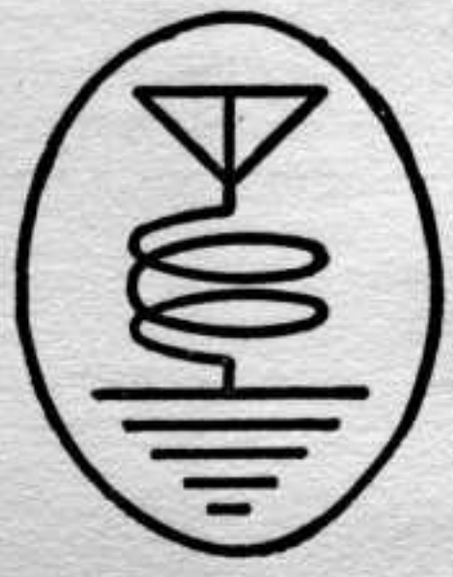
HOW TO BUILD YOUR RADIO RECEIVER

Edited by KENDALL BANNING *and* L. M. COCKADAY

Popular Radio Handbook—No.1



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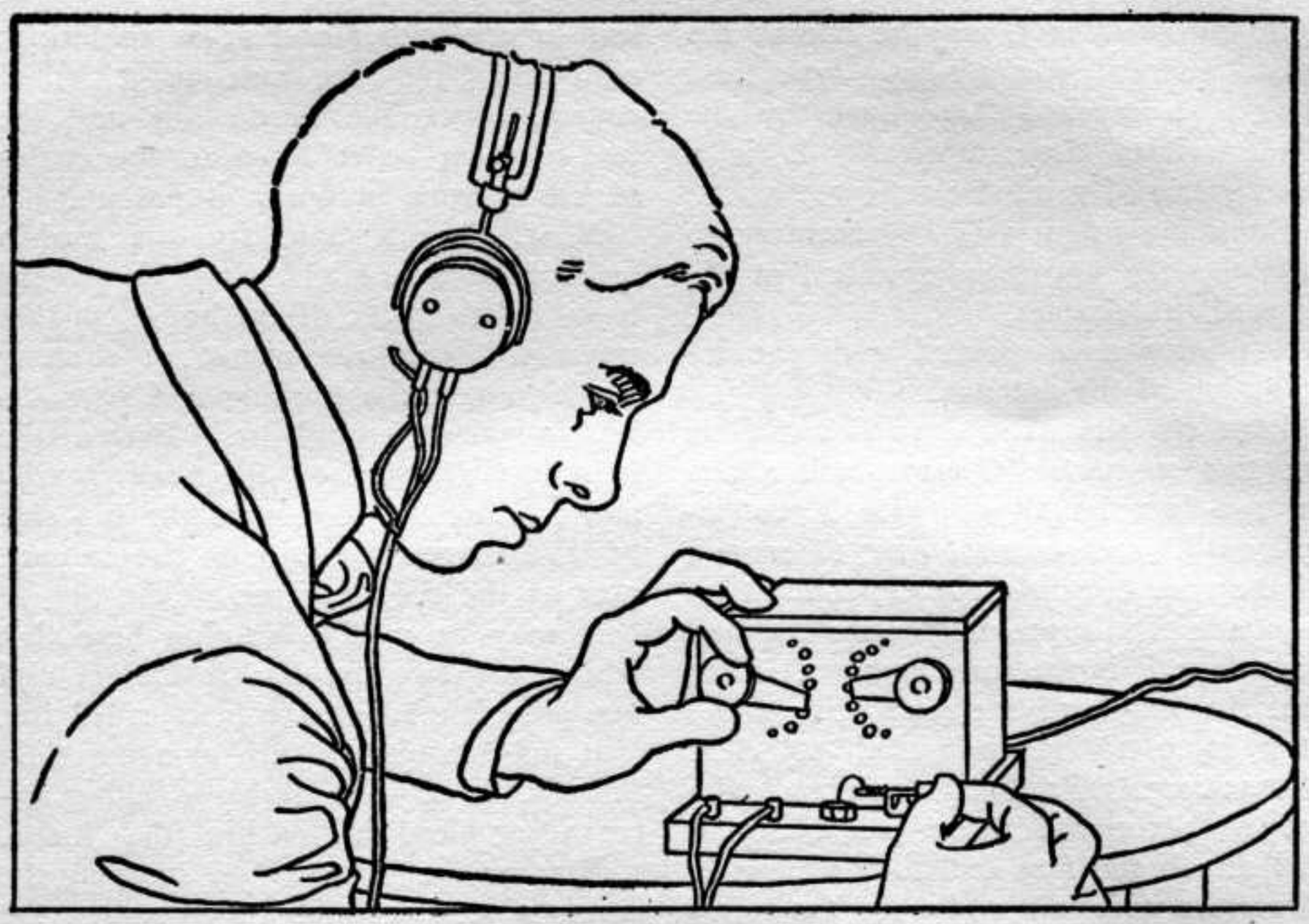

THE COMPLETED SET

FIGURE 1: *How to adjust the crystal detector while rotating the switch that controls the tuning.*

HOW TO BUILD
AN EFFICIENT CRYSTAL RECEIVER

For local reception, the crystal set is still the simplest that will produce satisfactory results. Here is a re-creation of the famous Bureau of Standards receiver,* brought up to date with a suitable wavelength range.

COST OF PARTS: *About $5.00*

RECEIVING RANGE: *About 15 miles*

HERE ARE THE ITEMS YOU WILL NEED—

A. BASE.
Required:
One piece of seasoned wood, 8 by 5½ by ¾ inches;
four rubber-headed tacks.

B. SWITCH PANEL.
Required:
One piece of seasoned wood, 5¼ by 3½ by ½ inches; three No. 8 wood screws, 1½ inches long.

C. COVER (top removed).
Required:
Four pieces of seasoned wood, ¼-inch thick;
one piece, 5½ by 5⅛ inches;
two pieces, 4⅝ by 3½ inches;
one piece, 4¾ by 3½ inches;
brads or small screws.

D. TUNING INDUCTANCE.
Required:
One one-pint carboard carton;
two ounces No. 24 dcc copper wire.

E. TAP SWITCHES.
Required:
No. 24 (B. and S.) gauge spring brass sheet, 1 by 2 inches;
two knobs cut from one-inch fiber rod;
18 inches No. 20 (B. and S.) gauge piano wire.

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two 8-32 brass machine screws 2 inches long;
eight 8-32 brass washers;
four 8-32 square brass nuts;
four 8-32 brass hexagon nuts.

F. Switch Points and Stops.
Required:
12 brass pins ⅛ to 3/32 of an inch in diameter and ¾-inch long;
four small brass pins, ½-inch long.

G. Crystal Detector.
Required:
One galena crystal mounted in a block of Wood's metal ½-inch in diameter and ¼-inch thick;
No. 24 (B. and S.) gauge spring brass sheet 2 by 2¼ inches;
eight inches of fine springy wire;
one 3/32-inch brass rod two inches long;
one ⅜-inch fiber rod ⅝-inch long;
two 8-32 brass machine screws one-inch long;
four 8-32 brass washers;
two 8-32 square brass nuts.

H. Binding Posts.
Required:
Four 8-32 brass machine screws, 1¼ inches long;
four 8-32 square brass nuts;
four 8-32 thumb nuts from dry cells;
eight 8-32 brass washers.

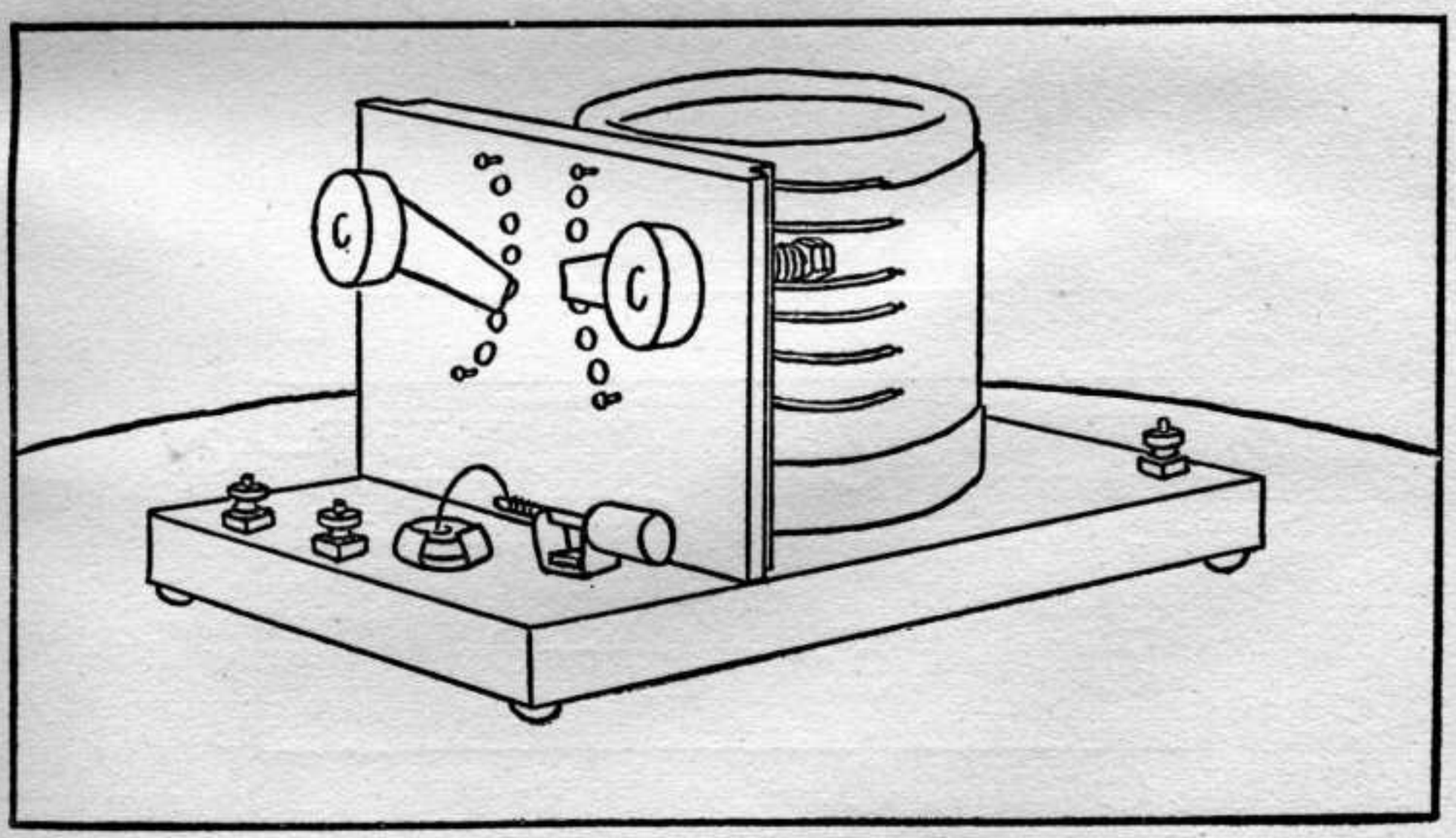
I. Connecting Wire.
Required:
Six feet No. 20 bare copper wire.

J. Miscellaneous:
Solder, *non-corrosive* soldering flux, stain and varnish (free from carbon pigment).

IN recent months the radio broadcasting services have been greatly improved. This development has been marked by a reduction of interference through the new assignment of wavelengths, a more uniform distribution of stations transmitting good musical programs (this includes the relaying of programs by wire before broadcasting) and a tendency for mediocre stations to discontinue transmission.

In the large communities there are now many thousands of people within a few miles of the Class B stations; from them comes a demand for simple receiving apparatus that requires a small monetary outlay. For this purpose a crystal set will give practically perfect reception.

A crystal set may be of rather elaborate construction or it may be very simple without reducing its efficiency. Its cost is then much less than a set equipped with a low-voltage tube.



THE COMPLETED SET WITH THE COVER REMOVED

Figure 2: *This shows what a neat-looking job can be made of the set if the experimenter takes the trouble to make every part as specified in this article.*

Other points, often overlooked, are clearness of signal, absence of distortion, and no operating cost. Although the crystal is a relatively insensitive device, there is no justification in statements frequently made in radio articles, which give the impression that there is a definite limit to its receiving range. From a low-power broadcast station the reliable receiving range of a crystal set is, say five miles; in winter the same set may receive high-power stations from a distance of three or four hundred miles.

This chapter describes a crystal set of satisfactory performance. All structural details are given so that one need not be in doubt as to dimensions. Attention is called to the importance of good mechanical design. This requirement includes convenience of adjustment, rigid connections, permanent contacts, light, stable contact of the fine wire on the crystal, elimination of jar-

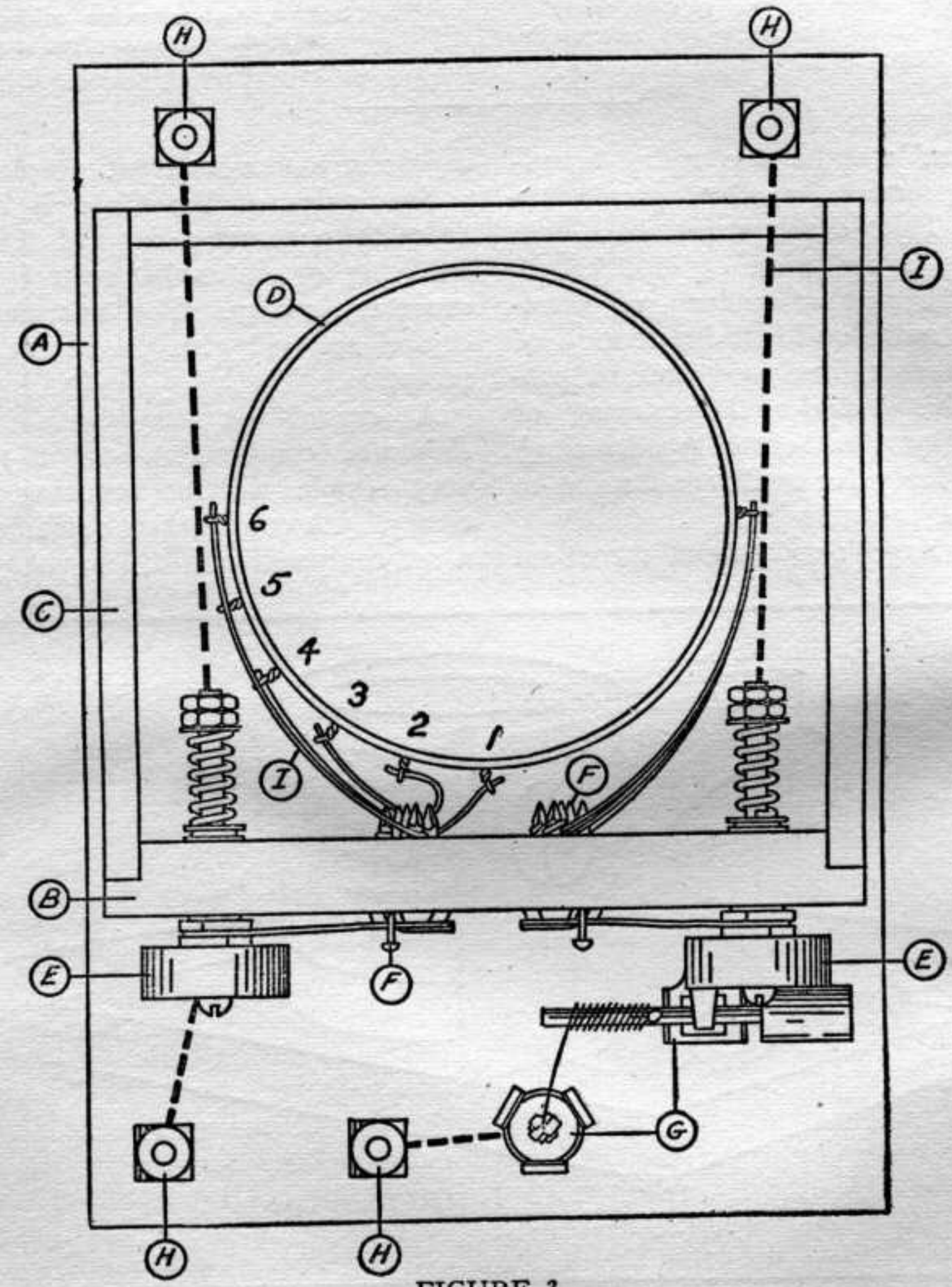


FIGURE 3

The working drawing of the set. This layout diagram shows the relative positions for all the instruments, as seen from above. The parts are designated by letters which reappear in the text and list of parts.

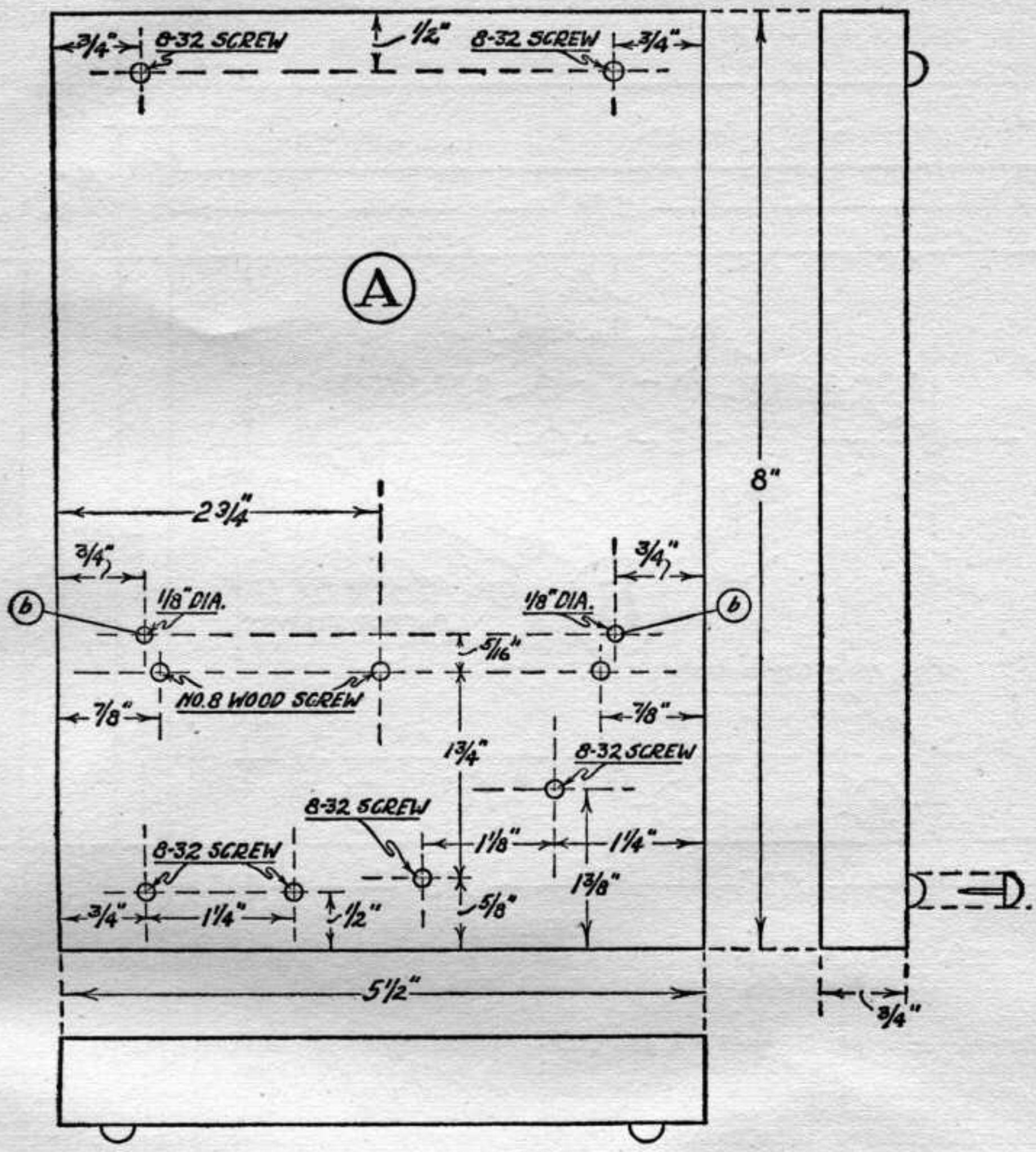


FIGURE 4

The dimensions of the base and the drilling plan. This drawing gives the front, side and top views of the base, together with the drilling data for the holes for the screws that are used to mount the instruments and binding posts.

ring and vibration from the tuning controls, and protection of parts from injury.

The parts of the set are arranged so that the connecting wires will be short and direct, and losses from unused turns on the tuning inductor have been reduced by cutting down the total number of turns. A variable condenser or phone condenser is not used. The former sometimes gives a little better selectivity but at the expense of signal strength; the latter is not necessary for broadcast reception. There is no objection to the use of wood for a switch panel. Tests show that there is less power loss in dry wood at radio frequencies than in the average insulating material used in radio panels.

Parts and Material

The completed set is shown in operation in Figure 1. Figure 2 is a picture of the set

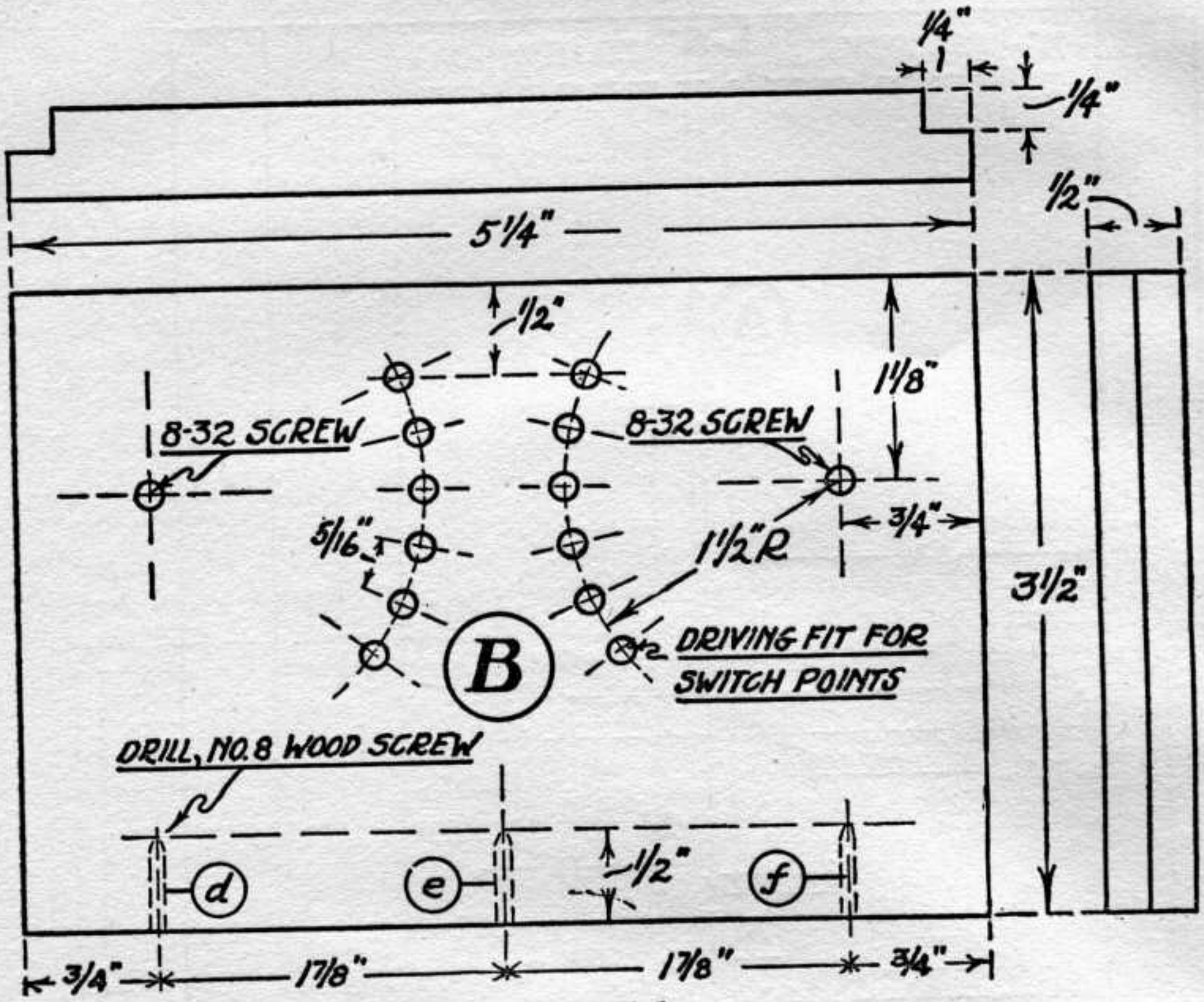


FIGURE 5

The dimensions of the switch panel and the drilling plan. This drawing gives the top, front and side views of the switch panel, together with the drilling data.

with cover removed. Figure 3 is a plan drawing and shows the parts and wiring. The list of parts printed at the head of this chapter names the specific items used and gives the material required to make them.

Construction

A. Base (Figure 4). All dimensions are given in the drawing.

B. Switch Panel (Figure 5). The spacing of the holes on the arcs is important to insure smooth operation of switches when switch points and switch blades are made as specified. Before the holes are drilled in the base and switch panel, these parts and the cover should be given a suitable finish. A dark finish will harmonize well with the exposed metal parts.

C. Cover (Figure 6). All dimensions are given in the drawing.

D. Tuning Inductance (Figure 7). This is made by winding wire on a one-pint cardboard carton, which as purchased, will be too long for the space requirements of the set. It is shortened to the dimensions shown in Figure 7a by cutting off a ring from the open end and also from the cover, and is here shown bottom side up with cover in place. The carton is wound with 76 turns of No. 24 dcc wire, starting with two small holes, b and e, and winding in the direction shown by the arrow. The wire fills the space between b, and the edge of the cover. In Figure 7 is shown the completed tuning inductance which has two terminals and ten intermediate taps. The terminals are made by forming the bare end of the wire into a small eye as shown. The intermediate taps are formed, while winding, by baring a ½-inch length of wire and twisting this into a small loop. The inductance may be dried in a warm oven.

E. Tap Switches (Figure 8). A completed tap switch is shown in Figure 8. Two switch blades are cut from No. 24 spring brass sheet, as shown in Figure 8a, with the grain of the metal running the long way. The end widths of switch blades are important and the edges of the blades must be bent up as shown, for smooth operation. Two knobs are cut from a fiber rod as shown at e, Figure 8. Two springs, as shown at b, Figure 8, are formed by wrapping 10 turns of No. 20 piano wire around a 3/16-inch rod clamped in a vise. The switch

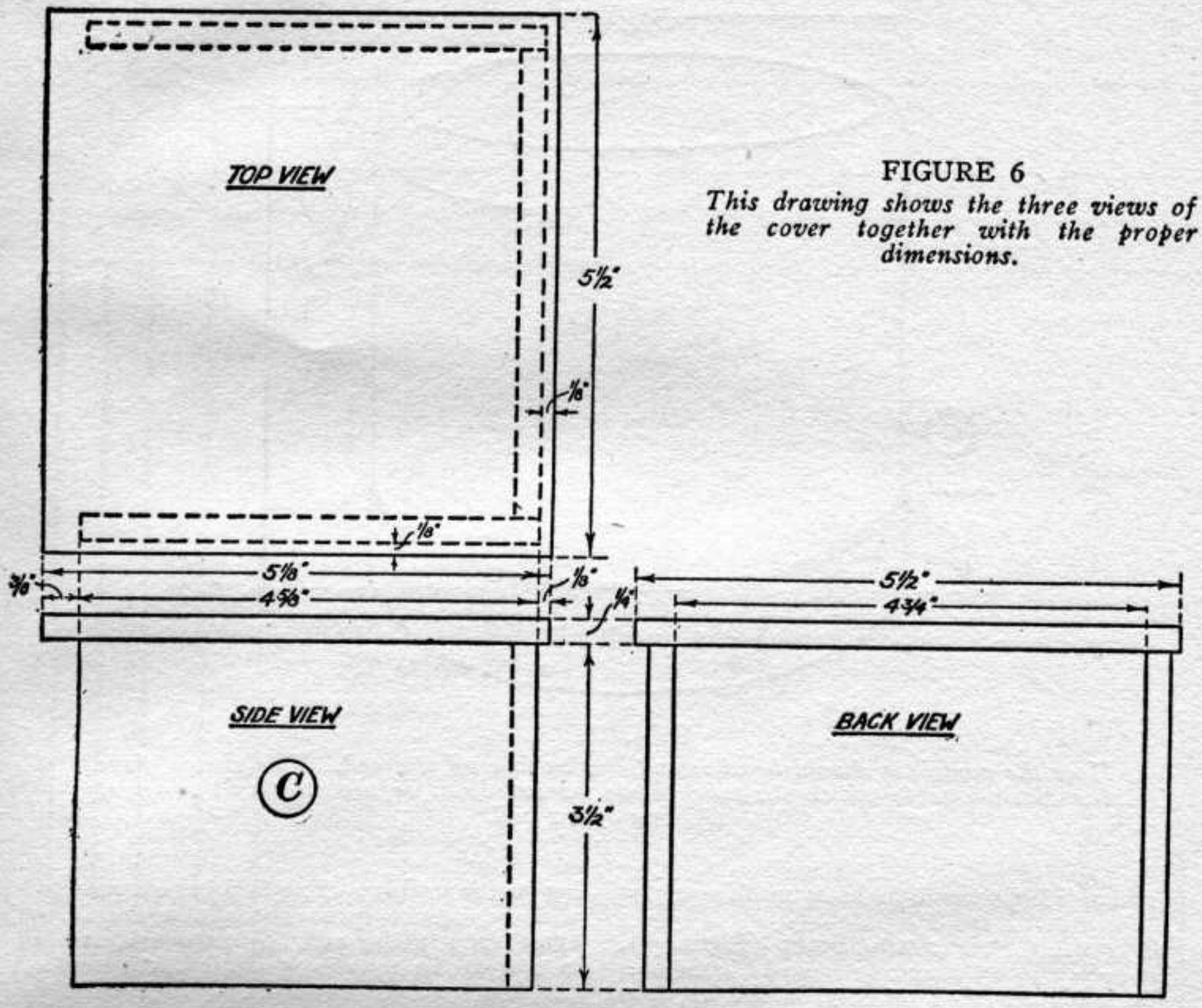


FIGURE 6

This drawing shows the three views of the cover together with the proper dimensions.

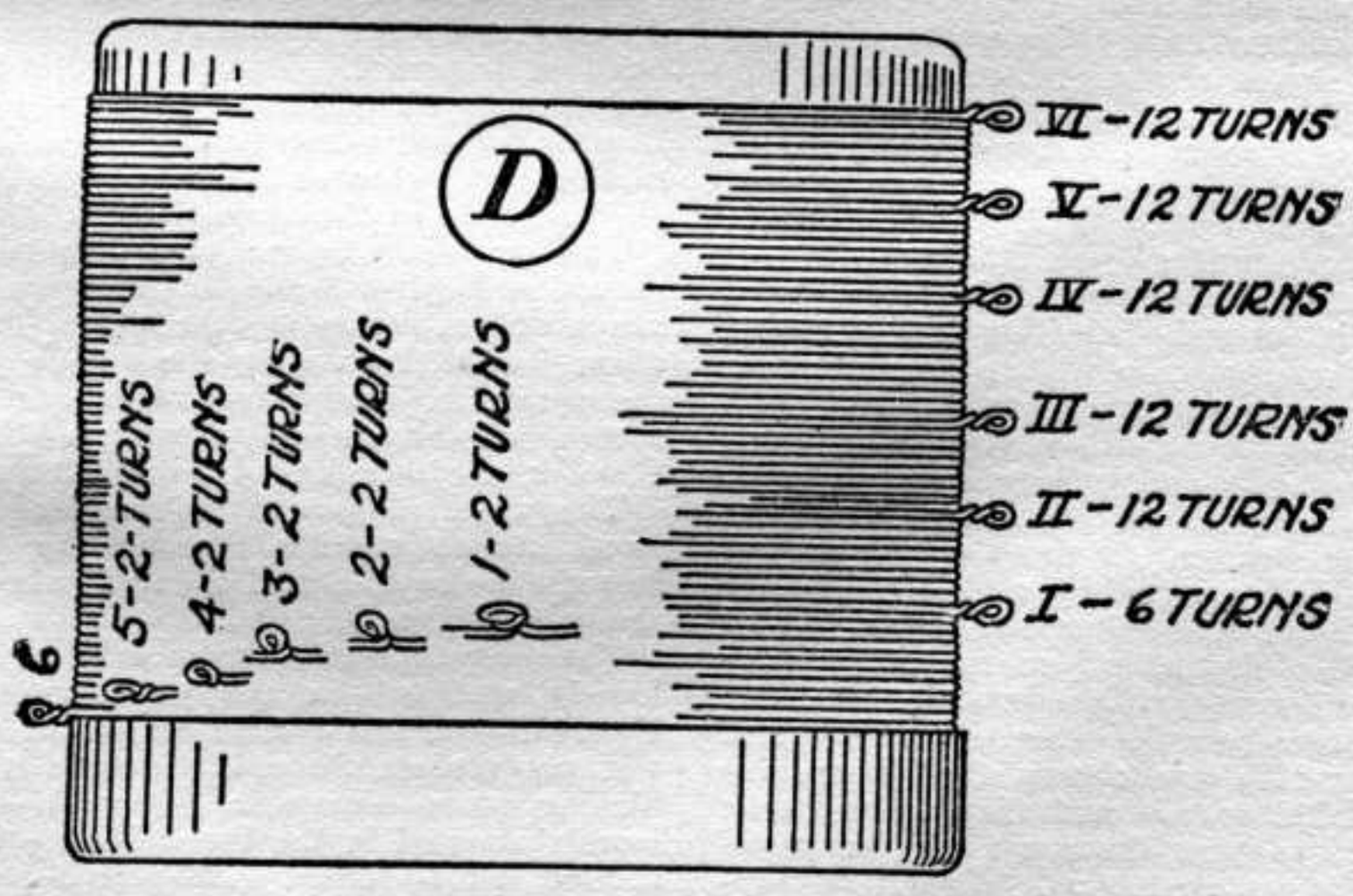


FIGURE 7

The completed inductance coil made on a pint-size container. This drawing shows the correct way to make the taps with the spacing between the taps indicated.

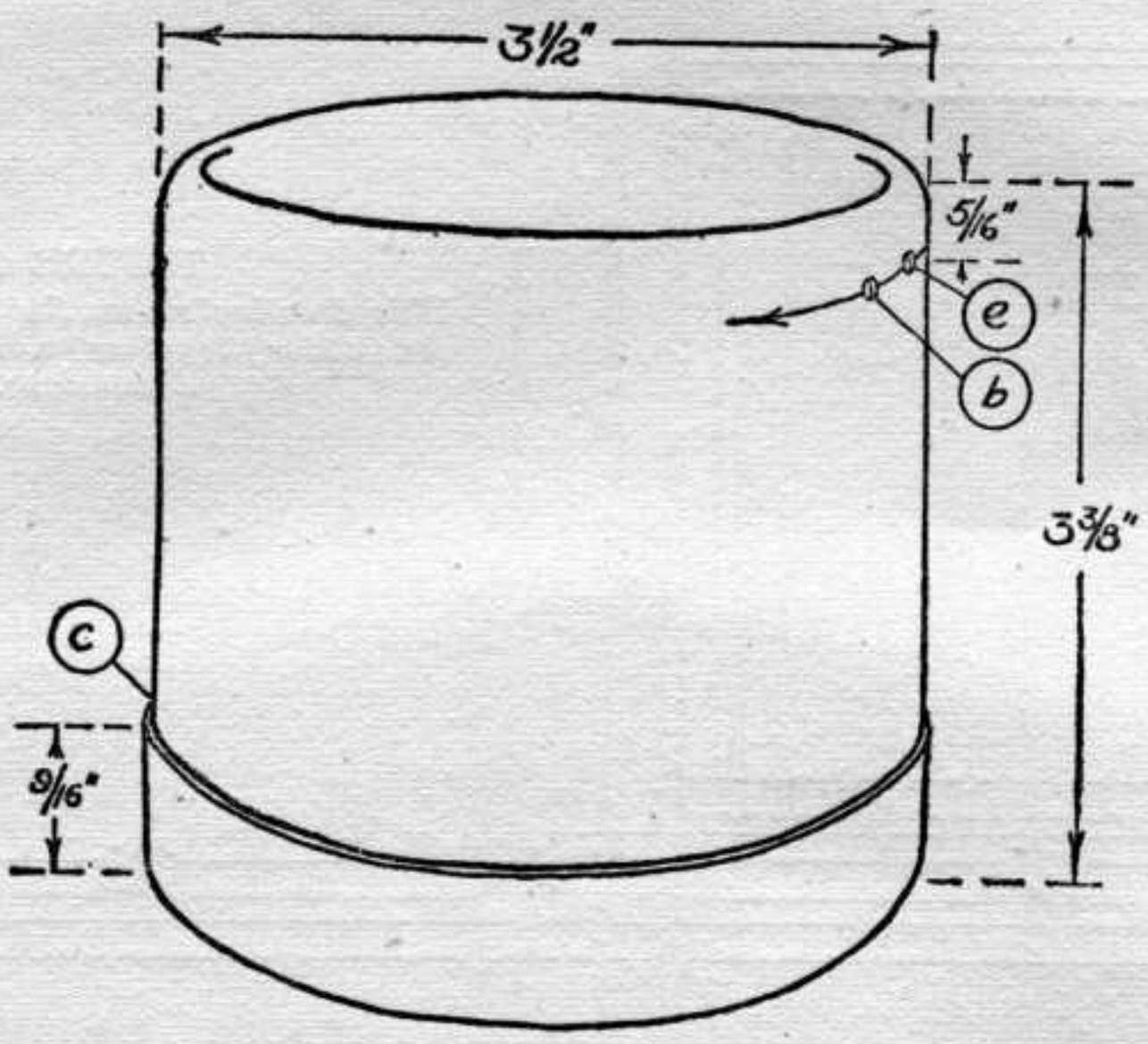


FIGURE 7A

How the container should be shortened by cutting off the end. This sketch gives the dimensions to which the tube should be cut down before starting the actual winding of the coil.

is assembled upon an 8-32 brass machine screw c, shown in Figure 8.

F. Switch Points and Stops (Figure 9). The switch points are made from 12 brass pins with heads surfaced off with a file or in a lathe. This work requires accuracy to insure smooth operation of switch blades. The switch stops are made from four small brass pins.

G. Crystal Detector (Figure 10). In Figure 10 are shown the assembled parts of the detector. These are: a clip b, holding a mounted crystal c; an 8-32 screw d, and nut e; a fine wire (catwhisker) f, wrapped around a rod g, and secured by a drop of solder h; a knob i; a rod-holder j; an 8-32 screw k, and a nut m.

The clip is cut and filed from No. 24 spring brass sheet as shown in Figure 10a, and bent into the shape shown in Figure 10. All brass sheet must be bent with caution, the bends being made slowly and kept well rounded.

The catwhisker is an 8-inch length of fine springy wire wrapped 20 times evenly around the rod g, and secured by a drop of solder h, so positioned that when the rod is placed in the holder the lateral movement will be equal to the diameter of the crystal. The fiber knob i, is forced on the other end of the rod.

In Figure 10b are shown the dimensions of the rod holder, cut and filed from spring brass sheet, so that the grain of the metal runs with the narrow tongue. When bent carefully into shape it appears as shown at j, Figure 10.

H. Binding Posts (Figure 11). Each binding post is made up of an 8-32 brass screw, two washers, square brass nut and a thumb nut taken from a dry cell. A groove b, is filed in two of the nuts to facilitate connections of telephone-receiver terminals.

How to Assemble the Set

Four rubber-headed tacks are driven into the corners of the bottom of the base as indicated in Figure 4. The panel (Figure 5) is laid face up on two supporting strips and the 12 switch points are forced into the holes, caution being observed to have the surfaces of all the points in the same plane.

The tap switches are placed in position as shown in Figures 3 and 8. The switch blades are bent as shown by the dotted lines, and when forced down upon the switch points by the spring b, final adjustments are made to secure smoothness of operation. The nuts f and k, are then locked.

The panel (Figure 5) is mounted by three wood screws passing through the base and into the holes d, e, and f. It then appears as shown in Figure 3.

The detector parts (shown in Figure 10) are loosely mounted—in the positions shown in Figure 3—the screw d, being cut off so that it will not project through the nuts. The four binding posts—shown in Figure 11—are then loosely inserted in the base (Figure 3). Connecting wires—shown in Figure 3—of No. 20 wire are run from the two rear binding posts up through two holes b (Figure 4) in the base, looped around and forced between the washers

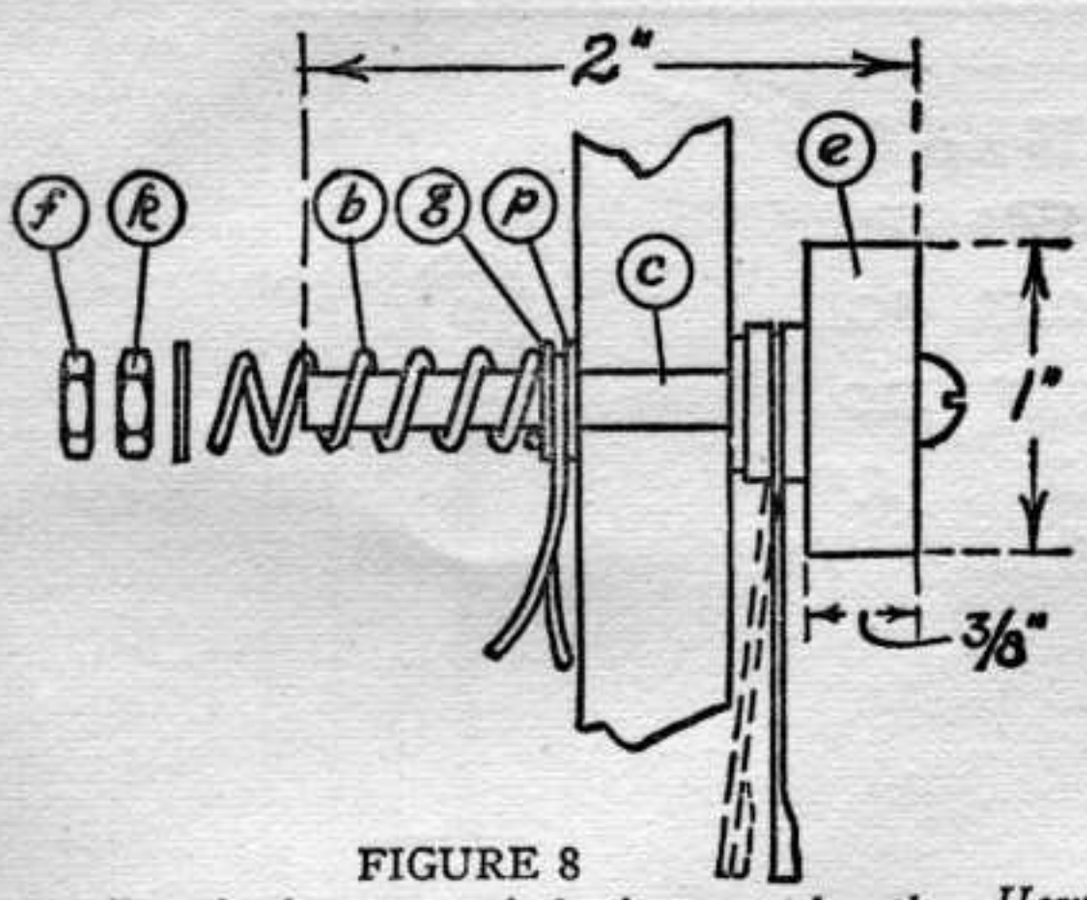


FIGURE 8

Details of the tap switch for wavelength control.

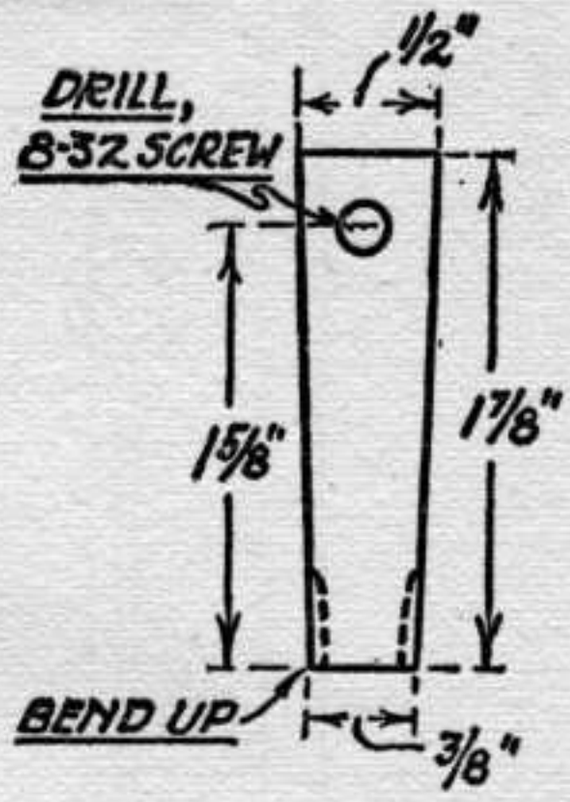


FIGURE 8A

How to cut out, drill and bend the switch blades.

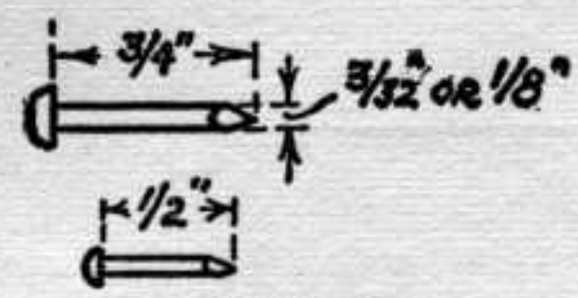


FIGURE 9

The dimensions for the switch points and stops.

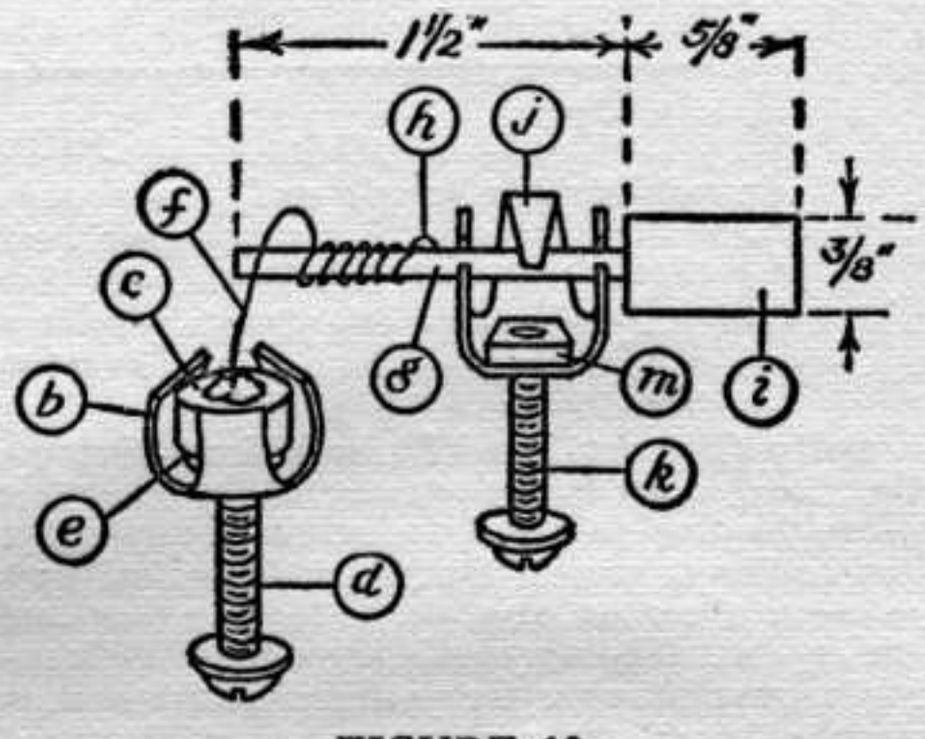


FIGURE 10

The complete detector assembly, showing the general arrangement of all the parts used.

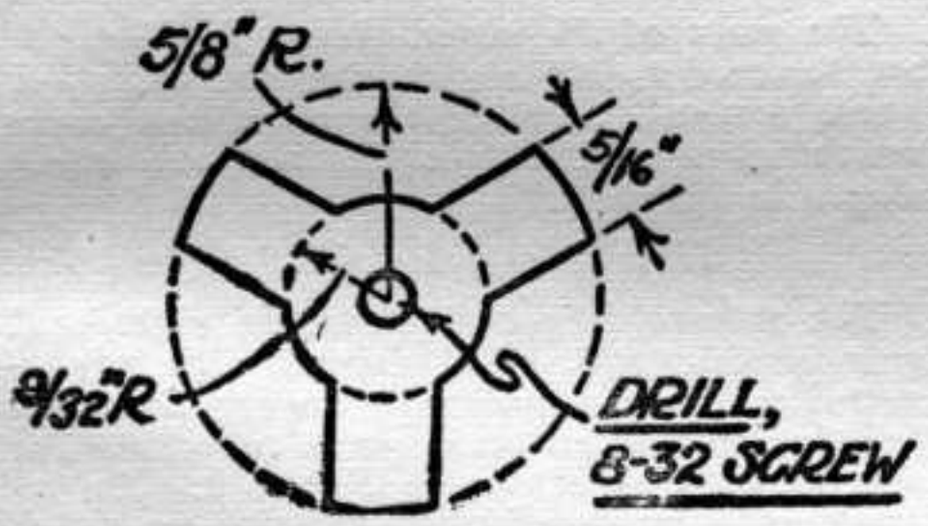


FIGURE 10A

How to drill and bend the clip for holding the crystal.

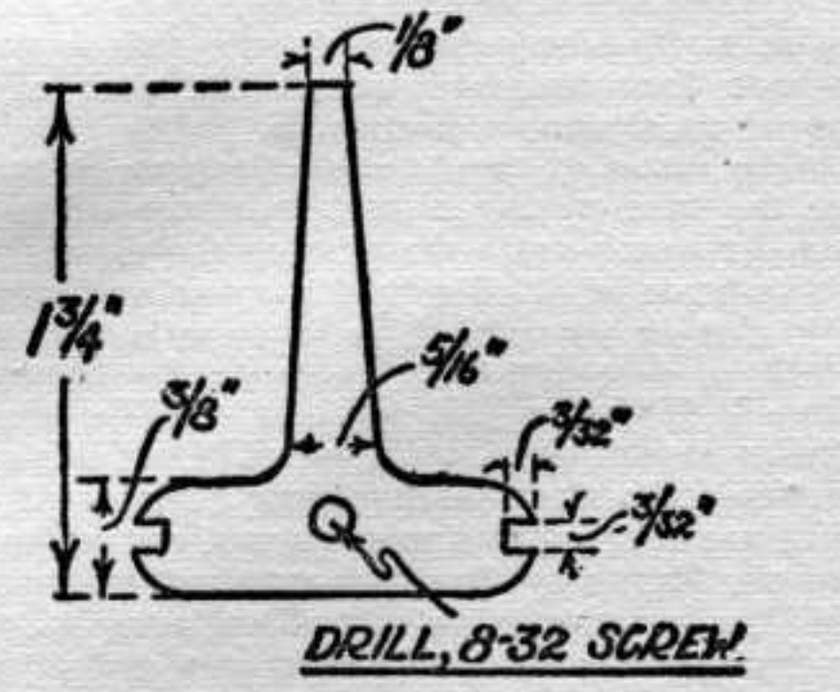


FIGURE 10B

The way to make the rod holder is shown here with the dimensions for drilling and shaping.

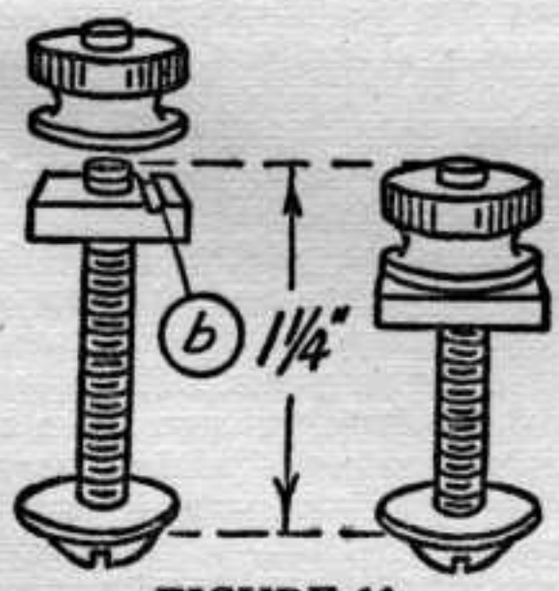


FIGURE 11

Sizes for the binding posts.

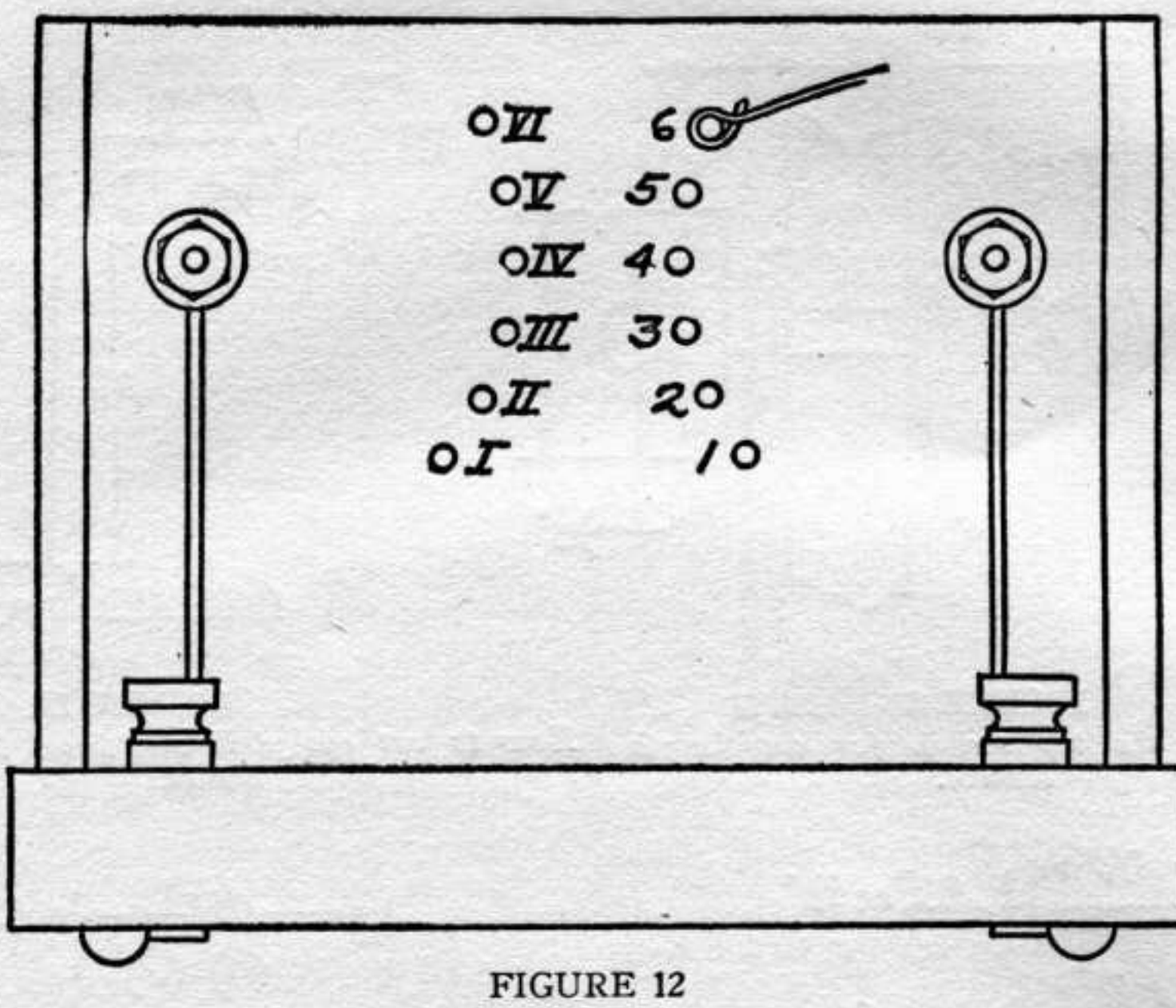


FIGURE 12

Assembling the panels and the switch points and binding posts. This is a view from the rear and shows how the switch points are forced into the holes drilled for them in the upright panel, and how the wire taps are connected one to each switch point. The two switch blades are connected by a wire to the two binding posts on the base.

g and p (Figures 3 and 8) back down through the base and thence connected to the left phone binding post and the screw securing the rod holder in place. One short length of wire connects the remaining phone binding post and the crystal. The wire ends are secured by looping around between the washers on the bottom of the base; the screws are then tightened until the nuts on top of the base become rigid. Before the crystal clip and rod holder are permanently secured in place a burr is formed on the edges which come in contact with the wood by bending down these edges slightly.

Twelve short lengths of No. 20 bare copper wire should be soldered to the switch points where they project through the rear of the panel as shown in Figure 12.

The cover of the tuning inductance is tacked to the base equally distant from the edges and one-half inch from the rear of the panel. The inductance is fitted into the cover and secured by glue or varnish. The location for the taps will be determined by referring to Figure 3. Tap 1 (Figures 3, 7, and 12), will be directly below switch point 1 (Figure 12). The twelve wires from the switch points (Figures 3 and 12) are formed into neat curves, cut off to the proper length so that they may just be inserted in the inductance taps, and soldered in place using a very small soldering iron and a small amount of solder. Switch points in Figure 12 are numbered to correspond to taps in Figure 7. Point 1, being most inaccessible is first soldered to tap 1.

The parts of the cover, shown in Figure 6, are fastened together with glue and brads (or small screws) forming the completed cover which gives the set the finished appearance shown in Figure 1.

How to Operate the Set

The antenna is connected to the right-hand rear binding post. The ground wire is connected to the left-hand rear binding post, thus bringing the phones near ground potential. The antenna wire is shown in Figure 1. An inspection is made of the mounted crystal to see that it is held firmly by the clip; the extreme end of the catwhisker should then be given a sharp diagonal cut with a pair of scissors.

Adjusting the set involves two operations:

(1) Securing a sensitive contact of the catwhisker;

(2) Tuning.

By means of the knob the point of the catwhisker is brought down lightly upon the crystal. The right switch blade is rotated slowly over its points and at each new position the left switch blade is rotated two or three times over its points. This operation explores all the inductance turns, two at a time. If there is no response in the phones, operations (1) and (2) are repeated and local stations should now be heard. Finally, when the switches are set at the most advantageous position, a more sensitive adjustment of the detector may be obtained by lifting the cat-

whisker and replacing lightly in various positions.

As the switch blades are moved *up* the wavelength of the set is increased. When the left switch advances one point the tuning inductance turns are increased by two. When this switch reaches point 6 the turns are increased somewhat less than two by advancing the right switch one point and returning the left switch to point 1. Thus, in tuning, as the successive turns are cut in, that part of the process which requires shifting both switches, will give a smaller wavelength increase.

The antenna may be a single wire 80 feet long (or two wires 50 feet long) and about 30 feet high. If the antenna is too large the number of inductance turns required to receive the shorter broadcast wavelengths will be so reduced that the signal strength will also be decreased. In this connection, most effective results will be obtained by keeping the antenna clear of obstructions and adjusting its length until signals from the longest wave broadcast station are heard with the switches near the upper points. With this set the writer obtained good recepton from a Class B station two and a half miles distant, using a small indoor antenna, but such an antenna is not recommended for a crystal set.

A telephone head-set having a resistance of 2,000 ohms or more will give good results. Reception from a considerable distance will be more satisfactory if phones priced above the conventional standard be used.

As the crystal is the life of the set, emphasis is laid upon the importance of securing a good one, which should not only be sensitive to weak signals, but which should give response from local stations at most random positions of the catwhisker. The crystal may be kept covered when the set is not in use, but after a time its surface may become insensitive. It may be cleaned with alcohol or soap and water and a clean brush.

The input terminals of a two-step, audio-frequency amplifier may be connected to the phone binding posts of this set and good volume of sound will be obtained from local stations. The use of the crystal detector gives signals of maximum clearness.