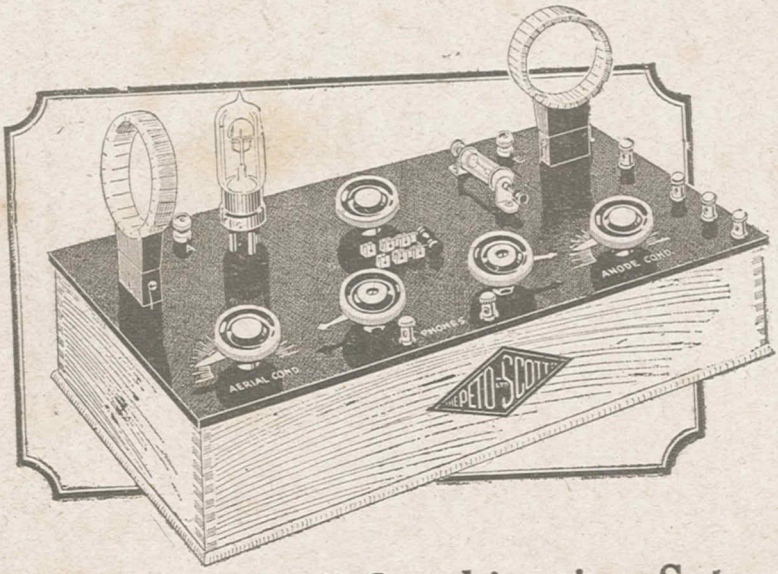
The "P.W." Combination Set

Full constructional details of a wonderful receiver that will, by means of single switching devices, provide six useful crystal and valve circuits using merely two valves and a crystal detector. This set will receive *all* the B.B.C. Stations. It is *the* finest set of the year.



The "P.W." Combination Set

(As erected by Peto-Scott Co. Ltd. and approved by Editor of "Popular Wireless").

ANYONE can build up the new POPULAR WIRELESS Combination Set from Peto-Scott complete Sets of Parts. The panel is drilled and engraved, and very clear blue prints explain every detail of the wiring. Instead of plugs and jacks, we supply, as an improvement, anti-capacity switches, as shown above. Note how neat and well balanced is the appearance of this splendid Set. As a further refinement, this Set is now designed to operate over *all* wave-lengths, and not merely over the B.B.C. wave-lengths.

Complete Set of Parts for Assembling above Instrument

Ebonite Panel, ¼ in. thick, engraved, drilled, and tapped. Polished Cabinet to fit. Variable Condenser, ·001 assembled; ditto ·002 (in parts for assembling); Rheostat, two Utility Switches, Series-parallel Switch, Crystal Detector, two Coil Holders, Valve Sockets, all terminals, screws, insulating sleeving, etc., etc., and full instructions **£4-0-0**

Marconi royalty extra, **12/6**

Amplifier Unit

The terminals of the Receiver shown above are arranged so that the amplifier is coupled directly to it on the right with short brass bars. Both of these instruments correspond exactly with the descriptions given in this Booklet, with the exception of plug-in coils instead of fixed basket coils—giving unlimited wave-lengths—and more convenient switches instead of plugs and jacks.

Complete set of parts for the Amplifier, including Cabinet and fully engraved panel **31/-**

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THE "P.W." Combination Set, Built and Described by the Technical Staff of "Popular Wireless."

Complete Instructions for the Construction of the most popular receiver of the year. Presented to readers with the compliments of "Popular Wireless."

CONTENTS:

Presented Free with "Popular Wireless," week ending October 6th, 1923.

HOW TO MAKE THE "P.W." COMBINATION SET.

"THE MOST POPULAR RECEIVER OF THE YEAR."

Introduction by the Editor of "Popular Wireless."

WINTER is closing in upon us. Leaden skies, a nip in the morning air, and plenty of rain—all have done their best to convince us that summer is over, and that winter, with shorter daylight hours and dismal evenings, is at our heels. And it is only natural that, with the close of outdoor evening sport, we should turn with revived interest to our wireless receivers and begin to plan out possible improvements and additions.

During the past year dozens of constructional articles have appeared in print—crystal sets, one-valve, two-valve, and three-valve sets have been dealt with *ad lib.*—but it was only recently that the all-round super-set was discovered and described for the benefit of amateurs. And that set is the POPULAR WIRELESS Combination Set.

It is not my intention here to enlarge on the merits of the POPULAR WIRELESS Combination Set. Its wonderful properties are dealt with in the following pages, but I do wish to emphasise the *proved worth* of this apparatus.

Some months ago I called a staff consultation, and requested my assistants to "get busy" and evolve a circuit which would assist amateurs to build a cheap, reliable, and economic receiver, capable of picking up all the broadcasting stations.

I must confess I did not anticipate such an extraordinarily successful result, but, to the great credit of the Technical Staff, the POPULAR WIRELESS Combination Set was evolved. The opinions expressed by leading manufacturers on another page are sufficient indication for the success of the labours of the Technical Staff.

Also, for two weeks, readers of POPULAR WIRELESS visited the office and tested out the set for themselves. In every case they were enthusiastic in their praises.

It but remains for me to wish my readers the best of luck in their constructional efforts. If the instructions given in the following text are faithfully adhered to, the reader will make the set of the year—a set which will render such service that he will, I am sure, never regret the day he commenced to build the POPULAR WIRELESS Combination Set.

THE EDITOR.

THE "P.W." COMBINATION SET.

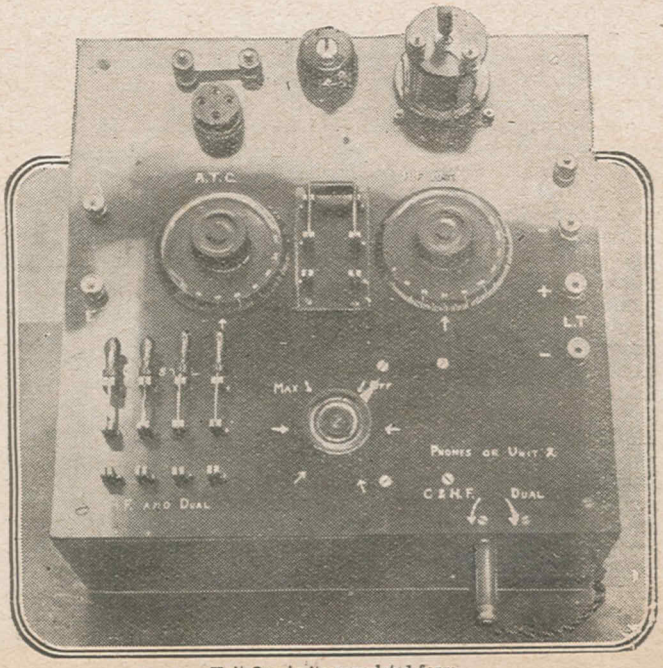
FULL DETAILS FOR ITS CONSTRUCTION.

By the Technical Staff of "Popular Wireless."

CHAPTER I.

MOST amateurs commence their wireless experience with a crystal set. When used to operating this set, something more is required either for the purpose of obtaining louder signals or a greater range. If louder signals are required, a low-frequency amplifier is necessary and for a greater range a high-frequency amplifier should be used.

The high-frequency amplifier is connected between the aerial and the crystal, to magnify the high-frequency oscillations before they are rectified by the crystal. The low-frequency



Unit One in its completed form.

amplifier, as its name implies, magnifies the low-frequency impulses that are normally produced in the telephones of the crystal set.

In Fig. 1 the connections of a high-frequency amplifier of the tuned anode type are shown. When a current oscillation is produced in the aerial a voltage is produced across the aerial tuning inductance, the aerial end of this inductance being connected to the grid of the high-frequency valve, and the earth end to the negative end of the filament. In the conditions under which this valve is operating, no current flows between the grid and the filament, these two points behaving as an extremely small condenser. Thus, the grid will have an oscillating voltage applied to it, and it will consequently cause similar but magnified variations in the current flowing between the plate and the filament from the H.T. battery.

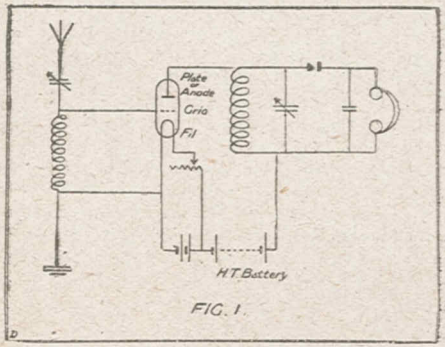


FIG. 1.

High-Frequency Amplification.

The current flowing in the inductance of the anode circuit will, therefore, rise and fall exactly in accordance with the perodicity of the oscillation applied to the aerial. If this inductance be tuned to this periodicity, the circuit formed by the anode inductance and the condenser will oscillate in tune with the aerial oscillations. The voltage across this inductance will be considerably greater than that across the aerial inductance, because a greater current is flowing. If, therefore, a crystal detector and telephone be connected across the anode coil as shown in Fig. 1, a rectified current will be produced in the telephones which will have a greater value than that which would have been produced if the detector and telephone had been connected across the aerial tuning inductance.

Note Magnification.

It will thus be seen that a signal which would have been too weak to produce an audible sound in a receiver if the detector and receiver had been connected across the aerial inductance will be rendered capable of producing a sound after being magnified by the high-frequency valve.

The low-frequency magnifier is connected as shown in Fig. 2. The telephone is replaced by the primary of an iron-cored intervalve transformer. The low-frequency currents produced by the action of the detector passing through this transformer induce a voltage in the secondary of roughly four times the value of the primary voltage, the number of turns on the secondary being four times those on the primary. These low-frequency voltages

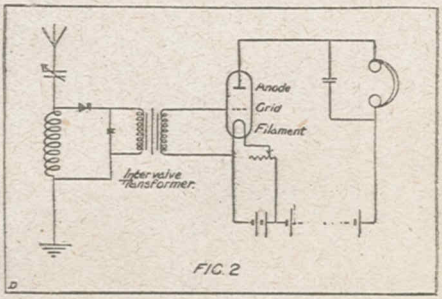


FIG. 2

applied to the grid of the valve cause similar but magnified variations in the current flowing in the anode circuit. These currents flowing through the telephones, being stronger than those flowing through the primary of the inter-

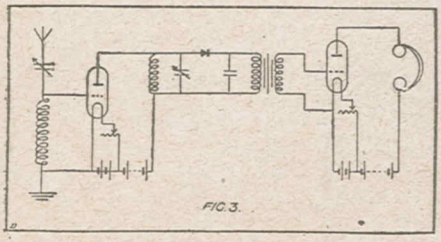


FIG 3.

valve transformer, cause stronger signals.

It will be appreciated from the foregoing that signals which are too weak to produce audible sounds in the crystal set will not be magnified sufficiently to give signals when amplified through this type of circuit.

In Fig. 3 a high-frequency valve followed by a crystal detector and then by a low-frequency amplifier is shown, separate batteries being shown for the sake of clearness.

Dual Amplification.

Having seen that both high-frequency and low-frequency amplification can be used on a crystal set, we will now give our attention to a method whereby both types of amplification can be obtained with the use of only one valve.

In the low-frequency portion of the set shown in Fig. 2 it will be seen that the telephones are connected in the anode circuit of the valve. If, therefore, we arrange to feed the currents from the secondary of the transformer into the grid circuit of the high-frequency valve, and to put the telephones in the anode circuit, this valve will also act as a low-frequency amplifier.

Under these conditions the connections of the circuit become as shown in Fig. 4. The high-frequency grid circuit is completed through the ·0002 mfd. condenser shunted across the secondary of the low-frequency transformer, and the valve amplifies the high-frequency voltages impressed on it. These amplified voltages are rectified by the crystal as before, and fed back to the valve through the transformer as low-frequency oscillations, thus causing low-frequency variations of the grid voltage and corresponding low-frequency variations of the anode currents which flow through the telephones. The valve in this case acts as a dual or high-frequency and low-frequency amplifier.

Six Circuits Available.

In the set to be described provision is made by means of switches and jacks to obtain the following combinations :

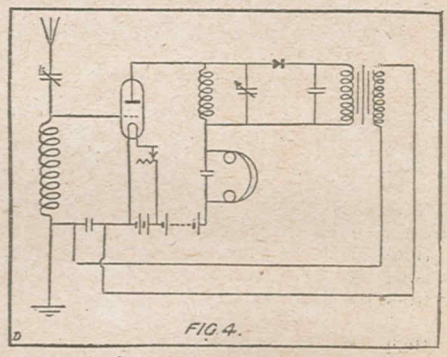
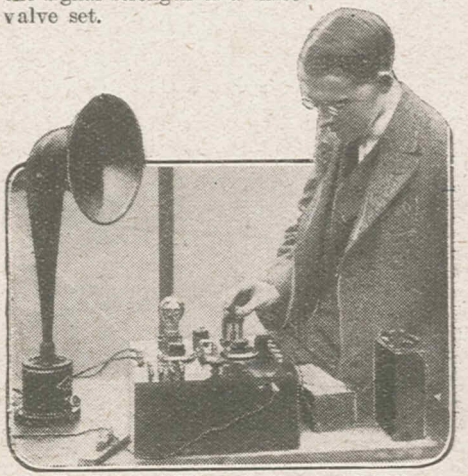


FIG 4.

1. Crystal circuit alone.
2. Crystal and low-frequency amplifier.
3. High-frequency amplifier and crystal detector.
4. High-frequency amplifier, crystal detector, and low-frequency amplifier.

5. Dual amplifier—i.e., high-frequency amplifier, crystal rectifier, and low-frequency amplifier; giving almost the signal strength of a three-valve set.



The Technical Editor adjusting the "P.W." Combination Set.

6. Dual amplifier with additional low-frequency amplification.

The complete set consists of two units, the first giving:

1. Crystal circuit alone.
2. High-frequency amplifier and crystal detector.
3. The dual circuit.

The second set provides a second low-frequency stage which can be also used with the first set to give the three additional combinations.

Only Two Switches.

Dealing with the first unit, the connections of which are shown in Fig. 5, two double-pole change-over switches and two break jacks are used to effect the circuit changes.

With the switch 1 in the left-hand position, the ends of the aerial tuning inductance are joined through to the centre terminals of switch 2. With this in the "top" position the crystal detector is connected across the tuning inductance, and if the telephone plug is inserted in jack 1 the set works as a plain crystal set. With switches 1 and 2 in the opposite positions and the telephone plug in jack 1, the set now becomes

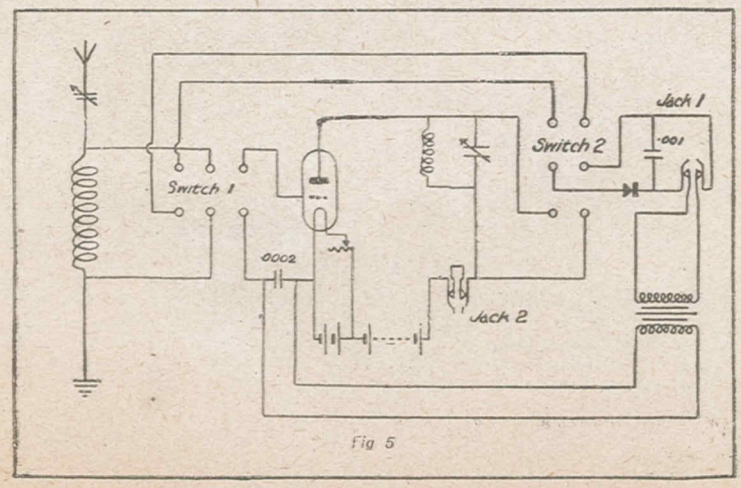


Fig 5

a high-frequency amplifier and crystal detector. Changing the telephone plug into jack 2 and leaving switches 1 and 2 in the same positions, the set becomes a dual amplifier.

The connections of the second unit

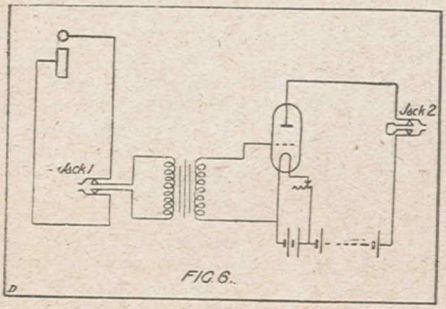


FIG. 6.

are shown in Fig. 6. The input terminals are replaced by a plug which can be inserted in the jacks of unit 1, and it will be seen that with the telephone plug in jack 1 the telephones are connected directly across the jacks in set 1, so that any combinations obtained in that set are obtained without the additional low-frequency amplification which is obtained when the telephone plug is inserted in jack 2.

The First Unit.

The construction of the unit 1 will be dealt with first, and it is proposed to give details of construction of the items; although, of course, component parts may be used instead.

The contacts for the double pole switches are constructed from $\frac{1}{4}$ in. square brass rods; 9 inches of this rod will be required to make the 12 contacts required.

Each contact consists of a piece of this rod $\frac{3}{4}$ in. long, a longitudinal saw-cut $\frac{3}{8}$ in. long being made to form the jaw of the contact as shown in Fig. 7. The opposite end of this piece of rod is tapped to take a 6 B.A. countersunk screw, which is drilled through its length to allow the wire connected to the contact being pushed up from underneath and clamped by the 6 B.A. screw tapped into the side of the contact block $\frac{1}{8}$ in. from the end.

The Switch Blades.

The centre contacts, of which four are required, have, in addition, a hole drilled as shown to take a rivet of copper wire to form the hinge for the blade. The blades, four in number, are composed of hard brass strip $\frac{1}{32}$ in. thick, $1\frac{1}{4}$ in. long, by $\frac{3}{8}$ in. wide. A hole is made $\frac{1}{8}$ in. from one end for the rivet, and at the other a No. 4 B.A. countersunk screw is soldered, the blade being inserted in the slot of the screw as shown in Fig. 7. The ends of the blade at the hinge should be rounded as shown. The handle is composed of a piece of ebonite rod $\frac{1}{4}$ in. in diameter, 1 in. long, tapped to screw on the countersunk screws on the handle.

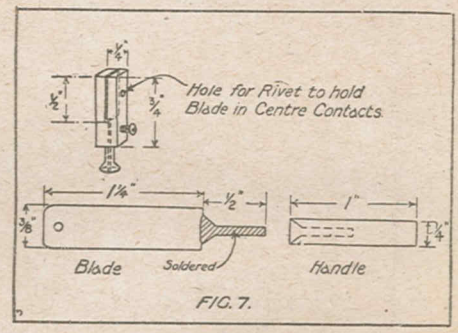


FIG. 7.

CHAPTER II.

THE next consideration is the aerial tuning condenser, for which the ordinary standard parts are to be used; 29 fixed and 28 moving vanes will be required, giving a

capacity of ·001 mfd. The usual types of vanes are shown in Fig. 8.

Ebonite end plates, which should be drilled as shown in Fig. 9, should next be prepared. These may be either rectangular or circular. The sizes of the holes should suit the rods and terminals available. The terminals and studs should be tapped into the end plates as shown, so that the top ebonite end plate will be flush with the panel when mounted.

Important Details.

Look over the spacing washers and free them from burrs left by the parting tools. This is important, or the vanes will be thrown out of line when assembled. Commence on the centre shaft when assembling by screwing the bottom nut hard against the square shoulder thread on the moving vanes and large spacers, commencing with a vane and locking the whole of them together by means of the top nut. It is, of course, unnecessary to say that these vanes should be assembled in line.

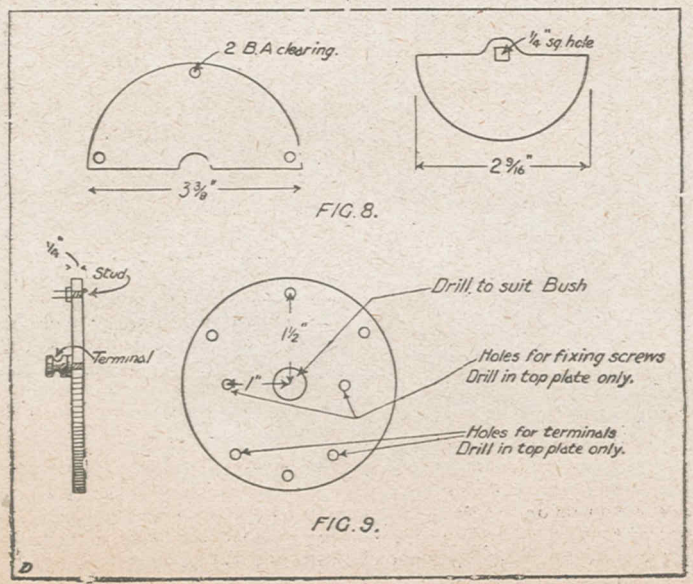
The foil connecting the terminals to the stud for the fixed vanes and the bush for the moving vanes should next be put into position. The four studs should then be screwed into the top plates and locked by nuts.

Assembling Condenser Parts.

Commencing with a plate, assemble the fixed vanes and small spacers, and lock them in position with nuts.

The two sets of vanes should now be assembled, the bottom plate, which should have a special bush with adjusting screw, as shown in Fig. 10, being fitted in position.

If the vanes come in contact, adjustments of the moving set up or down will have to be made by means of spacing washers, which may have to be filed down on the top of the spindle until they lie dead central between the fixed vanes. In no circumstances should any attempts be made to bend the vanes to clear contacts. The ·0002 mfd. variable condenser should be



made in the same way, using 7 fixed and 6 moving vanes.

The Aerial Coil.

The basket coil for the aerial tuning inductance is wound on a cardboard former of the dimensions shown in Fig. 11, having 11 slots $\frac{1}{8}$ in. wide. This former should be thoroughly dried and shellacked before any winding is done. Forty-five turns of No. 24 D.C. wire should then be wound on, leaving sufficient ends for making the connections when assembling. The anode coil is wound on a similar former 4 in. in diameter, and this consists of 70 turns of No. 28 D.C. wire.

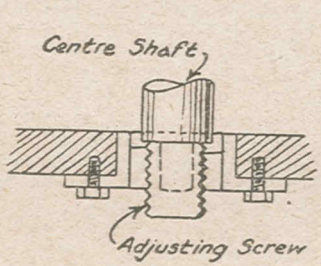


FIG. 10

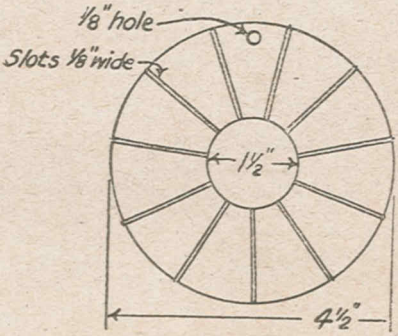


FIG. 11.

L.F. Transformer.

The low-frequency transformer should next receive attention. Two pieces of ebonite, $2\frac{1}{8}$ in. square by $\frac{1}{16}$ in. thick, are required for the end pieces. A circle 1 in. in radius should be marked on each piece, as shown in Fig. 12, and by a judicious use of saw and file the ebonite should be cut to this shape. One edge should be rounded as shown. A hole $\frac{3}{4}$ in. in diameter should be drilled through the centre for the core wires; and two $\frac{1}{8}$ in. holes, which should be given rounded edges, drilled as shown for the leads to the primary and secondary.

The core wires, which should be of No. 22 S.W.G. iron wire, perfectly straight and $9\frac{1}{2}$ in. long, should then be laid up until a tight core $\frac{1}{2}$ in. in diameter is formed. The bobbin cheeks should be fitted to a paper tube $2\frac{7}{8}$ in. long and $\frac{1}{16}$ in. thick, and carefully secured by shellac. This tube should be thoroughly dried and shellacked.

Winding the Primary.

Short leads of No. 30 S.W.G. about 6 in. long should be cut, and one soldered to No. 46 S.C.C. used for winding the transformer. This short end is inserted through the hole in the end cheek nearest the core, and winding commenced. For a man with a lathe the winding is a comparatively simple matter, but by the exercise of ingenuity it is usually possible to arrange some means by which this winding can be done by those not so fortunately situated.

Care Necessary.

The utmost care must be exercised in winding to prevent breakage of the wire; no sudden jerks must be given to it, and the bobbin from which it is

being unwound should be mounted so that it will revolve easily. The primary is wound on over the whole length of the tube to a diameter of $1\frac{3}{16}$ in. Another short end of No. 30 D.S.C. should then be soldered to the wire, which is, of course, broken from the bobbin and pushed through the second hole on the same side as the commencing end.

The Iron Core.

The secondary is wound in the same way to a diameter of $1\frac{3}{4}$ in., after the primary has been carefully covered with three layers of empire cloth, using the same size of wire and bringing the ends through the holes in the opposite bobbin to which the primary was brought. Two layers of empire tape over the secondary complete the winding of the transformer.

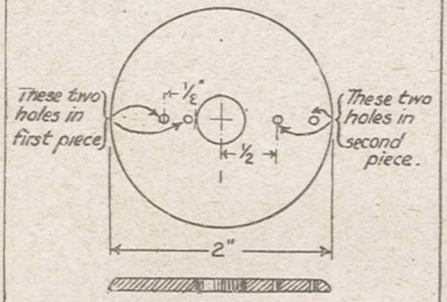


FIG. 12.

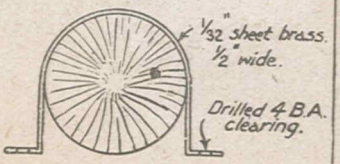


FIG. 13.

The core wires should now be inserted in the tube until they project equally from both ends. They are then spread out from a point at the exact centre of each end, and bent down evenly all over the windings and interlaced. Care should be taken to get the wires evenly spread out all round the bobbin and carefully interlaced. A brass band clipped over the core wires will hold them securely in position. A further band, as shown in Fig. 13, should be made for securing the transformer to the panel.

CHAPTER III.

IT is left to the constructor to decide what type of crystal will be used as detector. Either the double crystal combination shown, or the well-known hertzite, permanite, or other prepared galena can be employed, but either will give good results, and it is merely a matter of choice. In the set constructed by the staff a double crystal detector using zincite and bornite is shown, and this combination has the advantage of being more stable than the "cat's-whisker" type. Two clips as shown in Fig. 14 are required to hold this detector.

Two cups $\frac{1}{4}$ in. deep by $\frac{3}{8}$-in. diameter can be made out of $\frac{3}{8}$-in. diameter rod by drilling a $\frac{1}{4}$-in. hole to a depth of $\frac{3}{16}$ in., as shown in Fig. 14. These cups should also be tapped to take a 4 B.A. screw, as shown. The adjusting spindle is 1 in. long, and carries a ball and spring, as shown in Fig. 14. This ball should be turned out of the solid. The handle is composed of $\frac{1}{4}$-in. diameter ebonite rod $\frac{1}{2}$ in. long, tapped to fit the spindle. The other cup is fitted with a 4 B.A. screw and two nuts to clamp it to the clip.

Circular ebonite caps $\frac{3}{4}$ in.

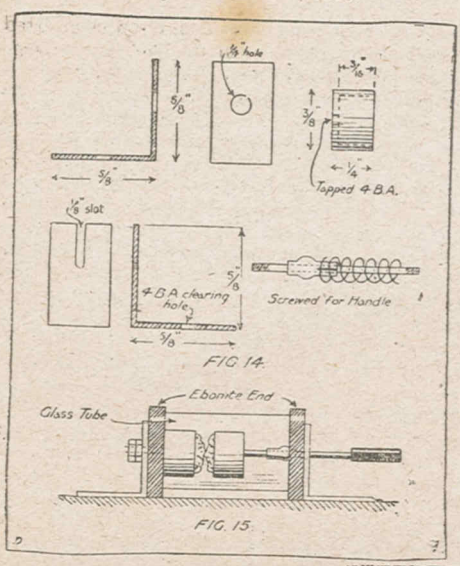


FIG. 14.

FIG. 15.

diameter and $\frac{1}{8}$ in. thick, recessed to take a piece of glass tube $\frac{5}{8}$ in. diameter and 1 in. long, are fitted to each end, one of which is also recessed to form a spherical seat for the ball on the adjusting spindle.

Fixed Condensers.

A filament rheostat and valve-holder should be purchased, as should the two jacks required. Six terminals will also be necessary. Two fixed condensers are also required, and these should be made by clamping copper foil between mica sheets. For the ·001 mfd. condenser six pieces of foil 2 cm. by 1 cm. and seven pieces of mica 3 cm. by 2 cm., ·002 in. thick, are necessary, and for the ·0002 mfd. condenser two pieces of foil and three of mica of the same size. Condenser cases can be obtained at a moderate price, and these can be utilised, or the usual method of forming the cases from pieces of ebonite can be adopted, taking care that the mica and foil are kept in intimate contact.

Drilling the Panel.

The panel on which these components are mounted is 12 in. by 12 in. and $\frac{1}{4}$ in. or $\frac{5}{16}$ in. thick. It should be carefully squared on the edges, and, if desired, may be given a matt surface by rubbing with emery cloth.

Many people experience difficulty in marking out a panel for drilling, but, even if such marking out can be satisfactorily effected, it is much safer to lay out all the items on a sheet of paper of the size of the panel and mark the positions of the holes on this sheet of paper. The sizes of the holes can then be pencilled on the paper, which

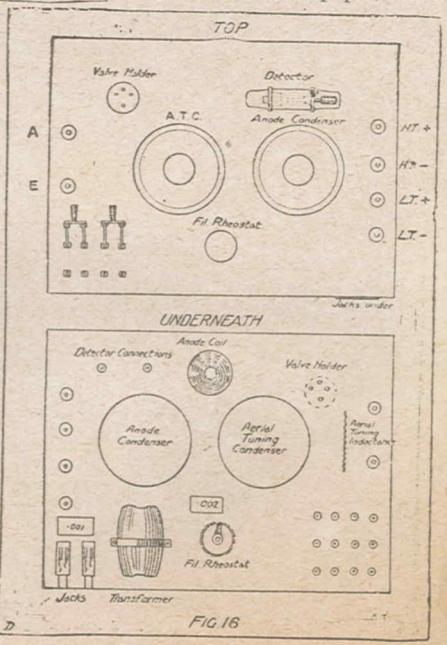


FIG. 16.

may be subsequently secured to the panel either by gum or by bulldog clips. For this reason it is not proposed to give a drawing showing the drilling of the panel, but the disposition of the various items is shown in Fig. 16, two views being given.

Mounting the Components.

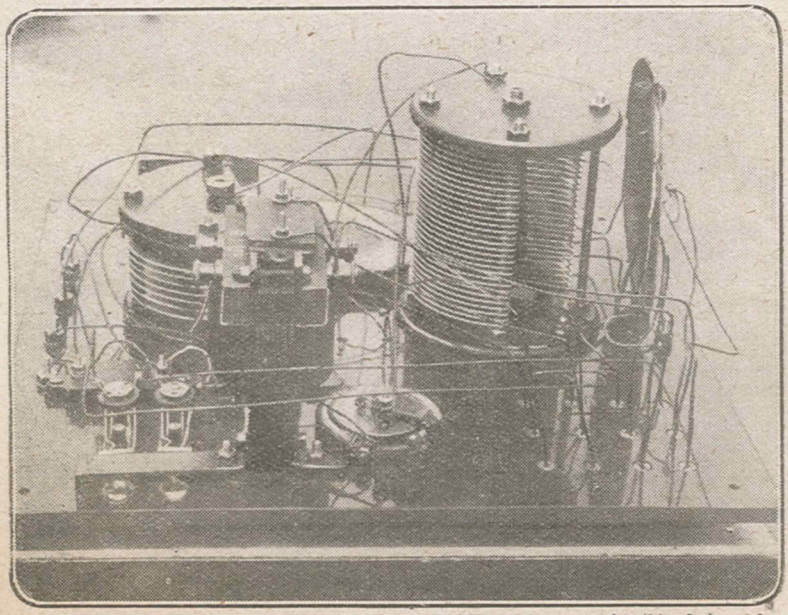
The anode coil is fixed to the panel by a screw in the position shown, whilst the aerial tuning inductance is carried on a piece of No. 18 copper wire connected to the condenser terminal as shown in Fig. 17. This piece of wire also forms the connection between the condenser and the inductance, one end of the basket coil winding being soldered to it as shown.

Wiring should be carried out with No. 20 enamelled wire. A length of wire should be fixed to a nail in the wall and stretched by pulling heavily on the end; by this means it will be found that the wire can be made to lie straight, and to take whatever sets or bends are given to it. Particular care should be taken to keep the wires spaced as far as possible to prevent trouble from capacity effects. The two jacks are fixed to the panel by two countersunk screws, which also secure a piece of wood $\frac{1}{2}$ in. by $\frac{1}{2}$ in. by $1\frac{1}{2}$ in., through which they are fitted as shown in Fig. 18.

The Cabinet.

The only things left to consider are the cabinet and the additional L.F. amplifier. Taking the former, the case should be built of $\frac{3}{8}$ in. hardwood, suitably pinned or dovetailed together, as the skill of the experimenter may permit. A piece is cut out as shown in Fig. 19, to allow for the jack carrying

(*Continued on page* 15.)



The interior "lay-out" and wiring can be very easily followed by comparing this photograph with the wiring diagram.

"Wireless Review and Science Weekly"

Every Tuesday. Price 3d.

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Edited by
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THE great success of "Popular Wireless" showed that a more advanced journal would meet the needs of many amateurs, and the production of "Wireless Review and Science Weekly" was quickly assured.

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"WIRELESS REVIEW AND SCIENCE WEEKLY" is indeed a super-journal. At the low price of 3d. it is within the means of all, and every week it presents an interesting section devoted to popular science, which has proved amazingly popular. Details of a clearly understandable nature are always to be found in this journal concerning the latest inventions and advances in science—and it constitutes a veritable weekly store-house of fascinating and invaluable information.

NO real amateur should miss his copy of "Wireless Review and Science Weekly." It can be obtained every Tuesday from all newsagents and bookstalls, price 3d.

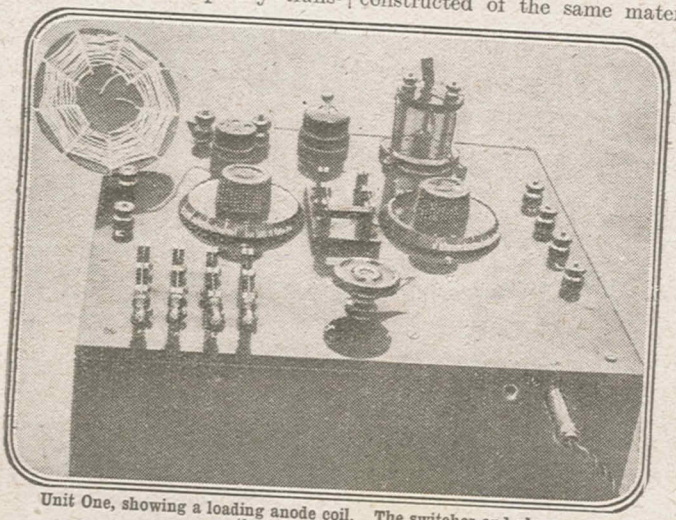
strip affixed to the panel. Corner fillets, ½ in. by ½ in., should be provided to give a firm hold for the screws holding the panel. The case should be finished by staining and varnishing or French polishing, as may be desired. Full dimensions are given in Fig. 19.

The Second Unit.

The low-frequency amplifier unit will require another low-frequency transformer, which should be made in the same way as the previous one, a filament resistance, a valve-holder, four terminals, two jacks, and a plug.

The panel on which the components are mounted consists of a piece of ¼-in. ebonite, 12 in. by 6 in. The components are arranged as shown in Fig. 20, underneath and surface views being given as before. The flexible lead connected to the plug forming the link between the two sets should be connected to the panel wiring by means of two connectors cut out of 1/16 in. brass, as shown in Fig. 20.

The battery terminals, both H.T. and L.T., which are the only terminals on the set, should be fitted on the left-hand side of the panel (viewed from above) to facilitate the common connections of the batteries to both panels. The jacks and transformer should be mounted in the same way as in the previous panel. The connections are made by means of No. 20 enamelled wire, in accordance with the skeleton diagram in Fig. 6. The case should be constructed of the same materials as those already mentioned, to the dimensions given in Fig. 21.



Unit One, showing a loading anode coil. The switches and plugs are in the "dual" positions.

Marking the Panels.

When the sets are completed the various terminals, switches, and jacks should be lettered. This can be done in white paint, either by lettering with a brush or by using rubber stamps, if the paint is properly thinned with turps. If the latter method is utilised, experimental trials should be made on a small piece of scrap ebonite before trying on the panels themselves.

With regard to the lettering to be adopted for the switches and jacks, the following is suggested. For the left-

hand position of switch No. 1, Fig. 5, "Crystal." For the right-hand position, "H.F. and Dual." For the upper position of switch No. 2, Fig. 5, "Crystal," and the lower, "H.F. and Dual." For jack No. 1, Fig. 5, "Crystal and H.F.," and for jack No. 2, "Dual." For jack No. 1 on the low-frequency amplifier, Fig. 6, "Set one," and for jack No. 2, "Amplifier."

The telephones used with these sets will, of course, have to terminate in a plug suitable for use with these jacks.

Loading Coils.

The wave-length range of these sets is, of course, limited by the anode coil and the aerial tuning inductance, but those desiring to have a greater wave-length range may obtain this by fitting a pair of terminals or sockets in series with the aerial inductance and anode inductance, to which loading coils, which may take any form, can be connected. These sockets would have to be short circuited when in normal use.

Useful Refinements.

With regard to the wiring up of the set it is advisable to space all the wires as far apart as possible, avoiding any parallel connections. Where these latter have to be made the wires should be separated as much as is practicable. Should the set appear "dead" when first tested, the primary leads of the L.F. transformer should be reversed, though little trouble will be experienced in this respect, as all transformer connections are clearly marked on the internal wiring diagram.

Although the construction of the two units has now been fully dealt with, there are yet two or three refinements that the ambitious amateur may wish to embody in the receiver.

These additions are not essential to the efficient working of the instrument, but they will be found decidedly useful, and will allow the wave-length range to be extended to any desired limit.

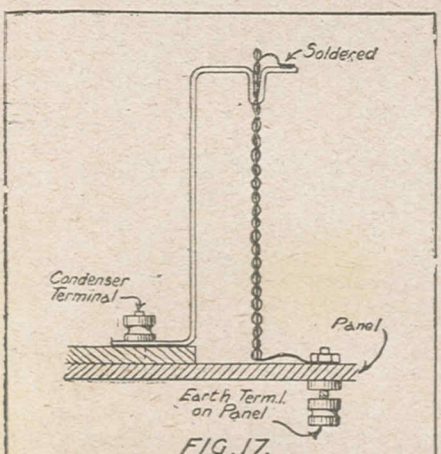


FIG. 17.

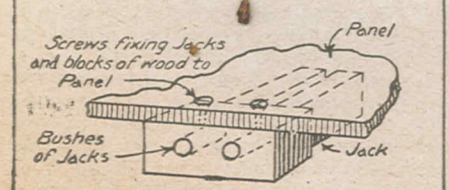


FIG. 18

Series Parallel Switch.

The first item to come under consideration is a series parallel switch for the aerial circuit. A very slight modification of the wiring is necessary; reference to the diagram, Fig. 2, will make this perfectly clear. It is advisable to number the studs of the switch, at least mentally, in order to facilitate the connections. The switch itself can be mounted on the panel between the two variable condensers. In the case of the original receiver a switch on a separate base is used, although a

neater job, perhaps, could have been made of it had the switch been constructed and mounted on similar lines to the other two change-over switches. However, this is quite a small point and one that each individual amateur will be able to solve with little trouble himself.

Extra Terminals.

Care should be taken in connecting up the series parallel switch, and the wiring should be followed point to point and line for line in comparison with the diagram, as even the most advanced of amateurs can quite easily trip up in this quarter.

Having completed the additional switch wiring, terminals can be provided for the purpose of loading up the anode coil. Obviously this will be necessary in order to bring the anode circuit into line with any increased range introduced into the aerial tuning circuit. These two terminals can be mounted behind the valve holder and a brass strap provided to short them neatly when not required. The wiring is simplicity itself. One of the leads going to the anode coil, it doesn't much matter which, is broken, and each end taken to one of the terminals. Thus, when the shorting strap is removed any coil connected to these terminals will be placed directly in series with the anode coil.

Additional Condenser.

A third addition is the fixed condenser and small tumbler switch, the mounting of which is very clearly shown in the photographs. When the switch is closed the fixed condenser is brought into circuit in parallel with the ·0002 mfd. variable condenser. This fixed condenser is only necessary for the longest ranges of wave-lengths. In order that the value of even this fixed condenser could be varied with a minimum of delay, should it be found to be necessary, the "Grelco" type, which consists of two knife clips and removable plug-in condensers, was employed.

With the above three additions it is possible to bring the wave-length range up to any point desired.

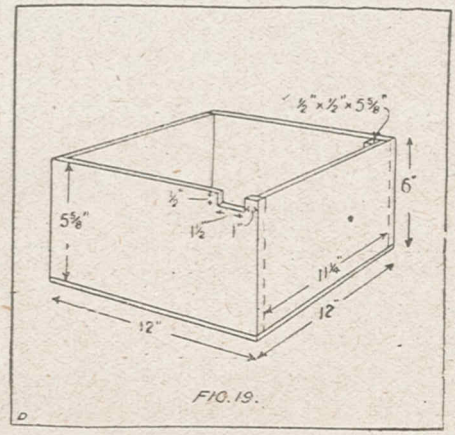


FIG. 19.

Will Not Howl.

The inductance loading of the aerial circuit is carried out merely by placing suitable coils in series with the aerial terminal of the set and the aerial lead-in. The set can now be reckoned to have reached the 100 per cent. mark of adaptability, and it is difficult to conceive anything more extraordinary than the fact that its design is such that even with these additions not the slightest tendency to "howl" is evinced. It must not be considered a matter of luck, however, that this is the case, as any serious diversion from the essential values of the circuit or the lay-out will very quickly prove. A considerable amount of time was spent in solving the problem of obtaining a "silent" circuit, and amateurs undertaking the construction of the units will be well advised to strictly adhere to the instructions laid down.

Probably it will be noticed that the photographs show the inclusion of an R.I. low-frequency transformer. Due credit must be paid to the manufacturers of this instrument, inasmuch as when the transformer, the construction of which was detailed in a previous issue, was taken out and the present one put in its place, a decided increase in signal strength was noticeable, fully justifying the additional expense involved in purchasing this component.

Efficient Transformer.

No doubt quite a number of amateurs not in possession of lathes or suitable winding machines will prefer this course to that of tediously winding a transformer by hand, and in this case the R.I. type is to be strongly recommended.

Free Assistance.

In conclusion it is to be hoped that the constructional details have been found sufficiently clear to permit the reader to carry out the construction of the set without difficulty, but should any reader find himself unable to grasp any little detail, the technical staff will always be pleased to help him out. All letters in respect of the POPULAR WIRELESS Combination Set should be addressed to the Queries Dept. in accordance with the instructions given on the Radiotorial page of POPULAR WIRELESS.

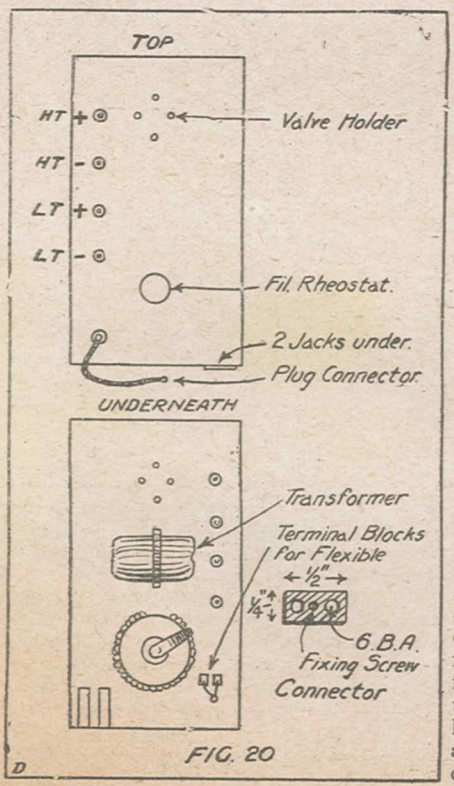


FIG. 20

Conclusion, by the Technical Editor of "Popular Wireless."

To the wireless man a good circuit gives as much pleasure as does a good horse to the huntsman, a good car to the motorist, or a well-tuned, speedy aeroplane to the aviator, and I can honestly say that the series of tests that I have conducted with the "P.W." Combination Set has been work of pure delight. At no point has there been trouble, and in every respect success has attended us all the way, from the first rough diagram on paper to the finishing off of the complete set. The reason for this is obvious to the more advanced amateur, to whom will be apparent the fact that the keynote of our labours has been "efficiency, adaptability, and simplicity." The very nature of the circuits involved has rendered it unnecessary to deviate from the path of the straightforward into the complicated and tortuous path of biassing batteries, high-resistance stabilisers, etc., and, apart from the fact that the component values called for rather

close attention, no trouble of an obscure nature was encountered.

It must be thoroughly understood, however, that results will suffer and "howling" can arise if the instructions regarding the construction of the set are not faithfully carried out. No guarantee of the efficient operation of the set can be given if amateurs modify the "lay-out" or the values of the condensers employed, either fixed or variable. Also the indiscriminate use of twisted flexible wires may cause capacity effects to arise. It is advisable to employ the shortest lengths of straight twin wires of the nature of telephone cords for the plugs.

Tuning-In.

In respect of the interior wiring of the units, the usual rules regarding good separation and avoidance of parallel wiring are, of course, essential. Should Unit Two not cause efficient note magnification, change over the transformer primary leads. As the L.T. + is directly connected to the H.T. — in both units, obviously only three battery connections between the two are necessary, but great care should be taken in seeing that the L.T. + and NOT L.T. — is taken to the H.T. — in either case, before connecting up.

With those few general remarks concerning the construction of the units, I will now proceed to deal with the handling of the set, and briefly detail some of the results obtained on the original model.

In the first place it will be found that the tuning on the H.F. condenser is not critical, but that the adjustment of the A.T.C. requires to be very close indeed. This is an interesting and useful point.

In the case of near-at-hand stations, however, tuning can at first be done on the crystal, which cuts down the variable factors or components requiring adjustment to two—the crystal detector and the A.T.C. This is one of the great advantages of the "P.W." Combination Set, and permits for finer tuning and the finding of a more sensitive point on the detector than is possible with any other type of reflex

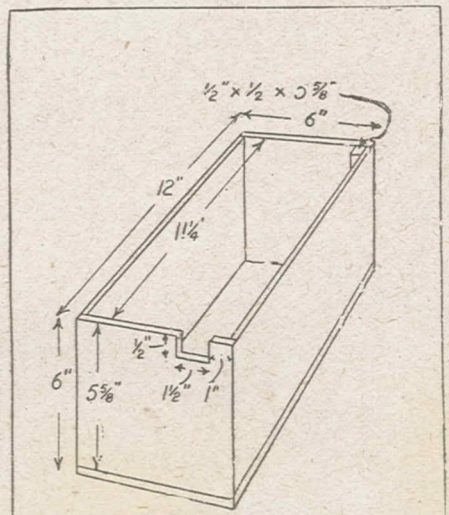


FIG. 21.

circuit. The change-over switches are over at "Crystal," and the telephone plug in the "C. and H.F." jack for this preliminary tuning. Having tuned in the A.T.C. and adjusted the crystal, the change-over switches are carried over, and the valve turned on. The H.F. condenser can now be tuned, and the telephone plug thrust into "Dual" if loud-speaker signals are desired. Where good signals are received on the crystal alone, loud-speaker work should be possible when working "Dual." Referring to loud speakers,

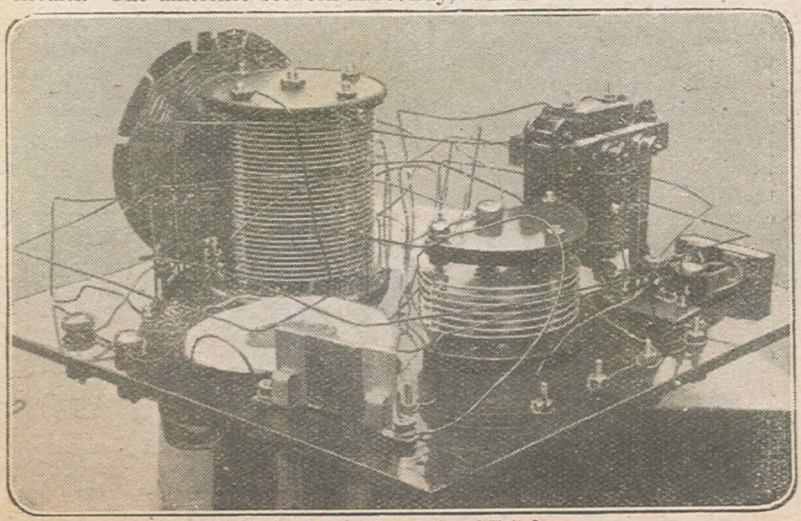
it will be found very convenient if the telephone plug is taken to a small terminal board; this will enable any number of 'phones or a loud speaker to be very quickly brought into circuit.

When working to distant signals it will be necessary to commence tuning with the valve in use as an H.F. amplifier, or it may be even necessary to start right away on "Dual." In these cases it should be remembered that the A.T.C. requires finer tuning than the H.F. condenser, and so, leaving the latter in approximately the correct position, close attention should be paid to the adjustment of the A.T.C. until audible signals are obtained. The crystal detector can always be adjusted to the signal of some near-at-hand station.

There are, with the two units, as everybody will by now know, six circuits available, and I will not anticipate the experiments of those who have constructed the set, because one of the most fascinating of all the possibilities of the receiver is that it permits a close comparison between various circuits. The difference between H.F. and L.F. amplification under varying conditions can be closely studied, and careful note can be taken of the behaviour of different valves operating in varying capacities with varying pressures of H.T. voltages. In fact, the possibilities of the set, as any amateur who handles it will quickly discover, are almost illimitable.

Some Results Obtained.

At the offices of POPULAR WIRELESS Unit One was tested on a frame aerial, and comfortable loud-speaker signals from 2 L O resulted. With Unit Two "plugged in," these became deafening. Such signals were also the order when Unit One alone was coupled to an outdoor aerial without using an earth. Birmingham came in comfortably on 'phones. At Sidcup, which is 15 miles from 2 L O, this station actuated a small loud speaker with sufficient intensity to fill a small room, using only Unit One on an outdoor aerial. This was also the case when the set was tried at Radlett, which is 15 miles from 2 L O in the other direction. Tried at Thorpe Bay, which is near Southend, some



Another view of the interior of Unit One.

forty or so miles from London, Manchester, Cardiff, Newcastle, and Glasgow were comfortably received, although trouble was experienced in some cases from "jamming" by ships.

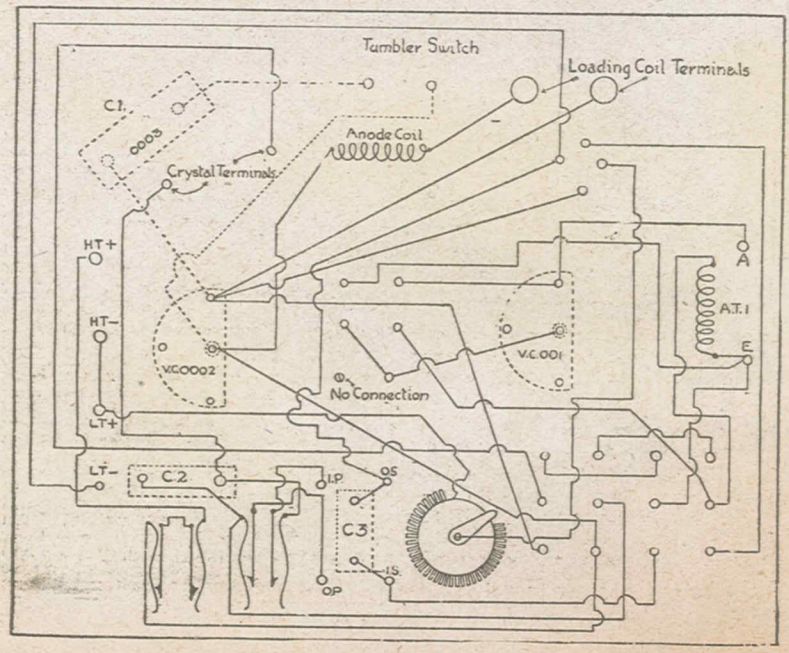
At Radlett, Newcastle was brought in on a loud speaker using both Units, while Glasgow gave comfortable telephone signals. School of Posts and Telegraphs, Paris, actuated a loud speaker comfortably.

The Demonstrations.

London at Thorpe Bay came in strongly on H.F. and crystal, while "Dual" nearly gave loud-speaker signals. These latter were comfortably obtainable with Unit Two plugged in. At Leyton, five miles from 2 L O in an easterly direction, the London station comfortably worked a loud speaker on the one unit. All the well-known amateurs were easily audible on 'phones, 2 O M at Brentwood, some 20 miles away, coming in with some considerable strength. Fairly hard valves, with some 60 volts on the plate, were used during these tests.

It is one's feeling, when listening-in on this remarkable receiver, that anything transmitting is within range wherever its location. I have been present during the majority of demonstrations given to readers who have visited the offices of the POPULAR WIRELESS in order to examine the original model, and in no single instance have those who have actually seen the set working, and have closely investigated its action, had anything but admiration and praise to offer.

Considering the fact that our callers have included not only amateurs, but professional wireless men of advanced standing, it is a fact of which the technical staff and myself are justly proud.



THE "P.W." COMBINATION SET AS A PORTABLE RECEIVER.

A few remarks concerning the adaptation of this remarkable instrument to out-of-doors work.

THE word "portable" is apt to be rather elastic in its application. Any set capable of being easily moved from one point to another is, broadly speaking, portable, but most amateur wireless outfits come within this category. The true portable receiver must, however, be able to take its place with the rest of the luggage without necessitating careful packing. In fact, the really portable set must be one that is built into, or is capable of easily being slipped into, quite an ordinary suit-case.

Fixing in the anode coil.

Dull Emitter Valves.

The "P.W." Combination Set lends itself to such a scheme very readily, and, as no doubt quite a few amateurs will be constructing this remarkable receiver, some indications as to how it can be employed in this capacity will prove useful. Unit One is all that will be necessary to provide quite good 'phone signals on improvised aerials over some considerable range of distance. A case, either of leather or of one of its stronger imitations, should be obtained. This must be sufficiently large to allow the unit to be tightly squeezed into one end, leaving clearance for its terminals and eight or so inches at the other end for batteries and telephones.

A rather better method, although it will take more time, is to obtain a slightly larger case, and build a wooden framework inside it in order to provide facilities for mounting the components more permanently, otherwise it will necessitate small screws being driven in from the outside of the case.

A dull emitter valve can be employed with the "P.W." Combination Set, and in this case a dry battery for filament lighting can be used. Otherwise some type of non-spillable accumulator is necessary. These latter, however, are generally of low capacity, not very efficient, and should, if possible, be avoided.

Important Details.

Wooden partitions should be provided to separate the batteries and to leave a small space into which the telephone receivers can be slipped. Accidental shorting of the batteries should be made impossible by carefully watching these details. Thick rubber-covered leads should be used for the battery connections, which should be made more or less permanent by tightening up the terminals with pliers. A switch to completely break the L.T. connections is advisable, as the majority of filament resistances have a tendency to switch themselves on should the receiver be accidentally jolted.

Aerial and Earth.

Another way of rendering the "P.W." Combination Set portable is to mount the units in boxes, with hinged lids and handles. Should this be done, holes must be bored so that the jacks are accessible. A further case to carry the batteries, telephones, valves, and spares, will be required.

The subject of improvised aerial and earths has been fully dealt with in articles that have appeared in POPULAR WIRELESS and needs but brief comment here. A tree will always provide a good mast, while a bottle and a length of string is all that is necessary to hoist the aerial wire over a branch. Due regard, should of course, be paid to the usual requirements of aerial efficiency, such as insulation, height, etc., while it should be possible to take great advantage of directional properties. Have the lead-in at the higher end, and this should be the nearest end to the desired transmitting station.

A small rod of brass or copper, twelve or so inches in length, driven into the ground at the dampest spot available, will make quite a good earth connection. Such an "earth pin" can very easily be slipped into one of the cases.

As a matter of fact, the whole operation is so simple, the set in question so suitable for the work, that it will be surprising if picnic wireless (weather permitting) does not considerably increase in popularity next summer.

SOME INTERESTING OPINIONS GIVEN BY LEADING MANUFACTURERS AND OTHERS, REGARDING THE "P.W." COMBINATION SET.

The following extracts are from letters received from five leading wireless firms, commenting on the "P.W." Set :—

Extract from a Letter received from Radio Instruments Limited:

"...One of the chief characteristics of this circuit is its stability and the ease of operation. We are glad to note that the Filament Rheostat is placed in the positive lead of the filament battery instead of the negative lead. This greatly assists in obtaining both efficient and stable operation."

Extract from a Letter received from Autoveyors Limited:

"...Our Technical Director, Mr. A. Chapman (who, you will remember, is the inventor of the famous 3-Electrode Variable Condenser), is of the opinion that this circuit would afford a very high degree of sensitivity, and enable long range reception to be effected with a minimum number of valves. Furthermore, the H.F. amplification coupling described on the Diagram would effect an appreciable degree of selectivity to the A.T.I. input, despite the fact of its being Direct-Coupled."

Extract from a Letter received from Igranic Electric Co., Ltd.:

"...Altogether, we were very favourably impressed with the results obtained, and have no doubt that a trial of this circuit will amply repay any of your readers who care to try it."

Extract from a Letter received from L. McMichael, Ltd.:

..."the ideal amateur combination in the form of the irreducible minimum. . . . on test we found the combination working amazingly well."

Extract from a Letter received from Tingey Wireless, Ltd.:

"...It is no small task to present sound, practical circuits to the public, and great credit is due to 'Popular Wireless' for the lead they have taken."

"THE EDITOR, 'POPULAR WIRELESS.'

"Dear Sir,—You may be interested to know that I have constructed the 'P.W.' Set and found the results simply wonderful.

"Using No. 1 Unit, 2 L O is audible in the 'phones at a distance of more than 20 ft away.

"I also get all the other B.B.C. stations, and I may add that 5 S C (Glasgow) comes in quite as loud as an average crystal set can pick up 2 L O. Amateurs and coastal stations come in quite loud.

"Wishing your paper every success,—I am, yours faithfully,

"W. R. DAVISON,

"71, Pekin Street, Poplar, London, E.14.
"31st August, 1923."

Mr. W. J. Grosvenor, of 52, Talbot Road, East Ham, E.6, writes:

"I have made the first unit and am pleased to say I am getting very good results. I received 2 L O and many amateurs very loudly, and 5 I T, 5 N O, S F R (Paris), P C G G, 5 S C, and the School of Posts and Telegraphs comfortably. I get far better results on the 'P.W.' Combination Set, using only one valve, than my friend does on his 3-valve set."

The following are some of the readers of POPULAR WIRELESS who were present at the demonstrations of the "P.W." set held recently, and examined the set under working conditions:

Mr. Boyer, 39, Morris House, Green Street, E.2: "A remarkable set."

Mr. Crabtree, 7, Tremadoc Road, S.W.4: "Simple with startling results."

Mr. Heathom, 133, Tooting Bec Road, S.W.: "Splendid! Shall construct."

Mr. Boncey, Southend: "Just what I needed."

Mr. D. L. Smith, 60, Kingstead Road: "A most efficient set."

Mr. A. Smith, 92, Overbury Street, E.5: "Quite surprising."

W. D. Desbruslais, A.M.Inst.C.E., A.M.I.E. (Ind.), 34, Tavistock Square: "Very nice indeed."

Mr. Harding, 4, Hillside Road, S.W.2: "One of the best reflex circuits I have tried."

Mr. Wilson, 45, Bartholomew Road, S.W.: "Perfect set."

Mr. Ireland, 11, Florence Road, Wimbledon: "Good set. Intentions of making."

Mr. Honnor, 61, Court Hill Road, S.E.13: "Appears to be worth making up. Intend to do so immediately."

Mr. Learson, Vice-Chairman of Walthamstow Radio Society, 98, Grove Road, Walthamstow: "Best dual circuit I have heard."

Mr. Wordman, 3, Rowantree Road, Enfield: "Very good indeed."

Mr. Humphrey, 170, Blomfield Terrace, W.2.: "Excellent."

Mr. Stephenson, 2, Park View Road, Addiscombe, Croydon: "Seems excellent."

Mr. Welsher, Moy Mall, Merrion, Dublin: "Very good."

Mr. Kirk, 54, Kingbridge Avenue, S.W. 16: "Excellent."

Mr. Clifford Potier, "The Marguerites," Roehampton, S.W.15: "Most interesting set. Intend to construct a similar one."

Mr. Letch, 43, Hague Street, Bethnal Green: "The best I have heard."

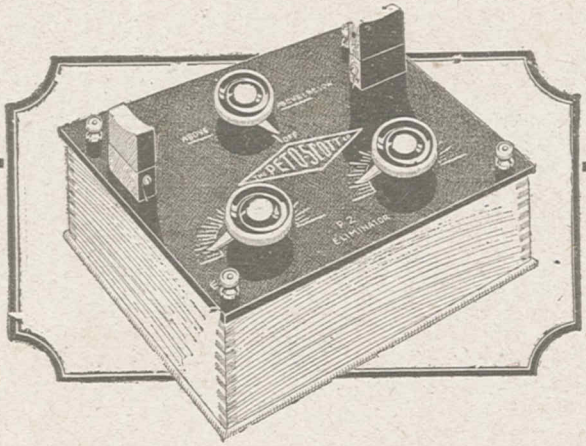
Mr. B. Simons, 182, Brooke Road, E.5: "All that the designers say!"

Mr. F. A. Jones, 46a, Central Hill, Upper Norwood: "Making one and satisfied with demonstration."

Mr. F. Betts (Vice-Chairman, Leyton Radio Association), 15, Westwood Road, E.4: "Excellent!"

Mr. Griffiths, 47, Leathwaite Road, S.W.11: "Best as yet."

Mr. R. A. Yarnell, 17, Ley Street, Ilford: "Absolutely IT!"



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NO matter how close you live to a Broadcasting Station, you can easily cut it out at any time with a **P 2 ELIMINATOR.** Here in Holborn, within 300 yards of 2 L O, we can easily cut it out, and select any other B.B.C. Station at Loud Speaker strength without the slightest trace of interference.

You can easily do the same with the P 2 Eliminator and a little practice in handling. This instrument can be attached to any set. It is the only one which will balance out unwanted signals *above and below* the required wave-length.

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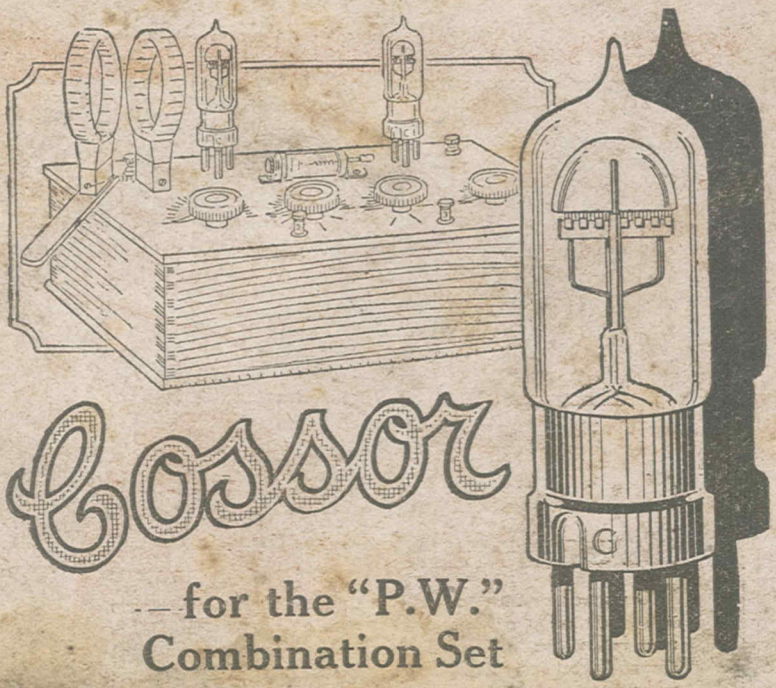

Cossor

—for the "P.W." Combination Set

THE "Popular Wireless" Combination Set uses a Reflex Circuit in which the Valve is called upon to amplify at both high and low frequencies.

Under these circumstances, therefore, you should take the greatest care in selecting a Valve which will stand up to these exacting conditions.

The **COSSOR**—because its unique construction enables practically the *whole* of the electron stream being utilised—has been proved ideal for this work. After actual tests, and on receipt of reports from independent sources, we recommend the P. 1 as being the most suitable for the "P. W." Set. The P. 2 (red top) is designed to act as a Valve amplifying at only high frequency.

Remember the extreme care used in manufacturing **COSSOR** Valves will enable you to use up to 100 Volts with safety in the plate circuit. This is a point worth bearing in mind when experimenting with a reflex circuit.

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