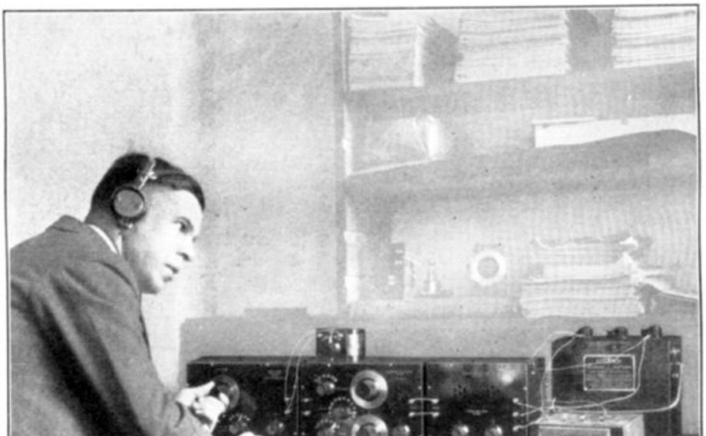
Vol. III

No. 3

RADIO & MODEL ENGINEERING

Edited by ~ M.B.Sleeper



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APRIL 1923

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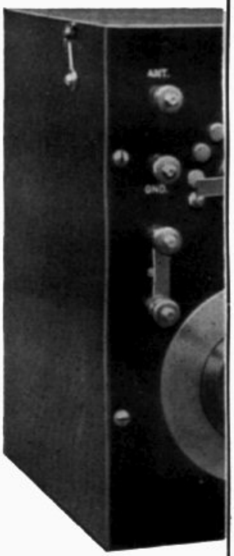
A Magazine For The Experimenter Who Builds His Own Equipment

Formica Panels

IN STANDARD SIZES



Do you know that the Sleeper Radio Corporation is probably the largest distributor of Formica panels, or, as we have called it in the past L. P. F., cut to standardized sizes?

Do you know that the Sleeper Radio Corporation supplies these panels, and full sheets as well, to dealers and manufacturers all over the country?

And do you know that of the many panel materials used for radio equipment, Formica alone has stood the test of general use by the public? Cheap substitutes of the fibre family have been discarded as being useful only as high resistance leaks for radio currents. Hard rubber serves its purpose in laboratory instruments, but its decided tendency to warp and its disconcerting way of cracking under a misdirected blow has only its cheapness to recommend it.

Formica, with its high polish, its great mechanical strength, and its splendid electrical characteristics is the correct material for panels. Accurately cut in standardized sizes it is also the easiest material to use.

Some dealers sell almost any black material under the name of Formica. You can recognize Formica by its smooth, flat finish. If, when you hold it to the light, the surface is closely mottled, the panel is of substitute material.

Type 152	**7 by 7 by 3/16 in.**	**1 1/8 lb.**	**$1.37**
" 153	**7 by 10 by 3/16 in.**	**1 3/4 lb.**	**1.81**
" 154	**7 by 14 by 3/16 in.**	**2 lbs.**	**2.46**
" 155	**7 by 18 by 3/16 in.**	**2 3/4 lbs.**	**3.14**
" 156	**7 by 24 by 3/16 in.**	**2 1/2 lbs.**	**4.18**
" 33	**7 1/2 by 15 by 3/16 in.**	**2 1/4 lbs.**	**2.97**
" 38	**7 1/2 by 10 by 3/16 in.**	**1 3/4 lbs.**	**2.00**
" 32	**7 1/2 by 7 1/2 by 3/16 in.**	**1 1/8 lb.**	**1.58**
" 166	**7 by 7 1/2 by 3/16 in.**	**7/8 lb.**	**1.45**
" 158	**7 by 5 by 3/16 in.**	**1/2 lb.**	**1.00**
" 98	**7 by 2 1/2 by 3/16 in.**	**1/4 lb.**	**.53**
" 126	**Tubing 3 ins. diam. 1/8-in. wall, 2 1/2 ins. long..................**		**.52**
" 151	**Tubing 3 ins. diam. 1/8-in. wall, 5 ins. long..................**		**1.04**
" 174	**Tubing 3 1/2 in. diam. 1/8-in. wall, 2 1/2 in. long..................**		**.56**
" 18	**Tubing 3 1/2 in. diam. 1/8-in. wall, 5 in. long..................**		**1.12**

Our shipment-from-stock service is of great benefit to the Experimenter who cannot buy Formica locally, and to the dealer or manufacturer who needs a constantly available source of supply, either for panels of standardized sizes or full sheets. Our quotations for your requirements will interest you.

Sleeper Radio Corp.

88-F PARK PLACE - NEW YORK CITY

One-Tube Reflex Set

As an experimental outfit or as a set for regular reception this receiver has a number of outstanding advantages.

General Description of the Set

OF ALL the sets I have ever built—I have long ago forgotten the number—I have had more real pleasure working with the one-tube reflex set than any other. As a matter of fact, I spent so much time on it that I could write a series of articles about the experiments I made. A number of things contributed to the fun of working with it. Like most anyone who uses vacuum tubes for everything, I wasn't too enthusiastic about a crystal detector. Now I've changed my mind about that for I spent hours, actually, listening in and changing things around without ever readjusting the Fada detector. Nor did I have to hunt for a sensitive spot the first time. The tuning was so sharp that the steadiness of my hand was tried in adjusting the condenser, far sharper than on any other single-control set I have ever used. And perhaps best of all the quality of reception was perfect. And by perfect I mean just that. There were no squeals, or tube or static noises. I won't make any claims for long distance because I did not hear any far off broadcasting stations, but those within 25 miles came in with good volume. In my workshop at home conditions are not particularly favorable for long distance reception. This is also true in the R and M laboratory. It is likely, therefore, that others can do better than I.

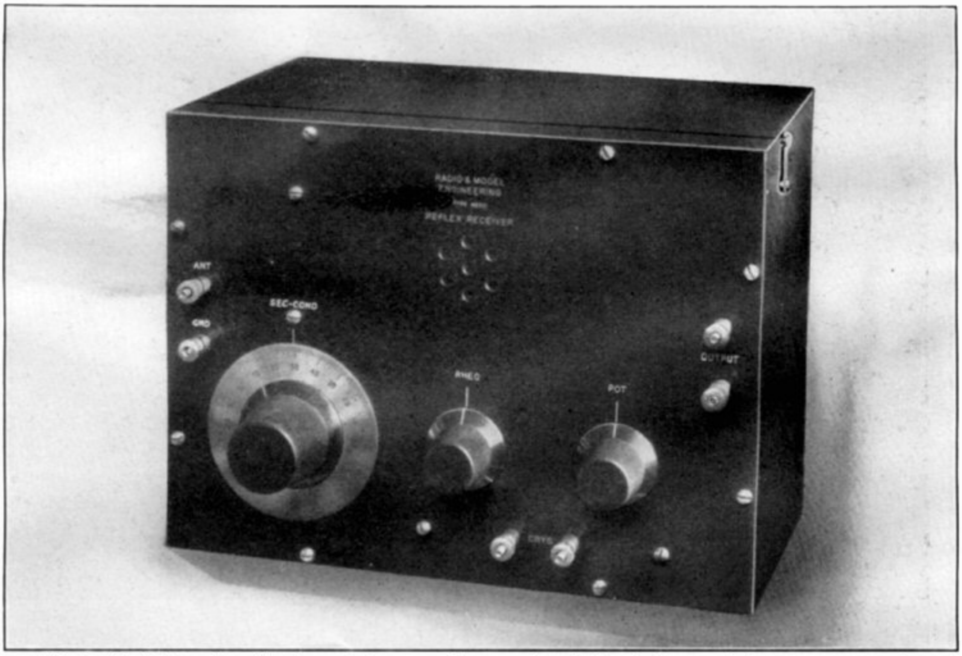


Fig. 1. A single-tube reflex that produces results—ready to be hooked up to the antenna, ground, batteries and phones

A new feature of design is shown in the construction of the antenna and secondary coils. So far as I know, this is the first set to be described in which a fixed, untuned primary coil is used, and the results were so favorable that still more work will be done with this type of tuning system. The antenna coil has only six turns, separated from the secondary, which has 50 turns, by 3-16 ins. Thus the usual units and tens switches and the coupling adjustments are eliminated. In addition, a high voltage step up is accomplished, an advantage, of course, since the audion is voltage-operated. Moreover, the large secondary inductance, 0.29 millihenry, allows the use of an 11-plate condenser.

Some experimenters are apt to over-estimate the value of fine tuning in the antenna circuit. Actually tuning cannot be very sharp, at best, because of the high resistance in the antenna and ground connection. Tuning the antenna circuit to the wavelength of the incoming signal may, in some cases, tend to weaken the signals and to broaden the secondary because of the reaction of the secondary upon the antenna coil. My own experience shows that nothing is lost in this new method and the elimination of three controls and the expense they involve are gained.

tube, as usual. The radio frequency passes thru the condenser connected across the phones but the audio frequency currents must go thru the phones because the small condenser offers too great an impedance to low frequencies.

Some circuits show a condenser across the primary of the audio transformer. I found that, at least with the type of transformer I used, the condenser did not affect the signals. I also used a larger condenser across the secondary, but that did not help. You should do a little experimenting, however, if you use any other audio frequency transformer.

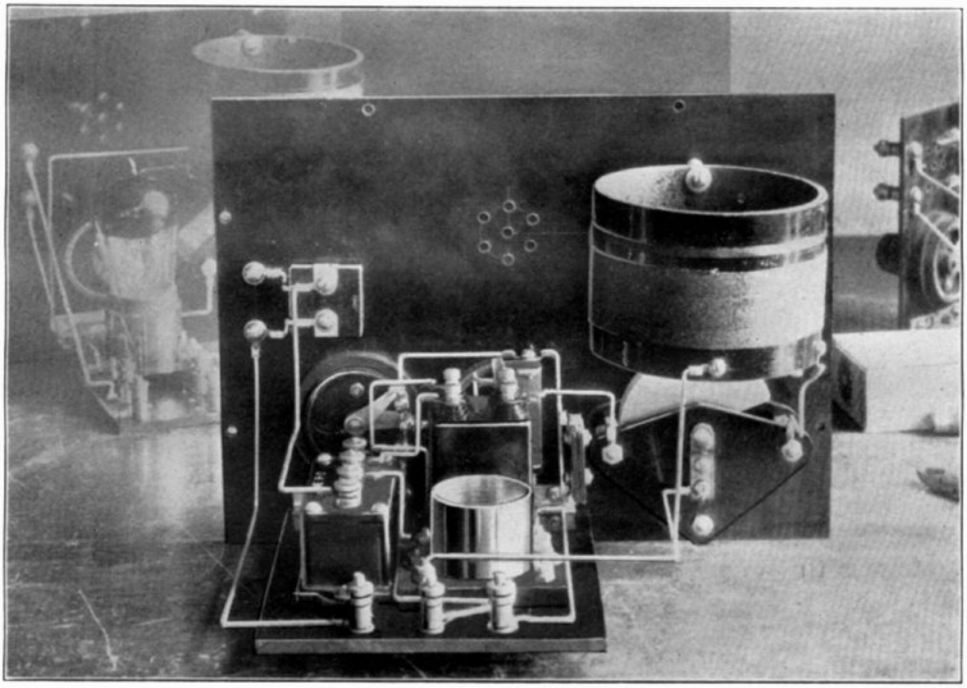


Fig. 2. The transformers and socket are neatly arranged on the base panel, held to the front panel by brackets and supported by the bottom of the cabinet

The Reflex Circuit

For those not familiar with the action of the reflex circuit a paragraph of explanation may be necessary. The first part of the circuit is made just as if a radio frequency amplifier alone were to be used. Then the secondary of the radio frequency transformer is connected in series with a crystal detector and the primary of an audio frequency transformer. The radio frequency current, detected or rectified by the crystal detector induces an audio frequency in the primary of the audio transformer. The secondary is then brought back to the grid side of the tube, and impresses upon it an audio frequency voltage. To that the tube responds as if it were in an ordinary audio frequency amplifier circuit. You will notice that the phones are in the plate circuit of the

Construction Work Required

Unlike most sets we make up for R and M, this one was not changed after the first experimental model was made. Both the experimental and the final models worked perfectly, and worked exactly alike, indicating that no trouble should be encountered in building one of these outfits provided, of course, the instructions are followed carefully. The work of drilling the panels and winding the coils is easy enough. The secret of success, and the hard part of the job, lies in the assembly and wiring. In all radio frequency circuits leakage paths must be watched closely. Wires must not be allowed to touch the panel or other insulated parts at nearby points, or surface leakage will result. Soldering paste must be replaced by rosin. This will not entail any special trouble provided square tinned bus bar is employed for wiring.

If you are building many sets, particularly if you are following designs in R and M, you ought to have a simple winding rig for 3½-in. tubing. It is so much easier to handle coils on a winder than to do the work by hand.

Standardized Parts Required

You must exercise great care in selecting the parts for this outfit because the insulation is so important. The front panel, of standard dimensions, 7½ by 10 by 3/16 ins., is of L. P. F. or, as it is generally called in the trade, Formica. This is the finest of all panel materials, combining high insulation properties with excellent finish and great mechanical strength. Both front and rear panels can be purchased cut to the exact dimensions. The coil tube, of the same material, is also a standard size 3½ ins in diameter, and 2½ ins. long, with an ⅛-in. wall. Hard rubber or, as it is sometimes called Radion, is the only substitute advised, but that cracks too easily and warps badly.

An important feature is the socket. One of the Sleeper Radio type was used because in most sockets surface leakage occurs or leakage thru the insulation itself. If that takes place no radio frequency amplification can be obtained. If the crystal detector adjustment does not affect the signals you can be reasonably sure that rectification is taking place in the socket. An Acme transformer was selected for the reason that it is practically the only transformer designed and adjusted at the factory to its rated wavelength band. Since this is one of the king pins of the set, substitution is not advised. For the audio frequency transformer a type of small dimensions is needed, and of a closed core design, to prevent howling from stray magnetic fields. Dubilier fixed condensers are necessary, as the paper types are not efficient, due to their liability to absorb moisture. While any good crystal detector can be used, my own experience counsels the Fada type as insurance against the annoyance of frequent readjustments. A well finished mahogany cabinet of standard size is needed to give the final touch to the appearance of the set.

Laying out the Panels

In Fig. 5 is a one-half size drawing of the front and base panels, showing the location of the holes. Dimensions are not given because they are apt to confuse Experimenters not accustomed to reading working drawings. It is easy enough, however, to double the distances on the drawings, and transfer them to the panels.

The front panel measures 7½ by 10 by 3-16 ins., a standard size, and of a height to line up with other equipment described in R and M. A standard size, 6 by 5 by 3-16 ins., is used for mounting the tube socket. Since the panels can be purchased accurately cut to size, and with true corners, it is easy enough to locate the holes by means of lines scratched with a scriber against a regular combination square.

All holes not otherwise marked are to be made with a No. 18 drill. Where concentric circles appear the hole must be countersunk for a flat head screw.

Winding the Coils

A detail drawing, one-half size, is given in Fig. 6 for the primary and secondary coils. The tube which carries the winding is of Formica, 3½ ins. in diameter and 2½ ins. long, with a ⅛-in. wall. It is carried on the panel by two coil mounting pillars located 2⅛ ins. apart, center to center. Machine screws of 6-32 thread, ⅜ in. long, hold the tube to the pillars and the pillars to the panel.

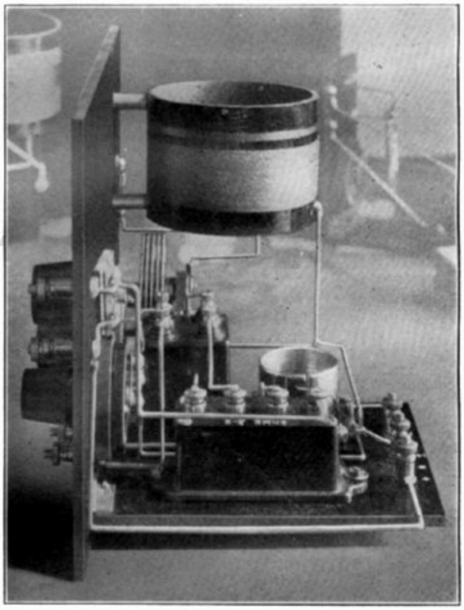


Fig. 3. The tuning inductance, with its untuned primary coil, can be seen here

The primary winding is started ½-in. from the end of the tube and near the upper pillar. Six turns of No. 24 S. S. C. wire, B and S gauge (No. 22 S. W. G.) are required for the primary. The ends of the wire are brought to terminal screws preferably located at the bottom of the tube, for there is not much room to spare if they are between the windings, as at 8 and 10 in Fig 7.

The secondary starts ½-in. from the other end of the tube, and calls for 50 turns of the same size wire. It is not necessary to have the turns in the same direction. Leads are brought to another pair of terminals at the bottom of the tube, 23 and 29 in Fig. 7.

Thorough comparative tests show definitely that there is no loss of signal strength in this type of loose coupler. A regular variocoupler is generally operated at minimum coup-

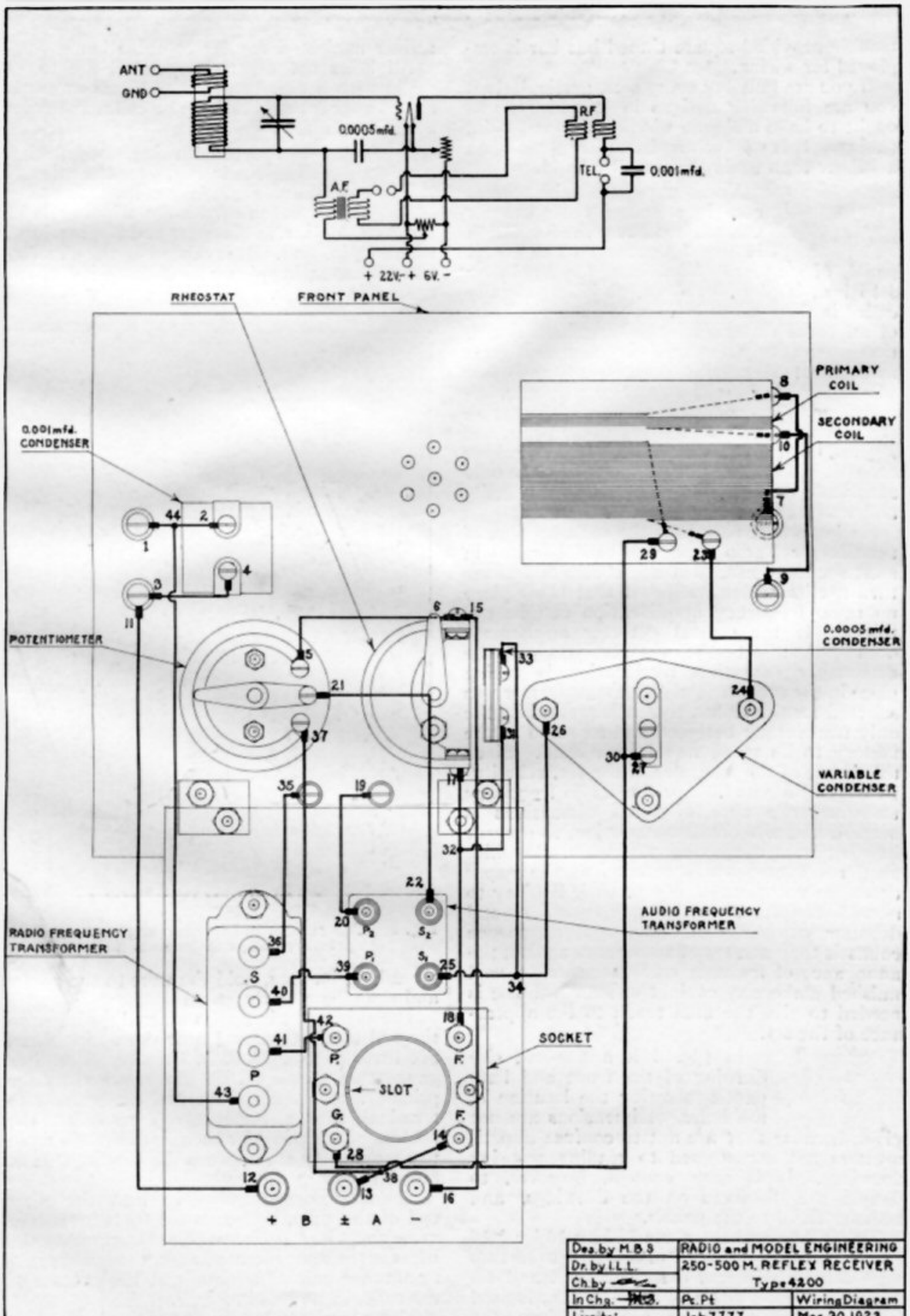


Fig. 7. This picture diagram is arranged just like the back of the panel. The base panel is tipped down, so that you see the top of it

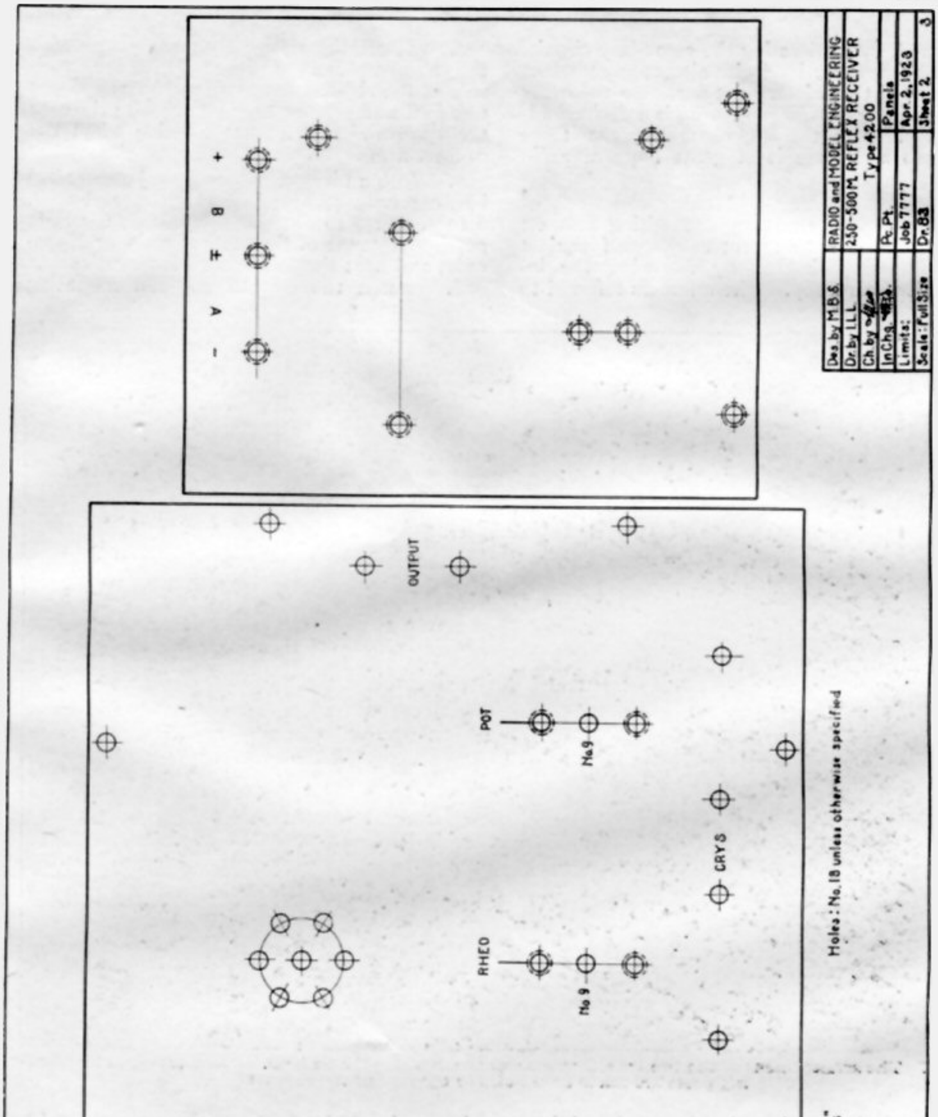


Fig. 5. One-half scale drawings of the front and base panels. Cross lines indicate the centers for the holes. Concentric circles call for countersinking

ling, and, by readjusting the secondary circuit, signals can be received with almost any number of turns of the primary cut out. On the other hand, the large voltage step-up is a decided advantage. And the difference between three controls and none is of great importance in tuning.

Assembly and Wiring

You will enjoy the work of assembling and wiring this set if you protect yourself against mistakes by following the instructions carefully. The numbers referred to

3. Mount the rheostat on the panel with the screws and nuts furnished. Have the terminals at the right. Put two lugs on the upper terminal and one on the lower. The lines on the knob and panel must coincide when the contact arm is up.

4. With a piece of square tinned copper bus bar, carefully bent and fitted, connect 1 to 2, 3 to 4, and 5 to 6. Use a hot iron, the least possible amount of flux, either rosin or Nokorode, and heat the solder until it flows freely.

5. Fasten the coil to the coil mounting

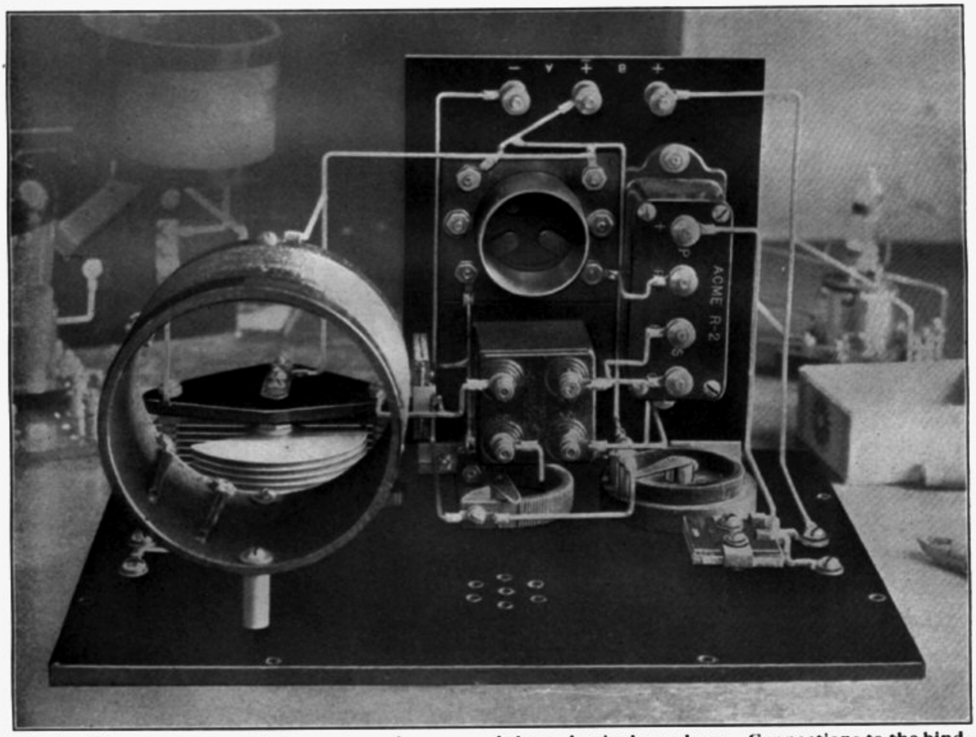


Fig. 4. The arrangement of the two transformers and the socket is shown here. Connections to the binding posts are made thru holes in the rear of the cabinet

appear on the terminals in Fig. 7. In addition to the picture wiring diagram there is a schematic circuit given.

1. Mount the binding posts with R. H. screws, 1, 11, 7, and 9, placing a soldering lug between each washer and screw-head. Have the lugs pointing in the directions of the short, heavy lines. Note that 11 requires two lugs.

2. Mount the potentiometer on the panel with the screws and nuts furnished after fitting each terminal with a lug. Have the terminals at the left, as shown. So that the knobs will all match, replace the knob supplied with the indicating knob illustrated in Fig. 1. Have the white line on the knob coincide with the line on the panel when the contact arm is in the position shown in Fig. 7.

pillars with 3/8-in. 6-32 R. H. screws, and with the same size screws fasten the pillars to the panel. Make sure that the primary coil is up.

6. Connect 7 to 8 and 9 to 10.

7. Put the three binding posts with F. H. screws, 12, 13, and 16, on the base panel, with a lug between each binding post base and washer.

8. Mount the base panel on the front panel by means of the nickeled angle brackets. Use 6-32 3/8-in. R. H. screws thru the front panel and 6-32 3/8-in. F. H. screws thru the base.

9. Connect 11 to 12.

10. Mount the socket on the base panel, using the screws and nuts provided.

11. Connect 13 to 14, 15 to 16, 17 to 18.

12. Mount the audio frequency transformer

with the screws provided for the purpose.

13. Mount the variable condenser, using the screws furnished. Have the 100-division mark on the dial coincide with the line on the panel when the variable plates are entirely inside the stationary plates.

14. Connect 19 to 20, 21 to 22, 23 to 24, 25 to 26, 27 to 28, 29 to 30, 31 to 32, 33 to 34.

15. Mount the radio frequency transformer with 6-32 ½-in. F. H. screws and nuts.

16. Connect 35 to 36, 37 to 38, 39 to 40, 41 to 42.

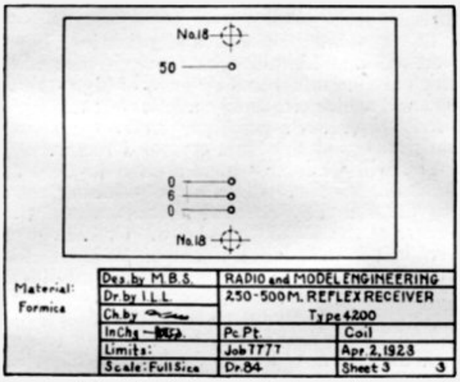


Fig. 6. The single-layer coil is readily wound. There are 6 turns in the primary and 50 turns in the secondary

Testing and Operating

To check the correctness of your wiring and to guard against burning out your tubes, make the following tests with a buzzer and battery circuit.

1. Across 7 and 9. Circuit should be closed.
2. Across 28 and 25. Circuit should be closed.
3. Put the tube in the socket and turn rheostat on. Across 13 and 16. Circuit should be closed. Take out the tube.
4. With a telephone and battery test across 42 and 1. Circuit should be closed.
5. Across 19 and 35. Circuit should be closed.
6. Across 26 and 13. Circuit should be closed.
7. Across 26 and 16. Circuit should be closed.

If these tests do not check, go over your wiring again to locate the trouble. Then put the set in the cabinet, and make the external connections necessary.

A WD-11, UV-201, or UV-201-A tube can be used for the amplifier, with 22 or, better, 45 volts on the plate. With a WD-11 tube 1½ volts of dry cells or one cell of a storage battery is needed for the filament current supply, or 6 volts for either of the other types.

Almost any type of antenna can be used, since the primary tuning circuit is fixed. In my own work I used a 100-ft. wire 4 ft. high at one end and 20 ft. high at the other. The screw at the center of the valve handle on the hot water radiator serves as a ground connection. You must be sure to get a good connection to a water pipe, as this is just as important as the antenna.

When you adjust the set, light the tubes to a little less than normal brilliancy, turn the potentiometer clockwise until the tube does not squeal, adjust the crystal detector, and vary the condenser until the whistle of a transmitter is heard. Then turn the potentiometer anti-clockwise until the squeal starts. At this point the signals will be loudest, but the set will not oscillate. You will find that, as you increase the capacity of the condenser that you can turn the potentiometer farther anti-clockwise.

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EDITORIAL

SOMETIMES letters come in asking why we do not have an article on this subject or that which has been taken up already in another magazine. Such a question is fair to ask, and can be answered readily. The reason is one of time.

Each month our Editorial Conference meets to decide upon new articles for R and M. Usually, in the process of preparing the articles two-thirds are dropped. Then the work on the remaining third may be held up for one reason or another. Frequently it happens that a good idea is held up because the mechanical design cannot be managed satisfactorily. Instead of letting it slide thru we wait until more time can be spent on it.

For example, altho information on the Hazeltine Neutrodyne circuit is offered in the form of preliminary data, it will not be shown in R and M until we are thoroughly satisfied with the mechanical design as well as the electrical features.

This is also true of the super-heterodyne receiver. Resistance coupling in the 50,000-cycle amplifying circuits is not really efficient. We have worked out a splendid transformer for 50,000 cycles, but, so far, have not found a company to manufacture it.

You will notice that the parts called for in the articles in this issue are not limited to the products of the Sleeper Radio Corporation. This is quite a change in editorial policy, but a review of changing conditions during the past year will show why that is done.

When R and M was first published radio products were so unstable in design that a transformer made by one company one day might be quite different from the transformer made by that company the next day. It was necessary, therefore, to standardize on the parts of one company which we could be sure would not change within a reasonable length of time.

That method worked out to great advantage until, during this winter, designs reached a degree of comparative stabilization. Now it is a disadvantage to so limit the range of parts, and with this issue we have started to branch out.

The general plan of standardization, however, will be maintained, and only items added which are manufactured by firms of high standing, and which are easily available thru wide distribution, such as Acme radio frequency transformers or the Fada crystal detector.

You will see in this issue a page devoted to the Radio Cruise. Plans are developing now, and have already reached a point where the success of the Cruise is assured. C. J. Brown, head of the radio department of Elliott-Lewis in Philadelphia told me he had his mind set on a new car, but the salt water smell got him, I guess, for he's about made up his mind to go on the Cruise instead.—But, I really think, with all the business he's doing, he'll go to England and pick out a Rolls-Royce while he's there.

Every month I have to call your attention to something that's important, or that you must remember. Here's something you must remember because it's important. The Down Town Radio Club of New York City is the first radio luncheon club ever organized, I believe. As Secretary of the Club I'm giving you a special invitation to drop in at 120 Liberty Street, one flight up, and meet our gang while you have a first rate and inexpensive lunch. The hours are from 12 to 2 P. M. You don't need a card or introduction—just walk right in. If you don't see anyone you know, ask Mr. Lyons, at the desk, to introduce you. It's a very informal affair—don't stay away because you haven't been there before.

Some of our readers have wondered why a charge of twenty-five cents is now made for answering questions by mail and of fifty cents for drawing diagrams. Almost anyone not familiar with correspondence cost figures will say that a letter costs two cents. True, the postage does cost that, but the postage is the smallest item. Mr. Banning, Editor of Popular Radio, stated in the last issue of his publication that each letter answered by mail costs actually eighty-eight cents. Answering questions is part of the service which every magazine must give its readers. I am sure, however, that you will not think it unfair when I ask you to pay a little of that expense.

M. B. SLEEPER,

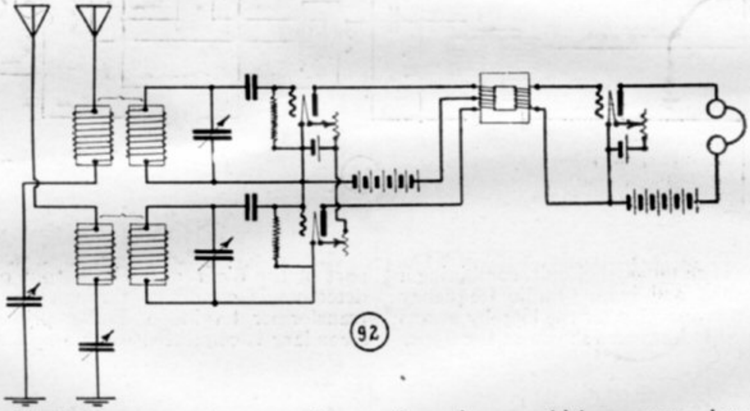
Editor.

101 Receiving Circuits

Twelfth Installment

90. In this loop receiving set an adaptation of super regeneration is employed. The loop inductance and tickler coil can be made up of an ordinary variocoupler. The other two inductances and their respective condensers should be of such values as to give resonant circuits at the wave lengths to be received. Note that a C battery, or biasing battery, is employed in the grid circuit. In this diagram, as well as in practically all of the others, the condenser around the phones and B battery is 0.001 mfd.

91. This diagram illustrates the use of 110 volts direct current from the lighting circuit applied to a vacuum tube receiver. Any type of tuning circuit can be used. The choke coil in the supply circuit should be of about 1 henry, and the condensers 1 mfd. each. A rheostat capable of carrying as much current as is required for the filament is employed. Two contacts are needed for obtaining the proper current and voltage for the filament and plate circuits.



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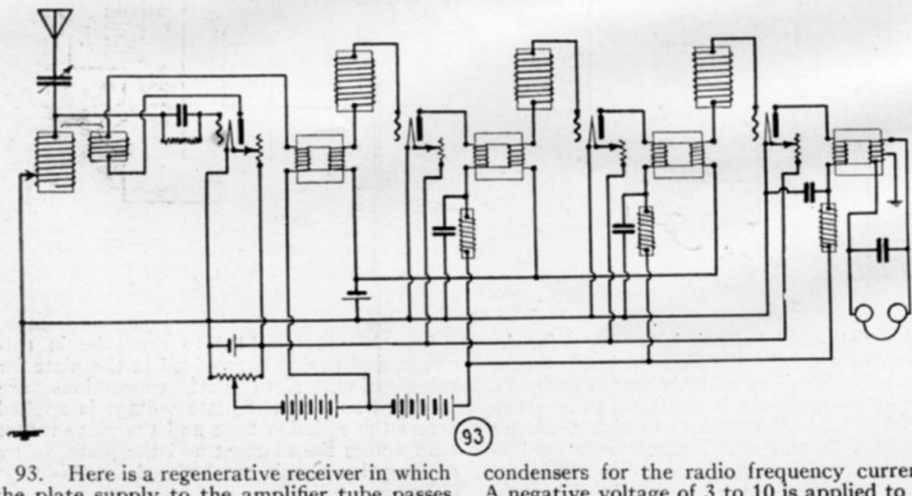
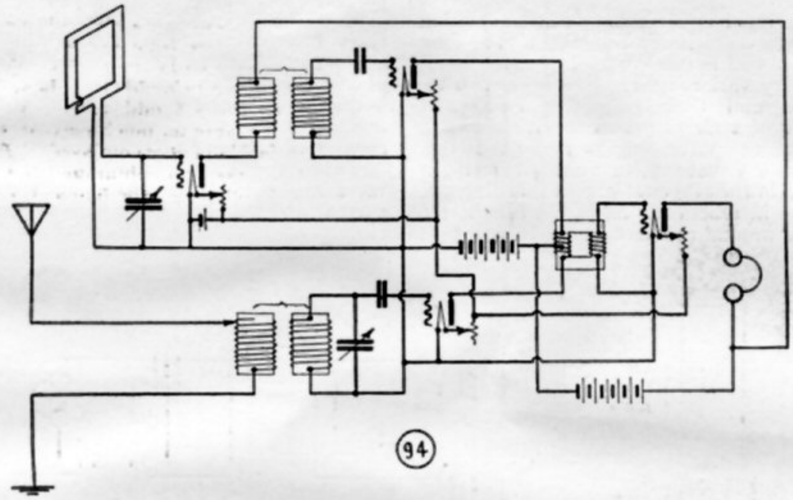
92. In this diagram two antennas and two separate tuning circuits are employed, each provided with a detector. The plate circuits are combined through the use of an amplifying transformer furnished with a double winding on the primary which operates into a single secondary connected to an amplifier tube. This arrangement is employed to give louder signals as well as sharper tuning.



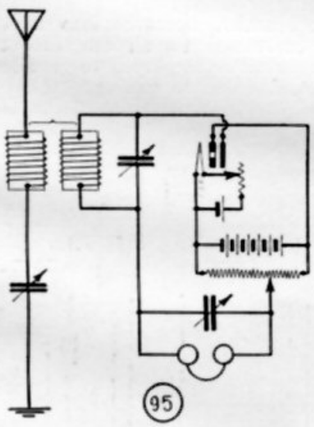
93

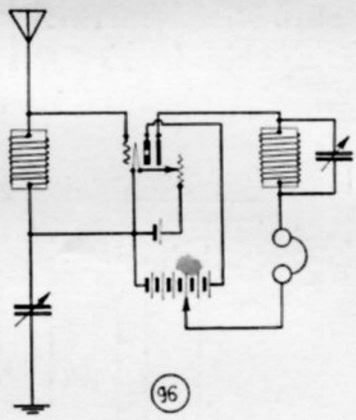
93. Here is a regenerative receiver in which the plate supply to the amplifier tube passes through radio frequency chokes, with by-pass condensers for the radio frequency currents. A negative voltage of 3 to 10 is applied to the amplifier grids. In the plate circuit of the de-

tector tube an A battery potentiometer is employed to produce a small step regulation of the plate voltage. An input transformer for the telephones is connected to the last step. The center of the secondary winding is grounded



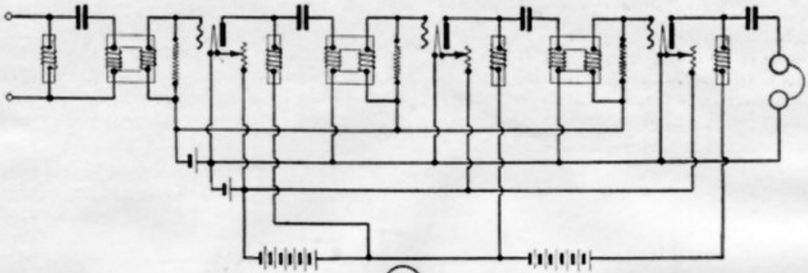
94. Here is an unusual circuit, combining a regular antenna and loop. Radio frequency amplification is provided for the loop by means of the coupled inductances shown at the upper part of the diagram. The output of the two detectors is combined through the use of a transformer having a double primary. The secondary is connected to an amplifier.





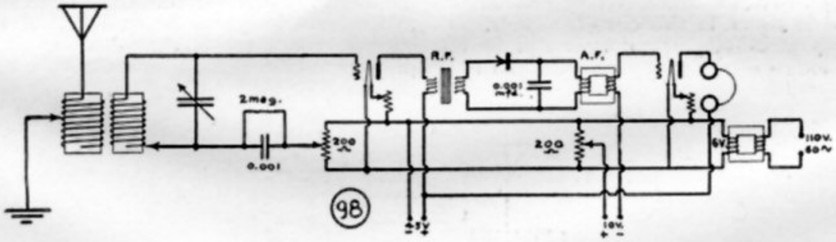
95. This special circuit is employed for the new tubes which have a filament inside a tube of metal which gives a high electron emission. Such an arrangement is employed to lengthen the life of the filament and to give a greater emission. In this circuit the tube is used as an ordinary Fleming valve rectifier. A potentiometer is connected across the B battery to give an adjustable plate voltage.

96. A grid is added to the tube in this circuit and tuning is provided in the plate for regeneration. Note that connections are arranged so that the plate voltage is applied across the emission tube and the plate rather than across the filament and the plate. Any regenerative circuit can be used for this type of vacuum tube.



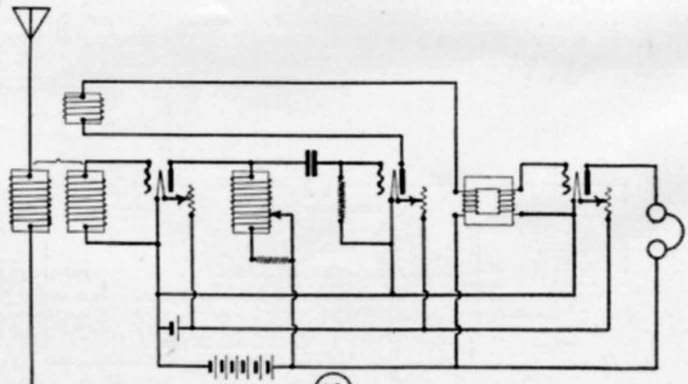
(97)

97. Here is an audio frequency amplifier such as is used in telephony as well as in radio circuits. The plate voltage is applied through choke coils of very high inductance, 1 henry or more. The direct current does not pass through the primaries of the amplifying transformers. The condensers between the choke coils and primary transformer windings are of 1 or 2 mfd. Across the secondary windings are resistances of 1 or 2 megohms. A biasing battery of 4 to 10 volts is employed to give a negative charge to the grids.



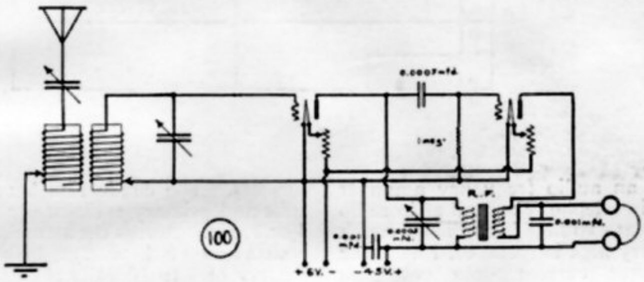
(98)

98. The Bureau of Standards developed this circuit for using alternating current to supply the filaments of the audion tubes. While it is very difficult to eliminate the 60 cycle hum, when an ordinary detector and audio frequency amplifier are used, this trouble can be overcome if one step of radio frequency amplification and a crystal detector are employed. Potentiometers are connected in the filament circuits for a proper voltage adjustment on the grids. A 10 volt biasing battery is connected in the grid circuit of the audio frequency amplifier. An iron core radio frequency amplifier is shown here although the ordinary air core type can be used.

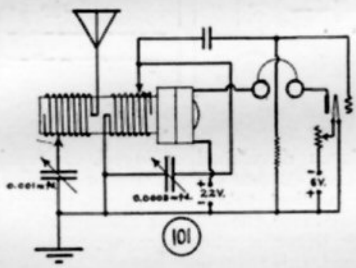


(99)

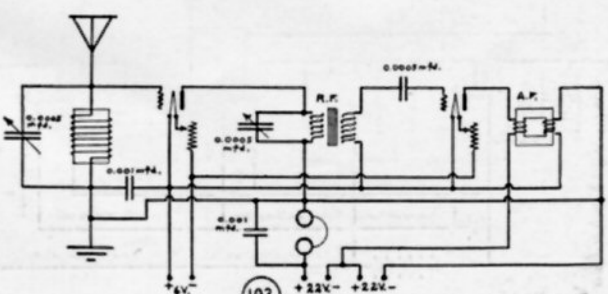
99. In this radio frequency amplifying circuit regeneration is employed. The tickler coil is connected in the detector circuit and coupled back to the secondary tuning inductance. Coupling between the radio frequency amplifier and detector plate and grid circuits is accomplished by means of an adjustable inductance. The unused turns of the inductance are shunted by a resistance of approximately 24,000 ohms. This is done to prevent oscillations in the dead end. A variometer might be substituted for the inductance.



100. A combination of radio frequency amplifier and detector which is very popular in England is shown in this circuit. The radio frequency amplifying transformer can be of iron or air core type. In England radio frequency transformers are generally of the pin type to fit in regular valve holders, making it possible to change the transformers according to the wave length to be received. A small variable condenser is connected across the primary to give adjustment at the wave length peak.



101. Fixed coupling between the primary and secondary circuits is used here, and the tube carrying those windings is fastened to the side of the plate variometer. For short wave length ranges it is not necessary to make the inductance variable, as is the case when the set is designed for broadcast reception If, however, the usual range of 150-600 meters is required the adjustment is needed. Because of the connection between the plate and grid circuits it is necessary to wire the gridleak across a grid filament.



One-Step Radio Frequency Amplifier

This instrument has been made in response to many requests for a radio frequency amplifier to be used with regenerative receiving sets.

Radio Frequency Amplifiers

WITH the growing interest in radio frequency amplification many Experimenters have asked for data on radio amplifiers of one to three steps, usually to be connected with regenerative sets. Actual tests on radio frequency amplifiers show that there is very little gain in the second step, and often trouble in the third. Consequently the use of more than one step is not recommended.

The proper choice of the circuit is important, for excessive howling must be guarded against. For that reason, the amplifier described here does not use a transformer but an infinite impedance circuit in the plate. The condenser not only controls the amplification but also helps in tuning the receiving set.

As an adjunct to the X-1900 receiver*, I have found this amplifier particularly efficient for increasing the strength of distant signals and reducing interfering noises. On the combination of this type 4300 amplifier, the X-1900 receiver, and the 3100 two-step audio frequency amplifier* I have copied stations right across the country.

Experiments were made with various types of controls, but it was found that they could be reduced to the four shown in Fig. 1. A potentiometer was added in the second experimental model, but it did not improve the results. The small coupling coil is for use with receiving sets of the Reinartz or single circuit type, where no separate antenna inductance is provided. I did not find it necessary, however, with the X-1900, for the primary coil served the purpose admirably.

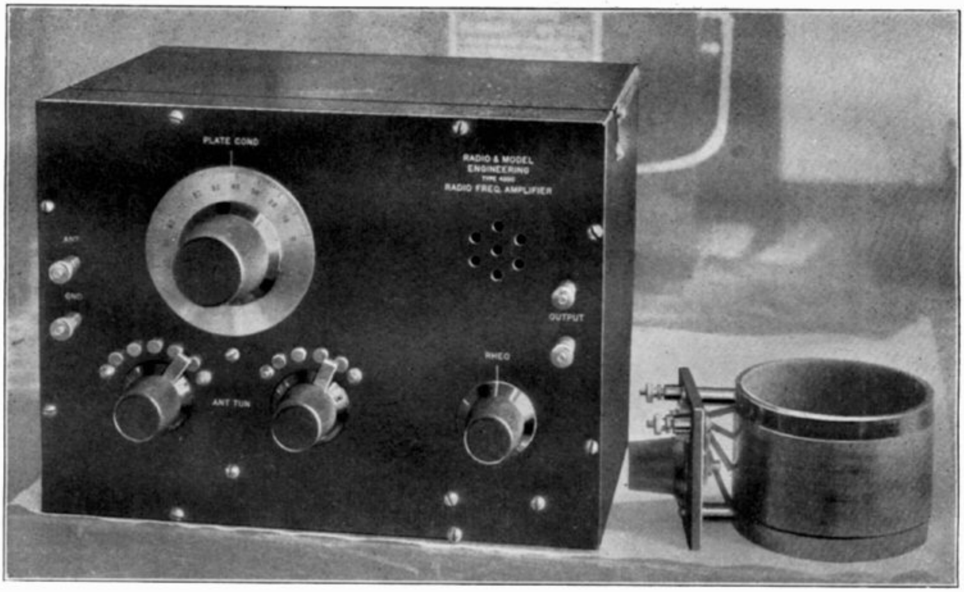


Fig. 1. The one-step radio frequency amplifier and the coil which is coupled to the regular receiving set tuning inductance

Construction Work and Tools

In building this set there are the front and base panels to drill, as well as the switch panel on the coupling coil, and the antenna and coupling inductances to wind. Your tool kit, for this work, should include a hand drill, No. 31, 18, and 9 drills and a 9-32-in. drill, a 12-in. Starrett combination square, scriber, center punch, small screw driver, pliers, cutters, and soldering iron. If you have not already purchased an electric iron, the light American Beauty type is recommended. A cheap iron is not safe to buy, for it will not last long and cannot be repaired.

* Described in Six Successful Radio Sets, Price 50c. Published by M. B. Sleeper, Inc., New York.

Standardized Parts Required

The parts for the amplifier are quite simple. It is made up on a panel $7\frac{1}{2}$ by 10 by 3-16 ins. on which are mounted an 11-plate condenser, a coil, two switches, and rheostat. On the base panel are the three terminals for battery connections and the socket. A standard size tube, $3\frac{1}{2}$ ins. in diameter and $2\frac{1}{2}$ ins. long, with a $\frac{1}{8}$-in. wall, carries the winding. Figs. 2, 3, and 4 show these parts and their arrangement.

Laying out the Panels

Fig. 5 illustrates the front and rear panels at exactly one-half scale, with the coupling coil panel in Fig. 6, at the right. The front panel measures $7\frac{1}{2}$ by 10 by 3-16 in., the base panel $2\frac{1}{2}$ by 6 by 3-16 in., and the coupling coil panel $2\frac{1}{2}$ by $2\frac{1}{2}$ by 3-16 in., cut from a panel of the size used for the base.

The holes for the variable condenser and rheostat are of standard location, permitting the use of any of a number of types. A 1-in. radius is called for on the switch, also standard. If you are not fortunate enough to have a drill press which takes No. 9 or 9-32-in. drills, you need not be discouraged by having to make holes of those sizes. Drill a small hole with your hand drill where the large hole is required. Then put the large drill in the vise and turn your panel around as you press down on it, using the small hole as a guide. A little ingenuity goes a long way in helping an Experimenter who does his work in a kitchen table workshop.

Winding the Coils

Details of the coils are given in Fig. 6, the antenna coil at the left and the coupling coil at the center. Both are wound on Formica tubes $3\frac{1}{2}$ ins. in diameter and $2\frac{1}{2}$ ins. long, with a $\frac{1}{8}$-in. wall. The wire is No. 24 S. S. C., B. and S. gauge (No. 22 S. W. G.) On the antenna inductance taps are taken off at 0, 4, 8, 12, and 16 turns for the small steps switch and at 16, 32, 48, and 64 turns for the large steps switch. The coupling coil is tapped at 0, 21, 46, and 74 turns. No. 18 holes are drilled in the tube $2\frac{1}{8}$ ins. apart, center to center, for the coil mounting pillar screws.

There are a number of ways to take off the taps. We have found it most satisfactory to drill three holes in a row at a tapping point, putting the end of the last section and the start of the next in the outside holes, and bringing both leads to the switch point out thru the center hole. Then we cut one lead short and solder it to the other down near the coil. This makes a one-wire lead, an improvement over the double lead in that the current does not have to travel out to each switch point and back again. With the two coils wound and varnished, the coil mounting pillars should be fastened to the end holes with $\frac{3}{8}$-in. 6-32 R. H. screws.

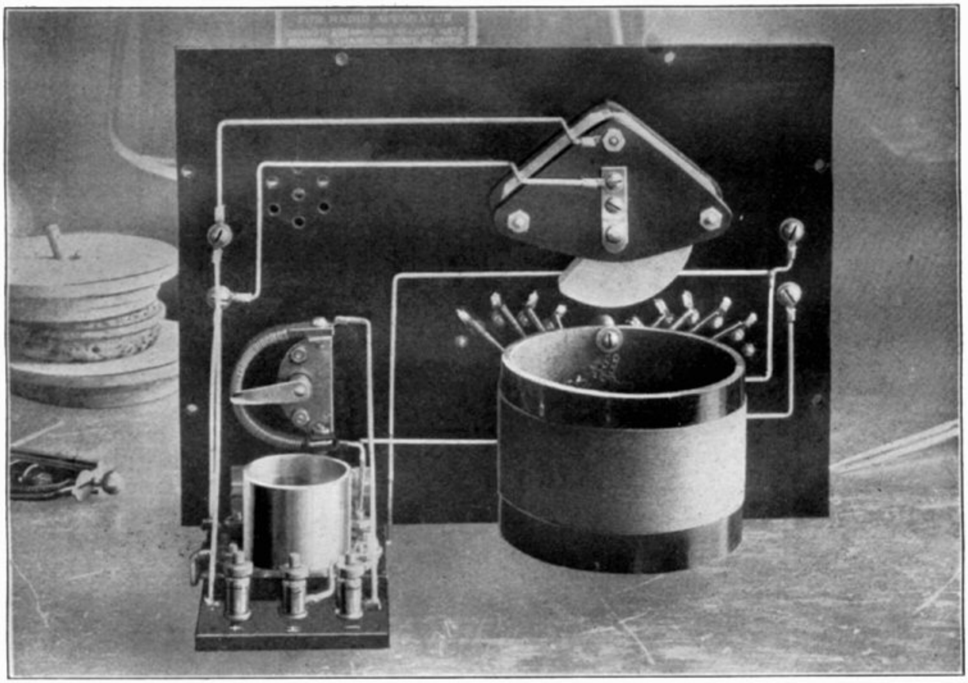


Fig. 2. The rear view shows the wiring clearly. It is sometimes helpful to compare the arrangement with your own work when you are putting on the connections

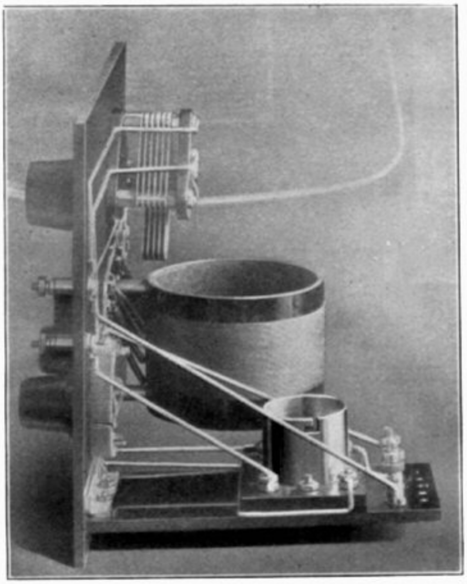


Fig. 3. Connections for the batteries are arranged at the rear of the base panel

Instructions for Assembly

When everything is ready to be put together go over the following step-by-step assembly instructions so that you will see just how the parts are to be fitted together and the wiring done.

1. Mount the four binding posts with round head screws, 4, 6, 14 and 18 on the front panel, putting two soldering lugs between the washer and screw-head of the first two, and one soldering lug on each of the second two. Have the lugs pointing in the directions indicated by the short heavy lines. This will help you considerably in planning the arrangement of the wires.

2. Mount the rheostat, using the screws and nuts supplied. Put soldering lugs on each terminal and have them toward the right, as in Fig. 7. Fasten on the knob so that the lines on the knob and panel coincide at the position of the contact arm shown.

3. Put in place the nine switch points and four stopping points. The latter are marked X. Have the lugs on the switch points arranged radially. Put the tiniest bit of soldering paste in each lug and fill it with solder.

4. Put the switches, 12 and 17, in place, tightening the collar at the rear so that perfect contact is established between the switch arm and switch point and between the collar and soldering lug on the shaft. Fill these lugs also with solder.

5. Mount the socket on the base panel with the screws provided. Make sure that the slot is in the position shown.

6. Mount the three binding posts 21, 1, and 3 on the base panel, putting a lug between each binding post base and washer.

7. Fasten the two nickel-plated angle brackets to the front panel with ⅜-in. 6-32 R. H. screws. Then fasten the base panel to the angles with ⅜-in. 6-32 F. H. screws. Do not tighten the nuts until the base panel is finally in position. The holes are made oversize so that the base panel can be fitted exactly in place.

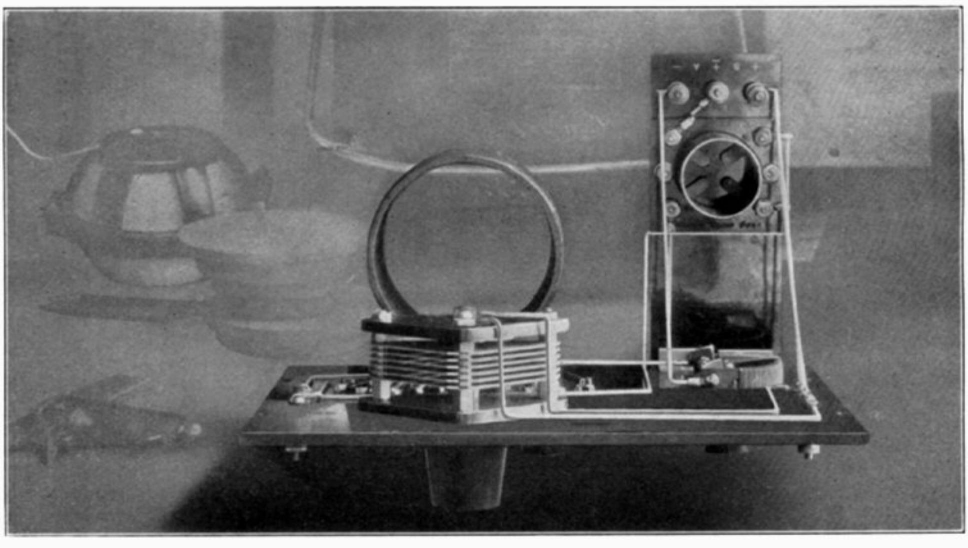


Fig. 4. It is an easy matter to make up one of these amplifiers and add it to the set you are now using, whether it is regenerative or not

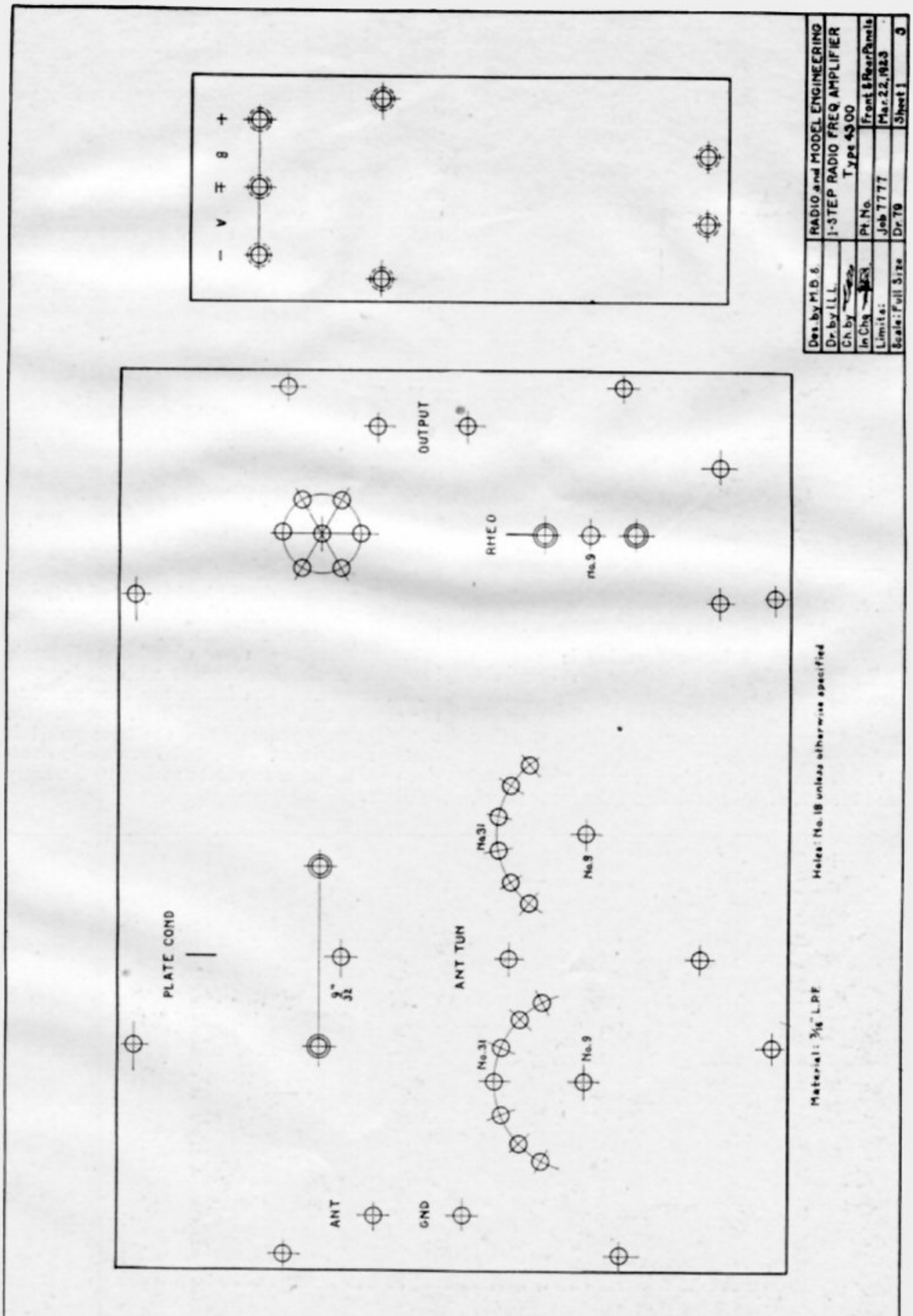


Fig. 5. Exactly one-half size drawings of the front and base panels. Remember that all holes are No. 18 except where they are otherwise specified

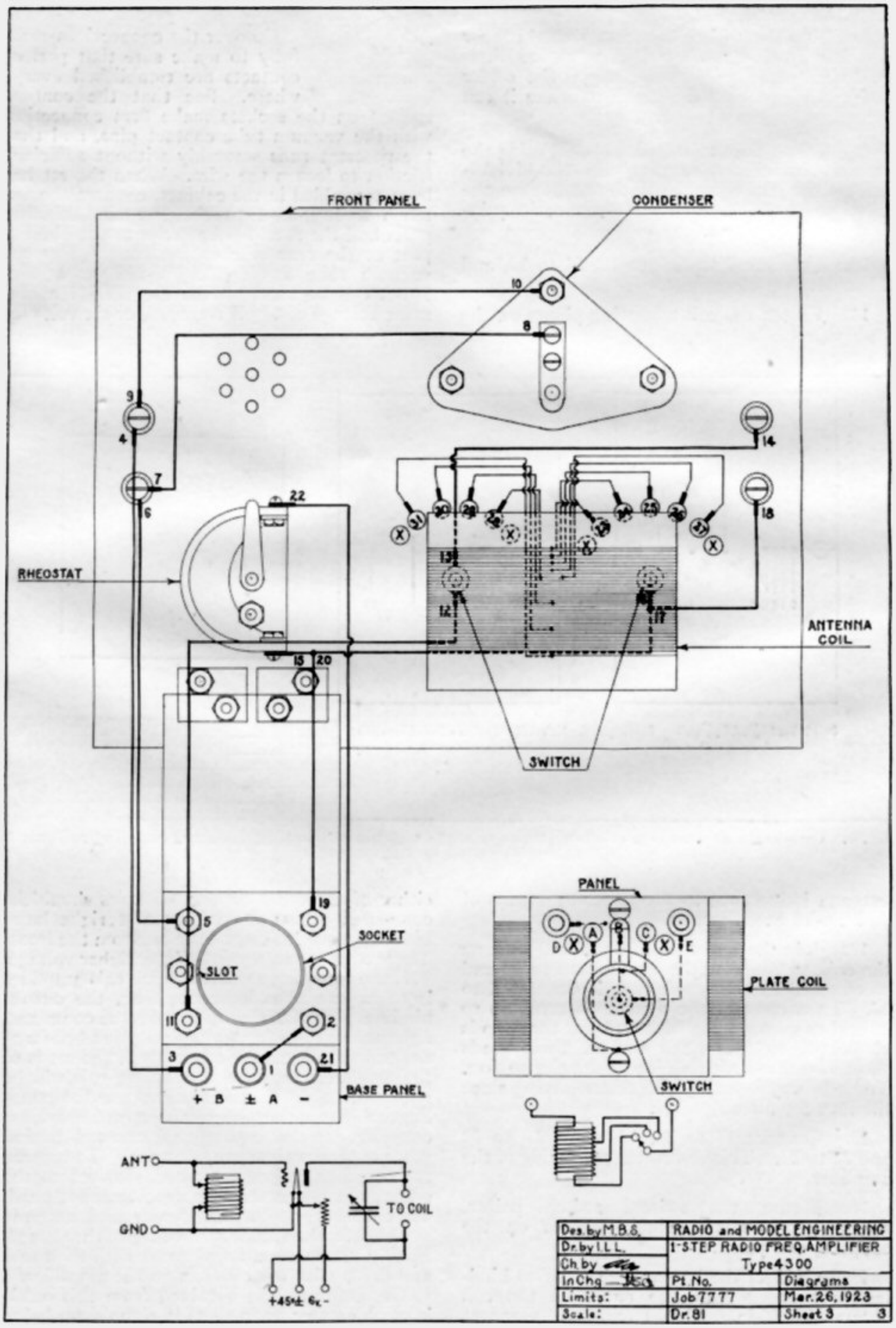


Fig. 7. Picture and schematic diagrams show clearly the method of connecting and the type of circuit

8. Fit a short piece of square tinned copper bus bar from 1 to 2. Always use as little soldering paste as possible, apply the solder sparingly, and heat it enough to make it run freely. Connect 3 to 4 and 5 to 6.

9. Mount the variable condenser, using the screws provided. See that the 100-division line on the dial coincides with the line on the panel when the variable plates are entirely inside the fixed plates.

10. Connect 7 to 8, 9 to 10, 11 to 12, and 13 to 14.

11. Fasten the coil mounting pillars on the antenna inductance to the panel by means of ⅜-in. 6-32 R. H. screws.

12. Join the upper tap, from the 0 turn on the coil, to 23, from the fourth turn to 12 and so on until the sixteenth turn is connected to 27. Then connect the second 16-turn tap to 28 and so on until the 64th and last turn tap is connected to 31. Each one of these leads should be fitted with a piece of empire tubing. You will find it easy to do this soldering since the lugs are already filled.

13. Connect 15 to 16, 17 to 18, 19 to 20 and 21 to 22. This completes the wiring of the amplifier.

14. Mount the switch, switch points, stopping points and binding posts on the coupling coil panel.

15. Connect the lug on the switch to binding post E. Mount the panel on the coil pillars with ⅜-in. 6-32 R. H. screws. Connect the 0 turn to D, the 21st turn to C, the 46th turn to B, and the 74th turn to A.

Testing and Operating

Go over the connections carefully to make sure that perfect contacts are established everywhere. See that the contact springs on the sockets make firm connection with the vacuum tube contact pins, and that the rheostat runs smoothly without sufficient friction to loosen the wire. When the set has been assembled in the cabinet, connect the antenna and ground to the left-hand binding posts and the A and B batteries to the binding post at the rear of the base panel. For the vacuum tube a WD-11, UV-201, or a UV-201-A can be used. With the WD-11 a filament voltage of 1½ is required, or six volts for either of the other tubes. 45 volts should be connected across the center and right hand binding posts, looking at the set from the front. There is no advantage in using a higher voltage.

If the receiving set with which this amplifier is to be used has loose coupling, the output binding post of the amplifier can be connected right across to the antenna and ground posts of the tuner. If, on the other hand, the set is of the single circuit type a coupling coil will be required. Some Experimenters use the coupling coil even tho the receiving set has loose coupling. In that case the antenna and ground posts of the receiver are left open. To operate the amplifier adjust your receiving set to the settings at which stations are normally heard. Then tune the plate condenser and antenna switches on the amplifier until signals are heard. Finally get an exact adjustment with the tuner and finish with the controls on the amplifier.

The amplification obtained from this outfit is much greater when distant signals are being copied, as is also true of other types of radio frequency amplifiers.

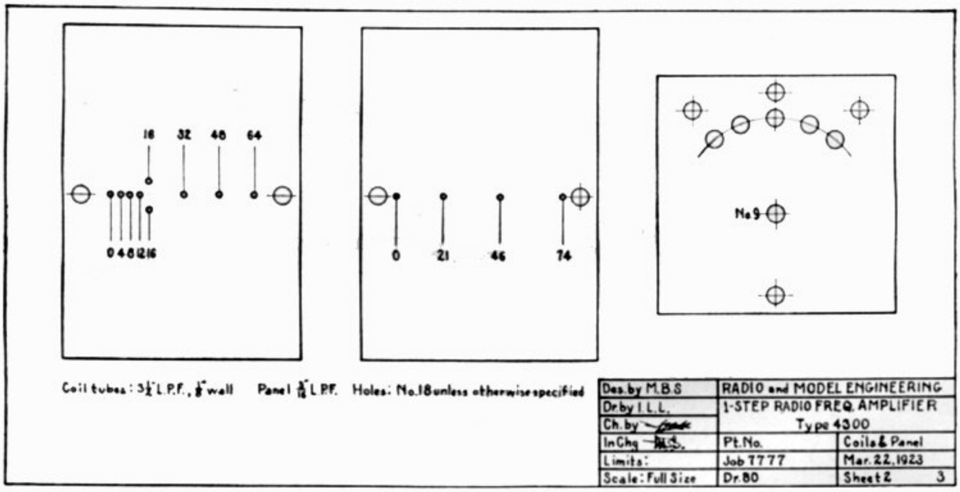


Fig. 6. **One-half size drawings of the antenna tuning inductance, coupling coil, and coupling coil panel. Taps are indicated by turn numbers**

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- Oct. 1921, Radio frequency amplifier and tuner.
- Dec. 1921, Rectifier for short wave transmitter
- Feb. 1922, Variometer tuning unit—Detector and 2-step amplifier.
- Apr. 1922, Compact receiver—3-step radio frequency amplifier.
- May 1922, Regenerative set with detector and 2-step.
- July 1922, Super-regenerative receiver.
- Aug. 1922, 2-step amplifier—Laboratory oscillator.
- Oct. 1922, Loop receiver—Wavelength, inductance, capacity tables.
- Nov. 1922, 2-tube telegraph or telephone transmitter—Inductance tables.
- Dec. 1922, Short wave receiving tuner—150 to 2600-meter receiver.
- Jan. 1923, Non-regenerative receiving set with detector and 2-step amplifier —Super range receiver.
- Mar. 1923, 150 to 700-meter regenerative set—Sleeper circuit set.

STANDARDIZED PARTS FOR THE TYPE 4200 REFLEX SET

The materials used to make up the sets in the R and M laboratory, and the companies from which they were obtained, are as follows:

Type	Name	Price
F. A. D. Andrea, 1581 Jerome Ave., New York City.		
101	1—Galena crystal detector	$2.00
152-A	1—200-ohm potentiometer	1.00
Acme Apparatus Co., Cambridge, Mass.		
R-2	1—Radio frequency transformer	5.00
Dubilier Condenser and Radio Corp., 48 W. 4th St., New York City.		
601	1—0.0005 mfd. fixed condenser	.35
601	1—0.0010 mfd. fixed condenser	.35
Sleeper Radio Corp., 88-F Park Pl., New York City.		
A-6	1—Mahogany cabinet 7½ x 10 x 6½ ins.	4.00
38	1—Formica panel 7½ x 10 x 3/16 in.	2.00
123	1—Formica panel 5 x 6 x 3/16 in.	.90
A-2	1—100-division knob and dial	1.00
A-22-X	1—Rheostat	1.00
A-10	6—Binding posts, R. H. Screws	.60
A-85	3—Binding posts, F. H. screws	.30
A-1-X	1—Audion socket	.80
A-15	1—11-plate variable condenser	3.25
A-14	1—Audio frequency amplifying transformer	5.00
185	1—Angle bracket, left hand	.10
22	1—Angle bracket, right hand	.10
58	2—Pkgs. 25 small soldering lugs	.40
140	1—Pkg. 10 No. 6 ½-in. wood screws nickeled	.13
47	3—2-ft. lengths sq. tinned copper bus bar	.15
140	1—Pkg. 10 nickeled wood screws ½-in. No. 6	.13
141	1—Pkg. 10 nickeled machine screws, 6-32 ⅜-in. R. H.	.12
91	1—2-ft. length Empire tubing	.25
14	2—Coil mounting pillars	.16
174	1—Formica tube 3½ ins. diam. 2½ ins. long, ⅛-in. wall	.56
40	1—¼-lb. spool No. 24 S.S.C. wire	.80

DRILLING AND ENGRAVING

Drilling front panel, extra	$2.20
Engraving front panel, extra	4.56
Drilling base panel, extra	.55
Engraving base panel, extra	.30

AUXILIARY EQUIPMENT

Stanley and Patterson, West and Hubert Sts., New York City.		
843	Deveau Gold Seal Phones, 2,200 ohms	$8.00
Pacent Electric Co., 22 Park Place, New York City.		
40	Telephone plug	.50
National Carbon Co., Long Island City, N. Y.		
767	45-volt variable B battery	5.00
6860	6-volt, 90-ampere-hour storage battery	18.00
Radio Corporation of America		
UV-201	Amplifier tube, 6 volts, 1.2 ampere	6.50
UV-201-A	Amplifier tube, 6 volts, ¼ ampere	6.50
WD-11	Detector-amplifier tube, 1½ volts ¼ ampere	6.50

STANDARDIZED PARTS FOR THE TYPE 4300 RADIO FREQUENCY AMPLIFIER

Sleeper Radio Corp., 88-F Park Pl., New York City.

Parts for the coupling coil		
174	1—Formica tube 3½ ins. diam., 2½ ins. long, ⅛-in. wall	$ .56
40	1—¼-lb. spool No. 24 S.S.C. wire	.80
30	1—Formica panel 2½ x 6 x 3/16 in.	.47
A-9	1—Switch	.60
A-13	3—Switch points	.12
A-28	2—Stopping points	.10
A-10	2—Binding posts, R. H. screws	.20
58	1—Pkg. 25 soldering lugs	.20
14	2—Coil mounting pillars	.16
141	1—Pkg. 10 nickeled machine screws, 6-32 ⅜-in. R. H.	.12
Parts for the set		
A-6	1—Polished mahogany cabinet 7½ x 10 x 6 ins.	5.25
38	1—Formica panel 7½ x 10 x 3/16 in.	2.00
30	1—Formica panel 2½ x 6 x 3/16 in.	.47
A-20	1—100-division knob and dial	1.00
A-9	2—Switches	1.20
A-13	9—Switch points	.36
A-28	4—Stopping points	.20
A-22-X	1—Rheostat	1.00
A-10	4—Nickeled binding posts, R. H. screws	.40
A-85	3—Nickeled binding posts, F. H. screws	.30
A-1-X	1—Socket	.80
A-15	1—11-plate condenser	3.25
185	1—Angle bracket, left hand	.10
22	1—Angle bracket, right hand	.10
58	2—Pkgs. 25 soldering lugs	.40
63	1—Pkg. 10 ½-in. 6-32 F. H. screws, nickeled	.12
71	1—Pkg. 10 ⅜-in. 6-32 F. H. screws, nickeled	.12
141	1—Pkg. 10 ⅜-in. 6-32 R. H. screws, nickeled	.12
61	1—Pkg. 10 ¼-in. 6-32 R. H. screws, nickeled	.11
49	1—Pkg. 10 6-32 nuts, nickeled	.08
47	3—2-ft. lengths sq. tinned bus bar	.15
14	2—Coil support pillars	.16
174	1—Formica tube 3½ ins. diam., 2½ ins. long, ⅛-in. wall	.56
40	1—¼ lb. spool No. 24 S.S.C. wire	.80
A-88	1—Indicating knob	.35

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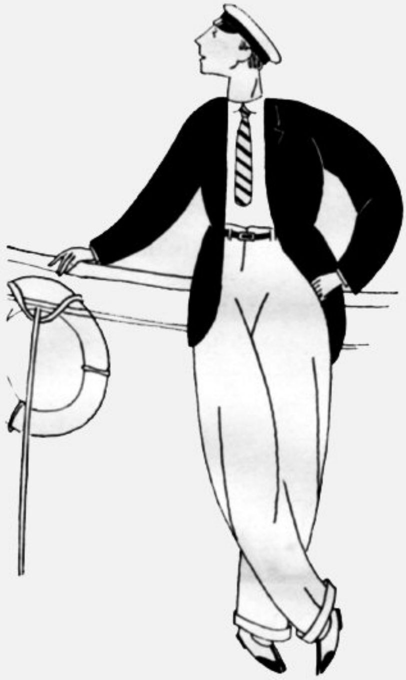

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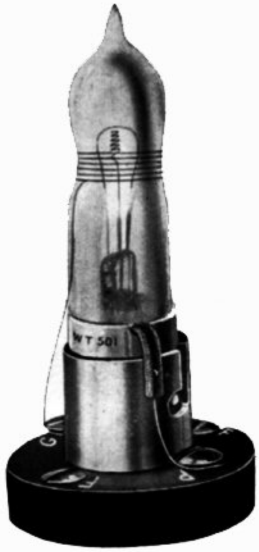

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