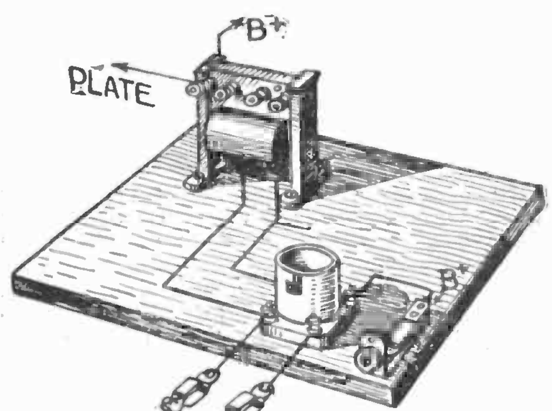


Fig. 3. The audio frequency amplifier is also made in a unit and provided with clip leads for connections.

There is an advantage in using tubes all having the same filament voltage, having both detector and amplifier tubes work at, say, 5 volts. With this combination a single rheostat may be used for the whole set. The rheostat can be mounted conveniently at the end of the

A busbars and put in series with the A— busbar. The one precaution is to be sure the rheostat is able to carry the combined currents of all the tubes. Some of the ordinary 6-ohm rheostats will carry 2 amperes without undue heating.

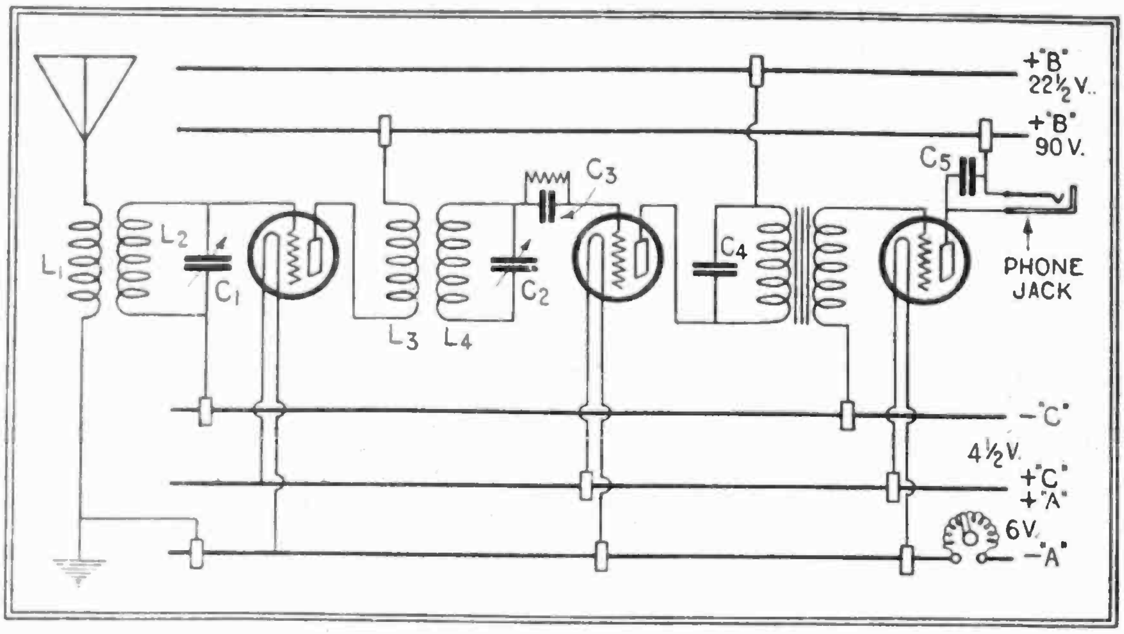


Fig. 4. A typical circuit which is only one of the many that can be readily hooked up with the devices described herewith.

This will allow the use of a 1-ampere detector tube and four ¼-ampere amplifier tubes. A lower resistance rheostat of about 2.5 ohms, such as is used for low-power transmitters, is better for use in sets having five tubes or more. If a panel type of rheostat is available a small hard rubber panel may be used to hold it upright, in the same manner as employed for the variable condenser. A voltmeter placed across the ends of the "A" battery bus will be very helpful in showing the proper filament voltage. Using No. 12 wire, as suggested, the difference in voltage along the wire will be only a few hundredths of a volt when using five tubes, which take a total of two amperes.

All receiving sets have some things that are always used in company with others, no matter what the circuit used. For instance, a detector tube always has a grid condenser and leak, an audio-amplifier tube always has a transformer and phone jack, and here is found the third feature of this experimental set. Wire such units together and leave wires for the connections which couple them with the rest of the set. Such a combination is shown in Fig. 3, an audio-frequency amplifier unit ready to be clipped in place.

Keep in mind this set is designed for favorite hook-ups, but any other kind of a wiring diagram may be tried at any time with a minimum of changed connections. Its main claim to fame is in its battery connections, which are all provided and are easily accessible. A typical set, only one of many possible ones, is shown in Fig. 4. This is meant to show possibilities only, and therefore only one radio and one audio amplifier are given with the accompanying detector. By duplicating the circuit of the first tube two radio amplifiers may be used, or neutro-formers may be put in and the circuit changed to a neutrodyne. Another audio-amplifying stage may be added for loud speaker operation.

Note the detector tube has its plate connected through the audio-frequency transformer to the 22-volt "B" battery, and no "C" battery is used on this tube. This assumes a soft detector tube is used drawing one ampere on the filament. A similar connection is advised for the 201A when used as a detector. In case one may want to try the set as shown the constants are given here. The grid coils L2 and L4 to cover the broadcast range should be three inches in diameter, with 50 turns of No. 24 DCC wire, shunted by condensers C1 and C2 of .0005 mfd. capacity. The antenna and plate coils L1 and L3 can have the same tubes and kind of wire with 15 turns. The grid condenser C3 is .00025 mfd. and its leak is 2.5 megohms; the condenser C4 is .00025 mfd. and C5 about .005 mfd. Connect the rotary plates of the variable condensers as shown to the "C" battery, or to the A— if the "C" battery is not used. This circuit will give distance and clarity and will cause no local disturbances, as it is not regenerative.

As for the speed with which connections may be made, of course it is necessary to have on hand a few variable condensers, coils and tube sockets, all mounted on small bases. After one set has been built it may be changed quite quickly into another for purposes of investigation. The writer has assembled a five-tube set, with two radio amplifiers, detector and two audio amplifiers in less than half an hour. The beauty of this arrangement is that one may change from a neutrodyne to reflex, try crystal detector with tube amplifiers, or revert to the standard three-circuit regenerative set—all in a very short time. By the way, always take out the tubes when shifting a connection, as the "B" battery may accidentally connect across the filaments and burn out the tubes.

From the success had with this scheme and from various comments received, it is believed that the real radio fan will be delighted with this experimental set, with its ease of operation, and its extreme flexibility.

A Home-Made Storage B-Battery

(Continued from page 71)

through with the hole. These pockets are used to contain the paste used to assist in forming the plates.

At the drug store get about ¼ lb. of red lead C.P. and an equal weight of yellow lead C.P. and make these powders into pastes by mixing with dilute sulphuric acid. Use C.P. acid and mix one part acid with four parts of water to make the pastes.

When the wire is clean use an old knife and press the red lead paste into the holes on one end of each piece and the yellow lead paste into the other end. Lay the hair-pin shaped electrodes aside for at least 24 hours so they will dry slowly. The short pieces are to be treated as above, except that half are made into "+" plates with red lead paste and half into "—" plates with yellow lead paste.

When all have dried out place them in the test tubes, being careful to keep all "+" ends of the plates to one hand and all "—" ends to the opposite hand. Put the single plates in their proper places in the end cells.

To make the electrolyte, buy about a pint and a half of C.P. sulphuric acid, and in a fine stream slowly pour this into a glass or porcelain vessel, containing about three pints of distilled water. Danger! Never pour the water into the acid, because the heat generated will crack the glass vessel and may blow the acid into your eyes and face. The density should be between 1230 and 1240. If below 1230 add more acid slowly as before. If above 1240 add some distilled water very slowly. In either case let it cool again and take another reading.

To keep the electrolyte from creeping paint the tops of the test tubes and the V bend of the lead with molten paraffin or wax.

Connecting Up the Battery and Filling

Put all the plates in the tubes and have the red lead plates to the right as shown in figure 1. Secure some lamp cord wire and untwist the two wires, using this to connect up the end cells to the connectors shown at the end of the battery. Solder a wire from each of the top connectors to each of the single "+" plates in the cells at the right end. Solder a wire from each of the bottom connectors to each of the single "—" plates in the cells at the left end and then brush over these soldered connections with molten paraffin.

We are now ready to fill the tubes with the acid solution. Use the hydrometer for this purpose and fill all tubes evenly to a point about one inch from the top.

The battery is now ready for charging. On account of the relatively small area of the plates, a very small charging rate is recommended, not over 2 ampere per cell, or when charging the five rows in parallel, the charging rate should not exceed one ampere.

Charge the battery at this rate for twenty-four hours and it will show one hundred volts, or a little more, across outside terminals. Discharge through a 40-watt 110-volt lamp until the lamp ceases to glow and again charge for twenty-four hours. After repeating this for three or four days, the battery may be used all evening in the radio without a material drop in voltage.

A Multi-Stage Radio Frequency Set

A VERY interesting form of alternate tuned and untuned radio frequency set is that deveolped by John Scott-Taggart of England. This receiver has proven very efficient and has won wide popularity among radio fans of Britain. Details of the circuit given by *A. Dinsdale* have lately been published in the *N. Y. Telegram and Evening Mail* Radio Section as follows:

Every one who has tried to use more than one stage of R. F., especially with the tuned plate method of coupling, knows how extremely difficult it is to stabilize the set. The moment the tuned circuits are brought into resonance the tubes break into violent self-oscillation, which can only be stopped by introducing into the circuit some stabilizing device such as a potentiometer.

The reason for this oscillation is that in all R. F. circuits where one stage is coupled to the next by means of a tuned circuit both the grid and the plate circuits of the tubes are tuned, and under such circumstances, when the two circuits are brought into resonance, only a very minute degree of coupling between them is necessary to cause oscillation.

Such an amount of coupling is always present, owing to unwanted stray capacities and inductive effects between the coils. Most of the capacity coupling is provided by the grid and plate of the tube itself, which really acts as a small two-plate condenser.

The effect of tube capacity can be eliminated by introducing into the circuit a small condenser of the same capacity as the tube and arranging it in such a way that it neutralizes the tube capacity. This is the well known neutrodyne method, invented by Hazeltine.

Another method of preventing oscillation is to introduce a potentiometer into the grid circuit. By means of this a small positive potential is impressed upon the grid of the tube, sufficient to make it impossible for the circuit to oscillate.

The use of any form of stabilizer, however, introduces into the circuit losses of various kinds, reducing the efficiency of the coupling, and at best they are not entirely satisfactory in operation, especially if more than one stage of R. F. is used. The receiver becomes more complicated owing to the additional controls and will always be critical in operation.

Other Methods of Coupling

There are, altogether, four ways in which R. F. stages can be coupled together. A radio frequency transformer, the secondary of which is tuned by means of a variable condenser, may be used, or the plate circuits of the R. F. tubes can be tuned simply by means of a simple closed resonant circuit. Both these methods are highly efficient, especially the latter, but both cause instability.

In the other two methods, coupling is effected by including in the plate circuit an R. F. choke coil, or a high non-inductive resistance. Both these couplings are aperiodic and not quite so efficient as the tuned couplings. The resistance coupling, in fact, will not work at all on wave lengths under 1,000 meters.

Now, as was explained above, instability in R. F. circuits is caused by the fact that both the grid and plate circuit of each R. F. tube is tuned. Obviously, therefore, if we make one of these circuits aperiodic, oscillation cannot take place, and our circuit will be stable.

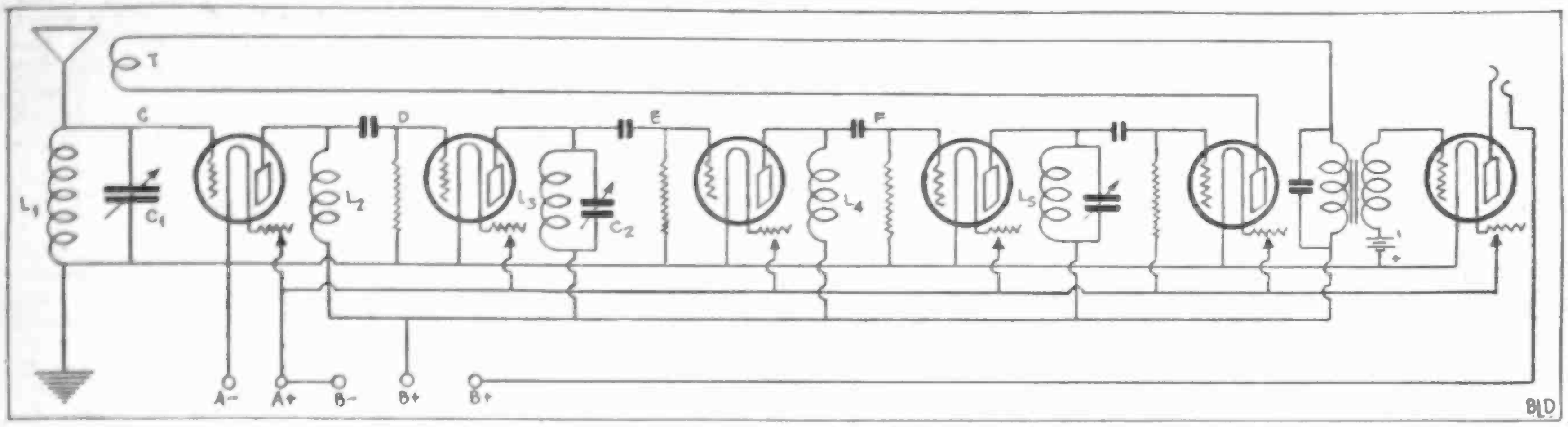


Illustration by Courtesy N. Y. Telegram & Eve. Mail

Circuit of the alternate-tuned and untuned radio frequency receiver developed by John Scott-Taggart.

Tuned and Untuned

The circuit shown in Fig. 1 was invented by John Scott-Taggart, and is all the rage in England at present. As will be seen from the diagram, no two tuned circuits are adjacent to one another, for tuned coupling is alternated with aperiodic coupling.

The first tuned circuit is L-1 C-1, which is followed by the aperiodic R. F. choke coupling L-2. This in turn is followed by the tuned coupling circuit L-3 C-2, and so on.

Provided that reasonable care is taken in arranging the components so that stray capacities are reduced to a minimum, any number of stages of R. F. amplification can be employed in this manner, but it is best to use an even number so that the last stage is always tuned. In this way the maximum use is made of tuned coupling, which is more efficient than choke coupling.

Particular care should be taken in the arrangement of the inductances and chokes. They should be spaced as far apart as practicable, and, if honeycomb coils are used, arranged at right angles to each other, so that all possibility of inductive coupling between coils is avoided. The tubes used should, for preference, be of the low capacity type, such as the Myers, but almost any tubes can be used quite safely.

Constants of the Circuit

Many radio fans prefer a straight circuit to the more complicated trick circuits, and for such people the circuit which is the subject of this article has much to recommend it. It is undoubtedly the best straight circuit ever produced, and no matter how many R. F. stages are included, it is absolutely stable. Unless regeneration is employed, it is quite impossible to make the circuit oscillate.

Coming now to the constants of the circuit, we have to decide first of all what kind of coils are to be used. We may use either specially wound low-loss coils and specially wound choke coils, or we can use honeycomb coils for all purposes.

In favor of the latter method is the fact that coils can readily be changed so that a wider band of wave lengths may be covered. Also, the use of honeycomb coils greatly simplifies the construction of the receiver.

The constants and manner of operation will be given for both methods, so that readers can adopt whichever one they prefer.

If honeycomb coils are to be used throughout, L-1, L-3 and L-5 will be No. 35 coils for wave lengths between 200 and 300 meters, and No. 50 coils should be used for the 300 to 500 meter wave band.

The size of the choke coils also depends upon the wave length, larger coils being required as the wave length is increased. For 200 meters, No. 150 coils will be found suitable, and for 300 to 500 meter work, No. 200 or No. 250 coils will be required, depending on the wave length.

The Condensers

The three variable condensers should be of the low-loss type, and preferably of the design known as "square law," which have the entering edges of the moving vanes slightly cut away. Such a condenser gives a straight line tuning curve, whereas with an ordinary condenser, a movement of one division at the lower end of the scale will give a much greater capacity change than a similar movement at the top end of the scale.

C-1, which tunes the aerial circuit, has a capacity of .0005 mfd., while C-2 and C-3 are both .0003 mfd. If matched coils are used, C-2 and C-3 can be a double condenser, the two halves of which must also be matched. If this is done we reduce the number of controls so that we now have four stages of R. F. controlled by but two dials.

If it is decided not to use a double

condenser the tuning will still be comparatively easy, for the dial settings of C-2 and C-3 for any given wave length will always be approximately the same.

If matched coils cannot readily be obtained, ordinary coils may still be used in conjunction with a double condenser provided that a small two or three plate vernier condenser is connected across one-half of the double condenser. Small variations between coils can be taken care of in this way.

The fixed grid condensers are all of the usual value, .00025 mfd., and the grid leaks have a resistance of two megohms. The condenser across the primary of the A. F. transformer has a capacity of .001 mfd.

The value of the filament resistances depends, of course, upon the type of tube employed, whether bright or dull emitter.

The value of tickler coil T depends, as usual, upon the wave length and the value of the coil to which it is coupled. It may be mentioned here that the tickler may be coupled either to the aerial coil or to either of the tuned circuit inductances.

If it is coupled to the aerial coil and the receiver is made to oscillate a disturbance to other listeners will be caused, whereas if coupled to one of the tuned plate coils any oscillations which may occur if regeneration is pushed too far will be prevented from reaching the aerial circuit by the presence of the R. F. chokes.

It will be found, however, that the receiver will be easier to handle if the regeneration is applied to the aerial circuit, and for that reason many people will prefer this method. There is really no necessity for regeneration at all, as the enormous DX getting power of four stages of R. F. is quite sufficient in itself. It has been included in the diagram so that those who wish can apply it.

Coil Construction

For the benefit of those who prefer to use low-loss coils instead of honeycomb coils the following data will enable them to wind their own coils:

Coils L-1, L-3 and L-5 should be wound with No. 18 double cotton covered wire, using the now well-known low-loss basket weave method of winding, making the coils self-supporting. They should be made three and one-half inches in diameter, and if wound with fifty turns of wire and used in conjunction with the variable condenser values given they will tune from about 250 to 500 meters. When completed these coils should be mounted on the baseboard in such a way that they are not in inductive relation to each other. The construction of the choke coils will prove rather more difficult.

In order to cover the various wave lengths, they must be made variable by means of tappings taken to rotary switches. A choke coupling is to all intents and purposes aperiodic, but not quite so, because it is necessary to vary the number of turns in use according to the wave length upon which the set is operating. The higher the wave length the more the turns required in order to secure proper amplification.

The chokes may be wound on a bakelite tube two and three-quarter inches in diameter and two inches long. One ounce of No. 40 single silk covered resistance wire will be required.

Starting half an inch from the end of the formers, wind on 150 turns of the wire, taking the first tapping from the fiftieth turn, and further tappings at every tenth turn thereafter until the 120th turn is reached, after which no further tappings need be taken.

That is to say, tappings will be taken at the 50th, 60th, 70th, 80th, 90th, 100th, 110th and 120th turns. These tappings, together with the two ends of the windings, are taken to the contact stubs of two ten-point rotary switches, which should be fitted on the face of the panel in convenient positions such that the chokes themselves can be mounted flat on the back of the panel in such a way that they are not in inductive relation to each other or any of the other inductances.

Operating the Set

No insuperable difficulties will be met with in operating this receiver, especially if a double condenser is used for the tuned R. F. stages. This condenser and the aerial circuit condenser should be operated simultaneously. At first, owing to the very great selectivity of such a combination as this, some difficulty may be experienced in picking up distant stations, but a few hours' practice should suffice to enable one to get the knack of it.

Tips on Wiring Your Set

A neatly wired radio set works best as well as appearing better than one that is carelessly wired. By choosing the positions of wires many capacity effects are avoided and a set that does not have these effects will have little howling.

It is well to keep wires connected to the plate as far from others as possible. These wires carry power, and if they are near other wires feed-back effects occur which are very annoying. Grid wires are best kept away from the panel, and, more generally, away from any point that is grounded. If you bring your hand near the grid post of an oscillating tube the change in capacity will make a howl in the headset. Battery and ground wires may be bunched. Wires at right angles have little effect on each other, and if for any reason it is necessary to cross grid and plate wires, it should be done at right angles. Parallel wires have a capacity effect and induce currents in each other which interfere with tuning. Your hand when you are tuning a set is close to the set and, of course, your body is grounded. If you are turning the dial of a variable condenser you change its capacity slightly when you remove your hand, and often lose the station that was just heard.

Rigid Wire Best.

The actual wire to connect the set may be any of several kinds. Some are easier to use than others, and each has some advantage. Stranded electric light wire such as found in extension cords is sometimes used. Due to its flexibility, which makes it easy to use, this wire will not be as satisfactory in a set as a rigid wire. The flexible wire sags, vibrates and often spoils the tuning at unexpected moments. A rigid wire is often termed a "bus-bar," so named after the original use of solid copper bars in central lighting stations to carry heavy currents. These original bars were bare, so that new circuits could be quickly clamped on to them, and there was no necessity of removing insulation. Present-day bus-bars for radio use are sometimes bare, connections being easily soldered without scraping off insulation. Also there are some types of bus-bars that are covered, either with permanent insulation that must be scraped off to make connections or bare bus-bars that are later covered with a flexible varnished tube known as "spaghetti." If the wire is stiff enough to support itself—and the tpyes of 18 to 12 B & S wire gauge are always fairly stiff—there is little need for covering. Tests show that a bare wire with air insulation is more economical of radio energy than one with a solid covering. The bare wire is more efficient because air is the best insulator known, having less loss than any solid material. Another point in favor of bus-bars is that they are fixed in place and do not spoil accurate tuning by their motion.

Copper Wire Satisfactory.

Bare bus wire may be had in various styles. Ordinary solid copper antenna wire makes a satisfactory bus. Regular bus-bars are often tinned and are either square or round in form. Round is to be preferred, as the corners of the square type radiate off the energy, in much the same manner that lightning rod discharges electrcity from its point during a thunder storm. Tinned wire is easy to solder, and its only disadvantage is that the conductivity of tin is rather low, and that as radio currents travel mostly on the surface, where the tin is, the resistance is large. A bright copper wire is a better carrier of radio currents than a tinned one of the same diameter. Silver wires would be ideal, and silver-plated copper wires would be nearly as good.

For the continued successful oreration of your set all joints should be soldered. This is an easy task, and will well repay your efforts by keeping your set always working, and not stopping, due to poor joints, at some inopportune time. A few words about soldering: Do not use acid or soldering paste. The acid will corrode the part, sooner or later, and should not be used.

Use Paste Sparingly.

Soldering paste will always remain a paste; it doesn't harden, and if in soldering you use a bit too much the excess will run and spread itself over the panel, jack or whatever you are soldering. This paste is a fair conductor of electricity and acts simply as a short circuit for the radio energy. Your set will not do its best if you use soldering paste. Resin is the best flux. If you should use too much of it there is no harm done, for the resin is solid when cold and a good insulator. Some types of wire solder have resin cores and are very good. But do not use a wire solder with an acid core; it will corrode the connection. If you have solder in bar form or in wire coils use powdered resin bought in bulk.

In soldering use a hot iron, which, by the way, is really copper, and do not try to work with an iron so cold that the solder barely melts. On the other hand, do not heat the iron so hot that it glows or is redhot. Don't try to heat the iron in a coal stove; you are likely to melt off the tip. A gas flame or a blowtorch may be used.—(*The Detroit Free Press.*)

The Ritz Super-Heterodyne

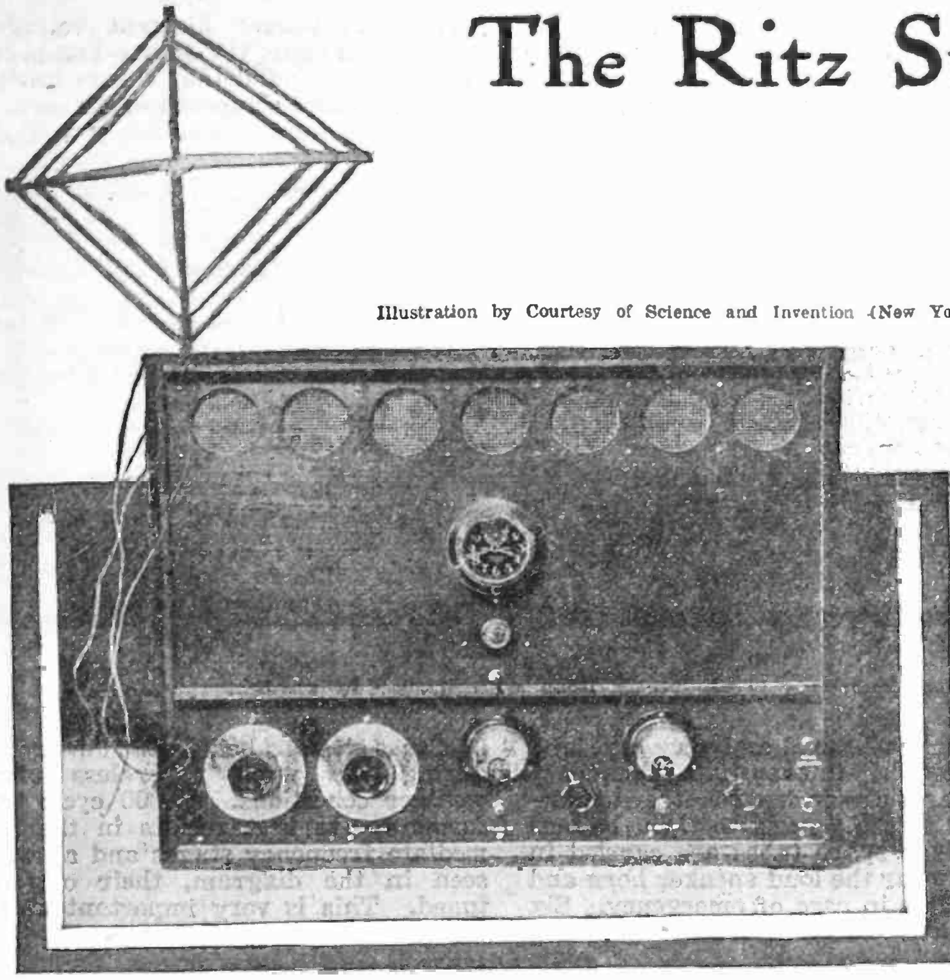
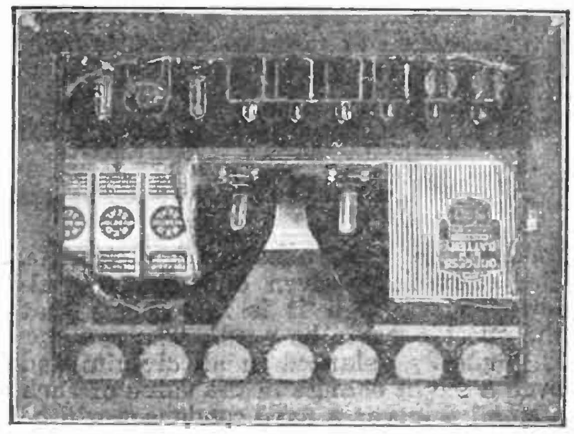


Illustration by Courtesy of Science and Invention (New York)

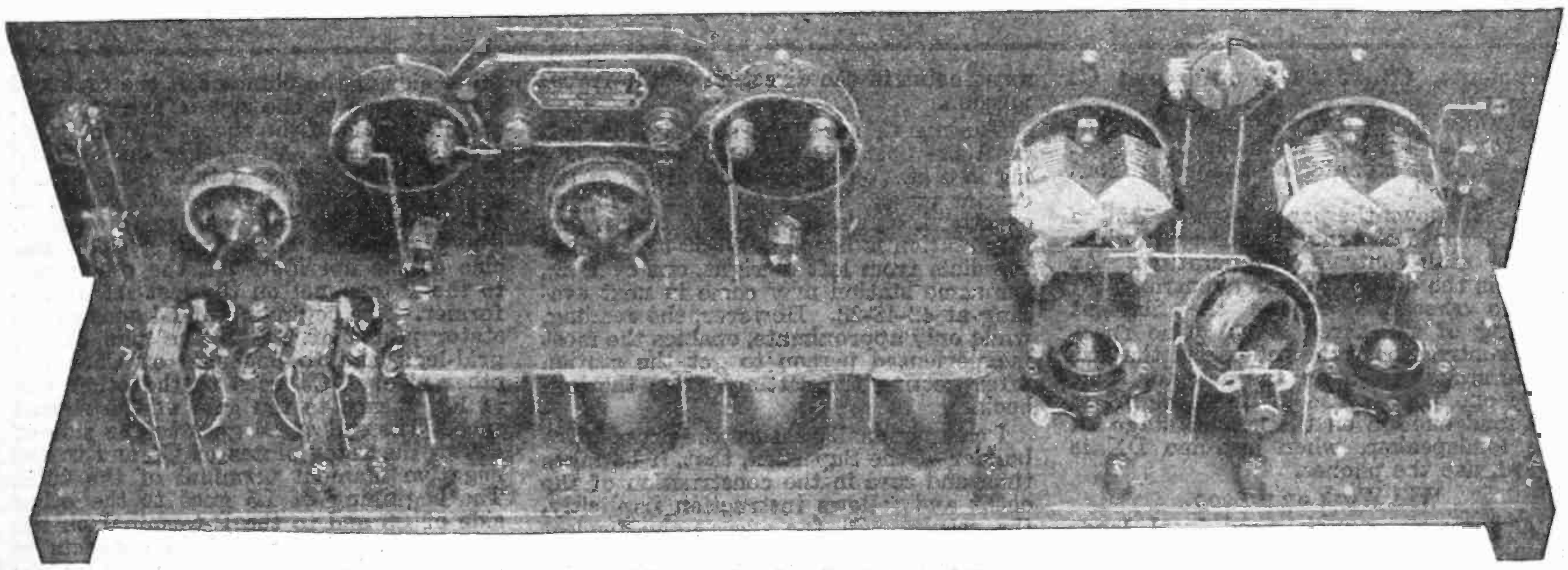
The set in the cabinet with loop at the top. A clock is mounted on the panel in the center just below the holes of the loudspeaker. Practically all the wiring is concealed beneath the baseboard.

ONE of the most popular types of Super-Heterodyne sets which has recently been introduced to the radio public is the "Ritz Super-Heterodyne." The description of this set as written by *Charles Caesar Ritz* in *Science and Invention* follows:

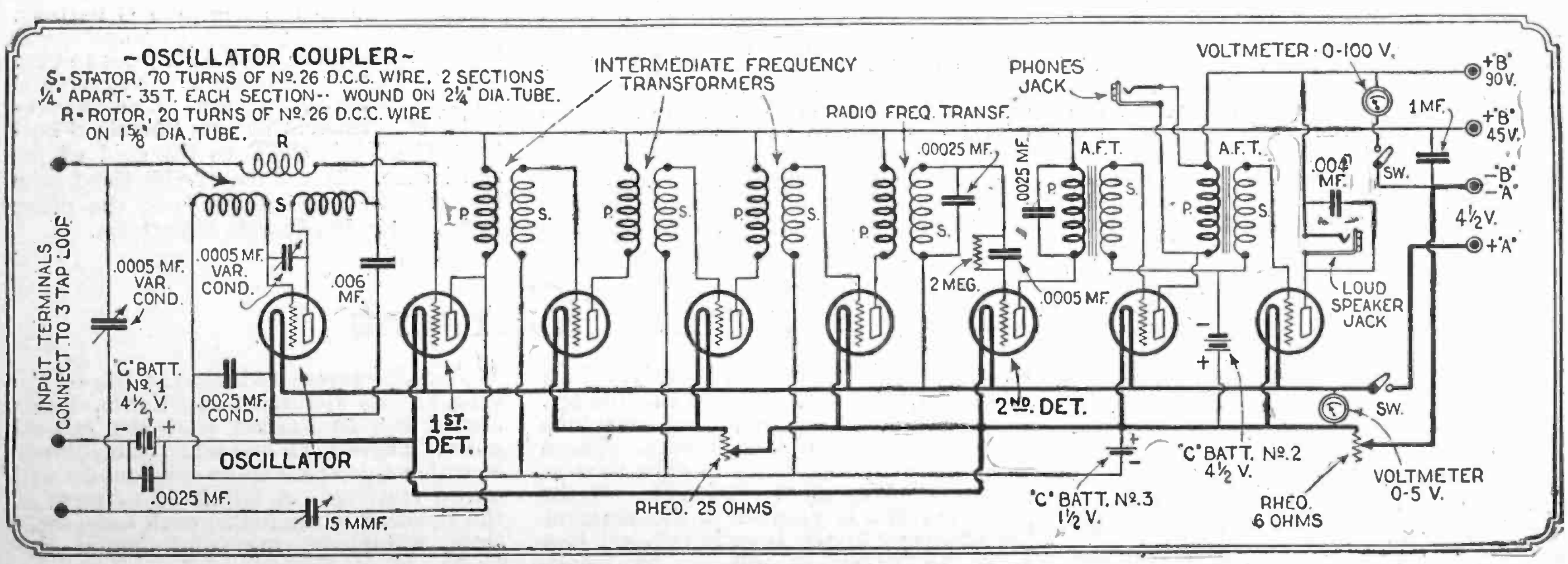
This receiver, the result of patient research, has as its outstanding features: maximum sensitivity, maximum selectivity, minimum size without reduced efficiency, minimum number of controls,



The cabinet containing the set is 38 inches long by 28 inches high and is 8 inches deep. Of course, it is not portable in the sense of the word to the extent that it can be carried around by hand, but is for automobile use in travel.



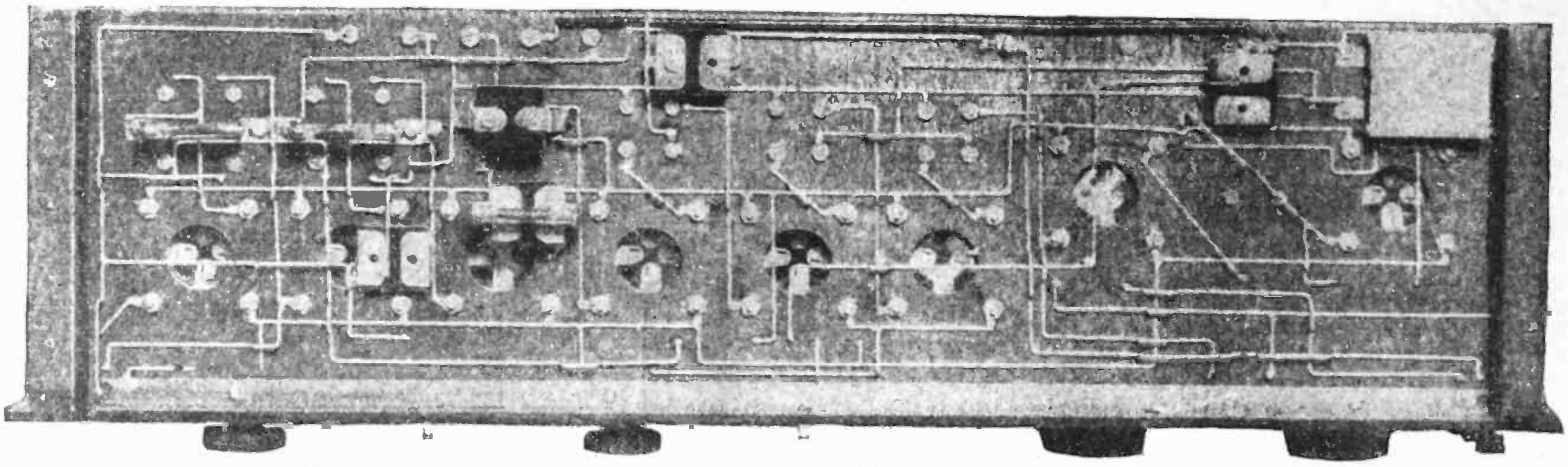
Rear view of the set showing the layout of the parts.



Wiring diagram of the Ritz Super-Heterodyne.

maximum stability during operation and, most important of all, employs a circuit which is easy to wire and when once built does not necessitate considerable adjustment, matching of tubes, nor gives undesirable and exasperating trouble. Deviation from given dimensions is allowable, although it is imperative that the specific parts be used. The receiver is perfectly balanced in all circuits and even a slight change in the value of such a small thing as a fixed condenser will be quite noticeable in the results attained.

A panel 36 by 8 accommodates the receiver proper. Note clean-cut workmanship and self-contained batteries and the loud speaker. Especial note should be taken of the wiring which is brought out on the base sub-panel and very carefully soldered. The intermediate frequency transformers are racked together upside-down, so that the leads to them become short. Four spare tubes are carried in the space near the loud speaker horn and are available in case of emergency. Six dry cells are connected in series-parallel, giving the proper filament voltage to operate the eight UV-199s. For best results, it was found that a loop having a center tap and composed of 15 turns 2½ feet square works remarkably well, Pacific Coast stations being heard every night during the week regardless of the weather conditions. 45,000 cycle transformers give best results in the intermediate frequency stages and as will be seen in the diagram, their output is tuned. This is very important and far superior to tuning the input.



The bottom of the baseboard. Note that the wiring is all neatly done with busbar in straight lines.

How to Make a 3-Tube Superflex

(*Continued from page 72*)

tachments, C2 is .00025 mfd. and C3 .001 mfd.

Binding posts are at the rear of the set for the sake of neatness in wiring. They may be mounted on the panel front if so desired.

Fig. 2 shows the panel layout. At the left is the RF tuning condenser. The center dial controls regeneration. At right is the detector tuning control.

Two rheostats control the filament beating of the three tubes. One rheostat controls both the reflex and the last audio stage, the other the detector tube. Only one jack is used. If the signal is not loud enough on the second stage on the loudspeaker, when extreme DX is heard, use the phones.

Will Work on a Loop

A loop gives very good local loudspeaker reception on this set and is very directional. A plug and jack system enables the operator to plug in the loop if he desires directional reception, or for portable use. Leave the aerial and ground attached to the binding posts always, unless, of course, the set is on a moving object. The plugging in of the loop automatically disconnects the aerial and ground, as well as the primary and secondary coils. Tune the set the same with the loop as with the aerial, with the exception that the loop must point in the direction of the transmission.

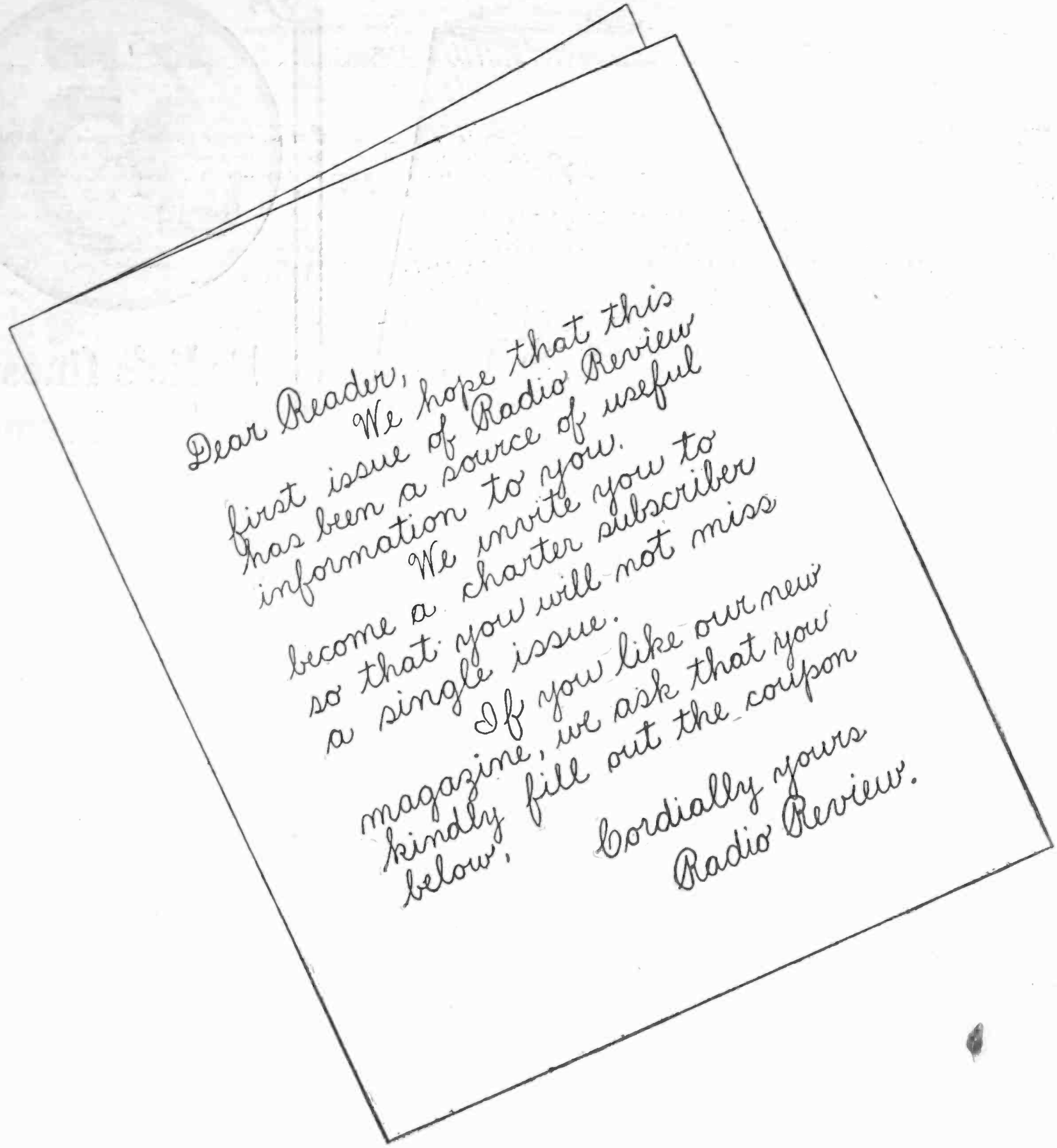
Tuning this set is slightly difficult until the operator becomes used to tuning in a station by the elimination of the carrier wave. This set cannot be logged exactly, i. e., should you find that a certain station is heard at 40-50-30, reading the dials from left to right, one evening, the same station may come in next evening at 42-48-28. However, the reading, while only approximate, enables the most inexperienced person to get the station after getting the settings from the logbook.

I can personally assure the prospective builder of the Superflex, that, if he takes time and care in the construction of the outfit and follows instruction implicitly, the results will far exceed the fondest hopes.

In wiring the set connect the beginning of L1 to the aerial, the ground to the end. The beginning of L2 goes to the stator plates of C1 and to the grid of the first tube, the end of L2 to the G side of the first AFT, the rotor plates of C1 and one side of C2. The other side of C2 connects to the negative A battery. Connect the negative side of all the filaments together. A lead is then taken connecting these negative filaments to the negative A battery. The other side of the filament of the first and last tubes go to one side of the rheostat, the other side of the rheostat to the positive A battery. The other side of the filament of the second tube goes to one side the rheostat, R2, the other side of that rheostat to the positive A battery. The plate of the first tube goes to one side of the aperiodic L3, the other side to the P terminal on the last AF transformer. The beginning of L4 goes to the stator plates of C4, to one side of the grid-leak and to one side of C5. The other side of C5 goes to the other end of R3, thence to the grid of the second tube. The end of L4 goes to one side of C3, to the rotor plates of C4 and to the negative filament terminal of the tube. The beginning of L5 goes to the other side of C3 and to the P terminal on the first AFT. The end of L5 connects to the plate of the second tube. F on the first AFT goes to the F on the second AFT, thence to the negative C battery. Positive C battery joins to negative A battery. B on the first AFT goes to plus 22½-to-45 volt B battery. Negative B goes to positive A battery. B on the second AFT connects to plus 90-volt B battery, G of this AFT to the grid of the third tube. The plate of the third tube goes to one leaf of the jack, the other leaf to the plus 90-volt B battery.

Controlling Filament Current

The efficiency of the filament in a vacuum tube is governed by the brilliancy. The brilliancy or heat is regulated by a rheostat or variable resistance, which controls the amount of current reaching the filament. The rheostat is necessary because most tubes differ in the amount of "A" battery current required to operate them most efficiently. Few tubes work the same at equal brilliancy. It is not a sign of defect if one tube burns less brilliant than others. There is one point of brilliancy in each tube at which it works most efficiently. If too much current is applied to the filament the efficiency of the tube is reduced just as if the current supply was too small. Too much current reduces the life of the tube, causes distortion and howls. Tubes should not be burned past the critical point. There is no one point of brilliancy at which a detector will work equally well on all stations. A slight adjustment of the rheostat is needed in each case, especially when receiving faint distant stations.—*N. Y. Times.*



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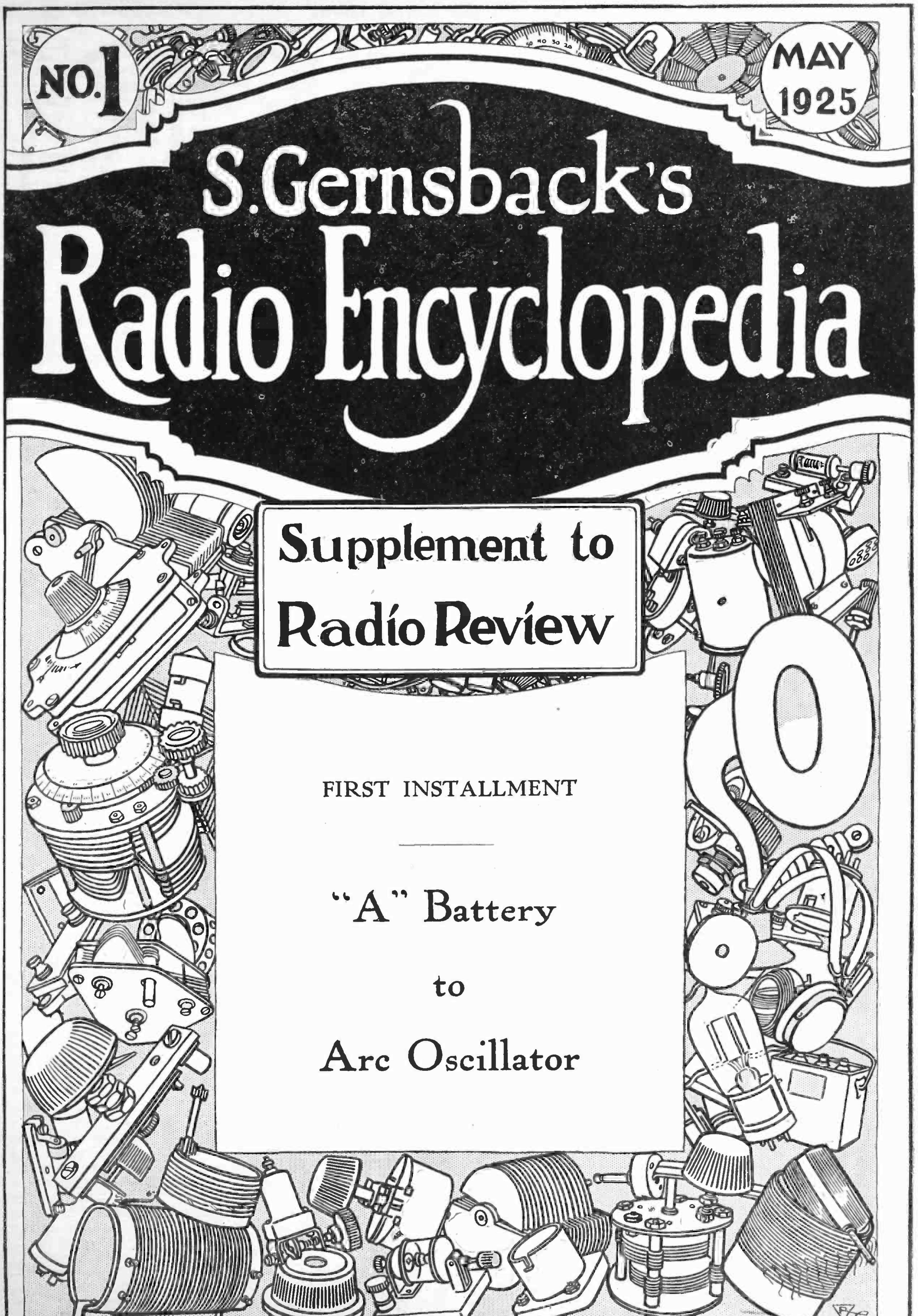

NO. 1

MAY 1925

S. Gernsback's Radio Encyclopedia

Supplement to Radio Review

FIRST INSTALLMENT

"A" Battery

to

Arc Oscillator

Printed in the United States of America

A LOOSE-LEAF BINDER FOR KEEPING SUPPLEMENTS

The pages of this supplement have been so arranged as to be removed from RADIO REVIEW and preserved in a loose-leaf binder. Each page can be torn out as indicated by the dotted line and holes punched through the hole markings for the rings of a patent binder. All subsequent installments of this encyclopedia can thus be collected from each issue until the work is completed.

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"A" BATTERY—An appliance for furnishing electrical current to light the *filaments* of a *vacuum tube*, and cause emission of *electrons* (see *Theory of Vacuum Tube Operation*). This battery may be in any of several forms,

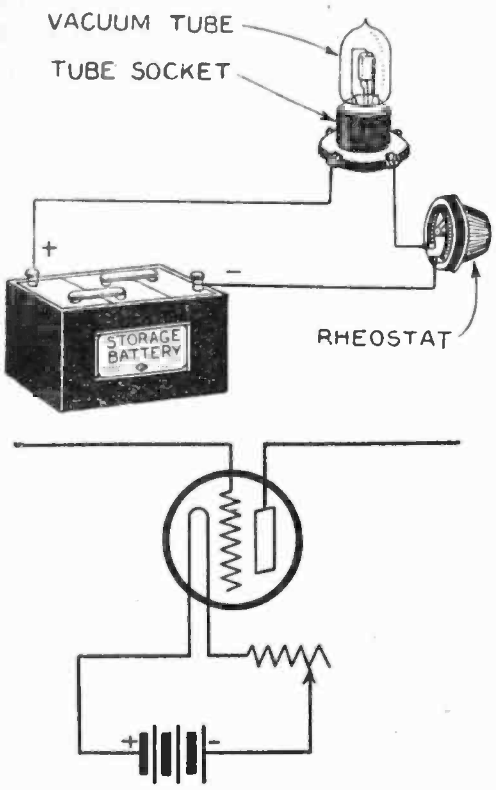


Fig. 1. Method of connecting the "A" battery to a vacuum tube in radio receiving circuits. The lower diagram shows the "A" battery as represented in schematic drawings

the two in popular use being the storage type (see *Storage Battery*), and the dry cell (see *Dry Cell*). Fig. 1 shows method of connecting the "A" Battery in a vacuum tube circuit.

Photos by courtesy of National Carbon Co., Inc.

Fig. 2. A storage battery such as used for "A" battery current supply

In Fig. 2 a popular type of storage battery is shown. Batteries of this type come in many individual forms, the usual voltage being standardized at 6 volts. However, for use with certain tubes, 2 and 4 volt storage batteries are available. For general radio work, using the low-consumption tubes, the battery, as shown in Fig. 2, can hold a charge of from 60-80 ampere hours. (*See Storage Battery.*)

The other common form of "A" Battery is the dry cell, usually having a difference of potential (voltage) of 1.5 volts. Fig. 3 illustrates a popular type of dry cell. In connecting a number of cells for use with a vacuum tube, the method of connecting will depend on the voltage rating of the particular tube. If the tube is rated at 1.5 volts, a single dry cell may be used as in Fig. 4, or several may be connected in *parallel* (*q.v.*) shown in Fig. 5, the total voltage however, being only the voltage of one cell. Three dry cells connected in *series* (*q.v.*) will give 4½ volts, Fig. 6. A connection for dry cells, known as *series-parallel* or *multiple* (*q.v.*), is shown in Fig. 7. This connection will also produce 4½ volts and at the same time increase the life of the cells. Four dry cells connected in series will give six volts for use with a standard six-volt tube, Fig. 8. Dry cells are only used with six-volt tubes where the tube has a current rating of ¼ ampere, and seldom more than one tube is used in this manner

Fig. 3. A dry cell "A" battery

due to the relatively high discharge and consequent short life of the battery.

A storage battery can be used for the "A" Battery current with a 4-volt tube if the connection is made as in Fig. 9. Here a standard 6-volt storage battery is tapped at the four volt terminal.

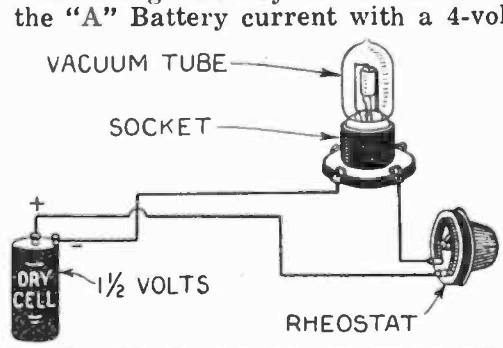


Fig. 4. This circuit shows how one dry cell is used as the "A" battery for types of tubes requiring 1½ volts filament current

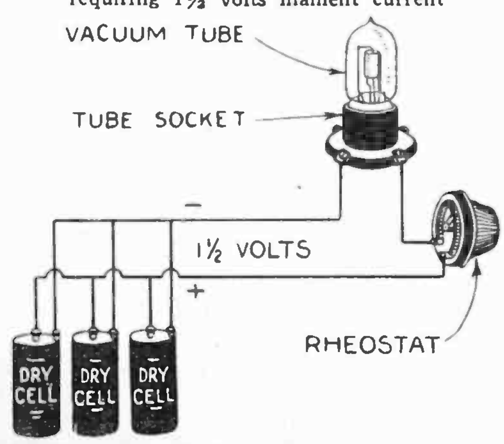


Fig. 5. Several dry cells may be connected in parallel for increased amperage or longer life of the "A" battery

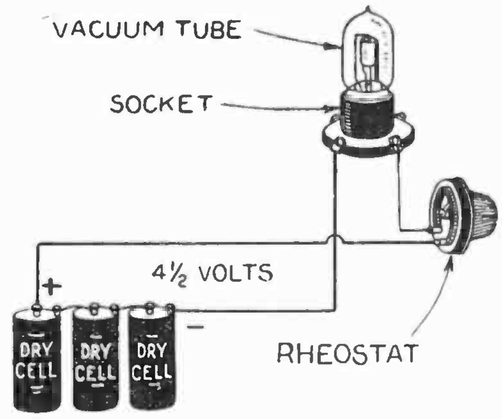


Fig. 6. Three dry cells connected in series give 4½ volts, serving as the "A" battery for the U.V.199 or C299 type of tube

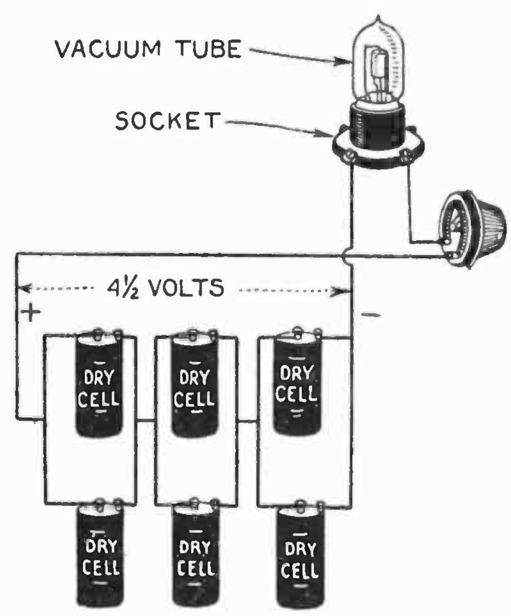


Fig. 7. A series—parallel connection of three dry cells for longer life of the "A" battery with 4½ volt tubes

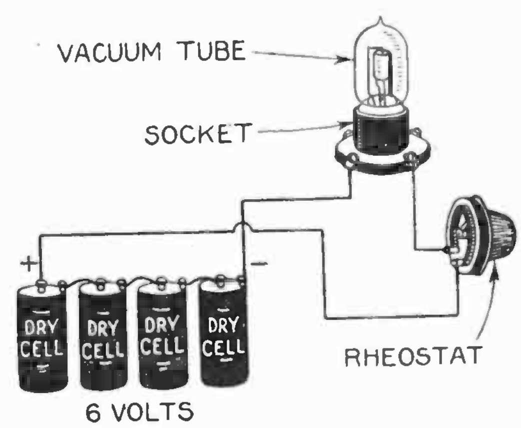


Fig. 8. Four dry cells connected in series give 5 volts for low consumption tubes

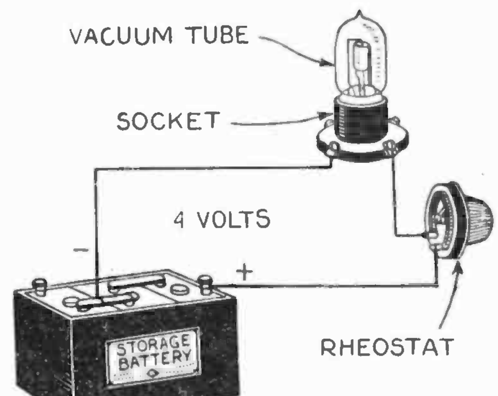


Fig. 9. Showing method of tapping at 4-volt terminal of a 6-volt storage battery for type U.V.199 or C299 tubes or other 4-volt tubes

Another connection for low voltage tubes can be made as illustrated in Fig. 10. Here only one cell of the storage battery is used. This cell can be used until exhausted when the other

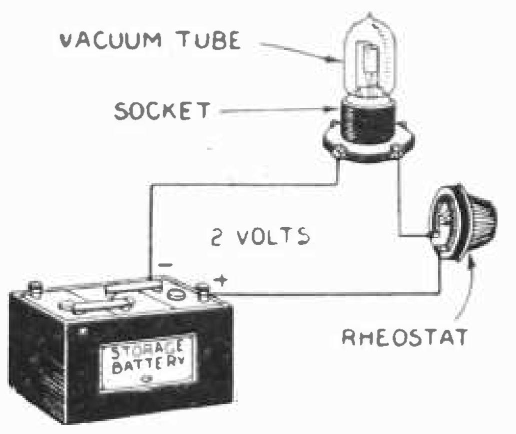


Fig. 10. How a single cell of a 6-volt storage battery may be employed to furnish "A" battery current for 1½ volt tubes

cells can be used in the same manner. When the three cells are exhausted, the storage battery may be charged by means of a *charger* (*q.v.*).

ABAMPERE—A unit of current used in special theoretical work. It has a value of 10 *amperes* (*q.v.*) and is not generally used in electrical work.

ABBREVIATIONS, AMATEUR — The transmitting amateurs of the United States use their own peculiar abbreviations in their inter-communication work. These are used to lessen the interference between transmitting stations as it permits conversation in a much quicker manner. The abbreviations generally used are listed below. Simplified spelling is always resorted to, words being spelled according to their sounds. Some such words are given, but others are so obvious that they are not listed. There are also the standard "Q" signals adopted by the International Radiotelegraphic Convention, to be found in official publications and given under the heading "Abbreviations, International Radiotelegraphic Convention."

ACCW—A transmitter using rectified alternating current as the plate supply.

AFTRN or P.M.—Afternoon.

AMMTR—Ammeter.

ARRL—American Radio Relay League.

BCL—Broadcast listener, one who does not have a transmitting station.

BC STATION—Broadcast Station.

BFRE—or B4—Before.

BLO—Blow.

BOTTLE or V.T.—Vacuum Tube.

C—See or Call.

CGE—Cage.

CM—City Manager of A. R. R. L.

CTPSE—Counterpoise.

CUL—See you later or call you later.

CW—Continuous wave transmitter.

DCCW—A transmitter using direct current as the supply for the plate.

DM—District Manager of A. R. R. L.

DOPE—Information, or in another sense, a varnish for coating inductance coils.

DS—District Superintendent of the A. R. R. L.

DX—Distance, receiving or transmitting.

FB—Fine Business.

FONE—Phone.

GA—Good afternoon.

GLD—Glad.

GM—Good morning.

GN—Good night.

FRQ—Frequency.

HAM—Being a term for the transmitting amateur.

HI—High or I am laughing—it's funny, according to use in sentence.

HI LOS—High loss.

HR—Here.

HV—Have.

KCK BCK—Kick back.

KONGRATS—Congratulations.

KY—Key.

LW LOS—Low loss.

LW WVE—Low waves.

MGHT—Might.

MIKE—Microphone.

MSG—Message.

NITE—Night.

OM—Old man.

OP—Operator.

OPS—Operators.

ORS—Official Radio Station.

OT—Oscillation transformer.

OW—Female operator.

PEEP-PEEP—Continuous wave transmitter.

QCW—Listen for my CW transmitter.

QCW?—Shall I listen to your CW transmitter?

QRMER—An operator who persists in interfering with other stations after being warned to stop.

QSR—I will relay the message.

QSR?—Will you relay the message?

QSS—You are fading.

QSS?—Is my signal fading?

RDO—Radio.

RECVR—Receiver.

RELY—Relay.

ROCKCRUSHER—Spark transmitter.

SA—Say.

SIGS—Signals.

SPIKE—Message file.

SPK—Speak.

SUREFIRE—Something positive in action.

THG—Thing.

THT—That.

TLL—Till.

TM—Traffic manager of A. R. R. L.

TMR—Tomorrow.

TRAFFIC—The handling of messages among the stations.

U—You.

UNLIS—Unlicensed.

UR—Your.

VLTMTR—Voltmeter.

WL—Will.

WRLS—Wireless.

WVL—Wavelength.

"X" LICENSE — Experimental License.

YL—Young lady.

"Z"—Special license.

73—Best regards.

ABBREVIATIONS — RADIO — ELECTRICAL—A letter or group of letters of the alphabet arranged so that there is a definite electrical meaning when used in radio telegraphy or telephony. These abbreviations are the means by which technical writings are simplified, *i.e.*, Alternating Current is simply A.C. when used in general telegraphy. As most of the latest radio text books use these abbreviations, the following are given to aid the reader in understanding the various abbreviations:

A.C.—Alternating Current.

A.F.—Audio Frequency.

B.E.M.F.—Back Electromotive Force.

B. & S.—Brown & Sharpe Wire Gauge.

B.S.W.G.—Birmingham Standard Wire Gauge.

C.—Capacity.

C.G.S. — Centimetre-gramme-second (*q.v.*).

C.W.—Continuous Waves.

D.C.—Direct Current.

D.C.C. — Double Cotton Covered (Wire).

D.S.C.—Double Silk Covered.

E.—Induced Pressure (See Abvolt).

E.M.F.—Electromotive Force.

H.F.—High Frequency.

H.F.C.—High Frequency Current.

I.R.E.—Institute of Radio Engineers.

L.—Inductance (in Formulae).

L.F.—Low Frequency.

L.F.C.—Low Frequency Current.

M.A.—Milliampere.

Mfd.—Microfarad.

P.D.—Potential Difference.

R.—Electrical Resistance.

R.F.—Radio Frequency.

R.P.M.—Revolutions per Minute.

R.P.S.—Revolutions per Second.

S.G.—Specific Gravity.

S.H.M.—Simple Harmonic Motion.

S.S.C.—Single Silk Covered.

S.W.G.—Standard Wire Gauge.

W/L—Wavelength.

X's—Atmospherics.

ABBREVIATIONS, INTERNATIONAL RADIO TELEGRAPHIC CONVENTION—All messages and conversations are not transmitted in regular form, various forms of abbreviations being widely used to increase the speed of transmission and to reduce cost. It also has the tendency to decrease the interference as messages are sent swiftly in half the time. In wireless telegraphy, abbreviations have been adopted as international, and today there are very few ships or shore stations that do not use at least part of them daily. Below we give the International Radiotelegraphic Abbreviations as adopted at The International Radiotelegraphic Convention. An example of the use of the abbreviations is as follows:

A station wishing to learn the name of a ship which is seen off the coast, sends in code the letters QRA?, which means, what is the name of your ship? The station or ship answers with the letters, QRA S.S. Lapland, thus in a few seconds the question had been answered.

Abbreviation	*Question*	*Answer or Notice*
CQ	—.—.—.—.—	Signal of inquiry made by a station desiring to communicate.
TR	— .—.	Signal announcing the sending of particulars concerning a station on shipboard.
	— —. .— —	Signal indicating that a station is about to send a high power.
PRB	Do you wish to communicate by means of the International Signal Code?	I wish to communicate by means of the International Signal Code.
QRA	What ship or coast station is that?..	This is ....
QRB	What is your distance?............	My distance is ....
QRC	What is your true bearing?.........	My true bearing is.........degrees.
QRD	Where are you bound for?..........	I am bound for..............
QRF	Where are you bound from?........	I am bound from.............
QRG	What line do you belong to?........	I belong to the.............Line.
QRH	What is your wave length in meters?.	My wave length is.........meters.
QRJ	How many words have you to send?..	I have .... words to send.
QRK	How do you receive me?............	I am receiving well.
QRL	Are you receiving badly? Shall I send 20? ....—. for adjustment?	I am receiving badly. Please send 20. ..—. for adjustment.
QRM	Are you being interfered with?......	I am being interfered with.
QRN	Are the atmospherics strong?.......	Atmospherics are very strong.
QRO	Shall I increase power?.............	Increase power.
QRP	Shall I decrease power?.............	Decrease power.
QRQ	Shall I send faster?................	Send faster.
QRS	Shall I send slower?...............	Send slower.
QRT	Shall I stop sending?...............	Stop sending.
QRU	....	I have nothing to transmit. I have nothing for you.
QRV	Are you ready?....................	I am ready. All right now.
QRW	Are you busy?.....................	I am busy (or, I am busy with.... Please do not interfere).
QRX	Shall I stand by?..................	Stand by. I will call you when required.
QRY	When will be my turn?.............	Your turn will be No. ....
QRZ	Are my signals weak?..............	Your signals are weak.
QSA	Are my signals strong?.............	Your signals are strong.
QSB	Is my tone bad?................... Is my spark bad?..................	The tone is bad. The spark is bad.
QSC	Is my spacing bad?.................	Your spacing is bad.

(When an abbreviation is followed by a mark of interrogation, it refers to the question indicated for that abbreviation)

ABSCISSA—A term in geometry adapted to radio use in making *curves* to show various values. The abscissae are the horizontal lines, and the ordinates are the vertical lines. In the diagram, the line AY is the axis of *ordinates* (*q.v.*) and the line AX the axis of abscissae. Fig. 2 shows a simple curve indicating the relation between voltage and current (amperes) in an *arc* (*q.v.*). The volts are given

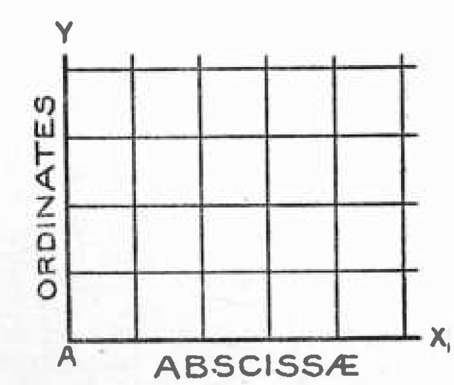


Fig. 1. Indicating axis of abscissae by the line A to X

as ordinates and the amperes are shown as abscissae.

The distance of any point from the axis of ordinates, measured on a line parallel to the other axis represents the value of the quantity and locates a point on the curve. Where abscissae and ordinates are known, it is a simple matter to plot a series of points and then draw the curve through these points. (See *curve.*) Thus, in Figure 2, the curve shows the operation of the arc to be such that when the voltage is zero, the current is 20 amperes;

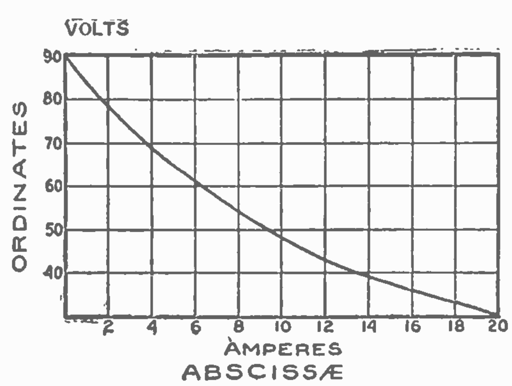


Fig. 2. A simple curve to illustrate the relation between volts and amperes

when the voltage is 60, the current is 6 amperes, etc.

ABSORPTION, ELECTRIC—(See *Soaking-in.*)

ABSORPTION MODULATION—In the production of modulated (see *modulation*) waves, used to transmit speech in radio, it is necessary first to produce *undamped* (*q.v.*) waves of high or *radio frequency* (*q.v.*). Then other waves of low or *audio frequency* (*q.v.*) are superposed or run together with them. Now, if we insert a *microphone* (*q.v.*) in the *aerial circuit* (*q.v.*) of the transmitting station, providing that the *resistance* (*q.v.*) of that instrument is such as to reproduce accurately the vibrations of the voice or music, it is possible to vary the current output of the system producing the high frequency currents, so as to transmit the voice vibrations. If the microphone has resistance comparably low with the antenna or *antenna resistance* (*q.v.*), then the high frequency power output is handled (apportioned) equally between the aerial and microphone. The result is the production of fairly well modulated waves. There are, however, better methods of modulating the waves for which see *Modulation.*

ABVOLT—The *CGS unit* (*q.v.*) indicating the pressure or induced E.M.F. (*electromotive force*) (*q.v.*) set up between the ends of a wire one centimeter long, moving with a speed of one centimeter per second across the magnetic lines of force (*flux lines*) (*q.v.*) of a uniform magnetic field of unit intensity or flux density. An abvolt is therefore a very small unit and 100,000,000 (10^8) are required to equal one volt. In all formulae for determining the output or E.M.F. that can be expected to be produced by a certain *alternator* (*q.v.*), the result is in abvolts, and the complete formula usually provides for obtaining the actual volts. This is done by dividing the result in abvolts by 100,000,000 or 10^8 as it is generally expressed. (See *Alternator* also *abampere.*)

A. C.—Abbreviation for Alternating Current. (See *Alternating Current.*)

ACCELERATION—The rate at which the speed of a body in motion increases within a certain period of time. If we assume a train running at a certain rate of speed when the brakes are applied, the speed will decrease, and if measured over a period of one second, there will be a definite amount of decrease or a rate of decrease. This is known as *negative* acceleration or *deceleration.* When the train is speeded up there will be a definite change (increase) in velocity. The rate of change of velocity per unit of time is the acceleration. (*See Velocity* also *Frequency.*)

ACCEPTOR—A supplementary combination of *inductance* (*q.v.*) and *capacity* (*q.v.*) tuned to the frequency of the desired signal and connected in series in the receiving antenna. Generally, a *coil* (*q.v.*) and *condenser* (*q.v.*) of a value to correspond with a certain given wavelength—thus literally to "accept" the desired signal. (See also *Rejector.*)

A series combination of *inductance* (*q.v.*) and *capacity* (*q.v.*) connected in series with a high-frequency C.M.F. When tuned to resonance with the impressed E.M.F., the impedance drops to a low value, limited by the resistance of the system

ACCUMULATION OF ELECTRICITY—The process of storing electrical energy as (1)—a *storage battery* (*q.v.*) in which electric charges are placed to be later withdrawn and expended at will for various purposes, or (2)—the collection of energy by a *condenser* (*q.v.*) wherein the *electrons* (*q.v.*)

or minute charges of electricity are stored up momentarily on the plates or electrodes of the *condenser* (*q.v.*) and then released into the circuit.

ACCUMULATOR—(See *Storage Battery.*)

ACID—An active chemical compound formed by combining hydrogen with various acid radicals. Acids are much used in radio, particularly in *storage batteries* (*q.v.*). The most commonly used acid in this connection is sulphuric acid—a compound or union of hydrogen, sulphur and oxygen in certain definite proportions as indicated by the chemical symbol H_2SO_4. (See *Flux, Soldering.*)

ACIDIMETER or ACIDOMETER—An instrument used to determine the *specific gravity* (*q.v.*) of an acid solution. It is similar to a hydrometer and used in the same manner. Much used for testing strength or purity of acids or solutions. Operates on the principle that the strength of an acid will be directly proportional to the quantity of carbonic acid gas which it will liberate from a carbonate of soda or potash. (See *Hydrometer.*)

ACLINIC LINE—An imaginary line on the earth's surface assumed as passing through points where there is no magnetic inclination or dip of the needle of a compass. (See *Agonic Line.*)

ACOUSTICS—The science of sound or the study of the cause and effect of vibrations which effect the hearing. Generally speaking, the production and transmission of sound.

ACOUSTIC WAVE—The term occasionally used to denote a *sound wave.*

ACTINIC RAY—A light ray or beam of invisible *radiant energy* (*q.v.*). Rays of light, generally considered as lying at the blue or extreme left of the *spectrum* (*q.v.*) and being of such short *wavelength* as to be invisible to the eye. These rays have the power to induce or bring about chemical action. The most powerful actinic rays are the violet (X Ray) and the *ultraviolet.*

ACTIVE CONDUCTOR—(See *Conductor.*)

ACTIVE MATERIAL—The spongy part of a plate of a storage battery. The part which changes in nature and appearance due to the flow of electric current and having the ability to redevelop the current by a secondary chemical change.

ACTIVE PRESSURE—The active *electromotive force* (*q.v.*) or the pressure which produces a current. The term is used to distinguish this pressure from one impressed on the circuit.

A component in phase with the current in an *alternating current* (*q.v.*)

ACTIVE SPARK—A spark produced from energy contained in a charged condenser, which produces active *oscillations* (*q.v.*).

Thus, the spark discharge from a coil without any method of storing energy will be "inactive." When a condenser is inserted in such manner as to allow it to store up energy and then discharge, the resultant spark will be "active."

Fig. 1 shows a simple spark coil circuit with the secondary discharging across a gap. This is an Inactive

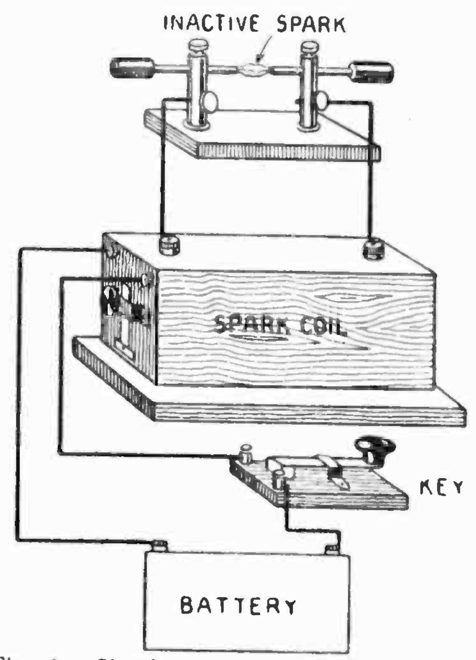


Fig. 1. Showing how an inactive spark is produced

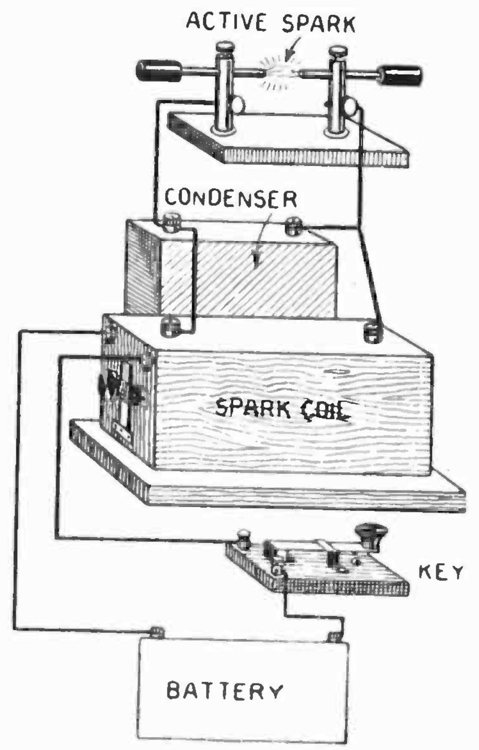


Fig. 2. The active spark is produced by means of a condenser in the circuit as shown

Spark. Fig. 2 represents the same coil with a condenser in the circuit to store up the energy before discharging across the *gap* (*q.v.*). This is an Active Spark.

ADAPTER, AERIAL—A device for utilizing an electric light line as an aerial for the reception of radio signals. Es-

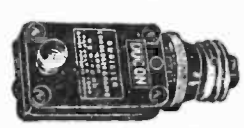
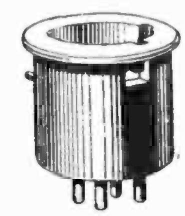


Illustration by courtesy of Dubilier Condenser and Radio Corp.

sentially, two or more fixed mica condensers of comparatively high capacity, in series with two metal legs attached rigidly to a standard plug for insertion in socket of electric light fixture. Terminals are provided for connection to receiving apparatus. The illustration shows one of the popular types of Aerial Adapters which consists of merely a condenser to prevent the voltage of the line from passing directly to, or through, the instruments.

ADAPTER, TUBE—A device similar in form to a vacuum tube socket. Usually comprises a cylindrical form or shell of either metal or insulating material with legs identical with the tips or legs of a vacuum tube. A receptacle is allowed for the insertion of a tube, and the lead from each tip recess is so connected to a leg or tip at its base, as to permit the use of a



Illustsation by courtesy of Pacent Elec. Co., Inc.

non-standard base tube in a standard *socket* (*q.v.*). The illustration shows adapter for U.V. 199 or C-299 type of tube. When it is desired to employ a tube having a non-standard base in a set already equipped with standard sockets, without the necessity of changing the sockets, an adapter may be used. (See *Socket.*)

ADHESION, ELECTRIC—Affinity of one body for another due to dissimilar charges of electricity passing through or being carried by them. The electrical equivalent of magnetic attraction.

ADJUSTABLE CONDENSER — (See *Variable Condenser.*)

ADJUSTABLE GRID LEAK—A form of *grid leak* (*q.v.*) that can be easily

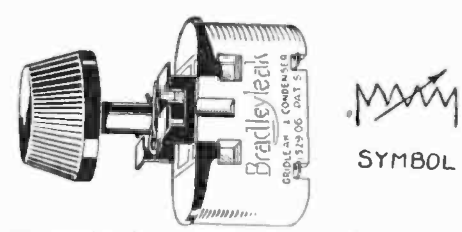


Illustration by courtesy of Allen-Bradley Co.

adjusted over a wide range of values without removal from the circuit. The illustration shows one type of Adjustable Grid Leak.

ADJUSTABLE RESISTANCE — (See *Variable Resistance.*)

ADMITTANCE—The inverse of *impedance* (*q.v.*). In an *alternating current* (*q.v.*) the Admittance acts in the opposite manner to impedance. A circuit having low impedance is said to have relatively high Admittance.

AERIAL—A system of wires suspended in the air or in any form in which they may be insulated or kept free from surrounding objects, used for the purpose of receiving or transmitting impulses as in radio transmission and reception. The term Aerial is actually identical with *Antenna*, but due to the general English definition of Antenna, authorities are gradually coming to distinction between transmission and reception Aerial systems by referring to a receiving device of this nature as an Antenna, and when used to transmit, as an Aerial.

There are different types and forms of Aerials, varying mainly according to purpose and facilities. The standard and perhaps more commonly used receiving Aerial consists of a single wire as in Fig. 1 or several wires as in Fig. 2. The wire used is usually of copper, as this metal combines low resistance with economy, strength, and durability. The theory of the action of the waves either received by or transmitted from an Aerial system will be found under the heading "Electromagnetic Waves."

The exact type and extent of an Aerial will depend entirely on the available facilities and the particular purpose for which it is intended. These various forms will be taken up under their respective headings. In the receiving Aerials, Figs. 1 and 2, a certain definite *wavelength* (*q.v.*) is obtained by arranging a certain length to the wires of the Aerial system including the *ground* and *lead-in*. (See *Fundamental Wave-Length of Aerials.*) In the single wire Aerial, the lead-in is usually taken from the end nearest the receiving apparatus, but where a particularly long Aerial is to be used, it is customary to attach the lead-in to the centre of the suspended wire. The former is known as an *inverted L* type and the latter as a *T* type Aerial. These designations will apply as well where a number of wires are used as in Fig. 2.

Generally speaking, an Aerial should be as high above the ground as possible, of course within practical limits. From 25 to 100 feet is the most practical height to use. Where the Aerial is suspended at a substantial height the incoming waves will be less likely to be obstructed by surrounding trees or buildings, and in the case of transmission the same factor will apply, inasmuch as the waves may be obstructed in their transmission, if buildings or trees closely surround the Aerial.

The insulation of an Aerial is of particular importance, and especially so in the case of a transmitting Aerial. The reason for insulating an Aerial is to prevent the currents from escaping to the ground by way of trees, buildings, or the masts to which the Aerial is attached.

Fig. 3 shows a method of arranging an indoor Antenna system where it is not possible to use the out-door type. The construction may be essentially the same as the usual form of outdoor Aerial and can be arranged in a number of different ways. Very often a wire is merely suspended around two sides of a room and insulated from the moulding. One end will be connected as a lead-in to the receiving apparatus. In constructing an indoor Antenna, it is well to remember that the effective length of the Antenna is not much greater than the direct distance from the receiving set to the farthest point of the Antenna.

Fig. 4 shows a different type of Aerial known as the *Cage* type. The illustration shows an inverted L, and the T arrangement. Fig. 5 shows a *Fan Aerial* and Fig. 6 the *umbrella* type. The illustration, Fig. 7, shows one type of *loop Aerial* (*q.v.*) and Fig. 8 the same general type in somewhat different form. Owing to the fact that the theory of operation of a *loop Aerial* is somewhat different than the ordinary types, it will be described more fully under the heading "Loop Aerial." Fig. 9 illustrates a form of *Aerial Adapter* which is arranged to allow the electric light wires to be used as an Aerial. (See *Adapter Aerial.*) Fig. 10 shows an *underground Aerial* system designed by Dr. Rogers and which is not appreciably affected by atmospheric disturbances. (See *Strays.*) This form of Aerial, however, is generally impractical due to the difficulties in construction.

Aerials for transmitting may be of the same general types as receiving Antennas arranged outdoors, with the exception as explained previously, that heavy insulators must be used owing to the high voltage employed. Aerial for transmitting will depend for size on the wave-length desired.

Fig. 11 illustrates several types and arrangements of *counterpoise* (*q.v.*).

In the case of the receiving Aerial a single wire may be from 75 to 150 feet in length, or if a number of wires are used, the over-all length may be considerably less. (See *Fundamental Wave-length.*)

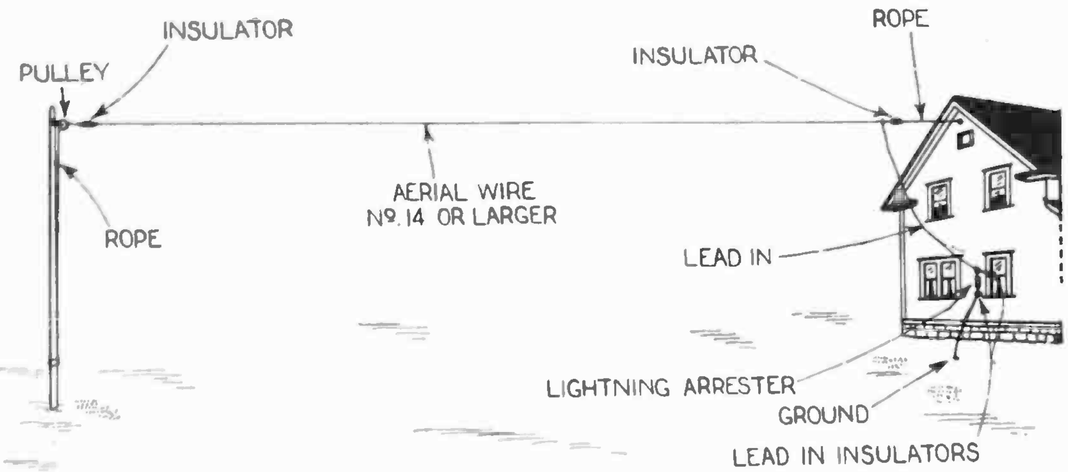


Fig. 1. A single wire aerial in the form of an inverted L. If a long wire is used, the lead-in may be connected in the center, forming a T type

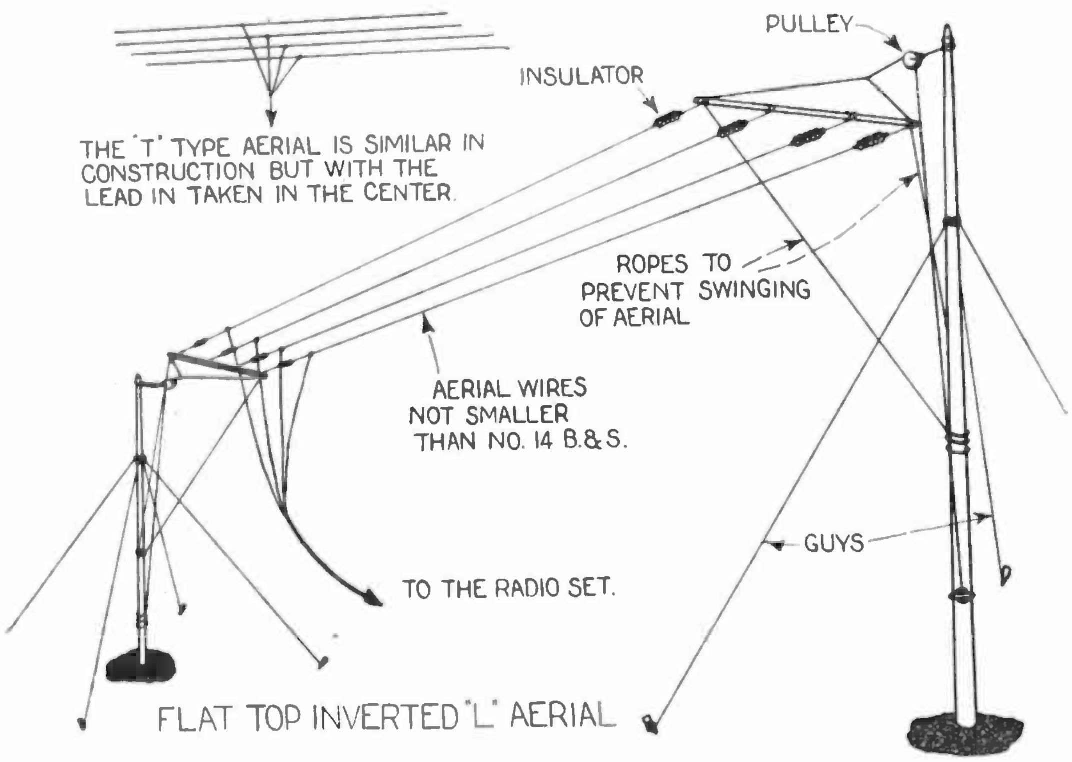


Fig. 2. Method of erecting a multi-wire aerial. This type of aerial may be made in either the inverted L or T form as shown

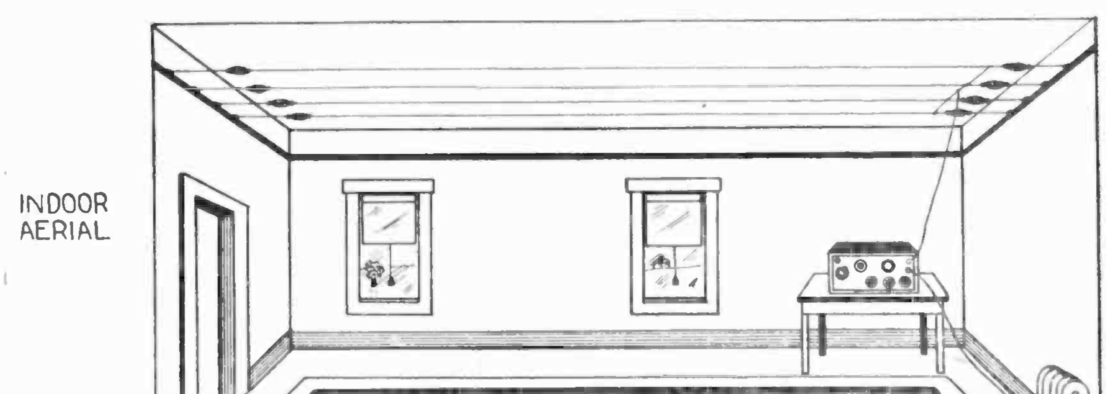


Fig. 3. Showing one method of installing an indoor aerial. While this illustrates a multi-wire type, a single wire run around the moulding of the room may give excellent results

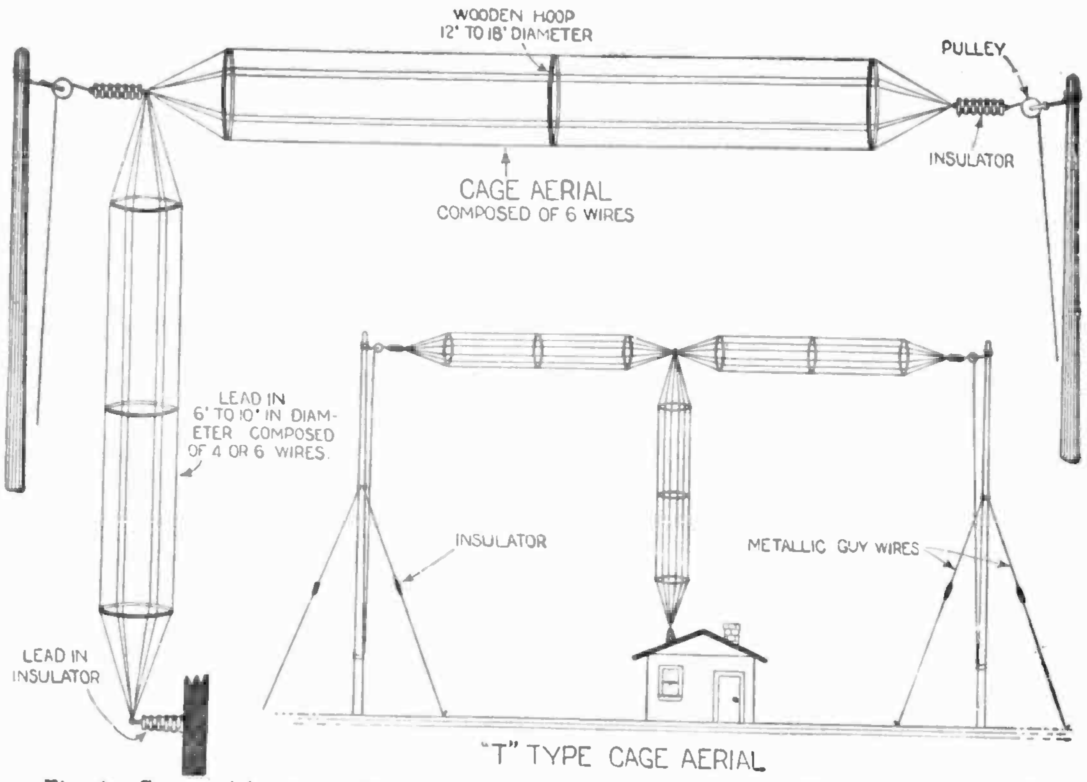


Fig. 4. Cage aerials are usually employed for transmitting purposes. The inverted L and T types are erected as shown

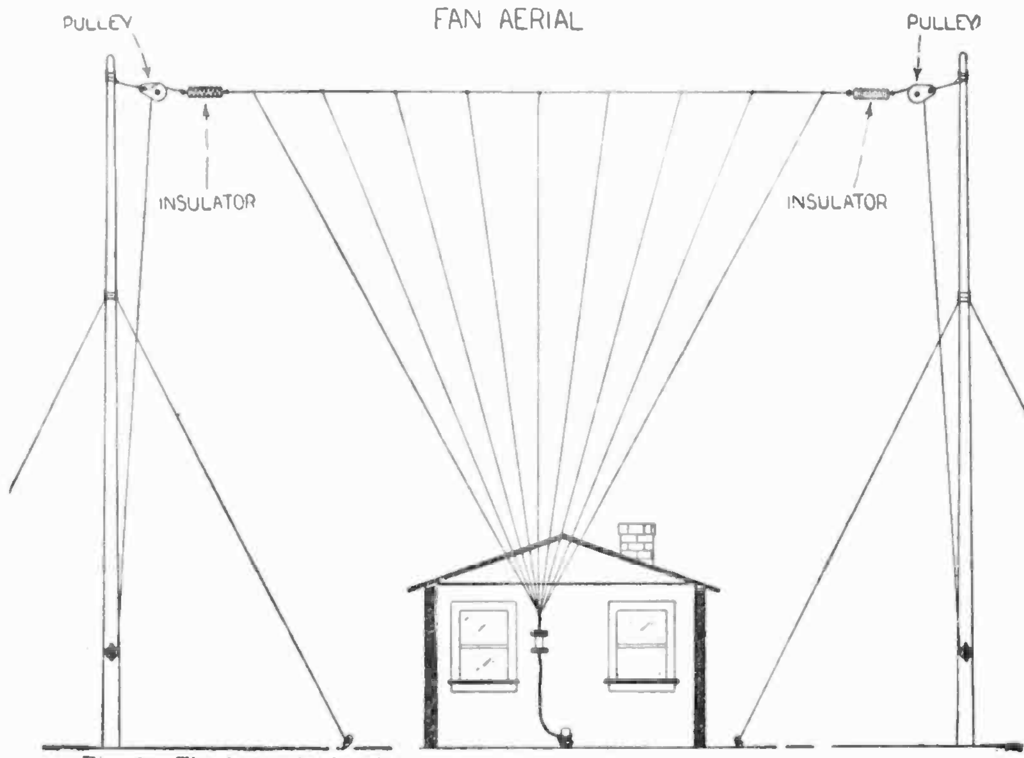


Fig. 5. The fan aerial has its wires spread apart at the farthest point, forming a fan

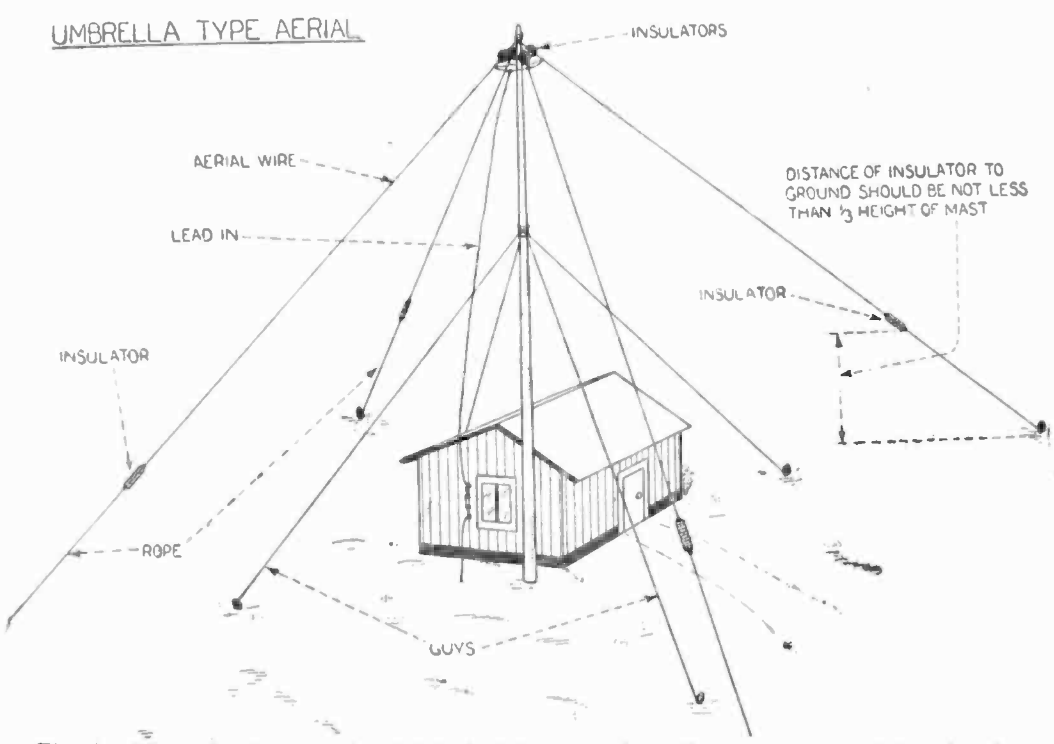


Fig. 6. The umbrella type of aerial derived its name from the arrangement of its wires in the form of an umbrella

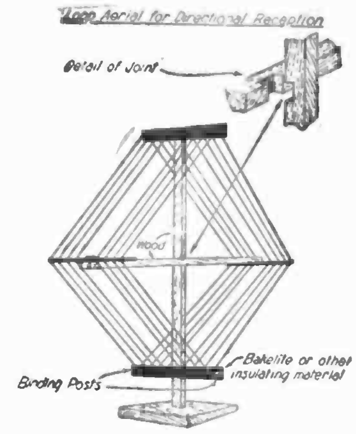


Fig. 7. The selenoid type loop aerial

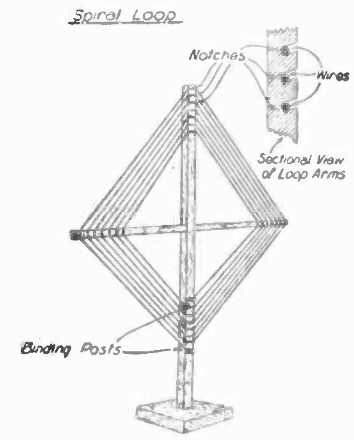


Fig. 8. The spiral type loop aerial

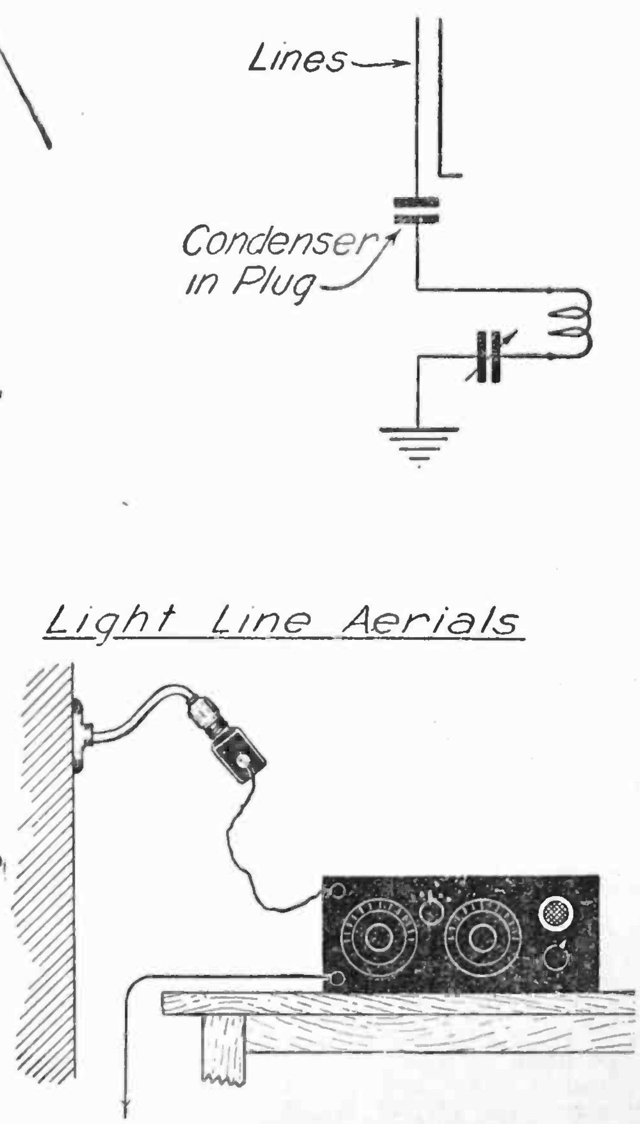


Fig. 9. Method of employing the electric light line as an aerial with an aerial adapter. Above is shown the diagram of the condenser in connection with the aerial circuit of a radio set

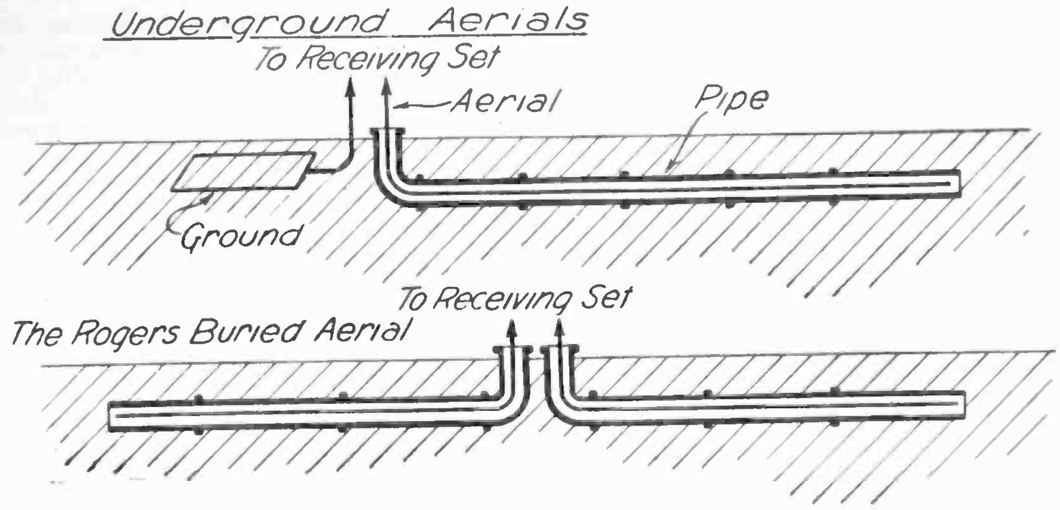


Fig. 10. Showing how wires are buried in the ground for aerials

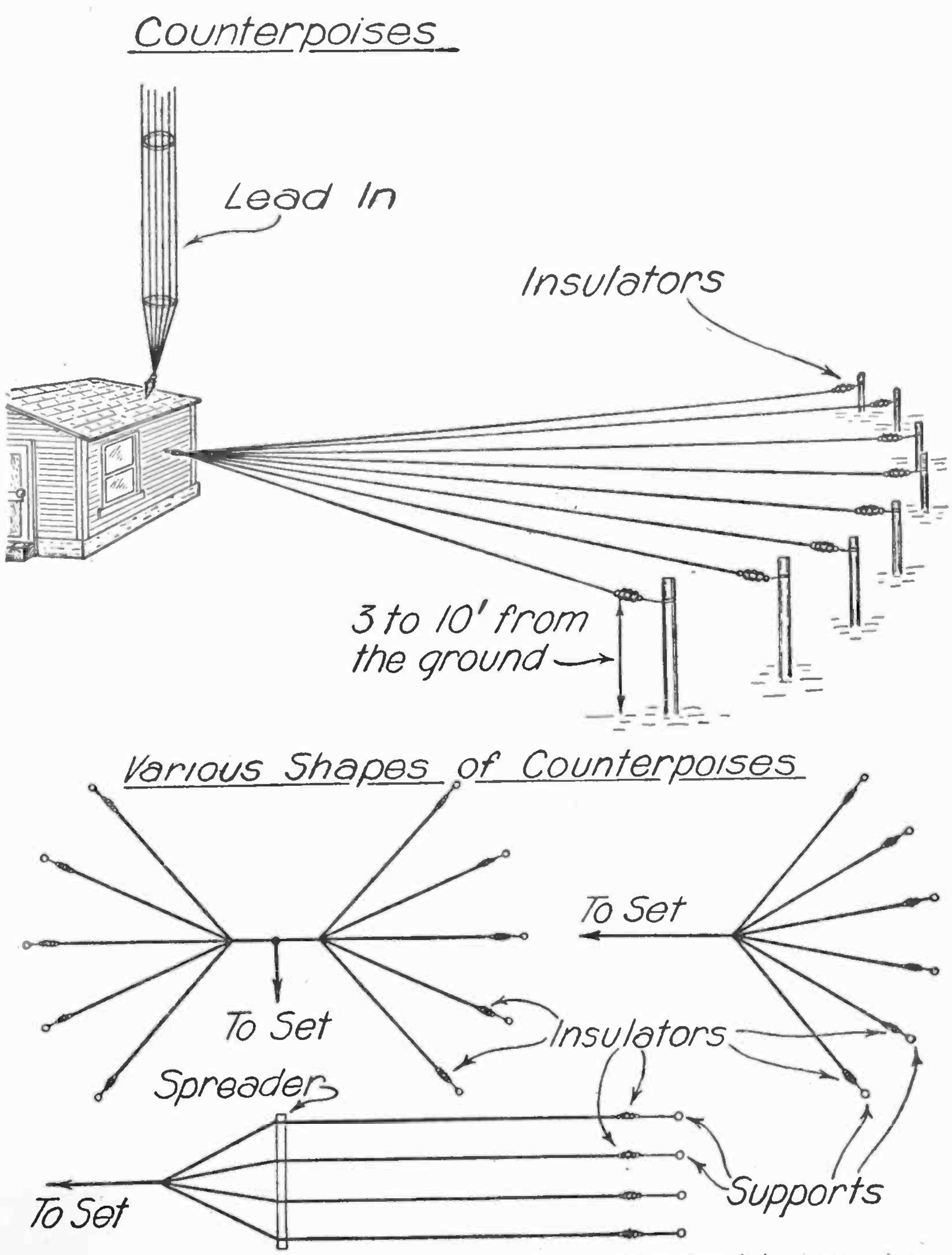


Fig. 11. Different methods of arranging counterpoises for either transmission or reception

AERIAL CAPACITY—(See *Capacity of Antenna.*)

AERIAL CIRCUIT—Consists of *aerial* and *earth* or *ground,* including all *coils* or *inductances, condensers,* etc., which may be connected with the aerial and earth and forming a direct path between those points.

AERIAL SWITCH—A device to transfer the *aerial* and *ground* connections from the transmitting circuit to the receiving circuit or vice versa. Its

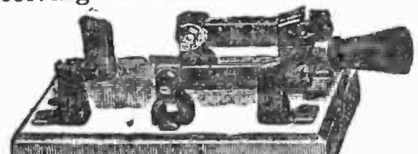


Fig. 1. A simple Aerial Switch

object is to separate the high tension current of the transmitter from the low tension of the receiver. The switch is usually installed in a convenient position so that the operator may change from transmitting to receiving by one motion of the hands. A

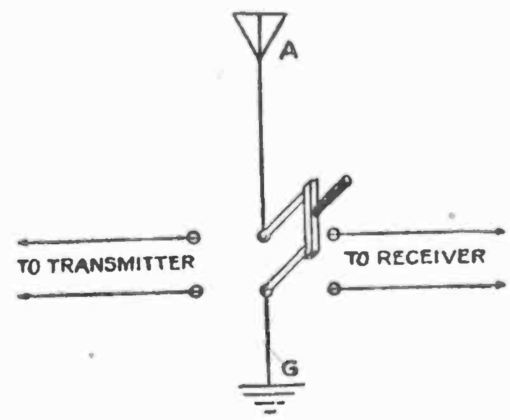


Fig. 2. Circuit for a simple Aerial Switch

simple form of aerial switch is illustrated in Fig. 1. The circuit for same is shown in Fig. 2. A more efficient circuit is the one shown in Fig. 3. This circuit requires another blade to control the primary current to the transformer. The latter circuit is most

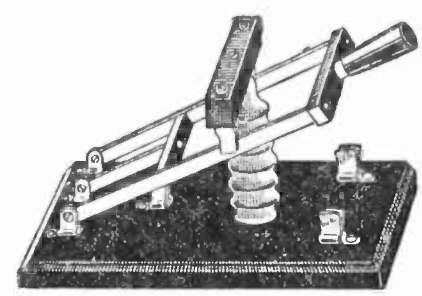


Fig. 4. An Aerial Switch with an extra blade

satisfactory as it entirely disconnects the current to the transformer, doing away with the possibility of dangerous shocks to the operator. The switch commonly used in such circuits is shown in Fig. 4.

The switches used in the various commercial wireless stations are of course more complicated. There is a need to control many circuits with the simplest possible method. In order to do this it was found more convenient to only change the aerial connections, and allow the ground connection to both the receiver and transmitter to remain permanently. This of course necessitates a small air gap in the aerial for the transmitter. This is called an *anchor gap* (*q.v.*). This small appliance allows the transmitter to be connected continuously to the aerial as the high voltage from the transformer discharges across the small air gap, as provided for in the *anchor gap* (*q.v.*). Fig. 5 shows the circuit when this type of aerial transfer is to be used. When the switch handle is pushed down it makes connections with the receiver, when it is raised, the transmitter is ready to be used as the primary current is connected also.

AERIAL TUNING CONDENSER—A *condenser* (*q.v.*), usually variable, connected in the *aerial circuit* (*q.v.*) for the purpose of adjusting the natural period of the receiving circuit to the period of the incoming waves (see *Wavelength*) or signals coming from the *aerial.* In the illustration is shown an Aerial Tuning Condenser.

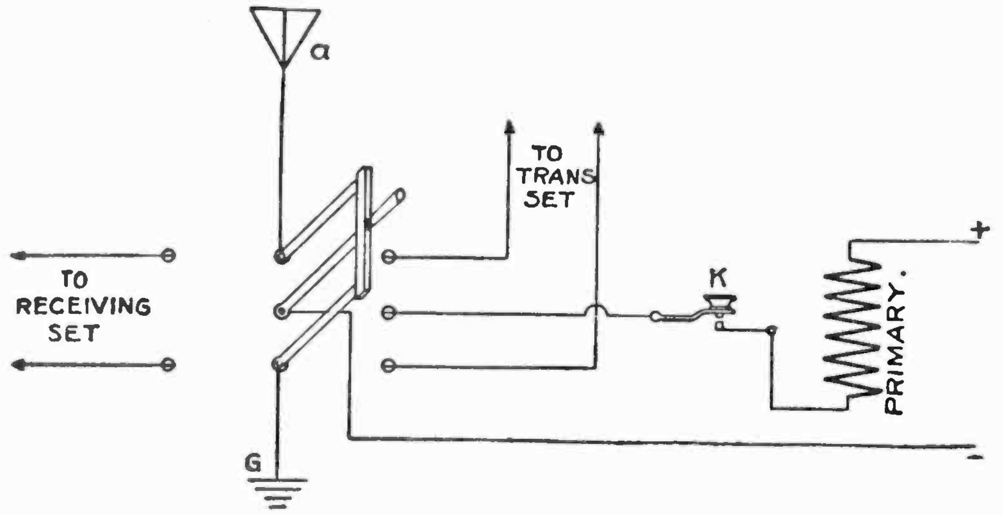


Fig. 3. Circuit for the Aerial Switch shown in Fig. 4 on page 7

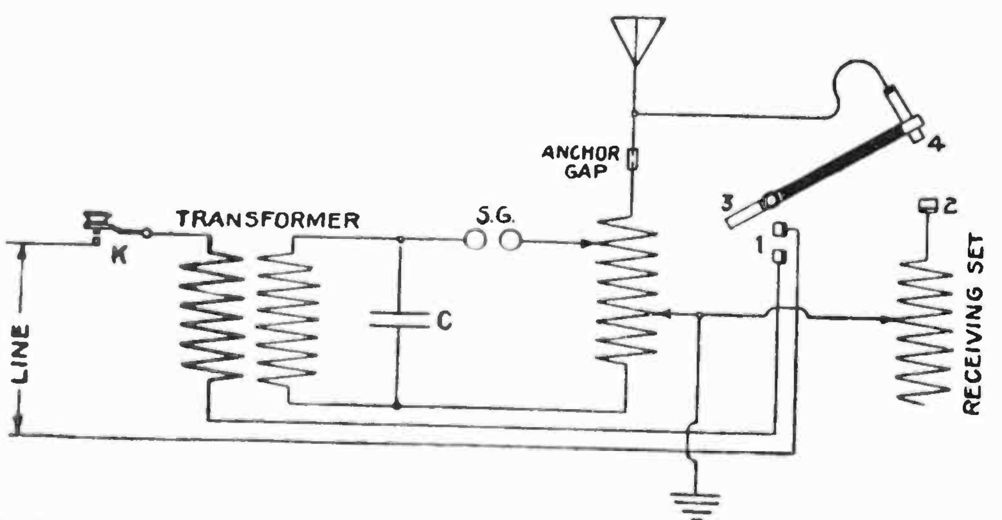
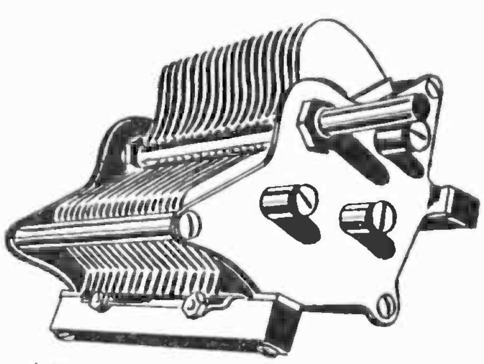


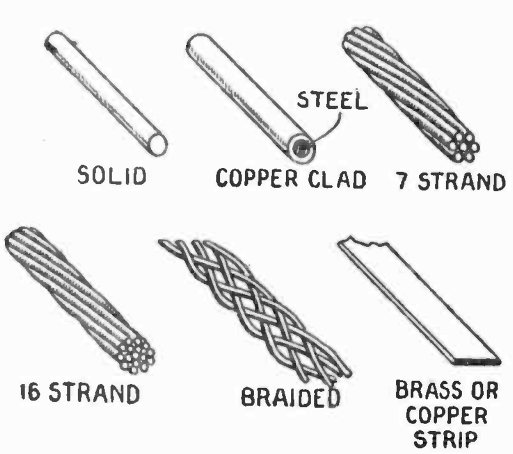
Fig. 5. An Aerial Switch employed in conjunction with an Anchor Gap as explained on page 7

Any *capacitive* (*q.v.*) means of establishing or varying the *oscillation constant* (*q.v.*) of the receiver.



A variable condenser such as commonly used for an Aerial Tuning Condenser (see page 7).

AERIAL WIRE—The wire forming the *aerial* (*q.v.*). Copper is generally used for this purpose as it offers very little

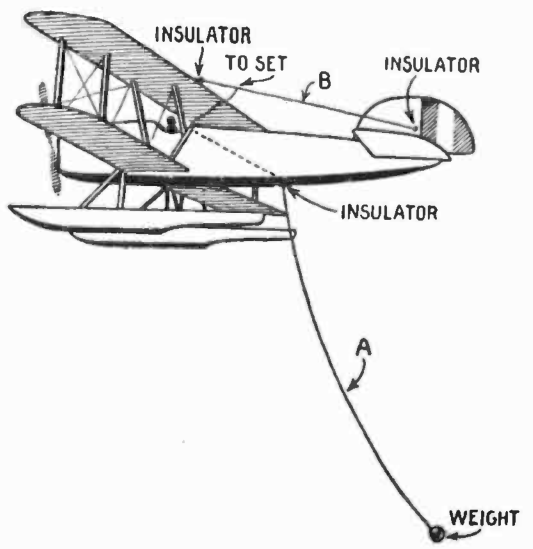


resistance (*q.v.*) to the feeble currents in receiving.

The illustrations show various types of wire as used for aerials. Among them there are the solid copper wire, copper clad steel wire, stranded wire, braided wire and brass or copper strip.

AERO-FERRIC INDUCTANCE—The *inductance* (*q.v.*) of coils wherein the *magnetic circuit* (*q.v.*) is completed through both air and iron.

AEROPLANE ANTENNA—Receiving or transmitting *antenna* (*q.v.*) used on an aeroplane. The commonest form is a suspended wire shown as A in the illustration. The *ground* or *coun-*



terpoise (*q.v.*) in this case may be another wire suspended on and insulated from the fuselage as indicated at B. When the plane is in flight, the hanging wire trails up and backward, depending on the speed of the plane and the size of the weight used. This type of antenna will be slightly *directional* (*q.v.*) in the direction the plane is traveling. If it is impractical to use a trailing wire antenna for any reason, a loop or coil of wire may be used, the results of course being less satisfactory. The metal frame of the plane is often used as a *counterpoise* (*q.v.*)

A. F.—Abbreviation for *Audio-Frequency* (*q.v.*)

AFTER-GLOW—Fluorescent phenomena in a *vacuum tube* after current has been withdrawn.

AGONIC LINES—Lines imagined as passing through points on the earth's surface where the magnetic inclination or dip of a magnetic needle (compass) is zero. (See *Aclinic Lines.*)

AGING, VACUUM TUBE—Gradual diminishing of the brilliancy of a tube due to the deterioration of the *filament* (*q.v.*) and the coating or deposit on the bulb. A tube is said to be Aging when it gradually loses its power to emit *electrons* (*q.v.*)

AIR CONDENSER—*Condenser* utilizing air as the *dielectric*. The majority of variable condensers used in radio work employ the air dielectric, that is, the space between plates is merely an air gap. Most *fixed condensers* (*q.v.*) use some substance such as mica, or sheets of waxed paper as a dielectric.

AIR CORE TRANSFORMER—A *transformer* used in radio, having no metal core, *the lines of force* having their path through air. (See *Amplifier, Radio Frequency.*)

ALBIZ, Count—Managing Director of the Compañia National de Telegrafia sin Hiols in 1910, of Scotch origin.

He was born in Madrid in 1858 and received a schooling at the Madrid University and London University College. He was a Tory member of Parliament.

ALEXANDERSON, Ernst Fredrick Werner (1878)—Radio engineer and inventor. Born at Upsala, Sweden, January 25th, 1878, he was educated at the High School and University of

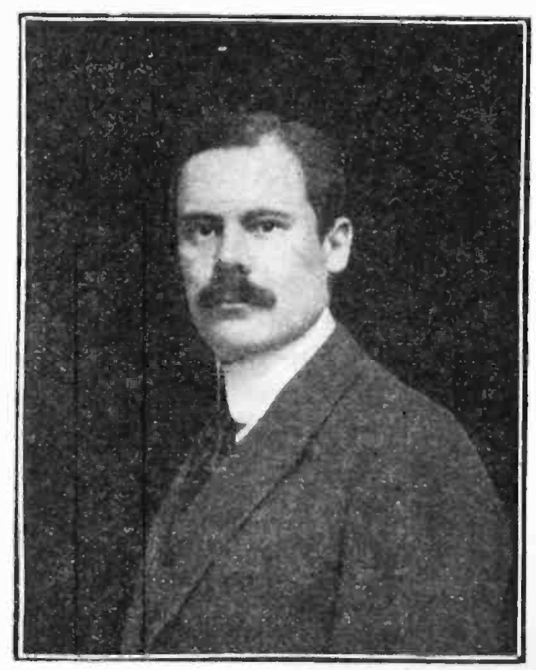


Photo by courtesy of General Elec. Co.

E. F. W. Alexanderson

Lund, Sweden, at the Royal Institute of Technology, Stockholm, and at Berlin. In 1902 he joined the General Electric Company, and has been for some years their consulting engineer. He holds the post of chief engineer to the Radio Corporation of America, and is a member of the American Institute of Radio Engineers. Alexanderson has read many papers on electrical subjects before the chief technical societies of America.

Alexanderson is famous for his work on *high-frequency alternators* used in Radio telegraphy. The Alexanderson alternator is connected directly or *inductively* to the aerial and earth, and constitutes the simplest possible connection for producing *continuous* or *undamped waves*. It is a machine of great speed and many *field poles*, and frequencies as high as 200,000 *cycles* are obtained. For long distance work, employing very *long wavelengths*, this high-frequency alternator is largely used. Alexanderson is also responsible for the *magnetic amplifier*, patented in 1913, and has carried out successful experiments on *duplex wireless telephony*. In the Alexanderson *microphone transmitter* the *modulation* is mainly effected by variations in the tuning of the *aerial circuit*.

ALEXANDERSON ALTERNATOR—A type of *high-frequency alternator* (*q.v.*) which produces *continuous oscillations* (*q.v.*)

ALLOY—A compound of two or more metals. (See *Woods Metal.*)

ALTERNATING CURRENT—An electric current that does not flow steadily in one direction—as from *positive* to *negative*—but completely reverses its

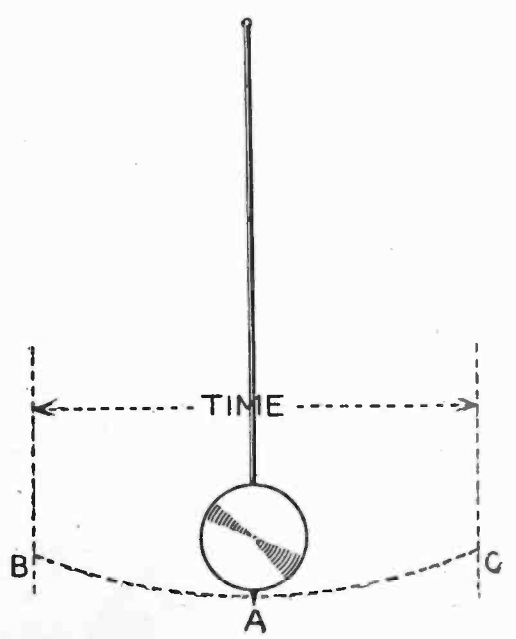


Fig. 1

direction or *polarity* (*q.v.*) at certain definite intervals. In other words, the current flows first in one direction and then reverses and flows in the opposite direction—these changes being referred to as changes of *phase* (*q.v.*). An electric current is either *direct* (*q.v.*), alternating, or *pulsating*. The latter is an alternating current that has been rectified. (See *Rectified Current.*) Practically the only direct current that is employed or appears in a radio receiver is that supplied by the "*A*" and "*B*" *Batteries* (*q.v.*). In an alternating current, the change in direction or polarity takes place in a steady, even manner.

An understandable analogy for alternating current is its comparison with a pendulum. In Fig. 1 the pendulum is supposed to be the alternating current or impulse. Now when the bob is swung from its natural (neutral) position A, which may be considered as zero value of voltage or current, it will move to a maximum point, either B or C. If we assume B to be the *positive* side, then the bob

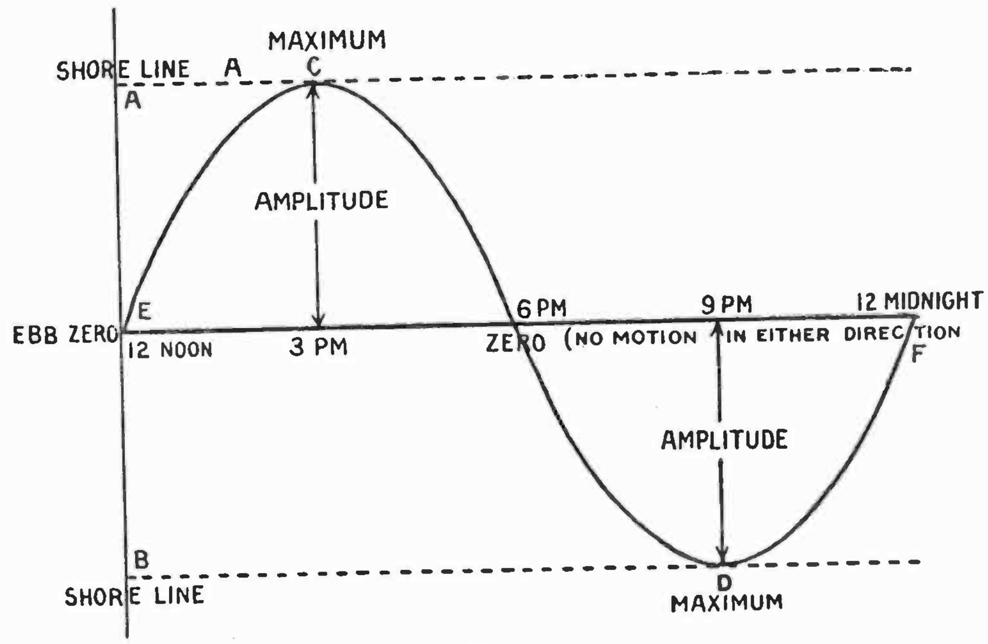


Fig. 2

will move to B which will be the maximum positive *amplitude* (*q.v.*). It will then fall back to zero again, and with the power behind it, the momentum in this case, will rise on the other side to C, which is the maximum *negative*

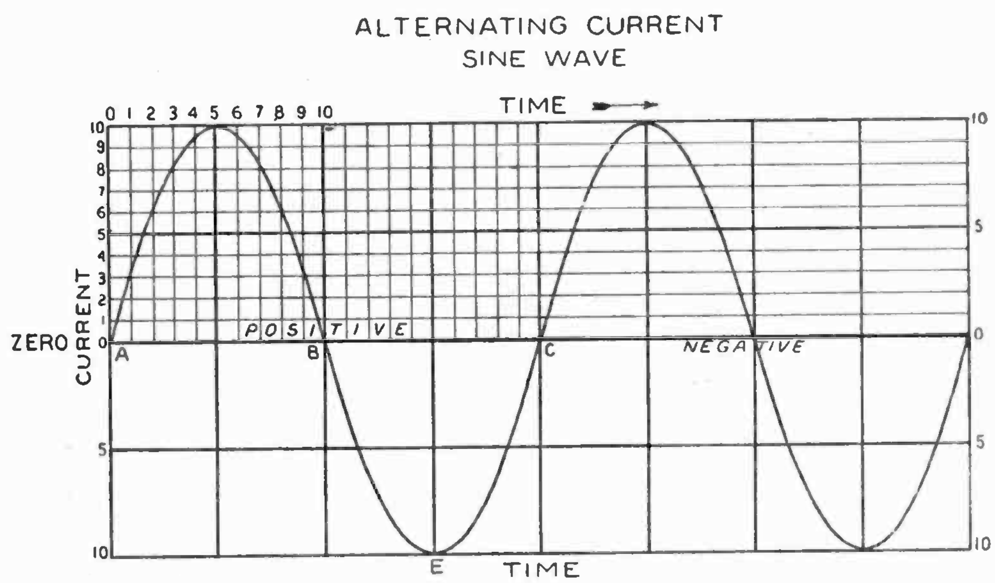


Fig. 3

amplitude. The bob will then fall back to A once more and will have undergone a complete change of direction and values; it will have gone through a *cycle* (*q.v.*). That is to say, it will have risen from zero A to positive maximum B, then back to A, rising on the other side to negative maximum C and back to A. Now the length of time required for this complete cycle (see *Alternation*), is known as the *time period* of vibration or *phase change*. If, for example, it required one-sixtieth of a second for this change to take place, then we say that the *frequency* (*q.v.*) is sixty cycles, because obviously, a change requiring one-sixtieth of a second will occur sixty times in one second.

The action of alternating currents may also be likened to that of ocean tides. In Fig. 2 the curved line represents the water in motion and is to be compared with current in motion in an alternating circuit. For the sake of clarity, we can assume that the tide rises and falls between two shore lines, A and B. At 12 noon the tide is at zero or "ebb" and there is no motion in either direction. Now the flow starts toward shore line A and gradually rises toward that side until at 3 P. M. it has reached its maximum height. In the case of an alternating current, we may consider that at 3 P. M. the current has reached maximum value on the positive side or in a positive direction. It then reverses and falls toward zero until at 6 P. M. it has reached the zero point. In the case of the current, it will have become zero. Motion again starts in the other direction and the tide rises once more, but in the opposite direction, toward shore line B. By 9 P. M. it will have reached maximum height in this direction, or in the case of the current it has reached maximum value or *amplitude* (*q.v.*) at D on the negative side. It then falls back again to zero, and at 12 midnight has come back to its original starting point, having gone through all stages of value or height from zero to maximum at one shore and then back to zero; then from there to maximum at the other shore and back to zero. The action of the alternating current then will have been to flow from zero to positive maximum, back to zero and reversing, from zero to maximum on the negative side, then back to zero. It will have completed one cycle. The time required for the tide to go through these changes E to F is 12 hours and is known as the *time period* or *period* (*q.v.*). Therefore, the time required for a complete change in the case of alternating current will be referred to as the period. The number of times that these changes take place within a certain time limit is known as the *frequency* (*q.v.*)

The current value in Fig. 3 is assumed to be 10 amperes, and the current values at any moment are shown as *ordinates* (*q.v.*), (vertical) while the time is shown in the *Abscissas* (*q.v.*) (horizontals). If the above curve is to be assumed as representing the Sine wave of an Alternating current having a frequency of 60 cycles per second, the total time in the chart would be one-thirtieth of a second. Thus, Time A to C would be one-sixtieth second, the Time of one complete cycle. A B is a positive Alternation and B C a negative Alternation, D and E represent maximum current values in each direction.

If the above Sine Wave is to be used as an example of a high frequency oscillation as in radio, the Time of one cycle can be assumed as about $\frac{1}{1,000,000}$ second. (See *Frequency-Oscillation - Sine - Phase - Characteristic of Alternating Current.*)

The frequency of an alternating current depends on the number of poles (field magnets) and the speed of rotation when the A.C. is generated by an alternator. (See *Alternator.*)

ALTERNATING CURRENT, THEORY OF PRODUCTION OF—Electric current in motion along a conductor always has a magnetic field (*magnetic flux*) surrounding it. If this current is passed near a number of turns of

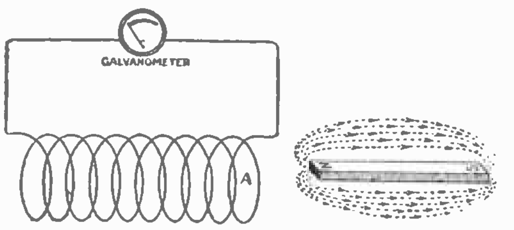


Fig. 1

wire, the lines of flux will link with the wire turns in the circuit. The number of flux lines through a coil will depend upon the current. A change of current will change the number of linkages. If two turns of wire are used, the circuit will link twice with the same magnetic flux. Thus, a change in the current or a change in the number of turns of wire will alter the linkages.

Now in the case of Fig. 1, the magnet being placed near the coil causes lines of force to pass through the coil. Each turn of wire will link the flux lines. Now any *change* in these linkages between the flux lines and wire turns will produce an E.M.F. (*electro motive force*) in the circuit of the wire turns. This is called an "induced current" because it is induced by the change in linkages. In Fig. 1, we have a coil of wire in a circuit with some sensitive measuring instrument for minute currents, in this case a *galvanometer*. Near it we have a bar magnet. When this magnet is moved toward or within the coil, a current is induced in the circuit by reason of the change in linkages. This current is *always* in a direction to *oppose* the change that causes it. (See *Lenz Law.*) "Whenever an induced current arises by reason of some change in the linkages, the magnetic field about the induced current is in such direction as to oppose the change." When the magnet is moved toward the coil, the change in linkages creates or induces a current that flows in the circuit in

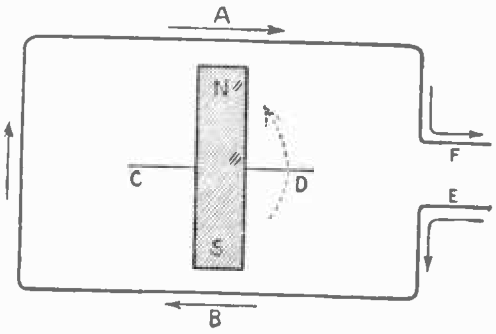


Fig. 2

such manner as to make A act as a North pole. As the North pole of the magnet is toward this point A, the similar poles will oppose each other according to the simple law of magnetic attraction and repulsion. Now if we attempt to withdraw the magnet, the change will alter the linkages again, this time creating an induced current that makes A act as a South pole, thus *attracting* the magnetic North pole and opposing in the opposite manner, the change in linkages that have created the current.

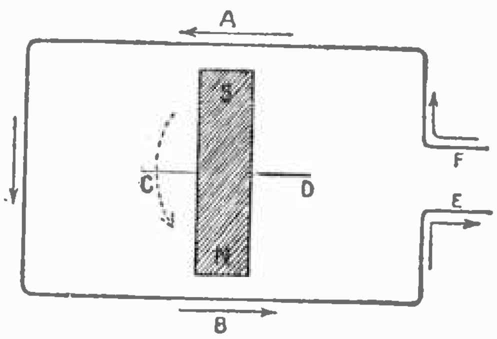


Fig. 3

We already know that if a conductor is moved across a magnetic field, an E.M.F. is induced in the conductor. The action is the same whether the

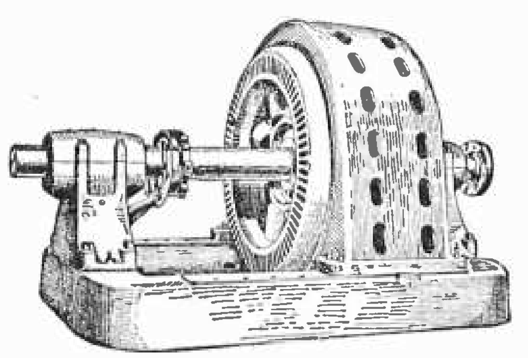


Fig. 4

conductor is moved across the magnetic field or vice versa. In Fig. 2, a magnet is shown in position on an axis—C D for rotation within the loop A B. As the magnet is rotated, the North pole passes across A, an E.M.F. is created toward F in the same direction. As the position of the magnet reverses in rotation and S passes A while N passes B, a current is induced in the *opposite* direction, both times in accordance with the law previously stated. Thus, if a meter is connected between the ends of the loop at E F and the magnet rotated, a current will be registered. With each half turn of the magnet, this current will reverse its direction. Therefore, we have produced an alternating current that changes direction with each reversal of the position of the magnets. This is the simple *AC generator* or *alternator*. The illustration, Fig. 4, shows a standard type of low frequency alternator.

ALTERNATION—In an alternating current, is the rise from zero to maximum *amplitude* and back to zero on either side, i.e., *positive* or *negative* directions. Two alternations—one positive and one negative—make a complete *cycle*. (See *Alternating Current.*)

ALTERNATOR—A machine for the purpose of changing mechanical energy into electrical energy. Fig. 1 shows an alternator in its elementary or

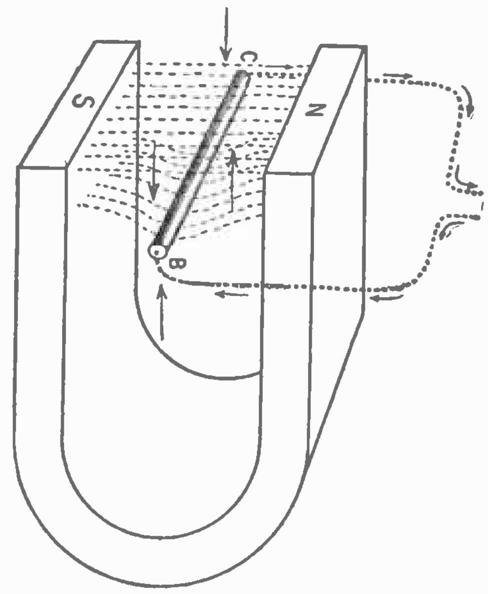


Fig. 1

simplest form—merely a conductor, B C moved across a *magnetic flux* (*q.v.*) (Note: For a complete explanation of the production of alternating currents, see *"Alternating Current, Theory of Production of."*) Here the conductor B C is moved to the right *across* the magnetic flux shown as dotted lines between N and

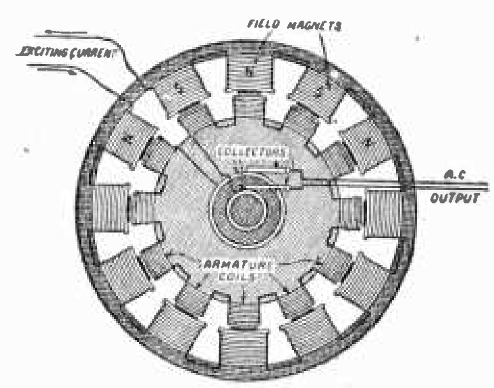


Fig. 2

S, the poles of the magnets. As the conductor moves across the flux lines of the magnet, an *electro-motive force* (*q.v.*) *or electric* current is set up or induced in the conductor, this force being in such a direction that the current produced will create a flux or magnetic field, in the same direction as the flux on the side of the conductor that comes first into contact with the flux lines N S on moving the conductor. In this case E.M.F. (electromotive force) is in the direction B to C in the conductor. In order to establish a circuit and utilize the current produced in this manner, it is only necessary to attach wires to both ends of the conductor as shown by the dotted loop. Now at this moment the conductor is being traversed by a current having a definite polarity, that is to say, it is flowing in one direction only. When the direction of the flux lines N S are reversed, as by reversal of the magnet, or the conductor is turned so that the other end comes into contact with the flux lines, then the direction of the current in the conductor will reverse and it will flow in the opposite direction. In other words, with every reversal of the position of the conductor in its relation to the magnetic flux N S, or the reversal of the direction of the flux lines, with respect to the conductor, the E.M.F. that is created will change its direction of flow. (See *Alternating Current.*)

In an alternator it has been shown that the result is approximately the same whether the magnet is rotated or the conductor is rotated through the magnetic flux. In either case the moving member is known as the *rotor*

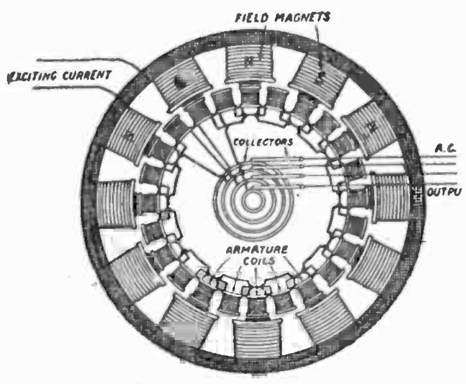


Fig. 3

(*q.v.*) and the stationary member is called the *stator* (*q.v.*). The magnets producing the flux lines may be stationary or they may revolve; in either case they are referred to as the *"field"* (*q.v.*).

It has been shown that with every change in the relative position of the field magnets and the *armature* (*q.v.*), irrespective of which member is the rotating one, a change of direction of the induced E.M.F. takes place. Then it is apparent that in order to increase the number of changes, that is, to increase the *frequency* (*q.v.*), it is only necessary to use (1) a greater number of field magnets, or (2) have the armature or conductor pass the magnets more frequently by means of greater speed in the rotating member, or by means of both. Now each of these changes is an alternation (see *Alternating current*) and two such changes will be a *cycle* (*q.v.*). Let us suppose that the moving member of a certain alternator has a rotary speed of 720 revolutions per minute and there are 10 poles or magnets. As frequency is figured by the changes per second, it will be necessary to reduce this number to the revolutions per second. Thus, there will be 12 revolutions per second. This figure multiplied by the number of *poles* (*q.v.*), which we assume as 10, indicates 120 alternations per second. As there are two alternations to each *cycle* (*q.v.*), the frequency in this case will be 60 cycles. The equation is as follows:

$$F = \frac{P}{2} \times \frac{N}{60}$$

where F is the frequency, P, the number of poles and N the speed of rotation per minute. The exact voltage or E.M.F. obtained will depend on the number of poles and the speed of rotation, and also on the distribution of the field windings and total flux from all the poles or magnets. In designing alternators the effective E.M.F. (electromotive force) is expressed by the formula:

$$E = \frac{K P \phi N Z}{10^8}$$

E is the effective electromotive force of the alternator.
K represents the E.M.F. factor of the alternator. This factor depends upon certain charcteristics of the poles and also the distribution of the windings on the armature.
P is the number of poles of the field magnates.
ϕ is the number of lines of magnetic flux that flow from one pole across the gap to the armature—known as the useful magnetic flux per pole; (see *Maxwells*).
N is the speed of rotation of the rotor in revolutions per second.
Z is the total number of conductors on the surface of the armature.
10^8 represents the number 100,000,000 —the calculation given would be determined in *abvolts* (*q.v.*), $\frac{1}{100,000,000}$ volt and it is therefore necessary to reduce it to volts by division.

In the "revolving field" alternator, as explained above, the field magnets are rotated and the conductor remains stationary. The windings in which the E.M.F. is produced, are placed in slots in the inner surface of the stator, the stator and the windings composing it being the *armature.*

In the alternators of the revolving armature type, the conductors or armatures are the rotating member and the field magnets remain stationary. Fig. 2 shows the revolving armature type of alternator in diagrammatic form. A small direct current *generator* (*q.v.*) may be used to excite or build up the field. That is to say, a

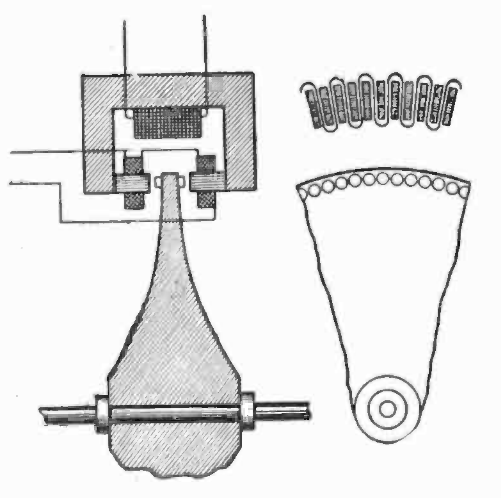


Fig. 4

current is sent through the field magnets (windings in this case) for the purpose of increasing or building up the *flux density* (*q.v.*). This is known as an *"exciter"* (*q.v.*). The exciter may be mounted directly on the end of the rotating shaft of the alternator, or mounted separately and connected to the alternator rotor shaft by means of a belt. This permits a heavy field to be built up by the electro-magnets used in place of the ordinary magnet shown in Fig. 1. If the machine is to be *single phase* (*q.v.*) there will be two *collector rings* (*q.v.*), the two phase type will have four rings, and the three phase six rings. The illustration Fig. 2 shows the general design of a single phase alternator. In this case there will be of course onlv two rings to collect the E.M.F. set up by the machine. Fig. 3 illustrates the general scheme of armature winding for a two phase machine. Here there

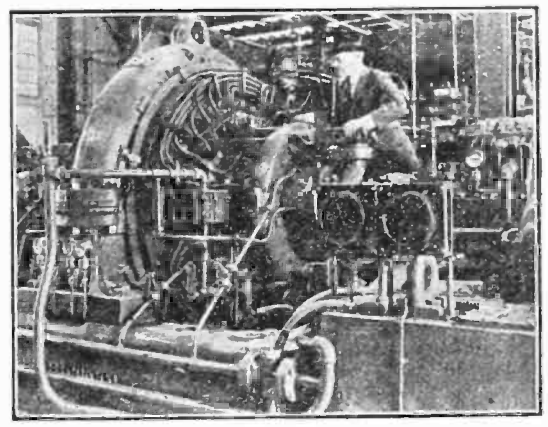


Fig. 5

are actually two separate E.M.F.'s set up by the separate windings and the ends of each of these windings are connected to collector rings as shown. In the three phase arrangement there may be three separate windings and six collector rings.

The use of the revolving armature type for comparatively small voltages is due, as mentioned previously, to the fact that they are easily constructed, and also the advantage that the exciter need not be an external source, but may be a separate winding with a *commutator* (*q.v.*) mounted on the main shaft. The revolving field type of course allows much greater space for the armature winding, inasmuch as the stationary member is not limited to any particular space, whereas the moving member must be arranged as small as possible to do away with mechanical troubles. Thus, the stationary armature can be wound and properly insulated for great voltages. For this reason the revolving field is generally used in high power work. Another point of importance is that where the armature revolves, the windings must be made very carefully as the centrifugal force due to rapid rotation of the members places a great strain on them.

One of the widely used forms of alternator for extremely high frequencies, is the Alexanderson, named after its originator, *Ernst Alexanderson* (*q.v.*), a noted engineer. This machine is of the inductor type. It is a well-known fact that magnetism is more readily established through iron than through air, and therefore when iron is placed in the air gap of a magnetic circuit, the lines of force or flux lines are greatly increased. Then when the iron is withdrawn, the flux lines fall to their original value. We have seen that as changes of flux take place throughout a magnetic circuit an electromotive force is induced in a coil or conductor (armature) surrounding the magnetic circuit. Now, if iron is periodically inserted into and withdrawn from the magnetic field, an alternating current will be set up in the coil surrounding the field. This principle is made use of in the inductor alternator and the field and armature thus remain stationary, contrary to the usual form of an alternator. Now if we arrange to have pieces of iron moved rapidly in the gap between field and armature, changes of flux will take place. Obviously, it is easy in this manner to create many changes of flux within a certain time, and therefore the alternating current set up (E.M.F.) will have a high frequency as seen by the explanation of this phenomena given previously. These moving pieces are so arranged that they practically close the gap between field and armature with only enough clearance to prevent the rotating member striking the stationary members. This is briefly the principle of the Alexanderson alternator. Fig. 4 shows the general plan of an inductor alternator. On the right shows the scheme of winding in slots around the entire form, and as there are necessarily many windings in order to obtain the high frequency, they are generally single turns of wire, each turn having a separate slot. On the left is given a general idea of the arrangement of the rotor, which in this case, as explained previously, is neither field nor armature, but iron teeth arranged on the periphery of the moving disk. The field is increased or excited in the usual manner by means of a source of direct current. In the assembly, the relation of the moving disk to the field and armature is shown. Fig. 5 is a commercial type of Alexanderson Alternator having a frequency (*q.v.*) of 100,000 cycles used for high power radio transmission (*q.v.*).

ALTERNATOR, SINGLE PHASE—(See *Alternator.*)

ALTERNATOR, POLYPHASE—(See *Alternator.*)

AMMETER OR AMPERE METER—An instrument for measuring current in amperes in a circuit. Is connected in series with a circuit. Exists in a variety of forms. The operation of the most commonly used type depends upon the fact that the force a magnet exerts depends upon the number of *ampere turns* (*q.v.*). Therefore, the greater the current sent through its coils, the greater will be its attraction for a balanced armature. Fig. 1 shows a common form of ammeter.

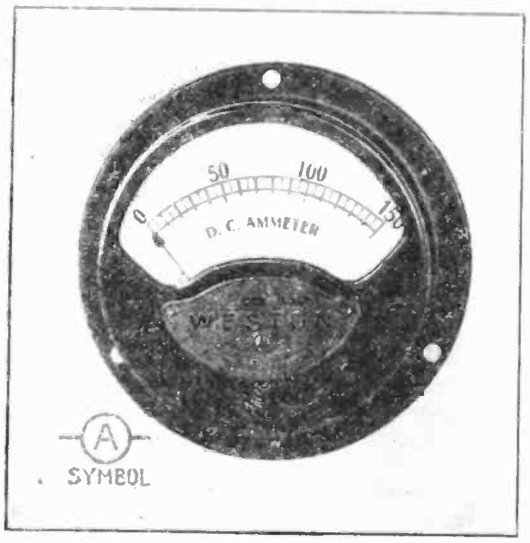


Photo by courtesy of Weston Elec. Inst. Co.

Fig. 1

AMMETER, THERMAL — Commonly known as *"Hotwire Meter."* Also called "Aerial Ammeter" and "Radio Frequency Ammeter." Operates on the principle of thermal expansion, i.e., the tendency of a wire to expand with heat of current passing through it. Is used to measure current in amperes at extremely high voltages as in radio transmission. Figure 2 shows a Thermal Ammeter which is generally employed in radio work.

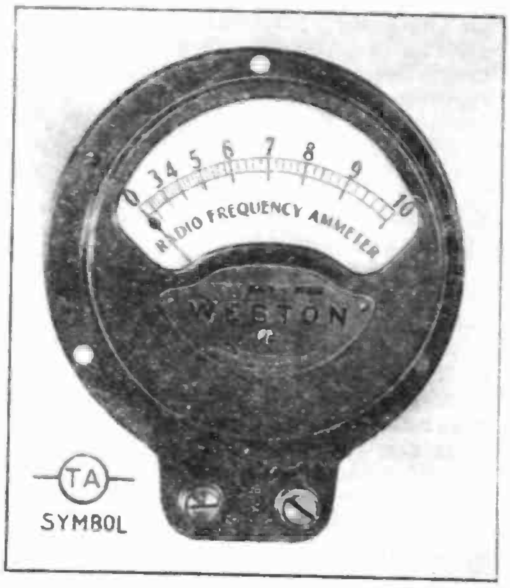


Photo by courtesy of Weston Elec. Inst. Co.

Fig. 2

AMP.—Abbreviation for *Ampere.*

AMPERE—The practical unit of the rate of flow of electricity. It is the unit current, or the rate of flow when one *coulomb* (*q.v.*) flows each second. The value or strength of electric current is almost invariably given in amperes. This unit is used to express the flow of a definite quantity of electricity in a second. If, for example, ten coulombs pass a given point in a circuit in one second, then we say that the current in that circuit is ten amperes. (See *Coulomb, Milli-ampere, Micro-ampere.*)

AMPERE, Andre Marie—A distinguished French physicist, born 1775, died 1836. Noted for his researches in the field of *electro-dynamics.*

AMPERE-HOUR—Commercial unit of quantity. Is that quantity which flows in one hour through a circuit carrying a current of one *ampere.* It is equal to 3,600 coulombs.

AMPERE, INTERNATIONAL—Symbol a—is defined as the unvarying electric current which deposits silver at the rate of 0.00111800 gram per second from a specified solution of nitrate of silver in water.

AMPERE'S RULE FOR DEFLECTION OF NEEDLE—"If one swims with the current and looks at the plus (+) or *north seeking pole* of a magnetic needle it will be deflected to the left, while the negative (—) or *south seeking pole* will be urged to the right."

AMPERE'S THEORY OF MAGNETISM—The theory advanced by *Ampere* that an *electric current continually circulates around each molecule of a magnetic substance and that the process of magnetization is one of arranging these currents in such manner that they all take the same direction.*

AMPERE TURNS—Expressed by the product of number of turns of, and the number of amperes flowing through, the coils of an electro-magnet. Thus, one ampere turn would be one ampere flowing through one turn. The ampere turn is very frequently used as a unit of *magneto-motive force* (*q.v.*) due to the ease with which it can be obtained.

AMPERE VOLT OR VOLT AMPERE—The expression sometimes used to denote *watts* (*q.v.*). For example 1 volt ampere will be one watt, as watts are equal to the product of the volts and amperes in D.C. circuits. (See *Efficiency,* also *Watts.*)

AMPLIFICATION CONSTANT — The factor expressing the maximum voltage *amplification* (*q.v.*) that it is possible to obtain with a given vacuum tube. Thus, if a certain tube will permit amplification of eight times the original voltage, the amplification constant is said to be 8. (See *Vacuum Tube.*)

AMPLIFICATION FACTOR—The ratio of the change of instantaneous voltage, between filament and plate of a *vacuum tube* to a small change of instantaneous voltage between filament and grid for a given constant plate current:

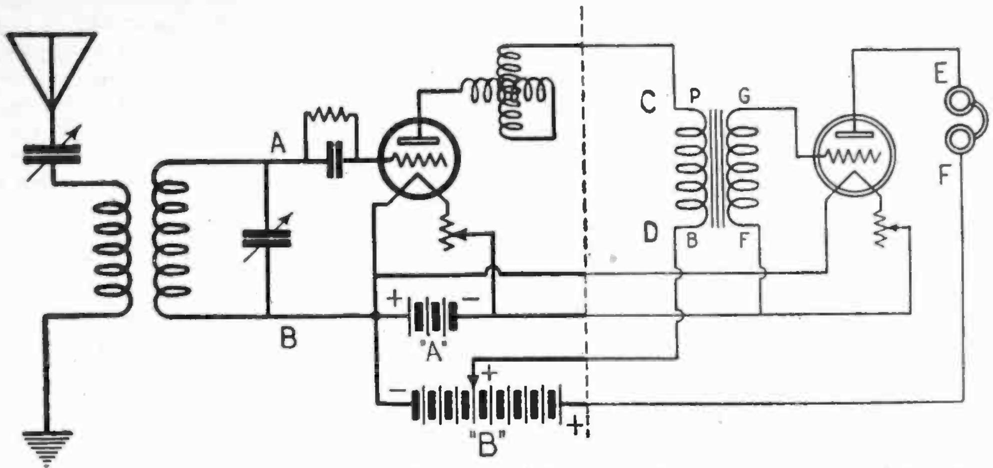
$$y = \frac{\delta Vp}{\delta Vg}$$

The ratio of power (radio signals), voltage or current output of an amplifying device to the power, voltage or current delivered to the input terminals. Generally speaking the degree of increase in amplitude or volume by insertion of an amplifying device in the circuit. (See *Amplification Voltage.*)

AMPLIFICATION, VOLTAGE — In a *vacuum tube* the ratio of the voltage apparent between the terminals of an impedance in series with the *plate,* to the voltage impressed on the *grid.* (See *Amplifier.*)

AMPLIFIER—One of the most important features of the *vacuum tube* (*q.v.*) is its ability under certain conditions to amplify or increase the intensity of electric currents. Such tubes are generally referred to as amplifier tubes and an amplifier is understood to be one or more such tubes with the necessary associated circuits to accomplish amplification.

X—In the accompanying diagram a circuit of a typical one stage *audio frequency* (*q.v.*) amplifier is shown in conjunction with the *detector circuit* (*q.v.*). In this case the *radio frequency signals* (*q.v.*) are impressed at the points A-B from the aerial and ground circuit. The resulting signals at points C-D are audio frequency or voice frequency because they have undergone a change or *rectification* (*q.v.*). Now, if we consider only the solid lines, the circuit will be an ordinary detector circuit and the signals at C-D can be heard by merely connecting the phones at that point in place of the primary of the transformer—P-B. However, by sending these currents through the transformer and impressing them on the second tube it is possible to obtain signals at points E-F of much greater volume and yet having the same general characteristics or sound. The signals or currents will have undergone amplification—the effect of the amplified tube on a local source of power increase the amplitude, but the form or nature of the signals or waves will be the same. (This statement is not entirely true as amplification is generally accomplished only at the expense of some slight changes in the nature of the waves). They will, however, sound about the same in the phones at E-F as they will when the phones are placed at C-D, the volume at E-F being greater due to the amplification. (See *Distortion*). Now it must not be assumed that an amplifier in itself actually has the ability to increase power without some assistance. It is no more possible to obtain something for nothing in electricity than it is in mechanics. What actually takes place is that the amplifier tube and associated circuits control local power—in this case the voltage of "B" battery—in such a manner as to boost or amplify the power of the signals without materially changing their nature. Therefore, an amplifier may be considered as a device which modifies the effect of a local source of power in accordance with the variations of input power, and produces an increased output power or a means of stepping-up or increasing the amplitude or volume of a signal or series of signals. (See *Amplifier Action or Vacuum Tube.*) (See *Amplifier, Audio Frequency, Amplifier Radio Frequency,* also *Transformer.*)

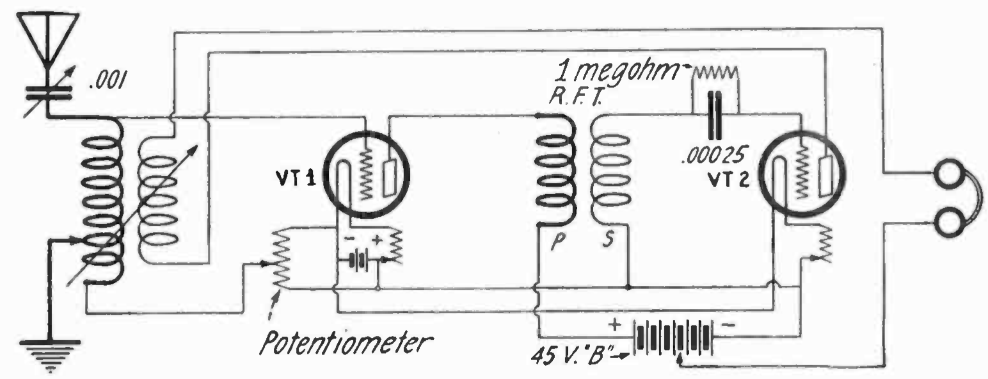


A single stage radio frequency amplifier as used in conjunction with a tuner and detector
Showing the method of amplifying rectified signals at audio frequency

AMPLIFIER ACTION OF VACUUM TUBE—The tendency of a vacuum tube to increase the power or voltage of incoming signals under proper conditions. In the illustration is shown a simple vacuum tube circuit. The incoming signals are impressed on the tube at points A and B. Now it has been noted that small changes of voltage at the *grid* (*q.v.*) will produce much greater changes at the *plate* (*q.v.*). (See *Vacuum Tube, Theory of Operation.*) In other words, the constant changes in value of the incoming signals that are impressed at A-B will produce comparatively larger changes in the current at the plate and therefore larger changes of voltage in the output circuit at C-D. These changes will of course manifest themselves in the form of signals in the phones placed at C-D. Now if these voltages are impressed on a *resistance* (*q.v.*) of suitable value—such as the primary of an amplifying transformer—they can be sent to another tube and again amplified. (See *Amplifier, Audio Frequency.*) In other words the amplifying action of a vacuum tube means the ability of that tube to use input power—the power of the signals delivered to the tube—to control a local source of power such as the "B" battery voltage used on the plate of the tube, and deliver increased power. The signals to be increased or amplified in this manner may be *Radio Frequency* (*q.v.*) or *Audio Frequency* (*q.v.*), each instance requiring a different type of *amplifier* (*q.v.*). The radio frequency signals are amplified by means of a tube and suitable apparatus (transformer or resistance) before they have been changed to audio frequency. The signals that have been *rectified* (*q.v.*) or changed to audio frequency may be amplified by means of a similar arrangement of somewhat different type. The latter would be known as audio frequencv amplification. The increase in power is accomplished without any material change in the nature of the signals or wave form (*q.v.*)

AMPLIFIER, INTERMEDIATE FREQUENCY—An arrangment of a *radio frequency amplifier* to increase the strength of signals at the *intermediate frequency* (*q.v.*) as used in a *Super-Heterodyne receiver*. This is usually a radio frequency amplifier using *transformer coupling* (*q.v.*) the transformers being designed to cover extremely high wave-lengths. (See *Super-Heterodyne*, also *Transformer.*)

AMPLIFIER, RADIO FREQUENCY — An amplifier used to increase the volume of the incoming signals at *radio frequency* (*q.v.*) before they have been *rectified* by the detector. In the illustration is shown a single stage of radio frequency amplification. This is the transformer coupled type. In this case the incoming signals of radio frequency are increased in strength and then passed on to the detector tube VT2. If further amplification is desired, more stages may be used, the number being held within certain limits due to *distortion* (*q.v.*). If more than three stages are used, it is often difficult to control the *feed-back effect* (q.v.) and efficiency is cut down.

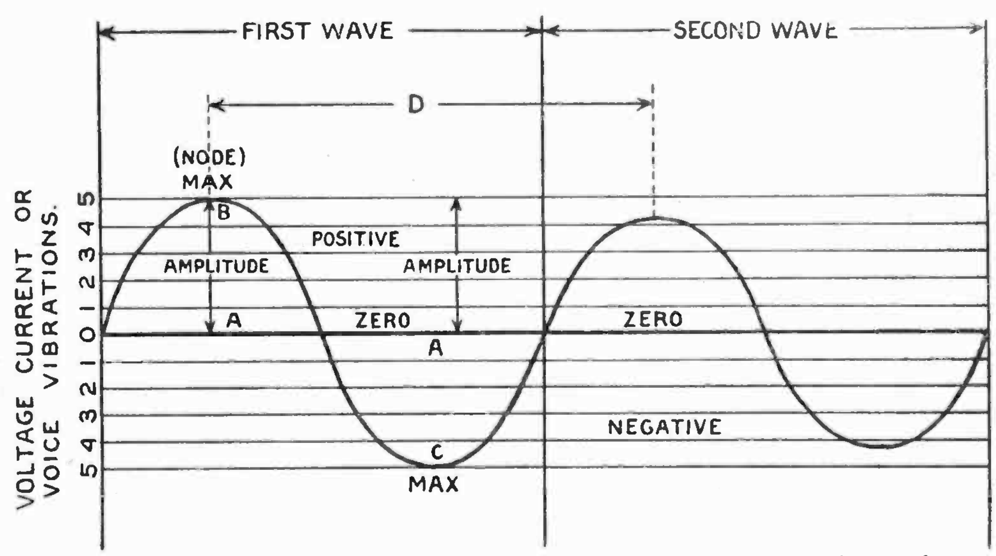


A single stage radio frequency amplifier as used in conjunction with a tuner and detector

AMPLITUDE—The current or voltage on an A.C. or H.F. circuit at any instant.

The greatest vertical distance above or below zero of the crest or trough of a wave is the maximum amplitude of the wave. In the accompanying illustration the numerals at the left (*ordinates q.v.*) may be assumed to be volts, current (amperes), or voice vibrations. A is the zero point; B the maximum *positive*, C the maximum *negative*, and D the length of the wave. Thus, A. B will be the maximum *positive* amplitude, A C the maximum *negative* amplitude, and D the wave length. B is known as the crest or Node—C is the trough or antinode.

X—Now if in a certain train or group of waves, the amplitude of one wave is less than the one immediately preceding it, there is said to be *damping* (*q.v.*), the degree of this damping or diminishing in amplitude being referred to as *decrement* (*q.v.*). Thus, if we assume that in Fig. 1 the current or amplitude of the first wave is 10 amperes, and the next wave has an amplitude of only 5 amperes, then the damping or decrement is 50 per cent, because the amplitude has decreased that much. Similarly, if the first wave amplitude were 10, and the second were 9 amperes, then the decrease

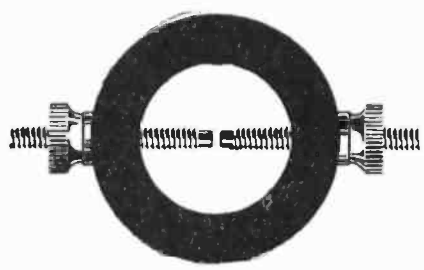


Line wave showing two cycles of an alternating current, indicating the amplitude and damping or decrement would be 10 per cent. In a damped wave the decrement or progressive decrease in amplitude must not exceed a value whose logorithm is 0.2. If it exceeds this value, it is said to be highly damped. The degree of damping is governed by government statutes. (See *Decrement* and *Alternating Current.*)

ANALOGY—"Resemblance of properties or relations; similarity without identity"—Webster. Analogies are much used in radio work for giving simple examples of difficult subjects. The most frequent analogy is the comparison of radio waves to water waves.

ANALYSIS-ELECTRIC—(See *Electrolysis.*)

ANCHOR GAP—A small spark gap in aerial circuit used to automatically disconnect the transmitter when the receiver is being used, see illustration. The powerful transmission spark jumps the gap instead of passing through the instruments. The device



is principally employed to protect the delicate instruments of the receiving set.

ANGLE OF LEAD OR LAG—In a circuit traversed by *alternating currents*, the degree by which the current falls behind or advances ahead of, the voltage in the circuit, due to the presence and effect of *self-inductance* or *capacity*. When a coil of wire is traversed by alternating currents the self-inductance of that coil tends to make the current lag behind the applied E.M.F. (*electro-motive force*). When a condenser is inserted in the circuit carrying alternating currents, the *capacity* tends to accelerate the current and makes it precede the applied E.M.F.

X—The tangent of the Angle of Lag will be the ratio of the *inductive reactance* (*q.v.*) to the resistance of the circuit, therefore: Where θ is the

$$\text{Phase Angle, } \tan\theta = \frac{\text{Reactance}}{\text{Resistance}} = \frac{2\pi F L}{R}$$

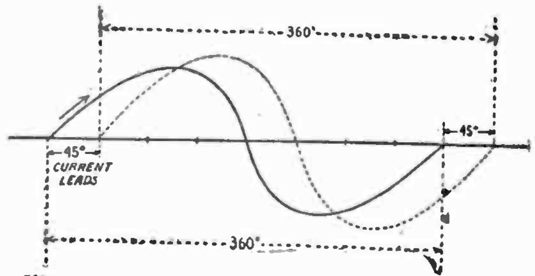
The tangent of the angle of lead will be the ratio of the capacitive reactance to the resistance of the circuit. As:

$$\text{Where } \Theta \text{ is the phase angle } \tan\Theta = \frac{\text{Reactance}}{\text{Resistance}} = \frac{1}{2\pi F C} \div R$$

These simple relations are true only when there is inductance *or* capacity in the circuit, and not both.

ANGLE, PHASE—The degree of difference in *phase* between two different currents or the angle of *lead* or *lag* in a circuit wherein the applied E.M.F. (*Electromotive Force*) does not reach maximum amplitude at the same instant as the current. (See *Angle of Lag.*) Thus, when the applied E.M.F. and the current reach *negative* and *positive amplitudes* simultaneously, there is no phase difference, hence no Phase Angle. If for instance, one current reaches a negative or positive maximum before or after the other current, the two currents are said to be "out of phase."

X—In the illustration it will be



Illustrating the angle of lead. The solid line marked with an arrow indicates the current phase, the dotted line representing the voltage.

noted that the current reaches maximum value ahead of the pressure. The angle of "lead" in this case is 45°. Therefore the angle of lead is the *Phase difference* or a 45° lead with respect to the voltage.

ANGULAR VELOCITY—Referring to a periodic alternating current, represents 2π times the frequency in cycles per second, the result being given in radians per second. Thus, $V = 2\pi \times F$. (See *Simple Harmonic Vibration.*)

ANION—The electro component. (See *Electrolysis.*)

ANODE—A *positive* electrode. In a vacuum tube the plate is sometimes termed the Anode, the opposite being *cathode* or *negative* element. (See *Dry Cells, Storage Battery* and *Electrolysis.*)

ANODE BATTERY—See *Plate Battery.*

ANODE CIRCUIT—See *Plate Circuit.*

ANODE CONTROL—See *Plate Control* and *Modulation.*

ANTENNA, COIL—See *Loop Aerial.*

ANODE CURRENT—See *Plate Current.*

ANTENNA—See *Aerial.*

ANTENNA RESISTANCE—Is usually considered as the total *effective resistance* of an antenna and the associated circuits to impulses at any particular wavelength. It, therefore, includes resistance of any sort, such as *radiation resistance* (*q.v.*), *ground resistance* (*q.v.*), etc. It is often referred to as the total loss, but this is not actually true, inasmuch as the power transmitted is in reality included in this figure known as Antenna Resistance.

Is regarded as an effective resistance which is equal numerically to the ratio of average power dissipated in the total antenna circuit, to the square of the effective current at the point of current maximum. In computations is held to include radiation resistance, ground resistance, *radio frequency resistance* of conductors in antenna system, and the equivalent resistance arising from *eddy currents, corona, dielectric loss, leaking insulators*, etc.

ANTI-CAPACITY SWITCH—See *Switch.*

ANTINODES—Points of greatest *amplitude* in a train of waves or oscillations halfway between the Nodes or points at rest. Also called "loops."

ANTI-RESONANCE—See *Parallel Resonance.*

APERIODIC—Untuned. Without *periodicity.* Attaining repose without vibrations. (See *Periodic.*)

APERIODIC CIRCUIT — Untuned. A circuit that has no natural *oscillating period* (*q.v.*) of its own. If a circuit has *capacity* (a condenser) and *inductance* (a coil) it has a *definite period.* If the circuit has capacity but no inductance, or inductance but no capacity, it is said to be Aperiodic. A current that has no period is also said to be Aperiodic.

The term aperiodic is generally applied to a circuit upon which are impressed R.F. oscillations differing considerably in frequency or period from the natural frequency or period of the circuit. The oscillations are said to be "forced."

X—Without periodicity—attaining repose without vibrations. A circuit in which an impressed *potential* will produce current that gradually diminishes in *amplitude* without reversing direction of flow. A *non-resonant* circuit.

APPLETON, Edward Victor—Born at Bradford, England, in 1892, and educated at St. John's College, Cambridge, where he took first-class honors in natural science. Appleton for some years made a special study of the thermionic valve (Vacuum Tube) on which he has become one of the leading authorities in Great Britain. He has been engaged in research work on valves at the Cavendish Laboratory, Cambridge, and has contributed articles on the subject to a number of scientific journals. He is a member of the Thermionic Valve Sub-committee of the Radio Research Board of England.

ARC CHARACTERISTIC is the curve showing the relation between *P.D.* (*q.v.*) at the terminals of an arc (usually taken as *abscissae*) (*q.v.*) and the current through it (ordinates) (*q.v.*). When voltage and current are increased or decreased slowly while making the measurements, the *curve* is called the *static characteristic*, and is the same with rising or falling current; when the voltage and current are varied very rapidly, the curve is called the dynamic characteristic, and the rising voltage curve is different from the falling one.

The static characteristic has a *negative* gradient or slope, hence an arc is said to have a negative or falling characteristic. The dynamic characteristic is a curve enclosing an area whereas the static characteristic is purely linear.

ARC GENERATOR—A machine producing a powerful electric discharge in a gap separating two *electrodes*, the continued passage of current being due mainly to the heat produced at either one or both electrodes. It generates sustained or *undamped oscillations* (*q.v.*) and is used for radio transmission of considerable power. The *positive* electrode is usually copper and is water-cooled—the *negative* electrode being of carbon.

ARC-GENERATOR SYSTEM—A system involving the use of the arc for the production of *continuous* or *undamped oscillations.*

ARC OSCILLATOR—See *Oscillator*

(*To be continued*)

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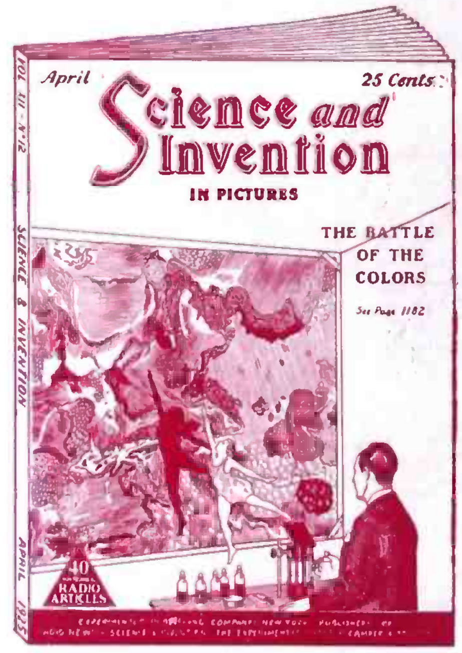

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