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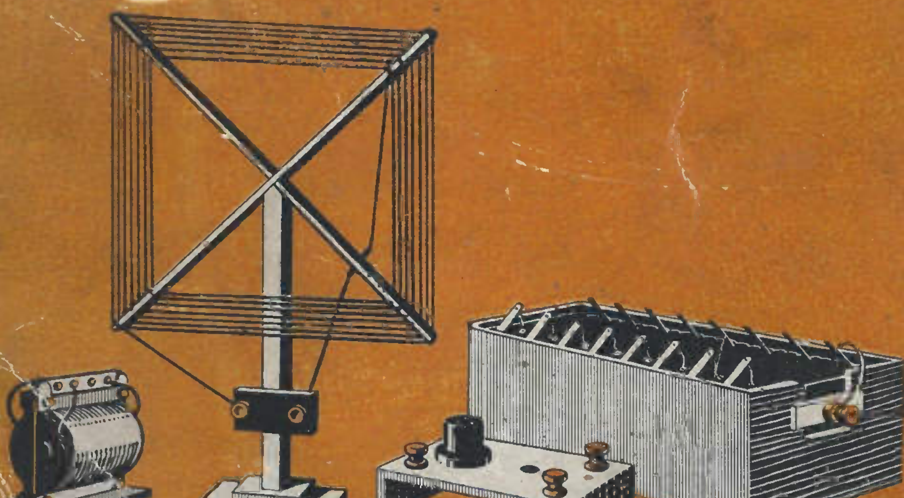
Radio Press Series No 16

HOME BUILT WIRELESS COMPONENTS

RADIO PRESS



An encyclopaedic handbook
Edited by the Radio Press
technical staff.

HOME BUILT WIRELESS COMPONENTS

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HOME BUILT WIRELESS COMPONENTS

CHAPTER I

FRAME AERIALS

A Collapsible Frame Aerial

A frame aerial is in many instances used where space is limited. It is not an ornamental article, and cannot therefore be looked on as a piece of furniture A collapsible frame aerial has several advantages, both from the point of view of appearance

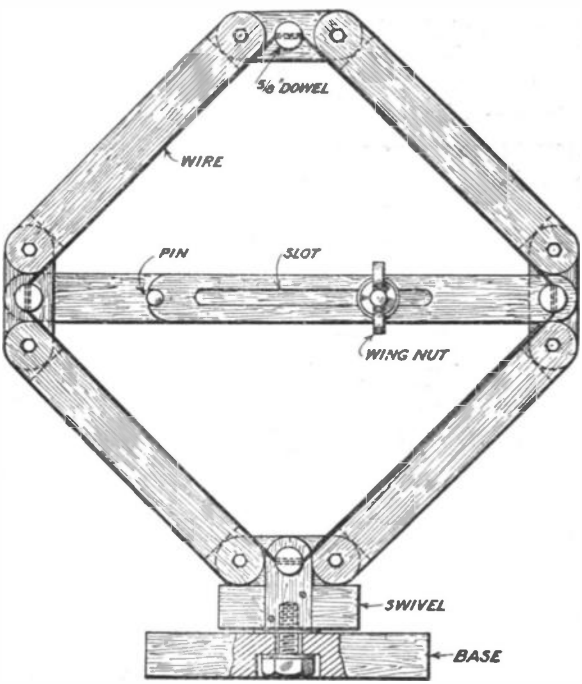

Fig. 1.—The finished frame

and the space it occupies. The aerial described in this note can be adapted to a table stand, a wall bracket, or may be suspended from the ceiling. In Figs. 1 and 2 the general construction of the frame open and the frame closed are shown. Fig. 3 shows the details of construction. *A* represents the diagonal stays, of which there are four These are cut from $\frac{7}{8}$ in. square wood, with a $\frac{3}{8}$ in. slot cut each end, and holes drilled to take securing bolts. *B* shows the four spacing pieces, which are made from $\frac{3}{8}$ in. and $\frac{7}{8}$ in. wood. The centre hole is drilled to receive a $\frac{5}{8}$ in. dowel, which is, in its turn, drilled to receive the wire.

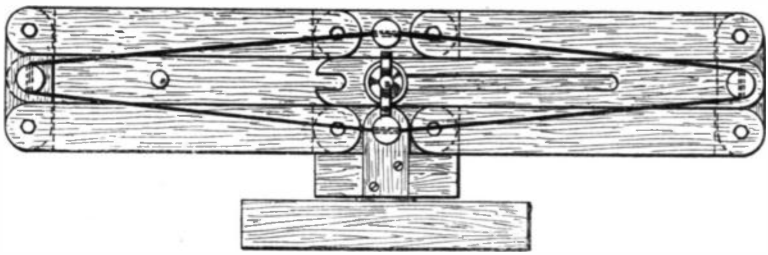

Fig. 2.—Frame aerial closed.

These drillings are made to correspond with the number of turns of wire desired, and should be a running fit for the gauge of wire used. The end holes are drilled to fit into the ends of piece *A*. *C* shows the centre stay, which is drilled one end to receive a $\frac{5}{8}$ in. dowel. The positions of the pin and wing nut can be deter-

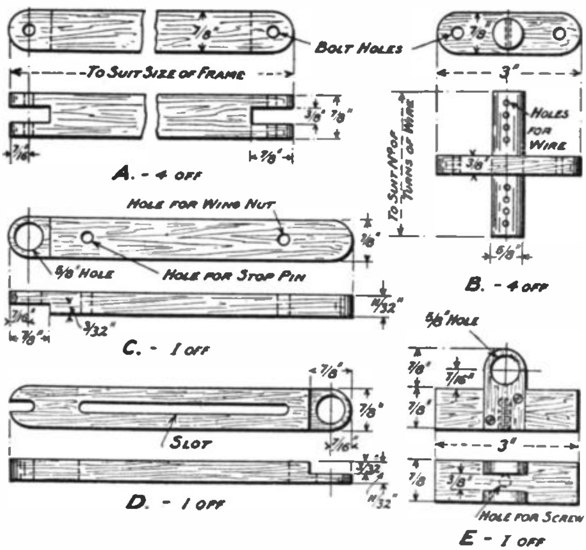

Fig. 3.—Details of construction.

mined from the open position of the assembled frame, the slot in piece *D* being long enough to operate in the closed position. The piece *D* is slotted to make a running fit on the bolt of the wing nut. The pin is to locate the two stays in a horizontal position when the frame is open and the nick cut in the end of piece *D* is for this purpose. The wing nut, when tightened up, locks the frame in both the open and closed positions. The wire working in the holes in the dowels retains the same length in both positions. *E* shows the swivel base which may be adapted with a little ingenuity as a bracket.

How to Make a Frame Aerial

A most useful addition to one's receiving equipment is a good frame aerial, with its extremely sharp tuning and strong directional properties. To those who live within a few miles of a broadcasting station the frame is probably the best solution

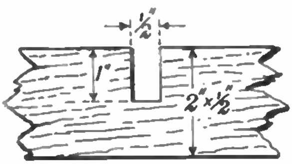

Fig. 4.—Showing the dimensions of the notch to be made in each arm of the cross.

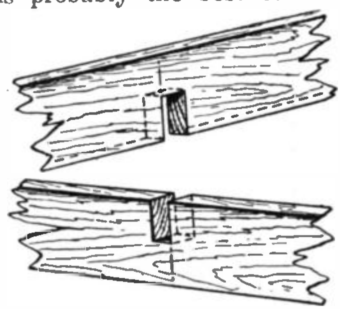

Fig. 5.—The two arms with notches ready for placing together.

of the problem of interference by the local station when attempting to receive one of those more distant, and it is well worth while to devote a little care to the construction of a good one.

Wavelength Range.

The design of a frame aerial to cover a given range of wavelengths is outside the scope of this book, but it may be as well to remind the reader that the matter is not a very simple one, and that in making frames he should adhere fairly closely to dimensions which he knows to be correct, such as those con-

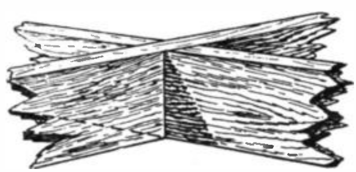

Fig. 6.—Showing the two wooden arms halved together.

tained in various published tables. The range of wavelengths covered by the frame whose construction is described in the lines which follow is approximately 350—600 metres when used with a tuning condenser of .001 μF capacity. (If it is desired to use it upon the broadcast band only, a capacity of .0005 μF is sufficient.)

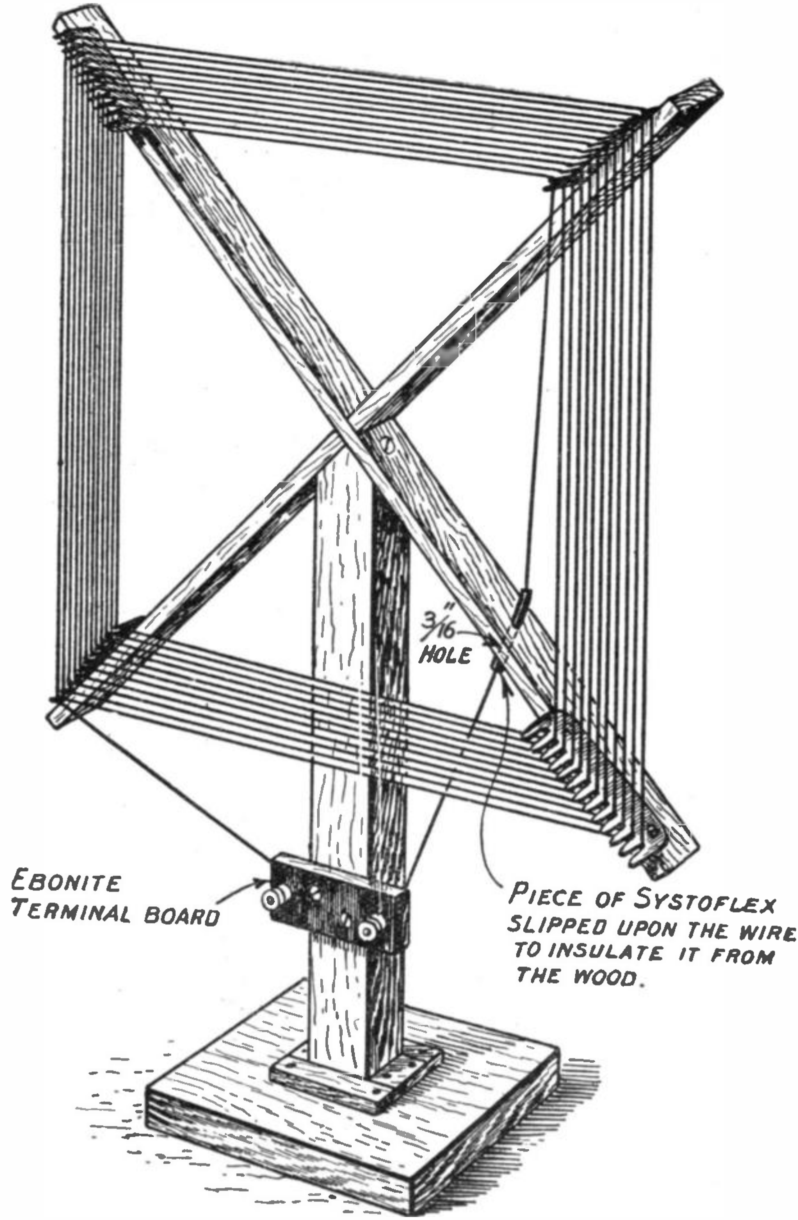

Fig. 7.—The completed frame.

Material Required.

For the construction of this very simple frame aerial the following materials should be obtained:—

Two pieces of wood 2 in. by ¾ in. by 3 ft. long.

One piece of wood, 2 in. by 2 in. by 2 ft. long.

One piece of wood, 9 in. by 9 in. by 1 in. thick.

Four vulcanite or celluloid combs with coarse teeth. These combs should be 6 in. long and fairly robust, to withstand the necessary drilling.

One piece of ebonite, 4 in. by 2 in. by ¼ in. thick.

One pound of No. 18 enamelled copper wire.

Two terminals, varnish, screws.

Construction.

The first proceeding is to "halve" together the two 3 ft. pieces of wood, so that they may be joined together to form a cross upon which to wind the wire. The operation of halving consists in cutting in the centre of each piece a square notch ½ in. wide and 1 in. deep, as shown in Fig. 4, so that when the notches of the two pieces are placed together the result is as shown in Fig. 6. Those who are unfamiliar with the method may have the work done for them by the local joiner for a trifling sum.

To each end of these pieces of wood must next be fixed one of the combs. This is best done by means of two screws passing through holes drilled near the ends of the comb. This is clearly

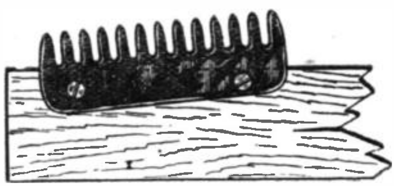

Fig. 8.—Method of attachment of the combs.

shown in Fig. 8, which also indicates that the comb is to be attached obliquely so that there shall be no tendency for the turns of the winding to slip out from between the teeth in which they will presently be placed. In fixing the combs take care also that they are all attached so that their teeth project upon the same side of the cross when assembled.

Next, fasten the two arms of the cross together by means of a small nail through their point of intersection, and proceed to mount them upon the pedestal, which is composed of the 2 ft. length of 2 in. square wood attached by means of a screw to the centre of the square piece of 1 in. thick board. Fig. 9 should make these details plain without further explanation.

Now drill the piece of ebonite with two holes for terminals and two for screws, attach the terminals (see Fig. 10) and screw it to the upright support of the frame as indicated in Fig. 7.

This completes the actual construction, and the woodwork should next be given a coat of varnish and allowed to dry before putting on the winding.

Winding.

First drill a $\frac{3}{16}$ in. hole in the position indicated in Fig. 7 in one of the wooden arms of the frame, then thread the end of

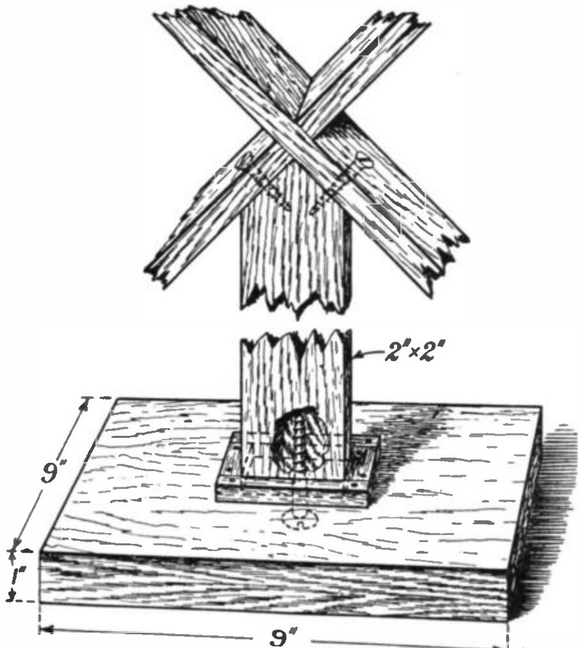

Fig. 9.—Showing the details of the pedestal.

the wire through a short piece of systoflex (or rubber) tubing and pass it through the hole. Scrape the end bright and screw it down under the back nut of the right-hand terminal (Fig. 7),

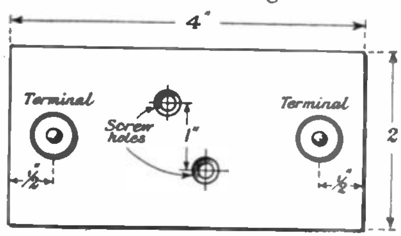

Fig. 10.—The terminal block.

and adjust the piece of systoflex so that it sleeves the wire where the latter passes through the hole in the wooden arm. Now take the wire round the frame, slipping it into the teeth of the combs at each corner, and keeping it tight. In this way wind on 12 complete turns, separating them, say, three or four teeth, depending upon the coarseness of the combs; the aim should be to space the wires about ½ in. apart. On the completion of the 12 turns fasten the finishing end of the wire under the left-hand terminal, and the frame is complete.

A Simple Frame Aerial

The improvements embodied in this frame aerial are simplicity and low cost of construction, compactness, and ease in

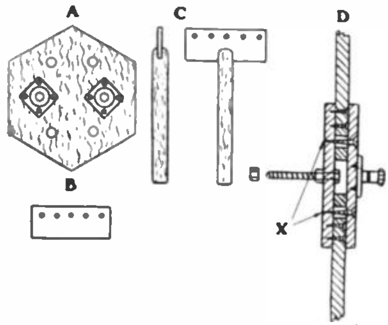

Fig. 11.—Parts required for constructing frame of aerial.

manipulation. The parts required to construct the frame are shown in Fig. 11. Two hexagonal hubs are cut out from a piece of ½ in. board, the diameter across the points being 8 in. One

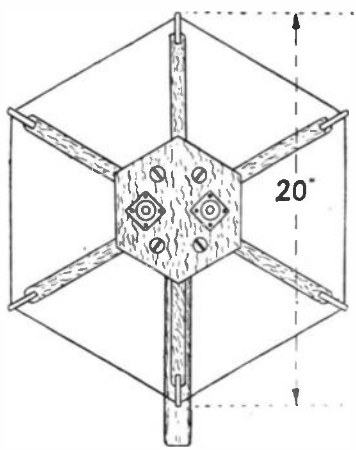

Fig. 12.—Illustrating the position of the arms.

of these is drilled through the centre to take a fairly long ⅜ in. Whitworth bolt, and the other, which is shown at A, is provided with two terminals suitably mounted on small pieces of sheet ebonite and drilled in the position shown to take four large wood screws or bolts, which eventually secure one hub to the other.

The arms consist of 8 in. lengths of ½ in. square section wood, slotted at one end to accommodate the spreaders B, which are cut from ⅛ in. sheet ebonite and drilled as shown to take the wire. These spreaders should be a "friction-tight" fit in the slots, and, if necessary, they should be secured by small bolts.

The general arrangement is indicated at C.

Fig. 12 shows the position of the arms, each one being attached by means of screws or nails to the back hub in the manner indicated in the sectional diagram D (Fig. 11), so that the distance between the extreme ends of each pair of opposite arms is 20 in. The front hub containing the terminals is screwed to the back hub by four wood screws, thus enclosing the lower ends of the arms between them. These screws are shown at X, Fig. 11. Fairly long bolts may be used for this purpose if it is not possible to obtain screws of the correct length. A small

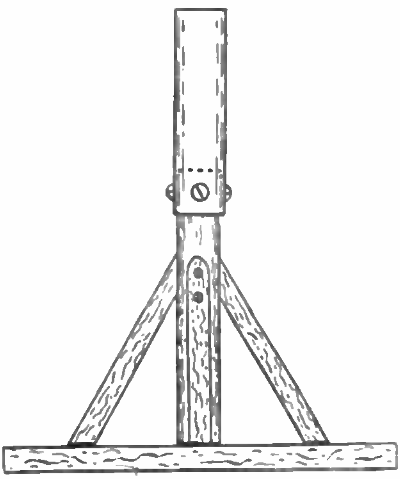

Fig. 13.—The supporting base

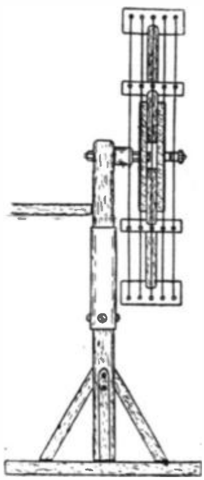

Fig. 14.—The complete frame aerial.

distance piece, comprising a short length of round wooden rod about 1¼ in. in diameter by 3 in. long, is drilled and slipped over the bolt attached to the back hub, and the frame is then fitted, as shown in Figs. 12 and 14, to a length of round wooden curtain rod about 1½ in. in diameter, the lower end of which is dropped into a 10 in. or 12 in. length of brass tubing secured to the upper end of another length of wooden curtain rod attached in any suitable manner to a supporting base as shown in Fig. 13. A side or end view of the completed instrument is given in Fig. 14.

A convenient manipulating device is provided by attaching a piece of round wooden rod to the movable pillar. The length of either pillar is optional, but the length of the brass tubular socket should not be less than 10 in., otherwise the frame will

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The flex is stitched on along these lines, care being taken that the ¼ in. spacing is maintained between turns. Wire with an inner sheathing of rubber should be used; the needle and thread can then be passed through the outer silk or cotton covering. An alternative to flex is the paper mounted wire sold by the General Electric Company, for use in household bell circuits. It consists of parallel copper wires lying between two paper strips, and can be stitched on to the holland.

The top of the " blind " is tacked to an ordinary roller, obtainable from any hardware shop, 1 in. in diameter and 38 in. long. To either end of this is fastened a piece of cord provided with a hook. To the lower edge of the holland is tacked a wooden slat, also 38 in. long. To it are attached two lengths of cord, as shown in Fig. 19, each of which is provided with a metal or hard wood pin.

For use out of doors the hooks of the roller can be slipped over a branch which points roughly in the direction of the station whose transmissions it is desired to pick up. The proper alignment is found by turning the frame slowly from side to side when the receiving apparatus has been attached and switched on. When the point at which signals are at their maximum strength is discovered, the blind is fixed by pushing the pins

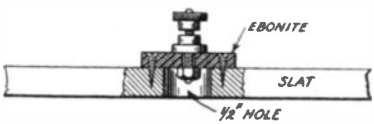


Fig. 20.—Method of mounting the terminals.

attached to the slat into the ground. To enable their cords to be drawn tight cleats like those used on tent ropes may be provided.

When used in the house the frame can be fastened to the top of a room or cupboard door by means of its hooks, and the proper alignment is obtained by swinging the door.

There are two ways of attaching the " blind frame " to the set. One is to bring the two ends of the spiral down to the slat, where they are anchored by means of staples, prevented from cutting the insulation by having little rubber pads inserted between their cross pieces and the wire. About 3 ft. of each wire is left below the slat.

The other method, which makes a better looking job, is to provide the slat with terminals, as seen in Fig. 19. These cannot be mounted directly on to the wood, which would not provide sufficiently good insulation for high-frequency currents. Fig. 20 shows how the desired end can be accomplished.

Two half-inch holes are made in the slat. Over each is, fixed by screws, a block of ¼ in. ebonite 1 in. square, provided with a 4B.A. terminal. The holes enable the shanks of the terminals and their nuts to clear the wood.

CHAPTER II

COILS AND COIL WINDING

An Inductance Tapped at Each Turn

Inductances may be wound either in a clockwise or anti-clockwise direction. The best way of designating an inductance coil is to say whether it has a right-hand screw or a left-hand screw. An ordinary corkscrew is called a right-hand screw, because to make the corkscrew enter the cork it is necessary to turn the handle round in a right-hand or clockwise direction. An inductance coil wound as a right-hand screw will be similar to a corkscrew. If we take the inductance coil, which we will presume is wound on a cylindrical cardboard tube, and if it is necessary to turn it to the right (*i.e.*, in a clockwise direction) to make it enter an imaginary cork, then the inductance is wound as a right-hand screw (see Fig. 21).

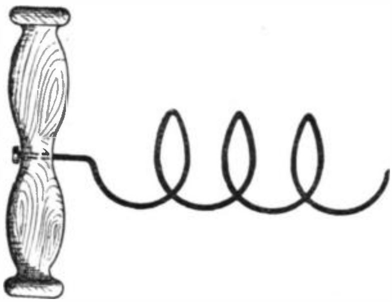


Fig. 21.—A right-hand screw.

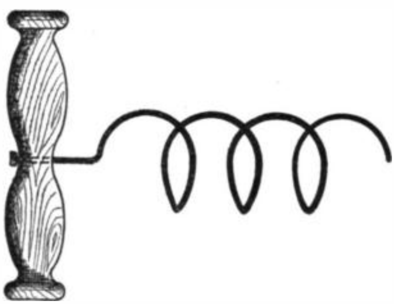


Fig. 22.—A left-hand screw.

If, on the other hand, the inductance coil is wound in such a manner that to make it enter the imaginary cork it is necessary to turn it to the left, or in an anti-clockwise direction, then the inductance is wound as a left-hand screw (see Fig. 22).

It is to be noticed that turning the inductance round the other way does not in any way affect it being a left-hand or right-hand screw. It will be necessary to turn it in the same direction as before to make it enter an imaginary cork.

Method of Winding the Inductance.

The inductance coil is wound for a distance of $\frac{5}{8}$ in. on a cardboard tube 5 in. in diameter and $1\frac{3}{16}$ in. long, and is tapped at every turn, there being 20 tappings altogether, these tappings going to studs over which moves a selector switch arm.

To the experienced constructor this conveys all the information which is really necessary, except as regards the size of wire, and this is No. 26 S.W.G. double cotton-covered copper wire, which is obtainable from many of the wireless dealers.

For the benefit of the beginner, however, a detailed explanation of the way the variable inductance is wound and made will be of interest, as different kinds of inductance may be wound in a similar manner at any future date.

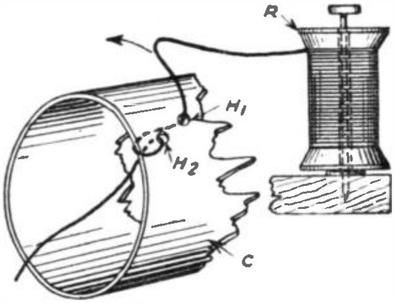


Fig. 23.—The first step in winding the coil.

Fig. 23 shows the cardboard tube C measuring 5 in. diameter by 1 $\frac{3}{16}$ in. in length. About $\frac{1}{4}$ in. from the left-hand side is made a hole H_1, a similar hole H_2 being made close to the edge of the tube and very slightly lower than the other hole. A reel of No. 26 double cotton-covered copper wire is now obtained; a half-pound reel will do, but it is better to obtain a full pound if much experimental work is to be done. The reel may be allowed to rest on the floor, or is preferably fixed to an old table by a nail, which will allow the reel to rotate as the end of the wire is pulled.

The end of the wire is slipped through the hole H_1, round the end of the tube at the left, and down through the hole H_2

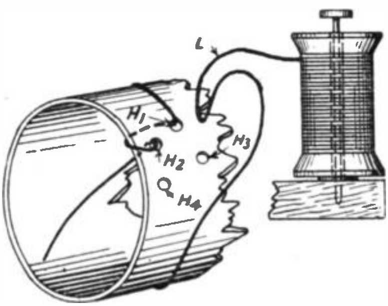


Fig. 24.—Completing the first turn.

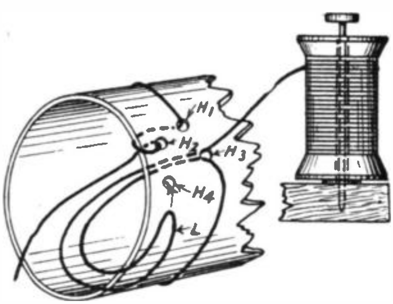


Fig. 25.—Taking the first tapping.

and out again, a loose end of about 12 in. being left. The wire is pulled tight, so that it is secured by the aid of the two holes. Any other method of fastening the wire to the tube will do, but this is sufficiently satisfactory for the purpose. The size of the holes has been exaggerated in order to show how the wire is threaded through them, but in practice they would fit the wire tightly. The wire is now wound round the tube for one turn. A hole, H_3 (Fig. 24). is now pierced through the carboard tube with the point of a pair of scissors or in any other manner. A similar hole, H_4, is also made, and is slightly below the level of H_3, and placed close to the edge of the cardboard tube. The hole H_3 should be a little lower than the hole H_1, and should be about the width of the wire to the right of H_1. The wire is now formed into a loop L, and the pointed end of this loop is passed through the hole H_3.

Fig. 24 shows the construction of the inductance just prior to inserting the end of the loop L through the hole H_3.

Fig. 25 shows the end L of the loop passed through the hole H_3. The end of the loop L is now passed through the hole H_4, and when this operation is completed the appearance of the inductance is as in Fig. 26. The loop should now extend beyond the cardboard tube for a distance of about 8 to 12 in., and should

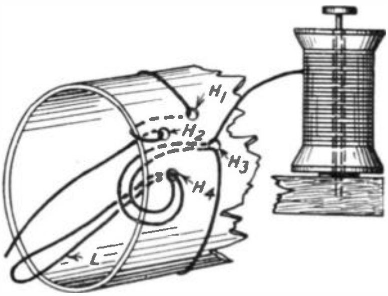


Fig. 26.—The first tapping completed.

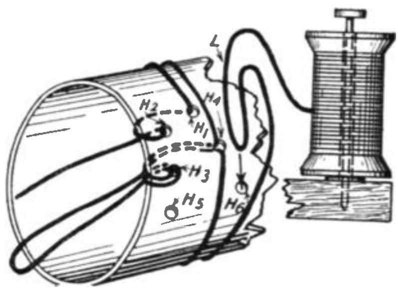


Fig. 27.—Completing the second turn.

be pulled tight. Having pulled the loop tight, continue winding the wire round the coil, keeping the turns close together.

Another loop L (see Fig. 27) is now made, and passes through another hole, H_6, and is then looped round the hole H_5 in the same manner as before.

The same procedure is adopted until 20 tappings have been taken, excluding the wire going to the beginning of the winding, but including the connection to the end of the coil.

Fig. 28 shows the general manner in which each tapping is made.

Fig. 29 shows another view of the outside of the tube, and shows how the various tappings are taken.

Fig. 30 shows a view of a portion of the inner surface of the cardboard tube.

Fig. 31 shows the completed inductance tube with all the tappings coming out at the left-hand side.

The Baseboard.

The cardboard tube wound with its 20 turns of wire is mounted on a baseboard fitted with terminals and a switch.

Two pieces of wood, measuring 3¾ x 3½ in x ⅜ in., are required, and one piece of wood as in Fig. 39, measuring 5¾ in. x 3¾ in. x ⅜ in. The figure 32 pieces are for the vertical supports, and the Fig. 39 is for the horizontal board on which the tube is actually mounted.

The Inductance Switch.

The switch, which is for the purpose of selecting diffierent numbers of turns of inductance, is arranged on a vertical piece of

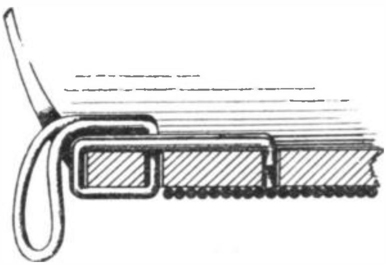


Fig. 28.—Method of taking tappings.

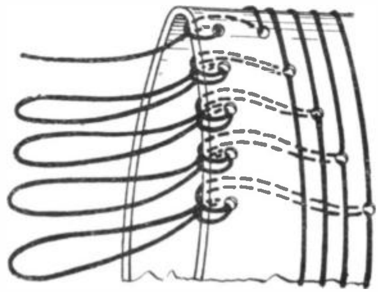


Fig. 29.—Appearance of finished tappings.

wood dimensioned as above. The vertical piece of wood, with its switch and two terminals, as shown in Fig. 33, and is the next thing to make.

Two single "Army" terminals, T_1 and T_2, constitute the terminals of the inductance. The left-hand terminal T_1 goes to the beginning of the coil direct, whereas the right-hand terminal is connected to the switch arm. Fig. 34 shows the general lay-

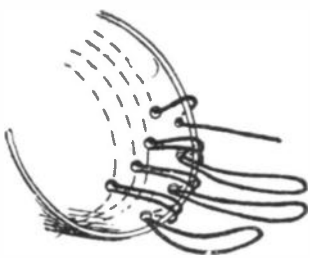


Fig. 30.—Inside of coil showing tappings.

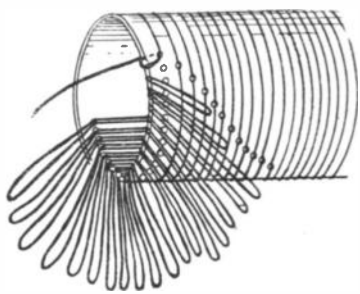


Fig. 31.—Another view showing tappings.

out of the vertical board carrying the rotary switch. The holes for the studs are drilled as shown, and the actual studs may measure ¼ in. in diameter. The actual diameter of the circle round which the studs are arranged will depend upon the length of the switch arm. This, however, is more a matter of common sense than anything else, but the reader is advised to separate the studs by a distance equal to about half their diameter.

Fig. 35 shows a side view of the board carrying the switch arm, and Fig. 36 shows the rear of the panel. The letters R and

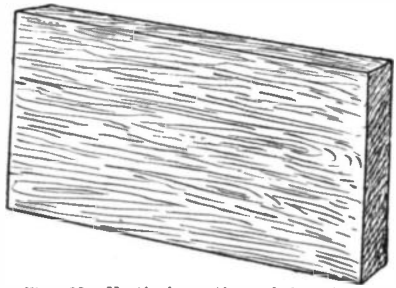


Fig. 32.—Vertical portion of base-board.

L indicate right and left, and correspond to the letters L and R of the front view of the panel shown in Fig. 34. It will be seen that the back of the terminal, T_2, is connected to the switch arm.

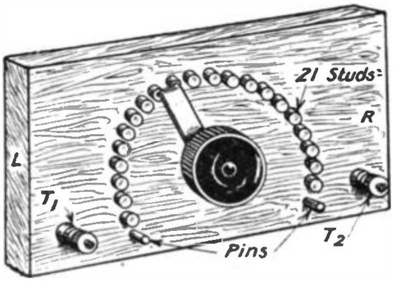


Fig. 33.—Arrangement of selector switch.

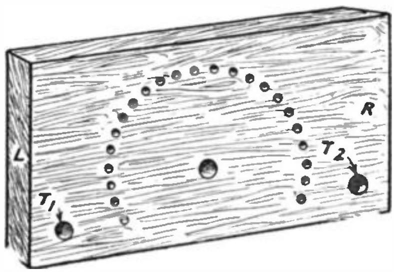


Fig. 34.—Holes drilled for selector switch and terminals.

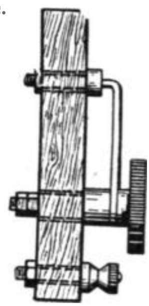


Fig. 35.—Another view of the selector switch.

The first stud (starting from the L side) is No. 0, and is connected to T_1, and also the left-hand end of the inductance coil.

Completing Baseboard.

Having constructed the three different boards, the two vertical ones and the horizontal one, they are assembled as shown in Fig. 37, screws or nails being used to secure the top board to the two vertical ones.

The only remaining operation is to screw the cardboard tube to the top board and to make connections between the tappings and the studs which correspond to them. There are altogether 21 studs, the one on the left (Fig. 38) being directly connected to the terminal T_1 at the back of the panel. The terminal T_1

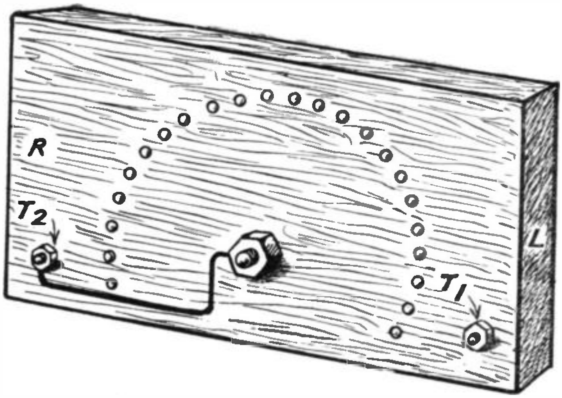


Fig. 36.—Back view of vertical panel.

itself is connected to the left-hand side of the coil; in other words, to the beginning of the coil. Stud No. 1 goes to the first tapping, stud No. 2 goes to the second tapping, and so on, the final stud, No. 20, being connected to the right-hand end of the coil, *i.e.*, to the last turn.

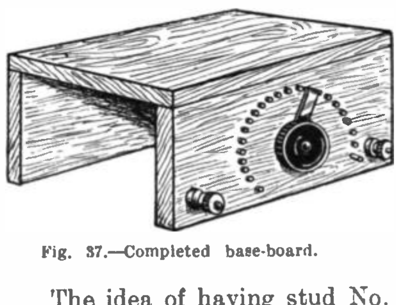


Fig. 37.—Completed base-board.

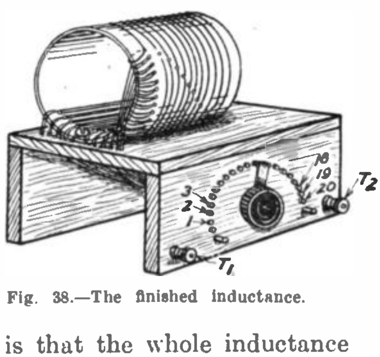


Fig. 38.—The finished inductance.

The idea of having stud No. 0 is that the whole inductance may be cut out if so desired.

Screws or other projections should be fixed at the end of the arc formed by the studs. These screws should be placed in the same positions as would be occupied by an additional stud at each end, and they serve to prevent the switch arm from slipping off the last stud. They are merely stops, and no connections are made to them.

Wiring up the Induction.

The backs of the different studs are connected in strict rotation to the different tappings, the loops, which constitute the tappings, being bared at their ends for making connection to the studs, either by soldering or by means of nuts. Soldering is

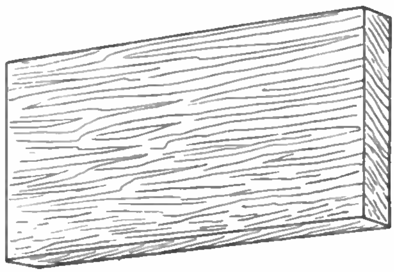


Fig. 39.—Horizontal portion of base-board

much to be preferred, and if the loop is too long it should be cut off where desired, the ends of both the wires being then bared, twisted together and soldered on to the back of the stud.

Fig. 38 shows how the completed inductance will look.

A Variable Inductance Tapped at Every 20 Turns

A variable inductance consisting of 20 turns of wire tapped at every turn has been described. It is now proposed to describe a companion inductance, which is wound on a similar sized tube with similar wire that is tapped at every 20 turns. It is later proposed to connect these two inductances in series, so that any number of turns of inductance between zero and 120 may be obtained. Accurate tuning may be effected in this manner, and there is no necessity for the use of a variable condenser.

Fig. 40 shows the completed variable inductance, and it will be seen that the method of construction is very similar indeed to that employed in the single stud inductance described.

Fig. 41 shows a cardboard tube on which the inductance is wound. It measures 5 in. external diameter and 3¾ in. long.

This tube is wound with 100 turns of No. 26 double cotton-covered copper wire, and tappings are taken at every 20 turns.

Fig. 42 shows the completed inductance with the tappings hanging out at the left-hand side. The method of taking these tappings is that described in the case of the single stud inductance, but if the reader has any preference for any other method he is, of course, at liberty to employ such method without interfering at all with the final operation of the apparatus.

The Baseboard.

The baseboard is formed in exactly the same way as before, but the sizes are naturally not the same. Three pieces of wood are required; two of them measure $3\frac{3}{4}$ in. by $5\frac{3}{8}$ in. by $\frac{1}{2}$ in., as shown in Fig. 43, and one piece measures $3\frac{3}{4}$ in. by $5\frac{5}{8}$ in. by $\frac{1}{2}$ in., as shown in Fig 44. Having made these pieces of wood to

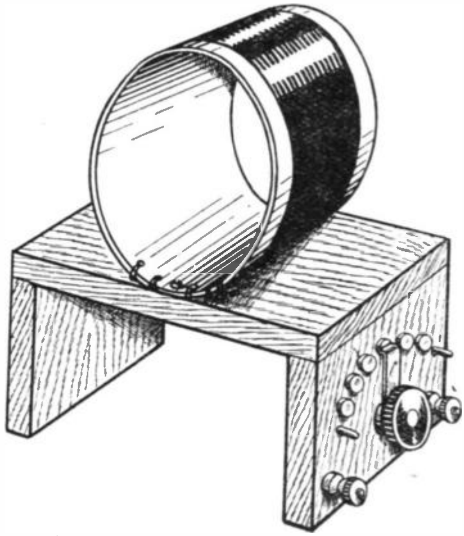


Fig. 40.—Showing the complete inductance.

the right size, the next step is to mount the selector switch, stud and terminals on one of the pieces of wood dimensioned as above.

Fig. 40 shows the general arrangement of the studs and terminals. The right-hand terminal is connected to the

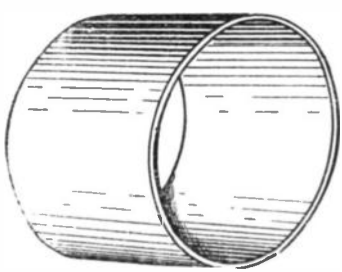


Fig. 41.—The inductance tube.

right-hand stud, which also goes to the right-hand end of the inductance coil. When the switch arm is on the last stud, which we will number zero, none of the inductance of the coil is included in the circuit, but if we move the switch arm so that it rests on the stud No. 1 we will include 20 turns of inductance, and if we move the switch over to stud 2 we will include 40 turns. If we move the switch over to studs 3, 4 and

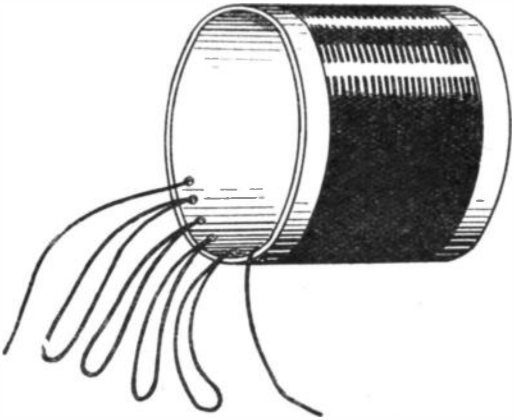


Fig. 42.—The complete inductance with tappings.

5, we will get 60, 80 and 100 turns respectively connected in circuit. Two stops are provided, one at each end of the arc

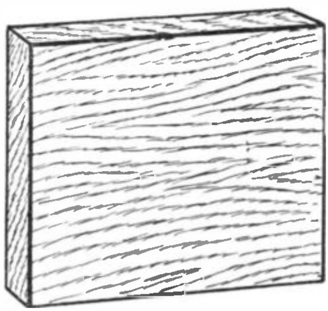


Fig. 43.—Sides of base.

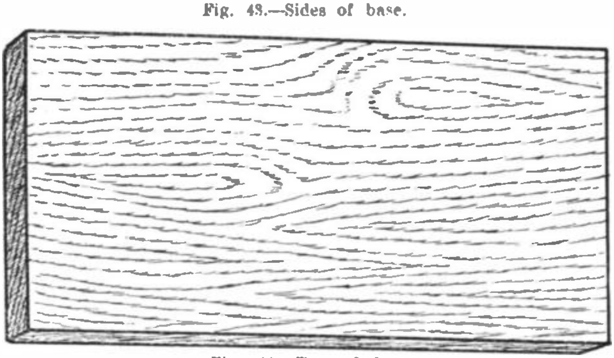


Fig. 44.—Top of base.

formed by the studs. These stops may be nails or screws, and their object is to prevent the switch arm from slipping off the end stud. A wire connection is taken from the selector switch to the left-hand terminal.

It is very important to see that the right tappings go to the right studs, and it is desirable that these various studs should be numbered on the front of the panel in ink on the wood. There will then be no doubt as to how much inductance is in circuit at any adjustment.

Winding Basket Inductances

On account of the ease with which they can be made, their low self-capacity, and the close coupling which can be obtained between them, basket coils are very useful to the enthusiast who is given to making up experimental circuits. Ready-made coils, which can be bought very cheaply, have two main drawbacks: in

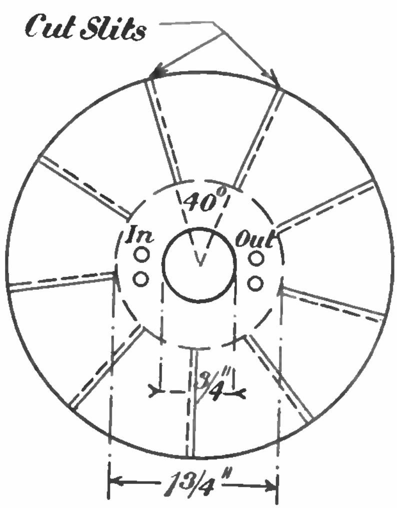


Fig. 45.--Showing dimensions of former.

the first place, the wire used for the smaller sizes is too fine, and in the second one finds that no two sets can be relied upon to be exactly equal in inductance value.

These defects are readily remedied if coils are made at home. The cure for the first suggests itself, the second is dealt with by adhering always to a former of the same internal diameter, with the same number of slits cut in it, and by winding the coils with great care.

A further blemish on the escutcheon of the ready-made variety is that they are made self-supporting by liberal doses of shellac or paraffin wax, which, by providing a good dielectric between turns, increases the self-capacity of the coils. This can be avoided by winding the coils on cards, and by leaving the formers in position when winding is done. Fig. 45 shows a convenient size for these formers. The hole is $\frac{3}{4}$ in. in diameter, and the inside ends of the slits lie on the circumference of a circle $1\frac{3}{4}$ in. in diameter. The outside dimensions of the card will depend, of course, on the wavelengths which the coil is designed to cover.

There must always be an odd number of slits, otherwise the windings will not criss-cross as they should. If a protractor is available marking out is easy, the slits, nine in number, being 40° apart. Without a protractor, measurement can still be done. If a fraction over one-third of the diameter of the card is measured off with a pair of dividers, the nine divisions can be marked out with quite even spacing by simply travelling round the circumference with the dividers and making pricks with their points. Failing even dividers, use the dial of your watch. A mark made to correspond with every fourth minute will give fifteen equal spacings, or eleven can be obtained by pricking off at each $5\frac{1}{2}$ minutes, and then making the tiny adjustment necessary.

When winding, anchor the end of the wire by passing it two or three times through a pair of holes on the left of the former, which should be marked " in " in ink. Carry the wire to the first slit, and wind clockwise, holding the former in the left hand and the wire in the right. The wire is woven in and out of the slits like basket-work, hence the name given to these inductances.

When winding is finished, pass the end of the wire from the outside to the inside of the coil through one of the slits, and anchor it as before, but on the right-hand side, marking this pair of holes " out." One will never have to puzzle out which end is which or be in doubt as to the direction of the windings, for you know that they run from " in " to " out " in a clockwise direction.

For short-wave work a set of coils should be wound with No. 24 or 26 gauge wire; these will be found far more efficient than those that are made with the very fine wire usually employed.

A Readily Made Variable Inductance

Never having possessed very much mechanical ability, the writer has always tried to make his experimental apparatus out of the simplest materials, and in such a way as to avoid much additional work in the making of apparatus. Naturally, the first thing that I had to make was a variable inductance, and as I did not care very much for the single slider type, evolved the design shown in the accompanying diagram (Fig. 46). The variable inductance is shown inserted in the usual place in a simple crystal receiving circuit.

In the figure seven tappings are shown, but it will be obvious that any suitable number may be used, and the range of wave-length required will largely determine the number of tappings taken from the inductance coil,, which is shown in the diagram. The inductance consists of a tube usually about 3½ in. or 4 in. in diameter, wound with, say, No. 26 S.W.G. double cotton-covered wire. One end of the coil is connected permanently to a terminal T_1, and the other end is similarly connected to a terminal T_8. Along the coil are taken tappings at every so many turns. The tappings may conveniently be in the form of twisted loops, the ends of which are bared and secured by solder, or otherwise,

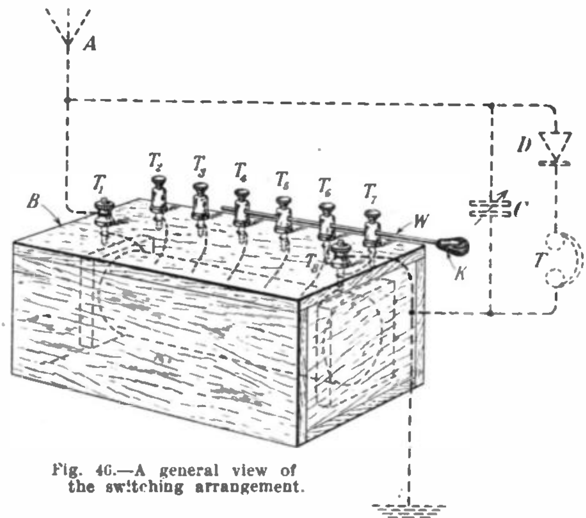


Fig. 46.—A general view of the switching arrangement.

to terminals, T_2, T_3, T_4, T_5, T_6 and T_7, screwed into the lid of the box B. These terminals are of the wood screw type, having a horizontal hole through the brass portion. When using these terminals in the ordinary way a wire would be passed through the hole and secured by turning round the head of the screw. In the present case, however, it is not proposed to employ the terminals in this manner. They are arranged so that a knitting needle, W, or other stout wire, may pass through all the holes in the terminals in the manner shown. At the end of the knitting needle is a wooden knob, K, which, however, may conveniently be made of ebonite, or even simply sealing wax.

When the knitting needle W is passed through all the terminals T_2, T_3, T_4, T_5, T_6 and T_7, only that portion of the inductance between the terminals T_1 and T_2 will be used. All the rest of the coil will be short-circuited, and short-circuited in the best possible manner, as each particular section will be shorted. Losses are thereby reduced to a minimum. If now we pull out the knob K, so that the knitting needle only passes through the terminals T_3, T_4, T_5, T_6 and T_7, more inductance will be added to the circuit, which will now include the turns between the terminals T_1 and T_3. All the rest of the coil will be shorted in sections.

If we pull out the needle so that it occupies the actual position shown in the accompanying diagram, the amount of inductance will be further increased, and will consist of the turns of wire between T_1 and T_4. Any amount of inductance may be obtained in this manner, and if the wire W is pulled out of all the terminals except the last, the whole of the inductance will be connected in circuit. It is to be noted that the terminal T_7 is also connected to the terminal T_8. Fig. 47 shows a plan of the box, illustrating the method of taking tappings from the coil.

The variable inductance thus constructed does not lend itself to rapid searching for a certain wavelength, as it is desirable to

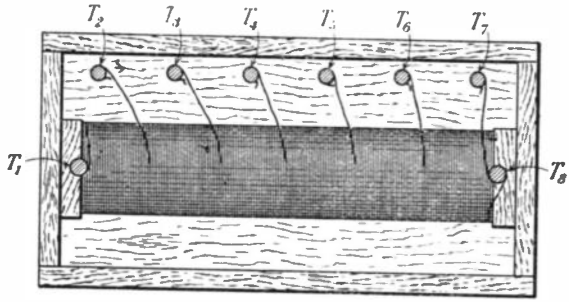


Fig. 47.—View of box with lid removed.

screw down the terminal screws on to the knitting needle or stout wire W in each case. The inductance, however, may be thoroughly recommended as a very simple form of apparatus for use in cases where a very rapid change in wavelength is not desired. The inductance may be used, of course, in any kind of circuit, although, in the diagram, it is shown employed in a simple crystal receiver circuit.

Basket Coil Formers

Baskets are quite the most easily made of all the low-capacity inductances, and they are so useful for wavelengths up to 3,500 metres that the construction of a simple former upon which they can be wound without difficulty will well repay the time and trouble spent.

Draw a circle six inches in diameter on a piece of paper, and within it draw a concentric 2 in. circle. With a circular or semi-circular protractor—even a condenser degree-scale will do at a pinch—make a mark at every twenty-four degrees round its circumference. This will divide the circle into 15 equal parts. Join each mark to the centre, and cut out the smaller circle with a pair of scissors. This is meant to act as a template.

Paste it on to a circular piece of ebonite 2 in. in diameter and ⅜ in. thick. Make a mark with the scriber on the edge of the ebonite disc corresponding to every ray drawn from the centre to the circumference of the circle. At each mark drill and tap a ⅛ in. (Whitworth) hole, ⅜ in. deep.

Cut off fifteen 2½ in. lengths of ⅛ in. round brass rod, put a ⅛ in. Whitworth thread on to one end of each. If you have no die you can get this job done at a bicycle repairing shop for a trifling sum. Screw the spokes in. The former is now ready for use.

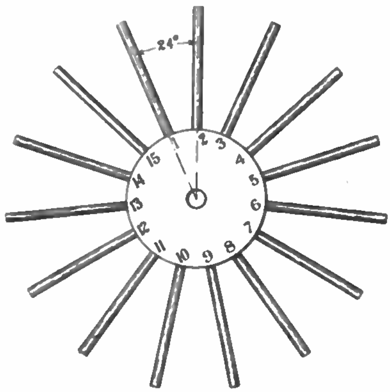


Fig. 48.—The complete former

To wind a basket coil, take a turn of the wire round the spoke at the top, hold the former in the left hand, and with the right weave the wire in and out of the spokes, taking care not to miss one.

When as many turns as are needed have been put on, tie the turns between the spokes so that the coil will not fall apart when taken off, and unscrew the spokes. An alternative method is to dip the coil in molten paraffin wax. The coil will generally come away quite easily, but if it does not, unwind the first turn by pulling on the starting end of the wire.

CHAPTER III

COIL HOLDERS

A Simple Stand for Honeycomb Coils

The coil-holder to be described is a handy little affair, very easy to make, and costing no more than about 3s. 6d. in all. It is most useful for taking the A.T.I. and the secondary, or for a tuned anode inductance and the reaction coil coupled to it. It may also be used with great advantage as a high-frequency transformer, the variable coupling between the coils conferring great selectivity.

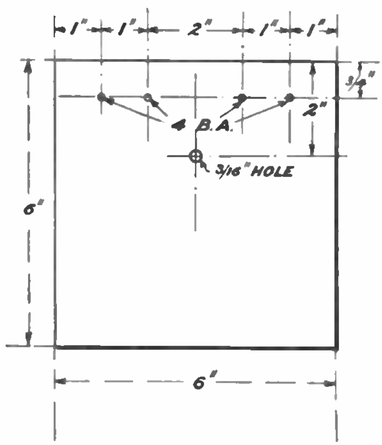


Fig. 49.—The layout of the panel.

The apparatus is designed to take two coils, the lower fixed, the upper moving; but if it is desired to make it up as a three-coil stand, the design is very easily adapted to the purpose. In this case the fixed holder becomes the middle one, and a second moving holder, mounted in exactly the same way as the upper one, is added below it, a longer spindle being used.

Fig. 49 shows the layout of the panel, which is a piece of ebonite 6 in. by 6 in. by $\frac{1}{4}$ in., and is not a very complicated business.

The coil-holders can be made at home from $\frac{1}{4}$in. ebonite. But, as they can be bought complete for 10d. apiece, it is hardly worth while to do so. Fig. 50 shows how that intended for the moving coil is treated. A $\frac{3}{16}$ in. hole is bored for the spindle, and two 4B.A. holes are drilled and tapped for the screws which fix the extension handle in position In the fixed holder only the $\frac{3}{16}$ in. hole is drilled. In both cases this hole should be placed far enough back to allow plenty of clearance for the screws running through the plug and the socket.

The spindle, which is a $4\frac{3}{4}$ in. length of 2B.A. screwed rod, is mounted in the $\frac{3}{16}$ in. hole by means of two nuts placed one above and one below the panel (Fig. 51). A second nut is added

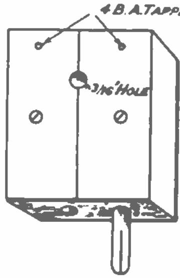


Fig. 50.—The moving coil-holder.

below to lock everything securely in position. Above the nut on the upper side of the panel comes a $\frac{1}{2}$ in. length of brass tube $\frac{3}{16}$ in. in diameter. This is followed by another nut. Then comes the fixed coil-holder, which is locked in place by having another nut turned hard down upon it.

A flat washer is next placed on the spindle, followed by a second piece of brass tubing 1 in. in length and another washer.

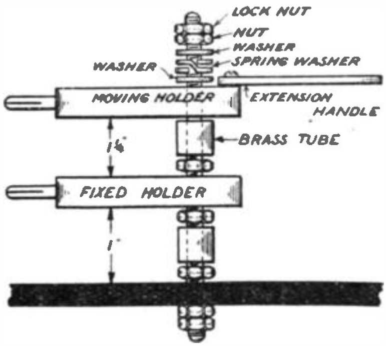


Fig. 51.—The arrangement of spindle.

A nut is screwed down until the holder moves easily but without wobbling. Then a lock-nut is put on to prevent the adjustment from altering when the stand is in use. The extension handle is simply a piece of ebonite $\frac{1}{8}$ in. thick and 3 in. long by $\frac{3}{4}$ in. wide. It is fixed by means of two round-headed 4B.A. screws driven into the holes made for them in the holder.

Into the four 4B.A. holes at the top of the panel are inserted small terminals, one pair being connected to the plug and socket of the fixed holder, whilst the others are wired to the moving holder by means of flex leads long enough to allow of sufficient swing in either direction. The panel may be mounted on a piece of hard wood ¾ in. thick, recesses being made with brace and bit for the lower end of the spindle, and for the shanks of the terminals with their nuts.

A Novel Coil Holder

A serious effort to combine simplicity with efficiency is a very interesting procedure, which, in this case, resulted in the production of the basket-coil holder, shown in Fig. 52. A 2½ in. length of brass tubing E, which is about ½ in. in diameter, is slotted for a depth of a little more than 2 in. to take a strip of

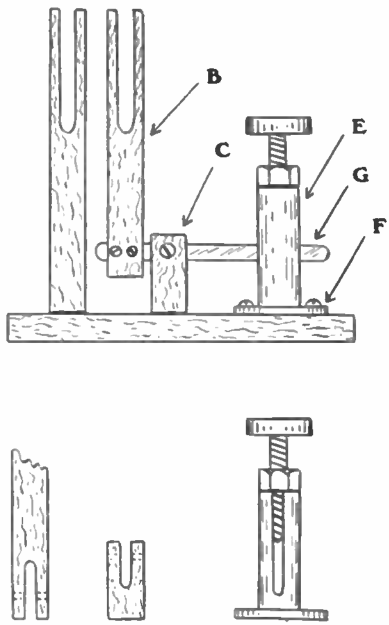


Fig. 52.—The coil holder and its details.

1-16th in. sheet brass G. A 2B.A. nut is soldered to the top of the tube, and a flange drilled to take two wood screws, is soldered to the base, as shown in Fig. 52. A short length of 2B.A. screwed rod is fitted at one end with a small knob and screwed into the nut. A piece of square wood C and one of the coil supports B are also slotted, as shown in Fig. 52. The brass arm is hinged to C, which is then secured to the baseboard, and the coil support B is firmly screwed to the end of the arm.

The other end of the arm passes through the slot in the tube E, so that when the knob is screwed down the end of the screwed rod engages the edge of the arm inside the tube, thus giving the desired movement to the coil. The weight of the coil and the support is sufficient to keep the arm pressed against the end of the screwed rod, but a small compression spring may be dropped down the tube, under the arm, if desired.

A Novel Three-Coil Stand

Though I have used at various times a great many of the two and three-coil stands now on the market, I have never come across one that was all that could be desired. The worst are those in which the movement of the coils is effected by means of toothed pinions. The gears very soon develop a good deal of backlash and the bearings tend to wobble; hence, when the handles are moved the coils travel in a jerky way, which makes fine tuning a matter of extreme difficulty.

Another bad fault found in holders of certain designs is that the moving coils are mounted on spindles which are supported at their upper ends by a brass plate. Stands of this type frequently break down in use through the occurrence of a short circuit through the plate.

But the quarrel that I have with almost every pattern is that they do not permit sufficiently small adjustments of the coupling to be made. In most makes the coils are mounted upon pivots, and the only adjustment that one can make is to increase or decrease the angle between them. This is all very well if they are fairly close coupled, but after an angle of about 45 degrees is reached the tiniest movement of the handle makes a very big difference in the degree of coupling.

There are coil stands which permit of a straightaway movement, the coils being mounted upon holders which travel on pairs of brass rods. This is quite good, but unless a turning movement is also possible, one cannot make those tiny adjustments that are often needed on a crowded wavelength in order to bring in a desired signal and banish others.

What is required in a coil-holder is a double movement. Then, besides being able to vary the angle between the coils, one can also turn each upon its axis in order to make fine adjustments. After a long series of experiments with all kinds of designs I am very much in favour of a pattern which makes use of a straightaway instead of an angular movement, and at the same time allows each of the travelling coils to be given an independent swinging adjustment.

The coil-holder about to be described was made up more than a year ago, and it has proved satisfactory in every way.

There are no mechancal parts to wear out, and the adjustments are so fine that one can get the very best out of the set with it. A glance at the photograph will show that it is simplicity itself. A brass rod, supported between two wooden end-pieces, is provided with three coil-holders, the middle one fixed, the other two capable of being moved inwards or outwards along the rod.

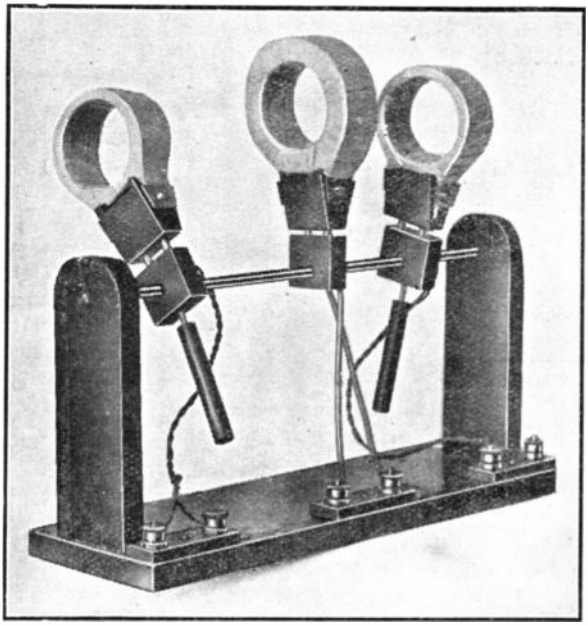


Fig. 53.—The finished coil holder.

Besides its motion towards or away from the fixed coil, each of these has also a circular movement, the rod being the pivot upon which they turn, and the handles acting as set-screws to keep them fixed in the position which has been found most suitable.

The base is a piece of wood—hard wood preferably, though this affects merely the appearance of the finished stand and makes no difference to its efficiency—measuring 12 in. by 4 in. by ¾ in. or 1 in. thick.

At either end is mounted a wooden support of the size and shape shown in Fig. 54. Two long screws secure it to the base. The guide for the coil-holders is a 12 in. length of ¼ in. round brass rod, which passes through a hole drilled in each end-piece, and is held in place by having a ¾ in. woodscrew turned down tightly upon it.

Fig. 55 gives details of the coil-holders themselves. Each is made from a piece of ½ in. ebonite measuring 1¼ in. by 1½ in. In the front edge are drilled two ¼ in. holes $\frac{9}{16}$ in. apart; these are for the plug and socket. Plugs and sockets may be purchased at 2d. a pair. Their shanks must be shortened with the hack-saw, so that they are half an inch or a little less in length. As they are a driving fit for a $\frac{1}{4}$ in. hole, they will fit very tightly into the edge of the holder.

When they are in place a 4B.A. tapping hole is drilled, as shown, in each side of the holder, and right into the brass of

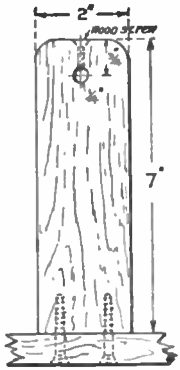


Fig. 54.—End piece.

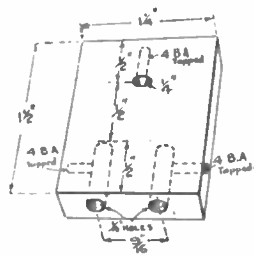


Fig. 55.—Detail of coil holder.

plug and socket. These holes are tapped and provided with 4B.A. round-headed screws long enough to make good contact with the brass. Half an inch beyond the ends of plug and socket a $\frac{1}{4}$ in. hole is drilled through the holder. This is for the guide rod to pass through. In the edge opposite that in which the holes for plug and socket were made a 4B.A. hole is drilled and tapped, running into the $\frac{1}{4}$ in hole. This, in the case of the fixed coil, is for a countersunk set-screw, which keeps the holder in place upon the rod. In the other two it is for the threaded rod, which is fixed into the extension handles.

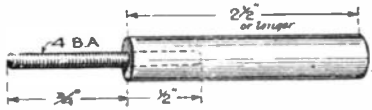


Fig. 56.—Extension handle.

These handles are made of $\frac{1}{2}$ in. round ebonite rod. Two and a half inches is a convenient length for them, but they may be made longer if the effects of body capacity are noticeable when the hand approaches the tuning stand. In one end of each a 4B.A. hole is drilled and tapped. Into this is inserted a $1\frac{1}{4}$ in. length of screwed rod, which is screwed tightly home. If the hole is a rather easy fit and the rod is found to be liable to work loose a 6B.A. countersunk screw may be used as a set-screw to keep it in place; as a rule, however, this will not be found necessary.

The holders having been placed upon it, the guide rod is placed in position between the end supports and fixed by means of the woodscrews previously referred to. We must next mount three pairs of terminals upon the base. The simplest and most satisfactory way of doing this is seen in Fig. 57. For each pair we cut out a piece of $\frac{1}{4}$ in. ebonite measuring $2\frac{1}{2}$ in. by $\frac{3}{4}$ in. In this are drilled four 4B.A. clearance holes, two for the shanks of the terminals and two for the woodscrews used to fix the block to the base.

Before inserting the terminals screw each block down to the base; then with the point of the scriber mark the exact centre of each of the terminal holes. Take the block off again, and with brace and bit make a deepish recess to clear the shanks of the terminals and their nuts. The terminals may now be mounted upon the blocks, and the latter screwed down to the base. If the recesses made in the wood are properly centred and of sufficient diameter and depth, the terminals will not touch the wood, and insulation will be as good as if the entire base were made of ebonite.

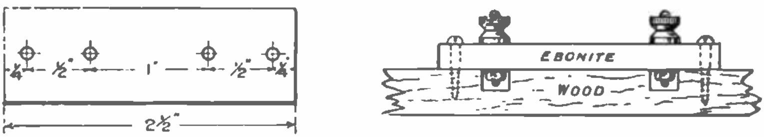


Fig. 57.—Terminals on ebonite block and plan of block.

The fixed coil is connected to the middle pair of terminals by means of systoflex covered copper wires. The moving coils are wired to the other two pairs by lengths of good, well insulated "flex."

The holder is now complete. Let us see what it has cost to make. The baseboard plus end-pieces will probably be made from some odd pieces of oak, teak or mahogany found in the wood box of the workshop. But even if they have to be bought, their cost will not run to more than ninepence. The other components required we may tabulate as follows:—

	s.	d.
3 plugs and 3 sockets	0	6
12 in. length of $\frac{1}{4}$ in. brass rod	0	4
Ebonite for coil-holders	1	0
Ebonite rod for handles...	0	6
Ebonite for terminal blocks	0	3
6 terminals	0	9
4 B.A. screwed rod, screws, etc. ...	0	4
Flex wire	0	1
Total	3	9

If we add ninepence for the base and the end-pieces the entire cost works out at only 4s. 6d.—and surely no three-coil tuning stand could be made for much less than this! Nor is the time needed excessive. If one works in quite a leisurely way the job can be done in three hours or less, all parts being well finished up. As the tools required are only a brace with a $\frac{3}{8}$ in. bit, a breast drill with $\frac{1}{4}$ in. and 4B.A. clearance and tapping drills, a 4B.A. tap, a hacksaw, a wood plane, a wood saw, a screwdriver, and a chisel, there are few amateur workshops in which it cannot be undertaken with the greatest ease.

In use the tuning stand will be found to be delightfully simple to handle. The middle (fixed) coil is the secondary, one of the moving coils being the primary. On broadcast wavelengths the third coil should not be used as the reaction inductance, for it is not advisable to couple it even to the secondary. When, however, one is working either upon foreign telephonic transmissions or upon the greater wavelengths the reaction coil may be fitted into the remaining coil-holder.

When tuning, the handle of the secondary is grasped in one hand and given a slight clockwise turn. This loosens the screwed rod, which was acting as a set-screw and holding the coil fixed, and allows it to be moved inwards or outwards along the rod. As soon as signals have been tuned to their maximum strength by the straightaway movement, the coil is pivoted gently backwards or forwards until the best adjustment is found. The tiniest clockwise turn of the handle then fixes it firmly in position. The reaction coil is dealt with in the same way.

As one is not depending upon any mechanical contrivances, tuning becomes a very simple matter, for there are few appliances so delicate or so sensitive as the human hand. Curiously enough, there are " hands " in wireless just as there are in riding or driving. The beginner is clumsy at first when he starts to make adjustments, but the expert gets the " feel " of a tuner very quickly, and can do what he likes with it.

The three-coil stand described will be found to be extremely selective on account of the double movement that can be imparted to the sliding coils. The advantages of this will become particularly apparent if it is tested on such a crowded band as that to be found just beyond 12,000 metres. The straightaway movement of the coils brings in a perfect babel of signals; but as soon as the primary and reaction inductances are pivoted slightly, some signals gain in strength whilst others grow weaker and weaker. With careful adjustment a desired signal may be picked out from the general medley and tuned in to the exclusion of the rest.

A Simple Tuning Stand

The average beginner generally finds that to construct a tuning stand similar to the type advertised is a little beyond him; but the accompanying sketches and description relate to a simple one, which is quite efficient, and yet easy to construct.

Referring to the sketches, Fig. 58 is the plan an elevation of the instrument, and Fig. 59 a cross-sectional end view with a coil-holder inserted In Fig. 58 there are the usual three holders, the stationary one in the centre marked A and the moving ones B, B on each side of it. B slides in a groove which the two strips C, C provide. This is more clearly seen in Fig. 59.

The following material will be required:—Six terminals, six valve legs, a few odd pieces of ebonite, twelve tags (these can be cut from sheet brass to the sizes given in Fig. 58), two brass rods 3¾ in. in length, having a screw thread at each end, and a piece of flexible wire.

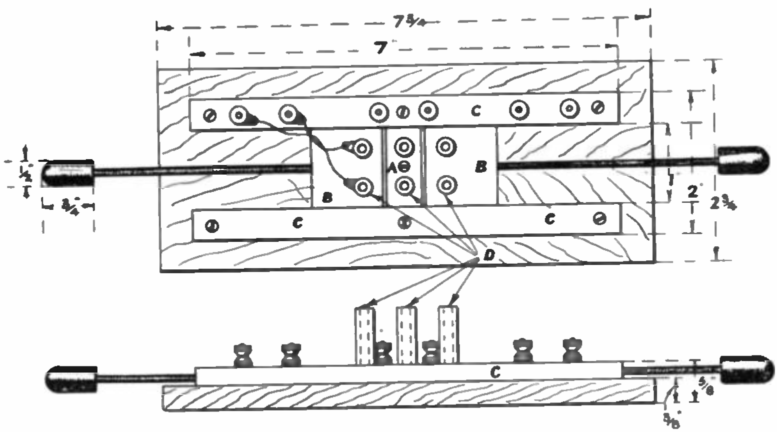


Fig. 58.—Plan and elevation of the tuning stand.

The first operation is the making of A and B, B. Take a piece of ¼ in. thick ebonite, file the sides to size (2¾ in. x 1¼ in.), and mark along each edge of one side a line ⅛ in. from and parallel to the edge. as shown in Fig. 60, and then file to shape, as seen in the end view. This piece is cut into three, as shown in dotted lines, the ends made true with a file, and the holes bored in their respective positions. The holes to take the valve legs and the two brass rods must be tapped. Place a tag on each valve leg and insert them in their holes, cutting off and filing level the thread that protrudes on the other side. Screw the brass rods into the ends of B, B. The two small knobs can be made from ebonite rod ½ in. in diameter, by cutting two pieces ¾ in. in length. filing them to shape shown in Fig. 58, boring the holes for the rods, and finally tapping them. The three holders will then be completed.

For C, C two pieces of ebonite 7 in. x ½ in. x ¼ in. are required. The bevel is cut in the same way as the holders. On one, holes for the three fixing screws and for the six terminals are bored, and an the opposite side (the side on which the bevel slopes inwards) the six holes are countersunk for the heads of the terminals. The other strip will only require the screw holes. A tag is placed on each terminal before fixing it to the strip. It is best, before securing this part to the base, to solder pieces of flexible wire from the tags on the holders to the tags on the terminals. The right-hand pair of valve legs are connected to the

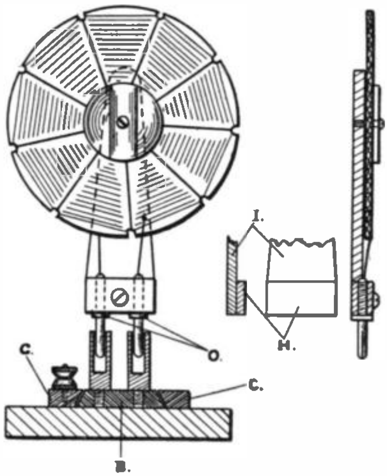


Fig. 59.—Cross-sectional view.

right-hand pair of terminals, the centre pair to the centre pair of terminals, the left-hand pair to the left-hand terminals. Take the base (which need not be precisely of the same sizes given), and screw to it the strip containing the terminals and the centre piece A. B, B are placed in position, and the other strip placed alongside. Hold the strip firmly with one hand, and with the other move B up and down. It may be found necessary to ease

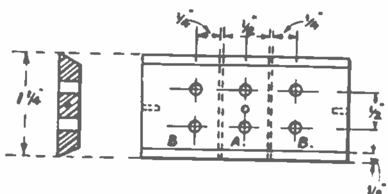


Fig. 60.—Mounts for the coil-sockets.

slightly the sides of B, B with a file, so that they will slide nicely. This strip is then screwed down, which will complete the tuning stand.

A Coil-Holder.—A coil-holder suitable for mounting various classes of coils, such as basket and slab inductances, is shown in the upper part of Fig. 59. The height of the holder will depend on the size of the coil to be mounted, but the other part has definite sizes. The material required for one holder is as follows:—Two valve pins, pieces of $\frac{1}{8}$ in. ebonite, and two screws. Cut pieces of ebonite to the approximate sizes of H and I. Drill a clearance hole in H and a tapped one in I, and screw the two together tightly. Grip it with a pair of pliers, and bore the holes for the valve pins. It is important that the distance between the centres must be exactly $\frac{1}{2}$ in., otherwise it will not fit into the tuning stand holder. The coil-holder is then finished off with a file. The ends of the coil can be either soldered to the pins or clamped underneath washers.

A Simple Tuner with Many Uses

This tuning stand represents an attempt to make up a little set designed on the simplest possible lines that would do everything that the most complicated and expensive affairs could accomplish, and a good deal more besides. The first experimental model was made up in the roughest way in an hour or two, and it gave such promising results that a decently finished set of apparatus was put in hand at once. Since then it has been in constant use on a six-valve set, and nothing could have been more satisfactory. Tuning is delightfully simple; the most minute adjustment of the coupling between coils can be obtained on all wavelengths between 100 and 30,000 metres in the easiest possible way. The total cost was as follows:—

	£	s.	d.
Set of basket coils	0	5	0
Set of slab coils	0	7	6
Six terminals	0	0	6
Six valve sockets	0	1	0
Thirty valve pins	0	2	6
Ebonite	0	5	0
Total	£1	1	6

Thus for less than the cost of a good three-coil holder alone, one has not only the stands themselves, but also a full set of coils covering all wavelengths.

The basket coils, seven in number, allow the set to be tuned from 100 to 3,700 metres, whilst the eight slabs range from 300 to 30,000 metres. For the short wavelengths basket coils are very efficient indeed, owing to their low self-capacity. Slab coils are comparatively inefficient, and they are not very easy to use on a large set, since they have an inherent tendency to cause circuits to fall into oscillation; still, one does not often work at much over 4,000 metres, and the slab coils, if carefully used, will be found quite good enough for ordinary purposes.

The tuner consists of three little stands made of polished wood, each with an ebonite top. The middle stand (Fig. 63) is made T-shaped, in order that quite close coupling may be obtained when necessary. In use, it is screwed to the middle of a polished base made of ½ in. mahogany, and measuring 12 in. in length by 5 in. in width. On this base the other two holders, little wood blocks 2½ in. by 2 in. are manœuvred by hand. The lines ruled across the baseboard (see Fig. 65) enable the user to note down the degree of coupling that gives the best results for any particular station. Fig. 64 gives details of the moving holders.

The construction of the holders is so simple that anyone can undertake it, even if his workshop contains none but the most ordinary tools. The stands may be cut from any kind of wood, but it is very important to hollow out the top of each so that

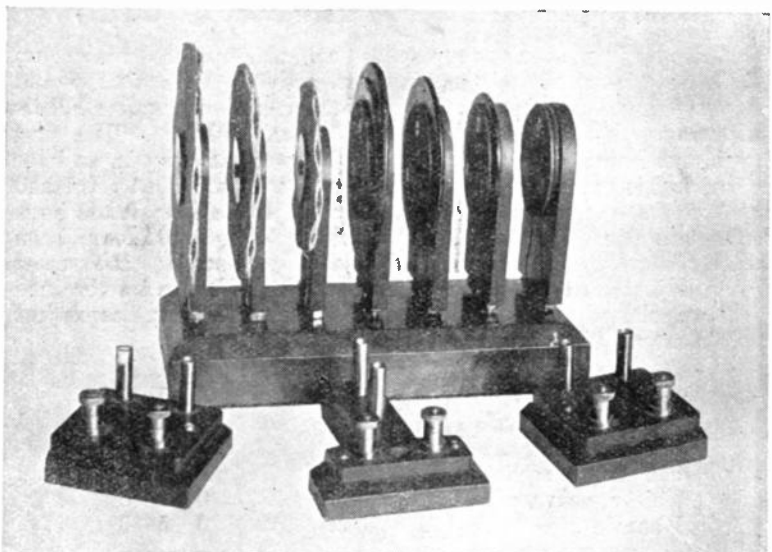


Fig. 61.—The coil-holders and rack of coils.

the lower ends of the valve legs and terminals and the bare wires joining these make no contact with the wood, otherwise a loss of signal strength may occur. High-frequency currents are kittle cattle, always ready to take advantage of any kind of short circuit, and wood is as a rule of very little use as an insulator where they are concerned. The hollowing out can be done by making shallow recesses with a brace and a good sized bit to take the nuts of valve legs and terminals, and by cutting a groove deep enough to clear the connecting wires. The ebonite tops are cut out with a stiff-backed saw and the edges finished up with a fine file, receiving their final trimming with 000 emery-cloth and turpentine. Each little ebonite plate requires eight holes to be bored in it, four for the holding-down screws and two each for terminals and valve legs. Valve legs are usually threaded 4B.A. and terminals with the same thread should be used.

Use a 4B.A. tapping drill to make this second set of holes, and tap them out; terminals and valve legs can then be screwed firmly into place, and there will be no risk of their working loose later.

Should you wish to use duo-lateral or honeycomb coils on these stands, pins and sockets to fit them should be fixed on to the ebonite plates instead of the valve legs. Little blocks containing one pin and one socket may be purchased ready-made for 1s. apiece, and these can be mounted just as they are on the stands. In order to make the moving holders quite steady when

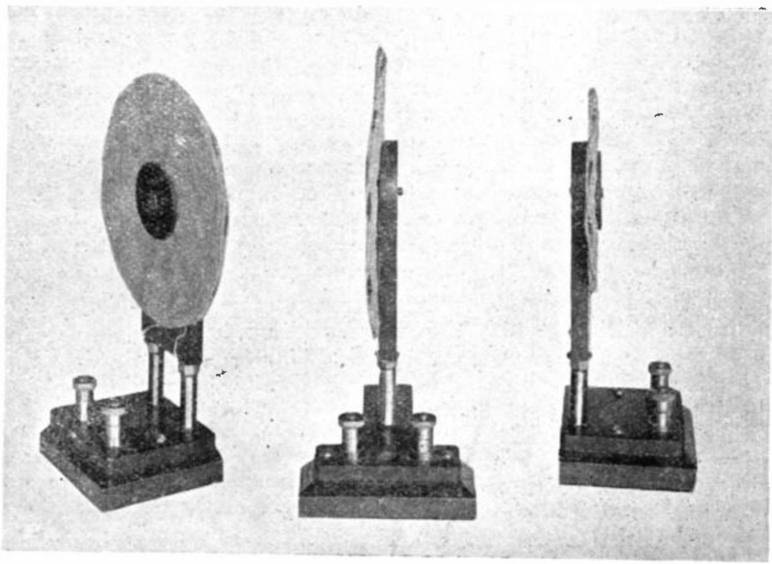


Fig. 62.—Showing three basket coils mounted in the holders.

carrying heavy honeycomb coils it would be as well to make them of rather larger dimensions than those already given, say, 3 by 3½ in.

For baskets and slabs the valve pin and socket mounting is excellent, and it can be recommended if these coils only are to be used. If, however, the reader desires to use honeycombs as well, he had better adopt the large plugs and sockets throughout.

The set illustrated in the photographs was made for the former types of coil only. It was found convenient to space legs and sockets just an inch apart, but those who desire to construct similar tuners can, of course, adopt just the distance that suits them best in case they have sets of coils already mounted.

The mounting of the coils themselves is again a job that no one need shrink from. Fig. 66 shows the shape and dimensions of the ebonite strips used for baskets, and Fig. 67 those for the mountings of slab coils. The latter had to be made rather wider since the holes in the middle of slab coils are considerably bigger than those of the baskets.

Basket coils were fixed in place by means of a single 4B.A. screw passed through a disc of ⅛ in. ebonite 1¼ in. in diameter. To prevent the disc from cracking under pressure—thin ebonite is very brittle stuff to work with—the hole of the coil was filled up with a rubber washer cut from an old inner tube, so that it might have something springy to bear against.

As a matter of fact there is no need at all to use ebonite for the discs, and fibre was chosen when it came to tackling the slabs. Besides being less brittle, this material has a decided advantage for the purpose, for it enables the maximum and minimum wavelengths of each coil to be stamped on its disc with a figuring punch. As the larger slabs are very heavy, it was found better to secure them with three screws rather than with a single one, in order to make a solid job.

To give the best results all coils, no matter what their size, should be concentric when placed on the stands of the tuner. The single hole for the retaining screw of the basket coils was drilled 2¼ in. from the bottom of the ebonite; the three screws of the slab coils are on the circumference of a 1⅛ in. circle, the centre of which occupies the same position.

In order that there may be no difficulty about drilling the holes for the valve-pins, the mounts should be made of ¼ in. ebonite, which allows plenty of room. The holes are tapped with a 4B.A. thread and the pins are screwed tightly in, each being provided with nut and washer to secure the ends of the wires from the coils. It is important that all coils should be mounted, so that their windings are in the same direction. To ensure that this is the case, always take the wire from the inside of the coil to the left-hand pin, and that from the outside to the right. When using the tuner adopt the rule of making the discs of all coils face to the right. The moving holders are connected to the appropriate terminals of the set by means of flexible leads.

When made, the tuner is an instrument which may be put to a very great variety of uses. The most obvious one is to employ it simply as an aerial tuning inductance. In this case one of the moving holders takes the primary coil, the secondary is slipped into the sockets of the fixed T, and the reaction coil is placed in the other moving holder. This arrangement ought not, of course, be used on broadcasting wavelengths during the specified hours, since it is risking radiation to couple the reaction coil even to the secondary of the A.T.I. We shall see in a moment how this difficulty can be overcome.

The best method of handling the tuner when used in this way is as follows:—Having chosen suitable coils for the transmission which it is desired to pick up—the secondary will usually be one size larger than the primary if the A.T.C. is in parallel, and the reaction coil one size smaller—bring primary and secondary fairly close together, keeping them parallel to one another; the reaction coil may remain further away for the time being. Tune with aerial and closed circuit condensers in the ordinary way until signals are at their best, next obtain a rough coupling adjustment by moving the primary coil nearer to or farther from the other straight along the polished base. When you have done the best that is possible in this way make fine adjustments by turning the primary at a slight angle in one direction or the other, which, owing to its "vernier" effect, enables extraordinarily sharp tuning to be accomplished. Then deal with the reaction coil in the same manner.

It will be noticed that the coils can be placed in *any* position in relation to one another Your adjustments are not confined,

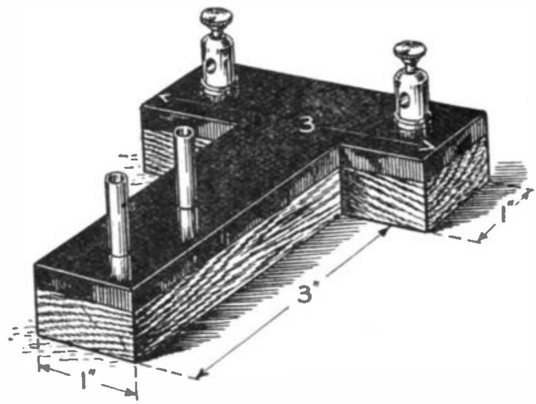


Fig. 63.—The middle holder.

as they are with the ordinary three-coil holder, to variations in the angles between the coils. Fig. 68 shows a few only of the combinations possible. Only one of these (*c*) can be obtained with the three-coil holder of the usual type.

As may be imagined, a tuner which allows such a variety of couplings is extremely selective; in fact even on such a crowded wavelength as 600 metres it is usually possible to pick out one set of signals from the babel that first meets the ears and to tune it to the exclusion of the rest. This is due largely to the amazingly fine adjustments that are possible in the couplings between coils.

The reaction coil may be used in rather a novel way to control a set which insists upon falling into oscillation; simply turn its coil-holder right round, the direction of the flow of current is thus reversed and the coil exercises a damping instead of a "boosting" effect.

The moving coil-holders may, if desired, be fitted with long handles but I have never found this to be necessary. If the effects of body capacity are noticeable when the hand approaches the holders a pencil may be used to move them, but if the set is properly controlled by means of a potentiometer, these effects will not occur, except perhaps when slab coils are in use on the greater wavelengths, and even then they are not serious.

For broadcast reception, where it is desired to make use of reaction in a legitimate way, the little holders and their coils can be used to great advantage. One very simple way is to make a fresh pair of moving holders to take primary and secondary coils, and to convert the trio already constructed into a high-frequency transformer with reaction coupled to its secondary, as shown in Fig. 69. Basket coils used in this way make an excellent transformer, and as the coupling is variable to any extent, very sharp

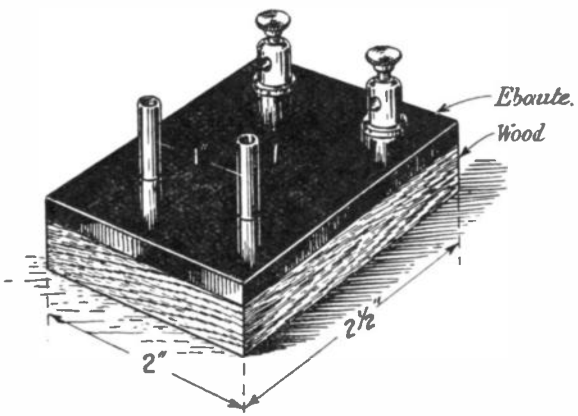


Fig. 64.—The moving holder.

and selective tuning becomes at once possible with little or no risk of causing interference with others' reception by means of re-radiation.

If tuned-plate coupling is used for the H.F. valve or valves, one of the little holders makes a first-rate stand for the anode coil. Reaction may be obtained—this again is a safe circuit for broadcast reception—by employing a pair of holders and wiring them as shown in Fig. 70.

To reach very long wavelengths several basket coils may be used in series to form an aerial tuning inductance or closed circuit inductance. All that is necessary is to mount each on a stand of its own and to connect them so that currents flow in the same direction.

There are, in fact, numbers of useful purposes which these little coil-holders can be made to serve in the set. One can even obtain a variometer effect by connecting two together and varying the coupling between them.

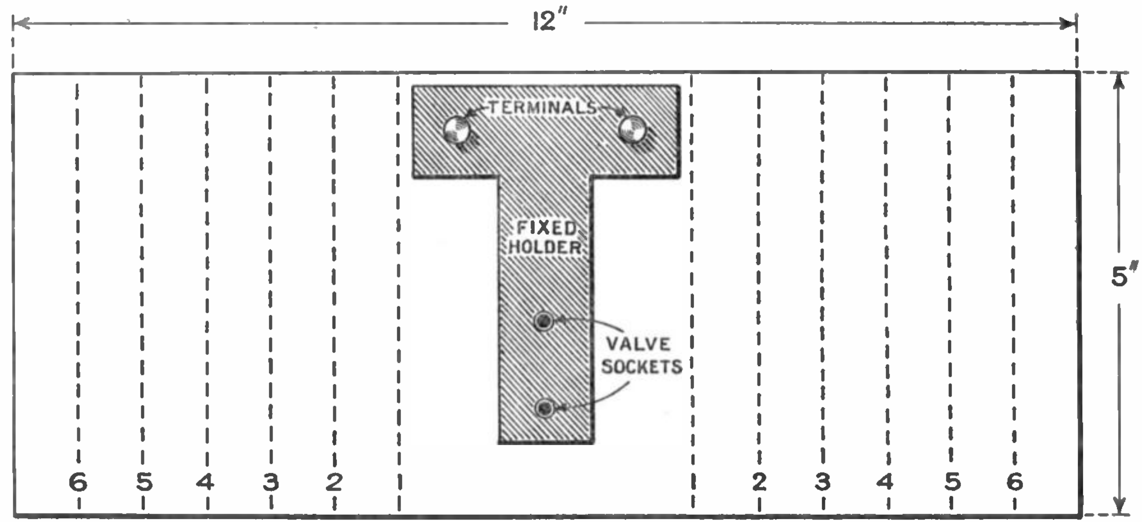


Fig. 65.—Showing the middle holder in position on the hase-board.

As there are no gear wheels or other moving parts there is nothing to get out of order; indeed there is no reason why they should not withstand many years of constant use and still be as good as ever.

There is one point, by the way, about basket coils which is worth noting. Many of those on the market are very flimsy affairs, loosely held together by a very meagre coating of paraffin wax. If these are purchased and mounted they will be a constant source of annoyance owing to their habit of starting to come to pieces almost as soon as they are handled. There are three ways of dealing with them. One is to give them a little more backbone either by brushing them over with wax melted down from a worn-out high-tension battery, or by applying stiff shellac varnish. Another and better method of prolonging their

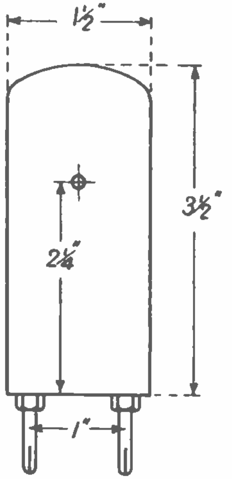


Fig. 66.—Ebonite strip for mounting basket coils.

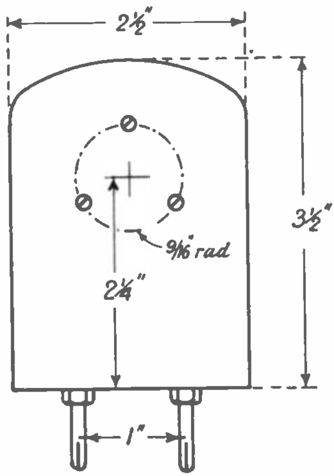


Fig. 67.—Strip for mounting slab coils.

lives and of saving one's own temper, is to "tape" them with sticking plaster. The best of all is to cut out two plates of thin celluloid with a diameter rather larger than that of the coil, and to place one on each side of it as a protector when fixing it to the ebonite mount.

The smallest sized baskets are of very little use—in fact it is not really worth while to mount them at all. The best plan for obtaining good reception on the lowest wavelengths is to make up a set yourself, using No. 26 double cotton-covered wire and winding them on stiff cardboard formers in which an odd number of slits have been cut. If the aerial tuning condenser is in series, as it should be, the primary can be quite large, with a corresponding increase in efficiency. A point in favour of card-wound coils is that they need have no shellac applied to them. Shellac is first-rate as a stiffener, but by providing an excellent dielectric between the turns it must be admitted that it increases the self-capacity of the coils, which is always a feature to be avoided if possibie.

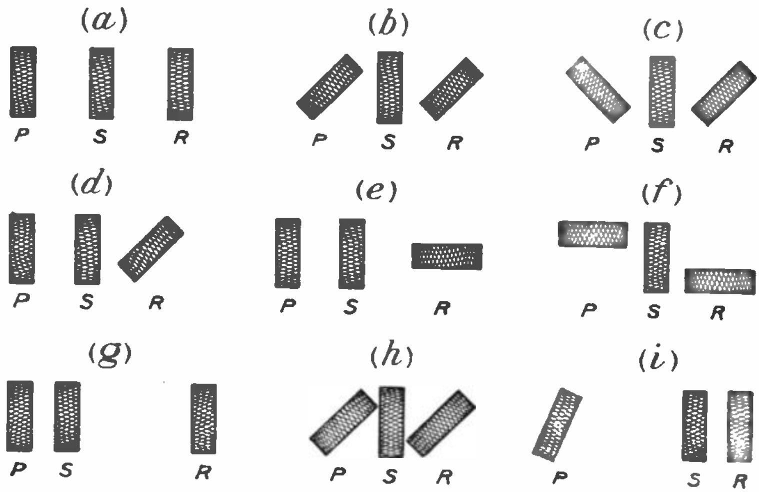


Fig. 68.—Possible arrangement of coils which can be obtained with the holders.

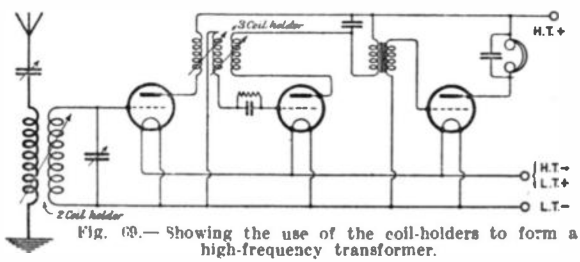


Fig. 69.— Showing the use of the coil-holders to form a high-frequency transformer.

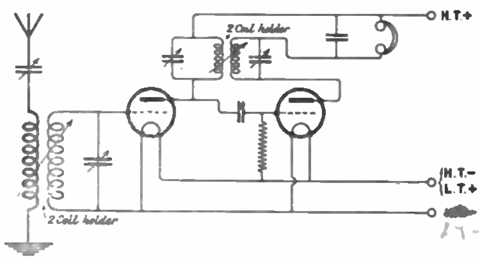


Fig. 70.--The use of the coil-holders in a tuned anode circuit.

To whatever type of coils you adapt it, you will find this simplest of all tuners a thoroughly sound piece of apparatus.

CHAPTER IV

CRYSTAL DETECTORS

Interchangeable Crystal Cups

These are very simply made, it only being necessary to solder or otherwise secure a brass spade piece to the bottom of the cup, as shown in accompanying sketch "A." This little "fishtail" may be cut from thin brass of about 24 or 26 W.G.

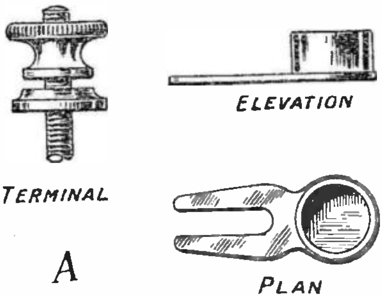


Fig. 71.—How to make the cups.

It will be apparent that used in connection with a terminal, these cups can be very quickly changed, and adjusted to any position in the horizontal plane. They are best employed with the "Perikon" type of detector, a rough elevation of which is shown at "B," but they can be used with equal advantage on the usual type of ball and socket detector by inserting a terminal

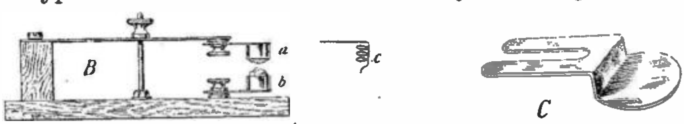


Fig. 72.—Method of fitting.

in the hole that is normally occupied by the screw which fastens the cup in such a detector, but when so used the "fishtail" or spade fastening will of course have to be bent to the shape shown in accompanying sketch, "C," as otherwise the cup would be mounted too high and come too near the "cats-whisker" holder. The writer employs some half-dozen of such cups of various crystals, the name of each (or a letter standing for the name) being scratched on the "fishtail," and he is thus enabled to change his crystals about with the utmost facility and certainty.

A Glass Enclosed Crystal Detector

The materials used being simple and the tools required few, the construction of this detector will appeal to those who make their own apparatus.

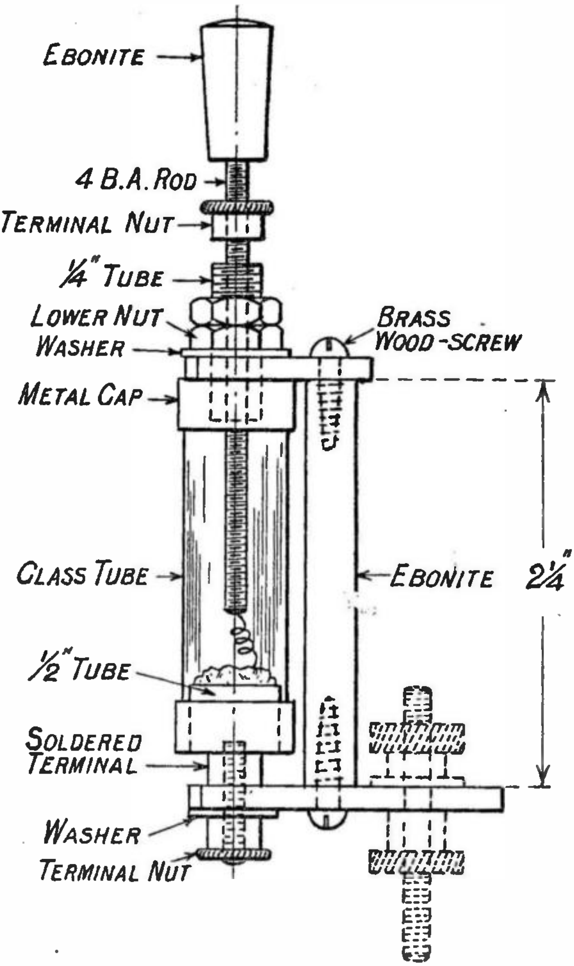


Fig. 73.—General arrangement of detector.

The component parts are one 3 in. length of 4B.A. screwed brass rod, one ¾ in. length of brass tube screwed ¼ in. outside and 4B.A. inside, two brass nuts tapped ¼ in. for the outside of the brass tube, two 4B.A. terminals of the screw-through type, one ⅜ in. piece of ½ in. brass tube, for crystal cup, one piece of 1¾ in. by ¾ in. by ⅛ in. brass strip, and one piece 1 in. by ¾ in by $\frac{1}{8}$ in., one $2\frac{1}{4}$ in. and one $\frac{3}{4}$ in. length of ebonite tube, one 2 in. length of glass tube, and two metal caps which will fit tightly over the ends of the glass tube.

The piece used was originally from a capsule tube, the bottom portion being nicked round the edge with a file and broken off, the rough edge being rubbed lightly on a piece of fairly smooth sandstone to remove the roughness. The tube is provided with nicely fitting metal caps, and as two are needed, it will be necessary to obtain two tubes, although only one will be required. Two $\frac{1}{2}$ in. round-headed brass screws and a couple of small brass washers complete the list of necessary materials.

Commence the construction by punching a hole through the centre of one of the metal caps to accommodate the bottom screw of a 4B.A. terminal, cutting off all but about $\frac{1}{32}$ in., leaving only sufficient projecting into the interior of the cup to keep the terminal in position until secured by solder. If it is possible to secure the screw by means of riveting without damage to the cap, it is preferable, as subsequent operations are somewhat simplified. Place the $\frac{3}{8}$ in. piece of $\frac{1}{2}$ in. brass tube concentrically within the metal cup, and drop in a small piece of solder, using a non-acid flux. By gently heating the tube and cap in a clean flame the solder will melt and make a firm joint. Previous to melting the solder the terminal nut should be removed to guard against the possibility of becoming sweated to the screw. The metal cap now forms the bottom crystal cup. The cap for the top is centrally punched for the accommodation of the $\frac{3}{4}$ in. length of the $\frac{1}{4}$ in. threaded brass tube. In this case the tube may project into the interior of the cup about $\frac{1}{8}$ in. for the solder to adhere to. Any solder which may run on to the outside should be removed with a sharp knife.

Having nicely cleaned, put on a washer and the two $\frac{1}{4}$ in. brass nuts, and through the centre screw the 3 in. length of 4B.A. threaded brass rod. If a "cat's-whisker" contact only is required, the attaching of a fine brass or copper helix may be left until the last to avoid accidental damage. Should, however, a two-crystal contact be desired, a bought cup may be screwed or soldered to the bottom end of the brass rod before screwing the shorter length of ebonite to the top. Previous to fixing the ebonite, take the top nut from the remaining terminals and screw it on to the brass rod, thus providing a binding screw to secure the contacts after final adjustment. If preferred, a cup similar to the bottom one may be made from another $\frac{3}{8}$ in. piece of the $\frac{1}{2}$ in. brass tube with a small piece of sheet brass as a cover. The main difficulty of construction in this case is to keep all accurately centred so that there shall be no danger of breakage of the tube on rotation of the screwed rod.

The larger of the brass strips may now be drilled with three holes to allow for the free passage of a 4B.A. screw, commencing $\frac{3}{8}$ in. from one end and making the centre $\frac{1}{2}$ in. apart. Two hacksaw cuts are taken from the end into the first hole to form a slot, thus completing the bottom plate (Fig. 74).

The small strip is drilled with two holes in a similar manner to the larger one, but allowing a ¼ in. clearance for the first hole, which, when cut into, forms a slot for the reception of the ¼ in. screwed portion of the top cup. Between the two brass strips screw the longer ebonite tube by means of the round-headed screws. If the screws are tight they should not be forced into the ebonite, but should be slightly heated, not being finally forced home until they are cold, as otherwise there is a danger of stripping the threads from the ebonite.

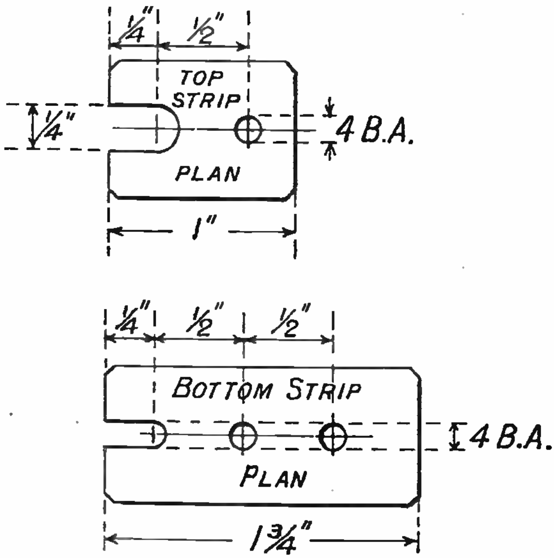


Fig. 74.—Details of brass strips.

Having secured the bottom crystal in its cup and the top "cat's-whisker" contact or crystal, the caps are placed over the ends of the glass tube, and, sliding the whole into position between the brass strips, slip a small brass washer over the projecting terminal screw at the bottom and secure with the terminal nut. The upper cap is fixed to the strip by the lower ¼ in. nut, the upper nut securing the lead wire when connecting up.

In order to dispense with a separate base-plate, the whole detector is fixed to a terminal placed in any desired position on the receiving apparatus, for which purpose the remaining hole in the bottom strip is provided. Although exact measurements are given, there is no need to adhere to them strictly, and they could be modified by the sizes of the materials on hand.

A Crystal Detector for Valve Sets

There can be no doubt that for the reception of speech and music the crystal detector is superior as a rectifier to the three-electrode valve. It rectifies all frequencies with equal efficiency, and hence distortion and " woolliness " are almost

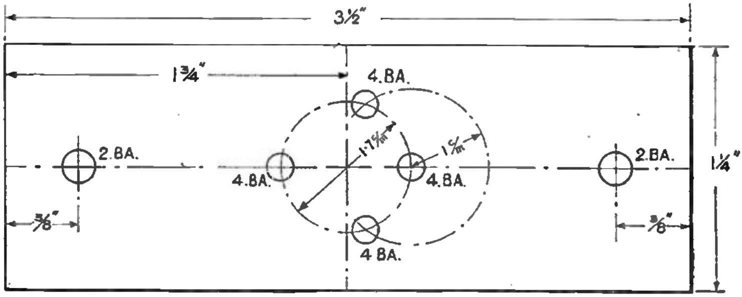


Fig. 75.—How to drill the ebonite.

eliminated. Further, being less responsive than the valve to weak impulses, it considerably reduces the volume of partially heterodyned " mush " that so frequently accompanies transmissions from broadcasting or other powerful stations.

If your set is powerful enough to bring in any particular telephonic transmission without the use of reaction, the use of

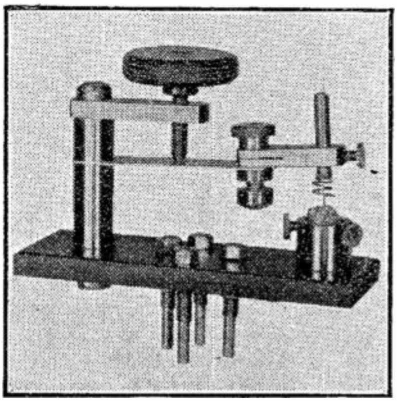


Fig. 76.—The complete detector.

the plug-in crystal detector about to be described may be found to have an appreciable effect on the quality of the reception. There may be possibly a very slight loss in signal strength, but as the " mush " is weakened more than is the legitimate transmission, you are the gainer on balance.

This little detector was designed to plug into the valve-holder of a rectifying panel of a set using two stages of tuned-anode high-frequency amplification, and either one or two note-magnifiers. It is extremely simple to make and most satisfactory to use.

A piece of ebonite 3½ in. long by 1¼ wide and ¼ in. thick is laid out and drilled, as shown in Fig. 1. The 2B.A. holes shown are for the screws of the crystal cup and the supporting rod of the detector. The dimensions and distances apart are those found suitable for an old detector which happened to be lying at hand; they will probably require modification to suit such types of detector as any readers who make up this little device may have by them.

The detector having been mounted, four valve pins are fixed into the 4 B.A. holes shown, brass strips connecting those corresponding to grid and plate with supporting rod and crystal cup respectively. It is important, with Permanite at any rate, that

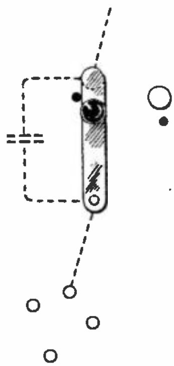


Fig. 77.—The short-circuiting switch for the grid condenser.

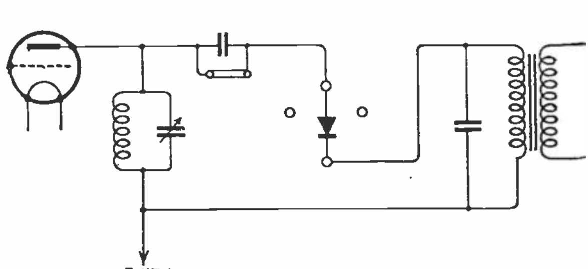


Fig. 78.—How the crystal is connected.

connections should be made in this way, for if they are reversed the crystal will not function well. The two pins corresponding to the filament legs are left unconnected; their only purpose is to give the detector a firm seating in the valve-holder.

The detector is now complete, its appearance being as shown in the photograph. One other little job, however, must be done if it is to work properly. The presence of the grid leak does not seem to matter in the least, but that of the grid condenser cuts down signal strength by more than fifty per cent. We must therefore make up a simple short-circuiting switch for throwing it out of action.

Fig. 77 shows how this may be done. Fig. 78 gives a wiring diagram, showing how the detector fits into the circuit when it is plugged into the valve-holder.

An Emergency Detector

It is often wanted to construct a crystal detector for purposes of experiment. Possibly the only crystal detector in one's possession is already engaged at the time, and one does not want either to have the bother of making an elaborate article to act as a substitute or to spend several shillings in buying one.

The illustration, Fig. 79, shows a simple type that can be made in a very short time. The foundation consists of a 2 in. length of glass tubing with a diameter of not less than ½ in. At either end is inserted a fairly tightly fitting ebonite plug.

In one of these a hole is drilled just large enough to allow a piece of fine insulated wire to be pulled through. The wire is fixed in place by making a couple of turns round a screw driven into the face of the plug. Its inner end is clipped off at about 1½ in., and coiled round a knitting needle to form a "cat's-whisker."

In the other plug is drilled a hole just large enough to take an empty revolver cartridge-case, anything from .300 to .45 is suitable for fairly large plugs, though if the glass tube is only ½ in. or so in diameter a .22 rifle cartridge-case will have to be used. This is secured by a set-screw, whose head is entirely countersunk, driven in through the edge of the plug. A lead is soldered to the base of the cartridge-case, a crystal of whatever

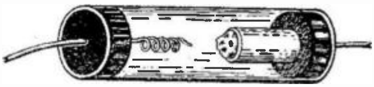


Fig. 79.—The complete detector.

kind is preferred being fixed by means of Wood's metal into its hollow end.

If a crystal such as hertzite or permanite is used which contains many sensitive spots, adjustment of the detector is not at all a difficult matter. Once a good position has been found for the "cat's-whisker" the plugs may be sealed in position by applying a coating of shellac to the joint between them and the glass. The detector thus remains permanently set, and it will stand quite an amount of rough handling without getting out of adjustment.

When much experimental work with detectors is done it is not a bad idea to make up a number of these detectors, all of the same size, provided them with different crystals. If a brass contact strip is fixed to the outer face of each plug they can be made to fit into spring clips similar to those used for supporting grid leaks and anode resistances. The name of the crystal used should be written on a small gummed label stuck to the glass.

An Experimenter's Crystal Detector

Probably 75 per cent. of the receiving sets in use in this country to-day make use of the crystal as a rectifier either with or without the addition of amplifying valves. Quite apart from its simplicity, its cheapness and the ease with which it can be operated, the crystal detector has a fascination of its own. For telephonic transmissions there can be no doubt that the crystal is supreme as a rectifier owing to its almost perfect action, which results in a complete absence of distortion. It has therefore a particular attraction for the experimenter.

The worst of detectors of the ordinary type is that they provide only one combination of either crystal and crystal, or crystal with metal contact. If one wishes to try others quickly it becomes necessary to have a supply of ready-mounted detectors at hand; and to make a change, leads must be detached and re-connected. The detector now under consideration provides in its simplest form from three to six crystal cups, so that this number of different crystals can be mounted, any one of which can be brought into action in a moment. An elaboration of the arm, which presents little difficulty, enables one to have a variety of upper contacts always instantly available.

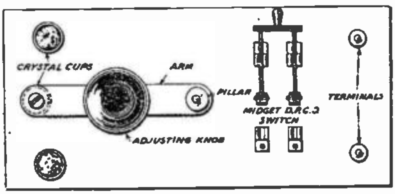


Fig. 80.—Showing plan of the finished detector.

A further point to be noticed is the provision of a double-pole double-throw switch, by means of which the wiring of the detector can be altered in a moment without the need of the fiddling and time-wasting process of changing the leads over.

Fig. 80 shows a plan view of the finished detector. The cups, from three to six in number, are arranged on the circumference of a circle of 2½ in. radius at whose centre stands the pillar supporting the contact arm and that upon which the adjusting screw is mounted. At the other end of the ebonite panel are two terminals for the leads from the set. Between them and the pillar is a double-pole change-over switch of the midget type, which can be bought complete, but unmounted, for about 2s. Those who prefer to make the switch can do so from descriptions given in a later chapter of switches of similar type though of larger size. The dimensions will have to be reduced in order to make a neat job. The length of the parallel arms will be 1 in., and their distance apart half an inch.

Fig. 81 shows the layout of the panel, which is of ¼ in. or ⅜ in. ebonite measuring 6 in. by 2¾ in. The holes for the two terminals and for the clips of the switch are 4B.A. clearance. A 3B.A. hole is drilled to take the rod which forms the backbone of the pillar. The holes for the screws that fasten the cups in place are shown as 3B.A., since this is a common size for them. Some cups, however, have 4B.A. screws.

In Fig. 82 are seen the details of the pillar and the arms of the detector. A $3\frac{1}{2}$ in. length of 3B.A. screwed rod is inserted into the hole drilled for it and secured by nuts above and below the panel. A piece of $\frac{3}{8}$ in. brass tubing $1\frac{1}{2}$ in. in length is slipped over it, then comes the contact arm, to the far end of which a fine "cat-whisker" has been soldered if the simplest form of the detector is being made up. Over this comes a short length of the $\frac{3}{8}$ in. tubing and then the supporting arm for the

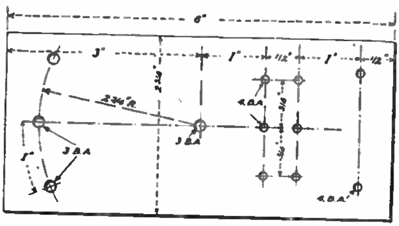


Fig. 81.—Lay-out of the panel.

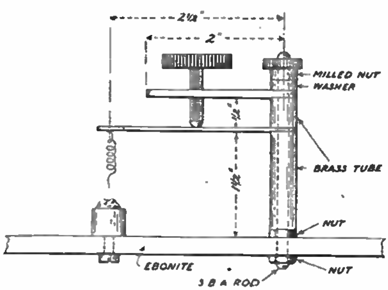


Fig. 82.—Details of the pillar and arms.

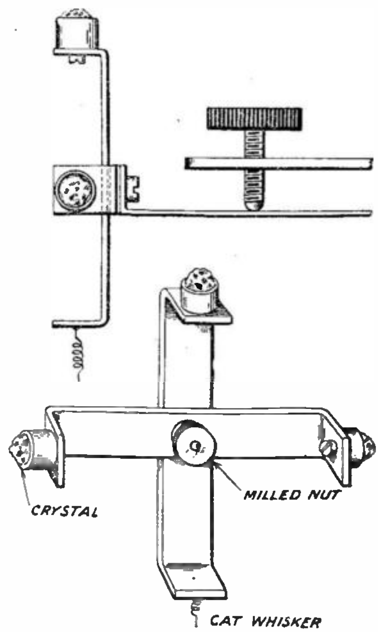


Fig. 83.—A suggestion for crystal-crystal combination.

adjusting screw. The contact arm is made of sheet brass of fairly heavy gauge. The supporting arm should be cut from a piece of metal $\frac{3}{16}$ in. in thickness, so that the adjusting screw may have a good bearing surface. Most knobs are sold tapped or bushed to make a 2B.A. screw, whose thread is rather too coarse to allow delicate adjustments of contact pressure to be made. It is best therefore to procure, if possible, an undrilled knob, and to fit it with a length of 4B.A. screwed rod.

Above the supporting arm is a washer, and a milled headed nut, such as those used for the tops of the terminals, clamps the two arms in place. It will be seen that they can be swung over any of the cups by merely loosening this nut temporarily.

If the experimenter intends to use crystal-to-crystal combinations he will find the more elaborate arrangement shown in Fig. 83 very handy. In this case the contact arm is raised 2 in.

instead of 1½ in. from the panel. Its end is turned up at right angles and drilled with a 4B.A. hole.

The revolving endpiece is made of two strips of sheet brass soldered together so as to form a cross. The ends of each of the four arms are bent at right angles, little cups made from empty .22 bore copper cartridge cases being soldered to three of them to take the small pieces of crystal which form the upper contacts. The fourth arm carries a " cat-whisker."

The endpiece is secured to the contact arm by means of a 4B.A. ½ in. screw, provided with a milled nut. Any contact can thus be brought into play by loosening the nut and revolving the endpiece.

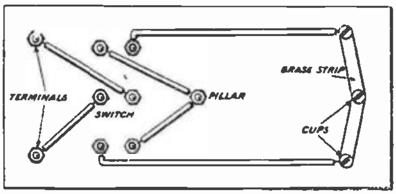


Fig. 84.—The underside of the panel.

Fig. 84 gives a wiring diagram of the detector. It will be noticed that a brass strip is placed under the heads of the screws which hold the crystal cups in place, and that leads are taken from this to two of the clips of the D.P.C.O. switch.

The effectiveness of the switch can now be seen. If this is thrown over in the direction of the top of the diagram the upper terminal is connected to whichever crystal cup is in use, the lower *via* the pillar to the contact arm. When the switch is turned over the other way the upper terminal is connected to the contact arm, the lower to the crystal cup.

An Improved Crystal Cup

It is surprising that so little thought has been given by the makers of wireless apparatus to the crystal cup, when one considers how unsuitable the usual pattern is. Crystal cups are generally far too shallow, with the result that when the crystal is placed in position and the clamping screw tightened up the crystal is either forced out of the cup or the crystal is broken. Another fault is that only the top of the crystal can be utilised.

A glance at Fig. 85 (which is self-explanatory) shows that the crystal has a flat surface to butt against, and is held in position by a substantial screw. Another point that will be noticed is that two sides of the cup have been cut away, exposing as large an area as possible to the contact wire. The cup can be readily made by placing a short length of ⅜ in. square brass rod in the vice, then cut to the shape shown in Fig. 85, a hacksaw being used for the purpose. A coarse file of square section, with one smooth side, should be used to remove the metal in the centre.

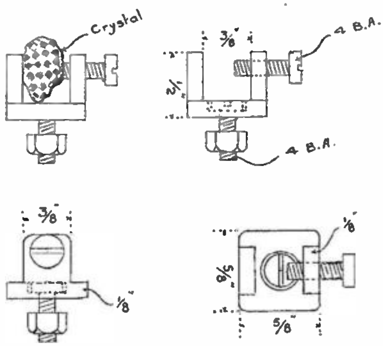


Fig. 85.—Details of the cup

This cup has been a great success, and it is unfortunate that no manufacturer has placed a crystal cup of this type on the market.

A Finely Adjustable Detector

Whether it is intended to be used by itself or to act as the rectifier on a multi-valve set, a finely adjustable crystal detector is one of the most useful pieces of apparatus that can find a place on the experimenter's bench. Most of those that one buys

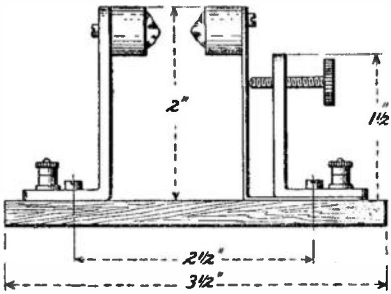


Fig. 86.—The detector assembled for use.

have defects in their design that make them unsatisfactory for delicate work. Sometimes the adjusting screw is too coarse, sometimes the supports are so flimsy that the slightest jar upsets the contact after laborious adjustments, sometimes again no movement is provided for the cups themselves, so that one cannot properly search the crystals held by them for their most sensitive spots.

The design now to be described, besides being both easy and cheap to make, has none of these drawbacks. Whilst adjustments are being made it is perfectly flexible, but once it has been set it can be counted upon to withstand any reasonable treatment, in the way of slight jars that must occur when one is working at the wireless table.

The base is a piece of ¼ in. ebonite 3½ in. long by 1½ in. wide. Only four holes are drilled in it; these, which are 4B.A. clearance, take the shanks of the terminals and the bolts (Fig. 5) which secure the supports in their places.

The supporting arms are made of stout angle brass, which is obtainable from most ironmongers. That which supports the fixed crystal is 2 in. in height; the other is ½ in. less. A 4B.A. clearance hole is drilled ¼ in. from the top of the longer one, and a slot is filed down to meet it (Fig. 87). The purpose of this is to enable cups provided with various crystals to be removed or

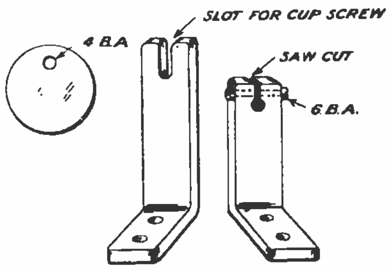


Fig. 87.—The parts of the detector ready for mounting.

inserted with the minimum of trouble. The arm for the movable crystal is of the same dimensions and shape; it is made of sheet brass.

The adjusting screw should have a very fine thread. If possible, one such as those used for the fine adjustment gear of microscopes should be obtained, but if one of these is not available an 8B.A. screw 1 in. in length may be used. It should be passed through a disc of ⅛ in. ebonite ½ in. in diameter, and held in place by a nut at either side.

Tap a hole for it ¼ in. from the top of the shorter support and make a hacksaw cut (Fig. 87) down to it. Drill a 6B.A. clearance hole through the support from edge to edge, and insert a bolt as shown in the drawing. This bolt serves to take up any backlash or wobble in the adjusting screw due to wear.

The parts may now be assembled on the base as shown in the first drawing. The base itself should be mounted on a piece of hard wood, recesses being made with a ⅜ in. bit for the nuts of the terminals and screws.

The cups are made from short pieces of ½ in. round brass rod, in which are deep hollows made with a ¼ in. or 5/16 in. drill. The holes for the 4B.A. retaining screws are made not in the centre but at a little distance from it (Fig. 87). The cups are thus capable of an eccentric movement which allows the surfaces of the crystals to be properly searched. If a number of different crystals are mounted in cups, one can test out any couple very easily, for it is a matter of seconds to change the cups in the supporting arms.

An Easily-made Crystal Detector

An exceedingly simple but effective crystal detector is illustrated in the accompanying drawings. It will beseen that it simply consists of a crystal cup containing a piece of Rectarite or Hertzite, on which presses a light spring S, which is mounted in such a way that the pressure may be adjusted.

The detector is mounted on a baseboard B. It will be seen that two ledges, L_1 and L_2, are provided in order to raise the underneath wiring above the surface of the table. The crystal cup C is connected to the terminal L by a wire underneath the board, while the spring S, which is a piece of No. 36 bare copper wire, is connected to the conducting strip of brass F and the other wire to the right-hand terminal R.

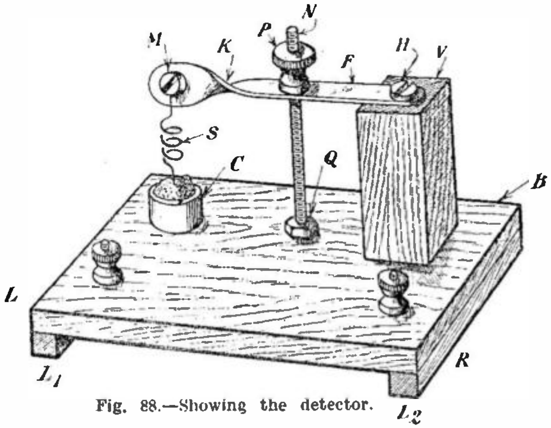


Fig. 88.—Showing the detector.

The strip of brass F is dimensioned in accordance with the figure, and is screwed to a block of wood by means of a round-headed screw H. The block of wood V is screwed down to the baseboard B by means of a screw let in from the bottom.

For a greater portion of its length the brass strip F is flat, but just at the end, at the point K, it is bent at right angles so as to be vertical. At its end is drilled a hole, through which passes a small bolt M fitted with a nut. A convenient substitute is a small piece of threaded brass rod passing through the hole in the brass strip and having nuts fitted, one on each side of the brass strip. The nut and bolt, or equivalent arrangement, is for the purpose of securing the end of the brass spring S, the other end of which should lightly touch the surface of the crystal in the Cup C.

In order that the pressure on the crystal may be varied, a piece of threaded brass rod N is made to pass through an oval slit in the brass strip F, and is secured to the baseboard by means of the two nuts Q and R. The head P of a brass terminal is screwed on to the piece of studding N, and by moving this terminal P round in an anti-clockwise or clockwise direction, the

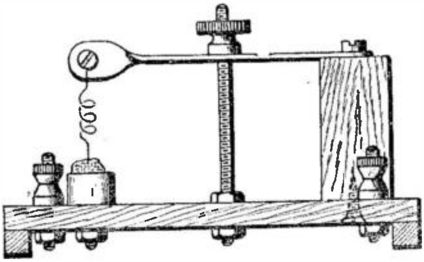


Fig. 89.—Elevation of crystal detector.

spring S may be moved up or down. The strip F should be of $\frac{1}{16}$ in. thick brass, and it may be made springier by hammering before use. The process of hammering on an anvil or its equivalent adds considerable springiness to the metal, and the strip should be given a slight bend so that, under ordinary conditions, the point of the spring S is kept well clear of the crystal. When the terminal head P is rotated in a clockwise direction, the strip F is pressed downwards and the point of the metal spring S is lowered on to the crystal. When the terminal head is rotated in the opposite direction the springiness of the brass strip F lifts the point of the spring S off the crystal again.

Fig. 89 shows the elevation of the crystal detector.

CHAPTER V

GRID LEAKS

A Handy Variable Grid Leak

The grid leak, whether fitted to the second of two valves coupled by the tuned-plate circuit or to the first, is a very important part of the wireless receiving set. In nine cases out of ten the leak with a value of two megohms, which has become

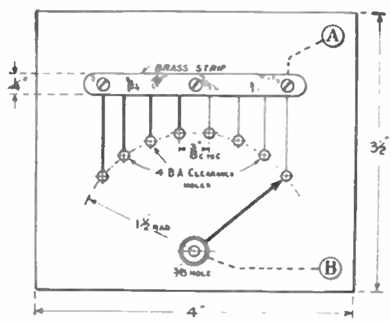


Fig. 90 —The lay-out of the leak.

almost a standard fitting, is mounted, and this will as a rule give quite respectable results. The experimenter, however, who is engaged in using different types of valves, and in trying to get the best out of them, will find it a distinct advantage to provide his set with some form of readily variable grid leak, such as that about to be described. The total cost of making it will be less than a couple of shillings, an outlay which is amply repaid by the time and trouble saved when experiments are in progress.

A piece of ¼ in. ebonite measuring 3½ in. by 4 in. is marked out and drilled as shown in the drawing. The central hole is for the spindle of a rotary switch arm, which can be bought complete with nut and bush for about 1s. The circumferential holes, made with a 4B.A. clearing drill, are for studs of the ordinary type, from eight to a dozen of which may be fitted.

The highly polished surface of the ebonite is toned down by being rubbed with fine emery cloth, a little turpentine being used as a lubricant. Lines are now drawn with a B.B pencil from the place where the brass strip will rest to each stud hole, care being taken to work the graphite well in at their ends so that contact may be as good as possible. Those on the right are made quite thin, those on the left about twice as broad. One thus obtains a great variety of resistances between the shortest thick line and the longest thin one.

So that the studs may make sound connection with the graphite, a flat washer is placed under the head of each, and it is drawn down as tightly as possible by means of its nut. For the same reason the brass strip is secured by means of three or more bolts, which enable it to be tightened down harder than would be the case if screws were employed.

Two terminals A, B, are provided to take connecting leads (unless the variable leak is built into one of the panels of the set). The former is connected to the brass strip, the latter to the bush which forms a bearing for the spindle of the switch. When the leak is completed the pencil lines should be given a coat of shellac so that there may be no danger of their being rubbed off.

One feature of the variable grid leak is that it enables the proper value for any valve to be found very quickly. Once this has been ascertained a permanent leak for use with this particular valve can be made by mounting a pair of terminals on a small piece of ebonite and drawing a pencil line of the right length and thickness between them.

An Improvised Variable Grid Leak

A variable grid leak recently made by the writer consists of a rubber heel-pad and a Meccano part. The pad was screwed on to a piece of ebonite and a brass rod passed centrally through the pad, being held in position by nuts below the ebonite and above the pad. The Meccano part, a flat piece of metal with a cylindrical portion at right angles at one end, was mounted on the rod so that the cylinder rubbed round the rim of the pad.

The high resistance leak was made by putting on the rim of the pad a thin coating of a paste made of powdered graphite and Indian ink. A fixed contact was made at one end of the leak, the other contact being taken off the moving Meccano part.

Another Variable Grid Leak

A variable grid leak that combines the merit of extreme simplicity with negligible cost is here illustrated.

This was constructed from a broken vulcanite dark slide shutter, but stout mica, slate, or even photographic ground glass would be equally suitable.

Five pencil lines of increasing width are drawn as shown, the vulcanite having, of course, had the polished surface removed; 28 g. copper strip ¾ in. wide, to which a connection has been soldered, is clipped over one edge, and five pieces of the same material ¾ in. by ¼ in. over the other edge, the merest smear of seccotine securing them in position. The connection on the other side is made of ¼ in. brass rod about ⅜ in. long, in

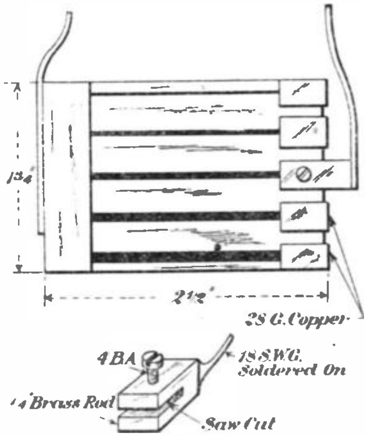


Fig. 91.

which a saw cut ⅜ in. deep has been made. This will probably be found to be a sufficiently tight fit over the copper studs.

Some Simple Grid Leaks

It is the small " gadgets " required for the wireless set that run away with one's money. Whether you are constructing a set, improving it, or conducting one of those frequent rebuildings with which all wireless enthusiasts are familiar, a whole host of small parts becomes necessary. Some can be made quite easily; others cannot, and that is where the money goes. Having recently adopted a novel system—which will be described later—calling for quite a number of non-inductive resistances, each with a value of about 100,000 ohms, the writer shied at paying from half a crown to three and sixpence apiece for them, especially as the scheme was still nothing but an idea, and might prove to be unsatisfactory in practice. No one wants to lay out thirty shillings or so on apparatus that may after all be of little or no use.

Was it possible to make resistances that would function properly? To be of any use they had to be compact and moderately robust; most important of all, they must be perfectly constant in action, remaining at their full value during the whole time that the set was in action. It was essential, too, that they should be easy and quick to make, and that they should not give rise to any parasitic noises in the set.

Numerous experiments were tried with indifferent success, until the idea came of using the compound known as "Aquadag," which is made for the purpose of lubricating machinery. This, when mixed with graphite, gives a sticky paste which can be applied to paper with a stiff brush. When dry it forms a coating that will not easily rub off, and resistances made with its aid were found to be perfectly satisfactory.

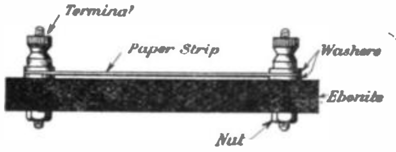


Fig. 92.—Elevation of grid leak.

Here is the recipe:—Take 80 per cent. of graphite and 20 per cent. of Aquadag by *weight*. Powder the graphite and suspend it in absolute alcohol. Then evaporate the alcohol until a paste remains at the bottom of the test-tube. Mix this paste with the Aquadag, working the two well together so that the graphite may be evenly distributed.

Now take a sheet of thin cartridge paper of good quality, and, with a stencil brush, work the compound well into its surface. Allow the paper to dry hard, and you have the material for a supply of resistances that will last you for years.

It is not possible to give definitely the dimensions of strips of the dressed paper that will have a given resistance, so much depends upon the way in which the coating mixture is mixed and the thickness and regularity of the film applied to the paper. If a resistance box is available, strips can be calibrated

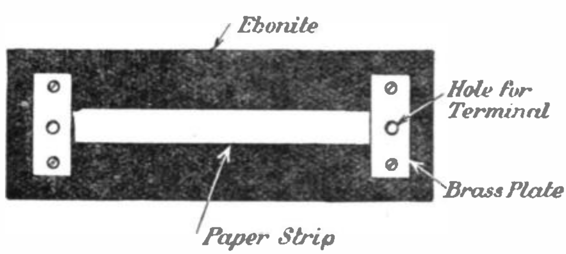


Fig. 93.—Plan of grid leak.

with ease; if not, the best method is to cut several strips all of the same length but of different breadths, and to test them until a size is found that gives the results desired. I found that strips 1½ in. in length and ¼ in. broad gave a resistance of approximately 60,000 ohms, but these figures would probably be quite different for pieces cut from another treated sheet.

The strips can be mounted without great difficulty. Fig. 92 shows a method which will be found to answer well. A 4B.A. clearance hole is drilled near either end of a piece of ebonite measuring $2\frac{1}{4}$ in. in length by 1 in. wide and $\frac{3}{16}$ in. thick. Holes are punched in the paper to correspond with those in the ebonite. Each end of the strip is sandwiched between two thin washers, the stems of the terminals being passed through these and through the ebonite. The nut on the underside must be tightened very carefully, otherwise the paper may be torn.

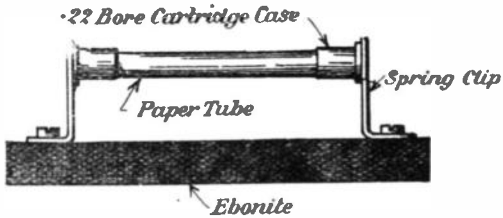


Fig. 94.—Another grid leak.

A rather better method is seen in Fig. 93. In this case the strip is secured by small brass plates which are screwed to the ebonite. The stems of the terminals are passed through the 4B.A. clearance holes seen in the drawing. Whichever mounting is used, a little of the graphite and Aquadag paste should be worked in round the washers or plates in order that there may be a good contact between the terminals and the strip.

A third method, which makes a neater and handier job, since resistances of different values can be inserted in a moment, is given in Fig. 94. Here a piece of undressed paper, rolled into a stiff tube, is inserted into the ends of a couple of used .22 bore rifle cartridges—these, by the way, should first be well cleaned inside. A resistance line is then painted on the tube, the compound being smeared fairly thickly over the joints between the copper cases and the paper. A small base made of ebonite supports a pair of spring clips spaced so as to grip the ends of the cartridge cases tightly.

Tests made with a Post Office resistance box showed that these improvised resistances were remarkably constant. When 100 volts was passed through them they showed a falling off after a few minutes under load of about 15 per cent. in value. Thus a strip that had a resistance of 80,000 ohms when first tested showed rather less than 70,000 at the end of half an hour, but after this it remained perfectly constant though left connected up for three hours on end. When used on the set the resistance proved to be satisfactory in every way, and no noises at all could be traced to them.

The method described serves excellently for making the resistances required for resistance-capacity coupling, and even for grid leaks, since any value can be obtained by cutting the strips sufficiently long and sufficiently narrow.

A Slate Pencil Grid Leak

The value of a grid leak is very important, especially when a loud speaker is used. It may make all the difference between muffled or clear results. The value of the required leak varies with practically every valve, and therefore an adjustable leak may be mounted on the underside of a panel or used as a separate unit.

A piece of slate pencil 3½ in. long is fixed to the underside of the panel or on a piece of ebonite. This can be easily done by using what are sometimes called telephone or pillar type terminals. Two of these are screwed to the ebonite panel 3 in. apart, and the slate pencil is pushed through them so that there is about ¼ in. at each end under the terminal. The centre of each terminal is screwed down, and will hold the pencil firmly. Tappings are taken from this by twisting bare copper wire tightly round the slate at intervals of, say, ½ in., and leads from these tappings are taken to a multi-point switch. The tappings can be more frequent if required. The leak is connected in circuit by using one of the two terminals, and the arm of the tapping switch as the points of attachment.

A Simple Grid Leak

The accompanying figure shows a very simply constructed grid leak or anode-resistance. On a small piece of ebonite or wood E are fixed two terminals T_1 and T_2 of substantial size,

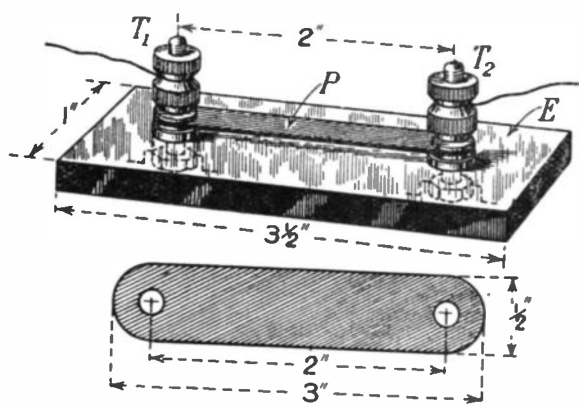


Fig 95.—Showing construction of the grid leak.

say, 2B.A., of the double type. Between the two lower nuts is tightly clamped a piece of blotting paper P, which has been thoroughly soaked in Indian ink and allowed to dry. The size of this blotting paper is shown in the lower portion of the figure. A washer above and below each end of the piece of blotting paper P is arranged, so that the paper is not torn by tightening up the middle nut. Various resistances may be obtained by double or treble soakings of the blotting paper in Indian ink. When an anode resistance (of about 70,000 ohms) is required the terminals may be brought within 1 in. of each other, and several strips of paper on top of each other may be used.

A Variable Grid Leak

One of the most important parts, and usually the most neglected by the amateur, is the grid leak, since most of the working diagrams of to-day simply dismiss the leak with " A value of two meghoms."

Each valve requires its own value of leak resistance, and any particular valve, irrespective of type, requires different

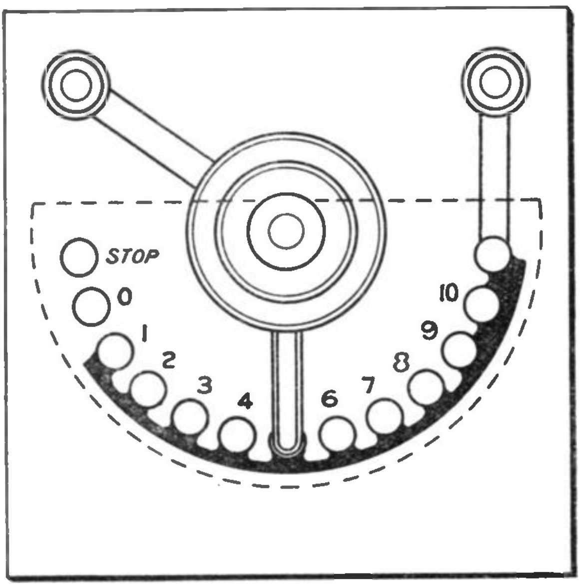


Fig. 96.—The general arrangement of the variable leak.

values of resistance dependent upon its operating characteristics and its use as a detector, amplifier, or oscillator. As a striking example of this in the Transatlantic tests a large number of successful entrants use leaks of their own manufacture, pencil marks on ebonite, slate pencil, etc.

Below are given the details of a variable leak that has been in use for a considerable time, and has become almost indispensable. The following materials are quite inexpensive, and the instrument can be made up by any keen amateur:—

One piece of ebonite, 4 by 4 by ¼ in.
One switch arm.
Eleven contact studs and two stops.
Two terminals.
A little Indian ink and a piece of cartridge paper.

The switch arm and studs may be purchased from any of the well-known dealers, or they may be made if so desired. Having obtained the switch arm and studs, proceed to drill the ebonite to suit the radius, taking care to get the studs fairly close together, otherwise the switch arm, especially if it is of the laminated type, will lodge between the studs. A little care in this direction will be amply repaid later. Take the cartridge paper and cut approximately to size as shown by the dotted line in Fig. 96. Carefully drill this so that it will fit over the contact

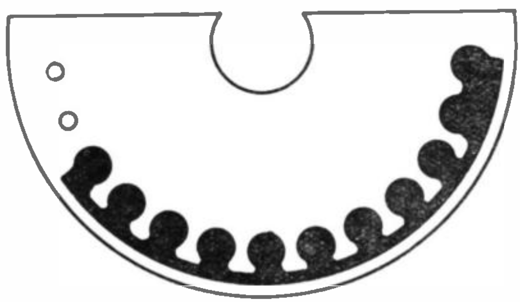


Fig. 97.—Showing details of the Indian ink and cartridge paper.

studs at the back of the ebonite. Having completed this operation, obtain some Indian ink, that used by artists already mixed being preferable, although the dry, dissolved in methylated spirit, answers the purpose just as well. The kind having been decided upon, mix a little graphite (scrapings from a soft lead pencil were used by the writer) with the ink until it is made up to the consistency of cream.

With a fine brush carefully mark over the cartridge paper as illustrated in the shaded portion of Fig. 97, care being taken to get it well under the spaces where the back nuts will cover it; at the same time it is necessary that one stud does not run into the other, as that stud would be shorted, and thus render it useless. Only a very thin layer is required, as the cartridge paper absorbs the mixture and tends to spread it. When the mixture has been applied it should be placed on one side to dry. The terminals are then fitted, a thin brass strip being connected to each. One is taken to the switch arm and the other to the last stud. An extra blob of ink should be applied to the last stud and the connecting strip to ensure proper contact. This should not be done, however, until the cartridge paper has been assembled in its proper place. Place the prepared cartridge paper over the studs and make the connections already mentioned, screw on the back nuts, and the variable grid leak is complete and ready to be fitted into some type of case to suit maker's taste.

In operation place the switch arm on the central stud, bring filament up to proper brilliancy, and you will note that by moving the arm either to right or left an increase of signal strength is obtained.

CHAPTER VI

FIXED AND VARIABLE CONDENSERS

How to Build Variable Condensers from Bought Parts

The true experimenter invariably has a desire to build his own variable condensers; but unfortunately the results are not always in accordance with his carefully thought-out plans, and very frequently difficulty is experienced in preventing all kinds

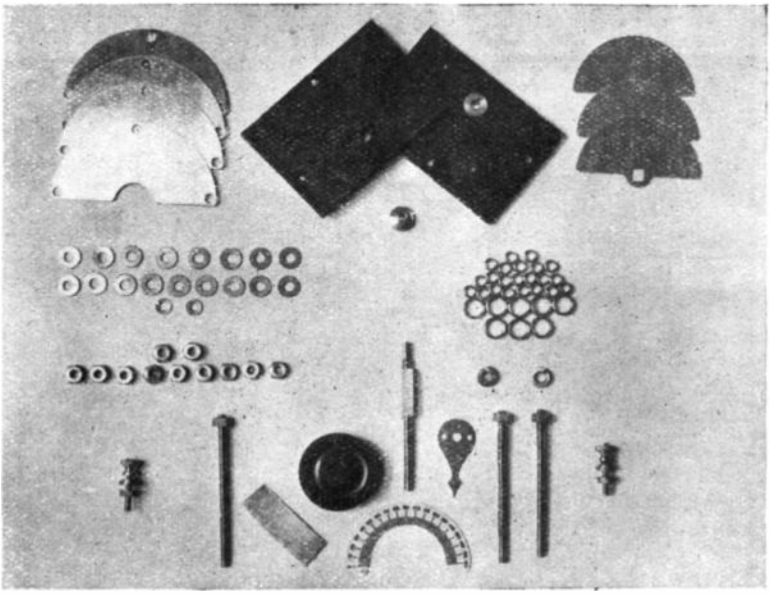


Fig. 98.—Complete set of parts for the assembly of a variable condenser of 0.0001 μF. capacity.

of untoward things happening, such as stiffness of action, occasional short-circuiting of the plates—in fact, a general lack of resemblance to the purchased article. Now the careful experimenter can produce a much better condenser than any he may buy—save the most expensive patterns—if he will give a little thought to the design before assembly of the component parts. Let us briefly examine what are the essentials of a variable condenser of standard pattern and type, having an air dielectric.

It is necessary to have, firstly, top and bottom bearing plates of considerable strength. These may be made of ebonite if desired, but it should not be less than ¼ in. thick, and ⅜ in. is very desirable. The best patterns of commercial condensers are either built up on very heavy ebonite or on metal.

As this is the starting point of all vane pattern condensers. emphasis is laid upon the necessity for really solid end plates, as a good foundation upon which to build. The small triangular pattern is now greatly in favour, and is unquestionably a sound investment in every way. The use of this shape of end plate also economises in space, which is very desirable where panel mounting is considered.

Suitable designs for bearing plates are given in Fig. 99. Attention is drawn to these as being worthy of study. The next consideration is, of course, that of capacity. It is becoming increasingly difficult to obtain condenser plates of any reasonable size, and on account of the present-day inclination to use very small plates with a radius of about 1¼ in., the following table of varying capacities has been drawn up—taking also into account the size of spacing washer with which one is most likely to come in contact.

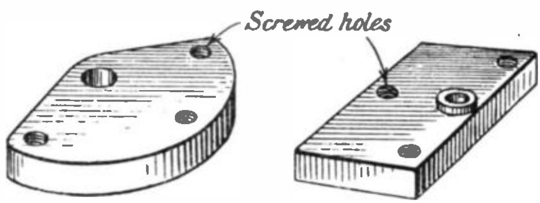


Fig. 99.—Good types of end plates.

This will be found very useful when basing an estimate for material on the capacity required. Now come several points which cause trouble to many amateur mechanics. Firstly, let us consider the question of side supporting rods or frame members.

No. of Washers Required		No. of Plates	Capacity—μF. Spring Washers ⅛ in. high	
126 ...	41 ...	85 ...	0.0015	
84 ...	27 ...	57 ...	0.001	Radius of moving plates 1¼ in.
63 ...	20 ...	43 ...	0.00075	
42 ...	13 ...	29 ...	0.0005	
27 ...	8 ...	19 ...	0.0003	
18 ...	5 ...	13 ...	0.0002	
9 ...	2 ...	7 ...	0.0001	
6 ...	0 ...	3 ...	0.00005	

It is often the practice to make these from No. 4B.A. brass rod; this is much too light for the purpose, and it often happens that when much pressure is brought to bear on the nuts to adjust the assembly, the threads become stripped and the condenser is therefore useless. No. 2B.A. brass rod should be the lightest used, but a much better plan, and one which very few experimenters would seem to avail themselves of, is to use screwed *steel* rod. This sounds rather a formidable proposition, but as a matter of fact screwed hard steel rod is very easily obtained in the form of "Meccano" spindles. These possess two great advantages, the first one being that they are dead straight, which, of course, is vital; and the second that they may be obtained cut to all sorts of convenient lengths. They have a $\frac{5}{32}$ in. Whitworth thread on them, and nuts of the same make are equally readily obtainable. In building up the side members, the arrangement indicated in Fig. 100 should be aimed at. This shows a means of assembly whereby the entire condenser, once built,

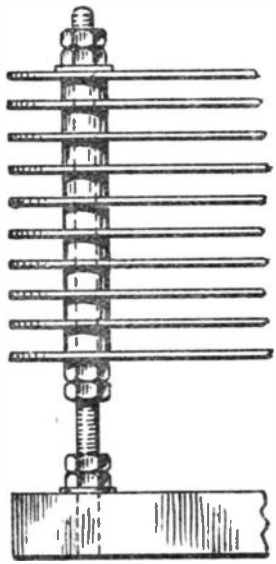


Fig. 100.—Enlarged view showing the assembly of the fixed plates upon the side rods.

may be so moved up and down the fixed rods as to obtain the position of regularity in regard to the clearance of the centre vanes. This is a very necessary provision.

Holes should be tapped in one of the end plates, preferably the lower one, to receive the rods; additional security may be given by means of a lock nut adjusted hard up against the end-piece, and brass rods of a convenient length having been cut, they should be screwed home. It is not necessary here to go into details of how to tap threads in ebonite, suffice it to say that the tap should not be forced in, but given a half-turn back for every turn forwards; this will allow plenty of clearance in the threads, otherwise the rod may be difficult to insert, as tools have a habit of working smaller holes in ebonite than in metals. This should always be borne in mind.

Convenient lengths to cut the side rods are:—0.0015, 8 in.; ·0.001, 6 in.; 0.0005, 4 in.; 0.0003, 3½ in.; 0.0002, 3 in.;

0.0001, 2 in.; 0.00005, 2 in. These facts will also be found of use. The centre spindles will be about 1½ in. longer in all cases, unless, of course, required for special purposes, in which case they may be of almost any length desired. But to return to the fixed vane assembly again; the requisite plates and washers having been laid out, another couple of nuts should be run down each side rod in such a manner that they will lock themselves together about ⅜ in. above the bottom end plate. These all having been adjusted to a height equidistant from the base, one fixed vane is slipped over them. This will rest upon the nuts, and three of the small spacing washers can be dropped down the rods so as to separate the next plate from the first one.

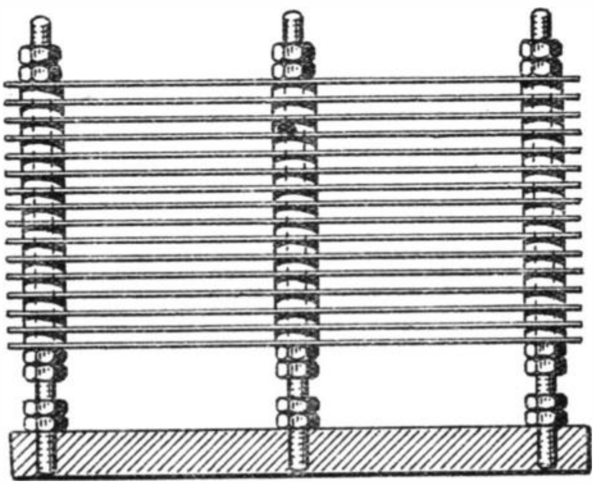


Fig. 101.—Showing the assembly of the fixed plates.

Alternate series of plates and washers are then put on until the required number is complete. The whole should then be locked together by two more nuts per spindle, when the complete assembly will resemble Fig. 101. This must, of course, be carefully aligned so that it is absolutely level with the base plate. The top plate may now be slipped on, and it is important in drilling it to remember that the three side holes must be of such a diameter as to *clear* the screwed rods—that is, they must slip freely over them, but at the same time have no play. The top plate cannot, however, be fixed in position until the centre rotating portion is completed.

There is a common practice of using square brass rod for centre spindles, with a screwed portion at each end to receive lock nuts, etc. This is an excellent idea where one can be certain of obtaining the rod of exactly the necessary length, but great care must be exercised in its selection; otherwise it is preferable to use ordinary round section rod of ¼ in. diameter, as most of the vanes now on the market have a ¼ in. square centre hole. If it is decided to use the squared rod, then the necessary length should be obtained and an arrangement of nuts

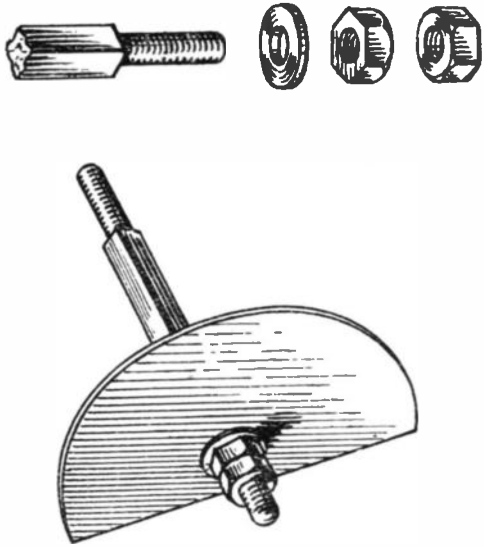


Fig. 102.—Method of assembling moving vanes upon a square centre spindle.

and washers as in Fig. 102 attached to it, as shown. This will greatly assist in the final adjustment of the condenser. Vanes and washers to the necessary number are then placed upon the

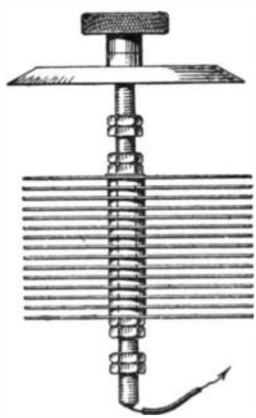


Fig. 103.—Complete assembly of the moving vanes.

centre rod in the same manner as for the fixed plates, and when all is complete the appearance will be as in Fig. 103. This also illustrates a bevelled dial and knob attached, which undoubtedly presents a good final appearance and allows of careful readings being taken.

It will now be time to assemble the condenser. To do this the end of the spindle carrying the moving vanes is placed in the hole in the lower disc (which must, of course, be a good fit for it), and the vanes turned away from the fixed ones. They are now rotated until they slide between the fixed plates, when the top is put on and gently screwed down by hand. This, now,

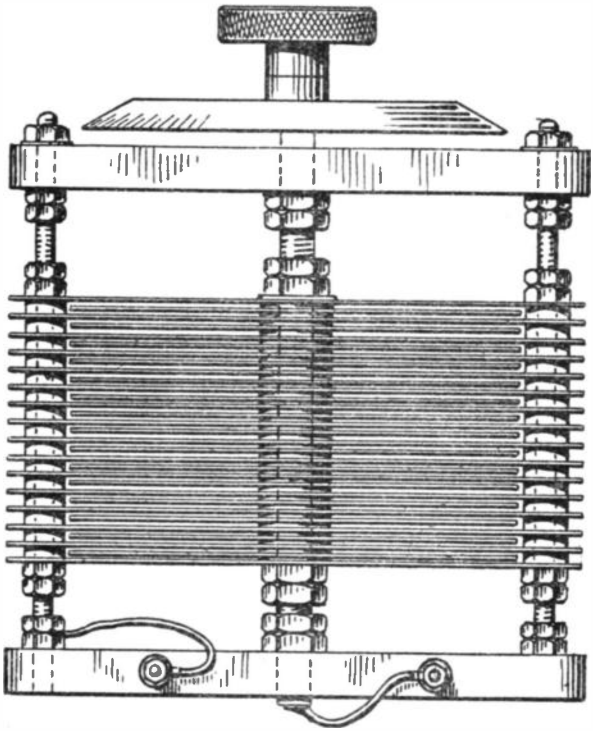


Fig. 104.—The completed condenser.

is the point where latitude in adjustment is appreciated; we will find that the moving vanes press up against the fixed ones, and in the first place the nuts on the moving rod are screwed up or down until a point is found where the spindle can be rotated. The top plate is, at this juncture, locked firmly in position; but it will probably be discovered that upon rotating the spindle (which may be very stiff, but the stiffer the better) the movable vanes make contact at one or more points with the fixed ones. Now, however, that the end plates are rigid, we can gently screw the fixed assembly up or down until a clearance is established at all points in the rotation of the centre portion. One side may be raised or lowered a little irrespective of the other, which will prove to be very handy in cases of inequality of the centre spindle; and once found, the correct setting may be securely locked by means of the various nuts provided. It will be noticed that so far no provision has been made for connections to the moving or fixed vanes. The rubbing contact is rather an uncertain method of carrying this out, and a thick flexible wire may be soldered to whatever portion of the spindle projects from beneath the lower plate. This is the most satisfactory arrangement, and if desired two small terminals can readily be mounted on the bottom of the plate, or screwed into the edge. This latter method is the better.

Contact with the fixed vanes is, of course, readily obtainable to any of the nuts securing the fixed spindles of the condenser. A bevelled ebonite dial and knob may be fitted, and at present these accessories are to be had at such a low price that they should certainly be used. No mention has been made of the use of metal and plates bushed with ebonite, as although the result is, of course, excellent mechanically, the trouble of making such end plates often proves too much for the experimenter who possesses limited workshop facilities. If he follows these instructions carefully he will succeed in making a first-class job, and having a condenser of such a nature as will stand up to all kinds of rough treatment, in addition to being electrically sound enough to be used for transmission. A typical condenser, such as the reader may expect to produce if he follows these instructions, is shown in Fig. 104. In conclusion, it might be said that the first size, 0.0015 μF, is useful for series tuning, transmission and wave-meter work; the second, 0.001, for series tuning; the third, 0.00075, for both series and parallel tuning; the fourth, 0.0005 for secondary circuit tuning; the fifth and sixth, 0.0003 and 0.0002, for tuning H.F. transformers and anode reactance coils; and the seventh and eighth, 0.0001 and 0.00005, for vernier and very fine adjustment purposes.

A Novel Vernier Condenser

A very serviceable vernier condenser of simple design and neat appearance is made up as follows:—A fixed plate A and a moving plate B, each 2½ in. across the diameter, are shaped and drilled as shown, the two small holes in each being provided respectively for bolts and screws, the other hole in the moving plate being made large enough to slip over a piece of 2B.A. screwed rod. This rod should be about 2 in. long, and the moving plate is soldered to this in a mid-way position, as shown at X, diagram E. The plates may consist of thin sheet brass, copper, or tin-plate, and the small holes should be well countersunk to take the heads of the screws and bolts. A wooden disc D, 2¾ in. in diameter by ½ in. in thickness, is drilled through the centre and recessed to take the soldered joint of the moving plate, as shown in the sectional diagram. This plate is now screwed to the underside of the wooden disc, great care being taken to see that the screwheads are quite flush. If desired, a nut may be attached to the end of the spindle at the other side of the disc, but in most cases this will not be necessary. An anti-capacity handle is attached to the edge of the disc in the usual way. The panel is now drilled to take the spindle. The fixed plate is placed in position over this hole, and using this as a template, the two bolt holes are marked off and drilled. The heads of these bolts should also be countersunk, so that

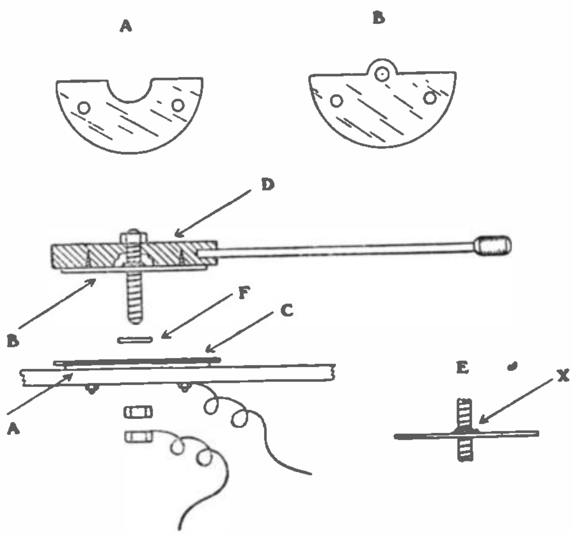


Fig. 105.—Showing parts for making Vernier condenser.

they are flush with the surface of the plate, which may now be bolted in position. A disc of very thin mica C slightly larger than the diameter of the wooden disc, is now placed over the plate and secured to same by means of some thick shellac varnish, which should be allowed to set hard before attempting to assemble the instrument, the general arrangement of which should now be clearly understood. A small cardboard washer F prevents the underside of the top plate from rubbing too hard against the mica disc. The capacity of the instrument will depend on the thickness of the mica dielectric. This should be as thin as possible. It is a good plan to round off all the edges of the plates with a smooth file. The connections are made one from the locknut attached to the end of the spindle and the other from one of the bolts holding down the fixed plate. If desired, an ordinary ebonite knob and dial may be arranged to replace the wooden disc and handle.

Another Vernier Condenser

A very useful little piece of apparatus is a vernier condenser. It is practically essential to success when using a variable condenser of large capacity. There are, as with other kinds of apparatus, various types of vernier condensers. Perhaps the simplest to make, and incidentally the cheapest, is one constructed from test-tubes, which can be obtained from any chemist for about twopence each.

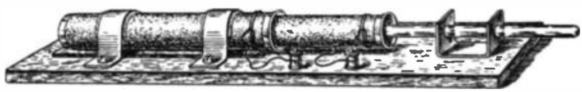


Fig. 106.—A simply made vernier condenser.

The little condenser illustrated consists of a test-tube, about 3 in. long and $\frac{5}{8}$ in. diameter, about which is wrapped some tinfoil, secured with shellac, and a smaller one $3\frac{1}{4}$ in. long and $\frac{1}{2}$ in. in diameter, also having tinfoil secured around the outside. A handle consisting of a length of glass rod, 8 in. long, is attached to the smaller tube, by filling the tube with paraffin wax, inserting the rod, and holding it in position in the centre of the test-tube until the wax is set. The base can be made from old, well-seasoned oak, if it is well dried in an oven and baked in shellac. Its insulating efficiency is then practically equal to that of ebonite. A convenient size is about 8 in. by 2 in. by $\frac{1}{4}$ in.

The next consideration is the bracket for supporting the glass rod. This can be made from brass, say, $\frac{1}{2}$ in by $\frac{1}{16}$ in. by $2\frac{1}{4}$ in., being bent up at right angles at about $\frac{5}{8}$ in. from each end. A hole should be drilled of such a diameter as to make a sliding fit for the glass rod in either end. The bracket is secured to the base by two small screws or nails. When fixing the larger test-tube to the base it is important that the centre of it should line up with the centre of the two holes in the bracket. This can be arranged by having a small block of suitable thickness. A good method of securing the test-tube to the base is to strap it down with two thin metal straps, as illustrated in the diagram. Between the strap and the glass a piece of velvet or similar material should be inserted in order to obtain a firm hold on the glass. The straps can then be nailed or screwed to the base, provided the smaller test-tube is in position. The leads should be twisted very tightly around the tinfoil on the tube, and slightly soldered in order to obtain good contact. They can then be taken to terminals on the base. The lead attached to the movable tube should preferably be flexible, as otherwise the continual bending and unbending would cause ordinary copper wire to break after it had been in use a short time.

Interchangeable Fixed Condensers

When one is engaged in making up a variety of experimental circuits it is frequently necessary to spend a little time in finding the best values for the fixed condensers needed in certain positions. In most super-regenerative circuits the values of some of the condensers are quite critical, and even the most ordinary of receiving sets of perfectly normal design can frequently be improved by a little experimenting with such condensers as those used for coupling tuned-anode units, the grid condenser of the rectifying valve, the condenser which shunts the primary of the first low-frequency transformer and that placed across the telephone leads.

A most useful addition to one's experimental outfit is a set of fixed condensers of known value ranging from 0.0001 μF to 0.001 μF in 0.0001 steps, and from 0.002 μF to 0.01 μF in steps of 0.001 μF.

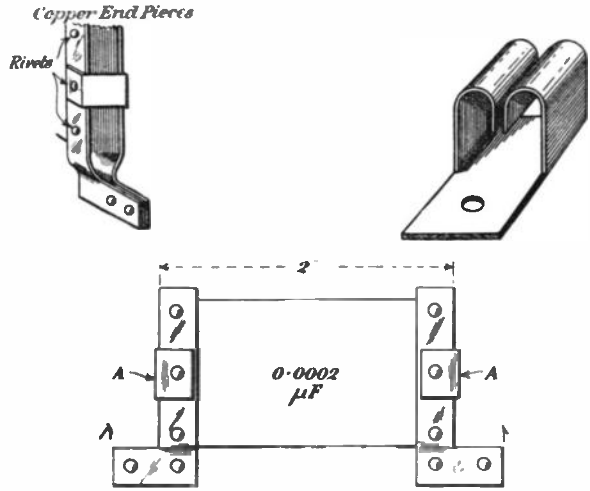


Fig. 107.—Mounting the condensers.

To buy such a set of really good make would involve a considerable outlay, but they can be made at home by anyone for a matter of a few shillings without a vast amount of trouble. Further, those to be described are designed to slip into permanent clip mountings so that any value may be changed for any other in a moment.

It is presumed that for all condensers the best ruby mica, .002 in. thick, will be used. The smallest sizes have a plate overlap of one square centimetre. Two plates will then give a capacity of 0.0001 μF, three, 0.0002 μF, and so on, each additional dielectric increasing the capacity by 0.0001 μF.

For the first four of the next series we use overlaps of larger size, but keep the number of the plates constant at 11. For

0.002 μF we require an overlap of 2 cms. by 1 cm, for 0.003—3 cms. by 1, and so on, up to 0.005. We obtain 0.006, 0.008, and 0.01 μF by doubling size of the plates needed for 0.003, 0.004, and 0.005 μF respectively. For example, our 0.006 μF condenser will have 11 plates measuring 3 cms. by 2. For 0.007 we use ten plates measuring 4 cms. by 2, which give an actual capacity of 0.0072 μF. The remaining capacity, 0.009 μF, is obtained by using 11 plates with an overlap of 3 cms. by 3.

Armed with these figures, and remembering the very useful working rule: Capacity in μF equals overlap in square centimetres multiplied by number of 0.002 in. thick ruby mica dielectrics, multiplied by 0.0001, we can make up fixed condensers of any desired capacity.

In order that condensers shall be readily interchangeable in clip mountings, it is necessary to adopt a standard width for all: 2 in. will be found a convenient figure.

The method of putting together the alternate layers of copper foil and mica is exactly as described, except that the plates are cut with tangs long enough to fold right over the copper end-pieces (A.A , Fig. 107), and that the outer covering of the condensers consists of thin sheet ebonite.

The end-pieces, shaped as shown in the drawing, are cut from sheet copper. There are four of them, one pair being fixed at each end (Fig. 107) by means of rivets snipped from very soft copper wire. The tangs of the plates are also secured by rivets. The lower parts of each pair of end-pieces are tightly pinched together and fastened by rivets spaced so far apart as not to interfere with the mounting clips.

These clips are shown in Fig. 107. They can be made quite easily from springy sheet brass, or they can be bought from wireless shops at about 3d. per pair. Besides placing them wherever fixed condensers are wanted in the set, it is an advantage to mount a pair of clips on one or two of the variable condensers, connecting one to either terminal. The capacity of these variable condensers can then be increased at will by placing fixed condensers of suitable value in the clips; for since the two capacities are in parallel the total capacity will be their sum.

Blocking Condensers

The usual method of constructing a blocking condenser is rather a fiddling job when making a condenser of fairly large capacity. An easier and quicker method is to cut the tinfoil into two long strips the size required, and rolling them up together, using as the dielectric good quality paper previously soaked in paraffin wax. The strips of paper should be ½ in. larger all round than the sheets of foil. Before rolling the strips of tinfoil and paper together lay a strip of copper foil ¼ in. wide on each piece of tinfoil for connecting purposes, as shown at A. When the condenser is rolled up press it with a hot iron. This re-melts the paraffin wax on the paper and binds the whole together as at

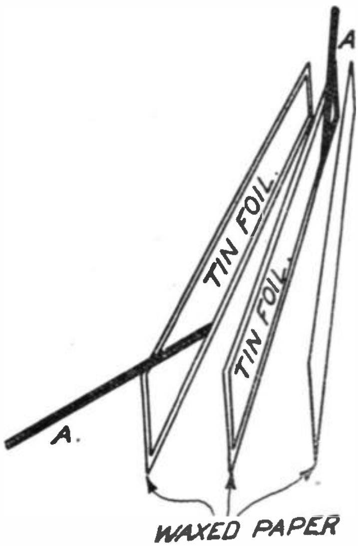


Fig. 108.—The assembly of the foils.

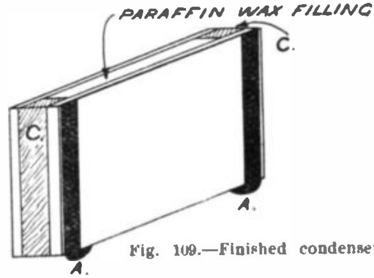


Fig. 109.—Finished condenser.

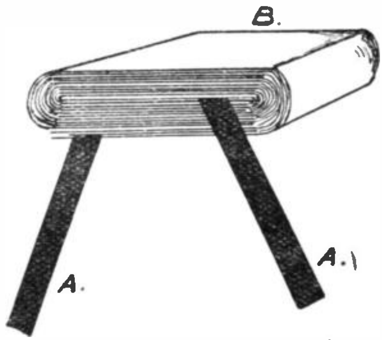


Fig. 110.—Condenser after pressing.

B (Fig. 110). The condenser should then be put between two $\frac{1}{8}$ in. ebonite sheets, turning the copper foil connecting strips up the side of the ebonite as at A, Fig. 109. A piece of ebonite

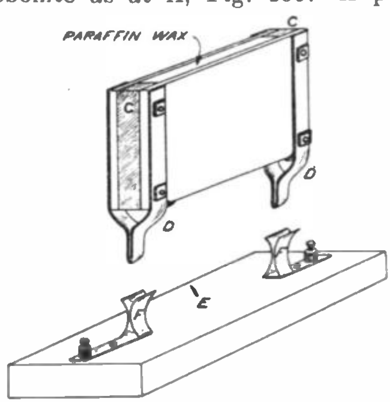


Fig. 111.—An interchangeable mounting for the condensers.

should be let in at each end to take up the space between the sheets of ebonite as at C. Make two clips of thin sheet brass and bolt them to each end, firmly clamping the copper foil strips between them as shown at D. Melted paraffin wax poured round the edges of the condenser will make it damp-proof.

A convenient holder for this condenser is shown at E, Fig. 111. The clips F are made from thin sheet brass, and the base is of ⅜ in. ebonite.

This type of condenser and holder is ideal for the experimenter.

Making Condensers of Any Capacity

One needs quite a number of fixed condensers about the set, and they are expensive little things to buy, for it is of no use to purchase cheap ones, which are often made with dielectric material of very poor quality, and whose stated capacity cannot be relied on as accurate. To make them at home is really one of the simplest jobs that the wireless constructor is called upon to tackle, and the saving is considerable, for a neat reliable condenser of definite capacity can be put together at the cost of a few pence.

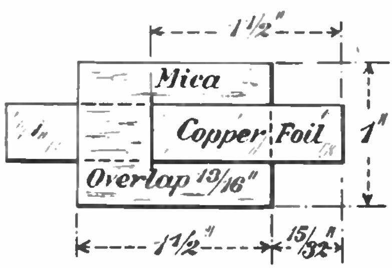


Fig. 112.—Showing how the strips are placed in position.

For the plates copper foil should always be used. Tin foil is apt to contain impurities, and it is not pleasant stuff to work with, owing to its flimsiness. It is convenient to adopt a standard size of 1½ in. by ⅜ in. for all one's plates, for, by so doing, we can make up, as we shall see, any given capacity without calculation. Foil is sold in sheets measuring 6 by 6 in. at 1s. per dozen. As a sheet will cut into 16 strips each ⅜ in. wide, and each strip will make four plates, a pennyworth of foil gives a supply of 64 plates.

The dielectric must be the best quality ruby mica 0.002 in. in thickness. For 1s. 8d. we can obtain a dozen sheets measuring 2 by 3 in. If a standard size of 1½ by 1 in. is adopted for the mica dielectrics, each sheet will make four of them.

The convenience of adopting standard sizes such as those mentioned will be seen when it is said that two plates with an overlap of 13/16 in. give a capacity of 0·0002 μF, and that each additional plate increases the capacity by 0.0002 μF. If, therefore, we want to make up a condenser of any value we have a simple working rule: halve the capacity, add 1 to the fourth decimal place, and you know the number of plates needed. Thus 0.001 halved = 0.0005; 5 + 1 = 6 plates; or, 0.002 halved = 0.001; adding 1 in the fourth decimal place we have 11 plates.

It will be noticed that the overlap given allows only capacities ending in even numbers (0.0002, 0.004, and so on) to be made up. Odd numbers can be obtained by using plates measuring 2 in. by $\frac{3}{8}$ in., and making the overlap $1\frac{3}{16}$ in. In this case two plates give 0.0003 μF, and each plate added increases the capacity by the same amount.

Now for the process of making up the condenser required. Begin by cutting out the mica and the foil, and place the pieces in two separate piles on the table. Provide yourself also with some shellac varnish.

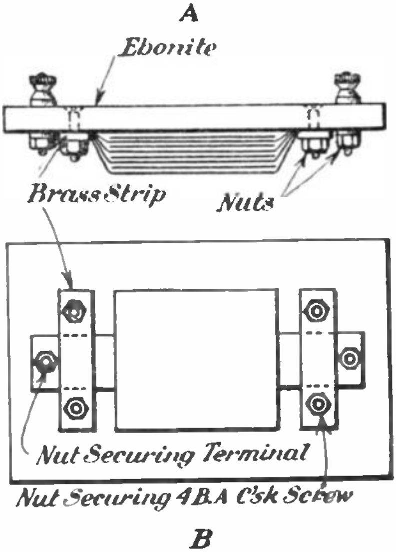


Fig. 113.—Method of mounting the condenser.

Coat a piece of mica with the varnish, and lay a foil strip upon it so that just under $\frac{1}{2}$ in. protrudes beyond it towards your right. Touch the copper with shellac, and lay a second piece of mica exactly over the first. Shellac again, and place another piece of foil on it so that the overhang is to your left. Continue with alternate pieces of mica and foil until the desired number is reached; then place a final piece of mica over all. Now lay the pile under a warm flat iron, and leave it to set hard.

Fig. 113 shows a good way of mounting the condenser. Each set of strips is clamped tightly together by the pressure of a brass strip, in which three holes are drilled. Two receive countersunk 4B.A. screws, the third the shank of the terminal, all of them being secured by nuts. Condensers mounted directly on to panels will not, of course, need the terminals, connections being soldered to the brass strips.

CHAPTER VII

TRANSFORMERS

A Simple Telephone Transformer

There are certain very great advantages to be gained from using low-resistance telephones with a valve set; amongst others the risk of a burn-out is reduced to a minimum, cheaper receivers may be employed with quite good results, and any parasitic noises due to the set itself are rendered less obtrusive. To be able to use low-resistance telephones it is essential to provide a transformer to step down the voltage flowing in the anode circuit of the last valve. A very satisfactory instrument for this purpose can be made by anyone who does not mind tackling the rather tedious job of winding a larger number of turns of fine wire.

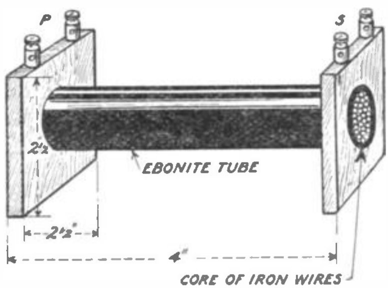


Fig. 114.—The bobbin and core of the transformer.

The drawing shows the foundation of the transformer. This is a kind of bobbin made by jamming a 4 in. length of ebonite tube with an internal diameter of ½ in. and an external diameter of ¾ in. into two ebonite end-pieces each ⅜ in. thick and 2½ in. square. If by any chance the holes in the end-pieces are bored slightly too large so that the tube is not a tight driving fit it can be secured in place by drilling and tapping a 4B.A. hole in one edge of each end-piece and inserting a setscrew.

It will usually be found best not to insert the core until the winding has been done. If the tube is left empty it is not a difficult matter to fit a wooden mandrel which will allow the bobbin to be mounted in the lathe or fixed up in an improvised winding machine made from the breast drill, or even from a combination of Meccano parts.

Two terminals are mounted on each end-piece, holes for their shanks being drilled and tapped in the ebonite. During the winding process their places may, if necessary, be taken simply by screws. The primary winding will consist of four ounces of No. 40 d.c.c. copper wire, which will cost about 5s. Attach the free end to one of the primary terminals, then take a turn round the tube and proceed to wind on evenly. Great care must be taken not to break the wire, which is very thin, and will not stand any jerks. Should a break occur, the ends must be soldered together, the joint being well covered with a layer of thin insulating tape. When all the wire is on secure the far end to the second primary terminal.

Next lay on two layers of Empire cloth to form an efficient insulator between windings. The secondary, which consists of 1½ ounces of No. 34 d.c.c wire, costing 1s. 3d., is now wound on as before, its ends being secured to the terminals of the opposite end-piece. A further layer of Empire cloth makes all secure.

The next job is to insert the core, which is made up of 4 in. lengths of No. 22 or 24 soft iron wire inserted one by one until the whole is packed as tightly as possible. If difficulty is found in forcing in a final wire so as to make all secure the core can be jammed in place by tapping one or two little wooden pegs in amongst the wires at either end. Nothing now remains but to mount the transformer on a baseboard of polished wood measuring 5 in. by 3½ in.

A Telephone Transformer made from a "Ford" Coil

As disused Ford ignition coils can be readily obtained, the following method of conversion to a telephone transformer will probably prove of use to wireless experimenters. The coil which

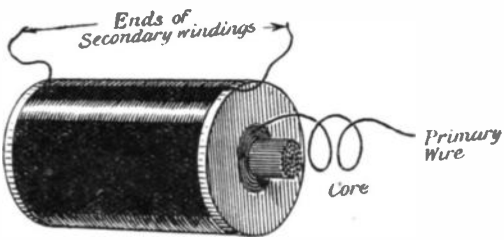


Fig. 115.—Showing original coil.

actually underwent this transformation was, for ignition purposes, absolutely useless.

A few simple tests were carried out, chiefly with a dry cell and a telephone receiver, and the following diagnosis completed. The secondary winding was quite in order, that is, there was no break in the wire. The condenser was hopelessly waterlogged and possibly punctured.

The outer wooden case was carefully removed, as well as most of the superfluous wax or pitch, taking care not to break any wires. The condenser was next removed, together with the slab of plate glass, which insulates it from the secondary windings.

The two ends of the primary or thick wire winding were cleared of wax, etc., at the point where they entered the inside of the coil. Carefully pulling on one of these wires, it began to come away in corkscrew fashion, as shown in the sketch, Fig. 115. This pulling was continued until all the wire was withdrawn and the iron core quite free. A few turns of the waxed paper from the inside of the secondary coil were removed to give more space. As the iron wire core was already covered with a layer of waxed paper, no special treatment was required beyond fitting a couple of fibre washers of such overall size that they would just slide inside the hole through the centre of the secondary coil. A winding of 36 S.W.G. s.s.c. copper wire was now put on to the core to fill up all the available space, that is,

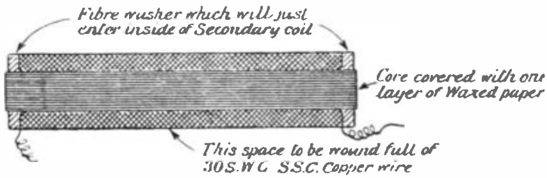


Fig. 116.—Showing new primary winding.

up to the outside of the fibre washers. About 6 in. of wire was left free at the beginning and end of this winding for connecting-up purposes. Core and winding were now immersed in molten paraffin wax for a few minutes and then placed inside the old secondary winding.

A suitable box was made up to take the complete coil. Four terminals were fitted on two pieces of $\frac{1}{4}$ in. ebonite sheet (*i.e.*, two terminals on each piece) and mounted at each end of the box in such a way that the terminals themselves were not in contact with the wood. The two wires from the old secondary winding were taken to one pair of terminals, and these terminals were marked " Primary." The ends of the 36-gauge winding were connected to the remaining terminals in the same way, and marked " Telephones." The box was now filled up with molten wax and a suitable lid fitted.

On test, with a pair of 120 ohm telephones on a crystal set, the results were quite satisfactory, though not so good as on a professionally made transformer. This particular transformer has been in use for about a year on a crystal set, and continues to give quite good results; it has well repaid the time spent in converting.

Another Telephone Transformer

From the point of view of cheapness, or perhaps on account of their more robust construction, many amateurs have purchased telephone receivers of low resistance. As such telephones cannot be satisfactorily used with either a crystal or a valve receiving set without the addition of a " transformer," it is thought that constructional details of another form of transformer will prove of service.

It consists of an iron core, 4½ in. long by ½ in. in diameter, made up of No. 22 S.W.G., soft iron wires; two end flanges, 1½ in. square by ⅜ in. thick, with central hole to take the ends of the iron core; insulation over the core, two layers of Empire cloth or paraffin-waxed paper; thick wire winding (or secondary, as this is a " step-down " transformer), 1,700 turns of No. 28 S.W.G. d.s.c. copper wire; insulation between windings, the same as that between core and first winding; fine-wire winding (or primary), 3,800 turns of No. 44 S.W.G. d.s.c copper wire; outer insulation and protection to winding, two layers of Empire cloth, or similar material; and four brass terminals, arranged as shown in the diagram herewith.

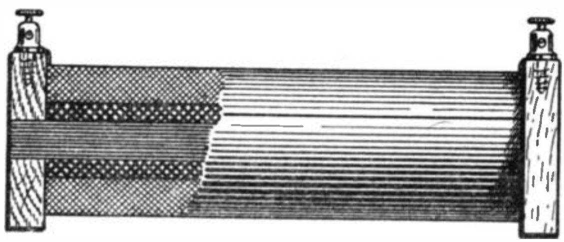


Fig. 117.—Details of a telephone transformer.

In use, the fine-wire winding is to be connected to the telephone terminals on the existing crystal or valve set, whilst the low-resistance telephones are connected to the thick-wire winding of the transformer. The effect of a transformer of this description is to reduce the voltage and increase the current through the windings of the telephones.

Easily-made H.F. Transformers

There is no doubt that, where only one stage of H.F. amplification is used for short-wave reception, there is nothing to hold a candle to the reactance-capacity method of coupling, which gives longer range and greater signal strength than any other. When, however, the number of H.F. valves is increased, the tuned-anode becomes increasingly difficult to handle, on account of its tendency to fall into self-oscillation. Two stages can be used by an expert; three make the set so unstable that, unless heavy damping is resorted to, it is almost impossible to use them without the occurrence of frequent and violent oscillation.

Though less efficient, the copper-wound transformer has the advantage of being not so liable to cause trouble. If, however, two or three tuned transformers are used, the tendency of self-oscillation will be marked.

The simplest solution of the difficulty is to use transformers wound, not with copper, but with resistance wire. The introduction of a series resistance into an oscillatory circuit has the

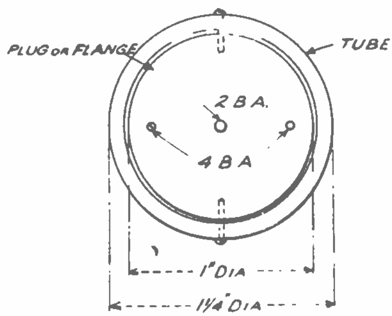


Fig. 118.—Dimensions for end pieces.

effect of flattening out the resonance curve; it also reduces the efficiency of the circuit to some extent owing to the resistance offered to oscillations not in resonance with it, for which in theory there should be an absolutely free path.

At first sight, then, the resistance-wound transformer would seem to entail loss of both selectivity and efficiency in amplification. In practice, however, neither of these effects is noticeable. Neither tuned anodes nor tuned transformers can be allowed to display their full powers on the multi-valve set. Selec-

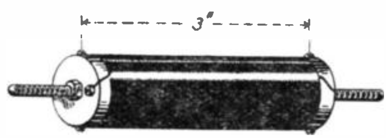


Fig. 119.—The complete winding.

tivity is reduced by the necessity for detuning slightly in order to avoid oscillation, and efficiency as regards amplification suffers owing to the damping that must be introduced to control them.

The resistance-wound transformer has an optimum wave-length, but as its resonance curve is very flat, there is no marked "peak," and it will work efficiently over a wide band. Since it has practically no tendency towards oscillation, hardly any damping is necessary, so that each transformer can be allowed to give its fullest measure of amplification. Thus for long-distance reception on the shorter wavelengths three, or even four, H.F. valves can be used with no great difficulty, potentiometer control being all that is needed.

The writer does not know of any firm from whom resistance-wound transformers can be purchased ready-made, but they are so extremely simple to construct that anyone can make them up at home. The wire used is No. 42 H.R. double silk covered "Eureka." The price, £2 10s. per lb., looks at first formidable, but as it runs something over three miles to the pound, and each transformer for broadcast wavelengths requires only about fifty yards, a single ounce will suffice for making quite a number.

The former consists of a 3 in. length of ebonite tube with an external diameter of 1¼ in. and an internal diameter of 1 in. Two end-pieces are made from ¼ in. ebonite; it does not matter in the least whether they are made as plugs to fit into the tube or as flanges fixed to its ends. In either case each must have a central hole to take a 2B.A. rod, and two others for 4B.A.

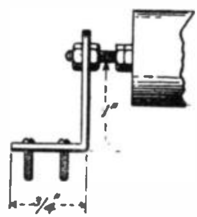


Fig. 120.—Clip for mounting the transformer.

screws or small terminals (see Fig. 118). The end-pieces are fixed in position by means of a couple of 4B.A. screws.

A 5 in. length of 2B.A. screwed rod is now passed through the central holes in the end-pieces and secured in place by means of a nut at each end.

The former can now be mounted in the lathe for winding. If a lathe is not available, fix the breast drill in the vice by means of its lug or horizontal handle, and insert one end of the 2B.A. rod into its chuck.

Attach the end of the reel of wire to one of the screws on the end-piece and wind on 250 turns as closely and as evenly as possible. Snip off the wire and attach it to the screw on the far end-piece corresponding to the "in" end on the near one. As this winding will occupy about 2 in., it may be started ½ in. from the end of the tube. To prevent the wire slipping, it should be given a thin coat of shellac varnish.

Next cover the primary winding with a layer of fine sewing silk. This will provide good insulation between the windings. The secondary, which has 300 turns, is wound over the primary in the same direction. It will begin and end about ⅛ in. nearer to each end. Its ends are attached to the two remaining screws. To make all secure, the windings should be shellac varnished, and may be wound over with silk to give a neat finish. The completed instrument is shown in Fig. 119.

The projecting ends of the brass rod provide a convenient means of mounting the transformer on the underside of the panel. A pair of clips, as shown in Fig. 120, can be made from sheet brass.

If it is desired to make transformers of various sizes which can be slipped easily into place, the spindle may be removed when the winding has been done and a different mounting made. Fig. 121 shows the details of this.

The windings given have an optimum wavelength of about 400 metres; they will deal quite effectively with transmissions on wavelengths from 300 to 500 metres, and may be found to

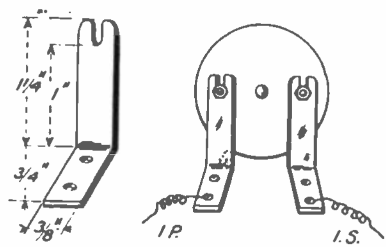


Fig. 121.—An alternative arrangement of clips.

cover an even wider band. The following table shows the primary windings necessary for higher wavelengths; the secondary will usually contain about 20 per cent. more. The reader may find that his particular set requires either rather fewer or rather more turns than those given, for much depends upon the capacities existing in the set itself and upon the valves used.

It is as well, therefore, to make a few experiments when the first transformer is being wound. It may contain a slightly greater number of turns than here stated, and the effect of stripping off a few may be tried until the best arrangement is found. Once this has been ascertained the table may be used by adding or deducting the percentage found as the result of these experiments. It is very important that each set of transformers used simultaneously in a multi-valve set should be identical, otherwise they will tend to hinder rather than to assist each other's action.

Optimum Wavelength.		Turns on Primary..
600	...	350
900	...	550
1,200	...	800
1,500	...	1,000

A L.F. Transformer

The making of a low-frequency transformer is not a task that every amateur wireless constructor would care to tackle, involving as it does the winding of very large quantities of wire so fine that the slightest jerk will cause a break. There are, however, people who take pride in making every possible part of their set themselves, and they will find useful the constructional details given below.

As it is essential to silent working that the insulation between windings and core shall be as good as possible, we will make the bobbin of a piece of ebonite tube 3 in. long, with an internal diameter of ½ in. The end flanges made of stout cardboard, are 2½ in. in diameter. In the middle of each is drawn a ¾ in. circle, as seen in Fig. 122, which is marked out as shown. The flaps are then cut with a sharp-pointed knife and bent up as depicted in Fig. 122. After a thorough dressing with shellac the

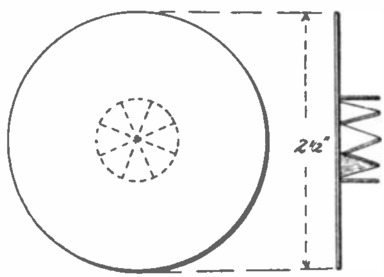


Fig. 122.—The end flanges of the transformer.

flanges are slipped on to the tube with the flaps pointing inwards. These are shellacked again and then bound tightly with silk whilst still wet.

The windings of the primary will consist of 2 oz. of No. 42 single silk-covered wire. The end is soldered carefully to a piece of stout insulated wire, which is anchored in the usual way to one of the flanges quite close to the ebonite tube. The end of the stout wire is allowed to project outwards from the flange, and the letters I.P. are marked on the cardboard beside it. We are now ready to begin winding.

To do this by hand is an almost impossible feat, since there will be about 10,000 turns in the primary alone, and the secondary will contain nearly two and a half times as many. If a lathe is available matters are very much simplified, for we can mount the bobbin on a mandrel. If not, some kind of winding machine must be improvised; Meccano parts can be made to serve quite well.

The fine wire is now wound on as tightly and as evenly as possible; the reel should be mounted on a spindle, the right hand feeding the wire on. When this winding is complete, solder the end to another length of stout insulated wire and anchor as before, marking the wire O.P. Cover the primary winding with a double layer of insulating tape wound like a puttee, so that the edges overlap.

The secondary is put on in the same way, its ends being marked I.S. and O.S. respectively. Should a break occur during the putting on of either winding, the ends must be bared and neatly soldered together. The joint should then be wrapped carefully with silk and given a good coat of shellac. About 4 oz. of wire will be required for the secondary.

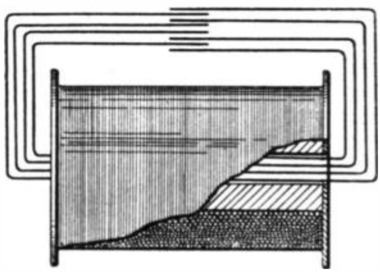


Fig. 123.—Showing the core and bobbin of the transformer.

The core consists of a bundle of 7 in. lengths of the best soft iron wire of small gauge. Each length should be shellacked. The wires are made into a bundle that will just pass tightly into the ebonite tube, being firmly bound for the middle 3 in. with stout thread. If the bundle is a loose fit, it should be wedged in with little wooden pegs.

The wires are now bent upwards and turned back over the bobbin to meet and overlap in the middle (Fig. 123). To reduce the reluctance of the magnetic path it is best to scrape the shellac off the ends and to bind each pair together with a few turns of very fine wire.

The whole transformer is next wound with tape and fine string to serve as a protection. The best way of mounting the finished instrument is to place it in a small box, packing it tightly in place with oily cotton waste, which will not collect moisture. Or if an old H.T. battery is lying about the workshop, its wax may be melted down and run into the box to make all secure. The four leads from the transformer are taken to terminals mounted on an ebonite lid made from the box.

CHAPTER VIII

SWITCHES

A Device for Using Several Sets of 'Phones

It often happens that one wants to be able to attach a second, a third, or even a fourth pair of 'phones to the set in order to enable a number of friends to listen to the signals or the music that is coming in. Where more than one pair of telephones are used it is desirable, when resistances are varied, that they should be connected in series, otherwise, owing to the differences in their windings, results will not be equal. One does not want, as a rule, to keep more than one pair permanently

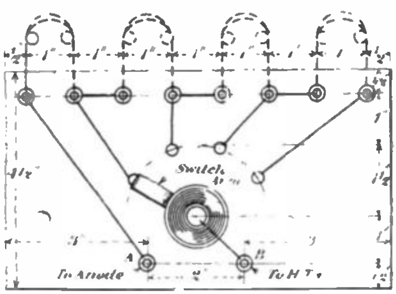


Fig. 124.—The wiring of the telephone board.

connected in this way, for when one is alone one naturally wishes signals to be at their best. What is required is some simple device which will allow any reasonable number of 'phones, say, from one pair to four, to be brought into use at will.

Fig. 124 shows how this can be accomplished without great difficulty. The materials needed are an ebonite panel, 8 in. x $4\frac{1}{2}$ in., ten terminals, a rotary switch-arm, and four studs. The ebonite, having been properly squared up, and finished at the edges, is marked out as shown. For the terminals and the studs 4B.A. clearance holes are drilled. A $\frac{3}{8}$ in. hole will be required for the bush of the switch-arm. The latter can be obtained for about 1s. 6d. The arm should be laminated, consisting of several strips of brass or copper, set closely together.

The two terminals on the base are for the output connections from the set. That to the plate is wired directly to the first of the terminals. The H.T. terminal is connected to the spindle of the switch-arm, and the four studs are wired respectively to terminals 2 and 3, 4 and 5, and 6 and 7 are connected together.

It will be seen that if the switch is placed on the first stud, only one pair of 'phones is brought into action. The second, third, and fourth studs each bring in another pair joined in series. One can thus keep the telephones wired to the terminals, but use as many or as few pairs as are required at any particular time.

Series-Parallel and Earthing Switch

Many readers will make, or will have made, series-parallel switches for their A.T. condensers, and they will also fit aerial-earth switches to safeguard their sets during thunder-s-torms. These two may be quite easily and simply combined, and, in the case of panel-mounting, with considerable saving of room and corresponding increase in neatness.

Fig. 125 shows the wiring of the modified switch. 1, 2, 3, and 4 are the studs, whilst A and B are the moving parallel arms. It

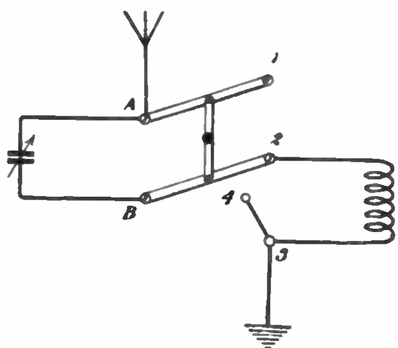


Fig. 125.—The connections of the combined switch.

is unnecessary to describe the making of the series-parallel switch, as it is quite simple.

The position of the 4th stud must be found by trial. The best way to do this is to stick a piece of stamp-edging somewhere near the correct place; it must be on the circle made by arm A. Move the switch, and determine if the end of arm A will touch it, and mark a pencil line on the paper. Then place B on 2 (A will be on 1, *i.e.*, the condenser will be in series), and see that the mark on the stamp-edging is clear of arm B, or the set will short-circuit to earth. Apply the punch to the pencil mark and drill a 4B.A. clearance hole. Put in a stud and connect up with stud 3. When the set is left unattended all that is necessary to be done is to pull the series-parallel switch down until arm A connects the aerial with earth through stud 4, thus giving perfect protection against lightning discharges.

Such a method of earthing is much to be preferred from the standpoint of safety to the various arrester type of protectors. These latter are, as a rule, by no means such a complete protection against lightning as they seem. Although most of them are capable of shunting off a discharge so that it does not damage the apparatus, yet in doing so they may produce an arc capable of starting a fire.

A Double-Pole Change-Over Switch

The double-pole change-over switch has many uses on the wireless set. Two of the handiest are seen in the figures. The series-parallel switch enables the aerial-tuning condenser to be placed in either relation with the inductance in a moment, a most

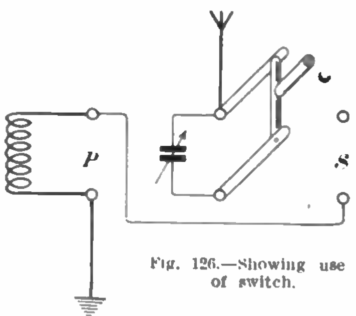


Fig. 126.—Showing use of switch.

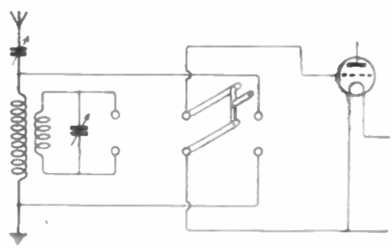


Fig 127.—An alternative arrangement.

useful arrangement when the set is used sometimes for long-wave reception and sometimes for short. For the latter it should always be in series in order to avoid the serious damping effects upon high-frequencies of a parallel capacity.

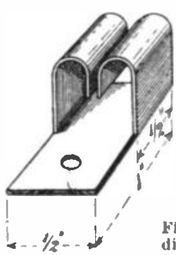


Fig. 128.—Showing dimensions of clips.

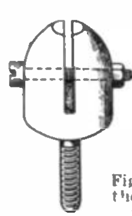


Fig. 129.—One of the two middle terminals.

The " tune " " stand by " arrangement greatly facilitates searching where several tuned stages of high-frequency amplification are employed. Throw the switch over to the right and the primary alone is in use, thus making the tuning as unselective as possible. When the desired transmission has been found and tuned-in with A.T.C. and the condensers of transformers or tuned anodes, the switch is turned right over, bringing the secondary into play.

The making of a switch of this kind is by no means a formidable undertaking. The materials required are a piece of ¼ in ebonite 2 in. wide by 4 in. long, a smaller piece measuring 2 in

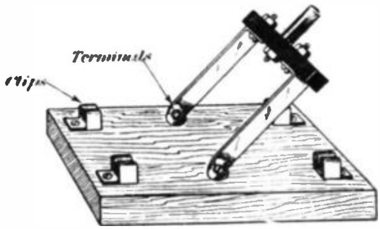


Fig. 130.—The complete D.P.C.O. switch.

by ½ in. by ¼ in., two " push-in " terminals, a few 4B.A. screws and nuts, a supply of sheet brass, and a short piece of ebonite tubing, the bore of which will just pass a 4B.A. screw.

Four clips of the size and shape given in Fig. 128 are made out of sheet brass. Next the two terminals are treated as shown in Fig. 129, a hacksaw cut being made in each, and widened a little if necessary with a thin, flat file. Clips and terminals are mounted on the ebonite (Fig. 130) in two rows each 1½ inches apart. The distance between the terminals and the clips is also 1½ in.

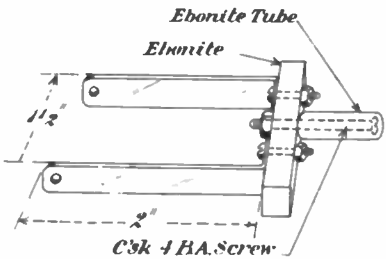


Fig. 131.—The double blade.

In Fig. 131 is seen the double blade of the switch, which is so simple to make that no further explanation will be needed. It is mounted on the slotted terminals, each blade being secured by a 4B.A. screw and nut. The ends of these screws may be lightly riveted to prevent them from working loose.

The whole switch is now fixed to a polished baseboard, leads being secured by means of the nuts which hold clips and terminals in place.

Apart from the uses given above, the switch may be very conveniently used as an earthing switch for the aerial.

In this latter case the two terminals on the left are connected to the receiver, whilst the two centre terminals are connected one to aerial and one to earth.

The terminals on the right should be fitted with a short-circuiting strap, so that when the switch is thrown to the right the aerial is earthed.

A Gridleak Selector Switch

The experimenter who spends a good deal of the time that he is able to devote to wireless to the trying out of different valves and a variety of circuits, will have discovered for himself what a nuisance the gridleak of the rectifying unit can be. In ordinary transformer-coupled circuits some valves work best with it in parallel with the grid condenser, others with it connected direct to LT+, others when it lies between the grid, and LT – ; others again give the best results when there is no gridleak at all.

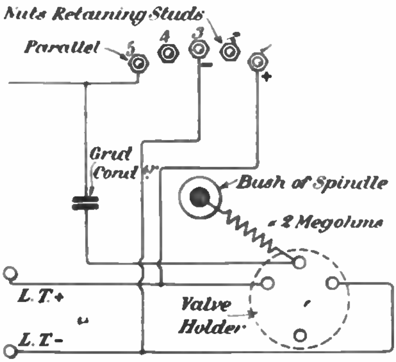


Fig. 132.—The connections of the switch.

However get-at-able the connections of the panel, one must make wiring changes that are a waste of time in order to try out these different connections, and the effect of constant unscrewing from and screwing up to terminals is not at all good for the leads, which, sooner or later, give way under such treatment.

The handiest fitting for the experimental set is a gridleak switch made on the lines shown in the drawings. It consists of a laminated rotary arm, mounted on a spindle provided with an ebonite knob, five studs and two stop pins. As these parts can be bought for eighteenpence, and as the fixing up of the switch needs no more skill than that necessary to drill 4B.A. clearance holes for studs and pins, and a $\frac{3}{8}$ in. hole for the spindle, the construction of this useful switch is neither an expensive nor a difficult job.

Ready-made switch arms have usually a radius of 1¼ in. or 1½ in. The position of the centre of the hole for the spindle having been marked out on the panel, a segment of a circle of the appropriate radius is drawn, and five marks $\frac{5}{16}$ in. apart are pricked off on its circumference with dividers. The six holes are then drilled, studs and spindle being afterwards placed in position. The points at which the holes for the stop pins will come are found by placing the arm on the two outer studs in turn.

The pins should preferably be screwed into holes tapped to receive their threads; but if you have no taps they may be passed through clearance holes and secured by nuts above and below the panel. The nuts will probably have to be filed down a little in order to allow the pins to come near enough to the end studs.

Fig. 132 shows the wiring of the switch. It will be seen that if the arm is placed on stud No. 1, the leak is connected directly to LT+ ; No. 2 throws it out of action altogether; No. 3 connects

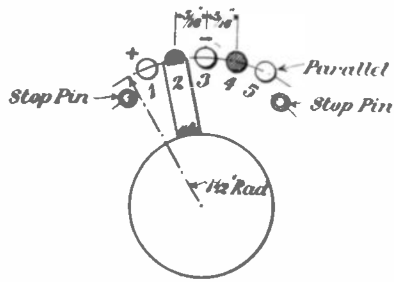


Fig. 133.—Details of the switch.

it to LT negative; No. 4, like No. 2, disconnects it; No. 5 places it in parallel with the grid condenser. The two " out of action " studs are divided in order to avoid short circuits.

The utility of the device will be appreciated by those who use sometimes transformer-coupled H.F. amplifiers and sometimes tuned-anode or resistance capacity coupling. A slight movement of the switch enables the rectifier to function properly with any form of coupling.

In the experimental set the gridleak should be of the cartridge type, and its best position is upon the upper side of the panel. Leaks of different resistances can then be tried without the least difficulty.

This is a great advantage to all those experimenters who take pleasure in testing different types of valves, since almost every type requires a different value of leak. Not merely does the value of the leak affect the results obtained in the sense that a correct resistance is required to produce signals of maximum strength, but the quality of reproduction in the case of telephony also depends upon its adjustment. Inefficient rectification is a very common cause of distortion.

A Useful Double-Pole Switch

The switch consists essentially of two arms insulated from each other in the manner to be described. One pole is formed by the 2B.A. spindle, while the other is the piece of flex wire which is pushed through a small hole drilled in the ebonite panel upon which the switch is mounted.

The switch is designed to work on the ordinary contact studs, and the arms may be arranged to work either on alternate studs, consecutive studs, or every four studs, as required. It may be used for a variety of purposes, such as series-parallel, reversing reaction coil, valve switching, shunting various capacity con-

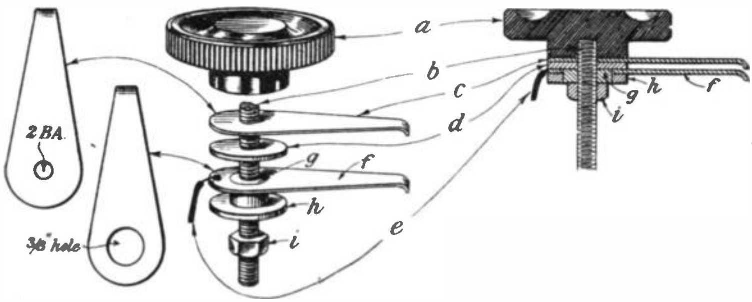


Fig. 134.—The switch in parts.

densers across variometers, etc. Presenting a neat appearance on the panel, the instrument is well worth any trouble experienced in building it, and, of course, the cost is measured by a few pence.

Its construction should be made plain by the detailed diagram, in which all the parts are lettered to correspond with the list which follows:—*a*, ebonite knob with 2B.A. hole tapped in centre; *b*, 2B.A. brass rod about 3 in. long; *c*, arm

Fig. 135.—The complete switch.

cut from brass sheet with 2B.A. hole—this arm may be soldered to the brass rod if desired; *d*, insulating washer with 2B.A. hole in centre; *e*, a short piece of flex wire soldered to *f*; *f*, an arm of exactly the same dimensions as *c*, but with a $\frac{3}{8}$ in. hole in centre to ensure clearance from the spindle; *g*, an insulating washer to keep the arm *f* from the spindle—this may either be a small piece of adhesive tape wrapped round the spindle or a short length of ebonite tubing of suitable diameter; *h* is another insulating washer with a $\frac{3}{8}$ in. hole, through which is forced the insulator *g*. This is backed by an ordinary 2B.A. washer, and the whole being assembled, is screwed home by a 2B.A. nut.

The finished switch knob and arms are shown in Fig. 135. The spindle is to be passed through a hole in the panel and secured by two nuts upon the underside, these nuts being tightened up and locked against each other in such a position that the spindle turns freely but without slackness; this adjustment may be more easily obtained if a spring washer is interposed between the nuts and the panel. A circle of studs upon the panel to the required number completes the switch.

Dead-End Switch

The following is a useful little hint for amateurs listening-in with the old type single-layer solenoid coil as A.T.I. With such coils signals are often considerably weakened from dead-end effects. These may easily be eliminated in the following manner,

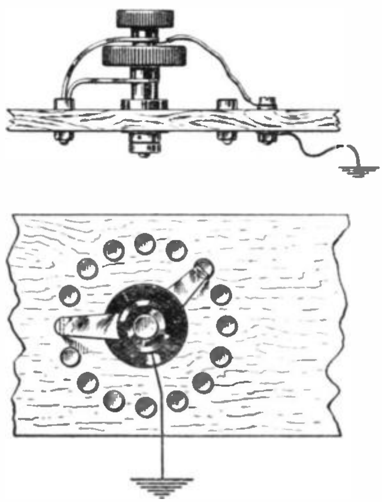


Fig. 136.—A useful switch to reduce "dead-end" effects.

without going to the trouble of rewinding the coil in sections. The method may also be used as a test to determine whether dead-end effects are present.

Tune in the ordinary way, and press the thumb against the tapping studs, trying them all the way round. One will perhaps be found which, when separately earthed in the above manner, will double or considerably increase signal strength. This proves the presence of dead-end effect in the coil.

Obtain a small ebonite knob, and fix it to the tuning knob of the A.T.I. by means of a single screw, in such a manner that it will rotate easily. The screw must not come into contact with the spindle of the switch arm. Fix to this knob a switch arm of springy brass, bent to make good contact on the studs. From the point of attachment of this arm to the knob a lead of flexible wire should be taken to a separate earth (even holding the bare end in the hand will do). Stations should now be tuned in as usual, and the second tapping varied until the best effect is obtained. This method of switching enables any section of the coil to be used at will, entirely eliminating all dead-end effect from the unused portion. It is especially useful in the case of telephony, and often brings in Morse stations quite loudly which before were practically inaudible.

A Simple Key Switch

There is a certain amount of fascination in possessing something in the nature of a mystery, and when small brothers cultivate the habit of interfering with receiving sets the possession of a master key is indeed something to be proud of.

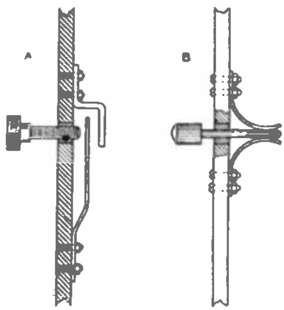


Fig. 137.—The switch terminals.

At A, Fig. 137, a strip of fairly stout brass is bent Z shape, and provided with two holes for attaching same to the inside of the panel by means of small screws or bolts. A strip of spring brass about 3 in. long and cut to the same width as the thicker piece is similarly attached to the panel in the position shown. Near the top of this strip and in a direct line with its centre a hole is drilled through the panel, and a 4B.A. nut is carefully fitted in same and secured (if it is necessary) with a little seccotine. The key comprises a short length of 4B.A. screwed brass rod rounded off at one end and fitted with a small knob at the other end.

The two brass strips are connected in series with one of the battery leads; thus it will be seen that by screwing in the key the lower strip makes contact with the upper one and closes the circuit.

B in Fig. 137 shows a still less complicated arrangement, although perhaps this method is not quite so reliable, owing to the spring brass strips having a tendency to sag and close the circuit when the key is withdrawn. To overcome this difficulty, however, it is only necessary to place the strips a little farther apart and use a key or plug of a correspondingly larger diameter. The panel is drilled and bushed with a small spacer washer, and the key is made from a short length of round brass rod which will slide freely through the bush. One end is slightly tapered and a small knob is attached to the other end. If desired, a small ring or the top of an old key may be soldered on in place of the knob. The switch is connected in series with one of the battery leads, the connecting wires being preferably soldered to any convenient part of the brass strips.

An Easily Made Series-Parallel Switch

It is a very great advantage to have on the wireless receiving set a switch which will enable the aerial tuning condenser to be thrown in a moment into either series or parallel with the inductance coil. Without such a switch one must make alterations in the wiring, always rather a fiddling business, in order to

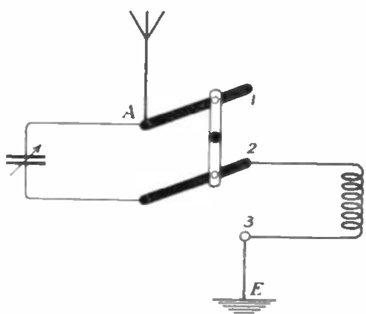


Fig. 138.

alter the position of the condenser; with it the desired change can be made by one small movement of a knob. For short-wave work the A.T.C. should always be in series with the inductance, otherwise the addition of capacity in parallel will have a certain damping effect. When we are dealing with very long waves it is an advantage to have the condenser in parallel, for to do so much increases the wavelength range of the particular coil that is in use.

Fig. 138 shows how the wiring of a series parallel switch is arranged. If the arms are placed as shown in the drawing on studs 1 and 2, the upper arm makes no contact with the coil. Impulses for the aerial pass through the condenser, then travel *via* the lower arm to the coil, after moving round which they reach the earth lead; the condenser is thus in series. Place the arms on studs 2 and 3, and it is in parallel; impulses on reaching the point A have two paths open to them, they can reach earth either by way of the condenser or by travelling round the coil.

To make this switch is a very simple matter. The arms shown in Fig. 139 are cut with shears from a piece of fairly stout sheet brass. The bridge is a piece of ⅛ in. ebonite 1½ in. in length. One hole is drilled in the middle of it to take the screw securing the knob; two others are for the 4B.A. round-headed screws which attach it to the arms. These are exactly 1 in. apart, and they should be large enough to allow the screws to pass easily. Drill corresponding holes of tapping size in the brass arms and thread them with a 4B.A. tap. Take a ⅜ in. screw, placing a flat washer on it, pass it through the ebonite, and drive it into the hole in the brass until the ebonite is securely

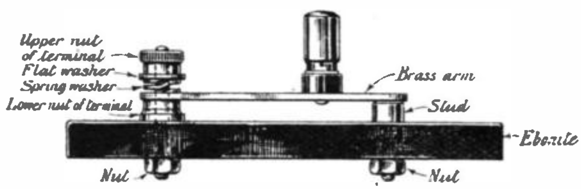


Fig. 139.

held, but able to move without binding. File the end of the screw almost flush with the face of the brass, then burr its end with a few taps from a light hammer. When the second screw has been fixed in the same way the arms are ready except that they require 4B.A. clearance holes drilled as shown. The knob is made from a short length of ebonite rod. A piece of ebonite 2½ in. square and ¼ in. thick is now cut out and two 4B.A. clearance holes (A.A.) are drilled through it. These are to take a pair of terminals which will form the supports for the arms. Pass the terminals through and secure them with hexagon nuts. Now place the holes at the ends of the arms over their screwed rods as shown in Fig. 139. On each put a spring washer, a flat washer, and, finally, its milled nut.

It is best to find the positions of the holes for the two outer studs by trial. To do this, stick a strip of stamp edging on to the ebonite; make a pencil dot on the centre line to show the position of the middle terminal, place one arm over this and mark the spot that is covered by the end of the other. The position of the third stud is found and marked in the same way. Apply the centre-punch to your pencil marks, drill 4B.A. clearance holes and remove the stamp edging. Ready-made studs can be bought very cheaply, but if they are not available 4B.A. cheese-head screws will do quite as well.

An Earthing Switch

Though there is probably little risk of an aerial being actually struck by lightning, it may become charged to a very high potential in stormy and changeable weather unless a connection direct to earth is provided. If the set is left connected up it may be seriously damaged in such circumstances.

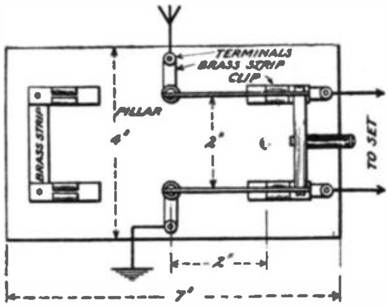


Fig. 140.—A double-pole earthing switch

To be effective, a switch must disconnect the set altogether. For this purpose nothing is better than a large double-pole double-throw switch wired as shown in Fig. 140.

The switch is made up on an ebonite base measuring 7 in. by 4 in. The pillars for the arms (Fig. 141) are made from 1 in. lengths of ⅜ in. round brass rod. A hacksaw cut ½ in. deep is made in each, a 4B.A. clearance hole being drilled through the rod from side to side to take the bolt which forms the pivot of the arm.

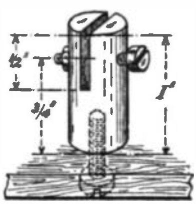


Fig. 141

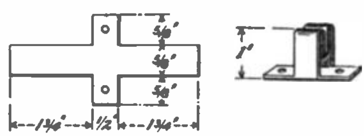


Fig. 142.—Dimensions of the clips.

The clips are of springy sheet brass. Fig. 142 shows the way in which they are cut out with the shears, and subsequently bent into their final shape.

The arms are also made of sheet brass, their dimensions being: Length, 3 in.; width, ½ in. They are secured by means of 4B.A. screws to the bridge, a strip of ¼ in. ebonite 2 in. long and ½ in. wide. The knob is a 1½ in. length of ½ in. round ebonite rod, secured to the bridge by a 4B.A. screw.

Fig. 140 shows the switch complete.

CHAPTER IX

VALVE PANELS

A Useful Valve Panel

A valve panel which may be made for about 5s. 6d. is shown in the accompanying sketches. An ebonite or wooden base B has mounted on it four terminals, T_1, T_2, T_3 and T_4, a valve

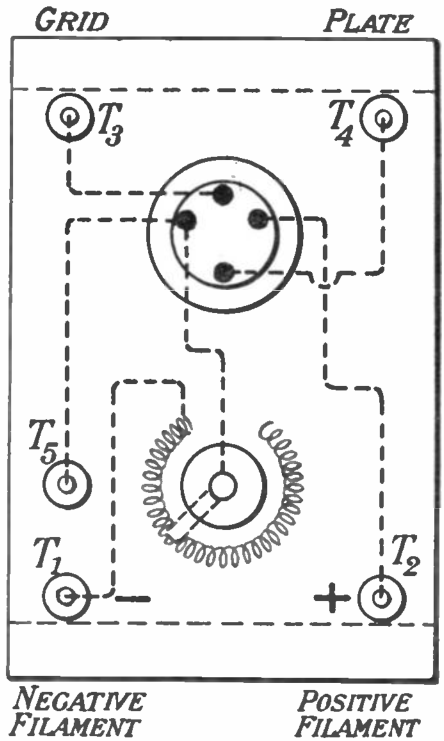


Fig. 143.—Wiring diagram of the panel.

holder which may be purchased for about 1s. 6d., and a rotary filament rheostat which may be purchased for about 4s. The method of securing the valve-holder and the rheostat to the baseboard B needs no description. The wiring of the panel is shown in Fig. 143. There is no need to mark the filament terminals positive and negative because in some circuits it is desirable to have the filament rheostat next to the positive side of the filament accumulator.

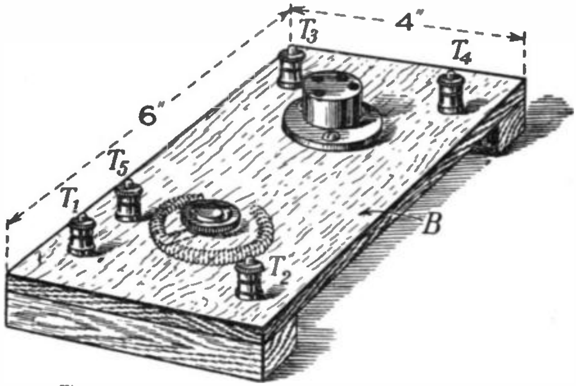
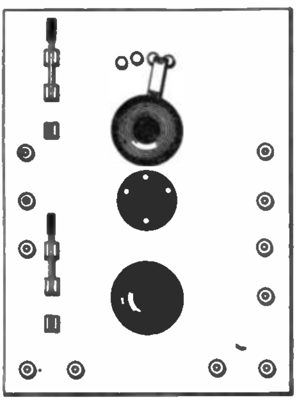


Fig. 144.—Showing dimensions of the valve panel.

In both diagrams an additional terminal T_5 is shown, and is connected to one of the filament sockets of the valve-holder. This terminal may be used in certain circuits where this special connection is shown.

An Experimenter's Valve Panel

For the experimenter there can be no more useful piece of apparatus than a valve panel so designed and wired that it will



Plan 145.—Plan of finished instrument.

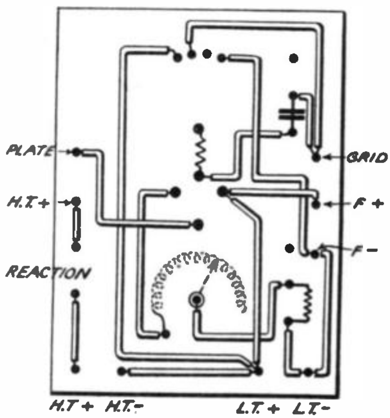


Fig. 146.—Wiring of panel.

allow any circuit to be made up with the minimum of trouble. The panel to be described has many special points which will commend themselves to those who are frequently engaged in trying out new ideas, since it can be used in any part of the set with the greatest ease. It contains a grid condenser, which may be thrown into or out of action in a moment by turning over a switch, and there is also a gridleak which a selector switch connects at will to positive or negative L.T., places in shunt with the condenser, or cuts out altogether.

An auxiliary resistance with a value of 10 ohms is available when required, so that dull-emitter valves can be used without

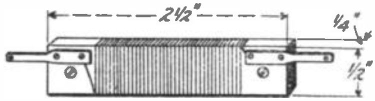


Fig. 147.—The extra resistance.

the necessity of making any changes in the accumulator connections. Last, but by no means of least importance, the filament resistance is connected to the negative low-tension terminal.

Fig. 145 shows the top of the finished panel. On the left are three input terminals, connected respectively to grid, L.T. + and L.T. – . Usually the secondary of the tuning inductance stand, or of a transformer, is connected to grid and L.T. – ; in some cases, however, it is an advantage to wire it to L.T. + instead of to L.T. – .

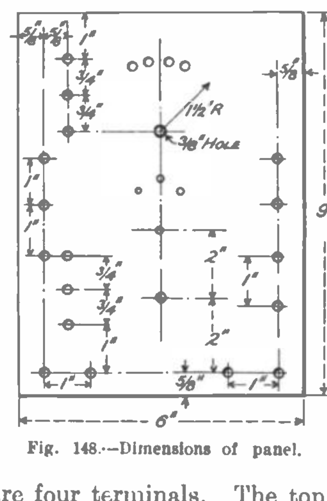


Fig. 148.—Dimensions of panel.

On the right are four terminals. The top pair are connected to plate and H.T. + . The second pair, for reaction, can also be used for the inductance and condenser of a tuned anode circuit, or for a non-inductive resistance if the resistance-capacity method of H.F. coupling is under test.

The selector switch, a laminated arm attached to a spindle moving in a brass bush, can be bought complete for 1s. 6d. The two single-pole double-throw switches, seen on the left, are of the midget type that has recently been placed on the market. These are neat and efficient little affairs, which take up only a small amount of room on the panel.

The extra resistance, controlled by the lower switch, is very simply made. Fig. 147 shows its appearance and dimensions. It consists of a piece of ¼ in. ebonite measuring 2½ in. by ½ in., upon which are wound about 2½ yards of No. 28 resistance wire. If " Eureka " wire is used, the total extra resistance available will be about 9 ohms; with Nichrome it will be rather over 10 ohms. As there are a good many makes of resistance wire with slightly different values for a given gauge, and as the rheostat mounted on the panel may have a resistance of anything from 4 to 7 ohms, the exact number of turns needed should be found by actual trial. If 2¾ yards of wire are wound on in the first instance, turns can be stripped off one by one until the happy

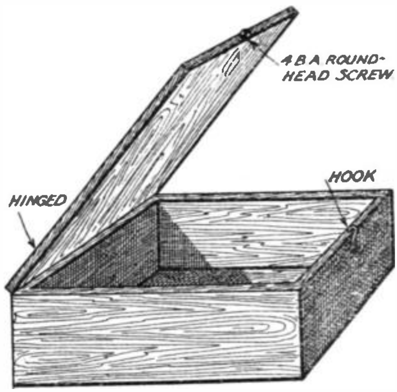


Fig. 149.—The containing box.

mean is reached. Little brass tags secure the ends of the wire; these allow neat soldered connections to be made. The ebonite former is fixed to the panel by means of 4B.A. screws.

An examination of the wiring diagram will show that if the gridleak and condenser are brought into play the panel becomes a complete single-valve receiver. When the reaction terminals are not required, as, for example, when the panel is used for housing a transformer-coupled H.F. valve, the reaction terminals are shorted by means of a brass arm, details of which are unnecessary.

Fig. 148 shows the drilling layout of the panel. It will be noticed that, with the exception of those for the bushes of selector switch arm and rheostat, all the holes are 4B.A. clearance. Use separate valve-legs for the holder, and not one of those moulded ebonite sockets which are popular because they save a little trouble. The grid anode caacity in one of these holders is of the order of 0.000005 μF; this may seem a small amount, but it is quite sufficient to cause undesirable effects on not balance correctly. If desired, the pillar may be in one piece, integral with the base, in which case it would be convenient to provide four small castors under the base, preferably those having porcelain wheels. It will be seen that the instrument may be easily detached at any time.

The wire used for the winding may consist of ordinary lighting flex with the outer insulation removed, or single 18 or 20 bare or cotton-covered wire, ten complete turns being sufficient for the broadcasting wavelengths. Tuning is accomplished by means of a 0.001 μF variable condenser connected in shunt with the winding. For longer wavelengths the arms should be made longer, and many interesting experiments may be carried out with different kinds of wire and various amounts of winding.

An Inexpensive Frame Aerial

The experimenter who is engaged in trying out new circuits, such as those containing double reaction or some other form of super-regeneration, is almost bound to have a frame aerial amongst his wireless gear, otherwise he will run the risk of

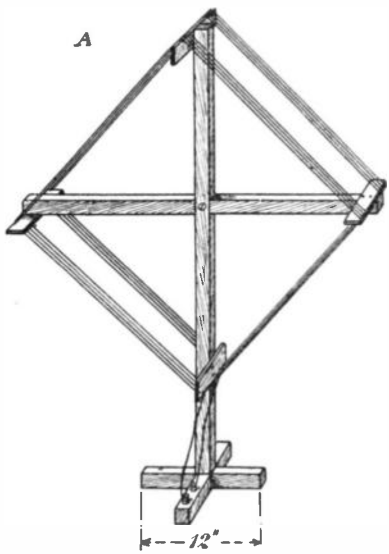


Fig. 15.—The frame aerial complete.

causing serious interference with others' reception during his tests, if he attempts to use broadcasting wavelengths. A frame will also be found very useful by those whose stations are so situated that jamming by local transmissions is the rule rather the H.F. side of the set when short-wave reception is in progress. The holes for the legs can be drilled with the greatest ease.

For making the connections of the panel, use stiff bare copper wire of No. 18 gauge, soldering every joint. When finished, the panel should be mounted on a neat little cabinet measuring 6 in. by 9 in. by 3 in. in depth, made of ⅜ in. oak. The most convenient method is not to screw the ebonite top to the cabinet, but to provide it with a pair of hinges at the top end, the fastening at the other end being a hook engaging with a screw. If this is done, the interior of the panel is instantly accessible should any fault occur, or should it be desired to try gridleaks or condensers of various values.

Another Experimental Single Valve Panel

The following is a description of a single valve panel which will be found capable of being put to a variety of uses, either alone or in combination with other valve or crystal apparatus. The construction will be dealt with first. The ebonite panel, about 6 in. by 5 in. by ¼ in. thick, forms the lid of a shallow

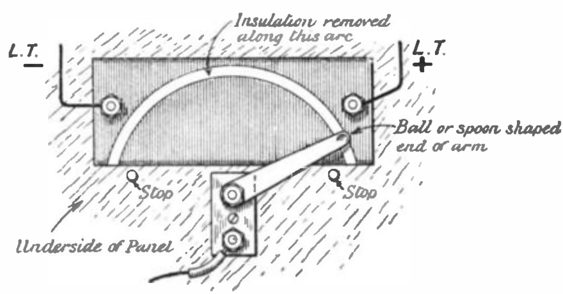


Fig 150—Showing construction of potentiometer

box about 2¾ in. deep. The bottom must be left out until all connections are made. A valve-holder is fitted in centre of top of panel, as shown in diagram. Eleven terminals are fitted in positions indicated. The potentiometer must now be made up. This consists of a close winding of about No. 38 S.W.G. single silk-covered Manganin or Platinoid resistance wire on a slate former about 2½ in. long, 1 in. wide, and ½ in. or ¾ in. thick. Two holes are drilled through the ends of the slate to take long brass screws, which form a means of fixing to panel and also the terminal ends of the winding, as shown in the figure. After winding, the wire should be given a coat of shellac varnish, and the whole fixed in the desired position. A moving contact arm is now made of light phosphor-bronze, the actual contact being made to present a ball surface to the winding by knocking a blunt centre punch on the extreme end of arm whilst it is supported on a piece of soft wood, as shown in Fig. 150. Stop pins should be fitted to the potentiometer to prevent the contact arm jumping off the winding if the knob is turned too far in either direction. It remains now to fit the customary knob and pointer. A filament resistance of usual type is fitted on the same level as the potentiometer knob. The grid condenser and two megohm leak are fitted between the two terminals A and B, and a connection taken from B to the grid socket of valve-holder. The scales for potentiometer and filament resistance may be cut direct on the ebonite if desired by means of a strong pair of dividers, and the lines filled in with white oil paint.

It is not proposed to describe the internal wiring in detail, as this is well shown in Fig. 152. The wiring should be carried out with fairly stiff copper wire in insulating tubing. The insulation of the potentiometer winding must now be removed by means of fine emery cloth held under the ball point of the contact arm. This is rather a tedious job, but if care is taken and a slight extra pressure applied to the arm, the actual wire will soon become visible on the arc of the circle which the ball point describes. Having finished the construction, a few hints as to use in various circuits will be given.

Single Valve Detector with Grid Condenser and Leak.

Connect a suitable accumulator to the terminals indicated. The terminals A and C are to be connected to the tuner and terminals R, R to the reaction coil if used; if not, short these two

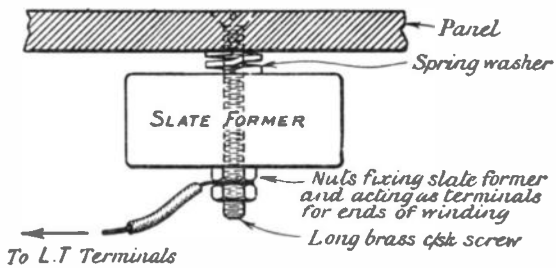


Fig. 151.—Attachment of potentiometer former.

with copper wire. The usual anode battery connections are to be made to D and E (positive to D), and the telephone or step-down transformer connections to F and G. The potentiometer may now be adjusted to give the best rectifying potential to the grid of the valve through the tuning inductance and leak.

Single Valve without Grid Condenser or Leak.

Connections as above, but change the lead from A to B. The potentiometer adjustment is important with this arrangement. It may be pointed out that the telephones are on the low-potential side of the high-tension battery, which is a much better arrangement.

H.F. Amplifier with Crystal Detector.

Connections as above, *i.e.*, tuner leads remaining at B and C. Transfer the H.T. battery leads to F and G (positive to F) after removing 'phones. Across D and E connect a suitable inductance, with variable condenser in parallel, to tune to same wavelength as aerial circuit, and across this condenser connect

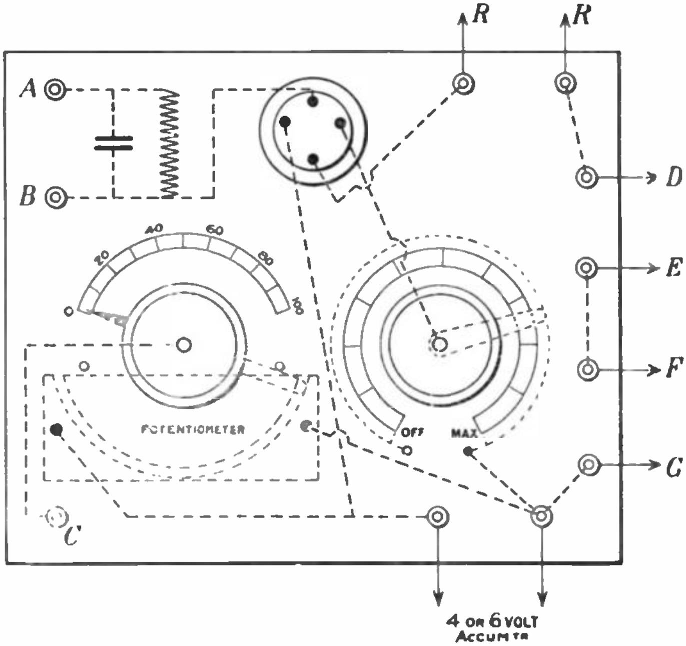


Fig. 152.—Wiring of panel.

crystal detector and 'phones in series. The potentiometer allows the best amplifying position to be easily found.

This panel may also be used as a rectifying panel after one or more H.F. amplifying valves, the potentiometer being used to control the grid potentials of all of them.

Its use as a low-frequency amplifying panel in conjunction with an inter-valve L.F. transformer will be apparent to most experimenters. It has not been considered necessary to go into minute details of the construction and assembling of the various parts, as the mode of procedure is well known.

Neat Experimenter's Panel

In the ordinary type of experimenter's panel—comprising valve-holder, filament resistance and four terminals, all mounted on ebonite—the valve-holder is situated on top of the panel, and the valve is consequently exposed to the danger of accidental knocks which only too frequently happen when the experimenter is hastily changing connections. The accompanying sketches show a design of panel where the valve is enclosed, which is a distinct advantage over the ordinary type.

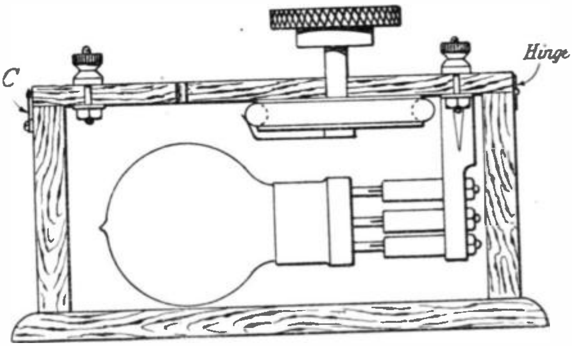


Fig. 153.—The complete instrument.

A sketch of the panel is seen in Fig. 153, showing valve and holder, resistance and terminals. Fig. 154 is a part sectional end view where the valve is not shown. As seen from the sketches, the ebonite top is hinged to the containing box and the valve is therefore easily accessible.

The box can be first constructed from suitable wood $\frac{3}{8}$ in. thick. The pieces required will be as follows:—Two side pieces

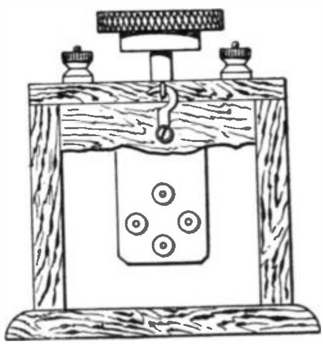


Fig. 154.—A sectional view.

each $5\frac{3}{4}$ in. by $2\frac{1}{2}$ in., two end pieces each $2\frac{3}{4}$ in. by $2\frac{1}{2}$ in., and the base $6\frac{1}{4}$ in. by 3 in.

A piece of $\frac{1}{4}$ in. thick ebonite is cut and filed to the sizes given in Fig. 155, and the various holes drilled. The parts are then fitted and the two holes marked are countersunk. The ebonite piece, which forms the valve-holder, is filed to the shape seen in Fig. 156, and holes bored in their exact position, including the two for the securing screws. The valve legs are fitted and the complete holder screwed to the panel. A substantial hinge is fitted to the end shown in sketch, screwing it first to the ebonite. This will not be difiicult, providing small holes are first bored a little smaller than the size of screws used.

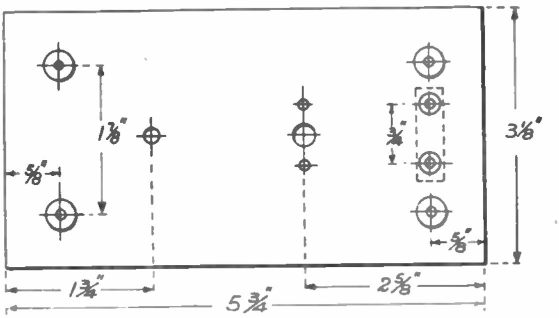


Fig. 155.—Lay-out of panel top.

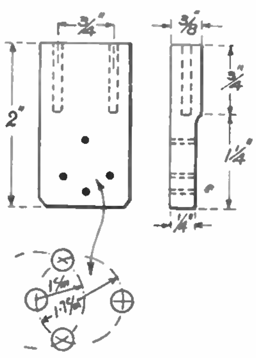


Fig. 156.—Valve holder.

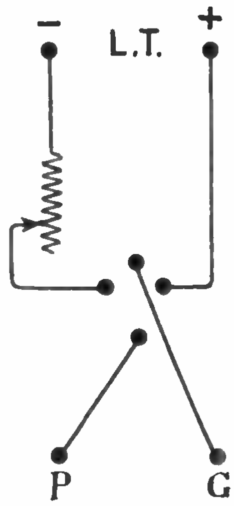


Fig. 157.—Wiring diagram.

Fixing a hook at the other end will complete the panel but for the connections, which are given in Fig. 157.

The terminals should be boldly marked to eliminate the possibility of making wrong connections to the batteries, with the probability of burning out the valve. To safeguard against the latter a pair of fuses could be put in circuit with the filament of the valve, fixing them in some convenient spot on the panel.

CHAPTER X

RESISTANCES

A Vernier Filament Resistance

Below are details for constructing a simple Vernier to be used in conjunction with the ordinary rheostat. This provides a method of adjusting the filament to millivolts, consequently

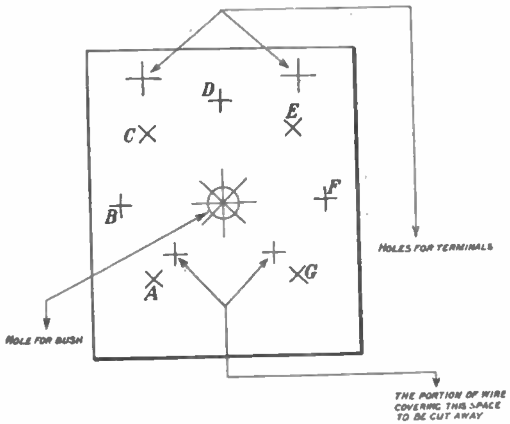


Fig. 158.—Showing the panel markings.

ensuring detector action at its best. Briefly, the following materials are required:—

Ebonite, 4 x 3½ x ¼ in.
Two terminals.
Seven No. 5B.A. brass nuts.
6 in. of 5B.A. threaded brass rod.
One laminated switch arm complete with bush and back nuts.
6 in. of No. 20 " Eureka " resistance wire.
3 in. of springy brass strip.

The first consideration is the resistance wire. This is bent to form a circle 2$\frac{1}{16}$ in. diameter, the most convenient method of doing this being to wind a single turn round a cocoa tin and temporarily solder the ends. The exact size is not critical, only bear in mind that the position of the holes A, B, C, D, E, F, G is governed by the diameter of the circle.

Take the ebonite, find the centre and describe a circle the diameter of which is exactly equal to the diameter of the ring just made. This is important. Point D (Fig. 158) should be marked on the circumference, and the points A, B, C, E, F, G equidistant on either side of it. The holes may now be drilled at the points, their size being $\frac{1}{8}$ in., cut from the threaded brass rod seven pieces $\frac{1}{2}$ in. long, and, placing a piece in each of the seven holes already drilled, lay the ring of resistance wire on the top. Now lightly solder the wire to the centre of each stud, care being taken that the solder does not run on the top surface of the wire, otherwise this will make it noisy and destroy the smooth action; this completed, the wire is cut at A and G leaving it in the form of the letter C. Carefully screw on the back nuts until the wire is flat with the surface of the ebonite; if these are screwed too tight, however, they will break

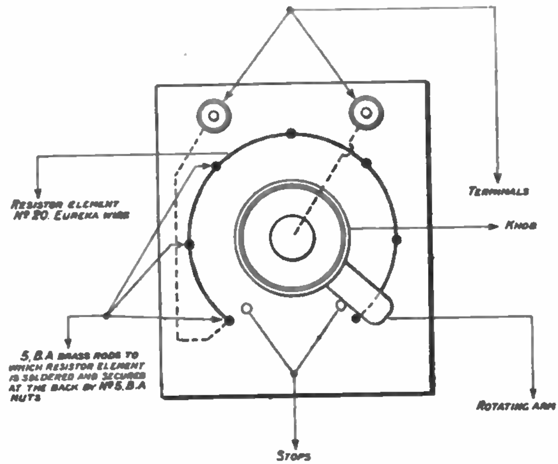


Fig. 159.—Showing the rotating arm.

away from the wire. Should the experimenter possess B.A. taps, dies, and a little engineering ability, the rotating arm and bush (particulars of which are given in Fig. 159) will present few difficulties to him. A switch arm of the laminated type, complete with bush and back nuts, may be purchased for a shilling or two, and the laminations removed, a piece of springy brass being substituted. The two terminals may now be fitted, connecting the right-hand one to the end of resistance wire, which is at G, and the other to the bush of the rotating arm. Two stops are made from the 5B.A. rod, each about $\frac{3}{4}$ in. long, their position depending entirely on that of the arm. The instrument is now complete, and should be connected in series with the resistance already in use.

Auxiliary Resistances for Dull Emitters

When one is using the low temperature valves that are now becoming so deservedly popular, it is often rather a difficult matter to reduce the E.M.F. of a 6-volt accumulator to a suitable value for the time being. If the three cells are connected by movable metal strips, these may be disconnected and replaced so that the cells are wired in parallel instead of in series. This is all very well so long as one is going to use dull emitters, and nothing else, but it is not very satisfactory if sometimes high temperature and sometimes low temperature valves are employed. One wants to be able to change from one to the other

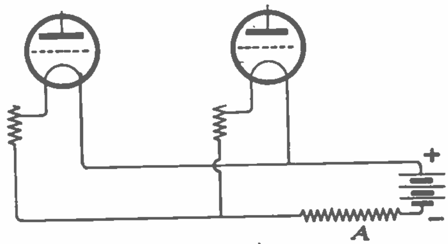


Fig. 160.—The wrong method of using the auxiliary resistance.

without difficulty or loss of time, which is impossible if the accumulator connections have to be altered whenever one type of valve or the other is inserted.

The normal 5 or 6 ohm rheostat is of no use at all by itself. Nor can we solve the problem by inserting a series resistance between the battery and LT-lead as A in Fig. 160. If we try this we shall find that if one's valve filament is turned down the others all brighten, and *vice versa.*

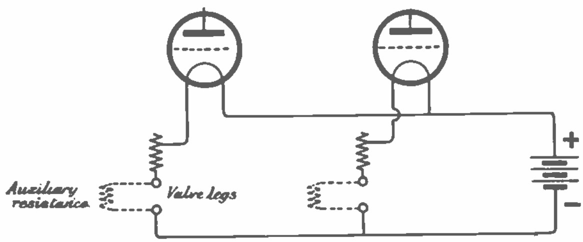


Fig. 161.—The correct way.

The best way is to make a small fixed resistance for each valve so arranged that it can be plugged when wanted into a pair of valve legs wired in series with the rheostat. The wiring is shown in Fig. 161. If high temperature valves are in use the plug-in resistances are removed and the gap between valve legs is shorted by means of another small "gadget," to be described presently.

Fig. 162 shows the resistance arrangement. It consits of nothing more formidable than a 2 in. length of ½ in. diameter ebonite rod, upon which are wound 2 yards of No. 30 resistance wire. The ebonite rod is secured to supports made of sheet brass by means of a 4B.A. screw at either end, the ends of the resistance wire being soldered to the supports. These are mounted on a piece of $\frac{1}{4}$ in. ebonite measuring 2$\frac{1}{2}$ in. by $\frac{3}{4}$ in., a pair of valve prongs being passed through the ebonite from underneath and through the feet of the brass supports and secured in place by means of nuts. When the resistance is plugged into the valve legs upon the panel an extra 8 ohms are obtained. If this proves to be more than is needed a little of the wire may be stripped off. For short circuiting purposes,

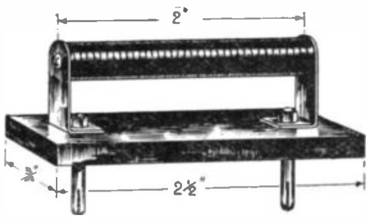


Fig. 162.—A plug-in attachment.

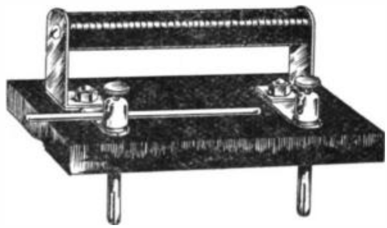


Fig. 163.—A modification of Fig. 162.

when dull emitters are not in use, another plug may be made consisting of a strip of ebonite containing two valve pins connected by a piece of sheet brass. Or, if desired, the arrangement shown in Fig. 163 can be made. Here two "push-in" terminals, connected by brass strips to the supports, are mounted on the ebonite. A length of $\frac{1}{8}$ in. brass rod serves to short-circuit or throw in the resistance in a moment.

The resistance may also be made roughly variable, as shown in Fig. 164. This is a great advantage if one is trying different types of dull emitters, for the voltage needed varies from 1.1 with the American W.D.-11 to 3 with the M.O. D.E.V. and D.E.Q.

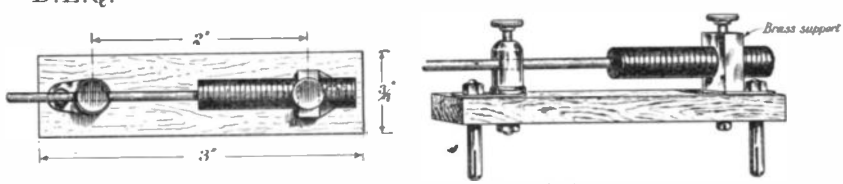


Fig. 164.—The resistance made variable.

A piece of $\frac{1}{8}$ in. rod is screwed into one end of the rod, the resistance wire being soldered to it. The brass rod slides in the hole of a push-in terminal. The wire-wound ebonite passes through a $\frac{5}{8}$ in. hole drilled in a piece of $\frac{1}{4}$ in. brass. The set-screws of the terminal and of the brass support enable a firm contact to be made. There is no need here for a special short-circuiting device, since if the ebonite former is pushed to the right until only its last turn is in contact with the brass support the extra resistance is practically eliminated.

Those who make up these handy little resistances should note that each cannot be used to control more than one valve of the D.E.R., or Mullard L.F. Ora B. and C. types, since its current carrying capacity is only about .6 ampere.

A Rheostat for Two or Three Valves

The rheostat, the construction of which is now to be described, has a carrying capacity of 1.8 amperes and a total resistance of 7½ ohms.

The wire most suitable for the resistance coil is No. 23 gauge, which if good quality, should have a resistance value of about 280 ohms per pound. As this wire resistance works out at approximately 1½ ohms to the yard, we shall have to wind five yards of it on to our coil. This cannot be done if the ordinary kind of open spiral coil is used without making the rheostat of unwieldy size. We can, however, get over the difficulty, first, by winding the wire on a deep ring-shaped former, and, secondly, by using enamelled wire, which enables the turns to be put on quite closely.

Fig. 165 shows how the spindle, which is made of a short length of 2B.A. screwed rod, is mounted. If the nuts above and below the panel are fitted with set screws, as shown, they will

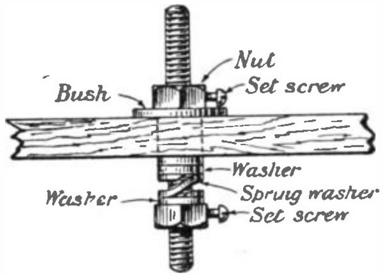


Fig. 165.—How the spindle is secured.

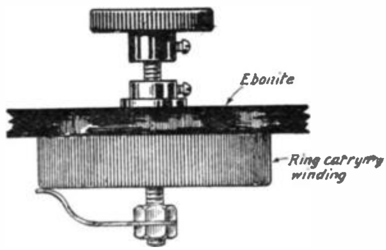


Fig. 166.—The finished rheostat.

never cause trouble by working loose. The bush is of the standard type used for variable condensers, variometers, and so on.

The ring former may be turned up from a piece of hard wood, its dimensions being: Diameter, 1¾ in.; depth, ½ in.; width, 3-16 in. But as such a ring is not easy to wind with even five yards of wire, it is better to make a horseshoe-shaped former from a strip of ebonite 3½ in. long, ½ in. wide, and 3-16 in. deep. This can be done if the ebonite is placed in boiling water for a few minutes until it has become soft. It can then be bent into shape on a lamp glass or some other round object of suitable diameter. Three holes are drilled right through it from edge to edge, one at each end of the horseshoe and one in the middle. These are to take the 6B.A. screws, which secure it to the panel.

The windings should now be put on as closely and as evenly as possible, a space being left where the holes for the middle screw comes The resistance may then be mounted. The contact arm is made from a strip of springy phosphor bronze. The windings are scraped bare of enamei on the lower edge of the former, so that the arm may make good contact with them as it is moved round.

than the exception, for this type of aerial is so markedly directional in its action that unwanted signals can usually be tuned out without difficulty.

A frame with two-foot sides will be found a very convenient size, since it does not take up too much room. With it, an ordinary set will give signals of about one-third the strength of those brought in by the outdoor aerial; to obtain anything like the same strength and range, high-frequency amplifying valves must be added to compensate for its lower efficiency.

To obtain two-foot sizes, the diagonal pieces must have a length of approximately 34 in. The upright one is cut 40 in. long to allow of its being mounted on a stand (Fig. 15). These diagonals are of pine 1½ in. broad and 1 in. thick. They are joined together by being slotted and fastened with a couple of screws. The upright is fixed to a cross-shaped stand.

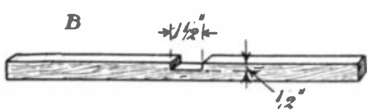


Fig. 16.—One of the cross feet.

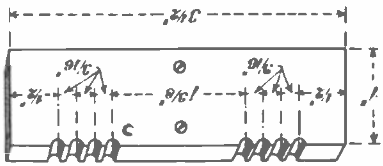


Fig. 17.—The ebonite spreader.

It is not desirable to tap a frame aerial, since to do so produces dead-ends, which give rise to a marked loss in efficiency. It is best, therefore, to adopt a number of turns that will tune with a 0.001 μF condenser in parallel to wavelengths useful for experimental purposes. Eight turns on the two-foot frame with $\frac{3}{16}$ in. spacing give a wavelength range of approximately 300 to 800 metres—a very rough rule of thumb which may be found useful is that on this sized frame, the minimum wavelength with a 0.001 μF condenser equals the number of turns multiplied by 40.

The spacing is done by making ebonite spreaders of the size shown in Fig. 17, and fixing them by means of screws to the arms. Stout bell wire of good quality will be found excellent for making the windings. Its ends are attached to a pair of terminals mounted on a small ebonite block fixed to one of the arms of the stand.

A Roller Blind Frame Aerial

No matter how portable you make the set itself, which you intend for holiday use, to take to picnics, or to rig up in a boat on the river, you are always faced by the aerial problem. Makeshift aerials contrived by slinging a wire from a branch of a handy tree, may or may not be satisfactory; usually they are not, since one cannot carry about a whole outfit of insulators. There is always the earth problem, too. It is easy enough to

CHAPTER XI

MISCELLANEOUS ACCESSORIES

An Easily-Made Wave-Meter for 300 to 9,000 Metres

The following is a description of a wave-meter which has given excellent results, and has amply repaid the little trouble in its construction. It has been found extremely useful for tuning a receiver to a given wave-length, and also for determining the points at which tappings should be taken on a coil in order that it may respond to some particular wave-length when connected to the aerial, for calibrating closed circuits, measurement of wave-length of stations received, and many similar uses.

Circuit and Finished Instrument.

The wave-meter is contained in a wooden box 8 in. by 6½ in. by 5 in., and it will be seen, therefore, that the finished instrument is quite compact. A general idea of the wave-meter can be inferred from Fig. 167. The circuit is shown in Fig. 168, the various components of which are to be described in detail.

The Variometer.

The variometer former is shown in Fig. 169. The winding formers are made from flat pieces of wood, the outer being 2¼ by 4 by 4½ in., and the inner 1¾ by 3¼ by 3 in. The outer former is wound with 70 turns of No. 26 enamelled copper wire and the inner former is wound with 90 turns of No. 30 enamelled copper wire. A clear space is left in the middle of each former in order that the spindle may pass through; half the winding, of course, being fixed on each side as shown in Fig. 169. The spindle is made of wood, a length of 4½ in. from a curtain rod about .4 in. in diameter being suitable.

The method of fixing the variometer in the box can be seen from Fig. 170. Two holes are made in the side of the outer former of such a diameter that the spindle can just pass through them with little friction, while the holes in the smaller former are so made that the spindle fits into them friction tight. Rotating the spindle, therefore, causes the smaller former to be carried round with it. A little glue may be used to make it quite secure.

A suitable knob at the end of the spindle is made from half a cotton reel, which is secured by means of a large-headed screw. The knob is provided with a pointer, which moves over the scale marked into degrees. It is so arranged that when it is pointing at 0 degrees the planes of the two variometer coils are the same, at 90 degrees they are at right angles, and at 180 degrees they are again coincident, but the direction of the winding of the moving coil is then naturally reversed.

Condensers.

The three condensers, C, D, E, shown in Fig. 168, are made as follows:—The condenser C is made from a ¼-plate photographic negative with the film removed, the thickness of the plate being about .055 in. A piece of tinfoil is secured to each side of the plate with a little shellac varnish, the foils overlapping for an amount of 1¾ in. by 4 in. The condenser D is also made from glass plates and tinfoil, the glass being the same kind as used in the first condenser. In this case ten pieces of tinfoil are required, the area of overlap being 3¼ in. by 2 in. The condenser E is made from mica and copper foil, the mica being

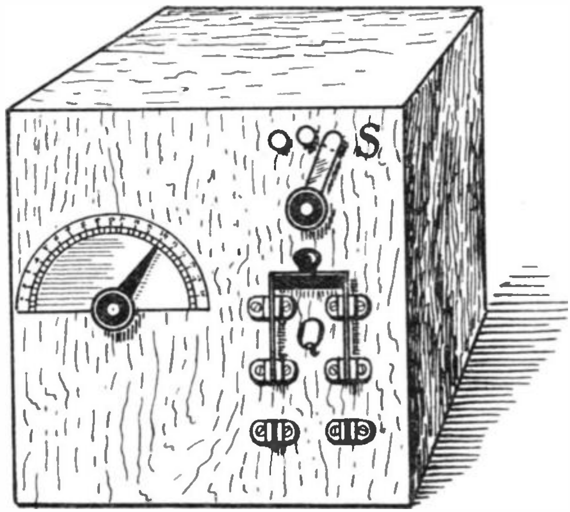


Fig. 167.—The completed instrument.

about .004 in. thick. Fifteen copper plates are used, the area of overlap being 1¼ by 2½ in. The actual construction of the condensers is of little importance so long as the resultant capacities are approximately C = .0003 μF, D = .003 μF, and E = .04 μF. Condensers of these capacities could, if desired, be bought ready-made.

Buzzer and Resistance.

Any buzzer will be suitable for the wave-meter, but one having a high note is preferable. The connections must be altered, if necessary, so that they correspond to those shown in Fig. 168, that is current flows through the point contact to the armature and thence through the coils in series, as shown.

The resistance R is connected across the buzzer coils as in Fig. 168, and is necessary to provide a path for energy stored up in the coils to discharge itself, so that it will not form an arc across the contacts when the buzzer operates. If this took place the energy in the variometer coils would flow across the conducting arc instead of charging up the condenser, and the wave-meter would not emit a wave of any definite wave-length.

To find the correct amount of resistance wire, first set the buzzer working by means of a battery. When it is going, connect a piece of resistance wire across the coils. If the resistance is too small, the buzzer will stop and the length of resistance wire must be increased till the buzzer will work properly. It will probably be found that two or three feet of about No. 30 " Eureka " wire will be sufficient. The resistance should be non-inductive, and may be wound on a wooden former in zig-zag fashion, or may be doubled upon itself and wound upon a small bobbin, in which case insulated resistance wire must be used.

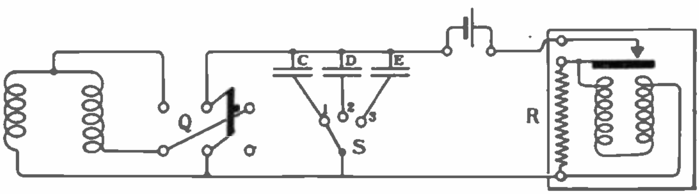


Fig. 168.—The wave-meter circuit.

A pocket lamp battery or dry cell may be used to work the wave-meter buzzer, and it is very convenient to fix this inside the box.

The Switch S.

This is merely a three-way switch of the usual type for the purpose of selecting the required condenser to give the desired frequency. The method of connection can be seen quite clearly from Fig. 168.

Switch Q.

This is an ordinary double-pole change-over switch, and is used to place the variometer coils in either series or parallel. It will be seen, of course, that when the switch is closed in either position, it automatically switches on the buzzer.

Calibration and Use.

It will be seen that six different ranges of wave-lengths are available, that is, two ranges with each condenser in circuit dependent upon the variometer coils being either in series or parallel. These are so arranged that there is a good margin of overlap between each, and a continuous range is obtainable between 300 and 9,000 metres. The instrument is best calibrated against a standard instrument if such can be obtained. The standard meter is set buzzing on the lowest wave-length, and the receiving set is tuned until loudest signals are obtained. The standard wave-meter is then switched off and the new one set buzzing and adjusted until loudest signals are once more obtained on the set.

The reading of the variometer pointer is then noted, and corresponds, of course, to the wave-length on which the standard instrument was working. This process is repeated for a series of

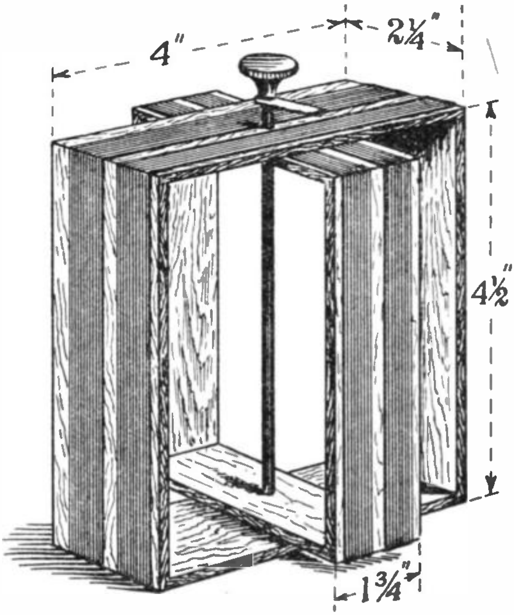


Fig. 169.—The variometer

wavelengths, for example, in steps of about 100 metres, that is, 300, 400, 500 metres, etc., until all the range has been covered. In order to find intermediate wavelengths it is advisable to draw a number of calibration curves by which these may be

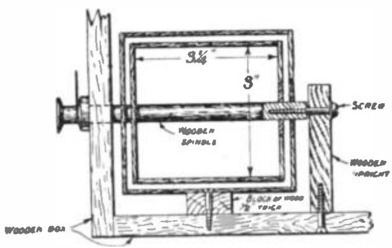


Fig. 170—The method of assembly.

determined. In the absence of any standard wave-meter, the instrument may be calibrated by stations of known wavelengths, and also more especially by those that transmit calibration signals, in a similar manner to that where a standard meter is employed.

A Cheap and Efficient Variometer

A simple little variometer that will give good results on the broadcast wavelengths can be made without difficulty, its total cost not exceeding eighteen pence. One great advantage of the type to be described is that it has no brushing contacts. Many variometers have two of these, and they are almost bound to become, sooner or later, a source of trouble as the spindles and bushes wear.

The former for the stator consists of a 1½ in. length of cardboard tubing with a diameter of 4 in. Two 2B.A. clearance holes are bored exactly opposite each other to take the spindles. A pair of smaller holes are then made quite close to one edge, and thirteen turns of No. 26 d.c.c. wire, one end of which has been passed two or three times through the two small holes to form an anchorage, are wound tightly and evenly round the stator. The wire is now carried diagonally across so as to clear the spindle holes, after which a further thirteen turns are wound. The winding is finished off by being anchored as before, a short end 2 in. or 3 in. in length being left protruding.

The rotor, a 1½ in. piece of tubing 3 in. in diameter, is drilled and wound in the same way, the number of turns being just as before. Both rotor and stator windings should be shellacked to keep them in place.

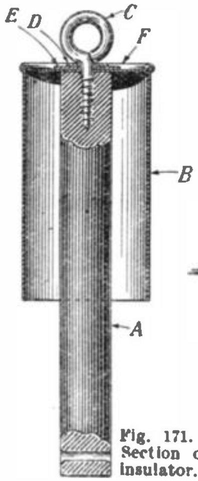
Three ebonite washers, two ½ in. in diameter and one 1 in., all drilled with 2B.A. clearance holes, are now prepared. Two of these are glued to the windings of the rotor so that their holes coincide with those for the spindles drilled in it. Their purpose is to protect the insulation of the wire when lock nuts are tightened down. The third and largest washer is fixed by means of screws over the upper spindle hole of the stator. Besides protecting the windings, it forms a bearing for the spindle. To the lower part of the stator is fixed, by means of 4B.A. bolts, an ebonite plate which may be provided with terminals, a plug and socket, or a pair of valve legs, according to the type of mounting desired for the finished instrument. A 2B.A. clearance hole to coincide with that in the stator is drilled in the plate.

We are now ready to assemble the variometer. A 1½ in. length of 2B.A. screwed rod is inserted through the holes in the ebonite plate and the stator. Over the end within the tube are placed a flat washer, a spring washer, a second flat washer, and a nut. The upper spindle, a 2 in. length of the same rod, is also passed through its hole, a single nut being placed upon it. The rotor is now placed inside the stator, and the point of the bottom spindle inserted in the hole drilled for it. The rod is now turned to screw it through the nut already placed upon it until a quarter of an inch or so protrudes into the inside of the rotor. A second nut is then put on and clamped down.

A nut is screwed on to the portion of the spindle which projects from the bottom of the mounting plate. This nut is adjusted until the rotor is drawn to an exactly central position within the stator; a second nut is then placed under it, and the pair are locked tightly. The upper spindle is then screwed in through an ebonite washer and through the rotor, to be fixed by a clamping nut on the inside. The beginning of the windings on the stator is now connected directly to one of the terminals on the plate. To the far end is soldered a short length of thin rubber-insulated flex, whose outer silk or cotton covering has been removed. This is taken to the " in " end of the rotor windings and soldered to it. Another piece of flex is taken from the " out " end of rotor winding to the second terminal, thus completing the circuit, and this quite efficient little tuning device.

An Aerial Insulator

It is surprising how many amateurs who, though they constantly design and construct good apparatus, do not turn their attention to the often most neglected part of a receiving set—the aerial. The important part of an aerial is, of course, the



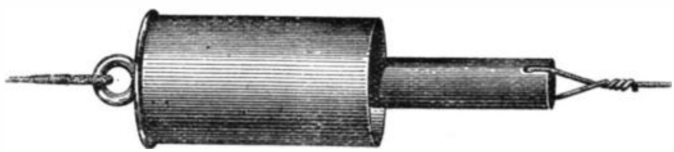


Fig. 172.—The completed insulator.

Fig. 171. Section of the insulator.

insulation. If the insulators are not good during all kinds of weather, one cannot expect the aerial, however well situated, to be really efficient.

The accompanying illustrations show a type of home-made insulator which possesses the advantage of being easily made without any sacrifice of efficiency, and which is a better insulator, particularly during wet weather, than most other types.

Fig. 171 is a cross-sectional view, where A is an ebonite rod; B the cover which protects the upper portion of the rod from rain; C an " eye hole " screw; D a metal washer; E a leather washer; and F paraffin wax. In construction the first article to obtain is the cover, as the dimensions of the rest depends on its size. The cover is an ordinary small tin box inverted. The majority of smaller boxes are made with a cardboard body and a tin base. These are quite suitable providing the cardboard has been well saturated in paraffin wax. The rest of the material can then be obtained.

Take the ebonite rod and drill a hole in the centre of one end, slightly smaller than the thread on the " eye screw," and another is bored cross-wise through the rod at the other end. A hole is bored in the centre of the base of the tin box. The " eye hole " screw is then passed through the hole in the metal washer, the leather washer, and the tin box, and is screwed tightly into the ebonite rod until the cover is held firm.

When completed the top of the cover is heated, and hot paraffin wax is poured into the depression until level with the edge. This prevents any tendency to leakage of wet around the " eye hole " screw.

An Efficient Lead-in Tube

The importance of having a good lead-in tube is not always realised, yet it may make all the difference to the quality and strength of one's receptions. If the lead-in is not well insulated on its way to the set a considerable part of the impulses brought in by the aerial may escape to earth before they reach the tuning inductance, and so do no useful work.

The tube to be described is simplicity itself, yet it is reasonably efficient. It costs very little to make, and it looks neat

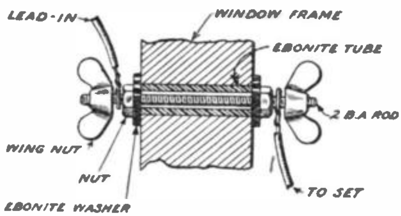


Fig. 173.—Sectional view of the leading-in tube.

when mounted in the window frame, for nothing is visible either inside or outside the window but a wing nut or terminal screw and an ebonite washer beneath it.

The first requirement is a piece of stout ebonite tube with an internal diameter of ¼ in. Its length must be exactly the same as the thickness of the window frame. A hole through which the tube will just pass is drilled with brace and bit in the window frame and the tube is inserted. A piece of 2B.A. screwed rod 2 in. longer than the tube is now passed through it, and an ebonite washer ¾ in. or 1 in. in diameter is placed over each end, the rod being clamped in position by nuts screwed tightly down both outside and inside the window.

The lead-in and the aerial wire of the set are fixed to the rod either by milled terminal screws or by wing nuts. The latter will be found the more convenient, since they are easy to tighten down and unscrew. One can thus be sure of obtaining tight connections, and when the set is to be disconnected there is no need to use the pliers, no matter how hard the nuts may have been turned down.

An H.T. Battery Box

There are two decided advantages to be gained from housing the high-tension battery in a neat box provided with a selector switch. In the first place the switch, if properly fixed up, makes the connections more positive than is the case when wander-plugs, often rather wobbly in their fit, are used. Secondly, the battery is protected from the dust and moisture, and, to some extent, from the effects of heat.

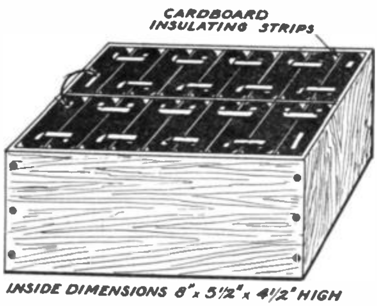


Fig. 174.—The H.T. battery in box with lid removed.

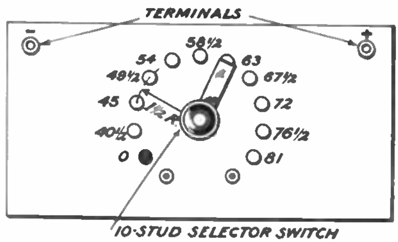


Fig. 175.—The top of the box.

The box to be described was designed to act as a container for a high-tension unit made up of flashlamp batteries connected in the customary way.

Eighteen of these provide a battery capable of giving plate potentials up to 81 volts, which should be ample for all ordinary purposes. They are arranged in the box in two parallel rows, each of which contains nine. The bottom of the box is covered with a layer of paraffin wax; strips of waxed cardboard are inserted between individual batteries and between the rows to ensure that they are properly insulated from one another. The *inside* dimensions of the box are: Length, 8 in.; width, 5½ in.; depth, 4½ in. It may be made of any kind of wood; ⅜ in. oak, sandpapered smooth and well oiled, is perhaps as good as any.

Fig. 175 shows the appearance of the top, which is of ebonite, ¼ in. in thickness. The selector switch has ten " live " studs, giving 4½ volts step from 40½ to 81 volts, and one " dead " stud, which serves as a cut-out when the battery is not in use. A 1μF Mansbridge type fixed condenser (not shown in the drawings) is mounted on the underside of the panel, and connected across the terminals.

The selector switch arm, with a radius of 1½ in., can be bought complete for eighteenpence or so, so that it is hardly worth while to make it up The studs should be of the smallest size.

It is very important that they should be so spaced that the arm cannot make contact with two at once, otherwise it will short-circuit each battery in turn as it is moved round. The holes for the studs (4B.A. clearance) are, therefore, drilled ⅝ in. apart round the circumference of a 1½ in. radius circle. This is all very well so far as it goes, but if we left such gaps between the studs the action of the switch would be very jerky, since the arm would spring down into them and have to be forced up on to the studs.

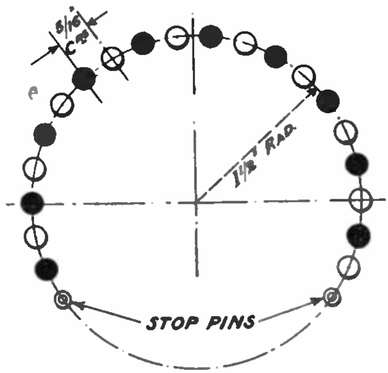


Fig. 176.—Suggested method for fitting studs.

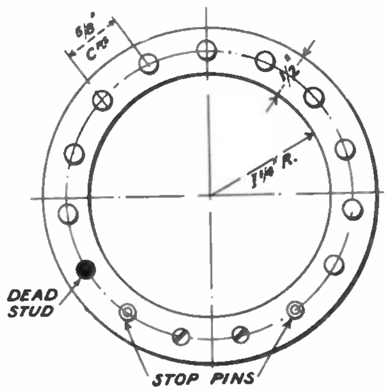


Fig. 177.—An alternative method.

We can get over this difficulty in either of two ways. One is to place a dead stud between each pair of live ones (Fig. 176), drilling double the number of holes and making their centres $\frac{5}{16}$ in. apart. The other is to cut out a circle of ¼ in. ebonite and to countersink the heads of the studs into it until they are flush with the surface.

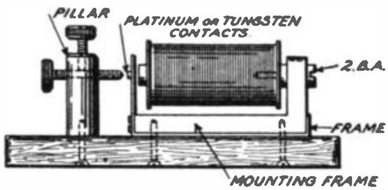
The wiring should be done with flex, for one is thus able to lift off the top of the box when necessary. The positive (short) strip of the first battery is connected to the + terminal, the other terminal being wired to the pivot of the switch. From the long strip of the ninth battery a lead runs to the first live stud; the tenth battery is connected to the second stud, and so on until the eighteenth is wired to the tenth stud. All connections should be soldered.

Batteries should be tested from time to time with the voltmeter; if any of them shows less than 3¾ volts it should be removed and replaced. The fact that this can be done with ease is one of the chief advantages of a H.T. unit made up and housed in this way.

A Home-Made Tuning Buzzer

A tuning buzzer is required by everyone who uses a crystal, whether for general reception work or for occasional experiments. Its use saves a great deal of time, enabling adjustments to be made quickly as well as making it possible to be sure that the set is working at its maximum efficiency before the reception of signals, brought in by the aerial, is attempted. Tuning buzzers can be improvised in endless ways—even an electric bell with the gong removed can be pressed into service—but unless a high singing note is produced it is somewhat difficult to obtain a correct idea of the degree of signal strength obtained on different points of the crystal. Many of the instruments sold as tuning buzzers were not designed for this purpose at all, having as a rule a low pitched note making them, therefore, less satisfactory for the reason stated above.

A buzzer that works excellently can be made with no very great difficulty by anyone whose workshop contains only a small



179.—The complete buzzer.

outfit of tools. The cost of constructing it is very small, and if we leave out the question of the platinum points needed, a modest amount should cover the outlay on materials. Platinum points are comparatively expensive, but one can sometimes rescue suitable old ones from discarded or broken pieces of apparatus in one's box of odds and ends.

The core for the bobbin consists of a piece of the best soft iron 1⅛ in. long and ⅜ in. in diameter. At one end a hole is drilled and tapped for a 2B.A. screw. This hole should be ½ in. in depth. Over it is slipped a bobbin made of a 1 in. length of stiff paper tubing, to which are glued two circular end-pieces 1 in. in diameter, cut from stoutish cardboard. The bobbin should be given a good coating of shellac both inside and out. If it is placed on the core whilst still wet, the shellac, when dry, will hold it firmly in place. The core projects $\frac{1}{16}$ in. at either end.

A short piece of 2B.A. screwed rod is inserted into the hole drilled in the core. This enables the bobbin to be mounted in the lathe for winding, or if a lathe is not available the rod can be fixed into the chuck of a breast drill held fast in a vice. The windings are made with No. 30 d.c.c wire, the bobbin being wound full.

The mounting frame is of brass. If suitable tools are available, it can be cut from the solid. If not, cut a stout piece solve if one is on the water, but on dry land it presents difficulties, unless an iron spike like the army telephone earth pin is carried.

The ordinary frame aerial does not weigh much, but owing to its spread, it is rather a bulky piece of gear to fit in with all the rest of one's paraphernalia. A device that solves all problems is the " roller blind " frame aerial, which when packed up occupies no more space than a sunshade, and requires, of course, neither insulators nor earth.

The materials required are simple, and their cost should not run to more than a few shillings. Here is the list:—

27 yards of single " flex."
1 piece of holland, 36 in. by 40 in.
1 blind roller, 38 in. by 1 in. diameter.
1 slat, 38 in. by 1 in. by ½ in.
2 terminals.
2 ebonite blocks, 1 in. by 1 in. by ¼ in.

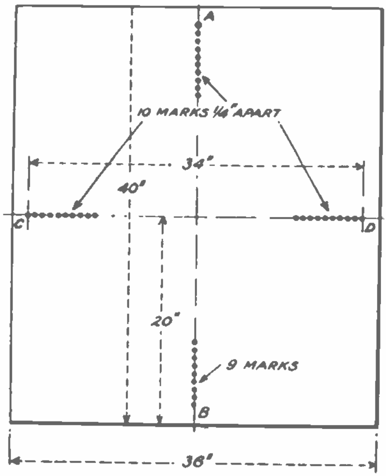


Fig. 18.—Dimensions of the holland foundation.

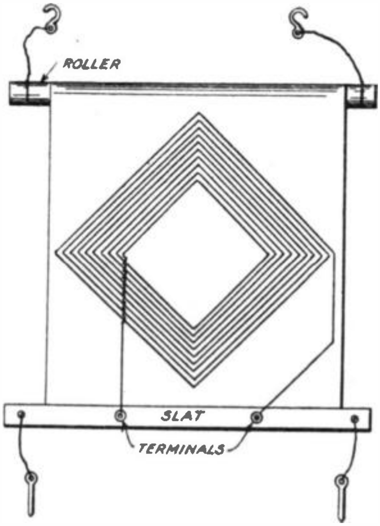


Fig. 19.—The frame ready for use.

The top and bottom edges of the holland should be hemmed. In the measurements given above it has been taken that the others will be selvedge edges; but if they are not, the material must be 2 in. wider and hems must be made.

Fix the blind to the table and rule lightly with the pencil the two straight lines AB and CD, each of which is 34 in. in length. At the ends A, C, and D make ten pencil marks, each ¼ in. apart. Make nine similar marks at B. Guide lines for the wires may now be ruled between the marks. The outside mark of D will be joined to the outside mark of C, and so on to B. From B the line runs to the second mark of D, finishing after 9½ turns at the inside mark at C.

of sheet brass $\frac{5}{16}$ in. wide and beat it into the L shape shown in Fig. 178. The bobbin is secured in place by means of a 2B.A. screw.

The armature is made of a piece of clock spring, which must be annealed by being heated and allowed to cool slowly before it can be worked. Two 6B.A. holes are drilled at one end to take the screws which secure it to the mounting. At a point which coincides with the middle of the core, a small hole is made. Into this is inserted a platinum rivet, which is flattened out by very gentle hammering. When the drilling has been done the armature is tempered by being heated in a bunsen flame and plunged into oil.

The contact pillar is a length of $\frac{3}{8}$ in. brass rod secured to the wooden panel by a 4B.A. screw driven into it from below. Through it is drilled and tapped a 4B.A. hole, the centre of which must be in line with the platinum rivet in the armature. Another hole, also tapped 4B.A., runs from the top of the pillar

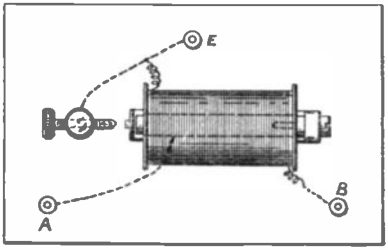


Fig. 179.—Showing connections of buzzer.

into the first. The horizontal hole takes a 4B.A. platinum pointed screw with a milled head. That drilled vertically is for a setscrew.

Three terminals are mounted on the panel as shown in Fig. 179. One end of the winding goes to B, the other end being taken to the contact pillar. The brass frame is connected to A, the contact pillar to E. A dry battery is connected to A and B, a lead from E being taken to earth.

A very neat job can be made if the panel is mounted on a shallow polished case, within which is a pocket flashlamp battery. A small switch can then be provided to throw the buzzer in or out of action.

Improving Vario-Couplers

The matter concerning the connections from the inner coil of a vario-coupler or variometer often presents a difficulty. The usual method is to solder short flexible leads to the ends of the winding, and run these out over the top of the larger coil to the terminals on the baseboard. The result is a more or less clumsy joint, to say nothing of the unsightly appearance of the flexible leads themselves. The weight of these, too, will often pull the inner coil out of adjustment at an inopportune moment.

This difficulty may be easily overcome by providing a hollow shaft, preferably of ebonite tubing, as shown in the accompany-

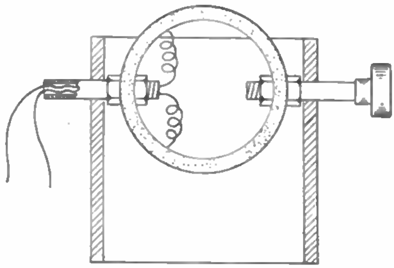


Fig. 180.—Suggestion for inner coil connections of a vario-coupler.

ing illustration, and running the ends of the coil winding through it to the terminals or direct to the circuit. If a metal tube is used it will be advisable to cover each end of the coil winding with insulating sleeving over that portion which passes through the tube.

A Rotary Potentiometer

A rotary potentiometer is a handy little instrument to use, for it can be provided with a degree scale, which makes it easy to note the exact setting required for controlling the grid potential of any particular valve. It is also much easier than the slider type to adapt neatly to the cabinet set, for nothing but the knob and the scale need appear on the upper side of the panel.

The former is a piece of $\frac{3}{16}$ in. fibre 8 in. long and $\frac{3}{4}$ in. wide. Care must be taken to get its edges perfectly true, otherwise the action of the potentiometer will not be satisfactory, since the arm will make a varying contact as it moves round the strip when it has been bent into a circle.

Two 4B.A. holes are drilled and tapped at the ends of the strip to take the screws retaining the ends of the wire, and three others are drilled in the top edges, as shown in Fig. 181.

The windings consist of No. 42 enamelled resistance wire, which must be put on with the turns as close and as tight as possible. At the middle hole in the edge a gap is left at the top just large enough to allow the screws from the panel to pass into the hole in the former prepared for it; this is done by keeping the windings close together at the top and putting on a few turns at a slight angle. The former will hold 500 turns of wire (there is no need to count them as they are wound), which will give a total resistance of about 300 ohms. Three-quarters of an ounce of wire will just suffice for them.

On the underside of the panel mark a 3 in. circle with the scriber and drill 4B.A. clearance holes to correspond with those in the former. Bend the former into a horseshoe shape and fasten it with countersunk screws. At the centre of the circle drill a $\frac{3}{8}$ in. hole to take a standard brass bush.

The spindle is a $2\frac{1}{2}$ in. length of 2B.A. screwed rod (or such other size as is a good fit for the bush). It is mounted as shown in the sectional view of the finished instrument in Fig. 182. The

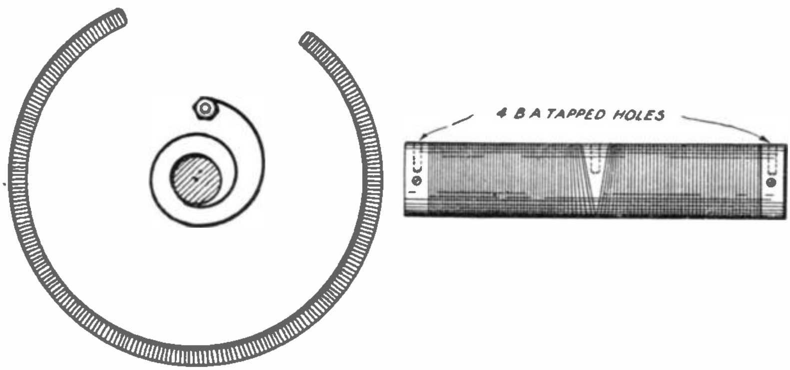


Fig. 181.—Illustrating arrangement of the resistance element.

arm is a piece of stiffish but springy sheet brass about $\frac{1}{8}$ in. wide at the point, and punch-marked from below so that it shall make contact with any one or two turns at a time.

As a brushing contact between spindle and bush would not be found satisfactory, the form recommended is that which consists of a spiral of thin sheet copper, whose inner end is soldered to the spindle, the outer being similarly attached to

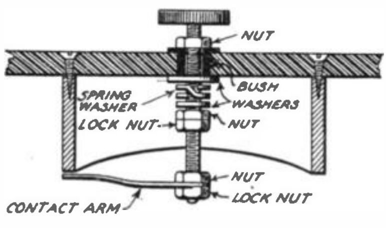


Fig. 182.—Sectional view of potentiometer.

a short length of 4B.A. threaded rod screwed into the panel and provided with a pair of nuts, to which a lead may be attached.

If the potentiometer is mounted on the set itself, connections will be made below the panel. But if it is to be a separate instrument with a small case of its own, connections from either end of the windings, and from the pillars of the copper spiral, should be taken to a trio of terminals mounted on the upper side of the ebonite.

Another Potentiometer

Most of those who conduct serious experimental work with crystal detectors swear by carborundum for general use on account of its stability. Though this crystal will give respectable results when used with a carbon contact without any applied E.M.F., it is at its best when a steel contact is used and a steady voltage of from 1 to 3 volts is applied.

For detector work there is nothing to beat the centre connected battery and potentiometer circuit shown in Fig. 1. For this two flashlamp batteries may be used joined in series, the connection being made by soldering a lead to the long strip of one battery, which is bent back and soldered to the short strip of the other.

A potentiometer to be suitable for use with flashlamp batteries must have a very high resistance, of the order of, say, 500 to 600 ohms, otherwise they will not last long if much work is done with the set.

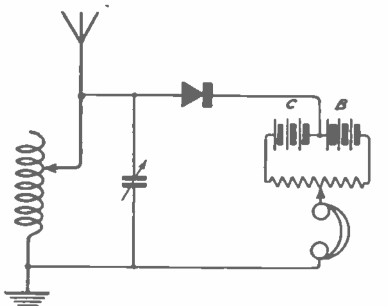


Fig. 183.—A simple potentiometer circuit.

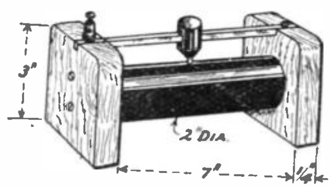


Fig. 184.—The finished potentiometer.

Fig. 184 shows how such a potentiometer may be made. A hard wood cylinder, 2 in. in diameter, is mounted by means of screws between two 3 in. square wooden end pieces each ¼ in. thick. On to the wooden roller we wind 1½ ounces of No. 32 enamelled resistance wire, the ends of which are passed through very small holes drilled in the ebonite. A slider moving on a square rod is fitted as shown, and provided with a terminal.

The instrument is now mounted on a polished wood base, on which are two terminals to which the ends of the windings are secured. A small cut-out switch should be fitted between one terminal and the lead running to it, so that when the set is not in use the battery current may be switched off.

This potentiometer has a resistance of about 600 ohms, and as the E.F.M. of the two batteries in series is 9 volts the current flowing will be only 15 milliamperes, which should mean a fairly long life for them, provided that the switch is used.