DEPARTMENT OF COMMERCE

CIRCULAR

OF THE

BUREAU OF STANDARDS

No. 137

AUXILIARY CONDENSERS AND LOADING COIL USED WITH SIMPLE HOMEMADE RADIO RECEIVING OUTFITS

FEBRUARY 23, 1923

PRICE, 10 CENTS

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CIRCULARS ISSUED DURING THE CALENDAR YEAR 1923 (SUPPLEMENT TO CIRCULAR NO. 113)

AUXILIARY CONDENSERS AND LOADING COIL USED WITH SIMPLE HOMEMADE RADIO RECEIVING OUTFITS.

ABSTRACT.

This is the fourth circular in a series of descriptions of very simple radio receiving outfits. In Circular No. 120 a single-circuit crystal-detector receiving set was described, and in Circular No. 121 a two-circuit crystal-detector set was described. The operation of either set can be improved by the use of a very simple and cheap condenser connected across the telephone receivers and a similar one connected in series with the antenna. Longer waves can be received by the use of a very simple type of loading coil. The coil is particularly useful in connection with the single-circuit receiving set.

The auxiliary condenser, which is used in series with the antenna, and the loading coil may also be used when the crystal detector is replaced by an electron-tube detector unit (as described in Circular No. 133) or when an amplifier (to be described in a later circular) is added to the receiving set.

The condenser used in series with the antenna makes it convenient to tune to wave lengths less than 300 m. The condenser used across the telephone receivers increases the intensity of signals which are received from some radio stations. The loading coil enables the equipment to respond to wave lengths above 600 m up to about 3,000 m. Time signals from high-power stations can thus be received. The parts for the auxiliary condensers cost about 80 cents, and the parts for the loading coil cost about $3.

CONTENTS.

I. INTRODUCTION.

This circular[1] describes auxiliary equipment for use with the simple radio receiving outfits described in Circulars Nos. 120 and 121. Both the auxiliary condensers and the loading coil may be

[1] This is the fourth of a series of circulars describing very simple radio receiving equipments, which were originally prepared for use by the Boys' and Girls' Radio Clubs of the States Relations Service, Department of Agriculture. The previous circulars of the series are: Bureau of Standards Circular No. 120, Construction and Operation of a Simple Homemade Radio Receiving Outfit; Circular No. 121, Construction and Operation of a Two-Circuit Radio Receiving Equipment with Crystal Detector; Circular No. 133, Description and Operation of an Electron-Tube Detector Unit for Simple Radio Receiving Outfits. These circulars are obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C. The price of Circular No. 120 is 5 cents; Circular No. 121, 5 cents; Circular No. 133, 10 cents.

Persons desiring an elementary book covering radio principles may refer to The Principles Underlying Radio Communication, Signal Corps Radio Communication Pamphlet No. 40. This is a book of over 600 pages, and contains over 300 illustrations. A copy may be purchased for $1 from the Superintendent of Documents, Government Printing Office, Washington, D. C.

used with the simple sets as described in those circulars. The loading coil and the condenser, which is connected in series with the antenna, may also be used when the crystal detector is replaced by an electron-tube detector unit (as described in Circular No. 133), or when an amplifier (to be described in a later circular) is added to the receiving set.

Three things are described herein—two simple condensers and a loading coil—the condensers are so-called fixed condensers; that is, the capacity is not variable. One of the fixed condensers, which is connected in series with the antenna, will be called in this circular the "series-antenna" condenser. The other fixed condenser, which is connected across the terminals of the telephone receivers, will be called the "telephone-shunt" condenser.

The effect of the series-antenna condenser is to enable the receiving equipment to give signals of somewhat greater intensity when tuned to wave frequencies above 1,000 kilocycles per second (that is, wave lengths of 300 m or less). It will thus be seen that the effect of this condenser is just the opposite of the effect obtained by a greater number of turns of wire on a tuning coil, which, it will be remembered, permits the receiving equipment to respond to lower wave frequencies (longer wave lengths).

The effect of the telephone-shunt condenser is to increase the intensity of some radio signals to which the receiving set may be tuned. In most cases the use of this condenser has no effect upon the intensity of signals which are received from a radio telephone transmitting station, but will increase the intensity of radio signals which are received from most spark transmitting stations.

The loading coil is primarily for use in conjunction with the single-circuit radio receiving set described in Circular No. 120. The experimenter who is interested in using it in connection with the two-circuit set described in Circular No. 121 is referred to the paragraph entitled "Use with two-circuit set," near end of this circular. The purpose of the loading coil is to enable the receiving equipment to respond to wave frequencies between 100 and 500 kilocycles per second (that is, wave lengths between 3,000 and 600 m). In other words, the loading coil increases the wave frequency (wave length) range of the receiving set. The receiving set described in Bureau of Standards Circular No. 120 has a wave frequency (wave length) range of between 500 and 1,500 kilocycles per second (wave lengths between 600 and 200 m).

The use of the loading coil will increase the receiving distance of the equipment, because many stations using the lower wave frequencies (longer wave lengths) use a high-power radio transmitting set. For example, the station NAA at Arlington, Va., which transmits time signals, uses a wave frequency of about 113 kilocycles per second (2,650 m wave length) and uses sufficient power to be heard a distance of about 200 miles when the loading coil described in this circular is used with the receiving equipment described in Circular No. 120 or its equivalent. At night this distance may be considerably increased. The cost of the parts for the two condensers is about 80 cents, and for the loading coil is about $3.

This publication describes simple apparatus of satisfactory performance without reference to the possible existence of any patents which might cover parts of the apparatus. Apparatus in general similar to that described can be purchased from responsible manufacturers whose announcements can be found in current radio periodicals.

II. DESCRIPTION OF SERIES-ANTENNA CONDENSER.

The series-antenna condenser is shown in detail in Figures 1A and 1B. Two thin strips of metal (*C* and *E*) 1 inch wide and 3 inches long are used with three sheets of insulating material (*B*, *D*, and *F*) 1½ inches wide by 3 inches long. The metal strips may be thin copper, brass, or aluminum. Each of the three sheets of insulating material is made up of two pieces of heavy white writing paper which are separately dipped in clean, melted paraffin. Each pair of sheets is then pressed together by means of a warm iron, and when cold the strip is cut out to the required size. A sheet of clear mica, having about the same thickness as the two sheets of writing paper mentioned above, may also be used for the insulating material. Two blocks (*G*=2⅝ by 3 by ½ inches, *A*=3 by 3½ by ½ inches) are cut out preferably from hardwood. Two screws pass through holes *H* and *J* in the upper cap block *G*, which is placed over the base block *A*, so that the edges of the two blocks are even on three sides. (See Fig. 1A.) The holes for the screws *H* and *J* are ⅜ inch from the sides of the cap block *G* and equally distant from the ends. Having located the correct position of the cap block *G*, the screws in holes *H* and *J* are loosened and the cap block is removed from *A*, leaving two small holes *H'* and *J'* to locate the proper position of the blocks when the condenser is finally

assembled. The two screws *L* and *M* are located just far enough in from the front edge (see *A*, Figs. 1A and 1B) so that the block *A* may be screwed to the left end of the baseboard of the receiving set described in Circular No. 120 or to the primary coil support described in Circular No. 121. (See Figs. 2 and 3.)

The wooden blocks are of dry wood smoothed up with sandpaper and given a coat or two of varnish which will not absorb moisture, such as a spar varnish, or treated with paraffin, as described in Circular No. 120.

A sheet of the paraffined paper or mica *B* is placed on the base block *A*, between the holes *H'* and *J'*, so that its ends are even with ends of the base block. A thin metal strip *C* is placed in position so that it lies in the center of *B* and has its right end ½ inch

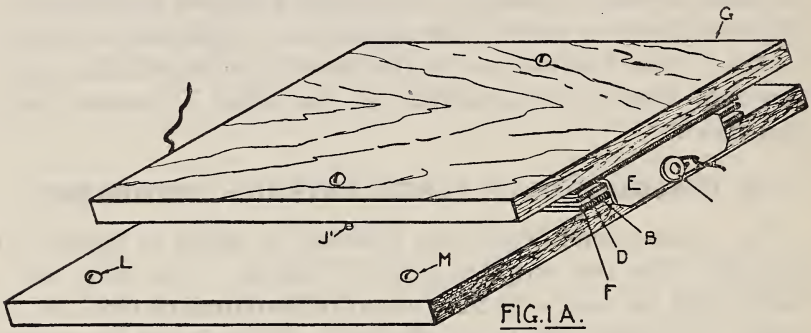

FIG. 1A.—*Completed series-antenna condenser.*

in from the edge of the base block and its left end projecting ½ inch over the opposite edge of the base block. (See Fig. 1B.)

Another sheet of paraffined paper *D* is placed on *C* directly above *B*. The second piece of thin metal *E* is placed on *D* above *C*, except that one end of the metal strip *E* extends ½ inch over the right edge of block *A* instead of the left, as did *C*. The third sheet of paraffined paper *F* is placed on *E* directly above *D* and *B*.

The alternate sheets of paraffined paper and thin metal are held carefully in position, and the cap block *G* is placed over them and screwed in position. The right end of the thin metal strip *E* is bent down, and a round-head brass screw *N* is passed through a hole *K* punched or drilled in the end of the metal strip. The projecting end of the strip *C* is not visible in Figure 1A, but it is bent and fastened in the same manner as *E*. The completed condenser resembles the sketch shown in Figure 1A.

(*a*) MOUNTING AND WIRING.—The condenser is mounted on either the single-circuit receiving set, described in Circular No. 120 or the two-circuit receiving set, described in Circular No. 121. Figure 2 shows the method of mounting the condenser on the

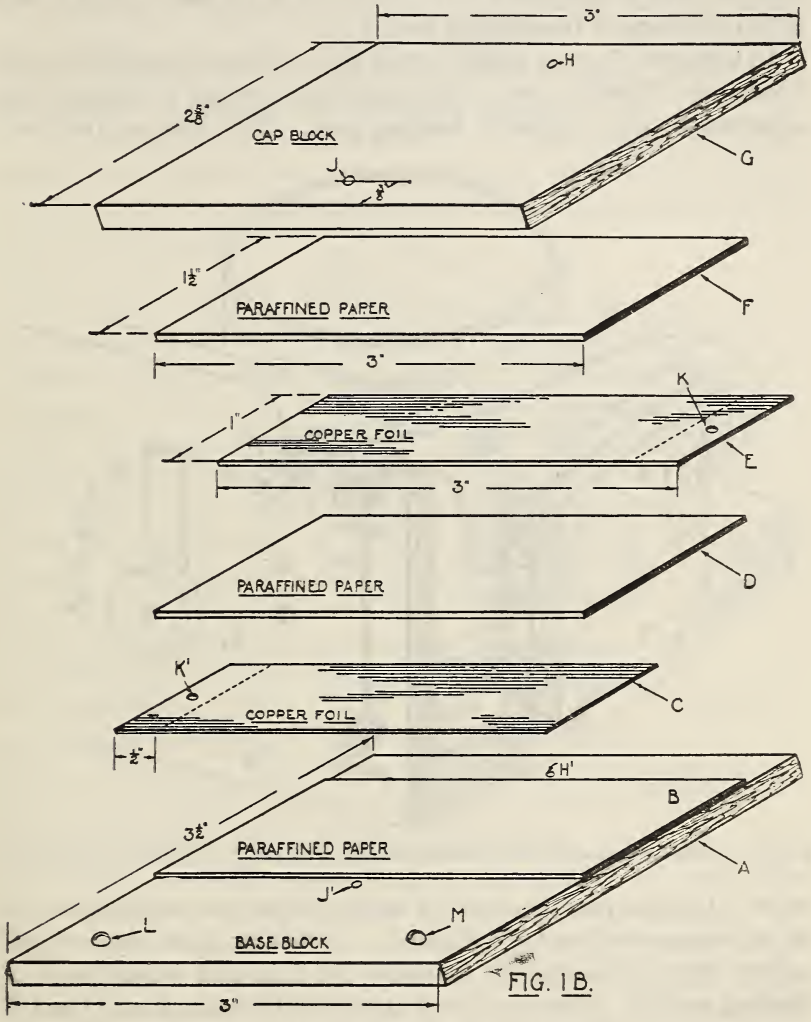

FIG. 1B.—*Assembly of series-antenna condenser.*

single-circuit receiving set. The condenser is fastened to the end of the baseboard by means of the screws *L* and *M*. A binding post *P* is added to the panel of the receiving set about 1 inch from the binding post marked "antenna," as shown in Figure 2. A wire is clamped under the condenser screw *N*, which passes

through the metal strip *E*, forming one terminal of the condenser. This wire is led to and connected to the back of the binding post marked "antenna" without disturbing any of the other wires which are already connected to this binding post. Another wire is connected to the terminal of the metal sheet *C* and led to the back of the binding post *P*.

In Circular No. 120 a short, stiff wire is shown attached to the "antenna" binding post and extending toward a similar wire attached to the "ground" binding post. The wire on the "antenna" binding post is removed and a longer one substituted, so as to form parts *Q* and *S'*, Figure 2. A similar short piece of stiff copper wire *T* is attached between the first and second nuts of binding post *P*. There is a very short gap between wires *Q* and *T* and between *S'* and *S*. These gaps are for protective purposes when one forgets to throw the lightning switch to the grounded side. Another method of protection would be to install a lightning arrester in the antenna system. The arrester may be installed just outside or just inside of the building, preferably the former. This serves as an extra precaution when one forgets to throw the

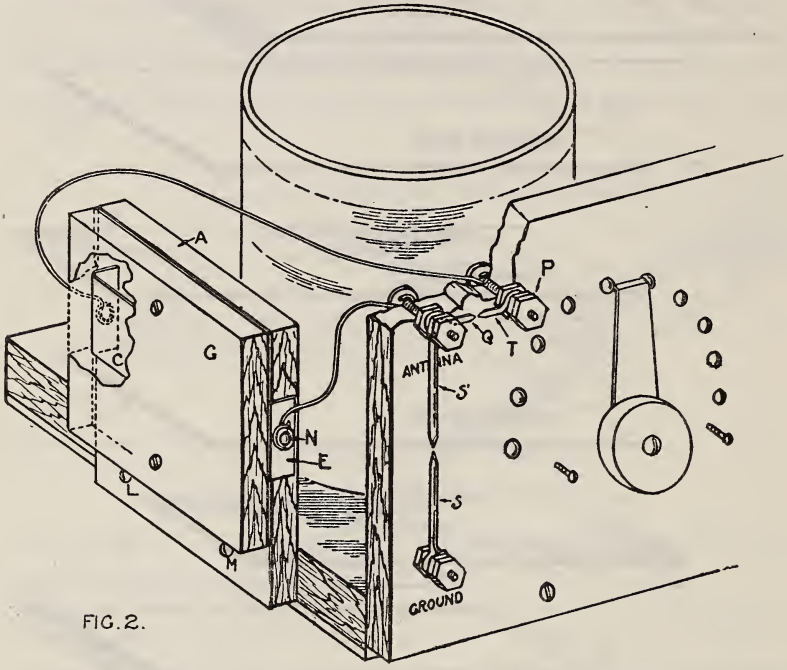

FIG. 2.—*Method of mounting series-antenna condenser on single-circuit radio receiving set.*

lightning switch to the ground terminal when the receiving set is not being used.

If the condenser is mounted on the receiving set described in Circular No. 121, it may be placed as shown in Figure 3. In other words, it is mounted upon the vertical board which supports the primary coil tube previously described. The connections from the condenser to the binding post on the front panel of the two-circuit set are made as described above.

If the connections to the receiving set have been made as described in Circulars Nos. 120 or 121, the antenna lead-in wire is removed from the binding post marked "antenna" and connected to the new binding post which has been added to the front panel of the receiving set. (See *P*, Figs. 2 and 3.) The condenser is now included in the electrical circuit, together with the tuning coil, between the antenna and ground. This connection to the binding post *P* is used when it is desired to receive wave frequencies of approximately 1,000 kilocycles per second or above (wave lengths of 300 m or below). To receive wave frequencies of 1,000 kilocycles per second or below (wave lengths of 300 m or more) the antenna lead in is connected to the binding post marked "antenna" and the operation of the receiving set is then as described in Circulars Nos. 120 or 121. In either case the set is tuned to the desired wave frequency in the same manner as described in Circulars Nos. 120 and 121. The switches are set so as to include more turns of wire on the tuning coil (or the primary coil of the two-circuit receiving set) with the antenna lead in connected to *P* than when it is connected to the binding post marked "antenna" when tuning to a given wave frequency.

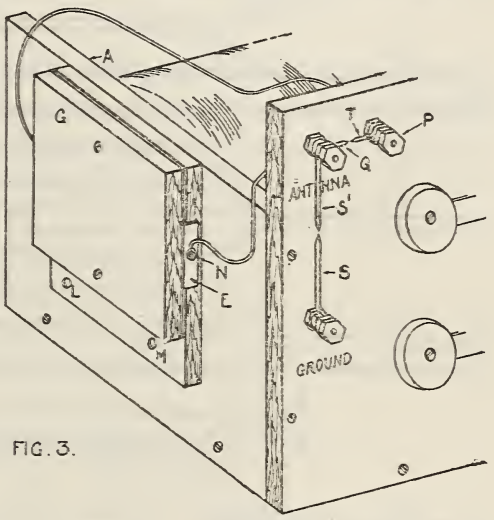

FIG. 3.

FIG. 3.—*Method of mounting series-antenna condenser on two-circuit radio receiving set.*

III. DESCRIPTION OF TELEPHONE-SHUNT CONDENSER.

The parts used in the construction of the telephone-shunt condenser are (Fig. 4): A cap piece of heavy pasteboard or wood *A* about 1⅜ by 3 by ⅛ inches, a similar base of pasteboard or wood *B* 1⅜ by 3⅞ by ⅛ inches, 6 pieces of tin foil *C*, *D*, *E*, *F*, *G*, *H*, ⅞ by 7 inches, 7 pieces paraffined paper or mica *J*, *K*, *L*, *M*, *N*, *O*, *P*, each 1⅛ by 3 inches, 1 stiff paper clip or its equivalent (for temporary use), about 10 feet of No. 24 bare copper wire, and 2 round-

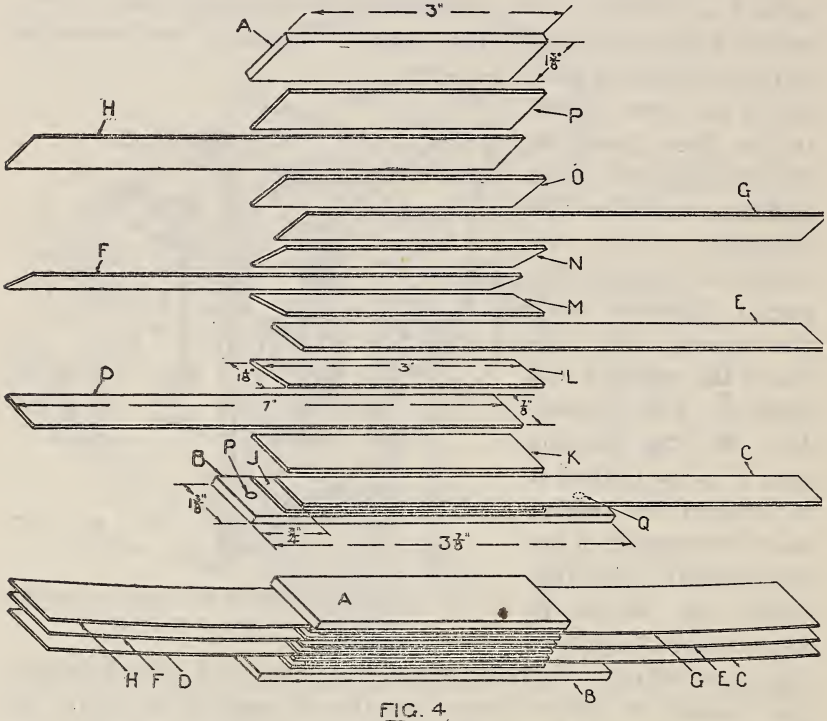

FIG. 4

FIG. 4.—*Assembly of telephone-shunt condenser.*

head wood screws about ½ inch long. The several steps in the arrangement of these parts are shown in Figures 4, 5, and 6. The layers of paraffined paper and tin foil are alternated as shown, starting with a sheet of paraffined paper on the base *B*. The paper *J* is placed in the center of *B*, so that there will be a ⅛-inch margin at the sides and $\frac{7}{16}$-inch margin at the ends of *B*. A sheet of tin foil *C* is then placed on the paper *J*, so that there will be a ⅛-inch margin of paper uncovered on three sides. The tin foil *C* will then extend 4⅛ inches over the right-hand edge of the paper

J, or $3\frac{3}{16}$ inches over the right-hand edge of the base B. The paraffined paper K is placed on C, directly above J. The tin foil D is placed on K. The overhanging end of D extends to the left

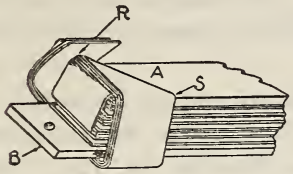

FIG. 5

FIG. 5.—*Method of forming terminals of telephone-shunt condenser.*

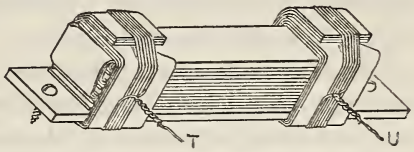

FIG. 6

FIG. 6.—*Completed telephone-shunt condenser.*

instead of the right, as did C. The other three sides of D are $\frac{1}{8}$ inch in from the three edges of K. This arrangement of alternate layers is followed until the seven paraffined papers and the six sheets of tin foil are placed in position. The cap piece A is then placed as shown in Figure 4.

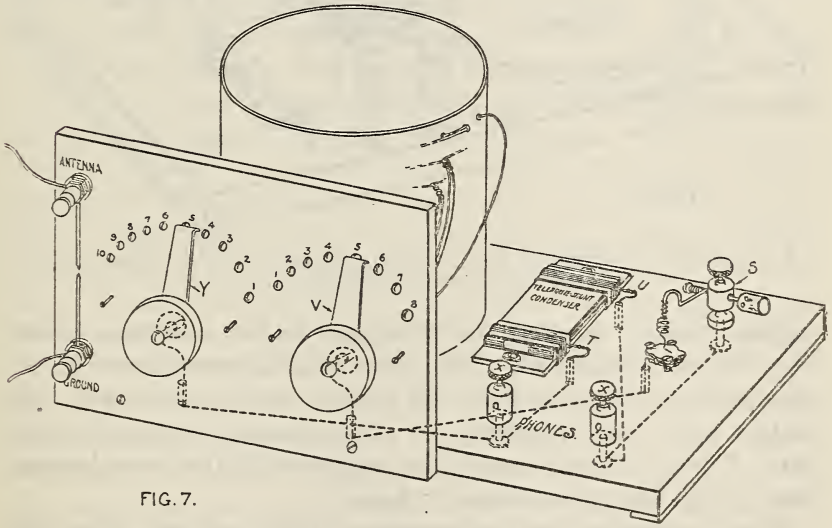

FIG. 7.

FIG. 7.—*Method of mounting telephone-shunt condenser on single-circuit radio receiving set.*

The condenser now appears as shown in Figure 4, except that the thickness of the condenser is much exaggerated here in order to better show the parts. A paper clip or other form of temporary clamp may be used to hold the parts firmly together. The tin-foil strips D, F, and H are now bent back over the end of the cap piece

A and folded over at an angle of 45° (see line *R S*, Fig. 5), so that the tin foil may be wrapped evenly around the pieces *A* and *B* and secured by several turns of No. 24 bare copper wire (see Fig. 6). The tin-foil strips *C*, *E*, and *G*, Figure 4, are wrapped in the same manner. The completed condenser appears about as shown in Figure 6, except much thinner.

This telephone-shunt condenser just described may be added to the single-circuit receiving set described in Circular No. 120 or to the two-circuit receiving set described in Circular No. 121. The condenser is placed as shown in either Figures 7 or 8. A somewhat

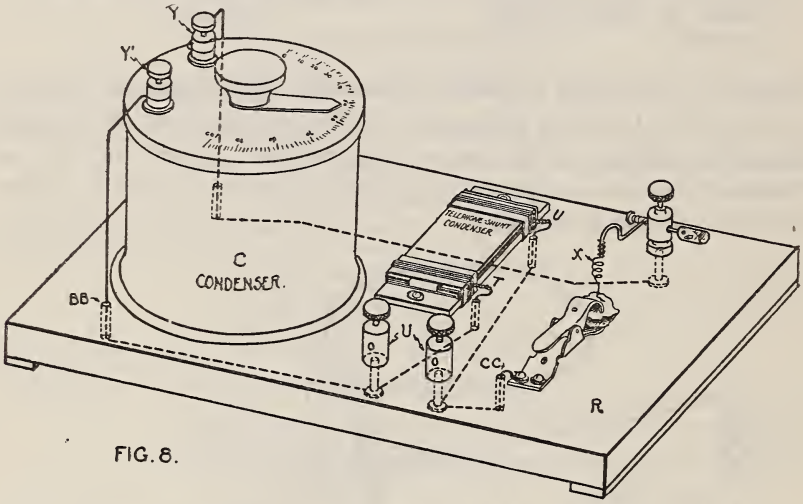

FIG. 8.—*Method of mounting telephone-shunt condenser on variable-condenser-and-detector unit of two-circuit radio receiving set.*

simpler plan is to screw the condenser to the underside of the receiving set baseboard. This saves drilling more holes in the baseboard in order to keep the wiring on the underside. No matter with which receiving set this condenser is used the two wires *T* and *U* (Figs. 7 and 8) are connected to the two telephone receiver binding posts marked "phones."

Fixed condensers may be purchased which will give about the same results as those described in this circular. The series-antenna condenser has a rated capacity of about 0.0003 microfarad (300 micromicrofarads). The telephone-shunt condenser has a capacity of approximately 0.0015 microfarad (1,500 micromicrofarads).

IV. DESCRIPTION OF LOADING COIL.

A loading coil is simply a coil of wire connected to the rest of the receiving equipment in such a manner that a variable number of its turns are included in the circuit between the antenna and the ground connection. When longer wave lengths (lower wave frequencies) are received, more turns are used on the coil.

The loading coil is shown at *A* in Figure 9A, and consists of 300 turns (about 5 ounces) of No. 28 double cotton-covered copper wire wound on a round cardboard box 5⅜ inches in diameter by about 8 inches long. An oatmeal box is used for the cardboard tube, with the cardboard cover glued to one end. Certain of the turns are provided with taps which are connected to switch contacts, so that the number of turns included in the circuit can be varied. One end of the wire is fastened at the closed end of the tube by weaving it through two holes ½ inch apart and ¾ inch from the end. The free end of the wire projects about 10 inches. The wire is wound on the tube in a single layer, so that the turns lie closely and evenly together. When 10 turns have been wound a 10-inch tap is taken off. The method of winding and also one method of taking off the taps has been explained in Circular No. 120. Instead of using the simpler method of taking off taps as described in Circular No. 120, a somewhat more difficult and correspondingly more satisfactory method is used on this loading coil. After the given number of turns of wire have been wound on the tube a hole is punched through the tube just underneath the last turn, and, by using a small blunt tool or stick, a 10-inch loop of wire is pushed through this hole. A second hole is punched through the tube about ½ inch farther along the circumference and the loop pushed through this hole to the outside of the tube again. The loop may or may not be twisted as it emerges from the second hole. (See Fig. 9B.) When 10 more turns have been wound, another tap is taken off in the same manner. The arrangement of these taps is shown in the left half of Figure 9A. It will be noticed that there are 13 taps on the completed coil, counting the two ends of the wire at the start and finish. Each tap is slightly offset from the preceding one, so that the line of completed taps progresses about half way around the coil, as indicated in Figure 9A. After the wire is wound on the cardboard tube or oatmeal box it is placed in a warm oven to drive off the absorbed moisture. After the tube has dried for some time and while still warm, melted paraffin is brushed over the tube, inside and out. The paraffined tube is put

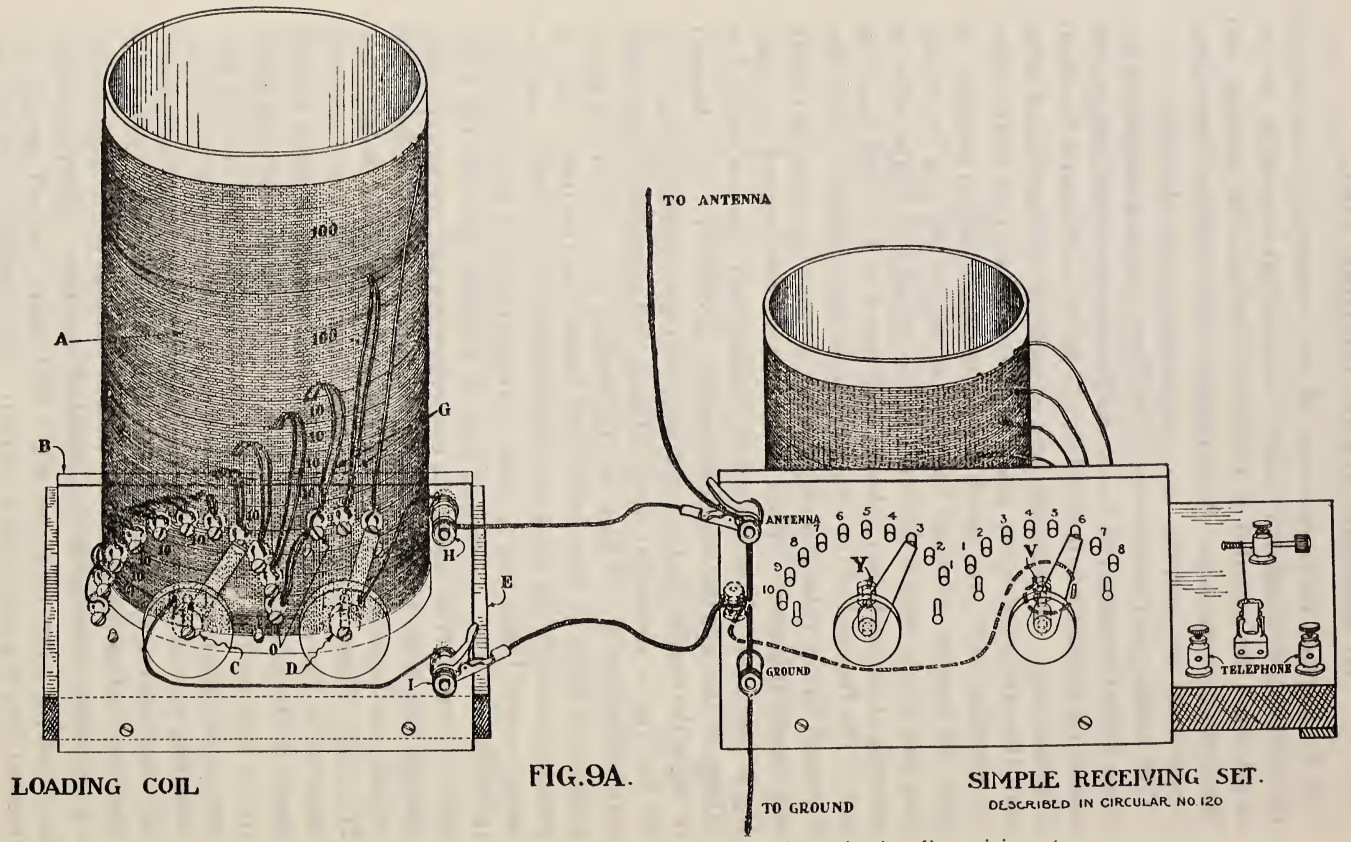

FIG. 9A.

FIG. 9A.—*Completed loading coil and connections to single-circuit radio receiving set.*

back in the oven for a few minutes in order to more thoroughly impregnate the tube.

The switch panel *B* is made from a piece of dry wood about 7 inches long, 4½ inches wide, and ½ inch thick. Its general construction is similar to the switch panels described in Circulars Nos. 120 and 121. The two switch arms *C* and *D* which are used with this panel have also been described in Circular No. 120. Having drilled the holes for the two switch-arm bolts, the switch arms are placed in position and the knobs rotated in such a manner that the ends of the contact arms describe arcs upon which the contact points are to be placed. The holes for the switch contact bolts are then drilled, the spacing between contacts depending upon the width of the end of the switch arms as well as upon the kind of contacts which are used. For the switch arm *C* there are 11 contacts and for the switch arm *D* there are 3 contacts, as shown. The wood base *E* is a block of wood about 7 inches square and ¾ inch thick.

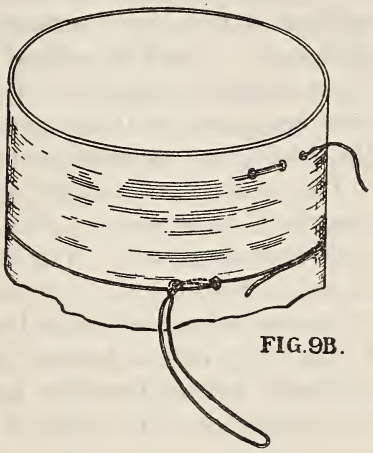

FIG. 9B.—*Method of taking off tape when winding loading coil.*

(*a*) ASSEMBLY AND WIRING.—Before any of the parts are assembled the base and panel are treated with paraffin, as described in Circular No. 120, or they may be thoroughly dried and coated with a good grade of varnish which will not absorb moisture, such as a spar varnish. Shellac is not used. The panel *B* is fastened to the base *E*, and the coil *A* is placed in position so that the row of taps faces the rear of the panel. The coil is fastened in this position by small wood screws passing through the cardboard end, each screw being provided with a washer. The two switch arms with the necessary contact bolts are placed in position on the panel. A wire connection is made between switch arm *D* and binding post *H* and between switch arm *C* and binding post *I*, as explained in Circular No. 120, or a spring washer is

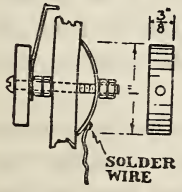

FIG. 9C.—*Detail of switch arm used on loading coil.*

slipped over each switch-arm bolt at the rear of the panel and the wires soldered to these. (See Fig. 9C.) The several taps from the coil are cut off to a length sufficient to reach from the coil to the contacts. The insulation is scraped from the ends of the wires and the ends of the double taps twisted together below the point *G*. (See *G*, Fig. 9A.) The taps are fastened between the nuts and washers of the proper contact bolts as shown in the left half of Figure 9A. It will be noticed that the two contact points marked *O* are connected together. This is done so that when the switch arms are placed on these contacts there will be no turns of wire on the loading coil included in the circuit.

This loading coil is used in connection with the receiving set described in Circular No. 120, except as noted below under "Use with two-circuit set." The method of making the connections is shown in Figure 9A. A 10-inch copper wire with a battery clip at one end is fastened to the binding post *H*, with the clip attached to the receiving set binding post marked "antenna." The wire originally leading from the back of the "antenna" binding post was connected to the back of the switch-arm bolt *V*. This wire is removed from the back of the "antenna" binding post and attached to a new bolt or binding post fastened to the baseboard of the simple receiving set. This bolt or binding post is located just at the rear of the receiving set binding post marked "ground." A 10-inch piece of copper wire is attached to this new bolt or binding post, with a battery clip attached at the end toward the loading coil binding post *I*. The wire leading from the crystal to the rear of the "antenna" binding post, as described in Circular No. 120, remains as it was. If one end of this wire was originally connected to the wire leading to the switch-arm bolt *V*, or directly to *V*, this end is removed and connected to the rear of the "antenna" binding post. All other wiring is the same as described in Circular No. 120.

(*b*) Method of Operating.—The wire leading to the antenna is connected to the binding post marked "antenna," and the wire leading to the ground is connected to the binding post marked "ground," as before. In order to receive messages transmitted at wave frequencies between 500 and 1,500 kilocycles per second (wave lengths between 600 and 200 m), the switch arms *C* and *D* on the loading-coil panel are both set on the contacts marked *O*. When receiving at the shorter waves (200 to 600 m), it is better to remove the battery clip from the "antenna" binding post and

put the clip previously attached to *I* in its place; that is, attach the wire from the new binding post to the "antenna" binding post. The loading coil is thus entirely disconnected from the receiving set and should be removed some distance from it. The operation of the receiving set is then exactly the same as described in Circular No. 120. In order to receive messages transmitted at wave frequencies less than 500 kilocycles per second (wave lengths over 600 m), the loading coil is again connected as shown in Figure 1A and the switches on the loading-coil panel are adjusted so that the proper number of turns is included in the circuit. The switches on the panel of the original receiving set are set so that they include all of the wire on the coil; that is, set switch arm *Y* on contact point *10* and switch arm *V* on contact point *8*, Figure 1A. (See also Fig. 3, p. 10, Circular No. 120.) The switch *D* on the loading-coil panel is set to the extreme left on contact *O*, and the switch arm *C* is rotated slowly over its entire range. If signals are not heard, the switch arm *D* is set on the next contact to the right and the switch arm *C* is again rotated over all of its contacts. If the signals are still not heard, the switch arm *D* is placed on the contact to the extreme right and the switch *C* again rotated over its contacts. When the transmitting station is heard, the signals may be improved by adjusting the right-hand switch arm *V* of the original receiving set, at the same time changing slightly the setting of the switch arm *C*.

(*c*) Use with Two-Circuit Set.—The loading coil as described herein has been found quite satisfactory in extending the wave length range of the single-circuit receiving set described in Bureau of Standards Circulars No. 120. The experimenter may be interested in trying various ways in which to extend the wave length range of the two-circuit set as is described in Bureau of Standards Circular No. 121. For the general guidance of the experimenter the following methods will give results with varying degrees of satisfaction: Use of the loading coil in one of the two circuits and no loading in the other (this means that one of the circuits will not be tuned to the wave, and hence the results will be relatively poor); use of loading coil in the primary, together with a fixed condenser (like those described earlier in this circular) in parallel with the variable condenser; use of loading coil in one of the two circuits and winding more wire on the coil in the other circuit.

The suggestions given above assist the experimenter in obtaining a better idea of the tuning of a two-circuit receiving set. For satisfactory results, however, the connections are made so

that the secondary circuit is not used for receiving wave frequencies below the range of the two-circuit set. This is accomplished by connecting a double-pole, double-throw switch to the rest of the apparatus in such a manner that when the switch is thrown in one position the connections are the same as a single-circuit receiving set. Throwing the switch in the other position then connects the apparatus for use as a two-circuit receiving set. The method of connecting this switch is as follows: The switch is first located in a convenient position near the two-circuit tuner. The wires connecting the secondary terminals of the tuner to the terminals of the variable condenser are next removed. The pivot terminals of the switch are now connected to the two terminals of the variable condenser, the switch is thrown so that it makes contact with one pair of terminals, and these two terminals are then connected to the terminals of the secondary coil. The other two terminals of the switch are connected to the "antenna" and "ground" binding posts of the receiving set, respectively.

Throwing the switch to one side disconnects the secondary coil from the circuit. The secondary coil is then moved about a foot from the primary coil, the variable condenser set at zero, and the loading coil then tuned as previously described. When the switch is thrown to the other position, the two-circuit set is operative.

V. APPROXIMATE COST OF PARTS.

The parts listed below are only those used in the condensers and loading coil. The receiving-set parts are listed in Circulars Nos. 120 and 121. All of these parts together constitute a complete receiving outfit which has a rather wide range of wave frequencies, as explained in the first part of this circular. The approximate cost of the complete equipment is therefore the sum of the amounts given below and the amount given in Circular No. 120 or that in Circular No. 121.

Series-antenna condenser:

2 metal strips (copper, brass, or aluminum)	$0.10
3 sheets of mica (if used)	.20
1 binding post (any type)	.10
6 wood screws	.10
2 small wooden blocks	
Paraffin	
Paper	
Total	.50

Telephone-shunt condenser:	
About 40 square inches of heavy tin foil	$0.25
2 screws for mounting condenser	.05
2 small pieces of heavy cardboard or thin wood	
Paraffin	
Paper	
Total	.30
Loading coil:	
5 ounces No. 28 copper wire, double cotton covered	.80
2 battery clips	.20
2 switch knobs and blades, complete	1.00
14 switch contacts, nuts, and washers	.60
1 cardboard box (5⅜ inches diameter by 8 inches long)	
3 binding posts	.45
Wood for panel and base	
Paraffin	
Total	3.05

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