Vol. III No. 1

RADIO & MODEL ENGINEERING

Edited by ~ **M.B.Sleeper**

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A Magazine For The Experimenter Who Builds His Own Equipment

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That's the maximum capacity of the A-95 Vernier condenser, another one of those distinctive Sleeper accessories that fit right into your set and make it do things you didn't expect it to do.

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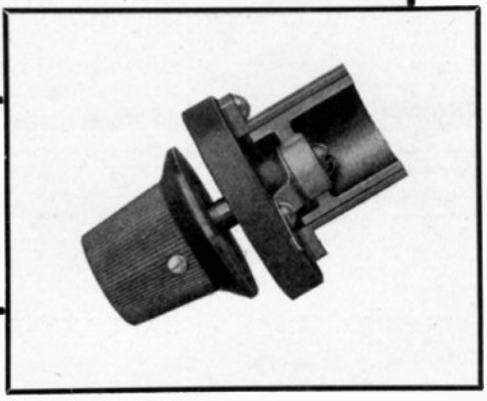
CONSTRUCTION PARTS



Type 3900 Receiver

Experimenters who prefer an all-purpose receiving set will find many advantages in the design of this new equipment.

General Description. THE type 3900 receiver has been designed in response to requests for a set which may be used either as a regenerative or non-regenerative outfit, to which radio frequency amplification can be added if necessary, and one that can be loaded to greater wavelengths than those to which the ordinary short-wave receiver will respond.

The designation of the type 3900 is in keeping with the plan adopted some time ago of giving each set described a type number for either identification when questions are asked about a set which has been described in RADIO and MODEL ENGINEERING or in one of the books. This receiving set, mounted on a 7½ by 15 in. panel, is made up of a vario-coupler, secondary tuning condenser and a detector and 2-step amplifier. Provision is made for loading the secondary circuit to high wavelengths. Loading coils can be inserted in series with the ground for increasing the wavelength of the primary. In addition it is possible to insert a variometer in series with the B battery for short-wave regenerative reception or a larger coil of variable inductance at the higher wavelengths. Moreover, the primary coil, shunted by a variable condenser, can be inserted in the plate of a radio frequency amplifier tube if radio frequency amplification is desired. In this way experiments can be made with the outfit or regular reception carried on. For receiving amateur or broadcast stations the set gives very good results, making up in clarity of reception what it may lack, from not being regenerative, in long distance range.

Fig. 1 shows the front of the panel. Two switches at the top vary the primary inductance in small and large steps, the left hand knob and dial controls the secondary coupling and the right hand knob and dial the secondary condenser. Rheostats are furnished for each

Fig. 1. Compact, sturdy, and reliable is this loosely coupled receiving set, shown here ready to connect for operating

tube and jacks for plugging in at the detector or amplifier. The antenna and ground binding posts are at the left and below short circuited binding posts, inserted in the secondary circuit, for attaching the secondary loading coil. Binding posts on the right provide connection for a loud speaker to the second amplifier or to a type 3100 2-step amplifier for operating a loud speaker.

Construction work Required. The actual construction work for the type 3900 set is limited to winding and mounting the coil, drilling the front and base panels, and assembling and wiring parts. You will find it very much easier and certainly more satisfactory to buy the cabinet all ready

made than to attempt its construction yourself. The one shown with the set in Fig. 1 is of well finished mahogany, carefully put together to give both strength and attractive appearance.

The drilling has been greatly simplified by the use of only six different sizes of drills plus a countersink required where flat head screws are employed. If you do not want to drill the panels and make up the variocoupler, these parts can be purchased with that work done.

Laying out the Panels. Fig. 5 shows the front and base panels at one quarter scale. To get the dimensions it is only necessary to measure distances between centers on the drawing with a pair of dividers and to multiply them by four for the actual size. You can get blue prints of Fig. 5 at half-size from the Blue Print Department of R. & M.

The 7½- by 15-in. panel, $\frac{3}{16}$ in. thick, can be purchased cut exactly to size with true corners, a great advantage in laying out the holes. As an example of the method for locating them let us go through the process with the No. 9 hole for the shaft of the left-hand switch. Measure on the illustration the distance from the edge of the panel to the center of the hole. Then lay off that distance four times down the panel. Put your combination square against the side of the panel and with the scriber, scratch a line through the point just found. Then measure the distance from the side of the panel to the center of the hole, lay it off four times from the side, and put your combination square against the top of the panel. Scratch a line with the scriber through the point just located. The intersection of the two scratch marks gives the exact center of the hole. Then with a plain or, preferably, automatic center punch make a mark to start the drill accurately.

Locate each hole in this manner before you drill any of the holes. In drilling do not put too much pressure on the panel or it will break through at the rear. Such engraving as is necessary can be done with a scriber, scratching the lines and filling them with white lead. If you prefer, however, you can obtain the panel completely engraved and also drilled if you wish.

Winding and mounting the coils. The complete variocoupler has been described separately. It is made up of an L. P. F. tube 3½ ins. in diameter and 2½ ins. long with a $\frac{3}{16}$ in. wall. The winding consists of 72 turns of No. 24 S. S. C. wire (No. 22 S. W. G.) tapped for units and tens switches. The secondary is wound on a 3-in. ball with 50 turns of No. 24 S. S. C. wire (No. 22 S. W. G.) Remember always to use mahogany for coupling balls since it does not warp and shrink as other kinds of wood do. Fig. 5 gives the details of the primary inductance and shows the location of the mounting holes, to which coil support pillars are attached, held to the panel, in turn, by flat head screws. Taps are taken from the primary coil at 0, 1, 2, 3, 4, 5, 6, 7, 8, 16, 24, 32, 40, 48, 56, 64 and 72 turns. The first eight taps run to the unit switch and the eighth to the sixteenth to the tens switch. Note that the eighth tap is common to both switches. A very satisfactory method of tapping coils is shown in the construction of this

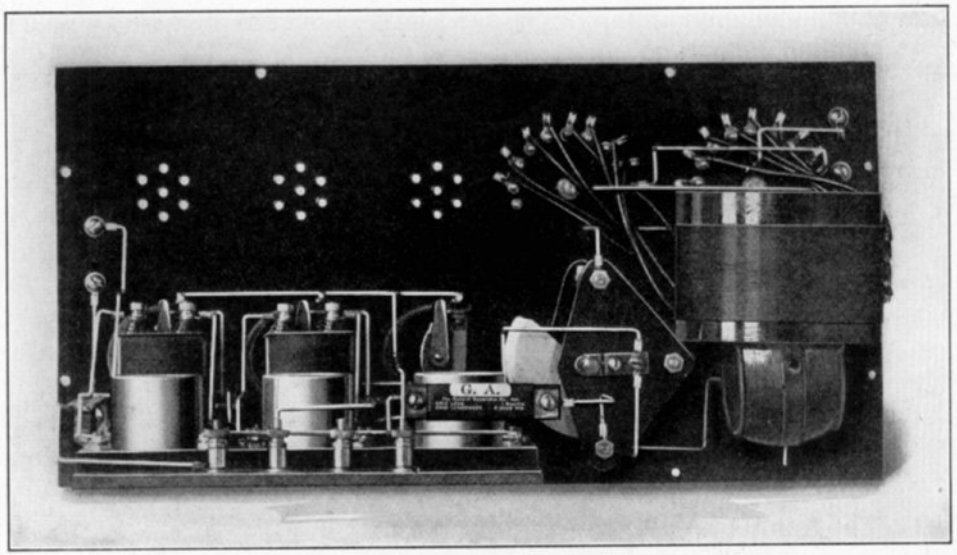


Fig. 2. This rear view illustrates the arrangement of the tuning instruments and the detector and two-step amplifier. Note the neatness achieved by the use of square tinned copper bus bar

inductance. Bend ordinary soldering lugs at right angles just behind the lips. Put the ring part of the lug under the wire when you come to a tapping point. Then wind the coil right along over the end of the lug. After the coil is completed, but before it is varnished, scrape the wire for ⅛ in. right next to the lug. Then, using the smallest possible amount of paste and solder, make your joint. This will give you a strong tap that will not break off and one to which you can solder easily. The use of tinned lugs greatly facilitates this work.

Instead of depending upon holes in the tubing or bearings fastened to the tube, either of which usually makes the dial run out of true, the shaft of the rotor is carried in a bushing. There is just a ½ in. shoulder on the bushing at the front of the panel, with two nuts to hold the bushing at the rear. The end of the bushing is slotted so as to give a slight, smooth tension on the shaft. Nuts on the shaft outside and inside the ball hold it securely. Leads from the rotor winding are brought out through two holes and run over to lugs fastened to the lower end of the primary tube. This arrangement was found more satisfactory than the one previously shown where the leads went to a small block clamped against the panel by the nuts which secure the bushing.

In connecting the taps to the switch points be very careful that you arrange them so that the inductance will be increased by clock-wise rotation of the switches. It is also important to arrange the lugs in such a way that the leads will be as short as possible.

Standard parts required. It is possible, of course, to substitute, in most cases, parts of any manufacturer for making up this receiving set. In the illustrations, however, Sleeper Radio parts have been shown as they go together well. The three types of knobs, for example, give an attractive appearance because they are of symmetrical design. If ordinary round-base rheostats are employed it will be necessary to swing the variable condenser 180 degrees to clear the rheostat base. With the type illustrated this is not necessary for a sturdy, unbreakable brass frame is employed and the resistance element covers only 180 degrees. A special advantage of this type is in the large cooling surface. Since the resistance wire does not heat excessively the strip carrying the wire does not dry out and shrink allowing the wire to come loose. The sockets are of conventional design, with polished nickel plated brass tubes and moulded bakelite bases. The sockets are provided with inserts so that it can be mounted directly behind the panel but, of course, that is not necessary in this design. The transformers, in their moulded bakelite cases, are of just the right size to fit between the telephone jacks, simplifying considerably the construction of the detector and amplifier end of the set.

Assembly and wiring. To make the assembly and wiring as clear as possible, Fig. 6 has been laid out with connections numbered corresponding to those used in the assembly instructions. The steps should be followed carefully in order so you will not discover that it is necessary to undo work already completed in order to carry out subsequent operations. This system, first used in RADIO and MODEL ENGINEERING, has proved to be most helpful to experimenters who have built sets after the designs shown.

1. Take apart the six binding posts with R. H. machine screws, slip a soldering lug between each washer and screw-head, and mount them so as to have the posts on the front or engraved side of the panel. All lugs are indicated by short, heavy lines and should point in the directions shown in the layout. See diagram numbers 15, 16, 38, 39, 41 and 43.

2. Fasten the four inductance switch stops

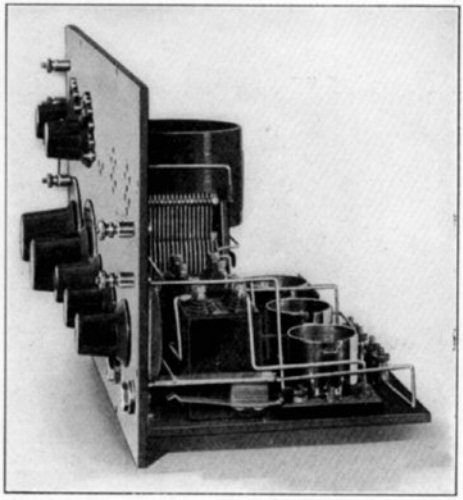


Fig. 3. End view of the assembled set

in the holes indicated as X in the diagram, Fig. 6.

3. In the remaining eighteen holes of the switches insert the contact points with heads on the front of the panel and lugs in the rear as shown. Tighten the nuts to avoid loose connections.

4. Fasten the three rheostats as shown, with the screws and nuts furnished.

5. Shift the contact arms of the rheostats around to the bare section of the resistance elements as depicted, and set the white lines on the knobs to coincide with the lines on the panel. Make sure a firm pressure exists between the contact arms and the resistance windings, then tighten the set screws in the knobs.

6. Next mount the variable condenser in place. Fasten the dial and knob to the shaft when the 100 line of the scale coincides with the line on the panel and the rotary plates of the condenser are wholly interleaved with the fixed plates.

7. To attach the variocoupler, first lock the brass bushing to the panel with the large hex nuts furnished. Slip the shaft of the rotor ball through the bushing, and tighten the nuts against the ball.

8. Solder a piece of flexible copper cable about 6 ins. long, to each end of the variocoupler coil.

9. Fasten the primary inductance coil to the panel with mounting pillars making sure the single taps are next to the rotor ball, and that the stopping pin of the ball is outside of the tube as shown.

10. Slip the 0-50 degree dial and knob on the rotor shaft and rotate the ball until its winding is at right angles to the winding on the tube. Then set the 0 of the scale to coincide with the line on the panel and tighten set screw.

11. Mount the two switches and tighten rear collars on the shafts making sure a firm pressure is obtained between the switch arm and the contact points.

12. Place the three jacks in positions indicated, the single circuit jack nearest to the edge of the panel, with the base of the jacks facing upward, to prevent any dust accumulating at the contact points.

13. Secure the remaining four binding posts with the F. H. machine screws apart, and tighten them properly in position.

14. Screw three sockets in place with slots as shown.

15. Attach the two angle brackets using two ⅜ in. F. H. machine screws and nuts on the base panel and R. H. screws of the same size for the front panel.

16. Now mount the base panel on to the front panel, holding it in place by means of two ⅜ in. R. H. machine screws and nuts.

17. Connect 1 to 2 to 3, 4 to 5, 6 to 7, and 8 to 9. To do that, first fit a piece of the square tinned wire from 1 to 2 to 3, running it as directly as possible. For the other connections use right angle bends, avoiding contact with any intermediate metal or wire. Then, solder the terminals neatly. See suggestions on soldering at the end of these instructions. For all other connections similar fitting and soldering processes are used.

18. Connect in the order mentioned, 10 to 11 to 12, 13 to 14 and also 13 to 15, 16 to 17, 17 being the frame of the jack. Again from 17 to 18, 19 to 20, 21 to 61, 23 to 24, 25 to 26, 27 to 28, 29 to 30, 31 to 32, 33 to 34, 35 to 8 also 35 to 36, 37 to 38, 39 to 40, 41 to 42, 43 to 44.

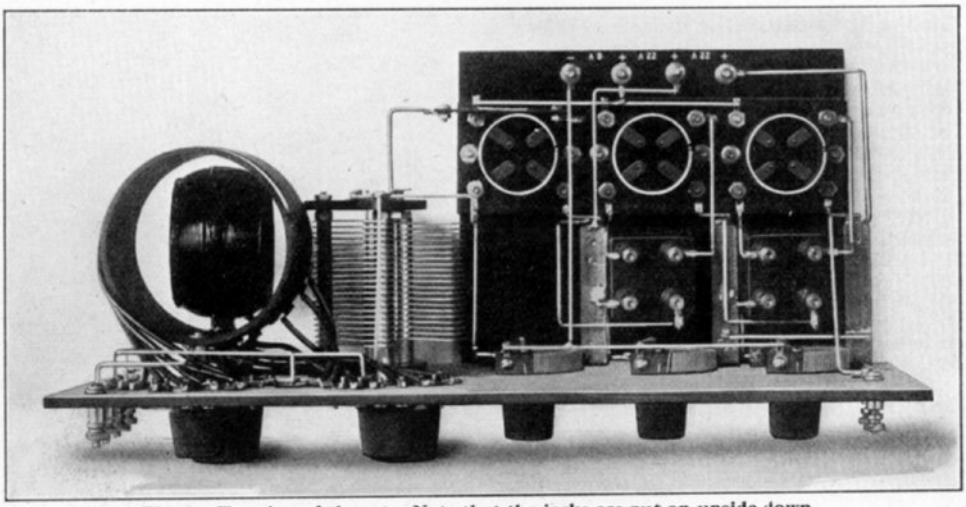


Fig. 4. Top view of the set. Note that the jacks are put on upside down for convenience in wiring

19. Mount the two audio frequency transformers in place, and make the following connections:—

45 to 46, 47 to 48, 49 to 50, (50 is frame of jack), 51 to 52, (52 is same as 5), 53 to 54, 55 to 56 (or 7), 57 to 58 (frame of jack) and to 59, 60 to 22, and 22 to 61.

20. Run the leads from the coil to the lugs of the switch points as depicted in the diagram. Slip a measured piece of empire tubing over the bare leads to avoid short circuits, solder the leads to the lugs and cut off any wires projecting beyond the lugs.

This completes the wiring of the set.

Testing and Operating. Before you mount the panel in the cabinet you should test it carefully to make sure that everything is all right. As you stand in front of the set connect the storage battery to the two left hand binding posts on the base panel, the negative at the left and the positive at the right. Then put one 22½-volt battery on to the two center posts, negative to the left and positive to the right. If you have

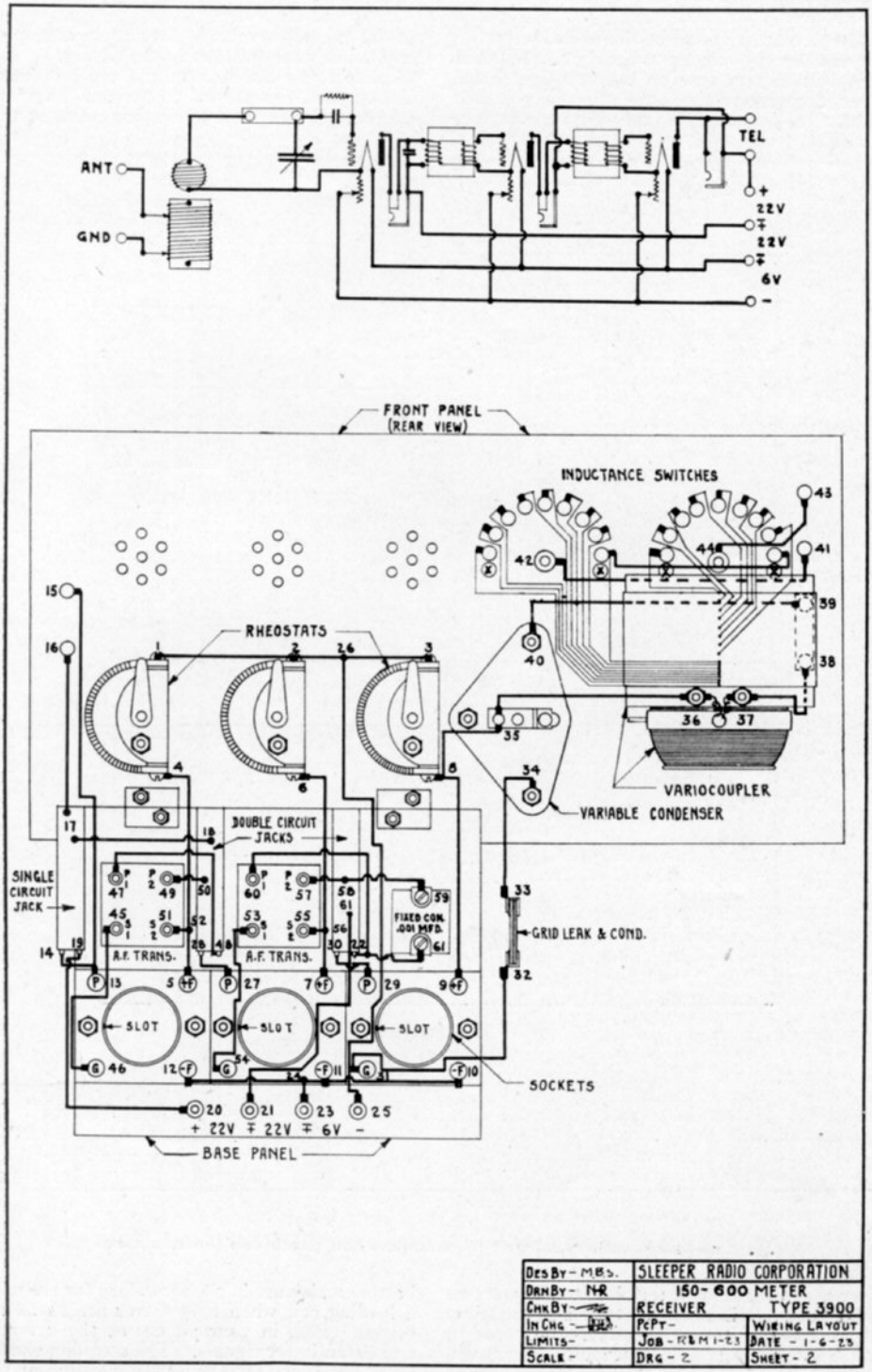


Fig. 6. Picture and schematic diagrams of the receiver. Follow the numbers carefully and you will have no trouble with your wiring

a 45-volt battery connect the negative to the left and the 2½-volt tap to the right. Another 22½-volt battery goes on the two right hand posts, negative to the left and positive to the right. In the case of the 45-volt battery, out by the high voltage battery in case you have made some mistake in the wiring.

Connect the antenna to the top left hand binding post, the ground to the one below it, and short circuit the two binding posts at the

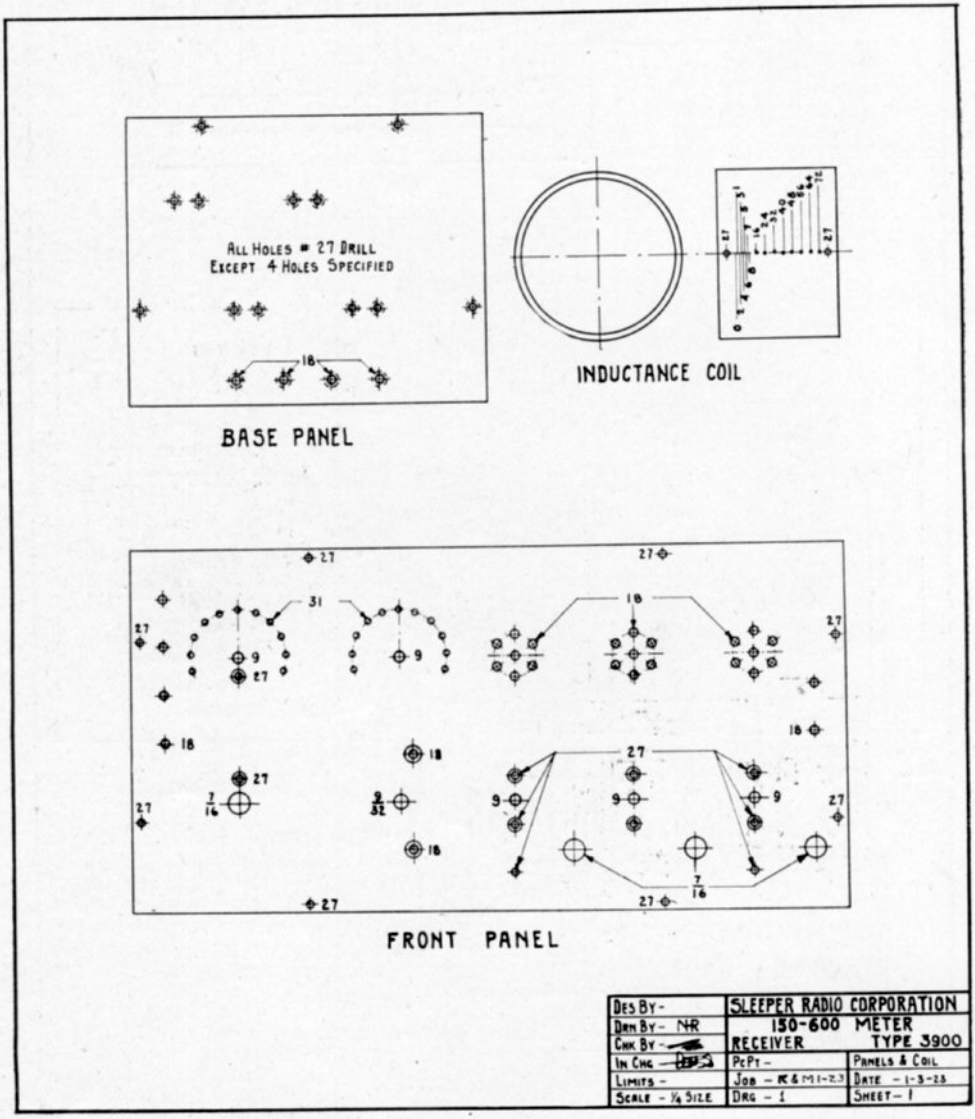


Fig. 5. One-fourth scale drawing of the front and base panels and the inductance coil

simply run the 45-volt terminal to the extreme right post. It is advisable to put in the tubes as soon as the storage battery is connected to make sure that they light properly. This will prevent the possibility of their being burned bottom which are in the secondary for use with a loading coil when long waves are to be received. Plug in your phones at the detector and listen in for signals. The coupling should be at maximum, the small steps switch at the

center while you turn the large steps switch and the secondary condenser back and forth until signals are heard. Then get a final adjustment with the small steps switch and the condenser. If interference is experienced loosen the coupling by rotating the ball and retune. With the detector working properly try out the first and second steps.

If the set fails to operate connect a buzzer across the antenna and ground posts to make sure that there is no open circuit. Repeat this process across the variable condenser terminals. Then try the contacts of the sockets, pressing the tube down a little and noting any sound in the receivers. It is an easy matter to bend up the springs if they do not make positive contact. Also test the transformer windings with a dry cell in series with your telephone. Try not only for an open circuit in either winding but a short circuit between the windings, not forgetting the outside connections which may effect the results of the tests. Failing to make the set work take it to the home of another experimenter who has an outfit in operation and see what it will do with his antenna and tubes.

The primary inductance is designed for use with an antenna about 100 to 150 ft. long, a single wire of No. 14 gauge. There is very little advantage in using more than one wire in a receiving antenna.

I used this outfit most successfully in England this winter for the reception of the Marconi House, Writtle, and Birmingham. This set was chosen for demonstration purposes because of the fact that regenerative or oscillating receivers are not allowed except with a special experimental license.

Taking Square Roots on the Adding Machine

The preparation of tables and the repeated solution of formulas can be speeded up by using this accurate method for taking square roots.

I HAVE asked several demonstrators of calculating machines if they could extract square roots on their devices, but all answered in the negative. Several times I have tried myself to work out such a scheme, but without success. Finally, however, I found that it could be done, and the way to do it, from Mr. Cooper, an engineer in Cleveland. We were trying each other with puzzles and problems, whiling away, in the lounge of the Baltic, an afternoon when the weather was too stormy to go out on deck.

Here is the method as given to me by Mr. Cooper:

Suppose that we are to take the square root of the number 5745.64. This must be registered on the adding machine.

1. 5745.64

2. Imagine the number divided up into groups of two figures, those on the left of the decimal point should be divided from the point to the left, and those on the right from the point to the right.

3. Subtract 1 from the last group to the left.

```
5745.64
 100.00
--------
5645.64
```

4. Advancing by two each time, subtract 3, 5, etc., until the first group has been reduced until no further subtractions can be made.

```
5645.64
 300.00
--------
5345.64
 500.00
--------
4845.64
 700.00
--------
4145.64
 900.00
--------
3245.64
1100.00
--------
2145.64
1300.00
--------
 845.64
```

5. Note that 7 subtractions have been made. This is the first figure of the root.

6. Double the number. $2 \times 7 = 14$.

7. Put a 1 after the 14, making 141.

8. Subtract the new number from the balance of the first group and the whole of the second.

```
845.64
141.00
------
704.64
```

9. Advancing the last figure by two each time, subtract 143, 145, etc. until the second group has been reduced until no further subtraction can be made.

```
704.64
143.00
------
561.64
145.00
------
416.64
147.00
```

269.64
149.00
———
120.64

10. Note that five subtractions have been made. This is the second figure of the root.

11. Double the first two numbers. 2 X 75 = 150.

12. Put a 1 after the 150, making 1501.

13. Subtract the new number from the balance of the second group, and the whole of the third.

12064
1501
———
10563

14. Advancing the last figure by two each time, subtract 1503, 1505, etc., until no further subtraction can be made.

10563
1503
———
9060
1505
———
7555
1507
———
6048
1509
———
4539
1511
———
3028
1513
———
1515
1515
———
0

15. Note that 8 subtractions have been made. This is the third figure of the root.

16. The square root of 5745.64 is 75.8.

Before using this method in regular calculations, try it out on a simple number, so that you can get the principles. Then you can apply them to any numbers.

This process may appear in the article a lengthy one, but when it is carried out on a machine, the work can be gone through very quickly, and, what is of more importance, very accurately.

Last Back Numbers Available.

The following numbers of R and M are available to those who want to complete their files. Since the quantities are limited, orders will be filled in rotation. A refund will be sent by return mail if we can't send you all the copies you order. The months and the feature article are listed below:

June 1921	Design of loose couplers.
Sept. 1921	Audio frequency amplifiers.
Oct. 1921	Radio frequency amplifiers.
Dec. 1921	Transmitting rectifier, short wave set.
April 1922	3-Step radio frequency amplifier.
July 1922	Super-regenerative set.
Aug. 1922	2-Step amplifier.
Oct. 1922	Loop receiver.
Nov. 1922	Undamped wave transmitter.
Dec. 1922	Long wave regenerative set.

The price of these copies is $.10, with $.01 for postage on each magazine. Don't delay about sending in your order.

We have had so many requests for the September 1922 issue that I would like to buy copies from those who may have extra copies. Twenty cents will be paid for each copy of this date.

Extension of Subscriptions

The December issue of R and M was delayed because I didn't return from England as soon as I had planned. Rather than move the date of issue forward a few days each month until it caught up we are calling this number the January-February issue. Previously, when a double number was published subscriptions were not extended because of the increase in the size of R and M. This time, however, your subscription will be extended one month to make up for this combination issue.

Advance Proofs

The experimental work on the new Sleeper Circuit set was completed too late to describe it in the January number. Drawings are now completed, however, and advance proofs are available of the article as it will appear next month.

The set is simplicity itself, for there are no variable condensers, no switches, no coils to wind, dry cells tubes can be employed with the outfit. Results obtained in New York and Hartford show an extraordinary efficiency for long distance phone or C. W. reception, coupled with a selectivity that has not been surpassed. However, the outfit is quite inexpensive to build.

Since the number of the advanced proofs is limited, only one can be sent to each Experimenter. If the supply is exhausted before your order is received, your money will be sent back by return mail. The price is twenty-five cents. Address your order to Radio and Model Engineering, 88 Park Place, New York, and mark the envelope "Advance Proofs."

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EDITORIAL

IS THERE no limit to the receiving range of our sets any more? Record after record is being broken, until it seems as if we shall soon have to confine our boasting to reception with a detector tube on a loud speaker. It is interesting to note that Captain Tanos, one of the best known ship owners on the Atlantic coast, has reported copying San Diego with the type X-1900 set, described in this issue, while one of his vessels was lying in Boston Harbor. But it doesn't pay to boast too much, for every time a fellow thinks he's done something really out of the ordinary, he finds that his next door neighbor has gone just a little farther.

It will be interesting to see, five or ten years from now, the effect of the nation-wide use of radio in this country. A brand new language has come into our homes, and new thoughts along with it, to say nothing of changed habits and bed-times. Our mothers are now borrowing battery chargers and vacuum tubes, as well as tea and eggs. Our fathers are getting down late to breakfast, looking a little bleary-eyed from sessions—on the air. Little brother now swells out his chest because he has heard Fort Worth or Chicago himself, while little sister knows that Mrs. Jones got that idea for trimming her hat from Bamburger's fashion talk. —And, in between times, we experimenters are learning a few things too. Where do you suppose it's all leading us?

In response to inquiries for full-size blue prints of sets shown in R and M, we have inaugurated a Blue Print Department, from which you can get the various prints which you need. While it is not difficult to scale off dimensions from the drawings in R and M, a full-size print is helpful because it can be laid directly on the panel, and the holes located by center punching right through the sheet.

For some time I have been thinking that we should have a directory of radio Experimenters who have only receiving sets. It would be interesting for you to know who the Experimenters are in your town—probably there are many whom you did not imagine owned sets, but with whom you might want to carry on tests and experiments if you did know about them. What do you think of our publishing a directory, similar to the Government call book, of receiving stations? If the idea appeals to you, will you write me? Tell me what sort of information, other than the name and address, should be given, and if you will help by collecting names in your section. If you'll take hold we can get out a really valuable directory.

After a considerable delay, owing to the new circuits so recently developed, the book of hook-ups, 101 Receiving Circuits, is now ready. I want to apologize to those who ordered copies in advance, but I think you will forgive me for the delay when you see the completeness of the new diagrams—I knew you'd want the latest reflex, radio frequency, and super heterodyne hook-ups, so I kept the printer waiting long enough to get them in.

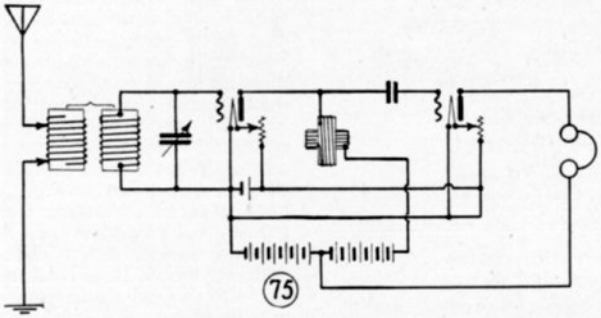
How do you like the picture diagrams and the step by step assembling instructions that are appearing in R and M? I tried for a long time to work out some scheme to get around the trouble that some experimenters have in following an ordinary schematic wiring diagram, and this new stunt is the result. I've been wondering if it is as good an idea as I thought it was because I haven't seen it copied by any of the other publications. That's usually the best test of a new idea. What do you think?

The renewal subscriptions from those December expirations have been coming in so fast they've almost taken my breath away. Of the 3,000, already 62% have renewed. It has certainly been gratifying to see them roll in. R and M, as you may have noticed, is no longer published by the Sleeper Radio Corporation. The magazine and the books are my pet hobby, and I've taken them under my wing entirely, now. R and M was never before expected to pay its own expenses, but now that its management and financing are entirely up to me, I've got to get busy and put it on a self-supporting basis. And that's why I need those subscriptions. Here's some inside dope, too—I had to leave the extra color off the cover because it cost too much. However, I felt that you wouldn't object as long as the right stuff was inside. Now I'm planning to get two or three more pages of advertising so that we can have additional pages of articles.

M. B. SLEEPER, Editor.

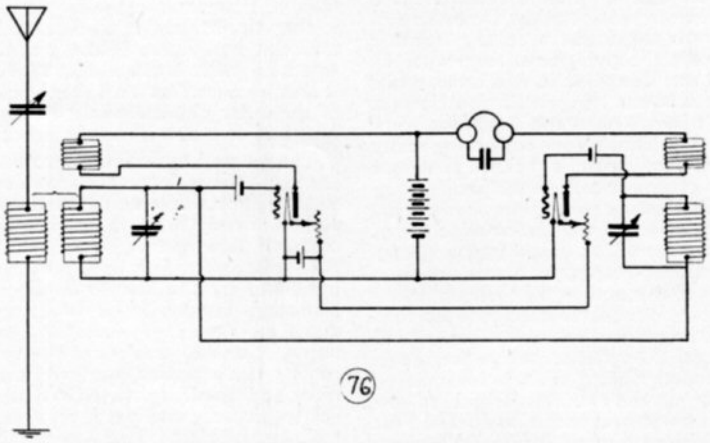
101 Receiving Circuits

Tenth Installment

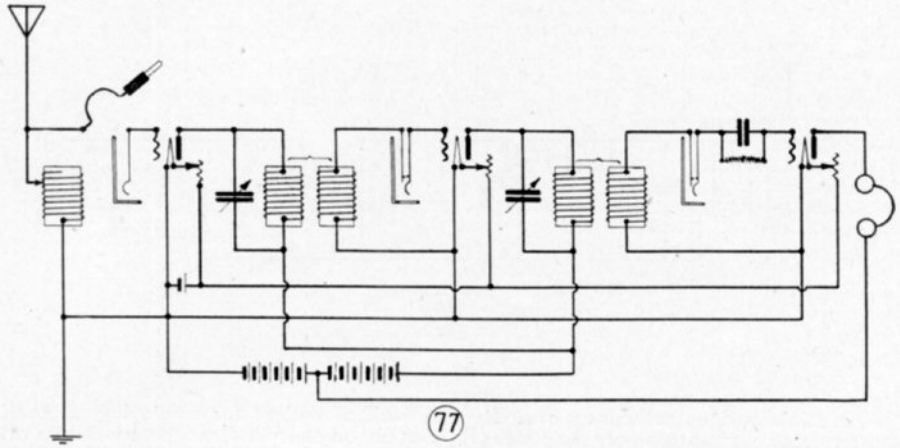


75. A very simple method of obtaining radio frequency amplification on a set designed to cover only a short wavelength range is to insert a variometer in the plate circuit of the radio frequency amplifier tube. This circuit is somewhat less sharply tuned than the others which have been described. The same method can be employed for additional steps of radio frequency amplification altho the necessity for tuning so many circuits makes it difficult to adjust the receiving set quickly.

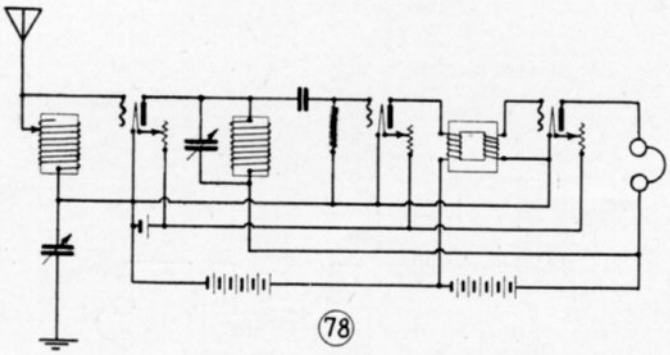
Remember that you must not expect too much in amplification from radio frequency amplifiers. Radio frequency brings in distant stations which cannot be heard with the detector alone. Per step, however, radio does not increase the volume of the signals as much as audio frequency. As to the number of steps which can be employed successfully, it is safest to start in the one radio frequency amplifier, for that is easy to make work well. Then, if you wish, add one or two more.



76. Two balanced circuits are employed in this diagram. Connected across the grid and filament of each tube is an oscillating circuit tuned to the incoming wave. A tickler coil is also provided in each plate circuit for regeneration. Altho this method of wiring is not commonly employed some very interesting results can be obtained with it. Note that biasing batteries are used intead of the ordinary grid condenser and gridleak. They should be of 1½ to 4½ volts, preferably regulated with a potentiometer. Amplifier tubes give somewhat better results than the ordinary gas filled detector tubes.

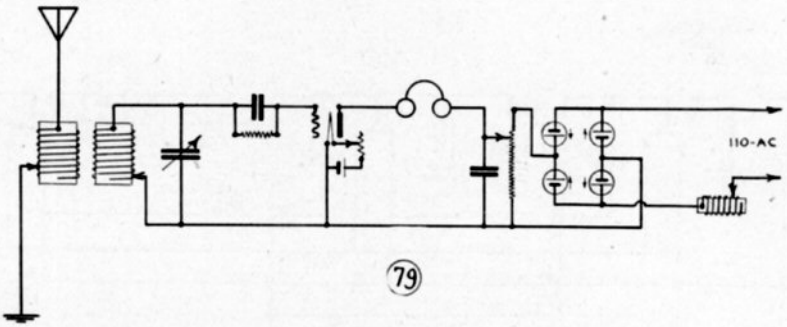


77. Radio frequency transformers are used in this circuit with a single slide tuning coil. Small variable condensers of 0.00025 mfd. maximum capacity are shunted around the primary of each transformer. A plug is provided by means of which the antenna circuit can be connected to the detector, one step radio or two steps of radio frequency amplification. This circuit might be rearranged for use with a loose coupler.



78. In this circuit an antenna inductance with a series condenser is used to tune the grid circuit of a radio frequency amplifier. In the plate circuit of the radio frequency amplifier tube an inductance and condenser are employed to tune to the incoming radio frequency. Following is the detector tube and a 1-step audio frequency amplifier. Here again the detector gridleak is put across the grid and filament rather than around the grid condenser for the purpose of keeping the high potential in the radio frequency amplifier plate circuit from the grid of the detector tube.

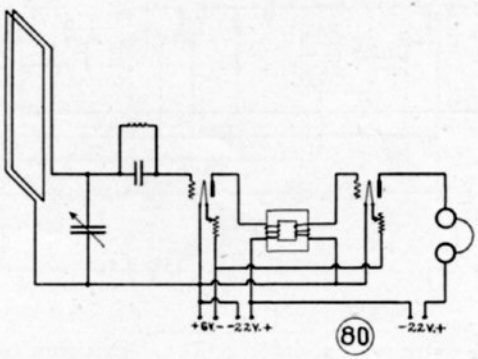
The single circuit tuning system can be replaced by a loose coupler with a variable condenser connected across the secondary winding. One or two additional steps of audio frequency amplification can be added if louder signals are required. As in other circuits of this general type 22½ volts of B battery are applied to the detector plate and 45 volts to the plates of the radio and audio frequency amplifying tubes. The grid condenser and gridleak in any of these circuits should be of 0.0005 mfd. and 1 megohm respectively.



79

79. Of all the various methods for using 110 volts alternating current to supply the plates of vacuum tubes this circuit is one of the best. The alternating current is passed through a heavy choke coil and on to a double chemical rectifier, so arranged that both halves of the alternating current cycle are employed. A potentiometer of about 500 ohms is shown, by means of which the plate voltage can be adjusted. The condenser shunted around the potentiometer should have a capacity of 0.001 mfd. This is to bypass the radio frequency in the telephone circuit.

Such a method for employing alternating current on the plate can be applied to other circuits. Generally it is not satisfactory to use audio frequency amplification as any hum is considerably amplified. However, this system can be used for radio frequency amplification since only the high frequencies are amplified. If the resistance of the chemical rectifiers is found to be so great that sufficient voltage is not supplied to the plate the voltage can be stepped up through a transformer before rectification.



80

80. When a regular outside antenna cannot be employed receiving can be accomplished by means of a loop. A loop antenna is merely a large coil. For short wave reception it generally takes the form of a rectangle 3 feet square wound with 10 turns of wire spaced ½ in. apart. In diagram 80 the loop is tuned by means of a variable condenser. Long distance work cannot be done except by the use of amplifiers. Usually two or more steps of radio frequency amplification are required in addition to the detector and two audio frequency amplifiers. A loop antenna receives only in the directions toward which the ends of the horizontal portion point. Therefore, the loop must be turned according to the direction from which it is desired to receive signals.

160 to 600 Meter Receiver

More long distance records have been made during the tests on this outfit than any that have been achieved in our laboratory so far.

General Description

DESPITE the claims made for various circuits using radio frequency amplification and the reflex system we have never been able to equal the reception accomplished with this 3-circuit regenerative set, with the possible exception of the type 2300 Reinartz receiver. Practically every station of any consequency, has been heard ranging as far west as San Diego, Calif. That station, however, was copied by the use of the type 3100 amplifier, previously described. Fig. 1 shows the front of the set with additional views in Figs. 2, 3, and 4. Fig. 1 illustrates the outfit when connected with the type 3100 2-step amplifier.

This equipment, designated as type X1900 receiver, is a redesign of the outfit shown in the December 1921 issue of R & M and in the Brown Book. The changes constitute a very considerable improvement both in efficiency and ease of assembly.

The circuit employed consists of a primary inductance with the secondary inductance carried entirely on the coupling ball and shunted by the 41-plate condenser. The condenser is in turn connected to the grid and filament of the vacuum tube. In the plate circuit, in series with the phones and B battery, is a variometer for regenerative tuning. The general design is similar to the ordinary type of circuit using a grid variometer. We found, however, that the variable condenser across the secondary gave a larger wavelength range than can be obtained with a variometer unless extra fixed mica condensers are switched in to increase the wavelength. Contrary to the ideas of some experimenters the use of the variable condenser did not broaden the tuning in the least.

Construction Work Required.

Unless you want to make your own variocoupler you will have very little work to do in assembling the X1900 set. In fact the only work required is that of laying out the front panel and base panel, for the condenser, variocoupler, and variometer can be purchased ready for mounting. The cabinet is not so very difficult to make but it is hard to produce the workmanlike appearance and finish that is achieved in regular working shops. You will notice that the top of the cabinet is in two parts, a stationary strip at the front to which the panel is secured and the hinged cover. This makes a more substantial arrangement than when the entire cover is free.

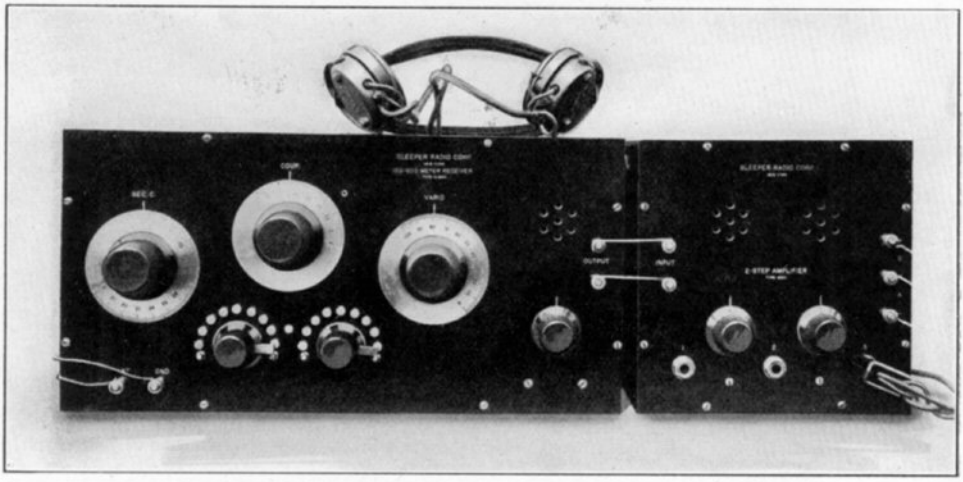


Fig. 1. The X-1900 receiver ready for operation. Exceptional results have been obtained with this equipment

Laying out the Panels.

Fig. 5 shows the front panel at one-half scale and Fig. 7 the base panel. Holes are marked for the drill sizes. Concentric circles indicate that countersinking is necessary to accommodate flat head screws. The 7½ by 15-in. panel, $\frac{3}{16}$ in. thick, can be purchased cut exactly to size with perfect right angles. This feature greatly facilitates the

work of laying out the holes. To determine the position of the centers measure with a pair of dividers on the drawing and transfer the distance, doubled, to the panel. Then, with a combination square and scriber scratch light lines which, at their intersection, indicate the point which should be marked with a center punch to start the drill. It is important to do this work carefully so that the parts will go together.

If you are going to leave the front of the panel polished you must make your marks on the rear. On the other hand graining the panel, if you prefer that sort of finish, will remove the lines. To produce a grain finish use No. 0 sandpaper and linseed oil, covering the sandpaper entirely with the oil. That will make it cut evenly over the entire surface.

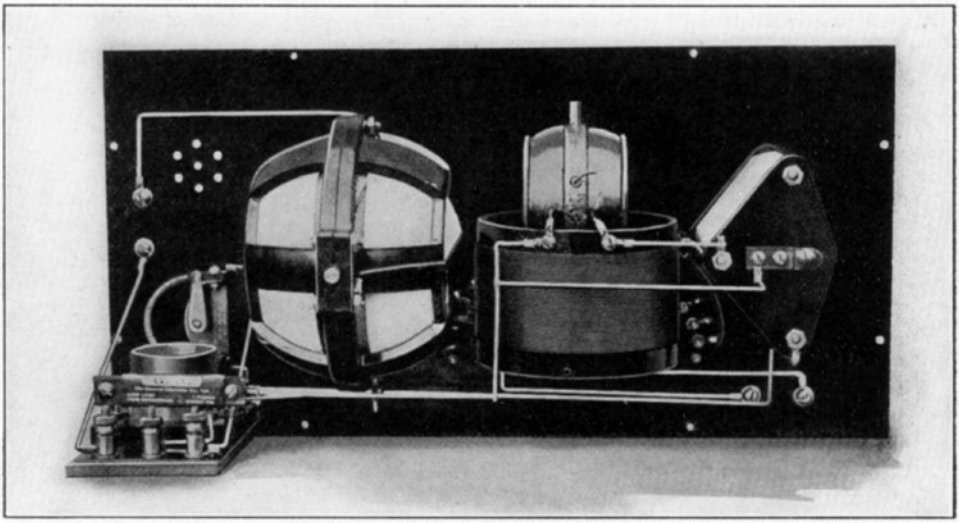


Fig. 2. You will have no trouble to assemble this set, for it is both simple in design and arrangement

Draw the sandpaper across the panel in straight lines back and forth, wiping off the oil occasionally until all the polished surface has been removed. The edges should be treated in the same way. If you do not want to drill and engrave your own panel you can buy an L. P. F. panel with this work already done at quite a reasonable price.

Winding and Mounting the Coils.

The complete variocoupler has been described separately. It is made up of an L. P. F. tube 3½ ins. in diameter and 2½ ins. long with a ⅛ in. wall. The winding consists of 72 turns of No. 24 S. S. C. wire (No. 22 S. W. G.) with units and tens taps. The secondary is wound on a 3-in. ball, with 50 turns No. 24 S. S. C. wire (No. 22 S. W. G.) Remember always to use mahogany for coupling balls since it does not warp and shrink as other kinds of wood do. Taps are taken from the primary coil as 0, 1, 2, 3, 4, 5, 6, 7, 8, 16, 24, 32, 40, 48, 56, 64, and 72 turns. The first eight taps run to the unit switch and the eighth to the sixteenth to the tens switch. Note that the eighth tap is common to both switches. A very satisfactory method of tapping coils is shown in the construction of this inductance. Bend ordinary soldering lugs at right angles just behind the lips. Put the ring part of the lug under the wire when you come to a tapping point. Then wind the coil right along over the end of the lug. After the coil is completed but before it is varnished, scrape the wire for an eighth of an inch right next to the lug. Then, using the smallest possible amount of paste and solder, make your joint. This will give you a strong tap that will not break off and one to which you can solder easily. The use of tinned lugs greatly facilitates this work.

Instead of depending upon holes in the tubing or bearings fastened to the tube, either of which usually makes the dial run out of true, the shaft of the rotor is carried in a bushing. There is just a $\frac{1}{32}$ in. shoulder on the bushing at the front of the panel, with two nuts to hold the bushing at the rear. The end of the bushing is slotted so as to give a slight, smooth tension on the shaft. Nuts on the shaft outside and inside the ball hold it securely. Leads from the rotor winding are brought out through two holes and run over to lugs fastened to the lower end of the primary tube. This arrangement was found more satisfactory than the one previously shown where the leads went to a small block clamped against the panel by the nuts which secure the bushing.

In connecting the taps to the switch points be very careful that you arrange them so that the inductance will be increased by clockwise rotation of the switches. It is also important to arrange the lugs in such a way that the leads will be as short as possible.

Standard Parts Required. With slight changes in the drilling and arrangement you can substitute the parts of other manufacturers. This outfit was made up of Sleeper Standardized parts as will be seen from the illustrations. The advantage in the use of German silver dials is that they provide a shielding effect, greatly reducing the body capacity which so frequently interferes with adjustments. Additional shielding can be accomplished by arranging, from the rear, a light contact on to the back of the dial. If this connection is then grounded there will be no trouble of any sort. The variometer has been described separately. Its great advantage is in the high inductance ratio, of 0.08 to 1.14 mh. at radio frequencies. The capacity effect is extremely low, only

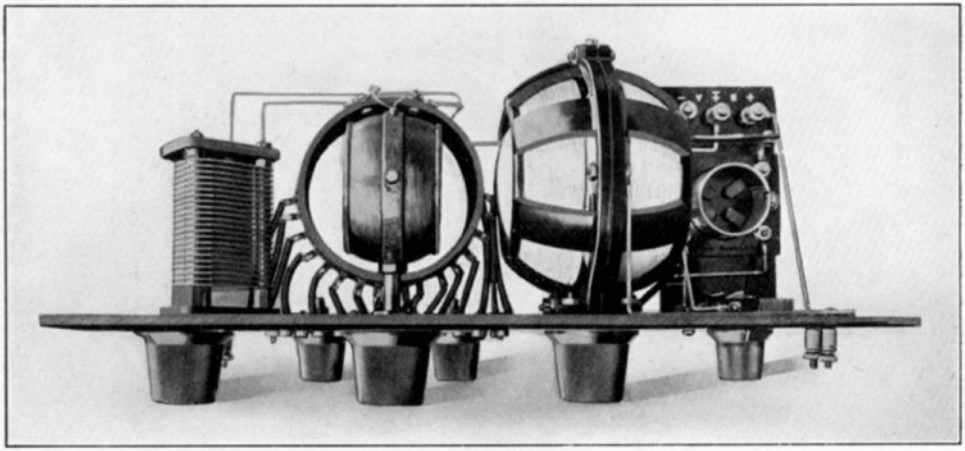


Fig. 3. In this top view the plan of the detector unit is shown, and the arrangement of the taps

0.000036 at maximum. The 41-plate condenser has a capacity of 0.00003 at 5 degrees and 0.00073 at 100 degrees.

Assembly and Wiring. In Fig. 6 you will find a picture diagram of the wiring with the connections numbered to correspond with the numbers used in the instructions. By following through, step by step, you will avoid any possibility of errors in the connections or the process of assembly.

1. Take apart the four binding posts, slipping a soldering lug between each washer and screw-head, and mount them so as to have the posts on the front, or engraved side of the panel. All lugs are indicated by short heavy lines, and should point in the directions shown in the layout. See diagram numbers, 35, 36, 2 and 4.

2. Insert the four switch stops into the end holes marked X on diagram. In the remaining nine holes ot each group, place the contact points, with heads on the front of the panel, and lugs on the rear as shown, tightening up the nuts to avoid loose connections.

Note:—Put a little solder on the ends of the lugs before assembling. See suggestions on soldering at the end of these instructions. Remove surplus paste on lugs with an old tooth brush, or other suitable means.

3. Mount the two switches and tighten the rear collars on the shafts, making sure that firm pressure is obtained between the switch arms and contact points.

4. Connect 1 to 2, and 3 to 4. To do that, first fit a piece of square tinned wire from 1 to 2, running it as directly as possible with right angle bends, where necessary, to avoid contact with any intermediate metal or wire. Then solder the terminals neatly. For all other connections follow this fitting and soldering process.

5. With a piece of No. 0 or No. 00 sandpaper, remove the insulation from the loops or taps of the winding of the variocoupler. From the bare copper wire supplied cut lengths about 4 ins. long and solder one end of each lead to a tap of the winding.

6. Mount the variocoupler in place, using 3/8 in. 6-32 F. H. machine screws. Run the upper end of the winding, next to the rotor shaft, to lug 5. Cut a length from the spaghetti tubing to slip over this lead. Solder the lead to the lug. The next taps are brought to lug 6, 7, 8, 9, 10, 11, 12, and 13. This provides the single turn adjustments used for tuning the antenna circuit.

7. The large taps are connected by running the upper tap to lug 14, and the remaining taps in order, as shown by the diagram numbers, 15 to 22. To make the soldering of leads to lugs 9 to 19 a little easier, loosen the variocoupler from the panel. Cut off all extra wire extending beyond the lugs to avoid any short circuit.

8. With all the taps soldered and the variocoupler rigidly fastened, place the knob and 50-degree dial on the rotor shaft with 50 of the scale coinciding with the engraved line on the

panel when the winding on the rotor, or ball, is parallel with the winding on the tube. Fasten the dial by means of set screw in the knob.

9. Mount the variable condenser, using ½ in. 8-32 F. H. machine screws. Fasten the dial and knob on the shaft so that the 100 line of the dial coincides with the engraved line of the panel when the rotating plates are wholly interleaved with the stationary plates.

10. Next, mount the variometer, with four screws. Attach the 0-100 dial and knob to have the 0 on the dial coincide with the engraved line on the panel when the rotor and fixed windings are parallel.

11. Mount the rheostat as shown with the screws and nuts furnished with it. Shift the contact arm of the rheostat round to the base end of the resistance element as shown in the picture diagram, and set the white line on the knob to coincide with the line on the panel. Make sure a firm pressure exists between contact arm and resistance winding, then tighten set screw in the knob

12. Assemble on the base panel the three binding posts which have flat head screws, 31, 33 and 34, with soldering lugs between the binding post bases and washers. Fasten the socket with two 6-32 ¾ in. F. H. machine screws and nuts. The slot in the socket should be on the side shown.

13. Fasten the base panel in place, with the two angle brackets and four 6-32 x ⅜ in. F. H. machine screws and nuts. This small panel is at right angles to the front panel, but it is drawn in the same plane, in diagram to show connections properly.

14. Connect in the order given, 23 to 24, 25 to 26, 27 to 28, 28 to 29, 30 to 31, 32 to 33, 34 to 35, 36 to 37, 38 to 39.

15. Solder one lug of the gridleak and condenser to 40, and the other lug 41, to G of the socket, marked 42 in the diagram. This completes the assembly and wiring.

Operating and Testing. When the receiving set has been completed, go over every connection with great care to make sure that all the joints are perfect, the wiring correct, and that no little slips have been made. Put an audion detector tube in the socket provided, run the antenna and ground leads to the binding posts marked ANT and GND respectively, put the 6-volt storage battery leads and 22½-volt B battery wires through holes in the rear of the cabinet and attach them to the binding posts on the base panel.

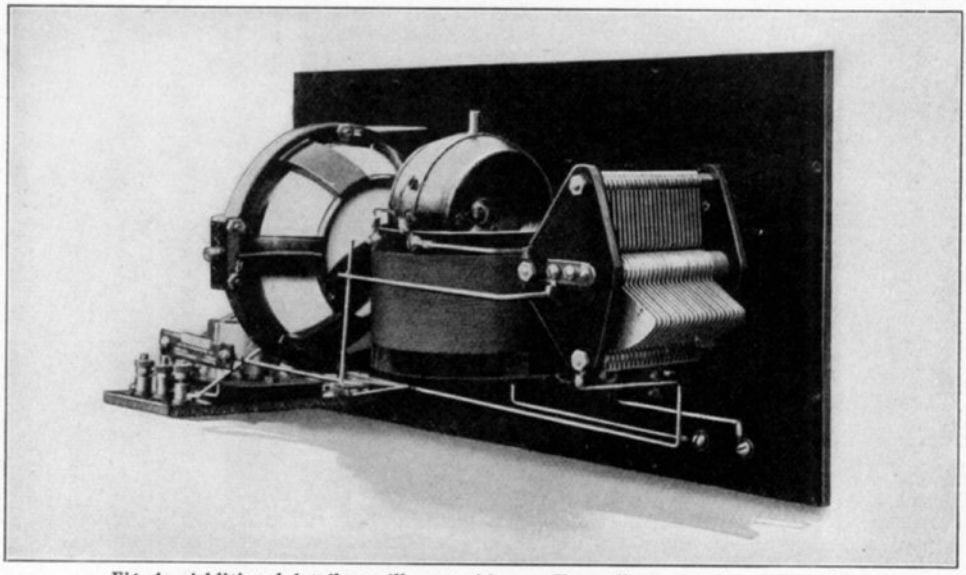


Fig. 4. Additional details are illustrated here. You will see that the rotor of the variocoupler is supported only by the panel bushing

Attach the telephone terminals to the binding post at the right. Increase the brilliancy of the filament to a point just before a hissing noise is heard in the telephone receivers. Set the variometer at about 50 degrees and rotate the secondary condenser with one hand and the large step switch with the other. When signals come in, get a close adjustment on the condenser, a fine adjustment on the inductance by means of a small step switch, and bring the signals to full strength with the variometer. Then go over the adjustments once more for the very best settings.

This set is extremely sharp in tuning so that it is necessary to get an idea at what points the various stations can be expected to come in

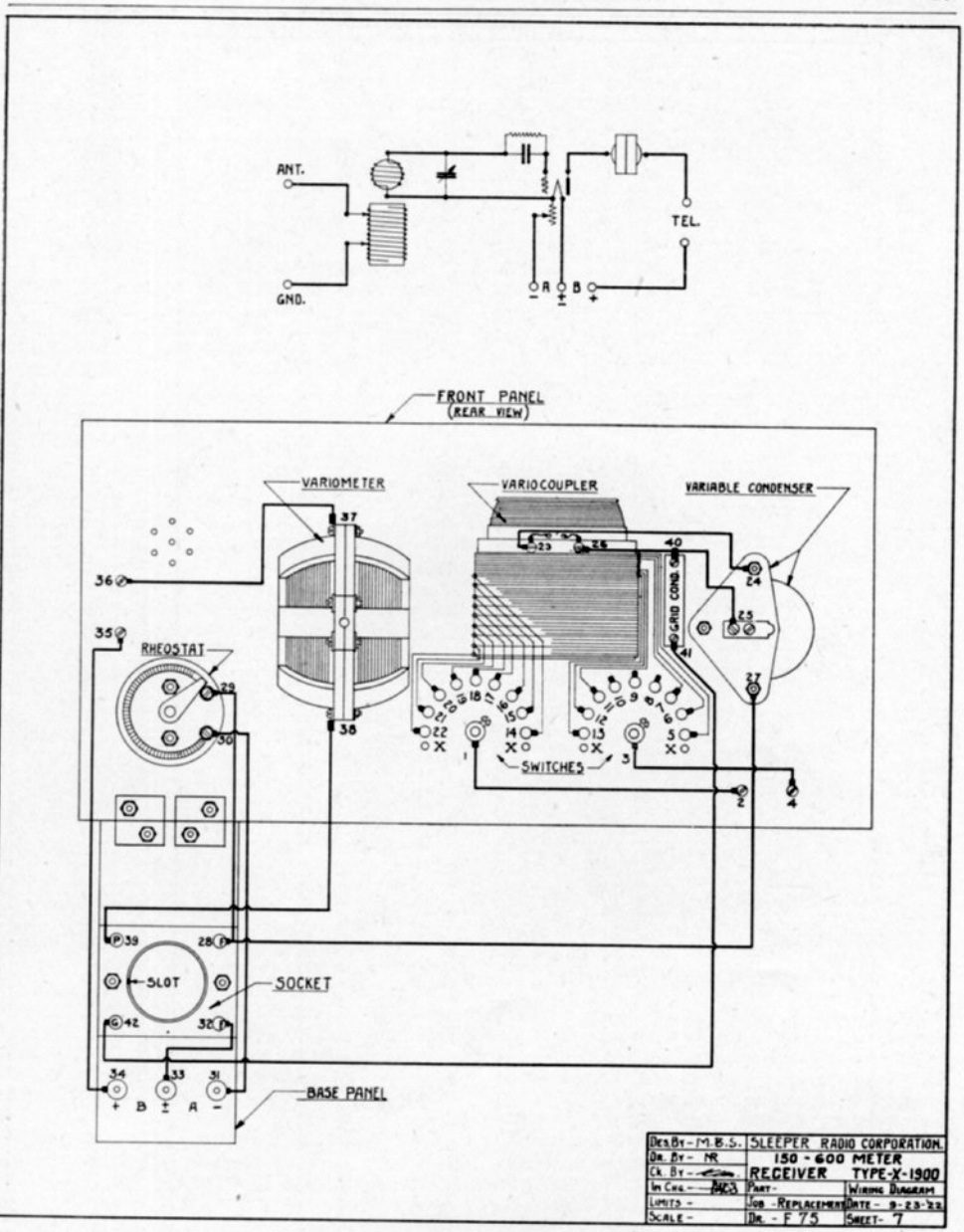


Fig. 6. Here are the schematic and picture wiring diagrams. The latter shows the connections as they appear on the set

from actual operation. As an example of results obtained with this set on a good antenna and ground under favorable conditions, Mr. Montgomery, Vice-President of the Fort Worth Life Insurance Company, Fort Worth, Texas, has reported the following stations heard plainly without interference in the course of one evening: Two stations in Denver, two in Kansas City, one in Saint Louis, one in College Park, Atlanta, Ga., Jefferson City, Mo., Louisville, Ky., Minneapolis, Indianapolis, Norman, Okmulgee, and Oklahoma City, Okla., Anthony Emporia, Wichita, Shreveport, Houston, San Antonio, El Paso, Dallas, Fort Worth, Fort Dodge, Des Moines, Davenport, Chicago, Salt Lake City, Los Altos, Monterey, Detroit, East

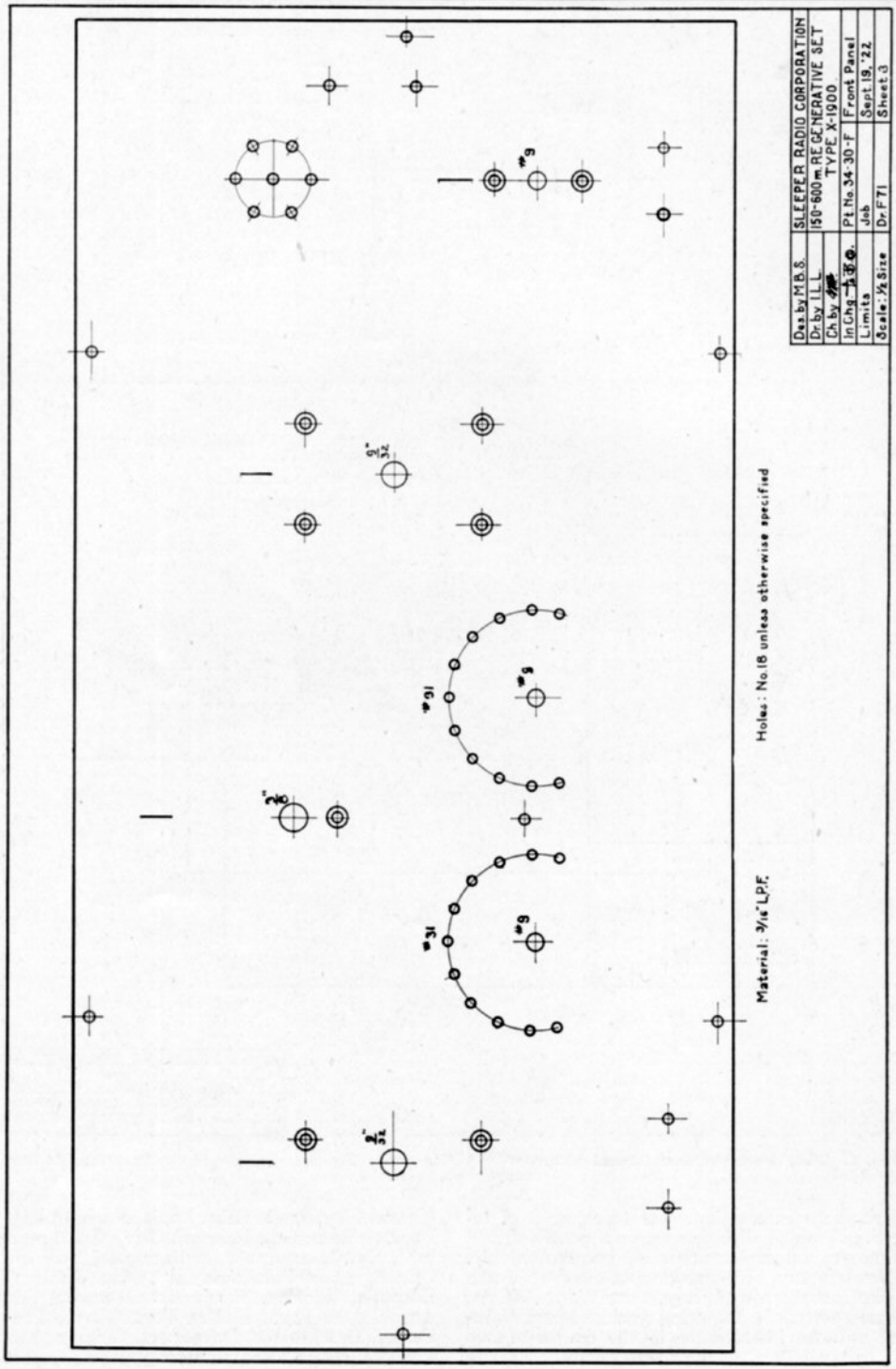


Fig. 5. One half scale drawing of the front panel. Drill sizes are given by number or fraction. Concentric circles indicate countersinking

Pittsburgh, Pa. In addition to these he has heard WJZ and WGY.

These results are, of course, unusual but in the hands of an expert operator, with the set properly installed, there is almost no limit to the work which can be done.

When Mr. Montgomery made this report, he was using in addition a 2-step amplifier. The type 3100 amplifier, which is also furnished as a construction set, is designed to be used with the X-1900 receiving set. Binding posts are arranged for easy connection and the design is planned to give a symmetrical appearance when the two are used together.

By means of a socket adaptor a dry cell tube can be used with this outfit. In that case one dry cell should be connected in place of the storage battery. The zinc terminal is negative and the center carbon terminal the positive.

Standardized Parts for the Equipment Described in this Issue

These parts can be obtained from the Sleeper Radio Corporation, 88-F Park Place, New York City, or from your local dealer. In ordering by mail be sure to give the part numbers and the type number of the set for which the parts are intended. Remember the postage.

PARTS FOR THE X-1900 RECEIVER

No.	Description	Price
A-5-D	1—Mahogany Cabinet 7½ x 15 x 6½"	$ 5.50
33	1—L. P. F. Panel 7½ x 15 x 3-16"	2.97
30	1—L. P. F. Panel 2½ x 5 x 3-16"	.33
A-202	1—Completely assembled vario-coupler	4.00
A-101	1—Moulded Variometer	7.50
A-17	1—41-Plate Variable Condenser	3.50
A-20	2—100° Knobs and dial, ¼" hole	2.00
A-21	1—50° Knob and dial, ¼" hole	1.00
A-1X	1—Audion Socket	.80
A-9	2—Locked lever switch, 1" radius	1.20
A-22	1—Rheostat	1.00
A-13	18—Switch Points with nuts	.72
A-28	4—Stopping Points with nuts	.10
A-4	1—Grid Leak Condenser	.56
A-10	4—Polished nickel binding posts, R. H. screws	.40
A-85	3—Polished nickel binding posts, F. H. screws	.30
22	1—1" nickeled angle bracket, right	.10
185	1—1" nickeled angle bracket, left	.10
58	2—Pkgs. of 25 small tinned lugs	.40
71	1—Pkg. 10 6-32 F. H. screws ⅜" nickeled	.12
141	1—Pkg. 10 6-32 R. H. screws ⅜" nickeled	.12
140	1—Pkg. 10 No. 6 Wood screws ½" nickeled	.13
49	1—Pkg. 10 6-32 Nuts nickeled	.08
91	2—2 ft. lengths Empire Tubing	.50
47	4—2 ft. lengths square tinned copper bus bar	.20

SPECIAL ITEMS

Drilling front panel for the X-1900 set, extra	$2.28
Drilling base panel, extra	.28
Engraving front panel, extra	4.10
Engraving base panel, extra	.30

PARTS FOR THE TYPE 3900 RECEIVER

A-5-D	1—Polished mahogany cabinet 7½ x 15 x 6½ ins.	$5.50
33	1—L. P. F. panel 7½ x 15 x 3-16"	2.97
32	1—L. P. F. panel 7½ x 6 x 3-16"	1.18
A-202	1—Complete variocoupler, wound and tapped	4.00
A-17	1—41-plate variable condenser	3.50
A-20	1—100° knob and dial	1.00
A-21	1—50° knob and dial	1.00

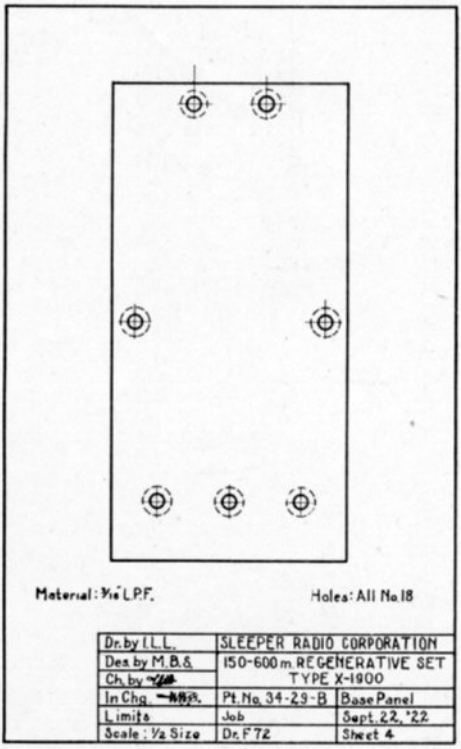


Fig. 7. One-half scale drawing of the base panel

A-1-X	3—Audion sockets	$2.40
A-22-X	3—Rheostats	3.00
A-9	2—Locked lever switches	1.20
A-13	18—Switch points with nuts	.72
A-28	4—Stopping points	.16
A-4	1—Gridleak condenser	.50
A-3	1—Phone condenser	.35
A-10	6—Polished nickeled binding posts R. H. screws	.60
A-85	4—Polished nickeled binding posts F. H. screws	.40
22	1—1-in. nickeled angle bracket, right hand	.10
185	1—1-in. nickeled angle bracket, left hand	.10
A-14	2—Audio frequency transformers	10.00
A-35	1—Open circuit jack	.70
A-36	2—Closed circuit jacks	1.70
71	1—Pkg. 10 6-32 ⅜ in. F. H. nickeled screws	.12
141	1—Pkg. 10 6-32 ⅜ in. R. H. nickeled screws	.12
143	1—Pkg. 10 No. 6 ½ in. R. H. nickeled wood screws	.14
47	4—2 ft. lengths square tinned copper bus bar	.20
58	1—Pkg. 25 small tinned lugs	.20
91	2—2 ft. lengths Empire tubing	.50

SPECIAL ITEMS

Drilling front panel, extra	$3.62
Drilling base panel, extra	.80
Engraving front panel, extra	4.80
Engraving base panel, extra	.85
Complete 3900 Receiver ready to operate	**$60.00**

—Yet Bill is always getting new radio apparatus

PROBABLY you, too, have wondered how it is that some of your friends, who seem to spend all their money on things other than the radio, can buy all the things they want for their experimental work.

The answer is simple enough. They do not spend money for their equipment—they buy what they want with Radio & Model Engineering Apparatus Coupons. Take Bill Hartley of St. Louis. He says he never could afford all the instruments and supplies he wanted, and now—well, I imagine the little sketch looks a lot like Bill in his spare moments. Still—Bill now has more radio equipment than his more affluent friends. Here's the secret:

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The type A-101 Sleeper Standardized variometer is, without exception, the finest instrument of the kind built by any manufacturer.

The maximum distributed capacity is 0.000036 mfd., and the inductance 0.05 to 1.2 mh. In no other variometer is the capacity, and the corresponding losses as low or the inductance as high.

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Beautiful in appearance, easy to mount, wonderfully efficient. If your dealer cannot supply them order direct by mail. $7.50, postage, 15c.

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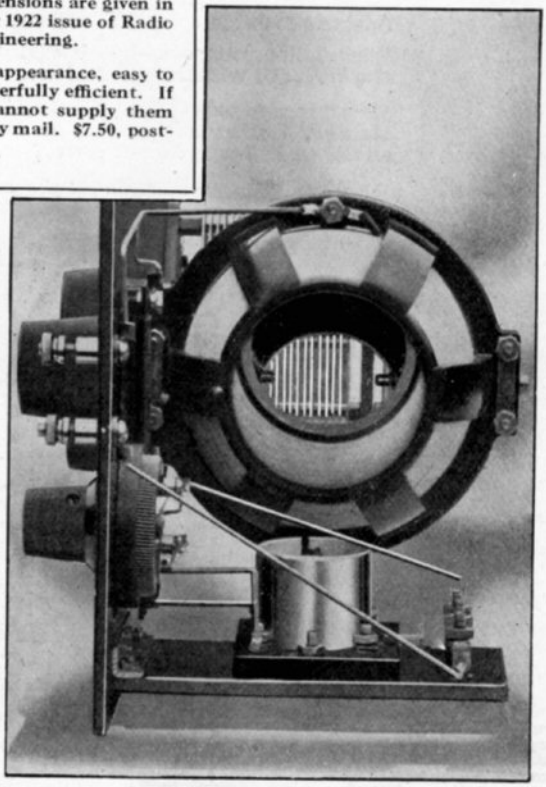
cents



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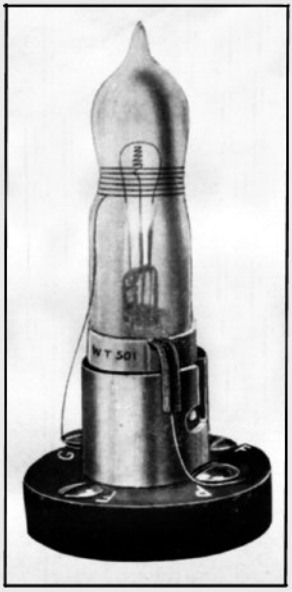

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"The Tube That Cannot Squeal"

Sold for experimental use as a detector only

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Actual size 2¼ inch. without socket.

Long Life. Uses only ½ amp. on three dry cells or regular six volt "A" battery. Plate voltage 16-22½ v.

Special Nickel plated socket, moulded base, double spring contacts, 40c. extra.

Adapters to fit Standard V.T. Sockets, 75c. extra.

Wiring diagram packed with each tube showing how to use the W.T. 501 with any crystal set.

Show this ad to your dealer. If he hasn't got his stock yet, send us his name and a money order covering the price of the tube and socket and we will send direct by insured parcel post.

We cannot fill orders which do not give your dealer's name.

RADIO TECHNICAL LABORATORIES
MANUFACTURERS

R·T·L

Dec.2,1922

Radio Research Guild. re TEST 112922
Newark,New Jersey.

Gentlemen:

The W.T. 501 detector tubes submitted to us for test are being returned to you today with test records.

These records we consider speak favorably of the high quality of your tubes particularly in view of the low current consumption.

The detectors function clearly, with good volume and a minimum of distortion.We have carefully tested each tube individually and over a wide range of conditions.We also note a complete absence of any tendency to howl.Answering your other question specifically:We believe your method of construction renders it practically impossible for it to howl. We believe you are quite justified in advertising your W.T. 501 detector tubes as "The Tubes Which Cannot Squeal".

Respectfully yours

Radio Technical Laboratories.

K. per Chief testing dept.

Hook the W.T. 501 right up with your crystal set. No need to discard any apparatus. (Full directions packed with each tube.) If you own a tube set use the W.T. 501 and the special adaptor to fit V.T. socket.

RADIO EXPERIMENTERS' LEAGUE
"RUN BY AMATEURS FOR AMATEURS"

NEWARK, N. J.

Dec.,9,1922

Radio Research Guild
9-15 Clinton Street,
Newark,N.J.

Gentlemen;

Thank you for your promptness in shipping us the 100 W.T. 501 detector tubes.

We have tried them out on all sorts of hook-ups and the members are enthusiastic about them.

From now on no one needs to bother with a crystal set as you have placed the price of a tube within the reach of everyone.We are glad to place the W.T.501 PEANUT tube on our list of approved apparatus and are so notifying our members.

The enclosed order for 300 more tubes is for use here locally and we certainly hope you will rush them to us---our members are clamoring for them.

You are to be congratulated on what you have accomplished.The W.T.501 surely is "The tube without the squeal?

Sincerely yours

Radio Experimenters' League.

per [signature]
Secretary

WG/se.

RADIO RESEARCH GUILD

9-15 Clinton Street **Newark, N. J.**