Radio Broadcast's Universal Receiver

Being the Study of Several of the Most Popular and Most Efficient Circuits for Home Construction With a View to Adapting Them to Fit Our Individual Needs

By ARTHUR H. LYNCH

HAVE you noticed that within the past few months the new Flexes, Dynes, and Supers described in the radio press have been extremely conspicuous by their absence? For some time, the passing of the trick circuit and its capitalization by the crafty and sometimes not too scrupulous publicist and manufacturer has been considered, by those who really understood the radio business, as a foregone conclusion. In passing on this interesting angle of the radio business, some of the older readers of RADIO BROADCAST will recall Zeh Bouck's article, entitled "The Truth About Trick Circuits" which appeared in our March, 1924, number. Some others may remember that we defended ourselves successfully in a libel suit for $100,000 which was brought against us as a direct result of the publication of this article and our refusal to make public apology for the things we said. We hope that article was instrumental in bringing about the situation with which the radio parts business is now blessed. Certainly, it is in better shape now than it has ever been before, even though there are those who would have us believe that, because the business in completed receivers has flourished so greatly, there is little or no parts business going on.

And before going directly to the subject at hand, perhaps a few words about the parts business will be of interest to the home constructor and others. On the magazine, we are in direct contact with thousands of the listening public by mail who express their likes and dislikes to us in no uncertain terms. Through our short wave transmitting station in our Laboratory at Garden City (2 GY) we are in direct communication with amateur radio enthusiasts in all parts of the world. Many manufacturers avail themselves of our laboratory services and from them we learn much of what is going on in their particular fields. Then, too, our laboratory has been chosen to pass on the quality of the products radio manufacturers desire to advertise in *The World's Work, The Atlantic Monthly, Harper's Magazine, Review of Reviews, Scribner's Magazine,* and *Country Life.* From these contacts, we come in still closer contact with many sides of the radio business.

There has been a considerable slackening off of the general parts business and there is no contradicting that fact. There are far fewer varieties of parts now to be had than there were a year ago. Allah be praised for that! Much of the older kind of parts business was little more than traffic in junk. Much of the junk has now been cleared out and it will not be long before the rest will have found its way to the scrap heap. Many of the junk dealers, who, a few months ago, believed themselves to be in the radio parts business have gone broke or have gone back to their old jobs, whatever they were. The parts merchant of to-day and to-morrow is not the fellow who attempts to unload a lot of radio jimcracks on credulous but misinformed radio buyers, but he is rather the man who understands the reason for every part he sells and is able to render the home constructor the sort of service he is reasonably entitled to expect. If more dealers would study some of the existing radio circuits and determine from actual performance just which is suited to their particular needs and then have samples made, which could be displayed in their stores and operated if need be, they would

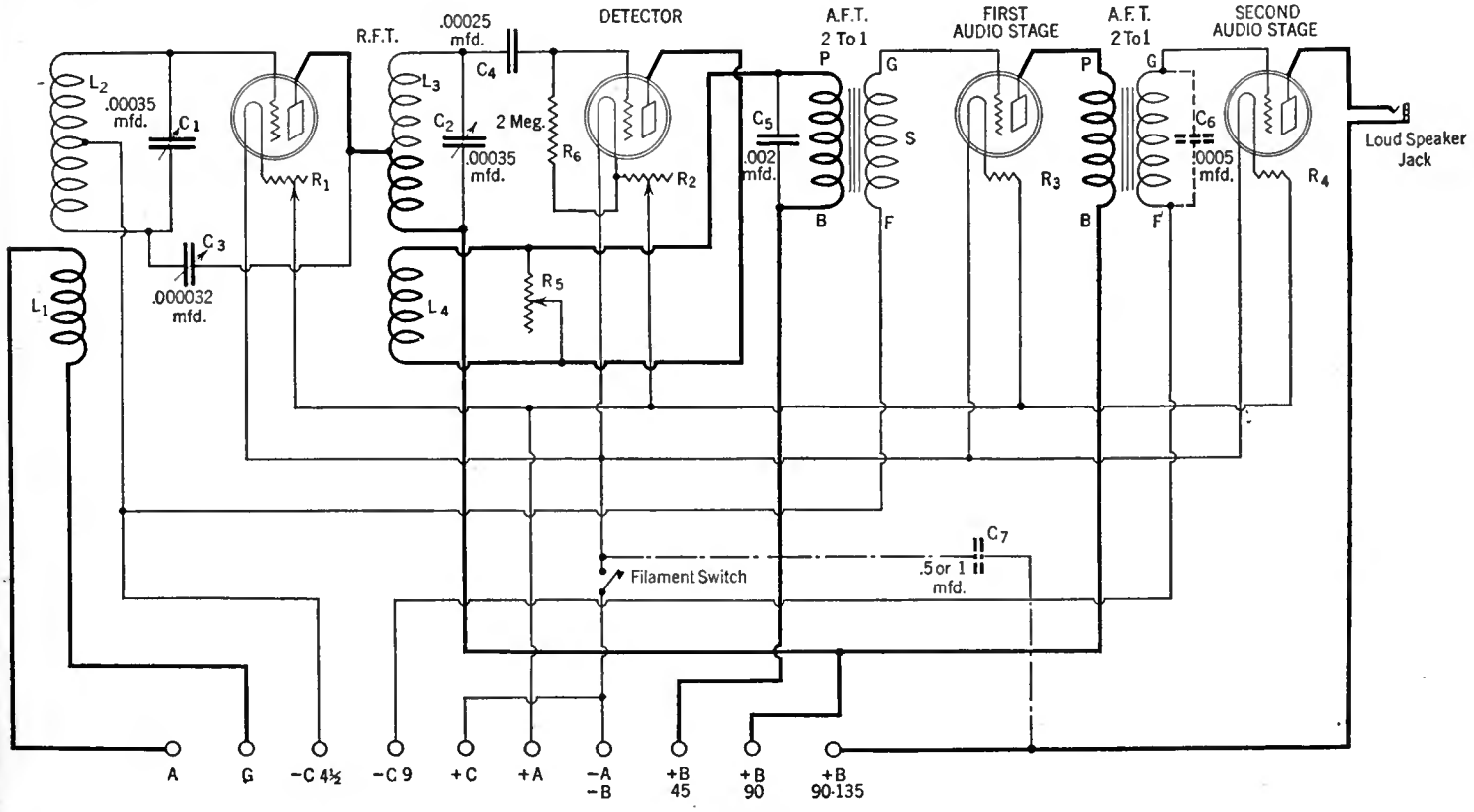


FIG. 1

This is the circuit diagram of the Universal Receiver. It consists of one stage of tuned radio-frequency amplification utiliz ing the Rice method of neutralization, a regenerative detector, and two low ratio stages of audio-frequency amplification. The wiring of the assembled receiver takes the same form followed in this diagram. For instance, the lower terminal of the radio frequency coupling unit is the lower end of L_4 in the diagram

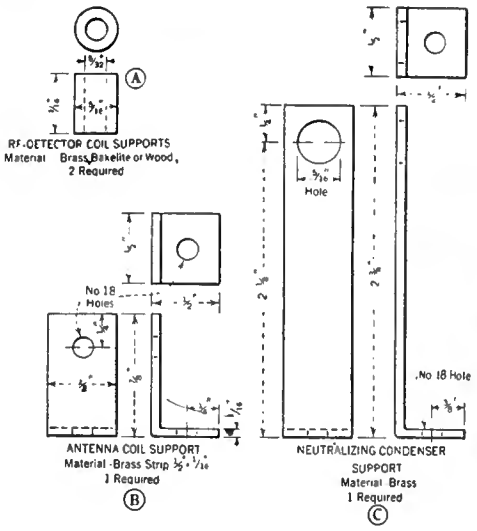
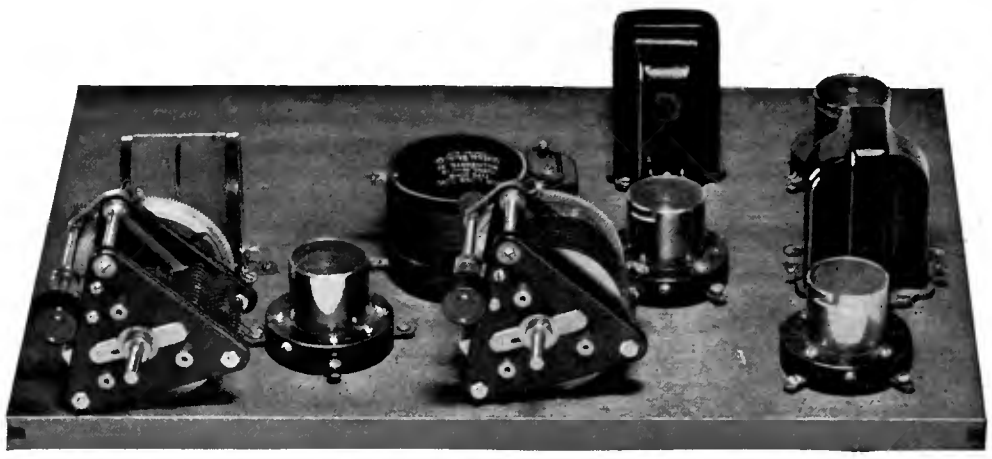


FIG. 2

The dimensions and other specifications for the angles and other hardware used to assemble the receiver are given here. In the case of the bushings, bakelite or wood will do as a substitute for brass



HOW THE SET STARTED . . .

The embryo "Universal." By laying out the parts on the base-board, it was possible to experiment with changes in location of the various coil and condenser units to observe any improvement in results obtained. This system of experimental construction is to be highly recommended

find a harvest in the parts business far beyond their most optimistic expectations. In fact, those dealers who are following this plan, and there are a great many of them, are finding the parts business to be anything but dead.

Every home constructor is actually a radio salesman in his neighborhood. If his receiver works well, and homemade receivers usually do, the builder generally proclaims from the housetops, first the wonders of his outfit and then the wonders of radio in general. Many of his auditors wouldn't give a red apple to duplicate his accomplishment, but many of them would like to be able to hear the things he hears and the rapid growth of the radio business to-day may well be credited to the home constructor.

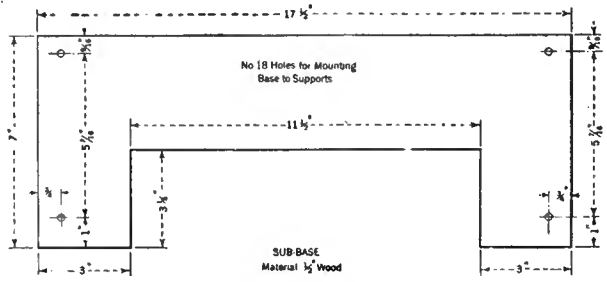


FIG. 3

The baseboard layout. Especial care should be exercised in cutting out the section to be removed so as to prevent splitting the wood. The use of this type of baseboard insures easy assembly and wiring

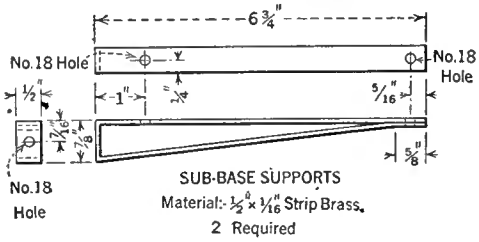


FIG. 4

Two brackets, made as shown here, support the baseboard assembly. Approximately 32 inches of ½ x 1/16-inch strip brass are required to make the two brackets

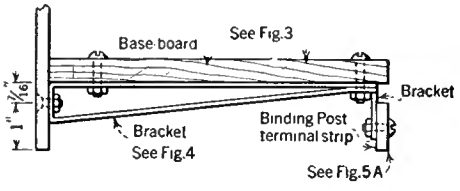


FIG. 4A

The baseboard is mounted on the brackets and panel in the manner shown above. Two brackets for the terminal strip are required. The vertical part is 1¼ inches long and the hole for the strip is located ¼ of an inch from the bottom

THE PROBLEM

ALL of the foregoing was brought to mind by a moment's consideration of the problem at hand and our reasons for dealing with the subject of the universal receiver. First of all it was necessary for us to determine on a particular circuit. It is almost impossible to think of circuits at all without thinking of all the dynes and whosits and so forth which were given so much free space in the newspapers a few short months ago. Most of them have met a natural death. There remain but a few tried and true circuits, so the matter of selecting the proper one for our individual use, is not such a difficult job, even for the uninitiated. There are many we could attack and use to good advantage, but when all the smoke has cleared away and the shouting is all over and we get back to a peace time basis, there is but one real type of circuit which may be called universal and that is the combination of one stage of tuned, neutralized radio frequency amplification, a regenerative detector and some kind of audio-frequency amplifier which will produce good quality. To explain the kind of a circuit we are describing, each time we have some variation of this circuit to contend with is indeed embarrassing and the name "Universal" is about as near the correct characterization as we have been able to find.

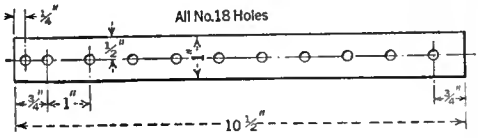


FIG. 5A

This is the layout for the binding post terminal strip. Bakelite, hard rubber, or formica 3/16-inch thick is satisfactory for use here

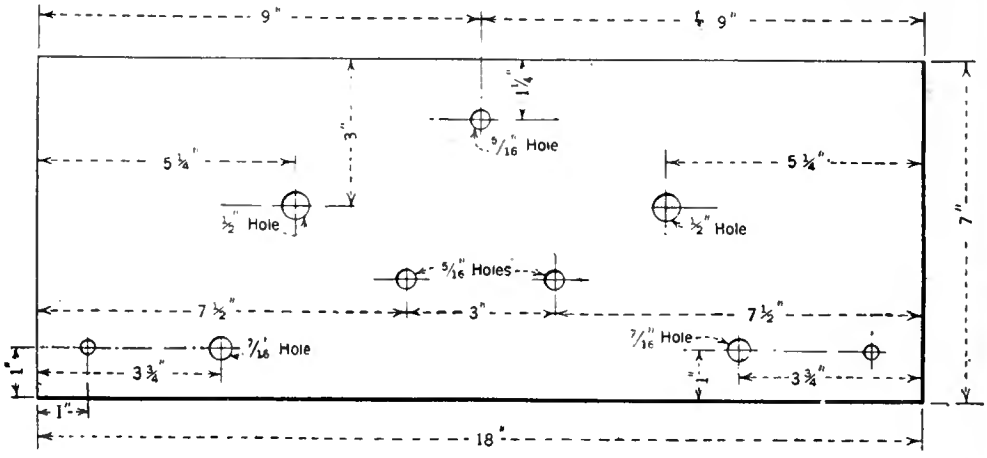


FIG. 5

The panel layout. Only center holes are shown so as to enable the builder to use parts that he may have on hand which differ in make from those recommended. In any case, before these center holes are drilled it is well to spot off the other mounting holes

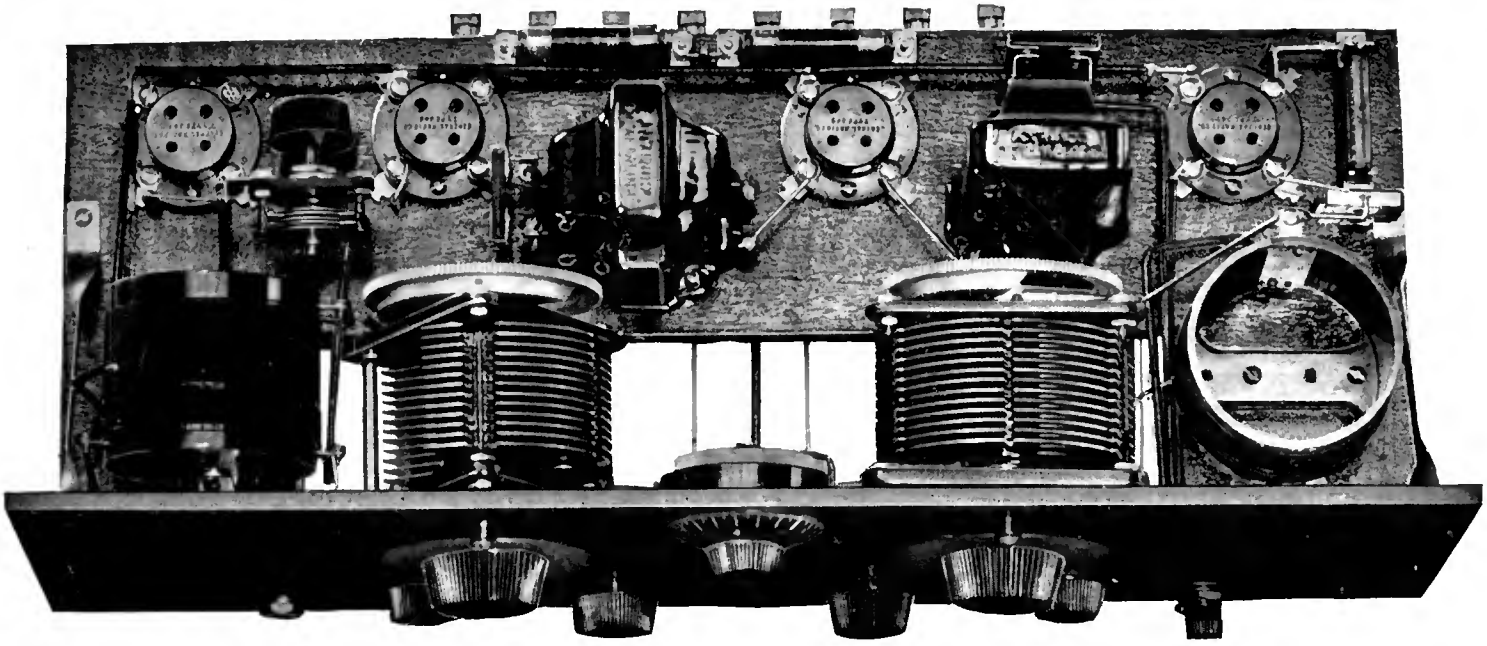


FIG. 7

Here is a view of the Universal employing the new UX sockets. With this arrangement there is a generous spacing of the parts and it is possible to employ any of the UX type of tubes such as the UX-199, UX-201A, WX-12, or UX-112 tubes in these sockets. The advantage of building the receiver with these sockets is apparent as there is not the necessity for using adapters when other voltage tubes are to be employed. Leads are short and direct, another obvious advantage

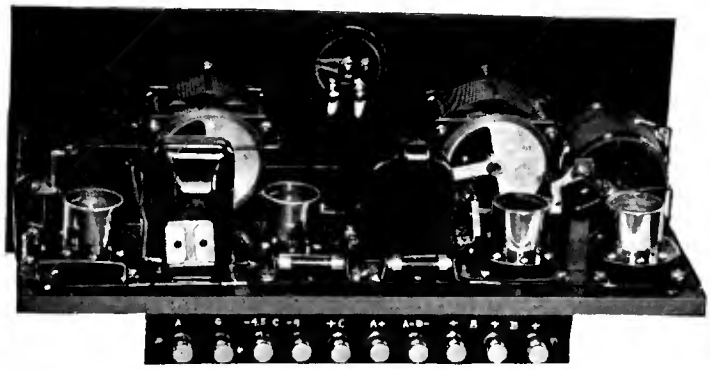


FIG. 6

This is a picture of the Universal receiver employing, in the main, General Radio Company parts. Standard UV type sockets are provided. This allows the use of either the UX or UV 201A type of tube in this set. Note the position of the neutralizing condenser between the first two sockets at the right. The grid leak and Amperite mountings are easily accessible if replacement ever becomes necessary. The binding post terminal strip serves also as a support for the rear of the wooden sub-base

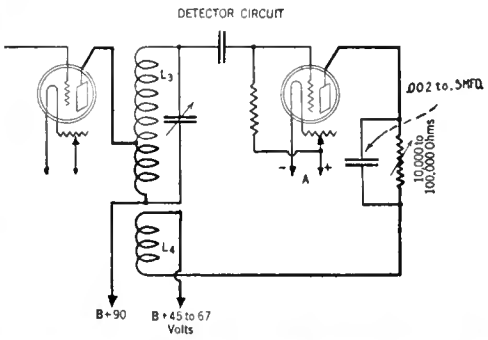


FIG. 9

Still another highly efficient way in which to control regeneration by a variable resistance. It is necessary to experiment with different values of capacity shunted across the resistance to obtain smooth control of regeneration. Such resistance units as the Bradleyohm No. 10, the Centralab, and the Royalty may be employed successfully

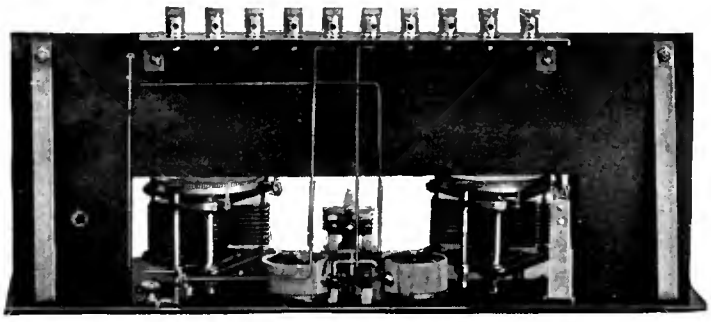


FIG. 10

With the use of the cut-out baseboard, the wiring and assembly of the parts employed in the construction of the receiver is made amazingly simple. Unlike a bakelite sub-base it is possible to screw down on to the wood the sockets, transformers, and other material without previously drilling it to admit the screws

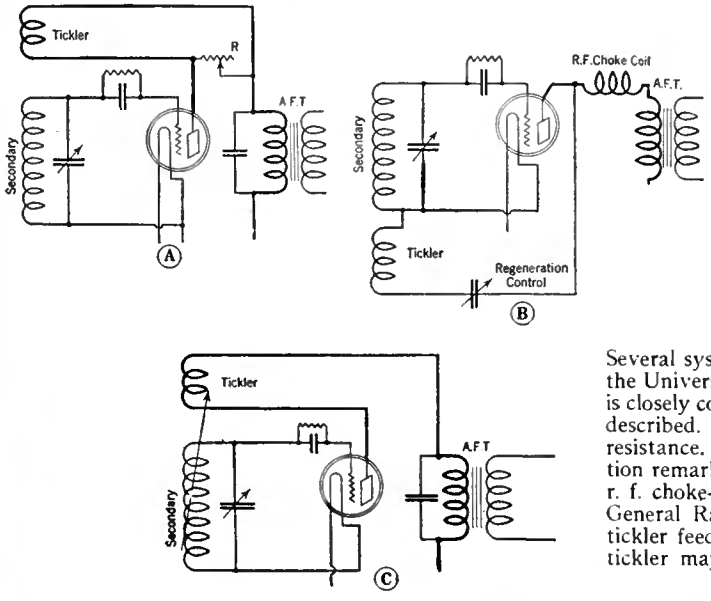


FIG. 8

Several systems of regeneration which may be incorporated in the circuit of the Universal receiver. In A, the resistance R shunts the tickler coil which is closely coupled to the secondary. This system is employed in the receiver described. Regeneration is obtained and then controlled by varying the resistance. In B, a condenser feedback system is employed which will function remarkably well when care is taken to include in the circuit a suitable r. f. choke-coil. In C is shown the usual tickler feedback system. When General Radio coils are used in the receiver and it is desired to employ tickler feedback, a mechanical arrangement must be provided so that the tickler may be coupled to the secondary of the detector coil unit. This puts another control on the panel

A circuit which would perform satisfactorily in city and country on dry cells or with a storage battery, without wasting B batteries, which would give more than ordinarily good quality of reproduction on a loud speaker over comparatively long distances, which was easy to build and easy to operate after it was built, and, last, but not least a circuit for which the parts could be procured in any town of any size in any part of the world; that was our notion of what the "Universal" should be. We believe we have found it. It is not a new circuit, by any manner of means. Fundamentally it was used in slightly modified forms in such popular receivers as the Teledyne, the Browning Drake, The Roberts, RADIO BROADCAST'S Four-Tube, Three-Tube, and Two-Tube Knockout Receivers. Hammarlund-Roberts, RADIO BROADCAST'S Aristocrat, the Samson T. C. Receiver and the Silver Knockout. But since the appearance of most of these receivers in RADIO BROADCAST, improvements have been made in the design of many of the integral parts and this improvement is particularly evident in the matter of tubes.

FIG. 11

A panel view of the Universal. Symmetrical layout has been one of the prime considerations in the construction of this receiver.

In order to show how various parts may be used in this circuit with satisfaction, we are illustrating with this article, a receiver employing just about the same circuit and sold in kit form by the Samson Company of Cambridge, Massachusetts, and another built to our design by the American Mechanical Laboratories of Brooklyn, New York. Other variations on the same theme may be seen by looking over the article by Allan T. Hanscom in our October, 1925, number and the description of RADIO BROADCAST'S "Aristocrat," by the present writer, in our November number. We are very anxious to have the fact understood that intelligent substitution of parts for those we have used will not detract from the performance of the receiver. It is impossible for us to list all those which can be used, but we wish to show no favoritism in the matter of recommending parts for the RADIO BROADCAST Universal Receiver.

So, then, as an example of what may be done, let us first consider the circuit and then the components of a single manufacturer which may be used to advantage in it. From a study of Fig. 1 it will be seen that there are two coil assemblies, one, a primary and secondary in the antenna circuit (L_1 and L_2; the latter tuned by the variable condenser C_1) the other, a tuned radio-frequency transformer of the auto transformer type and a tickler coil, which is fixed in position but adjusted electrically by means of the 500- to 50,000-ohm resistance, R5 shunted across it. These coils are indicated in the diagram by L_3 and L_4. By properly using the windings already provided on the General Radio Company's coils, No. 277D, both these coil units are instantly provided. No changes whatever need be made as the coils are of solenoid type with two windings on a single form. Two such forms are necessary. On each form there is a small and a large winding. The small ones are used for L and L_4 while the large ones are used for L_2 and L_3. The tap indicated on L_3 is easily provided by picking up a turn of the large coil, and scraping clean. It is merely necessary to solder the proper wire to it to carry out the correct circuit arrangement. In L_3 this tap is made 39 turns from the grid end and the tap on L_2 is made in the exact center of the coil. These coils may be used with .00035 mfd. variable condensers to cover the broadcast frequency range and the results obtained in our laboratory tests of the completed receiver indicate that they will go well below the lowest and well above the highest frequencies transmitted by the broadcasting stations now on the air. Let us now consider the remainder of the parts used for storage battery operation and once having done that we will study the few changes necessary for using the same circuit arrangement with dry cell tubes.

PARTS USED IN R. B. LAB MODEL OF THE UNIVERSAL RECEIVER

THE parts employed are: 1 Panel, 7 x 18, 1 Wood sub-base 7 x 17½, cut as shown in Fig. 3 and for simplicity of mounting and wiring we recommend the use of wood not more than ½ inch thick, 2 sub-base supports, made as shown in Fig. 4, from ½ x 1/16 inch brass strip (the approximate length of this strip required for the re-

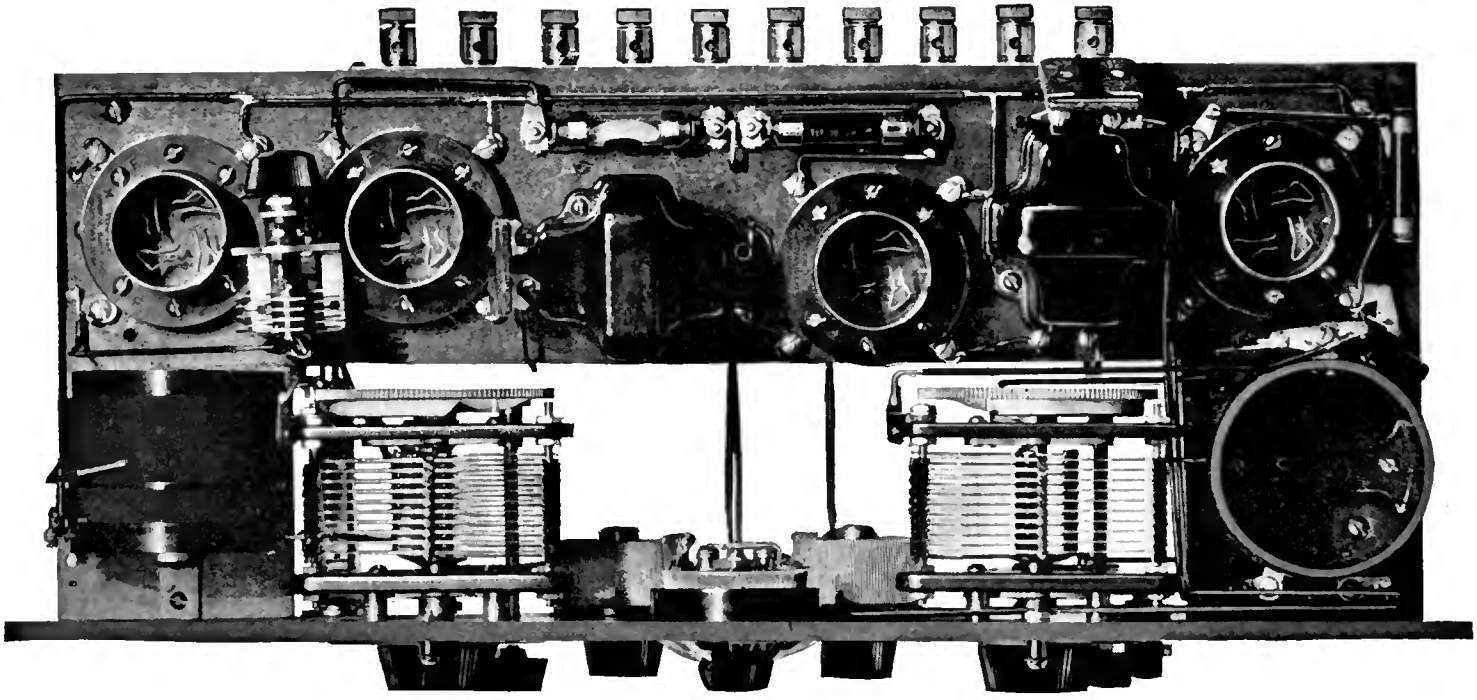


FIG. 12

A base view of the receiver. Note that the coil units are in line with and at right angles to each other. This is absolutely necessary for obtaining proper neutralization

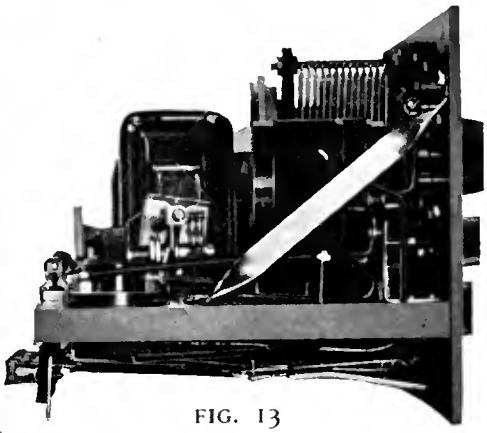


FIG. 13

In this end view the use of other brackets is shown. The builder may use either type according to his own desires

ceiver is 32 inches); 2 Detector coil supports, as illustrated in Fig. 2A; 1 Antenna coil support, as shown in Fig. 2B; 1 Neutralizing condenser support, as shown in Fig. 2C; 1 Royalty, 500- to 50,000-ohm variable resistor; 1 each Electrad, .00025-.002- and .0005-mfd. fixed condensers, and the following General Radio parts: 2 coils, type 277D; 2 variable condensers with vernier attachment, .00035 mfd. capacity, either S.L.W. or S.L.C., type 247P; 2 Dials type 310; 1 neutralizing condenser, type 368; 2 audio-frequency transformers, 2:1 ratio, type 285L; 4 sockets, type 156 for use with tubes having UV base, or type 349 UX sockets for tubes with UX bases, as explained further along; 1 binding post strip, with 8 posts, type 138Z; 2 rheostats, 10 ohms, type 301; 1 Yaxley filament switch and phone jack and one Electrad grid leak resistor, 2 megohm; and the large $\frac{1}{2}$ to 1 mfd. condenser across the B batteries is optional, but advisable. One each $\frac{1}{4}$ and $\frac{1}{2}$ ampere Brach or Amperite filament ballasts and mountings.

BEFORE BUILDING THE RECEIVER

TO BEGIN with, the combination which we have found to meet nearly every occasion, except where the storage battery is impossible for one reason or another, is the circuit in which 201-A type tubes are used in all sockets except the output of the amplifier and here we have found the UX-112 very satisfactory, when operated with 135 volts on the plate and a negative bias of approximately minus 9, as shown in the diagram, Fig. 1 With this arrangement, using the proper plate and biasing voltage (B and C) on the radio frequency tube as indicated in the same diagram the plate current consumption is in the neighborhood of five milliamperes and should not be above seven. The UX-112 will increase this figure somewhat. This sum is very low for a receiver of this general type and is one of the outstanding features of the RADIO BROADCAST Universal. If your receiver is to be located more than fifty miles from a broadcasting station, you may find that one low and one high ratio transformer will give you more volume and in such cases it is advisable to use it. It should not be more than 6:1, however. If this combination of transformers is to be used, be sure the high ratio transformer is used last and *not first* as is common practise. The reason for this change is well covered by Mr. Keith Henney, Director of RADIO BROADCAST'S Laboratory, in his article, *Tubes: Their Uses and Abuses*, in our last number.

The matter of sockets is a rather important one, in view of the great number of tubes already on the market and those which will probably follow. We have found that the standard socket is just about as satisfactory at the present time as any, because the standard tubes will fit in them and so will the tubes with the new UX bases. Where either the WD-11 or the UV-199 types of tube are to be used, they may be placed in the standard sockets by means of adapters. So much, for the receiver when the tubes to be used are those with which we have become quite familiar.

Now for the dry cell operation. We have found the combination of three 199 and one 120 tubes, or their equivalent, to be very satisfactory and, if you contemplate the building of this receiver without using any of your present stock, we suggest that you use the new type of socket because it may be used with any of the new tubes and it will be remembered that both these tubes are soon to be on the general market with the new UX bases, and by using the UX sockets, it will be possible to convert your receiver from dry battery operation to one which may be used with a storage battery by going to no greater bother than changing the tubes. Many of the independent tubes have been found to be very satisfactory and most of them will be on the market within a short time, probably before this article gets into circulation, with the new type bases. In order that you may have a direct comparison of the two types, we illustrate in Figs. 6 and 7, just how they will look when completed. The proper use of any type of tube in any receiver is one of the greatest factors in determining its performance and we can not urge too strongly the careful reading and then putting into application the instruction sheets which accompany the tubes now on the market.

BUILDING THE RECEIVER

AFTER procuring all the necessary parts and properly bending and drilling all the brass fittings and the wood subbase, the drilling of the panel can be undertaken and the layout shown in Fig. 5 will be found helpful in this connection. Next, all the parts which are to be directly attached to the panel should be put in place as should those which are to be attached to the sub-base. From this point on, the work of assembly is a very simple matter and it is but necessary to fasten the sub-base and the panel together by means of the brass supports and attach the binding post strip, which acts as the rear support for the receiver and then go ahead with the wiring. The dimensions of the entire assembly are such that the completed receiver will fit into a standard 7 x 18-inch cabinet and the use of a cable lead to the batteries is handy and is

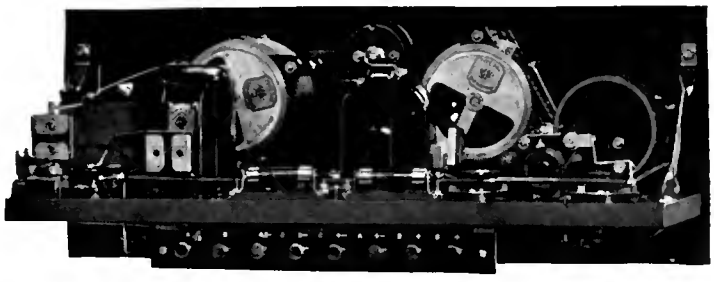


FIG. 14

This view of the rear of the Universal gives a pretty good idea of the disposition of the various parts. In this particular receiver, larger tuning condensers have replaced the .00035 mfd. variables. However, for the broadcast range the .00035's are entirely satisfactory

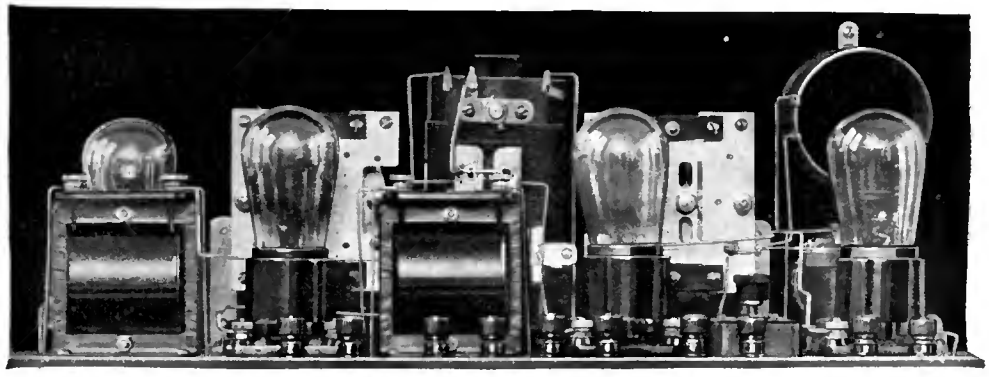


FIG. 15

So much equipment in such small space is, in itself, an accomplishment. This layout of the Samson TC Receiver is a little difficult to approximate but when you have it finished it's a real receiver. The tests run on it in our laboratory revealed it as one of the best receivers we have ever used. It is compact, easy to handle, economical to use and the tone quality is far above the average. On the second stage audio it performs very well with a cone speaker which is saying much for a transformer-coupled audio receiver

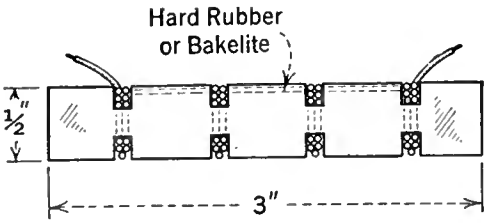


FIG. 16

To keep radio frequency currents where they are useful, a choke coil is shown in use in Fig. 8B. Such a coil is illustrated above and may consist of No. 30 wire wound 100 turns to the slot. With such a coil the feed-back condenser may be a small "midget" condenser

recommended. Furthermore, the dimensions on the sub-base are large enough to allow the use of any sockets or transformers now on the market, without making necessary any changes in design.

Perhaps there are those who would like to improve on the general design of this receiver in one way or another and the point which might well be expected to be attacked is the control of regeneration by the resistance across the tickler. Some of the attempts at this which were made in our laboratory, during the development of this receiver are indicated in Fig. 8, but for a number of reasons we have found the system finally employed here to be most practicable with the type of coils employed. Since the inductive relation of the tickler to the secondary of the radio-frequency transformer, that is coil L_4 to coil L_3, is always the same there is no change in wavelength or detuning in the radio frequency circuit, which is sometimes noticeable to a marked degree in receivers where a tickler of the rotary type is employed. Then, too, the number of moving wires and the breaking of connections they sometimes cause has been eliminated and with the proper detector plate voltage and the proper variable resistance, the control of regeneration is remarkably smooth, which is a distinct advantage.

CONDENSER FEED BACK

A VARIATION of the resistance control is the condenser feedback, probably due to Weagant and used commonly in the Reinartz circuit. A fixed coil is placed near the detector secondary and coupling to the plate is effected by means of a series condenser. The condenser and coil is then a shunt path for the radio frequency currents, and a choke coil may be necessary to keep these currents from escaping through the phones or amplifier primary. The circuit is shown in Fig. 8B and a drawing of a choke in Fig. 16. There should be no condenser across the output in this arrangement. This method of adding regeneration is particularly smooth in operation, and it avoids the movable tickler with its varying field.

And now there is little to do but the soldering and wiring. Wherever possible, the home constructor should fit himself out with a good soldering outfit, and a set of those small wrenches which comes in so handy in getting the nuts on and off transformers, tube sockets and such places. He should have a good supply of bus bar and spaghetti or flexible rubber-covered wire and a goodly supply of small sized lugs which may be directly fastened to the various units which go to make up the circuit and to which the soldering is actually done, rather than to the units themselves. By using this method of construction, it is possible at any later time to remove the holding nuts and off comes the wire with no fuss whatever. Then it should also be remembered that a good small screw driver is valuable in placing the soldering lugs under the heads of the screws in those units provided with screws instead of binding posts, and there are a great many of them on the market. That's about all there is to the building, and now we come to the point of putting our prize on the air.

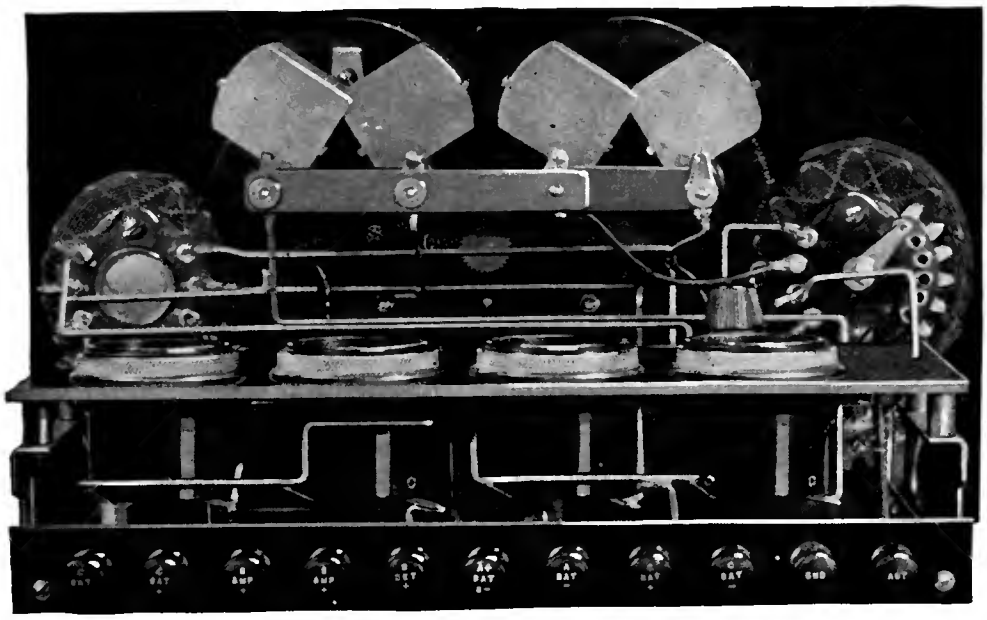


FIG. 17

A typical example of the Universal circuit worked into the small dimensions of RADIO BROADCAST's Phonograph Receiver. A Hanscom single-control unit with model 2 RK Clarotuner coils provides the tuning system, and the sub panel with special sockets was supplied by Osborne & Company of Boston to our dimensions. Note the freedom from visible wiring

OPERATING THE UNIVERSAL

THE antenna used with RADIO BROADCAST's Universal Receiver should be about 150 feet long, from the receiver itself to the outside insulator, including the length of the lead-in wire. With such an antenna, if you are located within 25 miles of a powerful broadcasting station you may find that the receiver is not selective enough to permit you to cut out the local station and bring in distant stations on frequencies near that of the local. This objection may be overcome by inserting a .0001-mfd. fixed condenser in series with the antenna or by reducing the length of the antenna a little. The former method is easier and usually more effective.

It will be found that the two dials will run just about even over the entire scale, if they are properly set when they are attached to the shafts. If the wiring is correct the receiver should respond as soon as it is put on the air, if there is any broadcasting going on. The only adjustment other than that which usually characterizes tuning is the setting of the neutralizing condenser and that is a simple matter, which once taken care of need cause no further worry. In order to set the neutralizing condenser properly, some broadcaster whose frequency is about 1000 kc. (300 meters) and whose volume is not very great should be tuned-in with the detector oscillating. The detector condenser should be tuned until the whistle from the station is quite loud. Then the first, or antenna, condenser, should be tuned. It will be noted that the whistle will change in pitch as this condenser is varied. When the set is exactly neutralized, this whistle will not change, and the problem is to adjust the neutralizing condenser until such a state of affairs exists. The neutralizing condenser should be varied a little at a time, each time noting the change in pitch of the whistle. On one side of the neutralization point, the pitch will rise in frequency; when the neutralizing point has been passed, the pitch will lower in frequency. By listening for these changes in pitch, the listener can tell on which side of the actual balance point he is.

The usual method of turning out the first tube and adjusting the neutralizing condenser until no sound is heard is not satisfactory. The grid-plate capacity of tubes differs by a large factor in the two conditions of tube unlighted and tube lighted. In other words, the tube will not be neutralized when it is lit if it is balanced with the filament turned out. It should be neutralized under actual operating conditions.

A more practical all-round receiver than RADIO BROADCAST's Universal will be hard to find.