Contents

MODERN WIRELESS

Radio Press Ltd
PUBLISHERS OF *WIRELESS WEEKLY*
DEVEREUX COURT.
• STRAND.W.C.2 •
Tel.—Central 3763.

All correspondence relating to contributions is to be addressed to the Editor of "Modern Wireless."

His Majesty's Wireless Receiver

Listeners throughout the country are delighted to hear that His Majesty the King has accepted from the British Broadcasting Company a cabinet broadcast receiver containing a capacity aerial, batteries and loud-speaker complete. Our photograph shows the exterior Details are given on another page.

How to Construct and Use a Three-Valve Dual Receiver

Designed by JOHN SCOTT-TAGGART, M.C., F.Inst.P., A.M.I.E.E.

This is the most efficient all-round three-valve receiver the Editor of MODERN WIRELESS *has yet tried. Not only does it give powerful signals, but it is ideal for very long range work. A test report of results appears at the end of this article.*

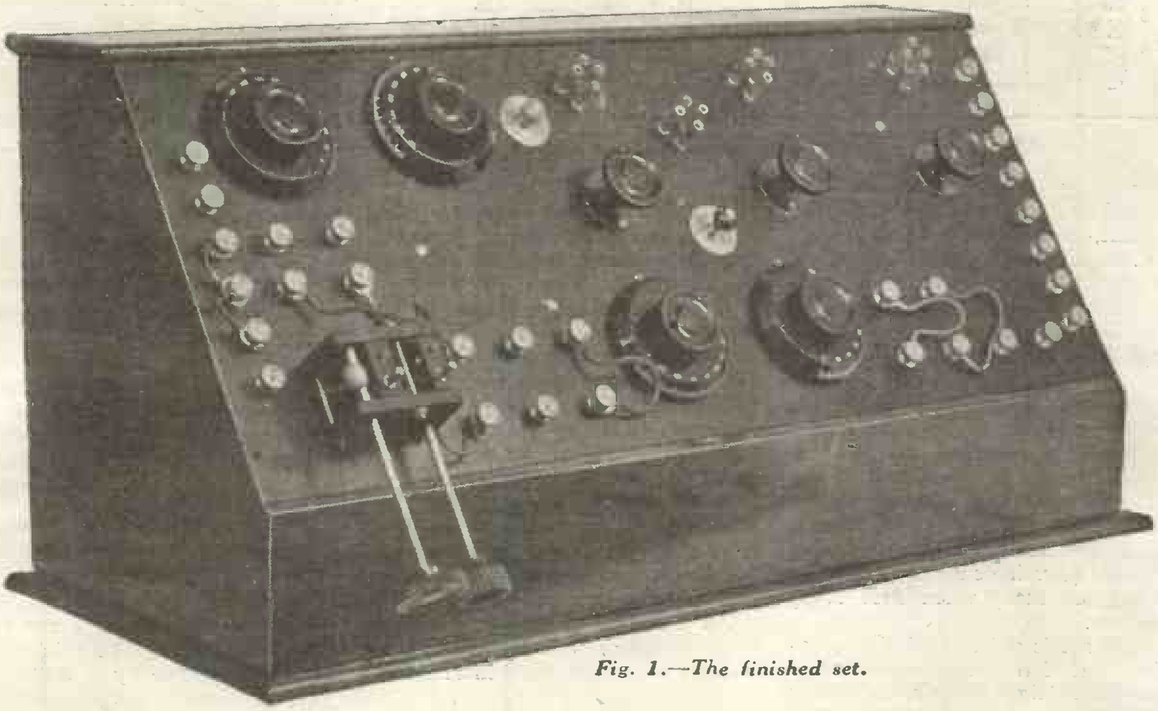

Fig. 1.—The finished set.

Introductory

THE desirability of having a receiver which would cover very long ranges, and at the same time give powerful results, led to the designing of the three-valve set here described.

Just outside London, about twelve miles from 2 LO, the latter station was obtained without either an aerial or an earth, on the telephone receivers, while a small frame aerial gave perfect loud-speaker signals. On the other hand, several other broadcasting stations could be obtained at will, and most of them were obtained really well on a loud-speaker. The capabilities of the set are indicated in the accompanying test report, and readers, in most cases, should have no difficulty in obtaining American stations, and certainly all the B.B.C stations.

Special Features of the Set

The set employs three valves and four principal circuits may be employed with it. These circuits are:

1 A three-valve dual.
2. A three-valve straight circuit.
3. A two-valve dual.
4. A two-valve straight circuit.

The main circuit is, of course, the three-valve dual, but as it was such a simple matter to enable the other circuits to be obtained, provision was made for them. The three-valve dual circuit does not employ a crystal detector, and some of the troubles sometimes experienced with this type of detector are obviated. The first valve acts as a high-frequency amplifier, and the second valve as a detector, using the leaky grid condenser principle. The coupling between the first and second valves consists of a transformer; this transformer has a tuned primary which is included in the anode circuit of the first valve, and the particular type used in the test was manufactured by L. McMichael, Limited, although suitable types are also supplied by Gent, Ediswan and Bowyer-Lowe. There is far more than meets the eye in the design of inter-valve transformers, and this part of the set is probably the most vulnerable of all.

The second valve, having rectified the high-frequency currents, has in its anode circuit the low-frequency currents which are passed through the primary of a step-up intervalve transformer, the secondary of which is included in the aerial circuit, in the manner first

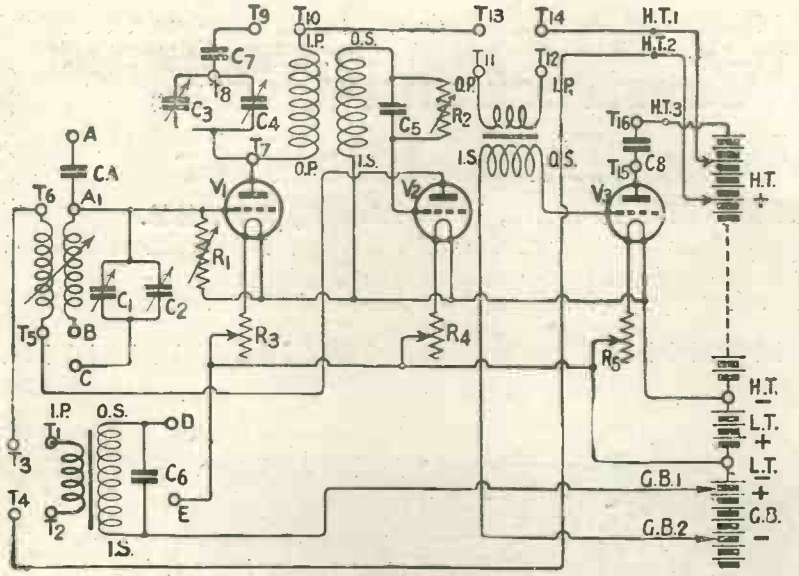

Fig. 2.—The general arrangement of the circuit.

introduced in the improved ST.100 circuit, and since adapted to all ST. dual circuits. The first valve, therefore, acts also as a low-frequency amplifier, and the amplified low-frequency currents are re-amplified by the third valve, which simply carries out this simple operation. As reaction was found, in some cases, to improve signal strength, a reaction coil was included in the anode circuit of the second valve and coupled to the inductance in the aerial circuit. This reaction coil is preferably shorted (terminals for that purpose being provided) when first using the set.

The set is quite stable in operation, but if the reaction is made sufficiently tight to make the valves oscillate, a low-frequency buzz may manifest itself, but any tendency in this direction may be prevented by the use of a stabilising resistance of the 50,000 to 100,000 ohms variety, which is connected across the grid of the first valve and the positive terminal of the filament accumulator.

Further Advantages

Further advantages of this particular design include provision for reversing either of the intervalve transformers, so that even in the particular types used in this set (Eureka and Silvertown) a number of experiments may be carried out without in any way having to rewire the underneath of the panel. Terminals and rubber covered leads enable the connections to the intervalve transformers to be reversed. In the case of the particular transformers employed, the table of connections, and the front view of the panel, indicate how the rubber covered links should be joined.

Another distinctive feature is the reaction reversal switching arrangement, which simply consists of two terminals and flexible leads which go to them. These leads may be reversed, in order to reverse the reaction. When experimenting with the set, a reversal of the reaction coil should be tried, but when first using the apparatus, it is advisable to short the reaction terminals, and to pull the reaction coil out of its holder.

As a matter of fact, one of the manufacturers of two-way coil holders has ingeniously introduced a reversing switch for the reaction coil, which may also be used for short circuiting the reaction coil.

Aerial Tuning Arrangements

Several aerial tuning terminals are provided, and these enable a variety of aerial tuning circuits to be tried. For example, the constant aerial tuning system may be used, and is recommended when first connecting up the set, because of the great simplicity and certainty of being able to tune in the desired station. The use of a series variable condenser, however, is also provided for, and those who wish to use the ordinary parallel condenser tuning method may readily do so.

A table will be found later on in this article indicating how the aerial and earth terminals should be connected. As already stated, the constant aerial tuning arrangement is advocated, and in the illustration of the front view of the panel, it is assumed that this tuning system is adopted.

Use of Set for All Wavelengths

The three-valve receiver here described works with plug-in coils and a plug-in intervalve high-frequency transformer. The set is therefore suitable for use on all wavelengths, and it may also be employed for the reception of continuous waves, but this is not recommended.

A Note on the Variable Condenser Arrangements

An added advantage in this receiver is the use of three condensers for tuning the primary of the high-frequency intervalve

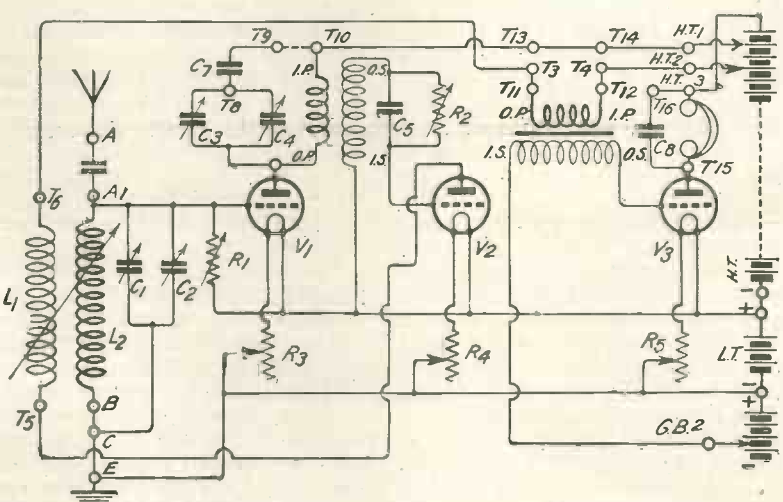

Fig. 3.—The connections for a straight three-valve circuit.

transformer. There is an ordinary condenser of 0.0005 μF capacity, shunted by a vernier having a maximum capacity of 0.00005 μF. In addition, we have a 0.0004 μF fixed condenser, and this is connected in series with the other two, under ordinary conditions. By this means it is possible to obtain a resultant variable condenser, having a maximum capacity of about 0.00022 μF, and also the minimum capacity of the combination is very much lower than the minimum capacity of a 0.0005 μF variable condenser. Experimenters who prefer to have the 0.0005 μF variable condenser and a vernier shunted directly across the primary winding of the high-frequency transformer can ignore the 0.0004 μF fixed condenser. Those who desire to receive long wavelengths on this set may like to have a condenser which goes up to 0.0009 μF, and in this case the 0.0004 μF fixed condenser is connected in parallel with the 0.0005 μF variable condenser, giving a resultant condenser which may be varied from 0.0004 μF to 0.0009 μF.

Any of these combinations may be obtained by varying two or three leads on the front of the panel, which has provided on it special terminals which facilitate experiment. The different connections possible are given in a separate table, but the experimenter, by looking at the general circuit diagram, will be able to see what to do to obtain the effect he desires.

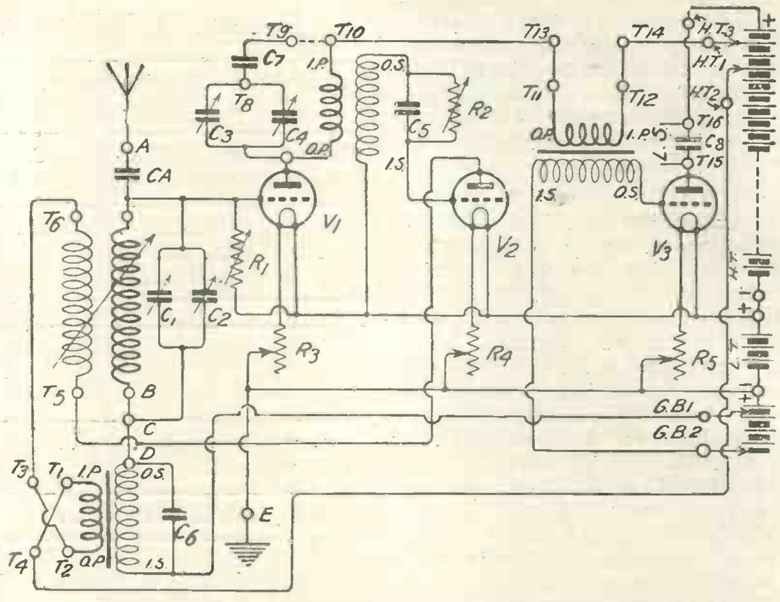

Fig. 4.—How to connect up the various terminals and batteries for the three-valve dual circuit.

The Finished Set

The finished set is seen in Fig. 1. The aerial tuning condenser and vernier are seen on the left of the panel above the two-coil holder, to the right of which are seen six of the circuit changing terminals. The two condensers next these terminals are those tuning the primary of the high-frequency transformer, and on the right of these are a further six circuit-changing terminals. Above are the filament resistances and valve holders, and the socket for the high-frequency transformer. A circuit diagram of the receiver is given in Fig. 2. It will be seen that by joining the aerial to A and earth to E, and shorting B, C and E, the constant aerial tuning system is applied, while this may be cut out by moving the aerial lead to terminal A_1, and leaving the rest as before. A frame aerial may be used by connecting its ends across B and E., connecting C and E together. This leaves the inductance L_1 in series with the frame. If it is desired to omit the inductance, the coil is pulled from its socket, and the frame joined across A_1 and E, C being joined to E as before.

For series aerial condenser, join the aerial to terminal C and earth to E, and connect B to E.

In the case of straight circuits, *i.e.*, those in which no dual amplification is employed, the terminal D is always left free.

Turning to the circuits available, it is possible to obtain two straight and two dual circuits, by suitable connections between terminals. A list of circuits is given, together with the necessary connections, and a separate circuit diagram of each circuit is provided.

It will be noticed that T_{10} may either be joined to T_8 or T_9. A glance at the circuit diagram, Fig. 2, will make this clear.

The small fixed condenser C_7 of 0.0004 mfd. capacity is shown in series with the tuning condensers, and may be included in circuit by making connection between T_9 and

V_1	V_2	V_3	H. T. Battery connections.	Grid Battery connections.	Other connections.	Telephones or Loudspeaker to :
H	D		H T_1; H T_2 2-valve "straight."	—	T_{13}—T_{14} T_{10}—T_8 or T_9	T_3 and T_4
H	D	L	H T_1, H T_2, H T_3 3-valve "straight." Fig. 3.	G B_2 to negative of grid battery. Positive of grid battery to L T—	T_{13}—T_{14} T_3—T_{11} T_4—T_{12} T_{10} to T_8 or T_9	T_{15} and T_{16}
H L	D		H T_1, H T_2 2-valve dual	G B_1 to negative of grid battery. Positive of grid battery to L T—	T_1 to T_3 T_2 to T_4 T_{10} to T_8 or T_9 D to B	T_{13} and T_{14}
H L	D	L	H T_1, H T_2, H T_3. 3-valve dual. Fig. 4.	G B_1, G B_2 to points on grid battery Positive of grid battery to L T—	T_1 to T_4 T_3 to T_2 T_{13} to T_{11} T_{14} to T_{12} D to B	T_{15} and T_{16}

T_{10}, while if T_8 be joined to T_{10} this condenser is omitted. C_7 may be joined in parallel with the tuning condensers by joining T_7 to T_9, and T_9 to T_{10}. Thus, a greater variation of capacity is obtainable than if the fixed condenser were not provided.

It will be seen that separate terminals are provided for the high-tension supply to each valve, thus allowing the most suitable voltage to be applied. At first it will no doubt be best to connect these terminals together, when using all three valves, or H T_1 and HT_2 when only two valves are in use, until a little experience in operating the set has been acquired. The grid battery terminals may also be shorted to L.T. —. In the foregoing table, columns headed V_1, V_2 and V_3, the letters H, D and L will be seen. These indicate that the valve in question is acting either as a high frequency amplifier, detector, or low-frequency amplifier respectively.

Two terminals T_5 and T_6 are provided, by means of which the reaction coil may be reversed.

The transformer in the aerial circuit should be connected as indicated above, when either of the dual circuits are in use, as experiment has shown that the best results are obtained when connections are made as stated. When the two valve dual circuit is in use, T_1 is connected to T_3, and T_2 to T_4, whereas when the three valves are employed in a dual circuit, T_1 goes to T_4 and T_2 to T_3.

Circuit.	Aerial.	Other connections for 2 or 3 valves.		Earth.
		Straight	Dual	
Const. Aerial Tuning	A.	B. C. E.	B. C. D.	E.
Series Aerial Condenser	C.	B. E.	B. D.	E.
Parallel A. T. C. .. No Const. Aerial Tuning.	A_1.	B. C. E.	B. C. D.	E.

Connections for Frame Aerial :

	Ends of frame	Other connections.	
		Straight.	Dual.
Frame alone .. .. Coil removed.	A_1. E.	C. E.	C. D.
Frame, with L_1 in series ..	B. E.	C. E.	C. D.

A list of the component parts required will be found on page 573 together with the retail cost. Burndept Dual Rheostats are used, as these are suitable for bright or dull emitter valves, using the same low-tension battery, but if desired, these may be replaced by Lissenstats or Microstats, at the discretion of the constructor.

It will be seen that separate vernier condensers are provided, but the type of condenser in which a vernier adjustment is incorporated is equally suitable, and may be preferred by some experimenters. The high-frequency plug-in transformer was supplied by Messrs. L. McMichael Ltd., and the connections to the socket are made as this transformer requires. If any other make be substituted for this, care must be taken that the connections to the valve socket into which the transformer is plugged are altered, if necessary, to suit the transformer used. For example, in the transformer used, the primary winding is brought out to the "filament" legs, but in some other makes it is connected across "grid" and "plate," and the connections to the socket on the panel must be altered accordingly.

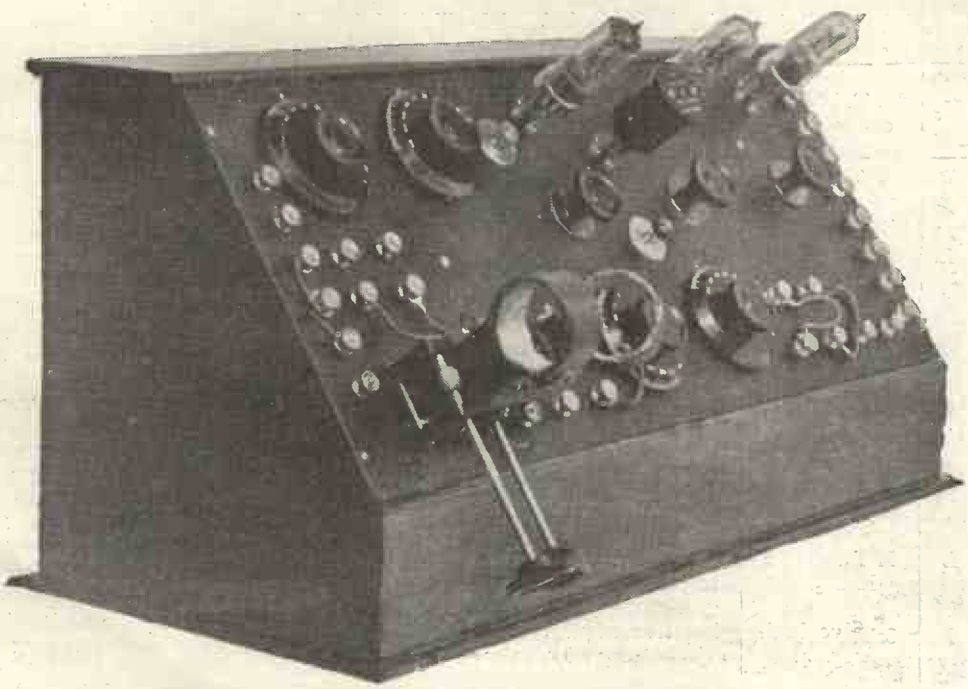

Fig. 5.—The three valve dual with coils and valves in place.

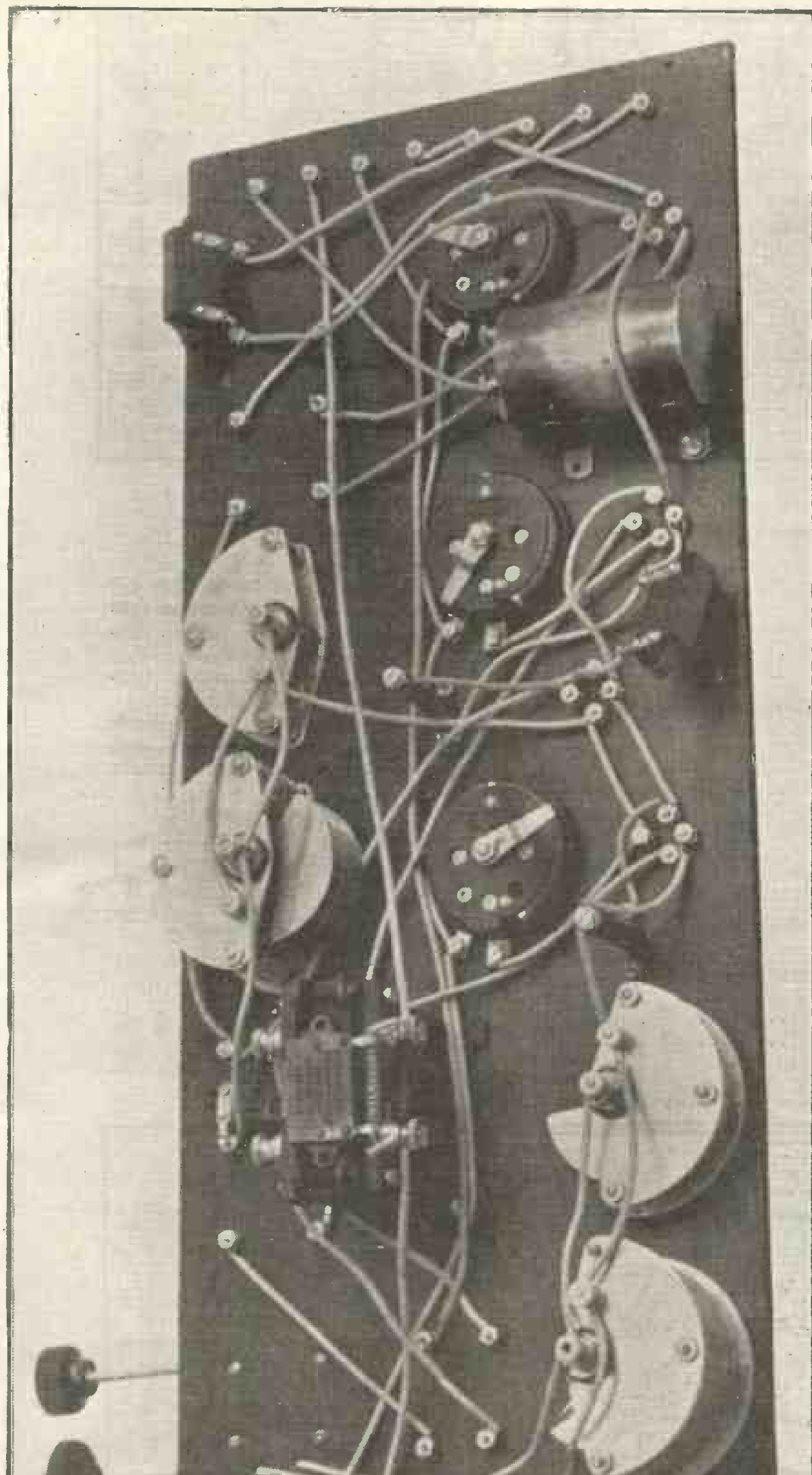

Fig. 6.—The back of the panel, showing the wiring. This photograph is approximately a third full size.

Fig. 7 shows the lay-out of the components on the panel, and all the necessary dimensions are given for drilling the holes. The terminals are connected correctly for the three valve dual circuit. The panel itself measures 24 in. by 10 in. by ¼ in., and has its glossy surface removed by rubbing with emery cloth. This is done on both sides, and helps to keep down undesirable noises, by improving the surface insulation. The various components are mounted in their correct places on the panel, and when everything is in position, wiring may be commenced. Use No. 20 tinned copper wire, covering it with systoflex tubing.

As seen in the wiring diagram, Fig. 8, each terminal and point to which a wire is to be joined is given a number, and a table is given below of the different sets of points to be connected together, each separate set being enclosed in brackets.

Numbers Allotted to Components

Circuit changing terminals T_1 to T_{16}.

Aerial circuit terminals A, 1; A_1, 2; B, 3; C, 4; D, 5; E, 6.

0.0001 Const. aerial condenser 7, 8.

Aerial tuning coil 9, 10.

Aerial tuning condenser 11, 12.

Aerial vernier condenser 13, 14.

100,000 ohm resistance 15, 16.

First valve G17, P18 Filaments 19, 20.

Second valve G21, P22, Filaments 23, 24.

Grid condenser 25-26.

H.F. Transformer. tuning condenser 27-28.

H.F. Transformer vernier condenser 29-30.

L.F. Transformer bypass condenser 31, 32.

First L.F. Transformer IS33, OS34, IP35, OP36.

Filament resistances R_3 37, 38. R_4 39, 40; R_5 41, 42.

Telephone condenser 43, 44.

Second L.F. Transformer, IP, 45; OP, 46; IS, 47; OS, 48. The OP of this transformer is marked 49 in error in the wiring diagram.

Watmel grid leak 49, 50.

H.F. Transformer OP, 51; IP, 52; IS, 53; OS, 54.

Third valve G55, P56 Filaments 57, 58.

H T_1, 59; H T_2, 60; H T_3, 61; H T—, 62; L T+, 63; L T—GB+, 64; G B_1 65; G B_2 66.

Fixed condenser, H.F. Transformer circuit 67, 68.

Connections

(1-7) (9-8-2-12-14-15-17) (3-10) (4-11-13) (5-34-32) (6-38-40-42-64) (16-20-53-24-58-62-63) (T_7-18-51-

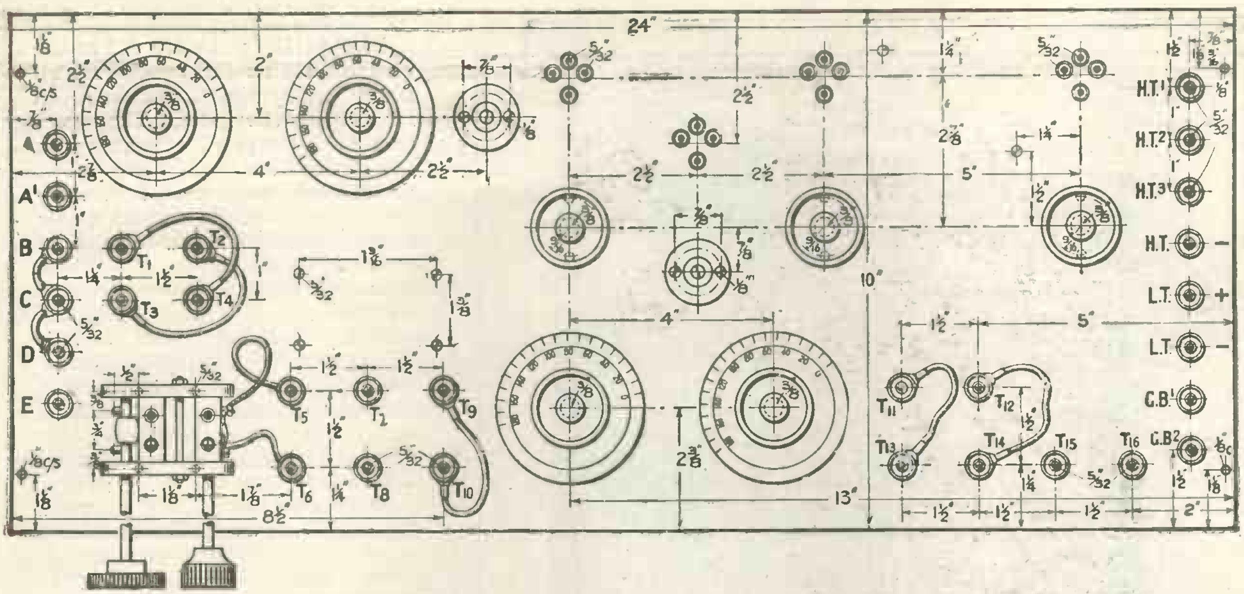

Fig. 7.—A view of the front of the panel, with all the necessary dimensions for drilling the holes.

Components.	£	s.	d.
Cabinet (Wright and Palmer, Forest Gate)	1	5	0
Panel 24 in. by 10 in. by ¼ in...		10	0
2 0.0005 Variable condensers C_1, C_3 } Brown Bros.		12	0
2 0.00005 Variable condensers C_2, C_4 } Brown Bros.		7	6
1 Two-coil holder (Goswell Eng. Co., Ltd.)		7	6
16 Valve pins with two nuts		2	8
1 50,000-100,000 ohm Watmel resistance		3	6
1 0.5—5 megohm Watmel grid leak		2	6
30 4 B.A. W.O. Type terminals		5	0
3 Burndept Dual Rheostats	1	2	6
1 Eureka Concert Grand L.F. Transformer	1	10	0
1 Woodhall L.F. Transformer	1	7	6
Dubilier Condensers 1 0.0001 C. A.		2	6
1 0.001 C6		3	0
1 0.0003 C5		2	6
1 0.0004 C7		2	6
1 0.004 C8		3	0
Wire, covering, screws, etc.		6	6
	£8	15	8

29-27) (19-37) (21-25-50) (22-25) (23-39) (26-54-49) (T_8-68-28-30) (31-33-65) (35-T_1) (36-T_2) (41-57) (43-T_{16}-61) (44-T_{15}-56) (45-T_{12}) (46-T_{11}) (47-66) (48-55) (52-T_{10}-T_{13}) (59-T_{14}) (60-T_3) (67-T_9) (T_4-T_6).

A large photograph of the back of the panel is given in Fig. 6, and will help to make the wiring details clear.

The Cabinet

The cabinet is shown in the dimensioned drawing, Fig. 10, and is made in ⅜ in. finished mahogany. The construction is perfectly straightforward, and the experimenter of average wood-working ability should experience no difficulty in making the cabinet. If the constructor is disinclined to undertake the construction, the cabinet may be obtained from any firm specialising in this work. In

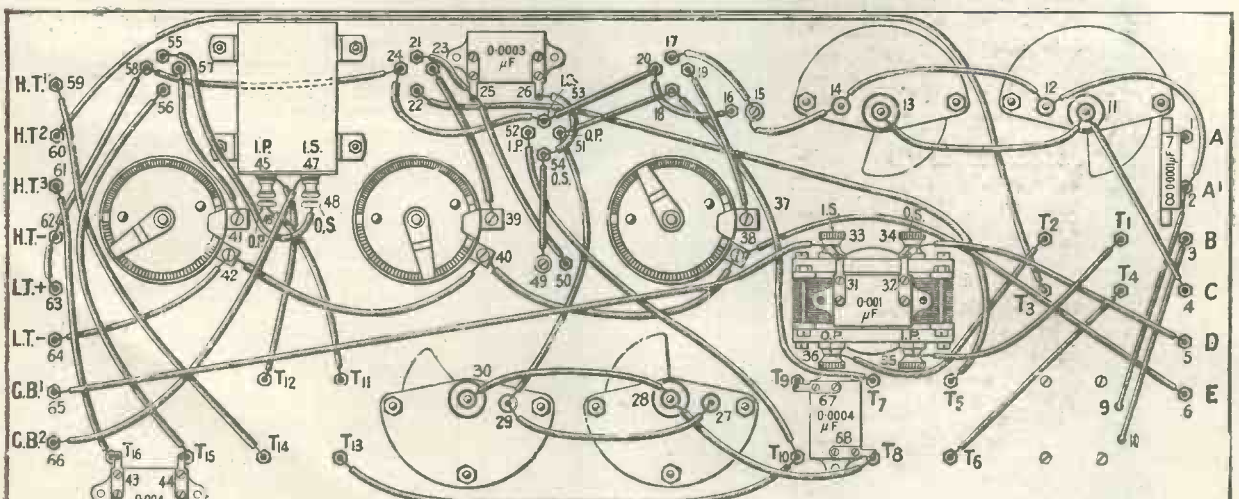

Fig. 8.—The wiring diagram of the receiver. A key to the wiring is given, thus simplifying the problem of wiring-up.

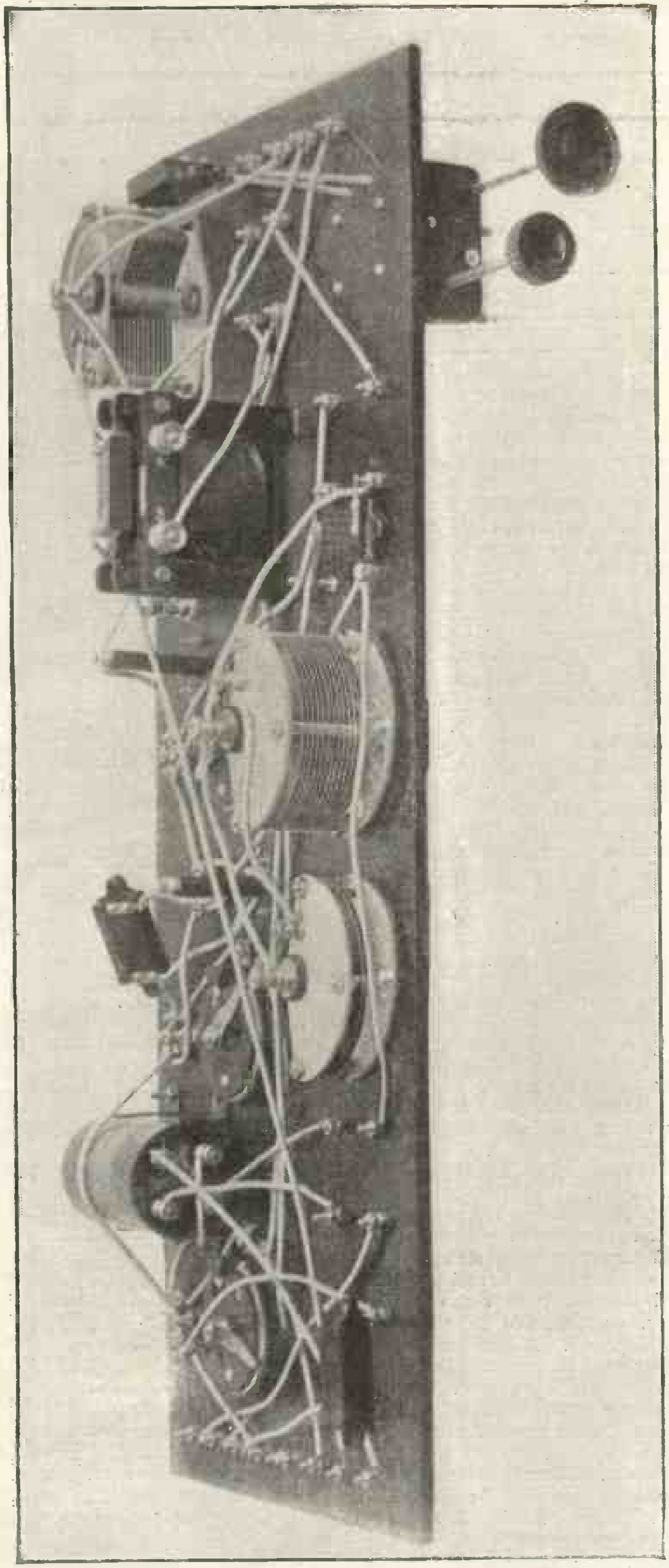

Fig. 9.—A further view of the panel arrangement and wiring.

the set described, the cabinet was obtained from Messrs. Wright and Palmer, of Forest Gate, at the price given.

The panel is secured to the cabinet by means of one wood screw near each corner, the holes for which are given in drilling diagram. A small fillet of wood is secured in the centre of the bottom edge of the cabinet, as shown, to prevent the panel from sagging.

For broadcast reception, a No. 50 coil should be used in the aerial circuit (the left-hand socket in the coil-holder) while the reaction coil may be a No. 50 or 25. Details of this coil size will be found in the test report.

As the rheostats are suitable for bright or dull emitter valves, no alteration to the set will be necessary if a change of type of valve is desired. A high-tension voltage of 75-100 volts should be used, especially when employing either of the dual circuits.

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TEST REPORT ON THE RESULTS OBTAINABLE.

At my home, which is nearly twelve miles from 2LO, the London broadcasting Station, I first of all wired up the set to the three-valve dual circuit, and without using any aerial or earth, but simply connecting the telephone receivers on the telephone terminals and attaching the batteries, I heard 2LO perfectly clear. Signals were audible on a loud-speaker, but could only be heard about 4 ft. away, and then speech was only just intelligible. The aerial tuning condenser (first on left) was set to 40 degrees, while the vernier condenser (second from left) was set to 100 degrees. The main tuning condenser across the primary of the high-frequency intervalve transformer (third from left) was set at zero degrees, while the vernier was adjusted to 80 degrees. A No. 50 Igranic coil was connected in each coil holder. It was found that these signals could be obtained, however, without the reaction coil in at all, the reaction terminals, however, being short-circuited.

The second test was with a wave-meter, and wave-meter signals of very feeble intensity could be heard 16 ft. away from the set, which was unconnected with any aerial or earth.

The third test was to do what I always try in the case of a new receiver; that is say, connect the

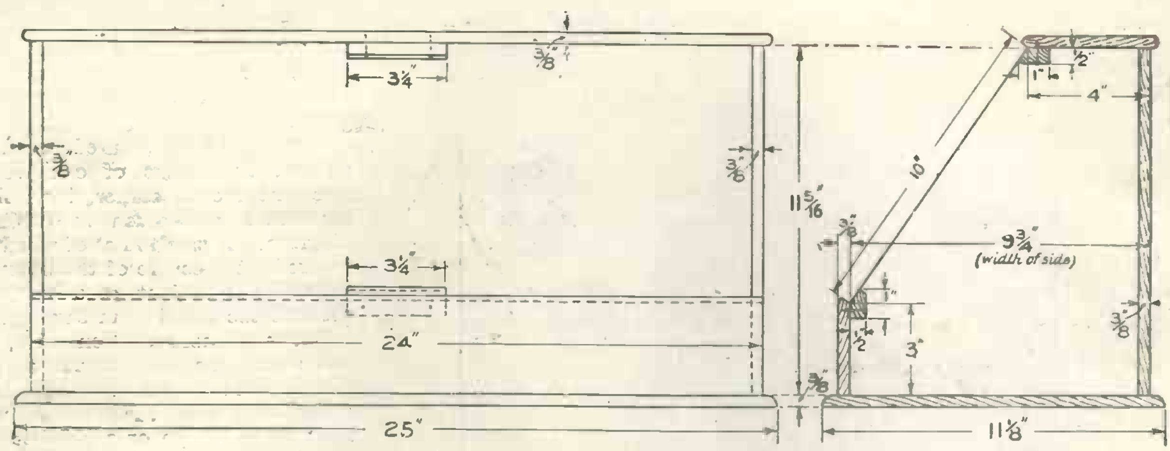


Fig. 10 --Cabinet dimensions.

earth wire on to the aerial terminal, no aerial connection, or other earth connection being taken. Remarkably good results are obtainable by this connection, and apparently the receiving set and batteries, etc., act as the aerial. By simply using this earth wire, and connecting it to the aerial terminal (so that constant aerial tuning was in use) loud-speaker results were obtained on 2LO which filled the room comfortably.

The next test was with an indoor aerial. This was a single piece of No. 30 cotton covered wire, 7 ft. high and slung from one side of the room to the other, the total length of wire used being only 16 ft. With this very small aerial connected on to the constant aerial terminal (terminal A) still louder loud speaker results were obtained, and the adjustments now were 40 degrees on the first variable condenser, 20 degrees on the second, zero on the third, and 100 degrees on the fourth. Reaction was unnecessary, but with some of the grid stabilising resistance in reaction gave improved results, a No. 50 coil being used as the reaction coil.

The next test was on the "average" aerial. This aerial consists of 75 ft. of aerial wire, a single wire is suspended at a height of 12 ft. from the ground outside the house, but the total length of wire, including the down-lead and lead-in, is only 75 ft. All sets tested have to give good results on this aerial, which is really very much inferior than the average. With this aerial, and using constant aerial tuning, 2LO was received 20 degrees on the first condenser, 100 degrees on the second, zero on the third and 100 degrees on the fourth. The signals from 2LO were now so loud on the loud-speaker that I tried to get Aberdeen, and this station came in with the condensers set at 80 degrees 150 degrees, 70 degrees and 80 degrees respectively. A good deal of spark interference was experienced, but Aberdeen came in on the loud-speaker at twice the medium strength. In the latter case, a No. 50 coil was used for the aerial circuit, and a No. 25 coil for reaction.

Bournemouth came in exceedingly well on the loud-speaker with the condensers set at 38 degrees, 10 degrees, 22 degrees and 20 degrees respectively. This was still using the small aerial.

The L'Ecole Superiore was next tried and came in on 500 metres with the condensers set at 60 degrees, 174 degrees, 43 degrees and 160 degrees respectively.

On a larger aerial, all the stations came in proportionately louder, and the general result of the test was that there was ample margin of safety and several other broadcasting stations, such as Birmingham, Glasgow, etc., were obtained without any difficulty whatever, and without any forcing. The provision of vernier condensers proved very valuable.

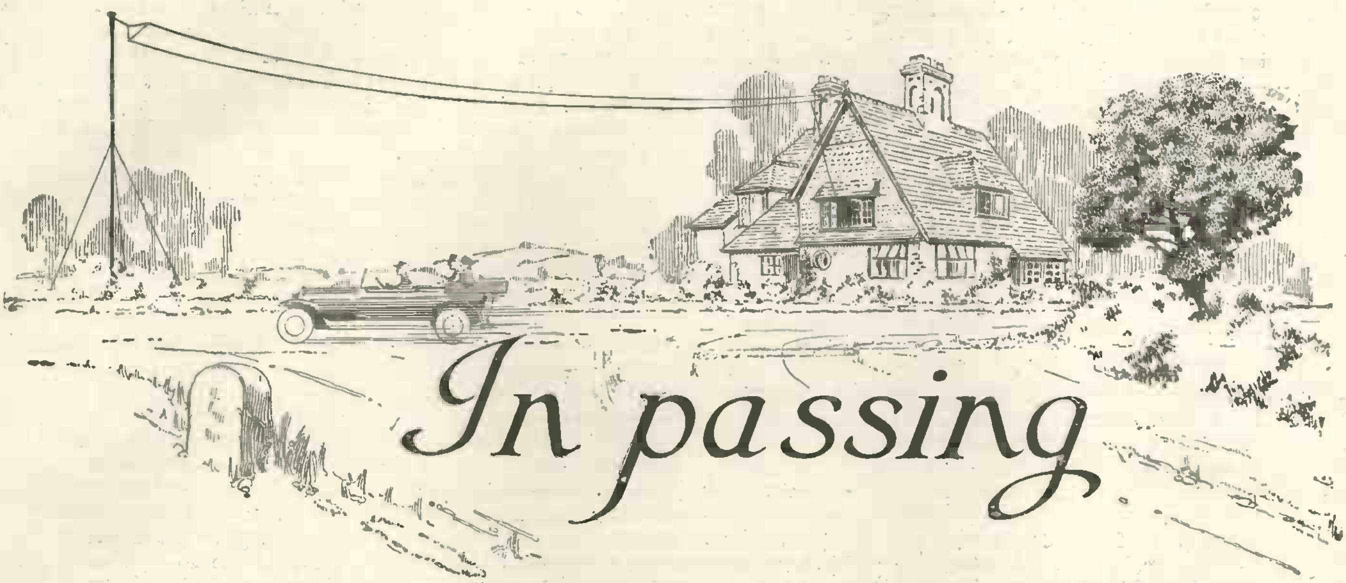
In all these cases, the variable condenser across the primary of the high-frequency intervalve transformer was connected in series with a fixed condenser of 0.0004 μF capacity, as indicated in all the circuit diagrams. A small vernier condenser was also connected across the main variable condenser. With this arrangement, and using a McMichael transformer, a range of wave-lengths of from 320 to 550 was obtained. The use of the series fixed condenser was found essential. The advantages of using a series fixed condenser with a variable condenser were fully explained in my Valve Notes in WIRELESS WEEKLY recently; a lower apparent minimum capacity is obtained, and the idea may be applied to different kinds of circuits.

JOHN SCOTT-TAGGART

Blue Prints of this set are available as follows:—

No. 25A.
Front of Panel as Fig. 7.

No. 25B.
Wiring Diagram as Fig. 8.

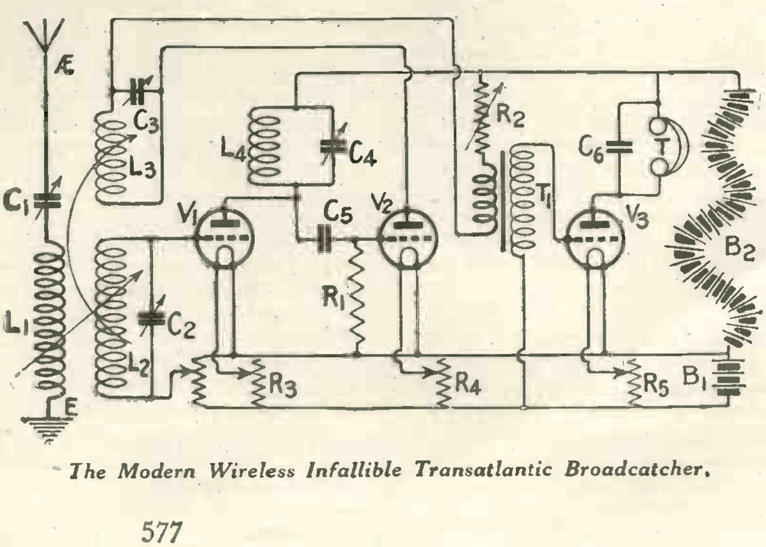


In passing

Lost Opportunities

THE B.B.C., I think, has shown a distinct lack of imagination in laying the blame eternally upon atmospherics in the course of their attempts to relay American broadcast transmissions. Now you and I, being among the lesser men of wireless, know that the harmless atmospheric is not a thing to be regarded always with loathing and dismay. Full many a time when our sets refused to work as they should in the presence of a not too well-informed audience, we have had reason to bless atmospherics, real or artificial, for the way in which they pulled us out of some particularly unpleasant hole. To rely upon the very present help of atmospherics in our time of trouble is all very well for you and me, but we do not want the B.B.C. to take the bread out of our mouths. Surely their enormous and highly paid staff of experts should be able to devise some entirely new and original excuse. When one comes to think of it, the announcer at Biggin Hill has the most wonderful opportunities for letting his imagination run riot. I envy him with all my heart. I would love to say, for instance, "Hullo, the British Isles! We are sorry that we cannot give you more of the musical programme of BUNK, but we are very pleased with the reception of the firework display held to celebrate the anniversary of the coming of Prohibition which you are now hearing. It is particularly fortunate that there are no atmospherics to-night for otherwise the noise of the fireworks might not have been so distinctly audible." That, I think, would go rather well. And Los Angeles seems to offer further splendid openings for annunciatorial (is not that a good word ?) ingenuity. I mean to say, that when things come straight from the home of the "movie" stunt, it should surely not be hard to find good and sufficient reasons for any kind of noise. "The rattling sound that you hear, ladies and gentlemen, is caused by the thousands of cinematograph cameras which are always at work day and night in Los Angeles. That crash was Mr. Charles Chaplin sitting upon his hat. The little moaning sound which comes in occasionally is *not* caused by the oscillation of our receiving set; it is Miss Mary Pickford putting real soul into her latest and greatest part. If you listen carefully you will distinctly hear the hoof-beats of Mr. Tom Mix's horse."

Not only are you giving a really good explanation of things, but you are introducing local colour, you are thrilling your audience, you are tightening the bonds of sympathy between you and them. Again, when things are a bit wobbly so that the music now swells to a full-throated roar, now dies away to the plaintive squeak of a sick chrysalis calling for its mamma, a little technical explanation would stifle all criticism. No one would be able any longer to say, "Judging from the hand capacity effects, those fellows must have pretty capacious hands," or nasty things of that kind. It would go rather



The Modern Wireless Infallible Transatlantic Broadcatcher.

well if the announcer were to launch out into a little disquisition upon the Heaviside Layer, followed by an account of the way in which ether waves travel over the surface of water. He could explain in the most convincing manner that you cannot expect perfectly even reception unless the Atlantic is comparatively calm and that, owing to the violent storm then raging upon the ocean, the ether swell (!) was so bad that three operators at the relaying station had had to be replaced through feeling seasick.

The Infallible Broadcatcher

These opportunities, however, have been missed in the saddest way. The general public has come to regard any reception of American broadcasting as no good at all unless it is accompanied by sounds suggestive of the rending of garments, the beating of drums, the shivering of timbers and the moaning of banshees. If you were to obtain something clear and distinct from the States when friends called round to hear what you could do, two things would happen: either they would refuse utterly to believe a word that you said about the American origin of the music, or they would say, in unison, "Great Scott! We don't think much of that; why, there was not one decent atmospheric in the whole thing. You should just come and hear our sets." This, of course, makes things rather easier for the man who wishes to obtain a reputation as a trans-Atlantic broadcatcher. For his benefit I have specially designed the circuit shown in the drawing, which is guaranteed to receive America. It may, perhaps, be as well if I give the values of the components. Inductances L_1, L_2, L_3, and L_4 may all be ordinary basket coils tuned by variable condensers of normal capacity for the purpose. The greatest care should be taken in mounting these condensers to see that the contact between the spindle and the bush is as uneven as possible, and one of the moving plates of C_3 should be slightly bent so as to ensure its touching its fixed next-door neighbours at certain points during its little journeys to and fro. The following are the remaining values of importance:

C_5 0.0003 μF.

R_1 2 to 5 megohms (approx). (Find by experiment the value most likely to make the set misbehave.)

C_6 .002 μF.

T_1 4d.

R_2 Minus 5s.

The transformer T_1 is one of the most important parts of the whole circuit. It should be as small and evil-looking as possible, with an openwork core which should not on any account be earthed. It is essential that no condenser should be shunted across T_1, otherwise the quality of the U.S. broadcast reception may be impaired. In series with the primary of T_1 is a very variable anode resistance R_2. This is so designed that the slightest movement of the adjusting screw is responsible for a bang which threatens to buckle the diaphragms of the receivers. B_1 may be an accumulator, but the best results are obtained if a bevy of ancient dry cells are pressed into service. B_2 is the nigh-pension battery, an ancient retainer brought down from the shelf to prove that though not so young as he was, he can still do his bit when required. On no account must a condenser be shunted across B_2, as otherwise many excellent atmospherics may be stifled at birth.

As regards the general make-up of the set there are several important points to be observed. As has so often been recommended in the pages of MODERN WIRELESS, no attempt should be made to mount the parts directly into a cabinet. They should be laid out first of all on a board and then moved about until the positions which give the maximum amount of interaction between each and every one of them has been found. Plate and grid leads should be kept strictly parallel and as close together as possible. It is essential during the wiring of the set that the soldering iron should be sheathed. All connections should be made with nuts whose threads have first been stripped by forcing them enthusiastically home upon a tap which is one size too large.

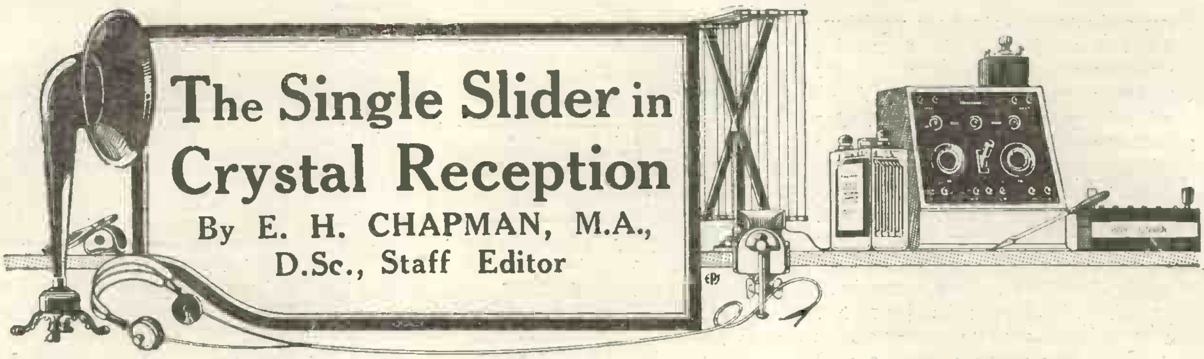
The Modus Operandi

The set is so delightfully simple to handle that children, or even old women of both sexes, can operate it without the slightest fear of failure. Having first surreptitiously stuffed his ears with wads of tow, tissue paper or cotton wool, the proud constructor tunes in any of our own broadcasting stations. He then brings up the reaction coil L_3 until the set is upon the point of oscillation. This done, he hands the phones to his first would-be listener and stands watching the mingled rapture and astonishment chasing each other over his countenance. In the meantime the operator produces the most admired type of fading by making mystic passes with his hands over the inductances. If American 'phones are used they will naturally impart a slightly nasal tone to any words that may be spoken, thus heightening the enjoyment of the hearers. When the first listener has been deafened he will hand over the 'phones to one of his fellow guests, telling him how beautiful it is and sitting down to enjoy to the full the spectacle of another victim grinning and bearing it. When you have worked through the whole of your audience, you will find that they are loud in their praises of your wonderful feat, and that they will be unanimous in telling you that your direct reception is equal to anything that they have ever heard relayed.

Nipped in the Bud

I had hoped to be able to carry out personally some experiments in relaying. So sympathetic was the Editor when the idea was mooted that he gave me a blank cheque and told me to go ahead. Later I discovered that the blankness extended not only to the space labelled £ s. d., but also to that provided for the signature. Despite this little *contretemps* I decided to make the attempt to organise a relay expedition which would erect a station on the top of Ben Nevis and put in some really good work. Amongst the members of the party I had hoped to include Captain B. B. Chuckersley as Director of Atmospherics, and Mr. John Henry (with wheelbarrow) as Transport Officer. The former was unable to accept, being himself just about to start for mid-Atlantic, where he proposes to erect a halfway boosting-station upon a large vessel to be permanently anchored there. Mr. John Henry was most enthusiastic, assuring me that nothing would please him better than a trip from the barbarous south to the more civilised north. But a few days before the expedition was due to start I received from him a telephone message in which he said: "Sitha lad, ah'd av liked to coom on yon expedishun wi' thee, but ah'm fair capped. Ah've bin practisn' and ah've 'ad a mis'ap. Ah've weeald t' weealbarrer till t' runnill's coom off." This concatenation of unfortunate occurrences has rather put the lid on things for the moment. But I have hopes that if all goes well you may yet be astonished to hear one night my clarion tones crying, "Hullo! Hullo! Ben Nevis calling the British Isles." Then, indeed, you may expect something. And if anybody dares to mention atmospherics I will track him down and lay his aerial mast flat.

THE LISTENER-IN.



The Single Slider in Crystal Reception

By E. H. CHAPMAN, M.A., D.Sc., Staff Editor

ONE of the most interesting pieces of work the wireless experimenter can undertake is the carrying out of a series of connected experiments with the idea of determining just what can be done with some particular type of apparatus. The writer has recently worked through a series of experiments of this kind with the object of ascertaining the best way to use a single-slider inductance coil in crystal reception. The results of the experiments proved decidedly interesting, and it is suggested that any experimenter who cares to work through the experiments will find something or other in them which will add to his interest and efficiency in the use of the crystal detector.

The Single Slider Inductance Coil.

The inductance coil used in the first experiments was wound on a cylindrical former 3½ in. in diameter and 6 in. long. For a length of 5 in. the former was wound closely with No. 22 enamelled wire.

When wound, the former was mounted in the following manner. First, at either end of the former two holes were bored at opposite ends of a diameter. Through each pair of holes a brass rod 6 in. long was placed and secured to the former by two pairs of nuts, one pair at each of the holes in the former, one nut of each pair being on the inside of the former and the other on the outside. A length of about 1 in. of each brass rod protruded at one side of the former, and a length of about 1½ in. at the other side. The two brass rods were then placed with their shorter protruding ends through two holes in a cigar-box lid, and were firmly screwed into position with nuts on the under side of the box lid.

At the top ends of the then vertical brass rods a square brass rod some 6 in. long and carrying a slider of the usual pattern was fixed by nuts screwed on the vertical rods. The path of the slider over the enamelled wire was then freed from the insulating enamel by passing the slider backwards and forwards a number of times.

Three terminals were mounted on the box lid, the one on the left being connected to the left-hand end of the coil, the one on the right to the right-hand end, and the one in the middle to the slider via one of the vertical brass rods.

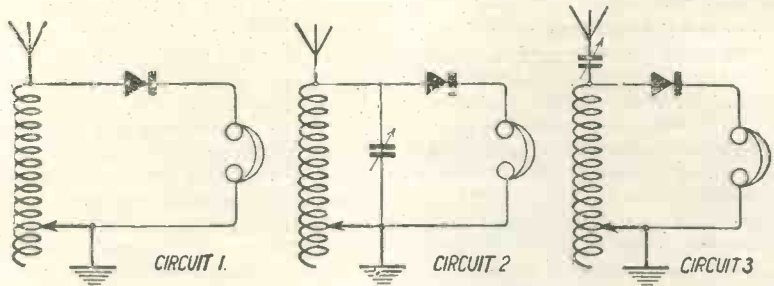


Fig. 1.—Some simple applications of the slider.

Familiar Circuits.

With a series of experiments in which no elaborate apparatus is to be used, the best starting point is a familiar circuit of which the powers and limitations are thoroughly understood. The starting point of the experiments which form the subject of this article was the well-known circuit numbered 1 in Fig. 1. As is generally known, this simple circuit, in which so much depends on the efficiency of the slider, gives good results, but the tuning is not sharp enough to cut out serious interference.

Using the single-slider inductance described, 2LO at a distance of 14 miles was received with circuit 1 of Fig. 1 at about the usual strength for crystal reception. The aerial was connected to the left-hand end of the coil, and the best position of the slider was with its left-hand edge 1 in. from the left-hand vertical brass rod. The lack of selectivity with this particular circuit may be judged from the fact that 2LO was audible over the whole track of the slider, though only very faintly at the right-hand end. One or two spark stations came out strongly about the centre of the coil, and these were audible over 1½ in. of the slider track.

The addition of a variable condenser, having four rotating and five fixed plates, in parallel with the inductance coil as shown in circuit 2 of Fig. 1, gave another familiar circuit. The addition of this condenser increased selectivity. Although 2LO followed the con-

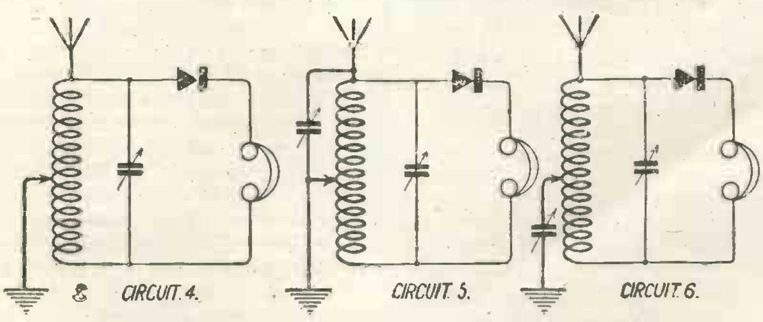


Fig. 2.—Using the slider in direct coupled circuits.

denser round when the slider had been adjusted to its best position, with the condenser set correctly, a movement of 2 in. of the slider cut out that station entirely.

Circuit 3 of Fig. 1 illustrates another familiar arrangement. The variable condenser shown in series with the aerial was the same condenser as used with circuit 2. With circuit 3 the telephony received from 2LO seemed to be slightly better than that received from 2LO with either circuits 1 or 2. There seemed more volume about the telephony when circuit 3 was used, and what was more interesting perhaps, the small series condenser was quite sufficient to tune out 2LO. The best adjustment of the circuit was with the condenser nearly all in and with the slider (left-hand edge) about 2½ in. from the left-hand vertical brass rod.

Fig. 2 indicates three more familiar circuits which were used in the experiments with a view of setting some kind of standard with regard to signal strength. In this case the coil was wound with 80 turns of Fr. 22 guage enamelled wire. The variable condenser placed across the crystal detector and the telephone receivers was, in each case, one with nine moving and ten fixed plates. The second condenser used in circuits 5 and 6 had four moving and five fixed plates.

Circuit 4 gave increased signal strength over circuits 1 and 2, but not over circuit 3. There was, however, a lack of selectivity about circuit 4. Circuits 5 and 6 may be passed over with the remark that the additional variable condenser is scarcely worth while. With regard to the second condenser in circuit 5, a fixed condenser instead of the small variable condenser in parallel with that portion of the inductance coil between the aerial terminal and the slider constitutes a useful method of increasing the range of wavelengths covered.

Less Familiar Circuits.

Fig. 3 indicates four circuits in which the first mentioned single-slider coil may be put to a somewhat unusual use in crystal reception. In each of these circuits the slider of the inductance-coil is connected to one side of a secondary circuit, the other side of which is connected to earth.

As would be expected, circuit 7 gave poor telephony, but high selectivity. In circuit 8 the secondary coil consisted of 70 turns of No. 26 D.C.C. wound on a basket former. This circuit gave excellent telephony from 2LO at a distance of 14 miles, and there was

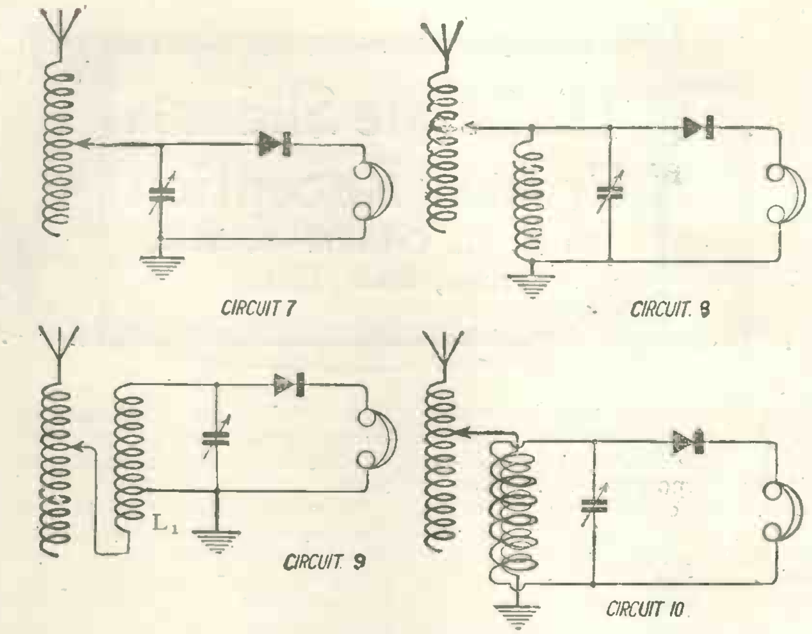


Fig. 3. Some unusual circuits.

no doubt that this circuit gave louder signals than any of the other circuits previously tried in the experiments. The selectivity of the circuit was also very good, a movement of the slider of ½ in. either way cutting out 2LO entirely. Circuit 8 is a circuit well worth experimenting with, and, in order to judge its efficiency, it is a good plan to start with the more familiar circuits as described in the present article.

Circuit 9, which did not give as good signal strength as circuit 8, is an interesting circuit. Coils L_1 and L_2 were wound together on a basket former in the proportion of five turns of L_2 to one of L_1. It is possible that further experiments with coils of different proportions would result in increased signal strength with this circuit.

The last circuit tried in the experiments, circuit 10, gave the best signal strength of all. It appeared to the writer that this particular circuit gave better signal strength than any other circuit he has tried for crystal reception. From the circuit diagram in Fig. 3 it will be seen that the slider of the inductance coil is connected to another coil, which, in turn, is connected to earth. Tightly coupled to this latter coil is the secondary coil of the closed secondary circuit. These two tightly-coupled coils were wound on the same basket former. The secondary coil consisted of 70 turns of No. 28 D.C.C. The smaller coil consisted of ten turns of No. 22 D.C.C. wound alternately with ten turns of the secondary coil in the middle of the basket former. A similar two-coil basket winding was used by the writer in making an experimental crystal set as described on page 141, MODERN WIRELESS, Vol. 2, No. 3.

Many wireless experimenters are of the opinion that we have not yet done the best possible with the crystal detector, and there is something to be said for this point of view. Experimental work with crystal circuits is well worth while, especially if it be planned with some definite object such as finding out just what can be done with some particular piece of apparatus.

Regular Programmes from British and Continental Broadcasting Stations

Times in Greenwich Mean Time.

GREAT BRITAIN.

Station.	*Call Sign.*	*Wave-length.*	*Times.*
Cardiff ...	5 WA	353	3.30 to 4.30 p.m
London ...	2 LO	365	and
Manchester	2 ZY	375	5.0 to 10.30 p.m.
Bournemouth	6 BM	385	
Newcastle ...	5 NO	400	SUNDAYS.
Glasgow ...	5 SC	420	3.0 to 5.0 p.m.
Birmingham	5 IT	475	and
Aberdeen ...	2 BD	495	8.30 to 10.30 p.m.

FRANCE.

EIFFEL TOWER FL 2,600. metres (*Daily.*)

6.40 a.m. Forecast.
10.50 a.m. Fish prices in the Paris markets.
11.14 a.m. Announcement of the time.
11.15 a.m. Regional forecast.
12.0 a.m. Livestock prices. (*Tuesdays and Thursdays.*)
3.40 p.m. Financial news.
5.30 p.m. Closing prices. (*Saturdays excepted.*)
6.10 p.m. Radio concerts.
7.0 p.m. General forecast.
10.10 p.m. General forecast. On Sundays the radio concerts and forecasts are given at 7 o'clock.

ECOLE SUPÉRIEURE DES POSTES ET TÉLÉGRAPHES (450 metres).

Concerts generally at 9 p.m. on Tuesday and Thursday.

RADIOLA (1,780 metres).

12.30 p.m.
4.30 p.m.
8.30 p.m. } Concerts.

These concerts are preceded by news items.

BELGIUM.

BRUSSELS (405 metres).

5.30 p.m.
6.0 p.m.
8.30 p.m. } Concerts and News.

HOLLAND.

THE HAGUE, PCGG (1,050 metres).
Concerts. Sundays, 3.0 to 6.0 p.m.

THE HAGUE, HEUSSEN PCUU (1,050 metres).
Thursdays, from 7.45 to 10.0 p.m., Irregular.
Sundays, from 9.40 to 10.40 a.m., Irregular.

THE HAGUE, VELTHYSEN, PCKK.
Fridays, from 8.40 to 9.40 p.m., Irregular.

THE HAGUE, IJMUIDEN, PCMM.
Saturdays, from 8.40 to 9.40 p.m., Irregular.

SPAIN.

MADRID (2,100 metres).
Trials from 10.0 to 12.0 a.m., Irregular.

SWITZERLAND.

LAUSANNE (1,100 metres).

8.5 a.m. Meteorological forecast for Lausanne.
10.50 a.m. Meteorological forecast for Geneva and Dubendal.
1.0 p.m. Meteorological report for Switzerland.
6.55 p.m. Meteorological report for Switzerland.
4.0 p.m. Tuesdays, Thursdays and Saturdays, Concerts.
7.0 p.m. Mondays, Wednesdays, Fridays and Saturdays, Concerts.

ITALY.

ROME (540 metres).
Weekdays from 5 p.m. to 6 p.m.

GERMANY.

BERLIN, VOX HAUS (Radio Stunde A.G., Potsdamer Str. 4).

Wavelength.—About 240 metres, varying between 415-435.

9 a.m.—Market prices.
9.15 a.m.—News report.
11.15 a.m.—Exchange quotations.
11.55 a.m.—Time signal.
1.15 p.m.—Exchange quotations.
3.5 p.m.—Concert.
6.30 p.m.—Lectures (not daily).
7.30 p.m.—Concert. (Sundays and holidays 6 p.m. / 7 p.m.).
8.45 p.m.—Last news report. Weather forecast.
9.50 p.m.—Dance music (not daily—usually Thursdays).

LEIPZIC—MITTELDEUTSCHE RUNDFUNK A.G.
Wavelength, about 400 metres.

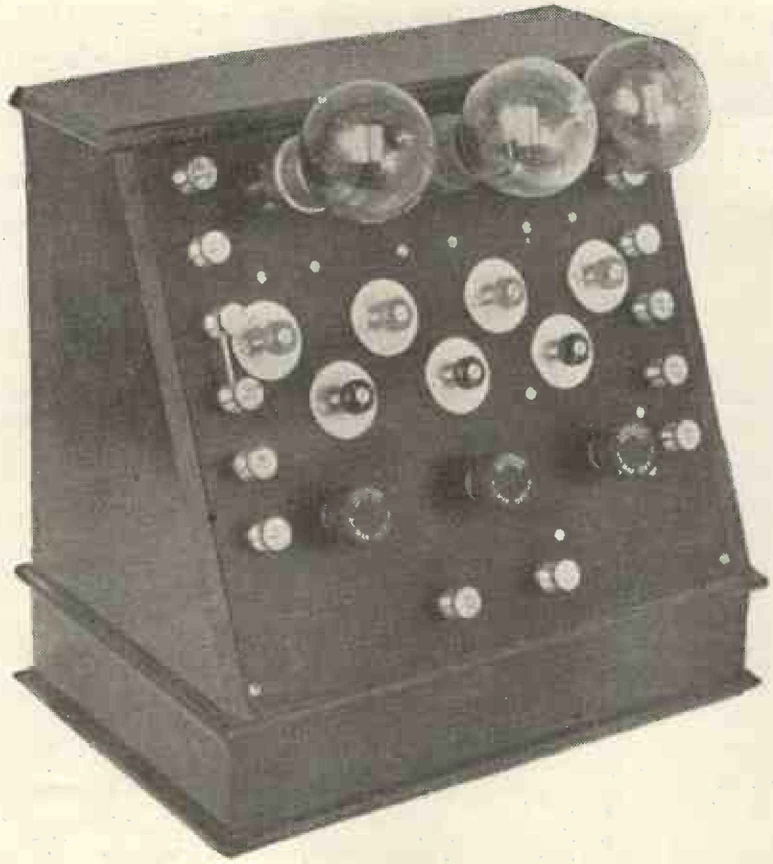
9 a.m.—Market prices.
11.45 a.m.—Exchange quotations, etc.
11.55 a.m.—Time signal (from Nauen).
3.30 p.m. / 5 p.m.—Concert.
8.15—Concert and news (Sundays and holidays, 4 p.m. to 5 p.m.)
9 p.m—Dance music (not daily).

KONIGSWUSTERHAUSEN L.P., 4,000 metres.

6 a.m./7 a.m.—News.
11 a.m. to 12.30 p.m.—Exchange (on 2,700 metres).
3 p.m. to 4.30 p.m.—Exchange and news (on 4,000 metres).

A Universal Resistance Amplifier

For High or Low Frequency



Every resistance is variable so that the best results can be obtained with ease.

DURING the last few months I have received a number of requests from readers of this journal to design a simple resistance coupled amplifier for low frequencies. The desire for such an amplifier is obviously prompted by the unsatisfactory reproductions given by many transformer coupled instruments. I hope that the present design will satisfy my correspondents, as I can assure them that the results given by it are quite as satisfactory as can be expected with this form of coupling.

Before we begin the description of the actual instrument and the method of constructing it, it is just as well to be clear on one or two points connected with amplification. It is quite wrong to start off with the supposition that satisfactory reproduction cannot be obtained with iron core low-frequency transformers or that we are bound to get first-class reproduction with any resistance amplifier. It is true that many transformers, particularly those cheap and shoddy instruments sold at prices far below those of the standard makes, distort the speech and music to such a degree as to jar the most uncultured ears, and even with the best intervalve transformers a bad design, unsuitable grid potentials and undesirable inter-stage coupling will quite ruin the best of modulation. The ideal audio-frequency amplifier would give equal magnification to all frequencies coming within the limits of the human ear; and in practice, provided the amplification is fairly even from about 50 to 5,000 or 6,000 cycles per second, we shall not get noticeable distortion. Actually none of the intervalve transformers (even the most expensive) has perfectly even amplification over all these frequencies, but the best of them have not too humped a curve. On the other hand a well designed resistance amplifier gives uniform amplification at all the frequencies within audible range, but has the grave disadvantage of giving relatively low amplification per stage. Generally speaking, we may say that three valves resistance capacity coupled will only give the same degree of amplification as that obtainable with 1½ to 2 transformer coupled valves, provided these latter have first grade transformers in a properly designed circuit. A further point to be taken into account is that a higher plate voltage is required than would be required with the corresponding transformer coupling. Roughly speaking, we can say that a 50 per cent. increase in plate voltage is needed for the same valves.

The reader who is interested in the principle of resistance coup-

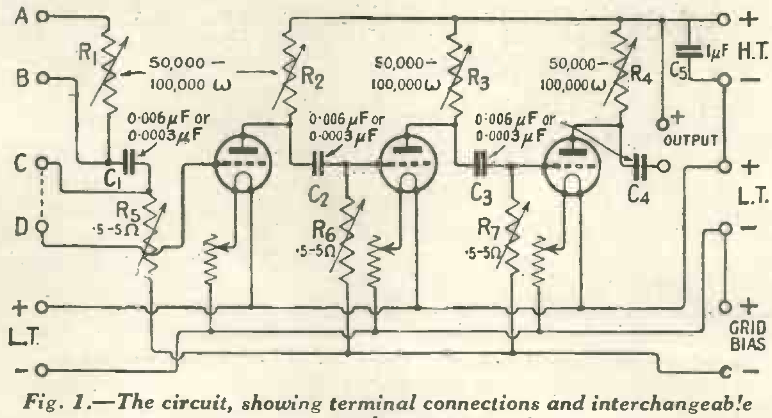
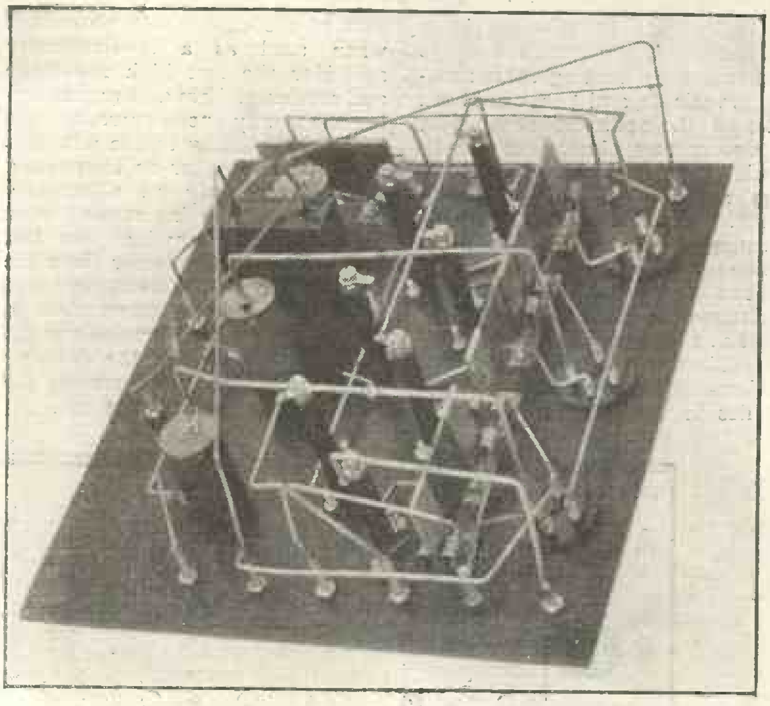


Fig. 1.—The circuit, showing terminal connections and interchangeable condensers.

By
PERCY W. HARRIS,
Assistant Editor

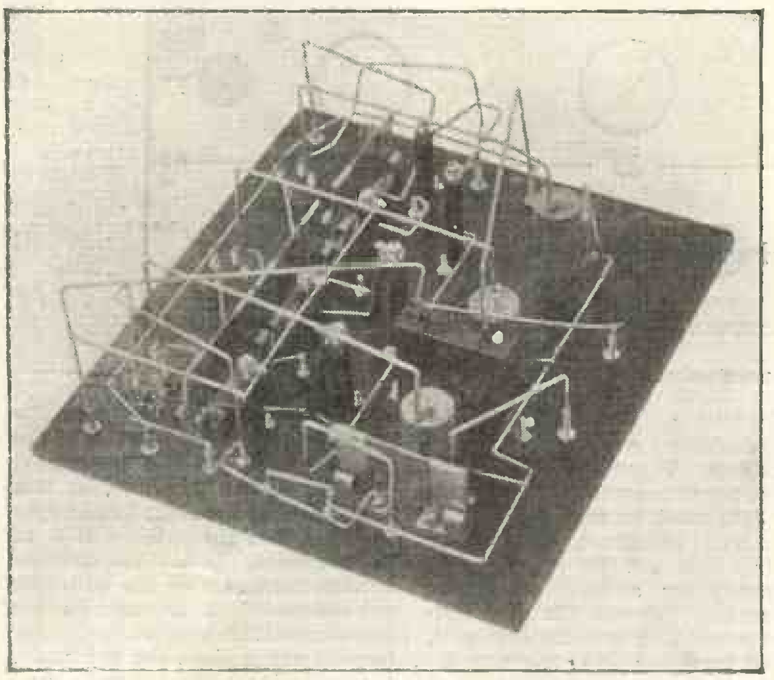
Resistance amplifiers have recently come into some prominence owing to the purity of reproduction obtainable with them. In this article Mr. Harris describes the construction of an ingenious amplifier which can be changed in a moment from a high to a low-frequency amplifier. It also has the merit of being inexpensive to build. A further advantage is its suitability for use as the high-frequency amplifying portion of an Armstrong super-heterodyne receiver.



The stiff busbar wiring gives a smart appearance.

ing is referred to MODERN WIRELESS for January last, wherein the matter is fully dealt with.

Resistance coupling can also be used for high frequencies, the difference between a high-frequency and low-frequency resistance-capacity coupled amplifier lying in the values of the coupling condensers and grid leaks. Low-frequency amplifiers have much larger capacities for coupling condensers, while the values of the grid leaks are not at all critical. When working out the design for the present amplifier it occurred to me that by a slight modification it should be possible rapidly to change from one form of amplifier to another, with considerable advantage to the experimenter. The instrument is therefore so arranged, and I think will fill the need for some kind of universal amplifier for high and low frequency.



With this photograph and that shown above, the general disposition of parts can be gauged.

If only we were able to arrange a high-frequency resistance capacity coupled amplifier to be efficient on the short wavelengths such as those used for broadcasting and below we should be in a very happy position, but unfortunately the efficiency of a resistance amplifier drops very rapidly when the wavelength is shorter than about 1,000 metres. On this latter wavelength and above the resistance capacity amplifier compares very favourably with other forms, although it is far less selective in its tuning than the tuned transformer or tuned anode method. The present amplifier, therefore, is only suitable, on the high-frequency side, for amplifying such wavelengths as those used for the Dutch concerts, Radiola, Eiffel Tower and Koenigswusterhausen. Those readers who are contemplating building the Armstrong super heterodyne receiver (an example of which was described in our last issue) will be able to use the present amplifier as the high-resistance unit for amplifying the longer wave signals into which the short waves are heterodyned.

The circuit used in the amplifier is shown in Fig. 1. The coupling resistance and the grid leaks are both of the variable variety. There are two reasons for this choice. Firstly, variable high resistances are readily obtainable of good manufacture at a reasonable price, and secondly, they are made in such a form as to fit on to a panel very conveniently. In practice it is not found that any great advantage is obtained by making these resistances variable, and I have not been able, on the audio-frequency side, to detect any change in amplification from one end of the scale to the other (50,000 to 100,000 ohms). Variable grid leaks are an advantage because on the high-frequency side the efficiency of the set can be augmented by proper adjustment of these parts.

I have already indicated that the difference between a high and low-frequency resistance amplifier lies in the different values of three grid leaks in all. Examination of the circuit will show that when used as a low-frequency amplifier the last high resistance and condenser form a filter preventing the steady anode current of the last valve passing to the windings of the loud-speaker or telephones. This is obviously an advantage. When using the instrument as a high-frequency amplifier the last resistance and condenser form the coupling on to the detector valve and it is only necessary then to connect the output terminals to the grid and filament of the detector valve, joining a leak between the grid and the positive filament.

advantage when we wish to use the instrument as a low-frequency amplifier with different kinds of sets. For example, when we join this amplifier to a crystal detector the output terminal of this latter can be connected to the grid and filament of the first valve direct without the interposition of any form of coupling. This is done in the manner shown in Figure 5. Telephones or loud-speaker can then be connected to the output terminals of the amplifier, and excellent reproduction will be given. If we desire to use the instrument as a low-frequency amplifier following a valve detector, we connect

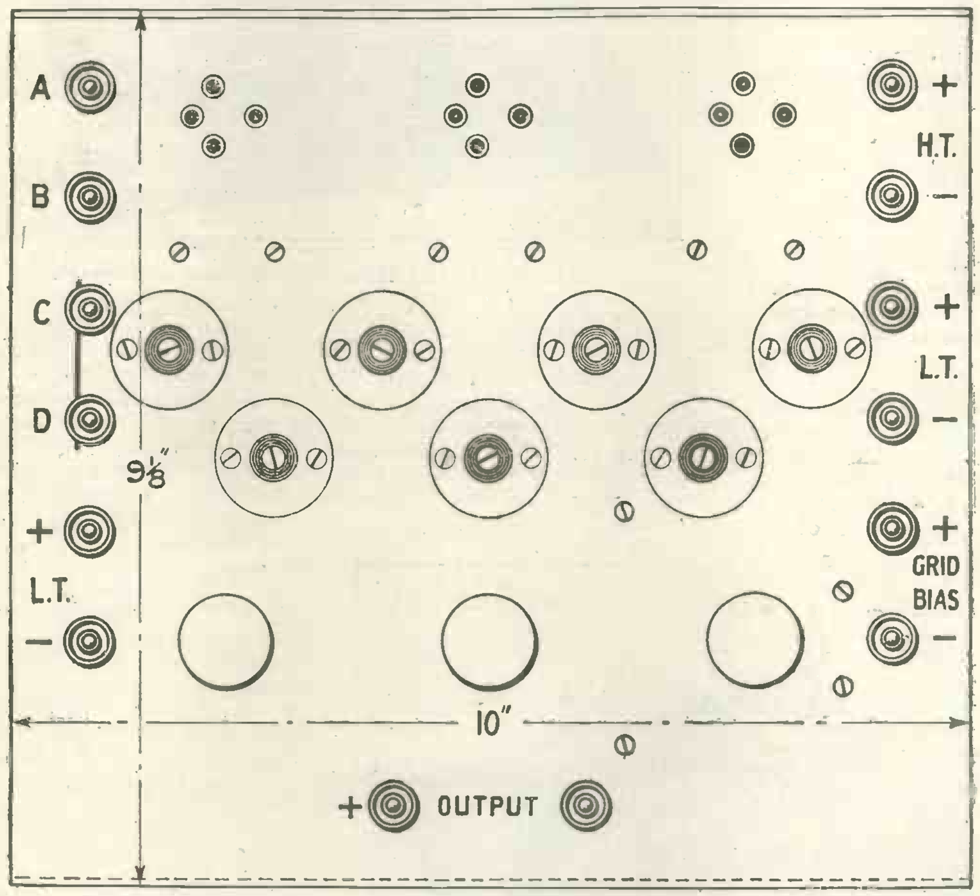


Fig. 2.— Panel layout and terminal markings. This illustration is exactly half scale.

grid condensers and grid leaks used. By using interchangeable condensers fitting into clips and variable grid leaks the change from one form to the other is rapidly made. For low-frequency amplification the coupling condensers have a value of .006 μF. By changing these to values of .0003 μF and by altering the grid leak a transformation from one type to the other is carried out at once.

There are four coupling condensers, four high resistances and

Looking at the front of the instrument we see two sets of six terminals. Those on the left are joined up as follows. The top pair are connected to each end of the first high resistance, the middle pair (which can be joined when necessary by a link) effect the connection between the grid condenser and leak and the first grid, whilst the lower pair are connected respectively to the positive and negative busbars. The arrangement of terminals given is of

up the plate terminal (normally connected to the telephones) of the detector unit to the uppermost terminal of the amplifier, in this case linked to the right-hand upper terminal, *i.e.*, the positive H.T. of the amplifier. If now the two low tension terminals of the amplifier are connected to the low tension terminals of the detector, no further battery connections are necessary. When the instrument is to be used as a high-frequency amplifier, it is only necessary to connect the tuning unit to the grid and filament as shown, the detector valve being connected at the right-hand side in the manner also indicated (Fig. 7).

Components Required

The following is a complete list of the components required:—

1 cabinet to take an ebonite panel measuring about 9 in. by 10 in. (Such a cabinet can be obtained from several advertisers in this journal. That shown was made by Scientific Appliances).

Ebonite panel of dimensions given, and ¼ in. thick.

12 terminals.

panel for the more conventional circular disc form).

1 fixed condenser 1 μF (Mansbridge).

3 valve sockets. (Those shown are the special low capacity type sold by the Bowyer-Lowe Co., Ltd.)

No. 16 gauge square section tinned copper wire. (I have used this wire from "Sparks," "Bowyer-Lowe," "Raymond" and "General Radio." All of these makes are quite good.) I strongly recommend the use of this stiff busbar wiring in the present instrument, especially if

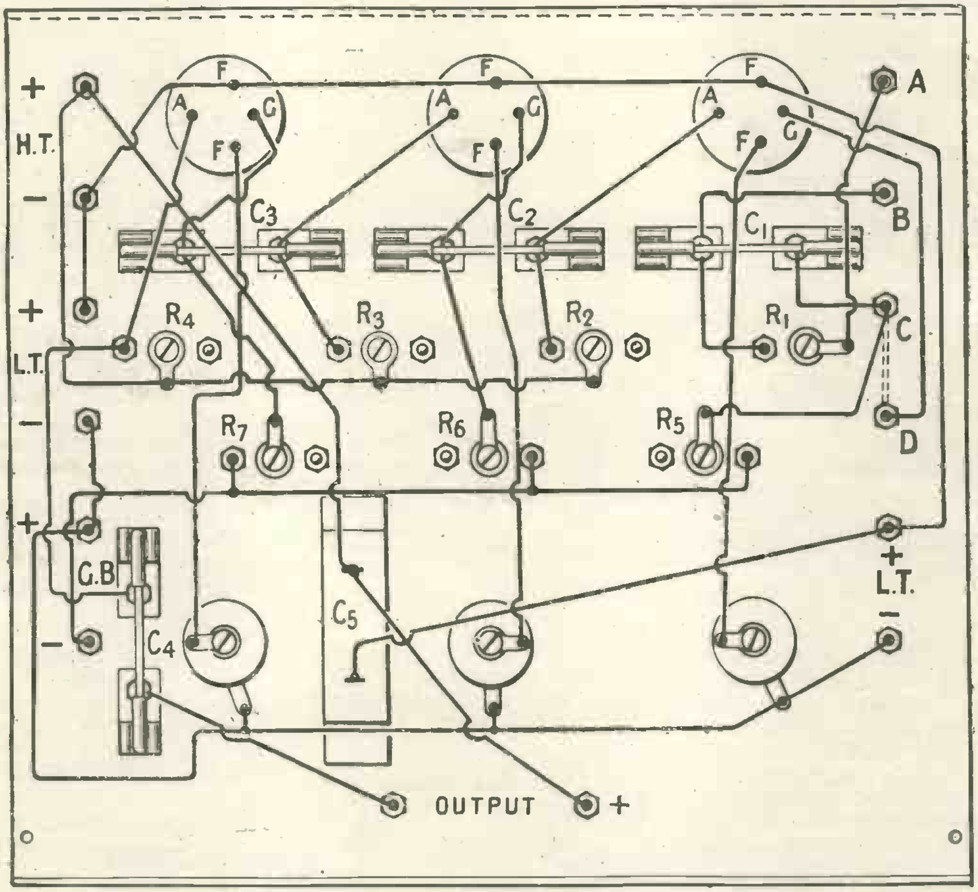


Fig. 3.—Practical wiring diagram (half scale).

4 variable resistances, 50,000 to 100,000 ohms (Watmel).

3 variable grid-leaks, 0.5 to 5 megohms (Watmel).

4 fixed condensers with clips, .006 μF (Grafton Electric).

4 .0003 μF fixed condensers for the same clips (Grafton Electric).

3 filament resistances of any suitable pattern for the valves used. (Those shown are Lissenstats, being suitable for dull or bright emitters. Any good filament resistances will do here, and space is allowed on the

it is to be used for high-frequency amplification.

Construction

I think the actual method of construction of the instrument will be quite easily followed from the photographs and diagrams. There are no particular difficulties, and only a few precautions are necessary other than those obvious from an examination of the photographs. First of all I would strongly recommend you to use small soldering lugs when joining up the wires to the ends of the variable resistances and leaks. It is not a simple matter to fasten this stiff wiring underneath the terminal screws provided. It is far more satisfactory to take small soldering lugs (obtainable from any of the dealers) and to tin these before wiring up is begun. When actually wiring the set it is then only necessary to place the end of the wire on the tinned lug and apply the hot soldering iron, when a good joint will be obtained.

The second precaution is to see that the wires joining the condenser clips and other portions are so bent as to allow the condensers to be pushed into the clips satisfactorily. It will be noticed that the clips are secured to the panel by metal screws passed through clearance holes. All of these securing screws in the present instrument are 6 BA. It may be found necessary to cut these screws short if they project too far through the back of the panel. If you can obtain them use 6 BA metal screws of a length not exceeding $\frac{7}{16}$ in. Fortunately there are a number of firms now supplying component parts for sets described in this journal, and if you order your parts from them they will see that you are given suitable screws. The firms will, if necessary, supply you also with a suitable drill for making the clearance holes. In making this set I have followed my usual practice of using clearance holes throughout, so that it is not necessary to tap any screw threads in the ebonite.

I advise you to adhere as closely as possible to the actual shapes of wire shown, for these have been worked out after some experiments, and will be found to give satisfactory results. The time spent in carefully bending and shaping the pieces of stiff wire to

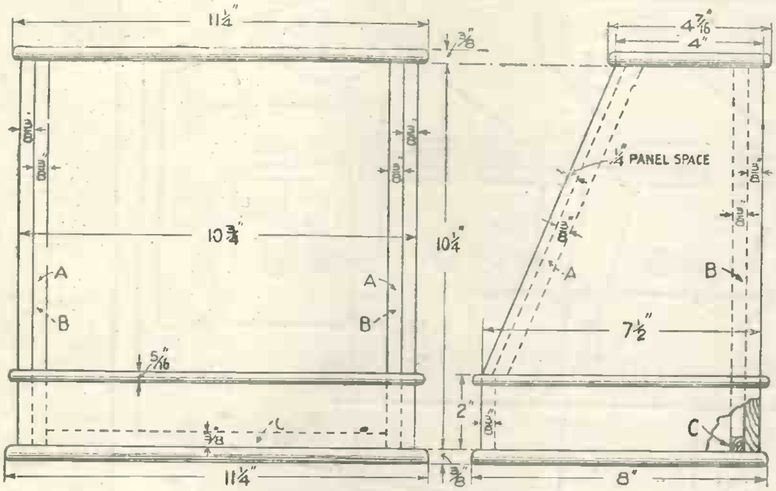


Fig. 4.—Cabinet dimensions.

make the connections will be well repaid. If it is desired to use the instrument solely for low-frequency amplification, there is no need to use the clip-in condensers, as the ordinary Dubilier type of condenser of .005 or .006 could be substituted quite effectively with a certain amount of simplification in wiring up. As usual, a blue print is available of the actual wiring of this set full size. In asking for this blue print the No. 24 should be quoted. For the panel you should use a good grade of ebonite, and if the makers do not guarantee it to be free from surface leakage you should take the precaution of rubbing down both sides very throughly with smooth emery before beginning work.

One end of each of the high resistances and leaks is joined, as I have indicated, by the aid of a soldering lug. Connection with the other end is made to one of the securing screws passing through the panel and the brass front plates of the resistances and leaks.

Operation

As it is probable that the amplifier will be used more frequently as a low-frequency amplifier than as a high-frequency, we will deal with this aspect of the case first. Any good valve may be used here, and I have personally used the Cossor, Marconi Osram R type, and Marconi Osram R5 type successfully, also the L.S. 5 power amplifier valve. The terminals marked grid bias should be connected to a small 4½ volt battery, such as is sold for flash lamp purposes, as this will give about the correct bias on the grid when using a high tension battery of 120 to 150 volts, the voltage suggested. A 6 volt accumulator should be used with the bright emitters. Dull emitter valves can be used here if suitable filament resistances are fitted; the popular

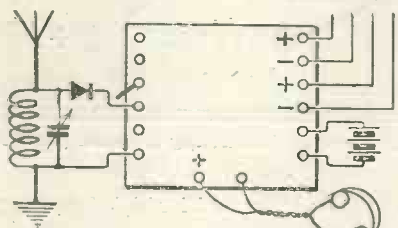


Fig. 5.—Connections of crystal detector to L.F. amplifier.

types of dull emitter using .06 of an ampere will require either three dry cells or a 4 volt accumulator, preferably the latter. I do not recommend you to use dry cells even with these low consumption valves, as the current drain of three valves is rather too high for dry cells. Suitable valves for high frequency amplification have

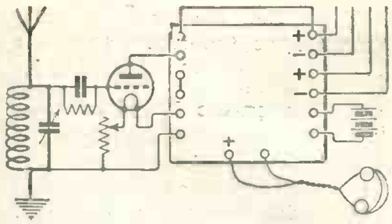


Fig. 6.—Connections of valve detector to L. F. amplifier.

already been recommended in this journal.

Admirable loud-speaker results of great purity are obtainable with this set when connected to a

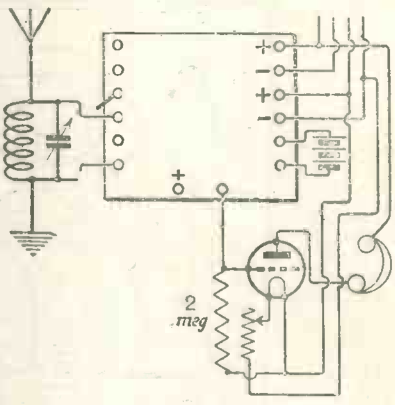


Fig. 7.—Connections for H. F. amplification with valve detector.

crystal or single valve receiver at distances up to 10 or 12 miles from a broadcasting station. In general, it may be said that if signals from any station are good on the telephones, this low-frequency amplifier will enable them to operate a loud-speaker in good volume. High-frequency results will be reported in our next issue.

RADIO PRESS BLUE PRINT GUIDES.

Full size blue prints of the wiring diagrams of MODERN WIRELESS constructional articles are obtainable from the publishers, price 1/6 post free. Always order by number. For example, the wiring diagram of this receiver is Blueprint Number 24. Other numbers are quoted in the articles concerned.

Distortionless Broadcast Reception

By H. J. ROUND, M.C., M.I.E.E.

An article of intense interest to all who aim at the best in their receiving sets.

PERHAPS you are satisfied with your broadcast reception, but even if you are satisfied, a few experiments in a novel direction may interest you.

For these experiments the ideal wireless gear is that in which there is, with a fair element of certainty, no resonance. It is wiser, if the experimenter can afford the valves and current, not to exaggerate the magnification to be obtained by each individual valve.

As I only intend these experiments to be done with telephones (the difficulties being much greater with a loud-speaker), a three-valve set should be sufficient, or even two valves with a crystal, and some work can actually be done with a crystal alone, or with one valve and the crystal. A great deal, of course, depends on one's nearness to a broadcasting station.

Figs. 1 and 2 represent two circuits which, if certain precautions are taken, will be distortionless up to the telephones.

In general, you can replace the 50,000 ω rods in the circuits by the secondaries of any commercial intervalve transformers without much risk of distortion, and in this way you will get more strength. Personally, I always use Zenite 50,000 ω rods whenever there is current to be carried, but the grid resistances can be of the usual graphite construction.

In the second circuit, particularly if you are near to the transmitting station, I advise you to keep your first grid-leak R_4 down in value, otherwise you will get distortion. A number of grid-leaks ranging from 50,000 ω to 2 Ω are very useful adjuncts to the amateur laboratory.

If you have the use of a sensitive microammeter, an occasional measurement of their value is also useful. If you have such an instrument (Paul unipivot 5 ω type is a good instrument) you can, of course, make them to any value at any time.

Do not exaggerate the reaction; this is a well-known way to distort. I personally like to have an easy adjustment of strength which is warranted not to alter quality, and Fig. 2 shows how I put in a grid potentiometer, sliding up and down the grid-leak of the second valve to do this; but you can do it usually by either mistuning or by varying the coupling, as my way necessitates a wire-wound grid-leak with tappings.

Experiments

Now to experiments. Having assured ourselves that all the distortion is either in the transmitter or in the telephones, let us attack the telephone question. I have determined that on an average you will get equal voltages produced at the end of your receiver with equal audibilities of sound produced at the transmitting end.

CAPTAIN H. J. ROUND, the author of this article, is world-famous for his wireless inventions and discoveries. These include a number of important inventions and circuits for wireless telephony. He is also the inventor of the wonderful microphone at present used by the B.B.C. During the war his remarkable direction-finding work attracted much attention in high quarters and was of enormous assistance to the Admiralty and War Office. At this time he was known as the "mysterious Captain X," and to-day he is still the "mystery man" behind the scenes at the B.B.C. Captain Round, of course, is the Chief of the Research Department of the Marconi Company.

An example of this will make the point clear. Suppose a small drum giving a note of 300 per second and a piccolo giving, say, 4,000 are arranged at a long distance away from you so as to be each just audible to you, by arranging that the drummer plays weaker or stronger as required, then the wireless transmitter will transmit such a modulation that the voltages across the grid of your last valve are equal. So you see that all you now require is a telephone which delivers to your ear equal audibility for equal voltages applied to the grid of this last valve. Unfortunately, telephones do not do this.

Fig. 3 shows approximately what a pair of well-known (and considered good) telephones do. The top notes come out fairly well, the middle ones much too strong, and the bottom ones (below 200 frequency) are hardly there at all. You have not noticed this directly because this resonance is very flat, as the scale covers such a big range of frequency, but you have, I expect, noticed it indirectly, and blamed it to the transmission. What you have noticed is:

1. Room echo effects, particularly from large halls.
2. Certain singers' notes being unpleasant and piercing.
3. Violins being rather flute-like.
4. And this is quite important—if you strengthened up your signals more than a certain amount, they jarred you, although that strength could not have been greater than what you would have received directly if you had been listening in the studio.

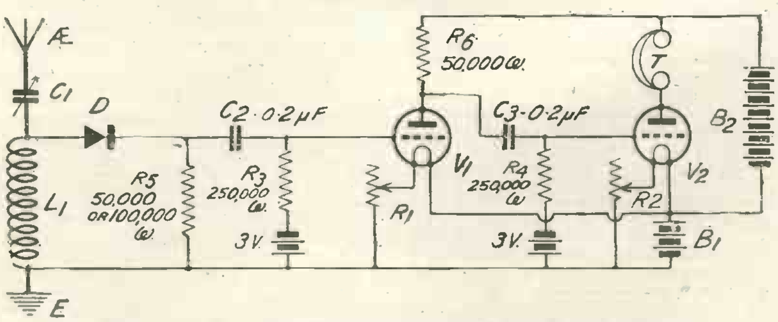


Fig. 1.—A useful distortionless circuit, using a crystal detector.

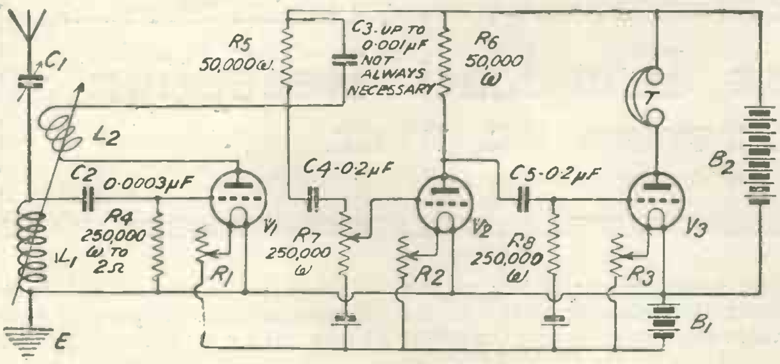


Fig. 2.—A distortionless circuit with valve rectifier.

5. Speeches, when very weak, unintelligible.

6. The top notes of the piano are too wooden and the bottom notes are too weak.

With our receiving gear we can, with small additions, very fairly put this right at a loss of some strength which is not of great importance, because its necessity is imaginary more than real.

Try putting condensers across the rods R_5 or R_6—anything you have for an experiment.

A 0.001 μF condenser will not have such action.

A 0.01 uF condenser will decidedly cut down the high tones.

A 0.1 μF condenser will muffle very greatly — giving orchestras a very decided distant,—"next-street-but-one" sound.

Now try some inductance coils; and here is an inductance coil which will be generally useful. A standard transformer iron core is used, as shown in Fig. 4. Four sections, each of 600 turns of, say, No. 38 double silk covered wire, are wound and connected in series, tappings being arranged for.

	Henries.
The total inductance is about	10
Half the number of turns will be	2.5
Quarter the number of turns will be	0.6

So that if you wind this up with four sections and tappings, you have a useful choke coil.

If you put 0.6 henry across R_5 or R_6, the lower tones will be greatly reduced and speech becomes high-pitched and super-intelligible (of course, weaker, due to the loss of magnification).

2.5 henries will be much less effective, but the four tappings will enable you to vary the ratio of high and low notes considerably. Perhaps a simpler way to make this easily variable is to stick to the .6 henry and vary a series resistance in series with it. This is illustrated in Fig. 5.

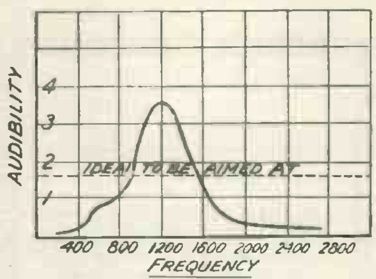


Fig. 3.—How a "good" pair of telephones deals with various frequencies.

The advantage of doing this operation on a valve plate resistance is that you can calculate exactly what you are doing. I will not give any formulæ here, but at any time, if there was sufficient demand, a short article on simple valve network calculations could be given.

In general now, a condenser, shunted across the resistance, does what is shown in Fig. 6 to our broadcast signals. It will be seen that the degree of amplification decreases on the higher notes.

Fig. 7 shows the effect of a shunt inductance, or the alternative arrangement of Fig. 5. The higher the note, the greater the amplification. In other words, the condenser weakens the higher notes, while the inductance accentuates them. The addition of resistance in series with the inductance tones down its action.

If we did the two operations together, then we should produce a curve, which would only exaggerate our telephone curve, but if we put the condenser in series with the inductance and make the minimum impedance frequency the same point as the maximum response of the telephone, we can see that a partial correction of our telephone curve is possible.

A good combination for most telephones is shown in Fig. 8, and this combination is connected across one of the resistances in the L.F. resistance amplifier (*e.g.*, R_5 in Fig. 2). You will find quite early about the best position for the condenser (I use an old Marconi 0.01 μF ebonite variable condenser), which should be adjusted first with R at zero, as there is a peculiar place where speech changes over from muffled to nasal through an intermediate position which is the correct one.

Without resistance this may overdo things, and give you speech which is full of "S" sounds and low tones but no middle. It all depends on your telephones—how much R you have to put in to get it quite right. Voice and piano are the best to listen to, particularly if you know the man's voice.

After you have done all you can with the combination, you may still be a bit dissatisfied (I find I am never quite satisfied); then across R_6, if you are already using a combination across R_5, try the condenser "tone-lowerer" or the inductance "tone-raiser." You have available:

1. A tone-lowerer.
2. A tone-raiser.
3. A middle-weakener (the Fig. 8 combination without the resistance R).
4. And if you like, you can arrange two middle-weakeners for different maxima.

And now one more point. You probably know what blasting means—I will define it as when, either in the transmitter or the receiver, the valves are carried beyond

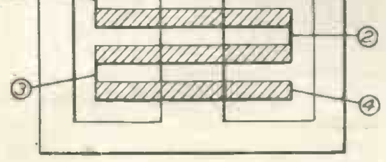


Fig. 4.—How to use a standard transformer core for choke windings.

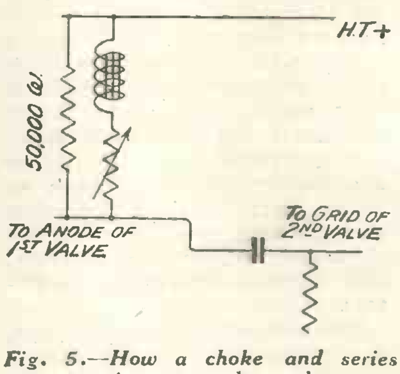


Fig. 5.—How a choke and series resistance can be used.

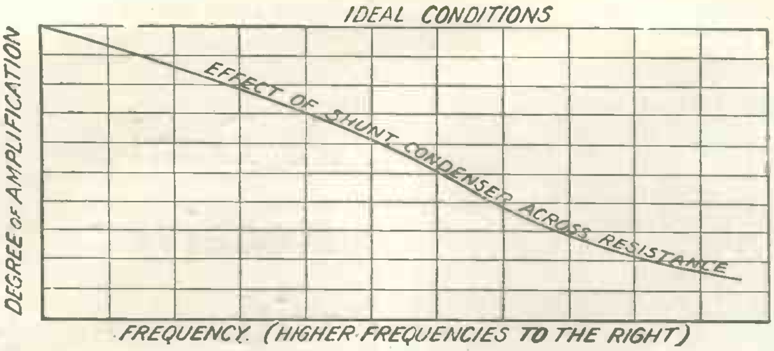


Fig. 6.—The effect of the shunted condenser.

their straight lines limits, *i.e.*, the representative point travels round the bend in the characteristic curve. Harmonics get produced by these blasts.

Now on these receivers which I have shown, with "telephone strength" of signals at the end, you are not likely to blast, and so the blasts will be transmitter ones—you have got 2LO nailed down—because blasts produced by frequencies round 1,000 are much more noticeable on these corrected circuits than on any ordinary circuit. The reason is obvious—the 1,000 note is exaggerated in ordinary reception, and any false harmonic passes unnoticed, but with the corrected circuit the higher harmonic is given out in its right proportion. But there is a counterbalancing advantage. Blasting by bass note is exaggerated by the ordinary telephones, but minimised by the corrected circuit.

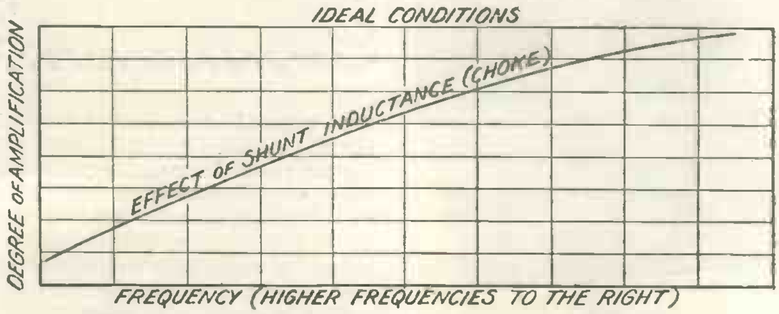


Fig. 7.—Effect of the shunt inductance on amplification.

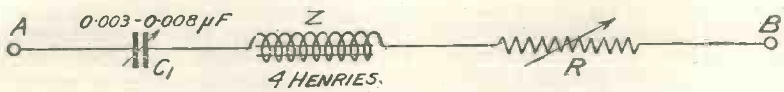


Fig. 8.—A good combination for most telephones.

Those who do these experiments thoroughly will be very satisfied, however critical they may be: voice, pianos and orchestras will be very much better than ever heard before.

Just one last word to those who have little time and patience. I will give a circuit (Fig. 9) which is a crude way of doing the previous tests, though not so satisfying, but quite effective, *if your receiver is fairly distortionless to start with.*

The condenser C_1 and the iron-core inductance ("choke") Z may, if desired, be connected across the telephone terminals of the set. The condenser C_2 (0.003 μF to 0.008 μF—depends on the 'phones), the choke Z (4 henries) and the resistance R all enable different combinations of tone-lowerers, tone-raisers, etc., to be obtained. All sorts of interesting experiments may be carried out by making different combinations of inductances, condensers, etc.

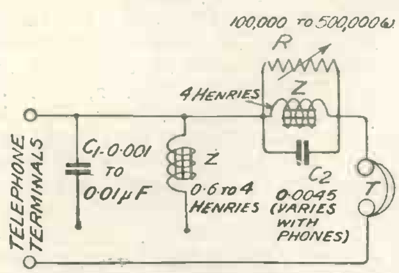


Fig. 9.—A useful circuit applying the previous ideas.

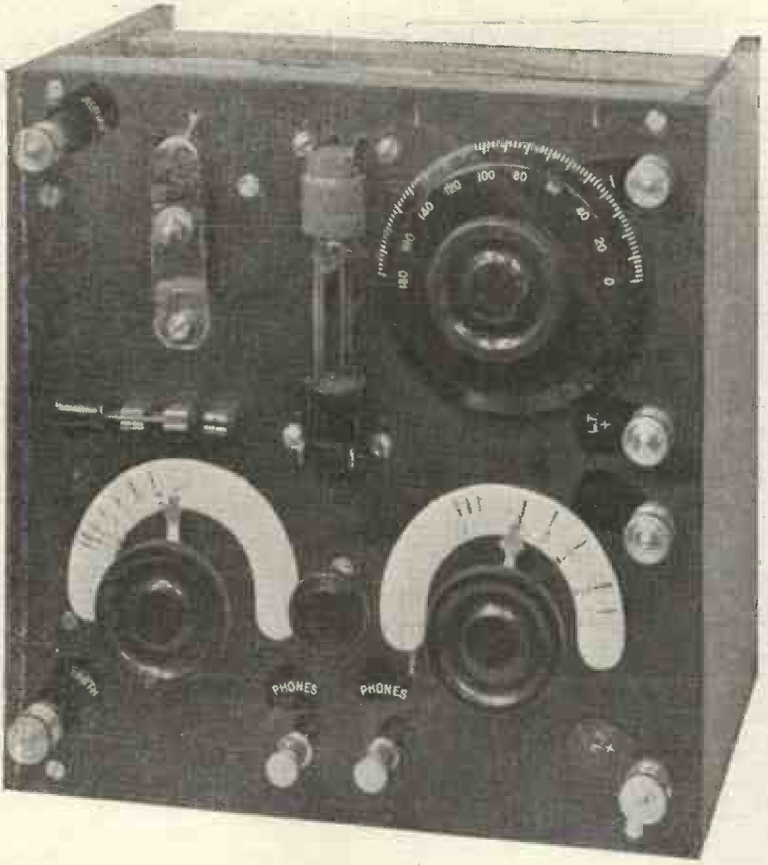
His Majesty's Wireless Set

Our frontispiece this month shows the exterior of the cabinet wireless receiver recently accepted by His Majesty the King from the British Broadcasting Company. The cabinet contains, on the right, a built-in loud-speaker, and a drawer to carry four pairs of telephones. On the left is a panel with seven valves, consisting of a reaction valve, two high-frequency valves and detector, and three power amplifier valves. Instead of an outside aerial, a capacity aerial consisting of two copper plates is used. One plate is situated in the top of the cabinet and the other in the base of the instrument. There are but two tuning controls—one for aerial tuning and the other for reaction. A switch enables telephones or loud-speaker to be used at will. A full description of the set, together with a circuit diagram, appeared in *Wireless Weekly* for April 2nd.

The 10-Valve Super-Heterodyne Receiver

The article which appeared on page 452 of our March issue entitled "A 10-Valve Receiver," by Mr. W. K. Alford, has aroused a considerable amount of interest in all parts of the country. Owing to the large number of letters received we have arranged with him to prepare a further article incorporating those points which seemed to be of general interest and likely to be helpful to our readers. In view of this we would ask our readers to withhold further queries on the subject until this article has appeared. We hope to publish it in the next issue.

A Dual Receiver with Neutrodyne Control.



This instrument uses the new Myers valve,

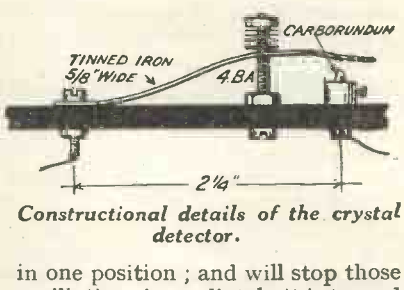
IN order to obtain the maximum possible signal-strength from a single-valve-crystal dual amplification circuit it is desirable to utilise reaction to a point which is just below actua self-oscillation, but which is narrowly adjusted to be as near this point as may be safe. This implies a positive and at the same time a smooth and easy control over reaction.

Undoubtedly the most efficient mode in which to link the valve—acting as high-frequency amplifier—and the rectifying crystal, is by placing the latter across a tuned anode; the subsequent feed-back of rectified audio-frequency energy being carried out preferably via a good step-up transformer arranged so as to apply the maximum possible audio signal voltage on the grid of the valve.

Now if either a small series condenser be used in the aerial circuit (as should be done in little-damped valve circuits so as to give a larger signal voltage across the A.T.I.), or if loosely-coupled circuits be used, together with high anode volts and a "liberal" valve, a critically-tuned plate generally means self-oscillation. With the severe damping of the crystal circuit across the anode inductance this may not be uncontrollable. For instance, in the familiar S.T.100 circuit a leak resistance of some 100,000 ohms is introduced across the grid and filament; this is found in practice adequate to control too exuberant oscillation, while allowing a considerable build-up of signals. The present writer has described recently a dual circuit in which, by the old expedient of actually negative magnetic reaction (i.e., slight reversed reaction by a vario-coupler device), self oscillation in a lightly-coupled circuit with sharply-tuned anode is held down delicately.

An exceedingly effective method of control is afforded by the Neutrodyne principle of Prof. Hazeltine. By adopting the modification described by the writer in *Wireless Weekly*, Vol. 2, No. 8 (Sept. 5, 1923, p. 320) for use with tuned anode H.F. coupling, this can be used to stabilise a single-valve dual circuit, or to give at will the finest possible control over reaction effects. In the receiver to be described here, a fixed coupling is used between the anode coil and the neutrodyne coil (as in the original transformer-coupled circuit published by Prof. Hazeltine) for the sake of simplicity; and the tiny coupling condenser, which transmits back to the grid of the valve the reversed stabilising impulses, is made here adjustable so that actually the reaction is controlled entirely by this neutrodyning condenser.

Self-oscillation in a valve circuit with tuned anode is generally ascribed to the back-coupling effect of the small condenser constituted by the plate and grid. Actually, more critical observation will show that in very many cases the real cause of such self-oscillation is to be sought in casual magnetic (and electrostatic) couplings beside the extremely small valve-capacity coupling, in receivers as they are commonly wired up and arranged. It is not generally realised that a tuned anode coil will at times produce violent oscillations when brought within a foot of the A.T.I.

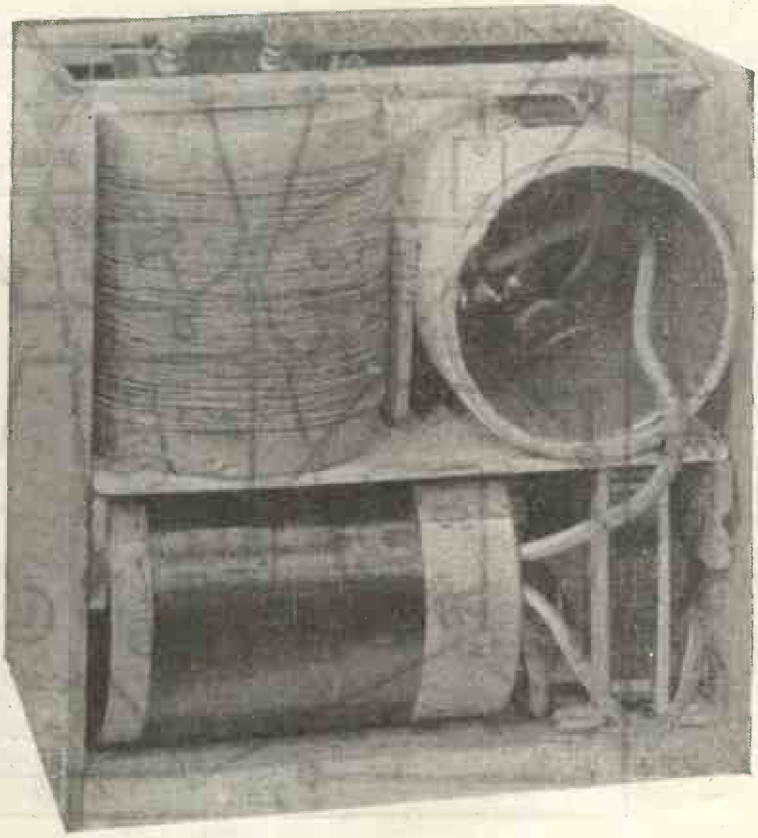


Constructional details of the crystal detector.

in one position; and will stop those oscillations immediately it is turned over. The casual couplings in a small, compact receiver such as that described here are almost always sufficient to bring about self-

By A. D. COWPER, M.Sc., Staff Editor.

In this instrument Mr. Cowper displays considerable ingenuity in adapting the Hazeltine Neutrodyne principle to an efficient dual amplification receiver.



The compact make-up is noticeable.

oscillation even when using a special low-capacity type of valve. It will be noticed that actually some pains have been taken to minimise casual magnetic couplings here, by arranging all inductances mutually at right angles ; and in addition the writer has used a valve of especially low internal capacity—though not explicitly for this reason ; yet with a heavily damping crystal across the anode coil, the receiver will oscillate most violently when the anode coil is tuned in unison with the A.T.I. The neutrodyne coupling is invoked to control this, which it does in the smoothest possible manner, when once properly adjusted with its small variable condenser. Material alteration in the arrangement of these inductances may possibly result in either accentuating the casual magnetic coupling to such an extent that it is no longer controllable by the neutrodyne device ; or perhaps by accidentally reversing the main magnetic coupling prevent the receiver from oscillating at all. Accordingly, the general arrangement of the anode and A.T.I. coils should not be departed from without careful preliminary trials to ascertain the effect.

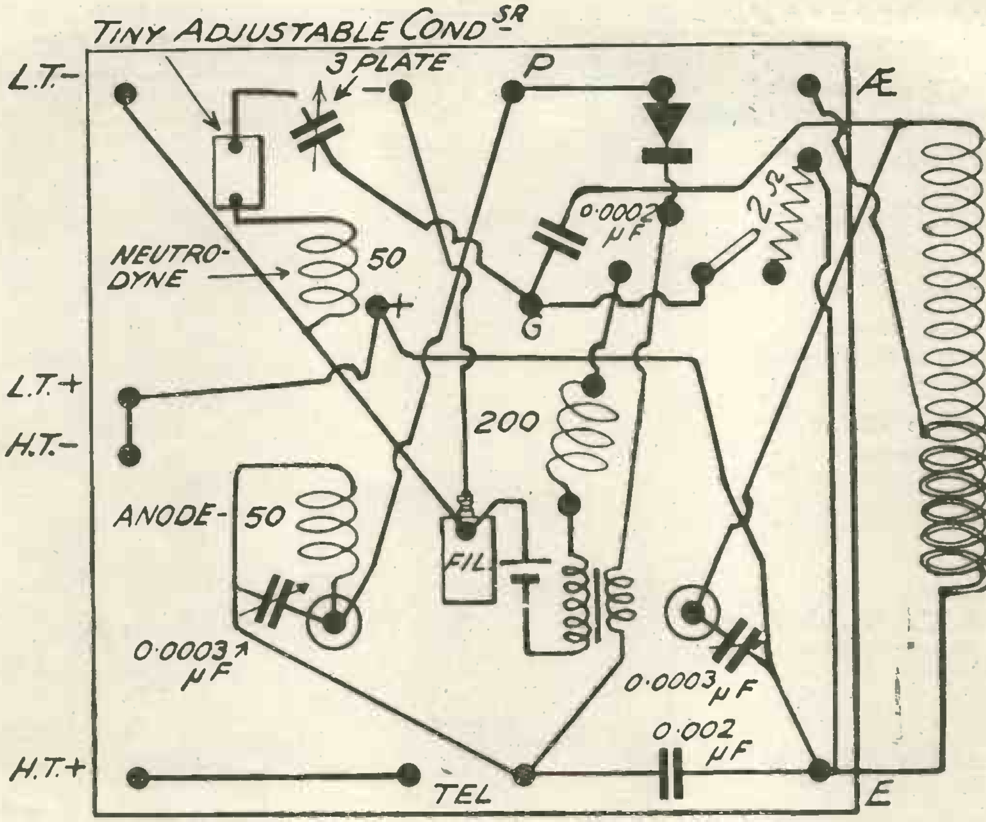
Examination of the circuit diagram will show rather an unusual type of aerial coupling, and a mode of introducing the L.F. impulses on to the grid which has been described several times, and is actually used in certain commercial dual receivers, but which has apparently not reached, as yet, the popularity it deserves, maybe on account of the extra radio-choke it involves. This latter method shows not only a great immunity from howling, and the effects of neighbouring A.C. mains, etc., but also permits the use of a small condenser in the grid circuit to by-pass the radio-frequency but stop the audio-frequency impulses, and gives most excellent signal strength with any make of L.F. transformer which has a good step-up ratio and adequate primary winding.

The aerial tuning is of an extremely selective type, with "wave-meter" tuning of the main inductance, with which the writer has obtained many interesting results lately. Almost incredible selectivity results, together with a curious indifference to aerial characteristics, so that both for wave-length and for reaction control the effect of suddenly throwing on and off a full-sized outside P.M.G. aerial is hardly felt at all. This makes possible the desirable feature of condenser scales graduated directly in wave-lengths (or stations), in place of meaningless or arbitrary degrees. In the instrument described here, both A.T.C. and anode condenser scales are marked directly in stations, with the help of a wave-meter and the B.B.C. transmissions themselves ; so that any station can be found in a few seconds. If searching is necessary, it should be carried out with single valve alone, the dual action being eliminated temporarily by throwing over the switch shown so that the grid is connected via the customary two-megohm leak to the L.F. plus, in place of to the L.F. transformer via the radio-choke. The margin between steady oscillation and howling is too small in a dual receiver to allow of comfortable searching in the dual position.

Of other details, the placing of the phones blocking condenser across the H.T. battery as well (common American practice) is merely a matter of convenience in actual wiring. It were well to have a 1-3 microfarad blocking condenser across the H.T. battery itself, particularly when the battery is old.

Constructional Details

As each constructor has his own ideas as to the style and size of cabinet, if any, in which he finally mounts his set, only the panel details are given here, together with a bare frame for use in the experimental stage to hold the

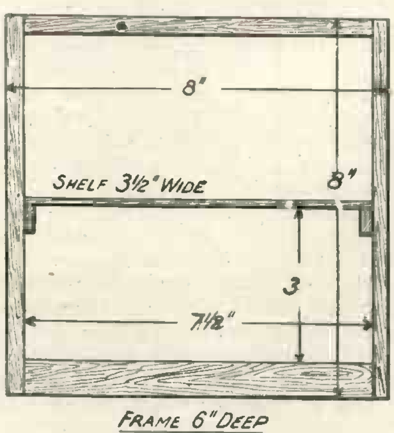


This picture will guide the home constructor in wiring up his receiver.

inductances and L.F. transformer, and perhaps to form a loose insert in a finished cabinet or carrying-case. The panel has been kept as small as possible (8 in. square) with the result that the components are somewhat crowded. Provided that the matter of casual magnetic couplings, discussed above, is borne in mind when trying out other distributions of the parts, and that grid connections are kept as short as possible, the whole could be rearranged at will for greater convenience.

The two tuning condensers can be .0003 or .0005 μF ; the neutrodyne adjustable must be a low minimum three-plate "vernier." Those in the set illustrated were the convenient one-hole fixing type supplied at a moderate price by the Wireless Traders Supply Co.

The principal real difficulty in constructing the receiver is offered by the second small fixed condenser in the neutrodyne circuit. The minimum capacity of ordinary vernier condensers is considerably too high for use here alone ; the capacity must be effectively diminished, whilst at the same time retaining the variable feature, by introducing in series a tiny fixed condenser. The value of this depends on the extent of casual couplings present, the particular valve used, etc., etc., so cannot be stated dogmatically. In the author's receiver it had to be made



Box details.

of the order of .00005 μF—three foils with about ¾ square inch overflap for each pair, and quite thick mica between, sufficed, mounted in an otherwise worthless "cheap" condenser shell. It is entirely a matter for careful experiment and adjustment ; the point to aim at, after completing all the rest of the receiver and finishing all wiring, etc., is to have violent oscillation (even to the howling point, with the neutrodyne variable condenser at zero, and cessation of oscillation before the 180 degrees mark, over the whole wavelength band. This may not be possible with critically tuned anode in the single-valve circuit alone ; but *must* be achieved in the dual position. Too large a neutrodyne condenser will bring in a fresh set of howls. Of course, all this adjustment is made on the bench, without aerial connection at all. Tiny variable condensers of extremely low minimum are on the American market, as the result of the growing popularity of the neutrodyne on the other side. It may be possible to come across a suitable one here ; many may desire to experiment in this direction themselves, in which case a *single* small adjustable condenser will do the work. The total capacity required is only a few micro-micro-farads.

The A.T.I. has on a 3½ in. diameter former of waxed cardboard ten turns of doubled No. 20

S.W.G. d.c.c., (i.e., two wires laid side by side and connected in parallel). This is to avoid using a few feet of much larger gauge wire, such as No. 15-18, which is sometimes hard to procure. This forms the (semi-aperiodic) actual aerial coil. It is then continued, auto-transformer fashion, for 60 turns more, single layer, and in the same direction, making in all 70 effective turns across the tuning condenser. The anode inductance has 50 turns of No. 22 S.W.G. d.c.c. wire, two-pile wound, on a 3½ in. diameter former. A second exactly similar coil, close to but not connected electrically with the first, forms the neutrodyne coil. These are connected up as shown, so that the middle or inner end of each is near "earth" electrically. As the two coils are wound on in the same direction, they will oppose each other's effects on the grid, as desired.

The radio-choke can be any available coil of fairly low distributed capacity, such as a No. 200 to 300 plug-in coil of ordinary type; a frame-aerial type of coil with ¼ lb. No. 26 S.W.G. d.c.c. wire (about 250 turns); or a simple single-layer coil 3 in. by 3 in. of No. 32 S.W.G. enamel-covered wire, about 200-240 turns. About 2 oz. of the No. 32 will suffice; and ½ lb. No. 20; ¼ lb. No. 22.

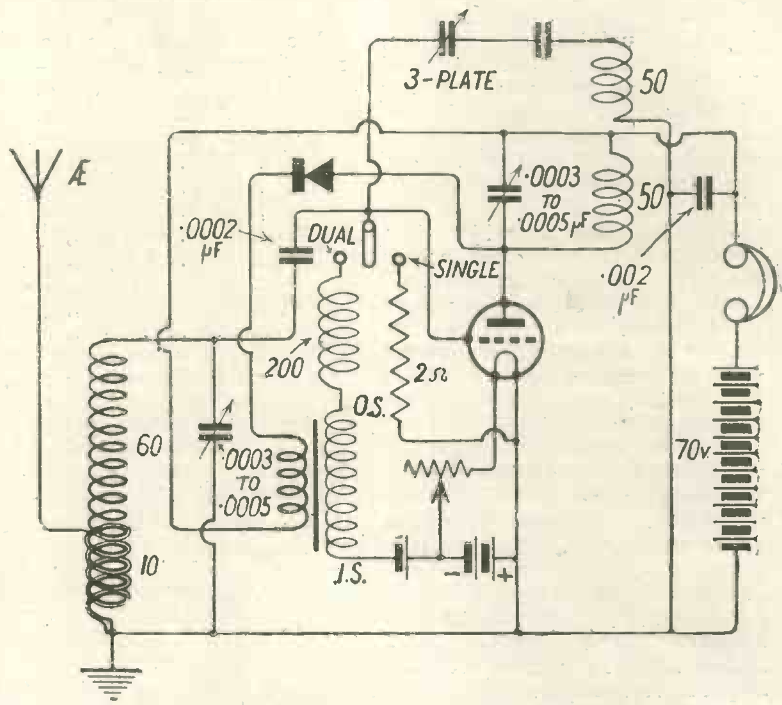
The fixed condensers are ordinary Grafton clip-in; the grid-leak is of the usual value, actually also a Grafton, as is the small switch. For compactness and smooth control, a D.E. type of T.C. Ball filament resistance is used. The valve actually employed is the low-capacity Myers, 4-volt type, which has an extraordinarily generous filament emission for its filament current. This fits very compactly in its special clips (which are provided with each valve) on the front of the panel. As the valve is extremely robust, it was not thought worth while to enclose it here. The circuit actually works successfully with any hard R type of valve.

For the crystal detector, careful experiment showed that the extra sensitiveness of galena or other types did not justify their use in this powerful circuit, where stability must be the first consideration; so the simple and reliable carborundum was used. It does not need any extra applied potential when used in this position. With a firm contact with a springy piece of tinned iron (ordinary "tin"), the fragment of carborundum being set in a cup with Wood's metal in the usual way, absolutely no attention or further adjustment is needed. It is not really necessary to have the crystal in such an accessible position in practice. (The carborundum is next to the plate.)

In the experimental instrument shown, the panel is simply mounted in front of a frame 8 in. square and nearly 6 in. deep, with a narrow shelf on which the tuning inductances are supported, the L.F. transformer, radio-choke, and grid-bias cell finding accommodation below this shelf. The base-board is of ½ in. soft wood, 7½ in. by nearly 6 in.; the two sides of ¼ in. hard wood each 8 in. by nearly 6 in. The shelf is 3½ in. wide; and there are two strips of wood across the top to support the panel and keep all secure. The tiny adjusted neutrodyning condenser, in series with the vernier, is placed in an accessible position just inside the top. In a more ambitious version it might well be mounted directly behind a larger panel.

A small 4-volt accumulator and from 60 volts upwards of H.T. are required.

Any kind of an aerial with an earth connection can be used, probably a frame also, though that has not been tried yet. Of course, the higher the better; but the operation of the receiver is peculiarly independent of the type of aerial, within limits.



The theoretical circuit diagram

Actual Performance

The receiver illustrated gave, with the equipment described, and with a good suburban P.M.G. aerial, the loudest signals that the writer has ever succeeded in getting with a single valve on any circuit or aerial.

In the Children's Hour of 2LO, the pleasant voice of one of the Aunties, in speech alone, was clearly audible all over the house with the help of an Ultra loud-speaker; and by placing the loud-speaker at the open window, was audible at the other end of a large garden. On a favourable night every one of the B.B.C. stations (except Aberdeen, who was hopelessly jammed out by Morse) came in at comfortable strength on the phones in turn, with remarkable selectivity. Manchester was actually readable in London whilst 2LO's wave was on, but no audio modulation, Bournemouth being separable with ease from London.

In a preliminary bench hook-up, extremely favourable results were obtained with a Pye No. 1. L.F. transformer in this circuit; in the receiver shown, an Igranic old-type is used for economy of space.

The Correct Adjustment of High Tension Voltage, Filament Current and Grid Potential

By JOHN SCOTT-TAGGART, F.Inst.P., A.M.I.E.E.,

An article of interest to every user of a Valve Set

POOR amplification, distortion, imperfect rectification and howling, are merely a few of the troubles experienced by the man who does not trouble to adjust his high-tension voltage, his filament current and the grid potential correctly.

There is more in the subject than merely telling the experimenter that he will only get the best results if he correctly adjusts these three factors. He ought to know why it is that so much depends upon the correct adjustment of the high-tension, the filament current and the grid potential.

It is important to know the meaning of characteristic curves because they greatly facilitate the understanding of the action of the valve, although many seem to be greatly scared at the word and imagine that they are entering the realms of abstruse mathematics. Nothing is further from the truth, and the following explanation should help the veriest tyro.

The Characteristic Curve

A characteristic curve indicates, graphically, how, by varying something, a certain effect is obtained. Take, for example, the case of the simple circuit illustrated in Fig. 1.

This circuit contains a battery B, which we will suppose is variable in steps of 1 volt, a resistance R, and a measuring instrument A, graduated in amperes.

We will find, with a circuit of this kind, that the greater the voltage, the greater will be the current flowing in the circuit. For example, if we have the tapping at the left-hand side of the battery B, so that only 1 volt is used, we will find that the current is, say, 1 ampere, as indicated by the ammeter A. If, now, we increase the voltage to 2 volts by readjusting the tapping on the battery B, we find that the current is 2 amperes; the use of 3 volts will give 3 amperes, and 4 volts will result in 4 amperes of current flowing round the circuit.

We can tabulate the results of 10 adjustments as follows :—

Volts.		*Current.*
1 volt.	..	1 amp.
2 volts	..	2 amps.
3 ,,	..	3 ,,
4 ,,	..	4 ,,
5 ,,	..	5 ,,
6 ,,	..	6 ,,
7 ,,	..	7 ,,
8 ,,	..	8 ,,
9 ,,	..	9 ,,
10 ,,	..	10 ,,

We can show the above results in a much better way by what is known as a "curve." Fig. 2 shows a curve indicating, graphically, the results obtained in the above table. We first of all draw two lines, O X and O Y at right angles to each other, as shown in Fig. 2,

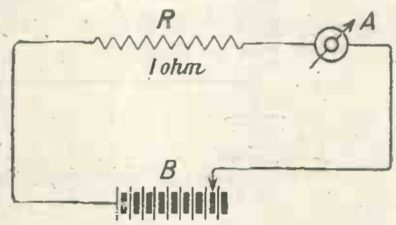


Fig. 1.—The apparatus for the first experiment.

and we mark along the line O X ten equal markings, to represent volts, and along the line O Y, we mark ten equal spaces to represent amperes. We now look at our table and find that one volt produces one ampere of current; we draw a vertical line 1A, through the point marked 1 on the line O X; we also draw a horizontal line through the point 1 on the line O Y; where these two lines cross, a cross is marked, and this is lettered A in Fig. 2. The point A represents the conditions in the circuit when 1 volt produces 1 ampere. We now look at the next line on our table, and find that 2 volts results in a current of 2 amperes. We draw a vertical line through 2 volts, and a horizontal line through 2 amperes and mark the point where the two lines meet. This point is lettered B in Fig. 2.

The same is done in the case of every observation in the table, and the result is that we get a series of crosses, A, B, C, D, E, F, G, H, J, K.

All these points are joined together by a line O, A, B, C, D, E, F, G, H, J, K, and this line may be called the "characteristic curve" of the circuit. In other words, it shows the effect of variation of voltage on the current flowing in the circuit.

A useful feature of this characteristic curve is that we can see at a glance what current will be produced by any voltage, even though that voltage may not have actually been tried when compiling the above table. For example, if we desire to know what current will be produced by 6½ volts, we find the point L, which is 6½ along the line O X, and draw a vertical line through L and make a cross where it cuts the line O K. If we now draw a horizontal line through this cross to cut O Y, we will find that this horizontal line cuts the ampere line at 6½ amperes, which is therefore the answer to our problem.

It is to be noted that the line O K is still called a "curve," even though it is straight. In most cases, however, characteristic curves are not straight lines. In the case of thermionic valves, the curves are of a peculiar shape, and we will now consider the characteristic curve of a three-electrode valve.

Characteristic Curve of a Three - Electrode Valve

In the case of a three-electrode valve we are primarily concerned with two variable quantities—grid voltage and anode current. The circuit is not quite the same as that of Fig. 1, even in principle, because in Fig. 1 a variation of voltage causes a change in the current in the same circuit, whereas in the case of a three-electrode valve it is the effect of a varying grid voltage which produces changes in the anode current which is flowing in a separate and distinct circuit of its own.

Fig. 3 shows a circuit for demonstrating the action of a three-electrode valve, and for making up the characteristic curve from certain observed facts. On the left of the circuit we have a battery B_3 and a resistance R_2, which latter has a value of about 400 ohms. The middle point along this resistance is taken to the grid G of the three-electrode valve. A sliding contact S_1, which can move along the whole of the resistance R_2, is connected to the negative terminal of the filament. It will thus be seen that when S_1 is below the point M the grid is positive with respect to the filament, and when S_1 is above M the grid is made negative. Any desired grid voltage may therefore be applied to the grid, and the effect on the anode current noted. This latter anode current is measured by the milliammeter I.

The following table was actually compiled from tests carried out with a typical modern valve.

Grid Volts.		Anode Current.	
— 8 volts.	..	zero	milliamps
— 7 ,,	..	0.004	,,
— 6 ,,	..	0.01	,,
— 5 ,,	..	0.02	,,
— 4 ,,	..	0.04	,,
— 3 ,,	..	0.08	,,
— 2 ,,	..	0.16	,,
— 1 ,,	..	0.24	,,
— 0 ,,	..	0.32	,,
+ 1 ,,	..	0.4	,,
+ 2 ,,	..	0.48	,,
+ 3 ,,	..	0.53	,,
+ 4 ,,	..	0.555	,,
+ 5 ,,	..	0.565	,,
+ 6 ,,	..	0.57	,,
+ 7 ,,	..	0.57	,,
+ 8 ,,	..	0.57	,,
+ 9 ,,	..	0.57	,,
+10 ,,	..	0.57	,,

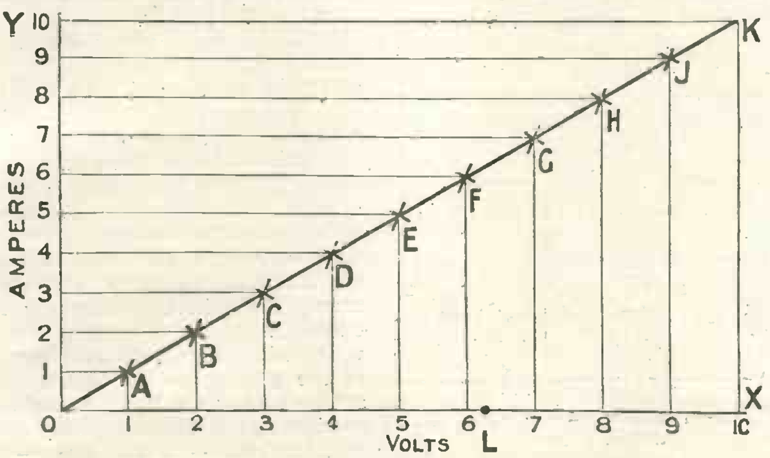


Fig. 2.—A simple " curve "

These tabulated results are drawn in the form of a characteristic curve, as shown in Fig. 4. From this characteristic curve it will be seen that there is a certain grid voltage at which all the electrons are repelled from the grid, which prevents any from reaching the anode; the result is that the anode current becomes zero at about — 8 volts on the grid. Similarly, it will also be noticed from the characteristic curve, that the anode current ceases to rise after about +5 volts on the grid.

The characteristic curve is really composed of three portions—a lower bend, a middle straight portion, and the upper bend. It may be safely stated that, in modern receiving circuits, only the middle portion is of any use; in other words, when using the particular type of valve whose characteristic curve is given in Fig. 4, the grid voltage should always be kept between —3 volts and +2 volts.

The three-electrode valve carries out two functions; it acts as a detector, and it also acts as a low-frequency amplifier. A method of detection which was frequently employed involved the operation of the valve under such conditions that advantage was taken of the bends in the characteristic curve, but as leaky grid condenser rectification is now universally employed, we can leave out of consideration the question of using the bends and simply state that for all uses of the three-electrode valve, in ordinary receiving circuits, the steep straight portion of the characteristic curve only should be used.

There are still those who seem to imagine that the bends in the characteristic curve are useful, but this is not really so. Whether the valve is to be used as a high-frequency or low-frequency amplifier, or as detector, it is desirable to work on the steep straight portion of the characteristic curve connecting grid voltage and anode current.

Low-and-High-Frequency Amplification

For the sake of simplicity, let us suppose that we are dealing with a low-frequency amplifier. Most of the distortion in a wireless receiver occurs in the stages of low-frequency amplification, and it may be eliminated or largely eliminated by understanding the principle of the characteristic curve.

In the first place, it must be realised that the anode voltage, filament current, and grid potential must all be correctly chosen to give proper amplification, that is to say, full and distortionless amplification.

Let us take one or two extreme cases which will show the importance of the correct values of the different batteries. If too low a filament voltage is used, the filament will be dull, and only a small number of electrons will be shot off from it; the emission from the filament, being so low, is insufficient to operate the valve. To get loud signals we must obtain a large fluctuation of the anode current, but if the maximum anode current obtainable is only small, due to the small emission of electrons, then obviously the valve will hardly amplify at all. Then again, if the anode voltage is too small, the electrons shot off from the filament, however copiously, will not be attracted to the anode. If, on the other hand, a very high anode voltage is used, every single electron will be drawn up to the anode and small variations of grid voltage will be unable to effect any control. The third case is where we give the grid a normal negative potential of, say, 15 volts, by means of a battery included in the grid circuit.

Fig. 5 shows a simple low-frequency amplifying valve in which a battery B_3 is included in the grid circuit for the purpose of giving the grid a negative potential. If this negative potential is in the neighbourhood of — 15 volts, it will be fairly obvious that the anode current will be entirely cut off and that variations of grid potential around — 15 volts would not affect matters in the slightest degree.

These, of course, are extreme cases, but nevertheless there are intermediate stages where improper grid, filament or anode voltages are employed, and imperfect signals are the results. The signals may be imperfect, either because the amplification is feeble, or they may be imperfect because distortion is introduced. The two troubles very frequently come together.

To obtain full amplification, without distortion, a positive impulse on the grid of, say, 1 volt, should produce an increase in the anode current exactly equal to the effect of a negative impulse of the same strength on the grid. When dealing with high and low-frequency amplification, the grid is being made alternately positive and negative, and to obtain distortionless amplification, the rise and fall of the anode current should be in exact ratio. If the characteristic curve between the two bends is straight, good results should be obtained, but if the characteristic curve is bent, obviously no adjustment of potential will enable pure amplification to be obtained. Some valves have straight characteristic curves, but others frequently have curves which introduce a small amount of distortion. We will, however, assume, as is usually the case, that the characteristic curve between the two bends is straight.

A Common Fault

A common fault, when amplifying low-frequency currents, for example, when using a loud-speaker, is to "force" the valves. This means that you are trying to get more out of a valve than it will give. Looking at the characteristic curve of Fig. 4, we will assume that the grid potential is zero. We are now working without any grid battery in the grid circuit, and by glancing at Fig. 4 we will see that if the grid potentials exceed 2 volts in a positive direction, the amplification of the positive impulses on the grid will not be fully developed and will be distorted. This is because the characteristic curve bends over at the top and every additional volt on the grid only produces a small increase in the anode current; this results in imperfect amplification and distortion, because every volt increase or decrease should produce an equal change in the anode current As a matter of fact, when using the curve of Fig. 4, distortion would not occur on the negative impulses until these exceeded 3 volts in magnitude. If we have a fluctuation of 5 volts positive and negative, on the secondary of an intervalve transformer, just before the last valve, say, of a receiver, the distortion will be very bad because both upper and lower bends of the characteristic curve will come into play and distortion and a poor degree of amplification will be obtained in the case of the last 2 or 3 volts positive or negative.

From this it will be seen that not only is the straightness of the curve an important factor, but also the length, and the length depends very largely upon the emission from the filament. Some valves are specially designed with a large emission, for use in high degrees of amplification, as in the case of power amplifiers so designed to operate loud-speakers. In the case of an ordinary valve, it is possible to obtain a longer characteristic curve by increasing the filament current, and also, simultaneously, increasing the high-tension voltage. The increase of filament current, however, very greatly shortens the life of the valve, and is not to be recommended. It is also to be noticed that, for reasons to be explained later, a negative potential on the grid becomes necessary.

Effect of Increasing H.T. Voltage

The effect of increasing the high-tension voltage is to move the characteristic curve to the left, so that it occupies a position somewhat similar to that shown in Fig. 6. A new characteristic curve is produced and this curve lies to the left of the original one. It will be seen that if the characteristic curve is to be employed on the steep straight portion, and somewhere about the middle of this portion of the curve, it will be necessary to give the grid a negative potential. If the grid remains at zero volts by dispensing with any grid battery, it will be seen that we are operating the valve near the upper bend, and that any positive potentials applied to the grid would remain substantially unamplified, thus resulting in distortion and loss of signal strength.

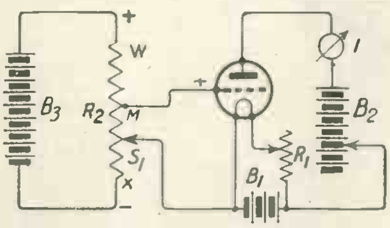


Fig. 3.—Apparatus for demonstrating action of valve.

Looking at Fig. 6, it will be seen that a negative potential of about—4 volts will be necessary to operate the valve as an amplifier effectively. This negative potential on the grid may be applied by means of a grid battery B_3, as shown in Fig. 5, and this is generally known as "grid bias," or grid base-line potential. This negative potential is desirable in all cases, and it is particularly necessary when a high anode voltage is employed. A decrease of anode voltage results in a new characteristic curve which lies to the right of the one shown in Fig. 4. This new characteristic curve does not slope as steeply as the others, and the degree of amplification is therefore less; moreover, the curve is very unsuitable because the operating point on the curve approaches too closely to the lower bend—the exactly opposite effect of the curve of Fig. 6, obtained by increasing the high-tension voltage.

Effect of Grid Currents

When amplifying high or low-frequency currents, the grid, as previously stated, is given both positive and negative impulses. If the normal grid potential is zero, *i.e.*, no grid battery is used, the grid may become as much as 1 or 2 volts positive with respect to the filament, and when this takes place, electrons will be attracted to the grid itself, and will flow round the grid circuit. When the grid is given a negative potential, however, the grid would repel any electrons and consequently, during the negative half-cycles, there is no grid current. As, however, a positive potential on the grid will draw electrons round the grid circuit, the grid current will have a damping effect which will prevent the building up of the grid potentials to the full amount. For example, if the incoming signal tends to vary the grid between + 2 volt and — 1 volt, while the — 1 volt will be fully developed on the grid, yet the grid will never attain the full potential of + 1 volt, owing to the immediate setting up of a grid current when the grid potential rises above zero. The effect is rather similar to that of a pendulum which is swinging, partly in air, and for one portion of its stroke in water. A similar effect is noticed in the case of a battery, or accumulator; the voltages across the terminals, as given by a voltmeter may read 6-volts, but when a lamp is connected across the terminals and a substantial current taken from the accumulator, the voltage may drop to 5¾ volts.

Ineffective Amplication

In the case of a three-electrode valve amplifier the damping of the positive half-cycles results in ineffective amplification, and also very considerable distortion.

To overcome this effect, it is necessary to prevent the grid ever

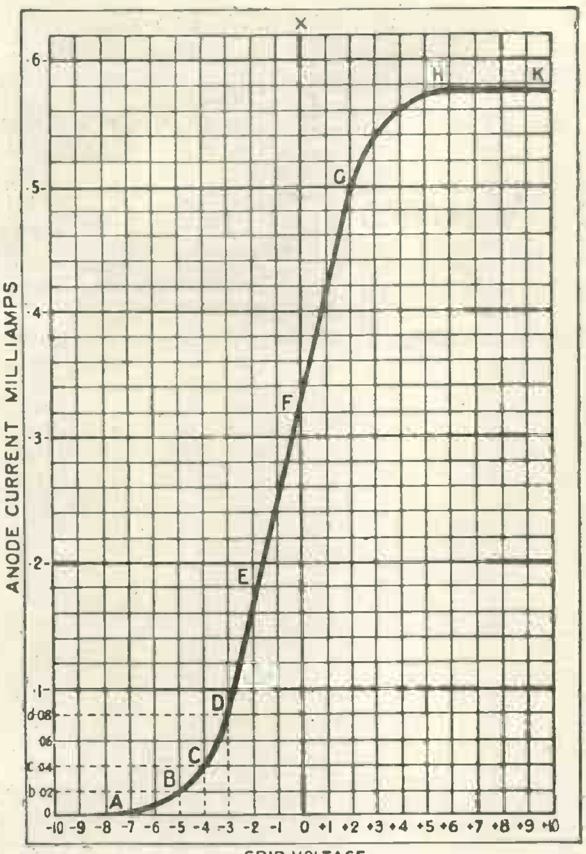


Fig. 4.—A typical valve characteristic curve.

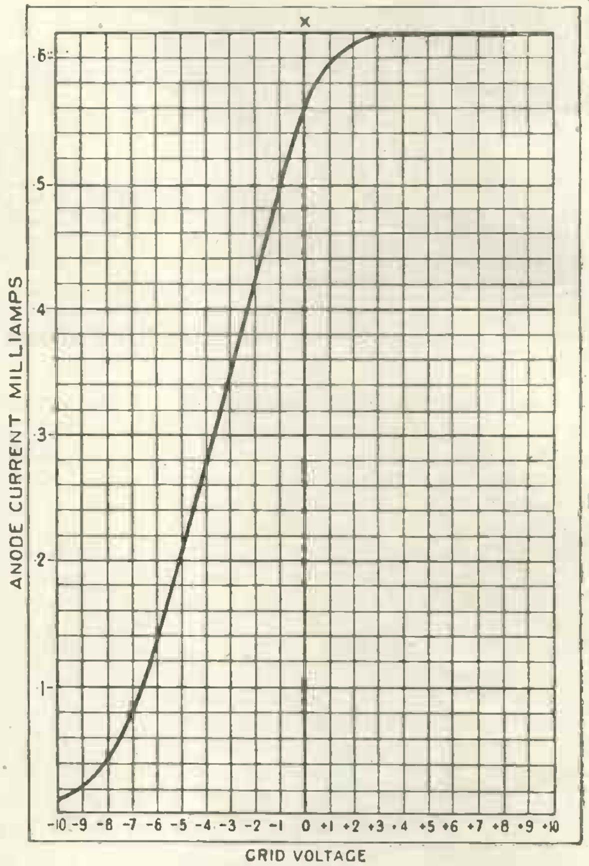


Fig. 6.—Correct curve for amplification.

rising above zero volts, and to do this we give the grid a negative potential of 1 or 2 to sometimes as much as 20 volts negative, according to the type of valve used and the value of the high-tension voltage. If we used the characteristic curve shown in Fig. 4 and gave the grid a normal negative potential of — 3 volts by the use of a couple of dry cells, we would very obviously be doing a very foolish thing, because the operating point would now be near the lower bend of the characteristic curve, and although it is perfectly true we would not have any grid current, yet there would be considerable distortion and imperfect amplification of the negative half-cycles. On the other hand, if we gave the grid a negative potential of about —1 volt, beneficial results might be obtained, although when the signals to be amplified are not very great, negative grid bias is not so very important because the grid currents are only small. As a matter of fact, sufficient negative grid bias is usually obtainable for connecting the grid circuit to the negative terminal of the filament accumulator, and connecting a filament rheostat in the negative lead. This effect would be obtained in Fig. 5 if the battery B_3 were removed and the bottom of T_2 connected to the negative terminal of B_1.

It is therefore very important to see that there is a correct proportion between the negative grid bias and the high-tension voltage.

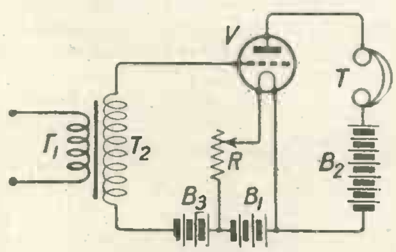


Fig. 5.—How negative bias can be applied.

Grid current should be certainly avoided, but it is not sufficient merely to add grid bias without increasing the high-tension voltage at the same time. The ideal state of affairs is to have the whole of the characteristic curve to the left of the vertical line through zero grid volts and to apply such a negative potential to the grid as will bring the normal operating point to about halfway along the steep, straight portion of the characteristic curve. These conditions are fulfilled in Fig. 6 when the grid is given a potential of — 4 volts.

Points When Using A Detector Valve

When using a leaky grid condenser for rectification purposes, on no account should any negative potential be applied to the grid. The grid should always have a potential in the neighbourhood of zero volts, because when rectifying, the very effect which spoilt low-frequency amplification is essentially desirable. Too high a high-tension voltage will result in poor rectification, and therefore it is really desirable that a considerably lower anode voltage should be applied to a detector valve than to a low-frequency amplifying valve. In order to simplify sets, a single source of high-tension voltage is employed, and 2 H.T. terminals provided, but if the utmost efficiency is to be obtained, separate H.T. terminals should be employed, one being used for the detector valve and the others for the amplifying valve.

Readers Views

To the Editor, MODERN WIRELESS.

SIR,—I have much pleasure in announcing to you my success on Friday night last (29th) in picking up "WGY," Schenectady, New York, at about 11.40. I clearly heard the whole programme, ending at 3.45, on your all-concert circuit, using Burndept short-wave coils. The speech at times was so perfect that I could very well have used a loud-speaker. I used a red-tipped Cossor for H.F. and a repaired Mullard as a detector and Mullard Ora for low frequency. As you were so recently discussing the question of valves and different circuits, etc., and seemed so decidedly modest regarding your own particular circuit, I feel more than justified in adding my modest but full-throated praise of it, and would not exchange it for any 7-valve set.

Yours sincerely,

E. R. BOLTON.

Wembley.

To the Editor, MODERN WIRELESS.

SIR,—I thought that you would like to know that I receive all B.B. stations on a home-made loud-speaker, using the ST. 75 circuit described in MODERN WIRELESS, No. 8. The loud-speaker is a gramophone horn with a 4,000 ohm phone clamped on to the end, which gives very clear signals without any sign of distortion. The valves I am using are a Cossor P2, and a Marconi-Osram R, which I find work very well in this circuit. For A.T.I. I use a coil of 35 turns with a .001 VC across. Anode coil 60 turns with a .0008 V.C. across. Reaction coil 100 or 75 turns. The above coils are wound on 2-in. formers and are the plug-in type. I am only using a 4 volt 30 amp. accumulator, and 70-90 volts H.T. I find that this circuit is very stable, and will receive 2LO without aerial or earth (2LO is about 31½ miles away). On the 12th December I received W.G.Y; the speech from this station was faint but very clear.

I think that the ST. 75 circuit equals many 3- or 4-valve sets of the ordinary circuit design. Thanking you for such a splendid circuit.

I remain, yours faithfully,

R. W. G. CHANDLER.

Farnborough, Hants.

To the Editor MODERN WIRELESS.

SIR,—You ask for reports *re* your Double-Dual Circuit as described in the March issue. I have made up this circuit on my Omni receiver and have adopted the choke-coil method—using the secondary of one of the intervalve transformers. Results are very satisfactory. I find the circuit much more selective than the S.T.100, and can get most of the B.B.C. stations on the loud speaker as well as the Ecole Supérieure *whilst 2L.O. is working*. This I found impossible with the S.T.100. I find no appreciable difference in adjusting either the 100,000 ohm variable resistance or the gridleak across the grid of the second valve and the accumulator. The circuit is by no means so stable as the S.T.100 and is liable to break into oscillation very freely. The adjustments of the variable condensers and coils are most critical. I am situated six miles S.E. from 2LO. Aerial, single, 60 ft. and 35 ft. high, directional N.E.

Yours faithfully,

R. D.

Streatham,
London, S.W.

To the Editor, MODERN WIRELESS.

SIR,—It may be of interest to you to hear that I have constructed the "Simple Reflex Receiver" described in your January issue, and that I am getting excellent results.

Using a 35 Igranic coil on the aerial circuit and a 50 coil of similar make on the anode, the local relay station comes in sufficiently loud to render de-tuning necessary. At the same time I have no difficulty in cutting the local station out, and can tune in to Cardiff, London, Manchester and Bournemouth any night after dark, without any difficulty.

On one or two occasions I have heard Newcastle, though only faintly.

The other four stations I have mentioned come in at comfortable strength, Bournemouth being the best, although I am only about 30 miles from Manchester.

No doubt by using 50 and 75 coils I shall be able to tune in some of the other B.B.C. stations; this will be my next experiment.

I found the receiver delightfully simple to construct, and its capabilities are far greater than Mr. Harris' article led me to expect.

Yours truly,

G. M. E.

Sheffield.

To the Editor, MODERN WIRELESS.

SIR,—An interesting little experiment was performed by my neighbour and myself this evening. During the broadcasting of the news bulletin voices besides that of the announcer were audible in my loud speaker, and after mystifying me for some time, I was certain I recognised one voice as that of my neighbour, who, by the way, has only a crystal set. This proved to be the case, and by getting him to speak into his 'phones, his voice was distinctly transmitted by my "Amplion."

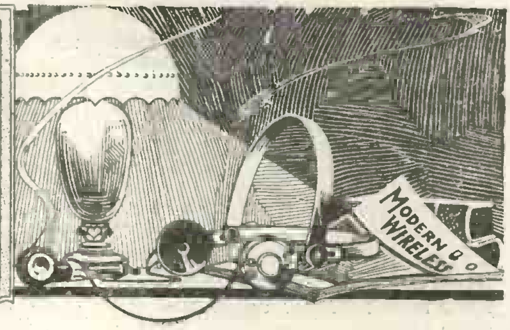
The fact that our respective aerials are one below the other—about five feet apart—doubtless accounts for this broadcasting in miniature. Incidentally it was only possible to hear his voice whilst 2LO were transmitting.

I trust I have not unduly wasted your time by this letter, but, as I have never seen anything of a similar nature mentioned in MODERN WIRELESS, thought you might be interested.

Yours faithfully,

CHAS. F. JONES.

London, S.E.20.



Getting the Most From Your Set

By G. P. KENDALL, B.Sc.,
Staff Editor

WITH any properly designed set built with good parts it is undoubtedly easy to obtain *fairly good* results, but to go further and get the best possible from any given receiver is another matter, and the effort to do so provides the operator with an almost infinite opportunity for the acquisition and use of skill and knowledge. Herein, I think, lies one of the greatest charms of wireless as a hobby: every increase in the skill of the user enables him to get better and better results from his set, and more and more pleasure in observing its response to his greater understanding of it. Here, too, is to be found the explanation of the curiously varying results obtained by different users of the same type of set upon aerials of roughly equal efficiency.

Now, getting the best from your set is an expression with a rather comprehensive meaning, since it may be taken to include three distinct aspects of the question, namely, the reception of long distance stations, getting the best and purest reproduction of music, and maintaining the set and its accessories with the minimum outlay. It will probably clear the ground for the consideration of the other two if we consider the details of the third aspect first.

Batteries

The principal cost of maintaining any kind of valve set is that involved in the upkeep of the batteries, and much more care might well be devoted to keeping them in good condition than is usually their portion. The subject of accumulator maintenance is, of course, a large one, and space will not permit me to treat it fully here. The essentials to good service from an accumulator are these:—

(1) A battery of good make,
(2) Proper charging,
(3) Considerate discharging.

The first essential is fairly obvious, but it cannot be overemphasised that the cheap type of accumulator is dear at any price. Only a battery of one of the really good makes will stand up to the strenuous service of running a valve set for long periods every night. Few amateurs have facilities for charging, and therefore the second essential resolves itself into a question of finding a reliable charging station. Avoid as you would the pestilence the small garage where they test batteries by flicking a wire across their terminals, and try to find a place where they do it with a hydrometer and there is a properly qualified man in charge.

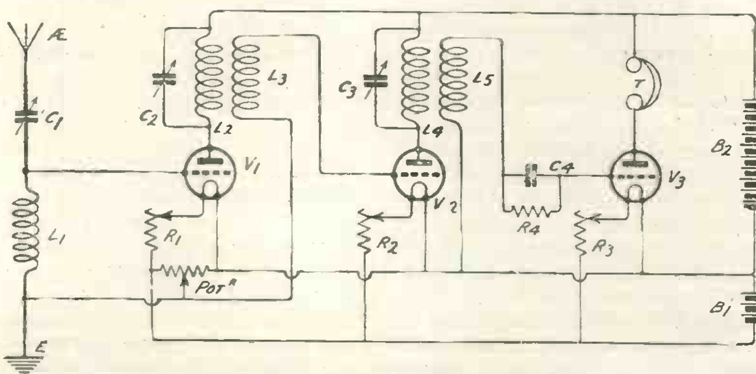


Fig. 1.—The usual method of adjusting the grid potential.

The question of discharging is entirely in the user's hands, and the most important points here are not to run the battery down too far before re-charging, or too rapidly. Every user of accumulators should possess one of the bead type hydrometers for rough testing, and should use it religiously to see that he is not over-discharging the battery. The injunction not to run the accumulator down too rapidly really resolves itself into a warning against too small a battery. If the accumulator is not large enough for the load which is put upon it, not merely will the cell itself suffer damage, but its service will be unsatisfactory. The voltage will fall rapidly, upsetting the adjustments of the set, and parasitic noises are likely to be heard.

The actual size to use obviously depends upon the number and type of the valves employed, and the best rule is to fix the minimum capacity of the battery by adding up the current taken by the valves and multiplying this by twelve, the result being the *actual* ampere-hour capacity.

The dry cells used for the filament supply of dull emitters and the H.T. supply of all types of valve need less care, but there are nevertheless a few points to be kept in mind if they are to give good service. For example, they should be kept cool, nothing being more harmful to their health than to let them be warmed by a fire or the sun.

The dry cells used for the filaments of dull emitters must be quite as carefully chosen as to size as the accumulator for high temperature valves, since the use of a battery of too low a current capacity will cause endless annoyance from unstable adjustments and noises. Incidentally, I should like to take this opportunity of warning my readers against attempting to use dry cells for the type of dull emitter of intermediate consumption, taking from a quarter to a third of an ampere. If more than one of these valves are used, only a very large dry battery is of the slightest use, and it should be made a rule to feed them from a two-volt accumulator. Quite a small one will serve, and will need charging at relatively long intervals only.

Care of Valves

Apart from the obvious necessity of treating valves with the respect due to their fragility, the most important factor in prolonging their lives is the proper adjustment of their filament current. Always give them the *minimum* current which is consistent with good reception, and pay special attention to this point in the case of dull emitters. Remember that D.E. valves can have their special properties entirely destroyed by being run for a while at too high a temperature, and that the lives of all valves are shortened by excessive filament current. In the case of low temperature valves, also, care should be observed not to exceed the H.T. voltage specified by the makers, since here again there is a possibility of injury to their special properties.

Bright emitters, on the other hand, are usually more hardy in this respect, and a valve which will not stand up to 200 volts upon its plate can hardly be regarded as of good quality.

General Maintenance Notes

The two principal enemies of wireless gear are dust and damp, and of the two the latter is the more serious. Damp in tuning coils, for example, may cause extraordinarily far-reaching trouble, some of whose symptoms are weak signals, flat tuning, interference between stations which can normally be separated, and erratic reaction effects. Hence the set should be installed in a dry place, and if any of the troubles mentioned appear in damp weather, the obvious remedy of gentle drying before a fire should be adopted.

Dust is chiefly harmful when it settles upon a panel and provides a nucleus for the condensation of a conducting moisture film; a good-sized camel hair brush and regular periodical dusting of all exposed surfaces is advised. Special attention should be paid to keeping crystal detectors free from dust, and here prevention is most decidedly better than cure. Use a glass-enclosed detector if possible, and failing that make some sort of cap or cover for the crystal, even if only a paper one. Watch the cat-whisker, also, and see that its point does not become tarnished. Should it do so, snip off a fraction of an inch with scissors, or use a fine file.

Needless to say, all interior wiring should be soldered, but if a set contains unsoldered joints they should be inspected at intervals, and any which appear tarnished or corroded cleaned, lightly smeared with vaseline, and screwed up again with pliers. All points of rubbing contact, such as switch studs, rheostat and potentiometer arms, etc., should also be watched, and cleaned at intervals with emery paper so that they are always bright and free from tarnish. A little vaseline here, too, is most helpful in preserving their clean surfaces and actually seems to *improve* the contact between sliding parts.

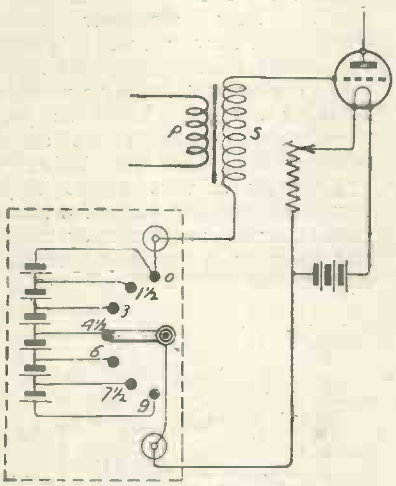


Fig. 2.—How to apply negative grid bias.

The aerial and earth must be given their due share of attention, and this point is especially to be commended to the notice of those who live in the smoky and corrosive air of industrial towns. Clean the aerial insulators at intervals, inspect the joints at the leading-in insulator, and keep an eye on your earthing arrangements, especially in dry weather.

Operation of Valves

Just as the valve is the most important single component in the receiving set, so is its proper adjustment the key to success in reception. Unfortunately, it is not possible to be very explicit here, since valves vary in their requirements, and the best that can be done for the reader is to show him how he may find out for himself the proper way to treat his own particular valves.

There are three factors which must be adjusted before a valve will do its best, and these are filament current, anode voltage, and grid potential. Since these will be different for valves performing different functions, they should be made independently variable for the high-frequency, rectifying and low-frequency valves. In the case of a single high-frequency valve the grid potential is not very important and the lower end of the grid circuit can be joined to the negative terminal of the accumulator, or, if that produces too great a tendency to self oscillation, to the negative end or even the positive end of the filament. To secure exactly the right tendency to oscillation a potentiometer may be used to adjust the grid potential, and this is usually done in circuits employing more than one H.F. valve (see Fig. 1).

The filament current of H.F. valves must be adjusted firstly to give the loudest signals and secondly to give the smoothest control of reaction, and this can only be done by experiment. Exactly the same may be said of the H.T. voltage required, but here it is possible to be a little more definite, since it is found that the great majority of the valves in common use work well as H.F. amplifiers with about 60 volts on their plates, and this figure can be taken as a starting point.

The adjustments for the rectifier are usually fairly easily made. The H.T. voltage for best results will vary considerably with the type of valve, and may lie anywhere between 30 and 70 volts with the commoner types. Different values should be tried and the effect upon signal strength, clarity, and the smoothness of adjustment of the reaction noted. For each different anode voltage variation of the filament current should be tried until the best combination is found.

The grid potential of the rectifier need not as a rule be varied, since experience has shown that the standard arrangement of a 0.0003 μF grid condenser and 2 megohm leak connected between grid and filament positive gives results which are difficult to improve upon. It is probable that the only real use for a variable grid-leak is in one of the special circuits, or where a "soft" valve is used.

The correct adjustment of these constants for the low-frequency amplifying valves is of the greatest importance where it is desired to secure the greatest purity of reproduction and freedom from distortion, whether 'phones or loud-speaker are used.

The essence of faithful distortionless reproduction is the use of a high plate voltage and a negative bias on the grids of the L.F. valves. The great majority of the valves now in use will give excellent results as note magnifiers with from 90 to 120 volts on their anodes, and a negative bias of perhaps four or five volts. The best plan is to apply a fairly high anode voltage and then proceed to vary the negative bias on the grids (derived from small dry cells, see Fig. 2) until the best reproduction is obtained. The filament current necessary will usually be found to be somewhat greater than that required when the same valves are used as H.F. amplifiers.

The preceding notes, of course, apply only to ordinary receiving valves used for low-frequency amplification; where the best possible reproduction is wanted it is necessary to use power valves and the appropriate higher anode voltages. The subject of power amplification, however, is a large one, and could not be adequately dealt with here. A good deal of information regarding it will be found by those interested in an article by the present writer, under the title "An Experimental Power Amplifier" (*Wireless Weekly*, Vol. III., No. 14).

Tuning

Here more than anywhere else in the field of operating does skill and practice tell, and little can be done for the beginner beyond pointing out the road which he must travel before he, too, can receive WGY on a single valve set. I cannot tell him how to be a skilled operator, but I can try to show him how to teach himself to become one.

Now, the first thing which must be realised is that tuning is a two-handed job; so long as the beginner contents himself with the all too prevalent method of using one hand only and turning first this knob, then that, then the other, he will never progress, and cannot hope to join the band of elect who receive America with half a valve and no aerial. Remember that the correct adjustment which you are seeking may be, and usually is, a ratio between two variable factors, and therefore if you vary them one at a time it may be a long while before pure luck enables you to stumble upon the right settings. For example, in a set possessing a tuned anode circuit you *must* learn to vary the tuning of both aerial and anode circuits simultaneously, increasing or decreasing the capacity of the two condensers in such a way that the two circuits are kept in tune with each other as you vary the tuning of the whole set.

Similarly, whenever you alter the filament current of the H.F. or rectifying valves you will find it necessary to adjust simultaneously the reaction coupling. As the filament current is increased the set will probably start to oscillate and therefore the reaction must be readjusted before the effect of the change can be properly noted, and hence a simultaneous modification of the reaction adjustment must be carried out every time the filament current, anode voltage, or grid potential is varied.

Again, alterations of reaction coupling alter the tuning of the circuit into which reaction takes place, and therefore whenever the reaction is altered a slight *simultaneous* readjustment of tuning is necessary before the effect can be properly noted.

Use of Reaction

This heading does not mean that I am about to follow the example of a certain well-known engineer, and launch into a tirade against those who react not wisely but too well, but simply that as the adjustment of reaction has been mentioned it may be as well to explain how the adjustment should be performed.

Now, when receiving, telephony reaction is primarily intended to increase the loudness of the signals and to enable one to pick up those of far-distant stations. To obtain the loudest signals the reaction has to be increased until the set is almost but not quite oscillating, and this point is known as the "threshold of oscillation." If that threshold is crossed the set breaks into oscillation, the telephony is heard more loudly still, but much distorted and mingled with howls and whistles when the tuning is varied.

To receive very weak signals it is essential that this adjustment be made accurately, and the beginner should practise it diligently. Before doing so, however, he must see to it that his set is capable of being so adjusted, and he will find that only when the H.T. voltage, etc., is properly adjusted can he set the reaction to the desired points. If he has much too high a voltage on the plate of the detector, for example, he will find that when he pushes the set up to the verge of oscillation it is hopelessly unstable, and will not stay put.

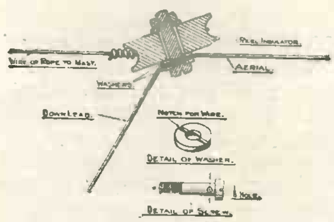
Although the adjustment just explained is the correct one when receiving very weak telephony, in that the nearer you can get to the verge of oscillation without falling over the edge the louder will be the signals, it is by no means to be assumed that it is *always* the correct adjustment. When receiving fairly strong signals the purity of reproduction will always be improved by weakening the reaction slightly.

An Aerial Hint.

AN ideal to be aimed at in aerial construction is to have an unbroken wire, free from bends or joints, right to the instrument.

Although this is not altogether practicable, anything which tends towards this ideal is desirable.

The sketch illustrates a method of attaching the aerial insulator used by the writer which allows the down-lead to be continuous with the horizontal wire of the aerial.



This construction will be welcomed by many on the ground that it avoids making a soldered joint.

It will be seen that an ordinary reel type insulator is used, and wire is clamped to it by a brass screw passing through the centre hole. The wire is shown passing between two notched fibre washers, which avoid pinching the wire.

R. J. B.

RESULTS.

To get the best results from any given set you must learn to operate it properly, as is explained in the article which ends on this page. But skill in operating may be wasted if your set is inefficient and does not respond to your efforts. One of the most important components in any kind of set is the tuning coil, and every user of coils should secure a copy of "Tuning Coils and How to Wind Them" (Radio Press, Ltd., 1s. 6d., post free 1s. 8d.), and make sure that he is using the type most suited to his requirements.

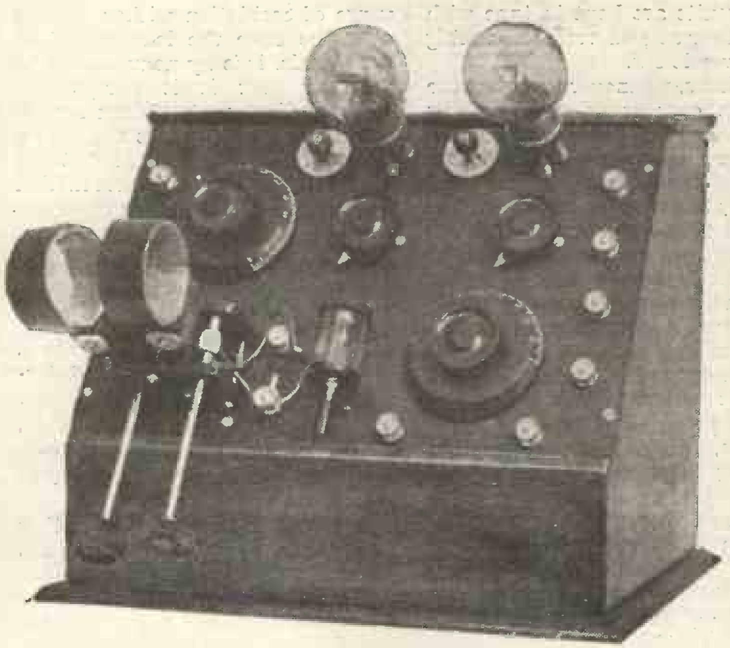


Fig. 1.—The finished S.T.100 Star receiver

An S.T. 100 Star Receiver

A Simple and Inexpensive Dual Amplification :: Instrument ::

SOME readers have experienced difficulty in the operation of the S.T.100 circuit, and this has been found to be owing to the use of unsuitable transformers, and in some cases to a faulty earth connection. The Star Circuit employs a choke coil in place of one transformer, and although it is perhaps difficult to state which is the better arrangement, the Star Circuit has given excellent loud-speaker signals up to 25 miles from a broadcasting station.

Photographs of the finished set are given in Figs. 1 and 2. On the left is the aerial tuning condenser, with the coil-holder below it. Next the condenser are the valve-holders and variable leaks, and under these are the filament resistances. At the bottom are the crystal detector and the anode tuning condenser.

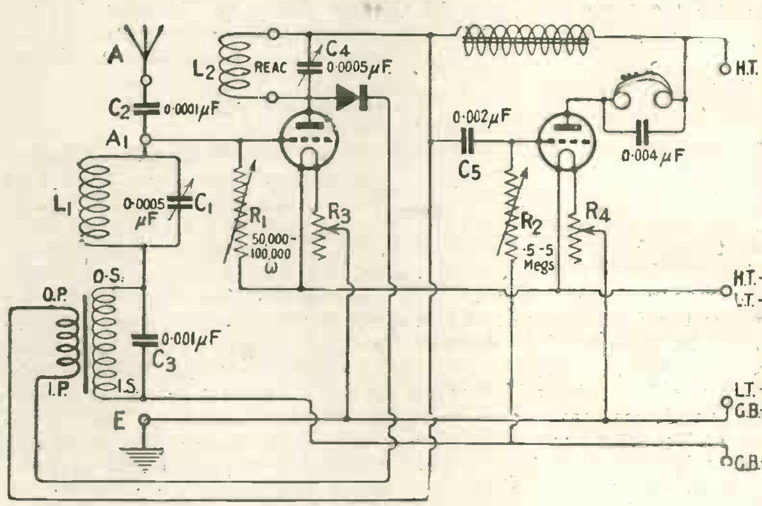


Fig. 3.—Theoretical circuit diagram showing position of choke coil.

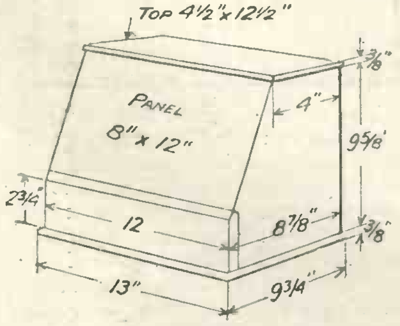


Fig. 4.—Dimensions of cabinet.

The terminals on the left are for the aerial and earth connections; those on the right for the batteries, and the telephones are joined to the two terminals at the bottom of the panel.

A circuit diagram is given in Fig. 3, and it will be seen that the aerial circuit consists of a variable condenser C_1, with a maximum capacity of 0.0005 mfd., and a coil, L_1. If desired, the constant aerial tuning system may be employed, a 0.0001 mfd. condenser, C_2, being provided for this purpose. The 0.001 condenser across the secondary of the transformer is also in the aerial circuit.

The anode circuit of the first, or high-frequency, valve contains the variable condenser, C_4, and the inductance, L_2. This circuit is tuned to the wavelength of the desired signals, which, after passing through this valve, is rectified by the crystal detector and fed back by the transformer to the first valve again, which now acts as a note magnifier. The magnified low-frequency currents are passed on to the second valve through the condenser, C_5. The telephones or loud-speaker are connected to the terminals T_1 and T_2 in the anode circuit of the second valve.

A list of the various parts

By
HERBERT K. SIMPSON

The S.T. 100 Star Circuit was described by Mr. John Scott-Taggart in the March number of "Modern Wireless."

In this article a practical form of the circuit is described.

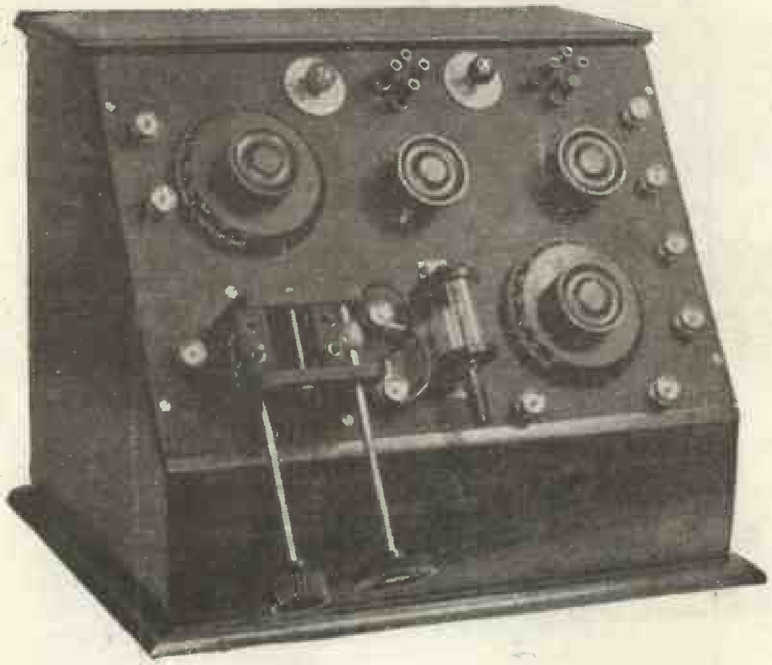


Fig. 2.—The receiver with coils and valves removed.

TEST REPORT ON THE S.T.100 STAR SET

EXCELLENT results were obtained with this S.T.100 Star set, and using the 75 ft. single wire aerial, 12 miles from 2LO, the latter station gave very loud signals on the loud-speaker. Constant aerial tuning was used, and 2LO came in on 30 degrees on the aerial condenser and 60 degrees on the tuned anode circuit condenser. A No. 50 plug-in coil was used in each case, and it was found desirable to have the 100,000 ohm variable resistance at zero, *i.e.*, full out, although these conditions might not be the same with a different type of intervalve transformer.

On a standard Post Office two wire aerial of large capacity, the aerial condenser needed readjusting to 18 degrees. Using an indoor aerial 15 ft. long and 8 ft. high, 2LO came in on 40 degrees of the aerial condenser and 60 degrees on the tuned anode circuit condenser, a No. 50 coil being inserted in each coil holder. Very good medium loud-speaker results were obtained.

Using an earth connected to the aerial terminal of the receiver, and dispensing with the ordinary aerial, 2LO was received with the two condensers set at 39 degrees (aerial condenser) and 60 degrees. The results on a loud-speaker were very satisfactory, and very nearly as good as when using the small indoor aerial.

Aberdeen was received on a 75 ft. aerial, using 95 degrees on the aerial condenser and 45 degrees on the secondary. In this case the aerial coil was a No. 50 and the tuned anode coil a No. 75.

Several of the B.B.C. stations were heard, but not loudly. This was not expected, because the circuit is pre-eminently suitable for giving loud results from the local broadcasting station.

The results obtained were very nearly as good as those with the S.T.100, which latter set, of course, uses two transformers. There was, in fact, very little appreciable difference in signal strength.

The set responds effectively over the whole broadcast waveband, and loud signals should be obtained on a loud-speaker within 25 miles of any of the broadcasting stations, while when using telephone receivers the range should be very much greater.

For wavelengths above 400 metres a No. 75 coil is recommended for the tuned anode circuit, whereas below 400 metres a No. 50 is advised. A No. 50, when using constant aerial tuning, may be recommended for use in the aerial circuit for all the stations.

JOHN SCOTT-TAGGART.

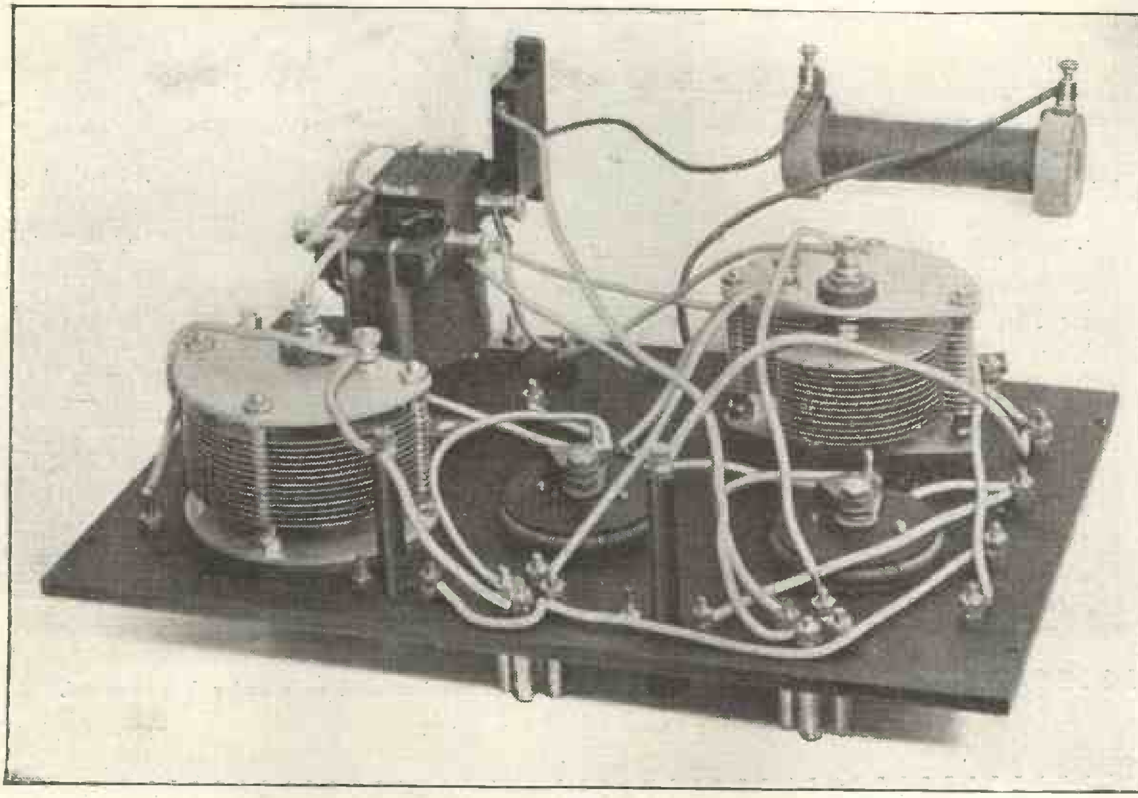


Fig. 5.—Disposition of parts showing connection of choke coil.

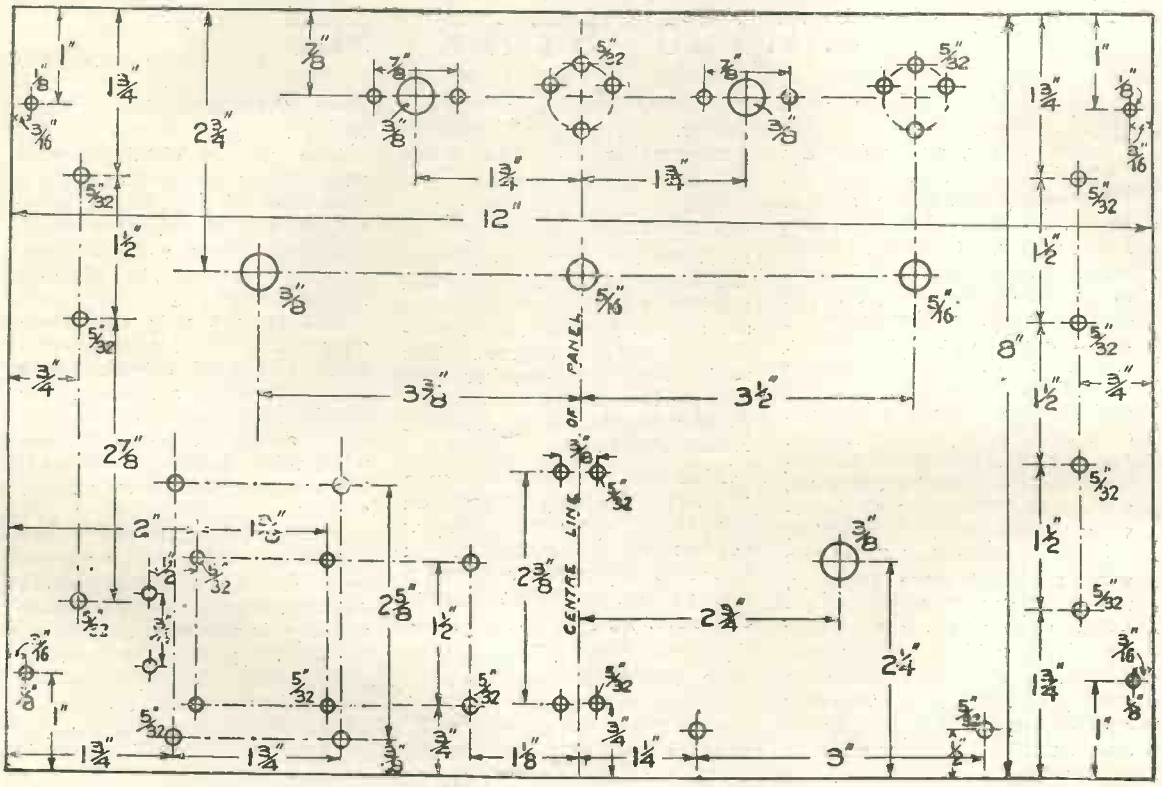


Fig. 6.—Drilling plan for panel.

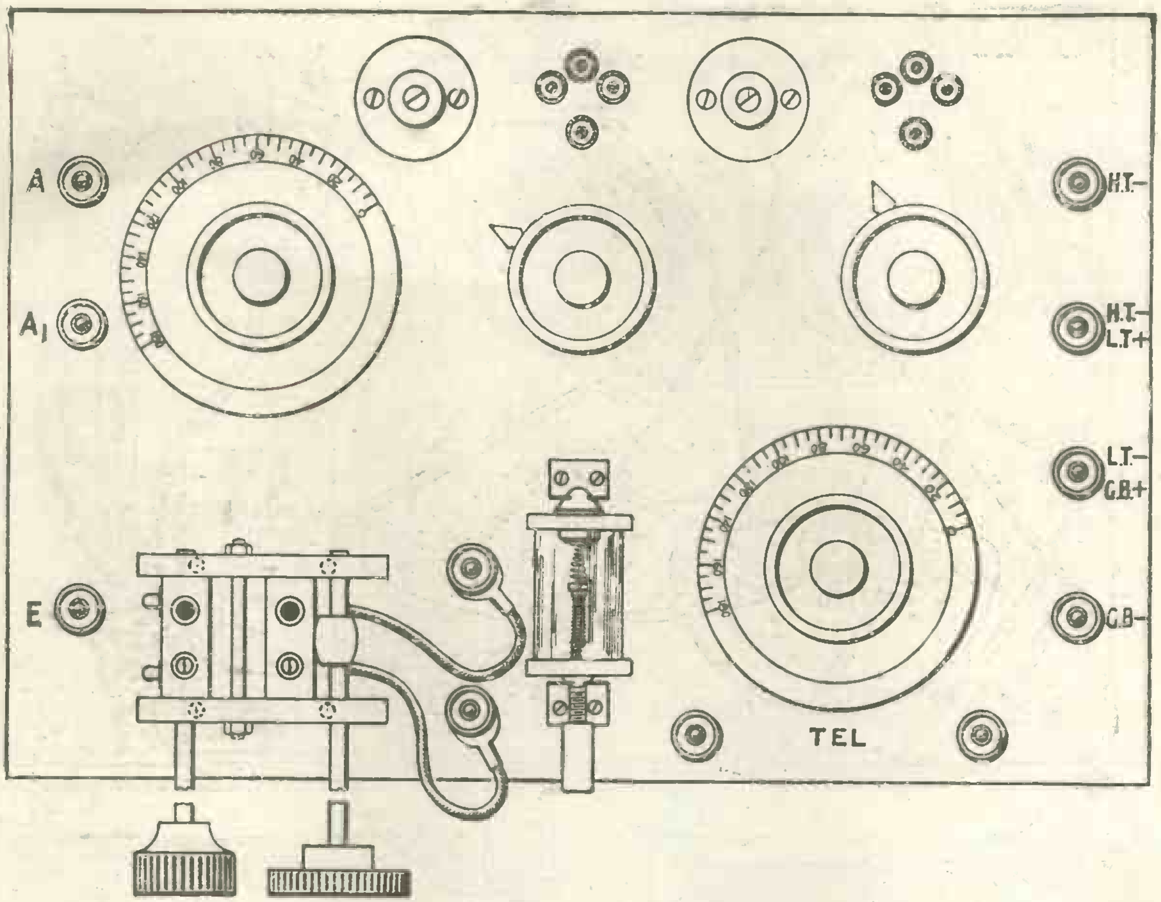


Fig. 7.—Layout of front of panel.

required to build up the set is given, together with the cost :—

Article.	£	s.	d.
Cabinet		18	0
Panel, 12 in. × 8 in. × $\frac{1}{4}$ in. ...		4	0
2 0.0005 Variable Condensers (K. Raymond, new type)		12	6
1 50,000–100,000 ohm Variable Resistance (Watmel)		3	6
1 0.5–5-megohm Grid Leak (Watmel)		2	6
2 Filament Resistances		4	0
1 Two-coil Holder (Goswell Eng. Co., Ltd.)		7	6
8 Valve Sockets		1	0
1 Burndept Crystal Detector ...		5	0
11 4 B.A. W.O. Type Terminals ...		1	10
1 0.004 Dubilier Condenser ...		3	0
1 0.001 Dubilier Condenser ...		3	0
1 0.0001 Dubilier Condenser ...		2	6
1 Silvertown Transformer	1	1	6
1 Peto-Scott Choke		7	6
Wire, Covering, Screws, etc.			11
	£4	18	3

While the constructor may use any suitable components which he may already possess, it is advisable, if buying new parts, to use those of good repute, as in many cases unsuitable components are the cause of failure to obtain satisfactory results with the S.T.100 Circuit.

A drawing of the top of the panel showing the lay-out of the components is given in Fig. 7, while a dimensioned diagram showing the positions of all the necessary holes is seen in Fig. 6.

The ebonite panel measures 12 in. by 8 in., and may be either $\frac{1}{4}$ in. or $\frac{3}{16}$ in. thick. It should have its surface or "skin" removed by rubbing with fine emery-cloth until all evidence of the glossy finish has disappeared.

The holes should then be drilled and the components built up on to the panel. With the aid of the photographs and drawings this should present no difficulty. Mount up the clips for the crystal detector, but leave the glass cylinder in a safe place until the set is ready for use. As will be seen from Fig. 7, two terminals are provided, to which the leads from the reaction coil is joined. This enables the reaction coil to be easily reversed, but if the constructor employs the new type of coil-holder made by the Goswell Eng. Co., Ltd., which incorporates a special device for reversing the connections to the coil, these terminals will not be required.

The Wiring

The wiring diagram of the receiver will be seen in Fig. 8, where a number is given to each point to which a wire has to be joined. A list of the numbered points to be joined together is given, thus greatly simplifying the task of wiring up.

List of Numbers Allotted to Components

A 1, A_1 2, E 3.
Const. aerial condenser 4 5.
Aerial tuning condenser 6, 7.
Aerial tuning coil 8, 9.
Transformer I.P. 10, O.P. 11, I.S. 12, O.S. 13.
Transformer by-pass condenser 14, 15.
First valve P 16, G 17. Filaments 18, 19.
Second valve P 20, G 21. Filaments 22, 23.
Anode coil (terminals on panel) 24, 25.
Anode tuning condenser 26, 27.
Crystal detector 28, 29.
50,000–100,000 ohm resistance 30 31.
Grid leak 32–33.
Choke coil 34, 35.
Grid condenser 36, 37.
Telephones 38, 39.
Telephone by-pass condenser 40, 41.
Filament resistances R_3, 42, 43.
R_4, 44, 45.
H.T. + 46. H.T. – L.T. + 47.
L.T. – G.B. + 48 ; G.B. – 49.

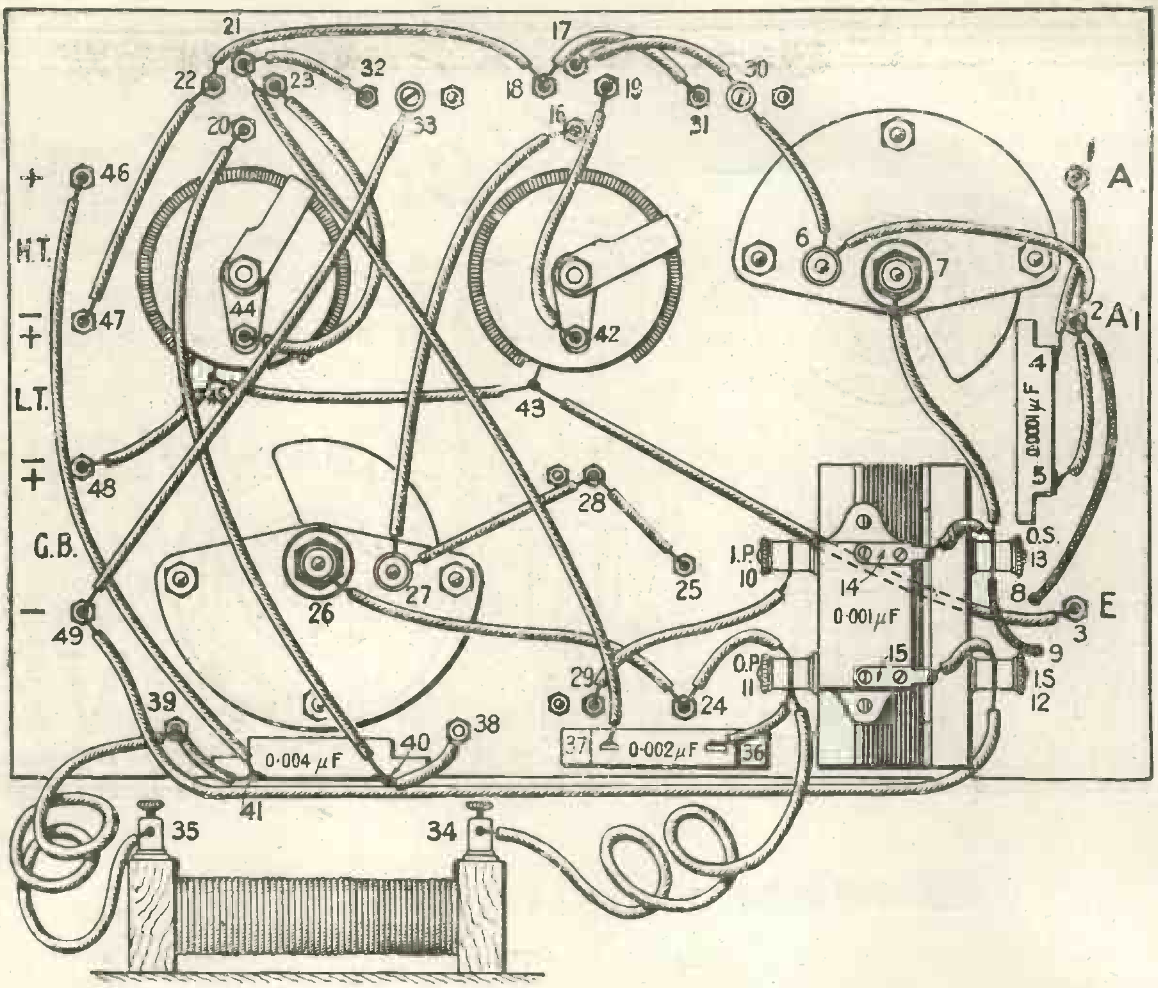


Fig. 8.—Back of panel wiring in detail.

Connections

(1–4) (2–5–6–8–17–30) (3–43–45–48) (7–9–13–14) (10–29) (11–36–34–26–24) (12–15–33–49) (16–28–27–25) (18–22–31–47) (19–42) (20–38–40) (21–37–32) (23–44) (35–39–41–46).

Photographs of the back of the panel are given in Figs. 4 and 5, and will help to clear up any little difficulties which may arise.

Wiring may be carried out with stiff tinned-copper wire of round or square section, or with a thinner wire covered with systoflex tubing, according to the desire of the constructor. It may be remarked that the use of square-section wire necessitates careful soldering, and unless the constructor is skilled in the use of the soldering-iron, he will find the alternative of thinner wire covered with systoflex much more manageable.

Full dimensions of the cabinet are given in Fig. 4, and it will be seen that the construction is perfectly straightforward, presenting no difficulty to the man of average wood-working ability. The price, as stated in the list, is an outside figure which should be paid if the article be obtained from a firm specialising in cabinet-making.

The panel is secured to the cabinet by means of four wood screws, one near each corner of the panel, in the holes provided.

For the reception of broadcasting, L_1 may be a No. 50 or 75 coil, and a 50 should be used in the right-hand socket. 100-volts high-tension should be used for the best results, but if dull-emitter valves are employed this value need not be so high.

Testing the Set

Connect up the batteries and telephones to the terminals indicated in Fig. 7, join the aerial to A and earth to E. This brings in the constant aerial tuning system, thus simplifying the matter of tuning. With the coils and valves in position and the cat-whisker lightly touching the crystal, turn on the filaments, and, with the coils well separated, move the condensers over their scales until a signal is heard. The aerial and anode circuits will need to be in tune to the same wavelength for best results, and it will be found that by tuning with the anode condenser and following with that in the aerial circuit the loudest signals will soon be obtained. The resistances R_1 and R_2 may also be adjusted for best results, and the coils brought slightly nearer each other, retuning if necessary on the condensers. Do not bring the coils too close, or a howl will result, owing to the set commencing to oscillate; in this case the coils must be separated a little, with corresponding readjustment of the condensers.

In conclusion, good signals have been received on the loud-speaker at 25 miles from 2LO, and headphone signals from other broadcasting stations. We should be glad to receive reports from readers constructing the set, giving details of reception of distant stations.

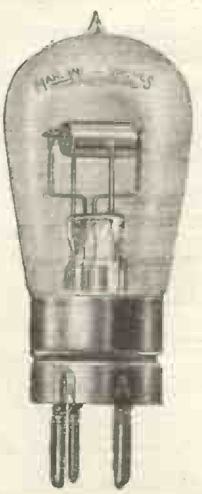
Valves may come and valves may go

BUT

MARCONI VALVES

MADE AT THE OSRAM LAMP WORKS

STILL REMAIN THE STANDARD WHEREBY THE REST ARE JUDGED



"D.E.R." Type Valve.

Length, including cap, 115 m/m.

The special feature of this valve is that the filament current and voltage, i.e., the working filament wattage, is very small, being in some cases less than ONE QUARTER of that required by ordinary valves having imilar operating characteristics. The filament runs at a dull red temperature, thus ensuring a very long life, as well as freedom from cracking, etc.

PRICE 21/- EACH
"R" Type 12/6 „

We are exhibiting at the BRITISH EMPIRE EXHIBITION, WEMBLEY, 1924. Electrical and Allied Engineering Section. Avenues 11-13, Bays 11-15.

The products of the firm which makes Osram lamps—and incidently were, nearly four years ago making "Dull Emitter" valves—can be relied on to give you maximum satisfaction.

It costs no more to say MARCONI OSRAM VALVES whilst their reputation is founded on their quality and high standard of efficiency.

Sold by all leading Wireless Dealers, Stores and Electrical Contractors.

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"The Result was Amazing"

"THE SOUND INCREASED ALMOST TWO-FOLD"

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Upper Norwood, S.E.19.
29th Jan., 1924.

DEAR SIRS—

I bought a Thorpe K.1 Valve last week. I had never heard of your firm, but was struck by your advertisement. Putting it as H.F. into a three-valve set in place of a standard make, **THE RESULT WAS AMAZING.** The sound increased almost two-fold in volume.

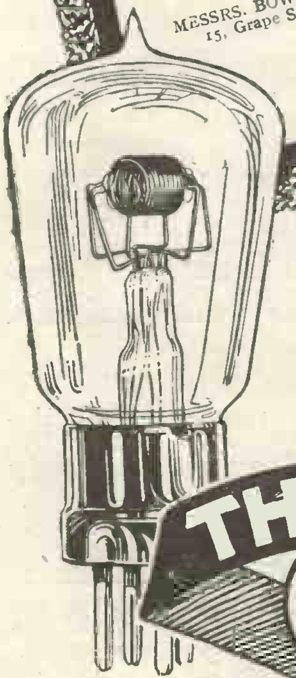
I understand you are also making a detector, and when ready I shall make it my work to get one.

This testimonial is spontaneous and bona-fide, and you can make what use of it you like.

Yours faithfully,
S. L. SALZEDO.

MESSRS. BOWER ELECTRIC, LTD.,
15, Grape Street, Shaftesbury Avenue, W.C.2.

(The original of this and hundreds of other testimonials can be seen on application.)



Consumption 0·42 amp. average.
Filament Voltage - 5·0 Volts.
Anode Volts - 50-100

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Adaptable to every type of receiving circuit, but more especially to those employing dual amplification and super-regeneration.

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Offices, Works & Showrooms : **15, Grape St., Shaftesbury Avenue, W.C.2**

Result of 15 years' experience.

Brandes

Grandpa now neglects his evening paper—a surprising fact, because with him it was almost a "fetish." Someone brought home Brandes, and the clarity with which he gets the broadcasting, the melodious tones ensured by their "Matched Tone" feature, claim his fervid interest. There he sits, with a finger in the bowl of a half-filled and forgotten pipe, oblivious to our entreaties.

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Matched Tone
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Radio Headphones

Above & below the Broadcast Wavelengths

AMATEURS are turning their attention more and more to reception upon very short waves, by which I mean those between 80 and 150 metres. For some reason not hitherto fully understood transmissions upon this waveband travel amazingly well, as any who have listened to KDKA can testify. This station works upon very large power, the output being in the neighbourhood of 15 kilowatts, and it might therefore be reasonably expected that its transmissions would make their way over great distances. But the surprising part of short wave transmission is that even transmitters of small power seem to be capable of achieving very large ranges. In the neighbourhood of 100 metres a single stage of high-frequency amplification is usually sufficient, provided that the aerial is a good one, to bring in the C.W. transmissions of quite a number of American amateurs on any night when conditions are favourable. Even if their call signs cannot be logged, one can generally recognise them by their characteristic note which when once heard sticks in the mind. On the very short waves, therefore, one can generally rely upon hearing a great deal that is of interest, so that one's vigils at the wireless set in the early hours of the morning are well repaid by what one picks up. Speaking broadly, these short waves are much freer from the devastating effects of atmospherics than the longer ones; hence one's reception is not so often ruined by fusilades of crackles as when one sits up to make an attempt to receive American stations working within the limits of our own broadcast waveband. There are of course occasions when atmospherics are appalling, even down on the lower levels, so that we cannot yet say with certainty that we will receive a given station upon a definite night some time ahead. Still it is perhaps the very uncertainty of wireless that makes it so attractive. Whatever type of set one uses one is always coming up against little problems, often of a very puzzling nature. To get to the root of the matter it is usually necessary to deepen one's technical knowledge in one direction or another. Hence it is that the wireless enthusiast is always learning more and more about the subject and that his interest never fails. In working his set he obtains practical experience, and as he nearly always wants to know the reason why certain causes produce certain effects he is constantly expanding his grasp of the theoretical side of the subject.

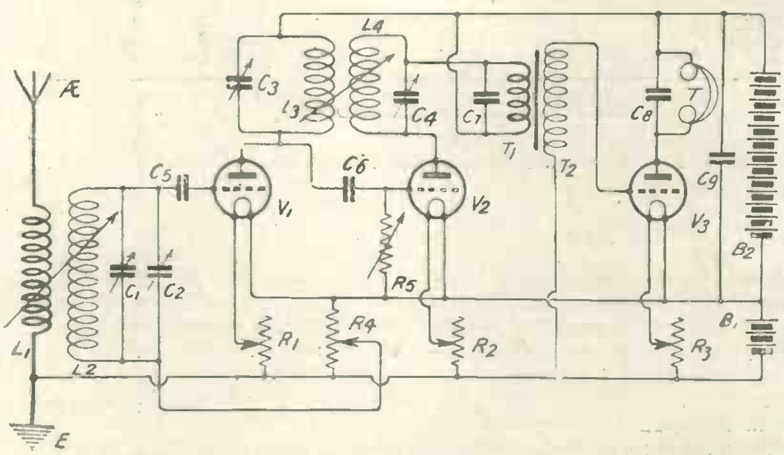


Fig. 1.—A useful circuit for short wave reception.

Harmonics

Most of us in the past have used very hard words about harmonics, which we knew chiefly in the form either of faint signals or of mush from big stations which have a nasty habit of becoming unduly strong just when we wish to obtain perfectly clear reception. When we come to the very short waves we find that harmonics have their useful side. Some time ago I made quite by chance a discovery which has since been most useful. On most nights it is next to impossible to receive the transmissions of L'Ecole Supérieure des Postes et Télégraphes since as his wavelength is 450 metres he is hopelessly jammed by stations employed for marine direction finding work. I do not know whether all readers find things as bad as I do on this wavelength. Thirty miles north-west of London one can seldom hear anything upon it but a perfect babel of spark signals, some of them of great strength. For this reason I had for some time given up L'Ecole Supérieure as a hopeless proposition until one night I happened to receive a very clear transmission in French when searching round upon a much lower wavelength. Measurements with the wavemeter showed that the set was tuned to 225 metres. The transmission, therefore, appeared to be undoubtedly L'Ecole Supérieure's first harmonic. Any doubts upon the matter were soon dispelled by the announcers giving the name of the station. Since then I have used the first harmonic of this station quite often, and have usually managed to obtain very clear reception with little or no interference.

The next discovery was that 2LO came in surprisingly well on just over 90 metres, this being a quarter of his fundamental wavelength. Sometimes reception upon this harmonic is very strong indeed, at others it fades a little; but it is a useful thing to know, for should interference from spark signals, mush or local oscillation be bad on 365 metres, one can always drop down to 91 and be fairly certain of receiving the programme without annoyance from these sources.

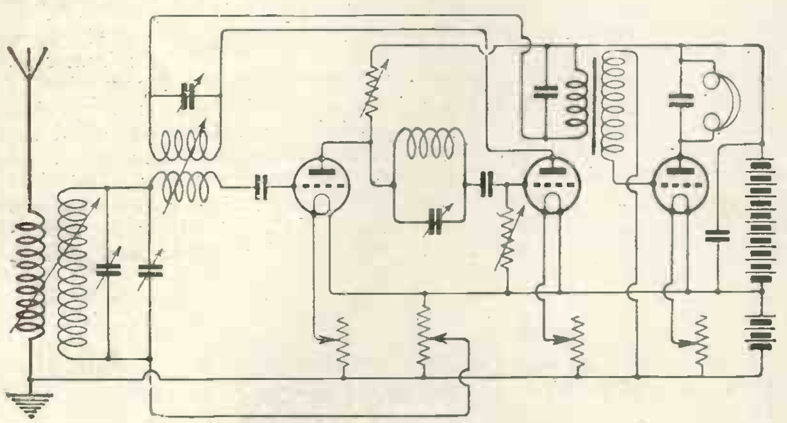


Fig. 2.—A modification of the Cowper circuit.

The Aerial

One of the most important points in long-distance short-wave reception is the quality of the aerial. I know this to my cost, for owing to a variety of causes it is impossible to erect a really good one in my garden. Hence I can never equal the performances of a friend living not far away who uses much the same kind of set but has a far better aerial. Length I can obtain without difficulty, but length in an aerial is not nearly such an important factor as height. The fact that the telephone wires cross the garden not far from the house limits the height of the free end to 28 ft., but as the garden slopes downwards from the house the effective height of the lead-in end is not more than 20 ft. Further, the wire is rather badly screened by outbuildings as well as by a tall tree which is near the free end. The friend referred to is lucky from the wireless point of view in that he lives on top of a hill—I say from a wireless point of view, for I do not envy him his walk home from the station on snowy nights! Having no obstructions of this kind he has been able to erect an aerial that is almost ideal. It is supported by masts 35 ft. in height and is absolutely unscreened in any way. If I take my set up to his house for a long night sitting we obtain results that are miraculous as compared with the performances at home. Similarly, if he brings his set when he pays a visit to me he finds an immense change for the worse. Still, even on my bad aerial I can and do receive both American broadcasting and American amateur signals; but I know that I should do far better if I could obtain height and freedom from screening, for there are many nights when he accomplishes trans-Atlantic reception, whilst I am unable to pick up anything from the other side of the world.

For short wave work I am strongly inclined to recommend the single wire aerial. Experimenters will have found that by far the best results are obtained if the aerial circuit is untuned. Now a single wire aerial 35 ft. high and 100 ft. in length has a natural wavelength of between 90 and 100 metres. Hence it is ideal for short-wave work. Great care, by the way, should be taken to see that aerial insulation is efficient when working upon these short waves. There is so small a margin of power to play with that one cannot afford to have any losses which can possibly be avoided. Should the mast be stayed with wire it is as well to place at least one insulator in each stay about half-way up.

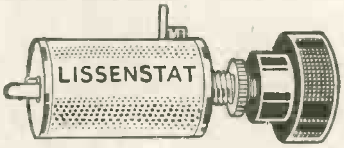
Practical Circuits

Very few ordinary receiving sets are capable of being tuned down to anything like 100 metres even if special inductances are substituted for those normally used. The reason is that with very high-frequencies any parasitic capacities which may exist exercise a tremendous influence upon the doings of the set. A receiver which will function quite well upon broadcast wavelengths may be perfectly hopeless when we come to frequencies of the order of 3,000,000 cycles per second. However if the set has been specially designed for the avoidance of capacity it will probably function well even upon very short waves. Two useful circuits for very short wave reception are given in Figs. 1 and 2. Fig. 1 shows a three-valve circuit (HF, R, LF), the high-frequency amplifier being coupled by the tuned anode method to the rectifier. Inductances can be made very simply. The former in every case is a piece of $3\frac{1}{2}$-in. diameter cardboard tubing of appropriate length, which may be fixed as shown in Fig. 3 to a standard plug and socket mounting. Before it is wound each cardboard former is fitted with a wooden disc which may be fixed in place by means of screws. If a lathe is not available for turning up the disc a single cross-piece will do quite well instead. To the disc or cross-piece is attached a strip of hard wood which is fixed by means of two screws to the plug and socket mounting. A better looking job will of course be made if ebonite is used instead of wood for the discs and strips, but there is really no need to do so, since no question of insulation is here involved. The aerial inductance L_1 consists of five turns of No. 18 s.w.g. double cotton-covered wire. The turns should be wound with spaces between them and they should not be shellacked. The secondary L_2 has 15 turns of the same wire, the windings again being spaced, and not shellacked. The anode inductance L_3 and the reaction coil L_4 are made in the same way. Each contains 25 turns of wire. The closed circuit tuning condenser C_1 has a maximum capacity of .0005 μF, and in parallel with it is a three plate "vernier" C_2. It is essential to use a small condenser in parallel since at very high frequencies tiny adjustments of capacity have often to be made in order to get the best results. C_3 has a capacity of .0002 μF or .0003 μF, and the capacity of the reaction condenser C_4 may be

LISSENIUM

MAGIC PARTS—

Minute energy coming miles through space—just think how carefully each part in your receiver must nurse these vital impulses which come to it! Parts of assorted make! If you use them, can you tell which one is letting your receiver down? Can you tell which part is leaking its precious energy? MIXED PARTS—WHY USE THEM? The writer in an article specifies mixed parts because it would appear to confer an undue preference if he used parts of all one make. NO SUCH CONSIDERATION WILL WEIGH WITH YOU, for you want your receiver to be full of "life"—responsive to each control—sensitive to every vibration of your aerial. You can build a receiver with mixed parts, of course, but it will never give you the same results as your receiver built with ALL LISSEN PARTS.



THE LISSENSTAT AS AN AID TO TUNING.
In tuning, particularly in long-distance work, and also where extremes selectivity is desired, there is alway one spot which will give the best results. LISSENSTAT control makes it possible to regulate critical electron emission to correspond exactly with the degree necessary for perfect detection.

There are three types of **LISSENSTAT: Lissenstat** (prov. pat.), the super filament control ... **7/6**

Lissenstat Minor, intended to provide something of the beautiful **Lissenstat** control at a popular price **3/6**

Lissenstat Universal, with its protection for dull emitter valves **10/6**

To those who think Lissenstat Control is the same thing as an ordinary rheostat—Let them try the difference.

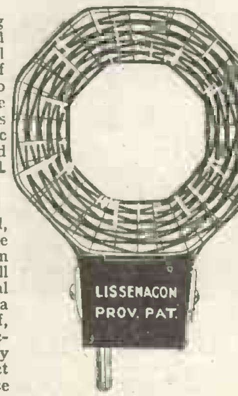
WHEN SOME SETS WILL FUNCTION WITHOUT A GRID LEAK.
The distance between the grid and filament pins in an ordinary R valve is only one centimetre, and if the valve holder should be made of slightly conducting or hygroscopic material, or if there should be anything on the surface of the ebonite such as tinfoil, or flux, or dirt, which will cause a leak between the grid and filament pins, you have **a Grid Leak without putting one in!** But obviously this is an undesirable means of obtaining correct grid potential! In some circuits and with some valves variable grid control is not so important, but with others it is extremely important. It is an excellent thing to be able to alter leak resistance, so that the correct value is obtained for every varying phase of the valve and circuit. If the LISSEN Variable Grid Leak be used correct grid potential can be obtained under all conditions. An interesting alternative use is across the secondary of a transformer, or across the loud-speaker itself, when it will improve reproduction by suppressing any tendency for the high notes of the musical scale to be amplified disproportionately to the lower ones.

LISSEN ONE HOLE FIXING, OF COURSE. POSITIVE STOPS BOTH WAYS. 2/6

LISSEN Variable Anode Resistance, same outward appearance as the LISSEN Variable Grid Leak, 20,000 to 250,000 ohms continuous variation **2/6**

HOW BLIND SPOTS ARE ELIMINATED IN THE LISSEN TUNER.
If the tapped and untapped portions of an inductance which is intended to cover a wide range are resonant to each other, signals over these particular resonant points will be seriously diminished in strength, and although the inductance would function after a fashion, it would be a common thing to find blind spots in such a poorly designed inductance—particularly on the shorter wavelengths. Each tapping point on the LISSEN TUNER is arranged so that the natural frequency of the untapped portion is not the same as that of the tapped portion, nor does it come within the band of frequencies which would be covered by the tapped portion when it was tuned by a condenser (otherwise a serious loss of signal strength in this case would also result). To make doubly sure the untapped portion of the LISSEN TUNER is short-circuited, which further eliminates the possibility of its having any resonant point.
The LISSEN TUNER, besides being very efficient, is also convenient—covers 150 to 4,000 metres with a .0005 condenser (preferably use the **LISSEN Mark 2 Mica Variable Condenser, price 17/6**)—has a switch already mounted—no drilling—no soldering—high inductance for a given length of wire—**LISSEN ONE HOLE FIXING, OF COURSE** **22/6**

COILS IN LOOSE COUPLED CIRCUITS.
The use of a loose coupled tuner has the effect of isolating the aerial damping losses from the grid circuit, so that the grid circuit is not influenced by them, and can therefore be tuned up as sharply as the design of the coils employed will permit. Much of the advantage of a loose coupled circuit is lost, however, if there are damping losses left in the coils themselves. Some makes of coils do not tune very sharply, so that they do not afford the full advantages of the loose coupled circuit. LISSENAGON COILS, however, are ideal for use in this circuit, as owing to the negligible losses, and because also of the strong magnetic linkage between the coils themselves, extremely sharp tuning is possible, and the full effect of a loose coupled circuit obtained. **HOLD A LISSENAGON COIL UP TO THE LIGHT.**

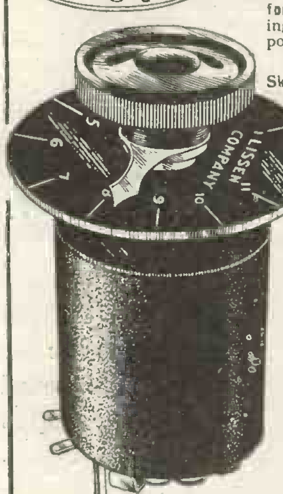


MAKE YOUR BATTERIES LAST LONGER.
When using dull emitter valves, although the current taken per valve is small, yet it imposes a distinct drain on the cells. When a dry cell is switched on, the voltage gradually drops owing to polarisation process, but if it is given a rest the cell will recuperate, and its voltage will rise to normal again. If you work your cells for too long a stretch, the recuperation will be partial. If, for instance, one dry cell is worked to destruction, and two cells are worked alternately during the period of their life, it is a fact that they will last a good deal more than twice as long as the one cell worked continuously. And more efficiently also, because the voltage would be far steadier. It is an advantage, therefore, to use two sets of dry cells and to switch over from one set to the other by means of the LISSEN Two-way Switch. This takes up hardly any room **2/9**
LISSEN ONE HOLE FIXING, OF COURSE.

MAKES A WHISPER LOUD.
This **LISSEN type T1 Transformer** will amplify a whisper to a great degree of loudness in a background of absolute silence. The coil alone weighs 8 ounces. The primary has an exceptionally large impedance value, and the windings are subjected to an exceptional test. No other transformer has such a valuable coil. Will give great amplification with entire absence of distortion due to the design of the coil and the magnetic field. The metal screen also shields it from all local low frequency currents. This LISSEN Transformer should be used always immediately behind the detector valve and also for POWER WORK. Use it throughout if superlative amplification is desired. **30/-**

AUDIO-FREQUENCY IN REFLEX CIRCUITS.
It has been found that the **LISSEN type T2 Transformer** is a fine transformer in these circuits, including the ST100, where it yields pure and very powerful amplification. **25/-**

AN EXCELLENT LIGHT TRANSFORMER—
Skilfully balanced in design, this **LISSEN T3 Transformer** actually compares with many expensive transformers. It is one of the best light transformers made ... **16/6**



AERIAL REACTION is no alternative to LISSEN Radio-Frequency Amplification.
It is a mistake to assume that because aerial reaction is used in a receiver there is no need for LISSEN Radio Frequency Amplification in the same receiver. If your aim is distance add one stage of LISSEN REACTANCE (prov. pat.). Its great efficiency, its rapid tuning, have made radio-frequency amplification more widely used in tuned anode circuits than anything else. Complete with switch already mounted—no complications—no soldering—**LISSEN ONE HOLE FIXING, OF COURSE.** Diagram with each shows how to connect.

150 to 10,000 metres .. 19/6
150 to 600 metres .. 17/6

To cover distance, every receiver should have one stage LISSEN REACTANCE—lower in cost than a set of plug-in coils—self-tuned, but sometimes a vernier might be an advantage (preferably use the LISSEN Vernier).

PUTTING THE CONDENSER IN SERIES OR PARALLEL.
On the shorter wavelengths it is sometimes difficult to get regeneration with the condenser in parallel, but when the condenser is used in series the set oscillates very much more readily. On the longer wavelengths, however the condenser should always be used in parallel. If you have fitted the LISSEN Series Parallel Switch you can put the condenser in series or parallel quickly with just a gentle pull or push of the knob. It takes up hardly any room. **Lissen One Hole Fixing, of course ... 3/9**

LISSENAGON TUNING CHART. Note the Intermediate Coils, 30, 40 and 60

TABLE 1. Wavelength range when used as Primary Coils with Standard P.M.G. Aerial and .001 mfd. condenser in parallel.			TABLE 2. Wavelength range when used as Secondary Coils with .001 mfd. condenser in parallel.		
No. of coil	Minimum Wavelength	Maximum Wavelength	Minimum Wavelength	Maximum Wavelength	PRICE
25	185	3[illegible]0	100	325	4/10
30	**235**	**440**	**130**	**425**	**4/10**
35	285	530	160	490	4/10
40	**360**	**675**	**200**	**635**	**4/10**
50	480	850	250	800	5/-
60	**500**	**950**	**295**	**900**	**5/4**
75	600	1,300	360	1,100	5/4
100	820	1,700	500	1,550	6/9
150	965	2,300	700	2,150	7/7
200	1,885	3,200	925	3,000	8/5
250	2,300	3,800	1,100	3,600	8/9
300	2,500	4,600	1,400	4,300	9/2

A SENTINEL BESIDE YOUR RECEIVER.
No difficulty will be experienced in cutting out any nearby broadcasting station. Most morse interference will also be successfully eliminated. There is, however, a certain type of morse interference which calls for greater skill. Even where the operator cannot quite get rid of all interference it can be subdued to the extent that it ceases to spoil reception of broadcasting. The LISSENCEPTOR is a useful thing to add to any receiver. It needs a separate condenser to tune it (preferably use the LISSEN Mica Variable Condenser Mark 2, 17/6). **Lissenceptor Mark 1, for broadcasting, 7/6; Lissenceptor Mark 1, for 600 metres, 7/6; Lissenceptor Mark 2, for broadcasting and 600 metres combined** (this type has a switch for more selective tuning) **15/6 The Lissenceptor Intercepts Frequencies.**

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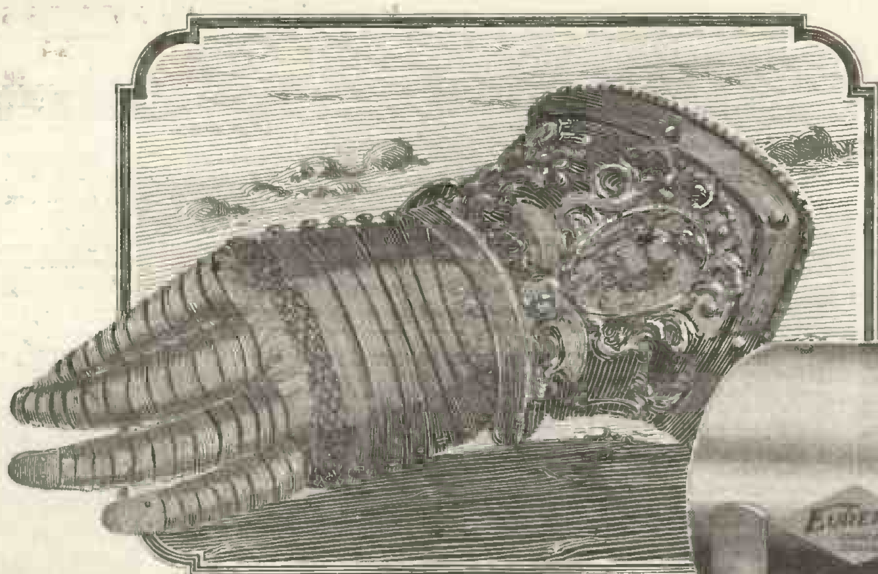

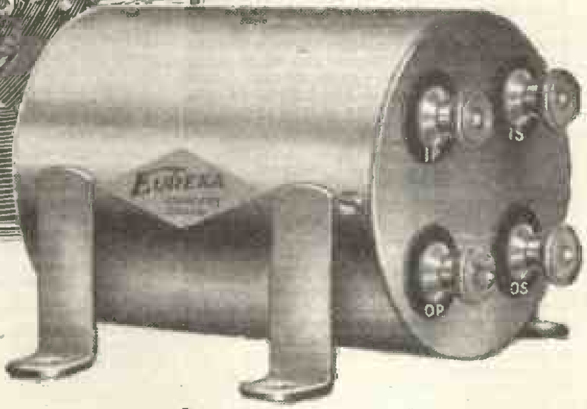

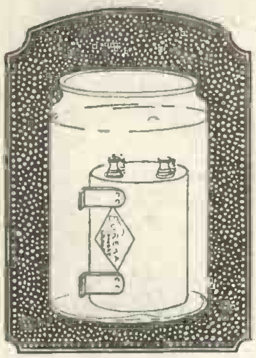

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—could any other Transformer ever built withstand such a drastic test?

This was the test—

A Eureka Concert Grand was totally submerged in water for a period of 14 days. At the end of that period it was taken out and dried and afterwards submitted to the usual electrical tests.

It was found that absolutely no difference was noticeable between the "water-tested" Eureka and a standard Concert Grand taken from stock. In each case the resistance between windings and between windings and case was greater than 100 megohms—which is four times greater than the usual safety factor allowed to Low-Frequency Transformers.

The secret of the success of this extraordinary test lies in the fact that every Eureka Transformer is *hermetically* sealed in its steel case.

EUREKA Transformers are so revolutionary and give such vastly improved results—not only in volume but in actual purity of tone—that no ordinary tests are considered good enough.

The test described here is infinitely more exacting than any Transformer would ever be called upon to undergo in everyday use, but it is useful for two reasons. Firstly, it shows the extraordinary care and forethought exercised by the designers in planning the Eureka Transformer. Secondly, it proves conclusively that even during the winter months when the atmosphere is often heavily charged with moisture it can have no harmful effects on the working of a Eureka Transformer. Ordinary transformers with simple coverings are not impervious to damp—rather, owing to their method of construction, do they become hygroscopic and attract moisture from the air. Even an infinitesimal amount will provide an easy path for some electric energy to leak across.

When buying your next Transformer, select a Eureka—when used with correct negative grid bias and sufficient H.T. supply it will give louder and purer results than the combined efforts of two ordinary Transformers.

From your Dealer or direct from sole Manufacturers.

¶ *As used by Mr. Scott-Taggart in the 3-Valve Dual Receiver in this issue.*

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Types:

Concert Grand 3½ ins. long 2¼ ins. high **30/-**

Eureka No. 2 For second stage, but can also be used as first stage **22/6**

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the same or a little greater. L_1 and L_2 are mounted on an ordinary 2-coil stand, which should be so placed that there is no interaction between these inductances and L_3 and L_4, which are similarly mounted. Should there be anything like strong coupling between the two sets of coils it will be almost impossible to work the set upon the short waves. It is desirable that the gridleak should be variable, for a device of this kind is of greater assistance in controlling any tendency to self-oscillation. The coupling condensers C_5 and C_6 if fixed should have a capacity of .00025 μF. It may be found an advantage to use variable condensers with a maximum capacity of .0003 μF instead of fixed condensers. It is important that the secondary circuit should be earthed as shown in the drawing.

The second circuit shown is a slight modification of that described recently by Mr. A. D. Cowper. It will be seen that instead of the radio frequency choke coil a variable resistance is used. One reason for adopting this method is that if the original circuit is used there are no less than six inductances which it is very hard to keep from acting upon one another. The experimenter is advised to see whether he obtains better results with a choke or with a resistance, Inductances are of the same type and contain the same number of turns of wire as those described above, except that the secondary is "split," the reaction coil being coupled to one half of it. This is done because if the ATI, CCI and reaction are all mounted on to one 3-coil stand there is a mutual coupling between all three coils which makes the arrangement most difficult to work with.

Valves

For either of these circuits it is recommended that the high-frequency amplifier and the rectifier should be valves of the anti-capacity type, such as V_{24} and QX, or their dull emitter counterparts DEV and DEQ. A good combination is QX as high-frequency amplifier and V_{24} as rectifier or DEQ and DEV in the same positions. It should be noted by the way if the valves of this type are fitted into adapters and then mounted upon the ordinary 4-leg holder, a very large part of their anti-capacity properties is nullified. They should always be held in clips mounted directly upon the panels of the set. Another valve which will give excellent results for short-wave work is the Myers' Universal, which can be obtained in two types. The first requires a filament voltage of 5 and the second a voltage of about half that amount. The Myers is a true anti-capacity valve, the plate and grid leads being very well separated. Like the other types mentioned it should always be mounted in clips fixed to the panel, and not in an adapter if the best is to be obtained from it. Any type of valve which works well as a note magnifier may be used for the low-frequency unit.

Overdoing High Frequency

It may be wondered that only one stage of high-frequency amplification is recommended in these circuits, whereas for relaying purposes the B.B.C. make use of several in their trans-Atlantic receiving set. The truth is that one stage of high-frequency amplification can be worked at its maximum efficiency, whereas if two are employed it is in most cases a matter of very great difficulty to obtain stability without using so much damping that the efficiency of each stage is very greatly reduced. It must not be forgotten, too, that if damping takes the form of excessive positive potential applied to the grids, distortion due to the flow of grid current is bound to occur. On medium waves, such as those of our own broadcast band, it is quite possible to use two high-frequency stages coupled by one of the tuned anode systems, but when we come down to the region of 100 metres the very high-frequencies involved make for instability. If it is desired to use a second stage of high-frequency amplification to compensate to some extent for the poor quality of an aerial it will be found best to employ the loose coupled transformer method, which was described recently by Mr. P. W. Harris. A circuit on these lines is shown in Fig. 4. Here the aerial and closed circuit inductances and the closed circuit tuning condensers are as before. The transformers consist of two 25-turn coils similar to those described for the anode tuning inductances, each mounted upon a two-coil holder. The secondary of each transformer is tuned with a .0002 or .0003 μF condenser. It may even be found possible to obtain a slight step up by placing 30 turns upon the secondary of each transformer. This, however, would depend largely upon the particular set. It is worth while trying the experiment, for the extra turns can always be stripped off if the set is found difficult to manage with secondaries of this size. The greatest care must be taken to keep these transformers well apart and to place them so that there is not a mutual coupling between the pairs of coils.

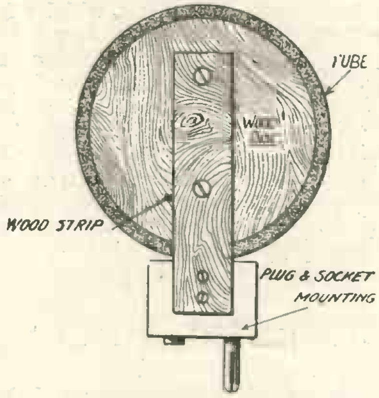

Fig. 3.—The construction of the short wave coils.

Relayed Transmissions

It cannot be said that the transmissions from KDKA relayed at the end of February and the beginning of March from 2LO were very successful. On both occasions atmospherics appeared to be very bad, though as the receiving set was obviously upon the verge of oscillation most of the time, I am inclined to suspect that a proportion of the cracklings heard were due really to noises in the set rather than to atmospherics pure and simple. One very curious effect noticed was that when the orchestra was playing, nothing could be heard for most of the time of the instruments which were taking the higher parts. The euphonium and the trombones came through fairly well, but of the violins, the cornets, the flutes and the clarionets nothing was heard at all during the greater part of the proceedings. To judge from the way in which the volume of sound rose and fell it appeared that the set was receiving continual attention at the hands of those who were operating it. One would say in fact that it was almost unmanageable. It really seems as if at present the problem of so amplifying trans-Atlantic signals that they are strong enough for relaying purposes presented difficulties which defy solution. The amateur who asks only for a small volume of sound is able to hear U.S.A. stations fairly clearly when he does get them, but when it comes to the large set, such as that used

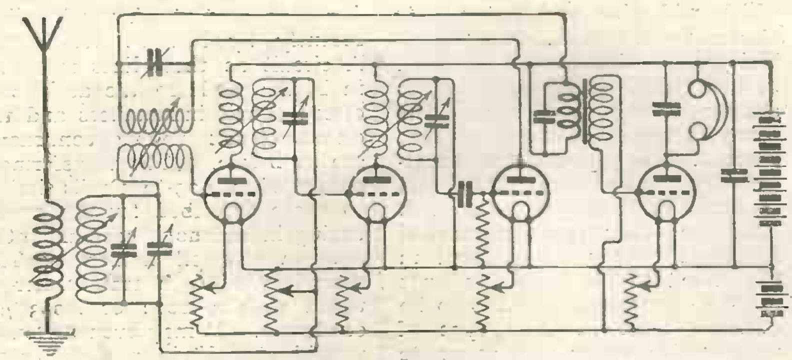

Fig. 4.—A short wave circuit employing two stages of high-frequency amplification, using two loose-coupled transformers.

by the B.B.C., the difficulties are so great that really good reception can be only a very rare effect. It is a problem that will no doubt be solved in time, but at present we must not expect too much.

Telephone Efficiency.

Captain P. P. Eckersley's technical talks from 2LO upon the subject of the efficiency of the telephones were most interesting to all wireless enthusiasts. Most of us were horrified to find that our receivers were quite incapable of dealing with several notes at the top of the piano. The top note of a full-compass piano is A. The C immediately below this (the third above the middle C) has an average frequency of 2,048 per second, and this seems to be the highest piano sound that most sets can cope with. The reasons for this apparent inefficiency are many. It must be remembered in the first place that no musical note is perfectly pure. When, for instance, a key of the piano is struck the resulting sound is really a chord consisting of the fundamental and *five* over-tones, which range over more than two octaves above the fundamental. Hence to hear the top notes of the piano properly we should require receivers capable of dealing with over 10,000 vibrations a second. As it is we hear the fundamental without its harmonics; hence the wooden sound. Even the best telephones can hardly be expected to do this, for it must be remembered that on the lower side they are called upon to respond to frequencies right down to about 30. The human ear is a much more perfect device than any that has yet been artificially made; yet it has its limits. The very high notes of the piano have little musical ring to most people, and there are few who can detect such a high-pitched note as the squeak of a bat. We must not overlook the fact that "inefficiency," if indeed it be inefficiency, is caused also by the inter-valve low-frequency transformers which must respond to the same huge range of frequencies. The more of them you use the less likely are you to obtain a perfect response over the whole range, and the effects will be felt more among the higher frequencies than among the lower. With a pair of phones in the plate circuit of the rectifying valve the number of "wooden" notes is small. It is slightly increased by the addition of one note magnifier, and a second makes matters worse. It is possibly largely on this account that the high-pitched notes were entirely suppressed in the relayed American transmissions, as mentioned in the previous paragraph. Doubtless the future will bring a very great improvement in telephones, for a great deal of attention is being given to them, both by theorists and by practical inventors. The real inefficiency of telephones at the present time lies in the fact that at the outside not more than a thousandth part of the current put into them does any useful work. The rest is employed in heating the windings and in various other quite useless ways. If telephones were really efficient in this way there would be no need for valve amplifiers for the operation of loud-speakers.

LAMBDA.

Readers' Letters

To the Editor of MODERN WIRELESS.

SIR,—With further reference to my Transatlantic Receiver, I have now carried out the slight modifications as suggested by your Mr. Kendall, and have much pleasure in informing you that I am getting really wonderful results from same. Last evening I was in touch with every British Broadcasting Station also Brussels.

With 2LO working (and he was very strong last night) I was able at will to tune in Aberdeen, Birmingham and Brussels without the slightest interference from 2LO, Brussels being uncomfortably loud in the 'phones. The only trouble I experienced was that Morse was occasionally very prevalent and somewhat spoilt the reception. I find that once the best position of the filament rheostats is found, it is comparatively easy to control reception of the different stations by means of the condensers and potentiometer.

Please allow me to take this opportunity of thanking you for the information which you so kindly forwarded to me also for the courteous and kindly interest displayed by your Mr. Kendall.

Wishing your publications an ever increasing success, I am,

Yours faithfully,

Acton. S. C.

[This set is described in Mr. Harris' *Twelve Tested Wireless Sets*.]

To the Editor of MODERN WIRELESS.

SIR,—I should like to comment upon Mr. A. E. Stone's crystal holder described in the current issue of MODERN WIRELESS. As an experimenter with crystal reflex circuits and a firm believer in the superiority of the crystal as a detecting device, I have tried out a good many mechanical devices in the hope of getting a stable mounting for the galena and light contact combination. My experience is that the type described by Mr. Stone is about the most stable, but I have one severe criticism to make. The type of springs he describes necessitates both the crystal cup and the catwhisker being supported upon slender pieces of metal quite an inch and a half away from the uprights, and I believe that this would entail great sacrifice of rigidity. My own method is to use valve sockets for the uprights with pieces of spring such as are sold for petrol lighters in the hollow of the socket. I enclose a rough diagram.

For cat-whisker I find a piece of watch spring ground to a sharp point gives excellent results.

If you would care to try out this device both for ease of adjustment and stability, I shall be delighted to fix up one similar to that which I am using and send it along to you.

Yours truly,

Reading. D. F. V.

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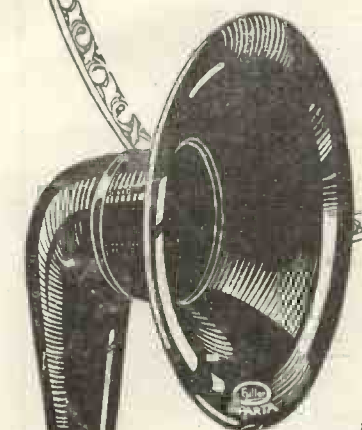

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A Frame Inductance Crystal Set

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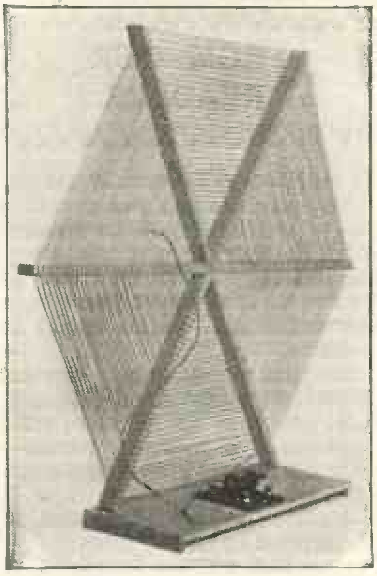

Fig. 1.—Photograph of the crystal set.

THE crystal set illustrated in the above photograph has several novel features which may interest readers of MODERN WIRELESS. It will be noticed that the inductance, instead of being of the conventional pattern, is made on the lines of a frame aerial. It is wound with No. 16 tinned copper wire, which has the double advantage of reducing high-frequency resistance, and at the same time the spacing between the turns reduces the self-capacity of the coil.

There is the added advantage that, while the set is primarily intended for use with an outside aerial and the usual earth connection the inductance itself may be used as a frame aerial in conjunction with a valve set.

The frame, as will be seen from the photograph, is mounted on a wooden base, which carries a piece of ebonite, upon which the crystal detector and necessary terminals are mounted.

The circuit arrangement is seen in Fig. 2. The aerial connection is made to the outside end of the inductance winding and to the crystal, while the earth connection is made to the telephones and the wandering lead to the inductance. The free terminal of the telephones is joined to the other side of the crystal detector. The circuit is of the simplest form, the frame inductance replacing the usual coil.

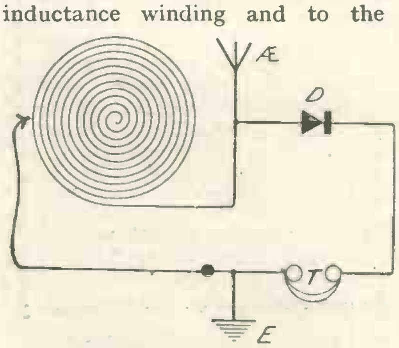

Fig. 2.—The circuit arrangement.

The construction of the cross-arms is seen in Figs. 6 and 8. Oak should be used, as it is hard, and will not tend to split, when the slots are cut, so easily as would a softer type of wood. The arms are each 28¼ in. long, 1 in. wide and ½ in. thick and are shaped in the manner shown in the figure. On each side of the centre, in each arm, are 37 slots, ⅓ in. apart, about ¼ in. deep. The former dimension may be obtained from a rule graduated in twelfths of an inch. The positions of the slots are marked out with a pair of dividers, the first slot being ⅓ in. from the end of the arm.

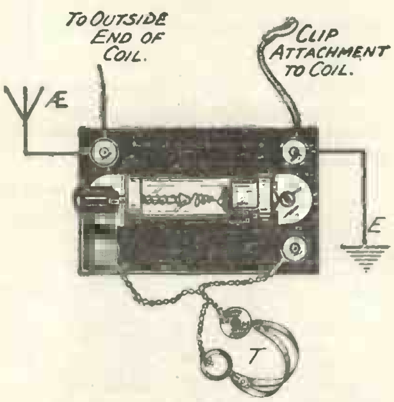

Fig. 3.—Showing how to connect up the set.

A groove is made along each of the 1 in. sides at the bottom of the slots, as seen in Fig. 8. This groove is ⅛ in. deep, and is made by means of a chisel, scraping the wood out until the required depth is reached. A key is thus formed, which tends to secure the wire in the slots. The arms are then fitted together and secured by means of a 1 in. wood screw through the centre.

A hole is then made, near the centre, in one of the arms, and the beginning of the wire threaded into this. No. 16 tinned copper wire is used, and about 2 lb. will be necessary.

The wire is pressed into the first slot in each arm, then the second, and so on, commencing in the centre and finishing at the outside of the arms. The wire is bent round the last arm to prevent it becoming loose.

The base is now prepared, measuring 16 in. by 6¼ in. by ⅜ in., and is seen in Fig. 7. A hole 2¾ in. square is cut in it, towards the front in the centre of the longest side, as shown in the figure. At each end of the base a strip of wood 6¼ in. by ½ in. by ⅜ in. is screwed on, to give a clearance to the wires and terminals under the base.

The ebonite panel measures 3½ in. by 3¼ in. by ¼ in. and has a hole drilled in each corner for the wood screws which secure the ebonite to the wooden base; the crystal detector is mounted in the centre of the piece of ebonite, the holes for this being given in Fig. 4. Two terminals are fitted behind and two in front of the crystal detector.

The frame is secured to the base, as shown in Fig. 7, by means of two wood screws 1½ in. long. The

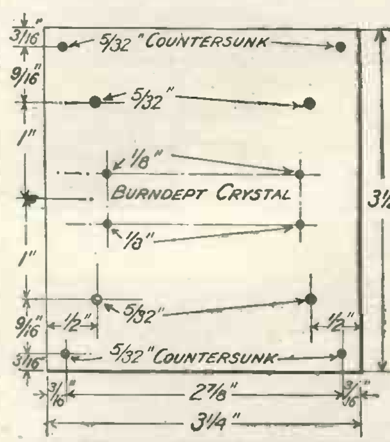

Fig. 4.—The ebonite panel, showing the positions of all the necessary holes.

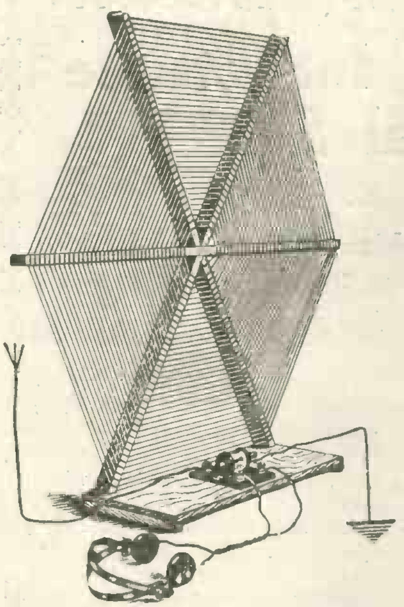

Fig. 5.—A drawing of the finished set showing aerial, earth, and telephone connection.

outside end of the winding is connected to the aerial terminal, which is the left-hand terminal at the back of the crystal detector, and this is also connected to the crystal cup. A wandering flexible lead is connected to the earth terminal (the right-hand back terminal), and this is also joined to one telephone terminal. The flexible lead has a clip soldered to the free end, by means of which connection is made to the inductance winding.

This clip may conveniently consist of a spade terminal, which has the two "spade" ends bent over so as to form a clip. The cat-whisker is joined to the other telephone terminal, and wiring is complete. The set may now be tested. Connect up the aerial, earth and telephones, as shown in Fig. 3, and, with the cat-whisker touching the crystal, adjust the position of the wandering lead until signals are heard at their best. The crystal may now be adjusted to the most sensitive position.

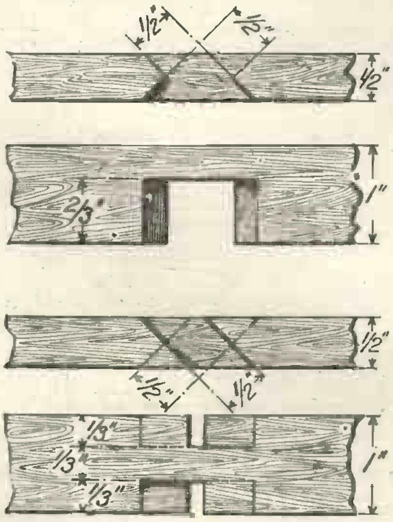

Fig. 6.—The centres of the cross arms are cut out so as to fit together.

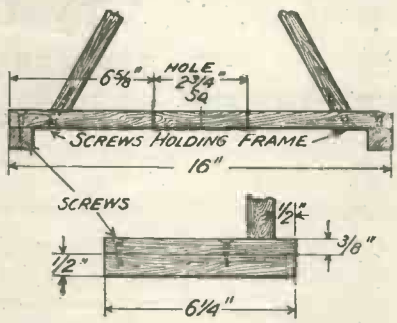

Fig. 7.—The baseboard, and how the frame is joined to it.

To use the set as a frame aerial in conjunction with a valve set, connect the grid of the first valve to the aerial terminal, filament negative to the earth terminal, and remove the cat-whisker from the crystal. The inductance now functions as a frame aerial, with the usual directional properties, the amount of wire in use being variable, by means of the clip.

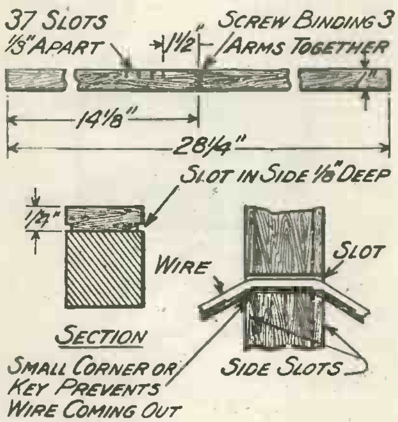

Fig. 8.—Further details of the cross-arms, showing the slots which hold the wire.

Good signals have been received at 10 miles from 2LO, using the set with crystal detector and the usual aerial and earth connections.

"RADIO"

We have received a copy of "Radio," the new 1s. house-organ of Radio Communication Co. It consists of 32 pages beautifully produced on art paper. We are informed that it is not obtainable at the ordinary newsagents and bookstalls, but from "Polar" Stockists; or direct from Radio Intelligence Ltd., 34, Norfolk Street, W.C.2.

FROM OUR READERS

To the Editor of MODERN WIRELESS.

SIR,—As the S.T.100 circuit is one of the most popular circuits, if not the most popular one, to-day, might I suggest that an article on its use for the proposed new high-powered B.B.C. station would be welcome.

So many amateurs content themselves to the usual broadcast band that they are at a loss when confronted with 1,600 metres—and the larger plug-in coils are expensive.

A few hints would, I am sure, be appreciated by many.

Yours faithfully,

Winchester. C. E. WALPOLE.

[The S.T. 100 will work on all wavelengths. It is merely a matter of using appropriate coils. Meanwhile we await the 1,600 metre station.—ED.]

To the Editor of MODERN WIRELESS.

SIR,—Concerning S.T.100 Star. I wired up this circuit about a week ago and have had good results, including reception of America for the last two nights. On the first night WGY came through but was badly distorted. Atmospherics were bad, too. Last night was better, but I am not sure of the station. It sounded like WSG or perhaps WFG. The station closed down at 1.30 or thereabouts and so did I. The wavelength was about 380 metres. When I told the man who supplies my components about it he was politely incredulous, and really I scarcely blame him.

Gravesend. J. W. ROUGHTON.

SPECIAL NOTICE

Readers are recommended to buy their copies of MODERN WIRELESS as soon as published because the edition is always sold out. It is impossible to gauge the exact demand, and the publishers cannot take the risk of overprinting because of the high cost of production.

It is expected that the circulation will be fully maintained throughout the summer because of the important serial on Dual Amplification, and the fact that specially attractive features will be forthcoming. It will be remembered that last summer all the S.T. 100 articles appeared.

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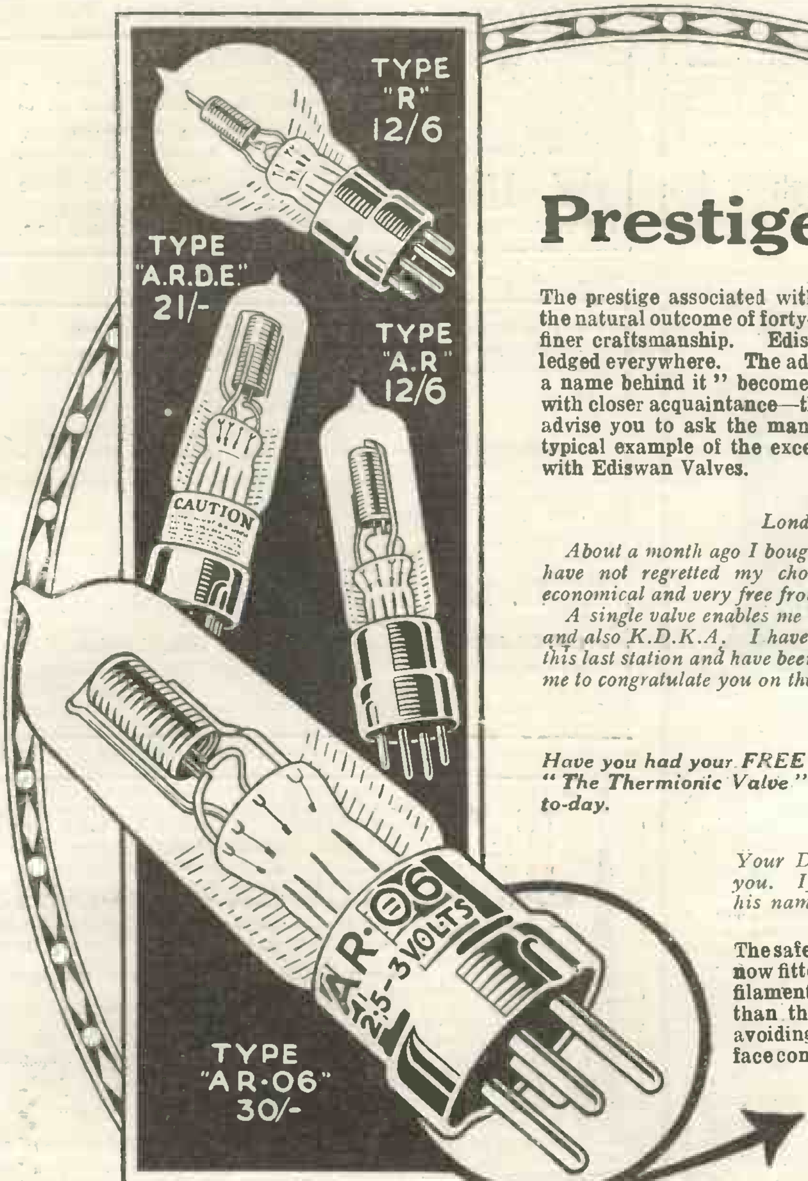

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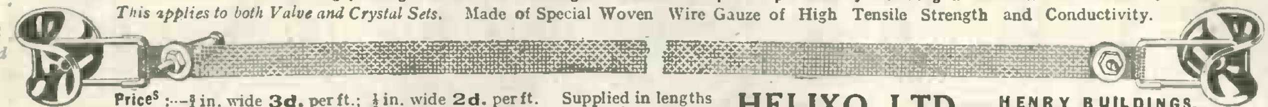

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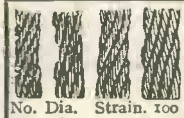

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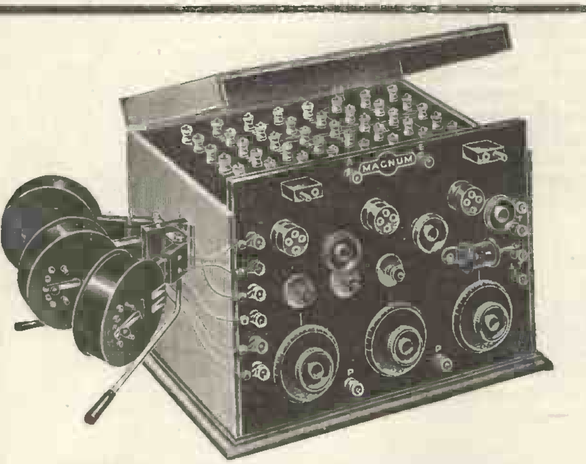

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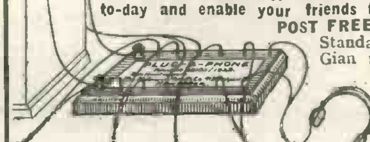

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TRADE ENQUIRIES INVITED.

A Five-Circuit One-Valve Receiver

By E. H. CHAPMAN, M.A., D.Sc. (Staff Editor).

An interesting little instrument for the experimenter in circuits is fully described in this article.

THE one-valve receiver to be described in the present article possesses the following features :—

1. It may be used as a "Haynes DX" receiver, a type of one-valve receiver which has gained a great reputation for long-distance reception in America.

2. It may be used as a Flewelling super-regenerative receiver, the circuit being that given in *Wireless Weekly*, Vol. 2, No. 2.

3. It may be used as a modified Flewelling receiver, according to the circuit shown be'ow.

In addition, the receiver can easily be adapted to function with circuit S.T.14 or with circuit S.T.18, thus making five circuits in all on which the one-valve receiver will function.

Changes from one type of circuit to another are readily made by means of a two-way connection on the panel of the receiver and by varying the type of coil used in the aerial-earth circuit.

The Containing Box.

The box containing the receiver was of stained and polished mahogany. With the lid closed, the outside measurements of the box were :—

Length, $8\frac{5}{8}$ in. ; breadth, $5\frac{3}{8}$ in. ; depth, $6\frac{1}{4}$ in. The outside depth of the lid was $1\frac{3}{8}$ in., and the wood of which the box was made was $\frac{5}{16}$ in. thick.

Mounted on the left-hand end of the box, looking at the box from the front, was a "Universal" two-coil holder (see Fig. 2). This particular type of coil-holder is intended to take any kind of flat or fairly thin coil which has a central hole or aperture of about $1\frac{1}{2}$ in. diameter. Basket coils suit this type of coil-holder extremely well.

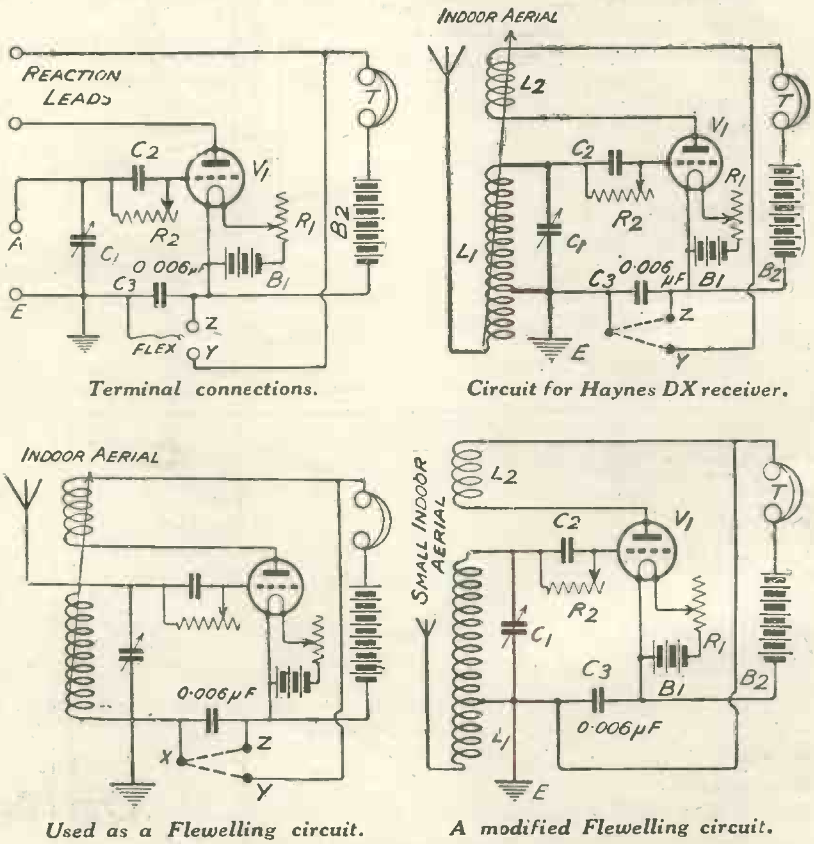
With the coil-holder used in this particular case, it was found an advantage to change round the two terminals on the aerial coil carrier so that those two terminals were on the *outside* of the carrier and not on the inside. As the two terminals on the reaction coil carrier were already on the outside, both pairs of terminals were then on the outside and were in the most easily accessible position for the quick fixing and changing of coils.

The Panel.

The ebonite panel, which fitted flush with the top of the lower part of the box and rested on a ledge provided, measured 8 in. by 5 in. and was $\frac{1}{4}$ in. thick. Fig. 3 shows in plan the top of the panel.

Attention is especially drawn to the flex lead between Y and Z. When the spade at the end of this lead was connected to terminal Y, the Flewelling condenser was in circuit and the receiver was ready for use, either with the Flewelling circuit or with the modified Flewelling circuit given in the figure. When the spade tag of this flex lead was connected to terminal Z, the Flewelling condenser was shorted and the receiver was ready for use as a "Haynes DX" receiver, cr as a S.T.14 receiver, or as a S.T.18 receiver.

The reaction leads R1 and R2 were also flex leads soldered to spade tags. These reaction leads were connected to the reaction coil terminals on the coil-holder fitted on the outside of the box when reaction was to be used. When it was desired to close the box, the



Terminal connections. *Circuit for Haynes DX receiver.*

Used as a Flewelling circuit. *A modified Flewelling circuit.*

Fig. 1.—How the various circuits can be joined up.

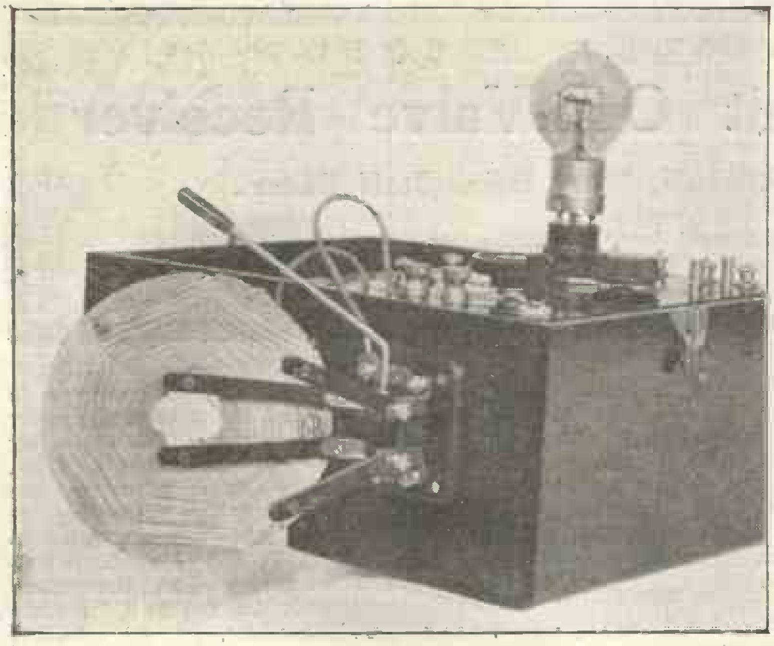


Fig. 2.—End view of the set, showing the type of coil-holder used.

reaction leads were placed inside the box on the ebonite panel.

On the panel the following component parts were mounted :—

- Variable condenser, 7 fixed plates, 6 rotating vanes (about .0002 μF).
- Variable grid leak, Lissen make.
- Filament rheostat, Igranic pattern.
- Flewelling condenser, .006 microfarad.
- Grid condenser, .0003 microfarad.
- Valve holder.
- Aerial earth, 'phone and battery terminals.
- Terminals Y and Z.

The wiring of the panel is given in Fig. 4.

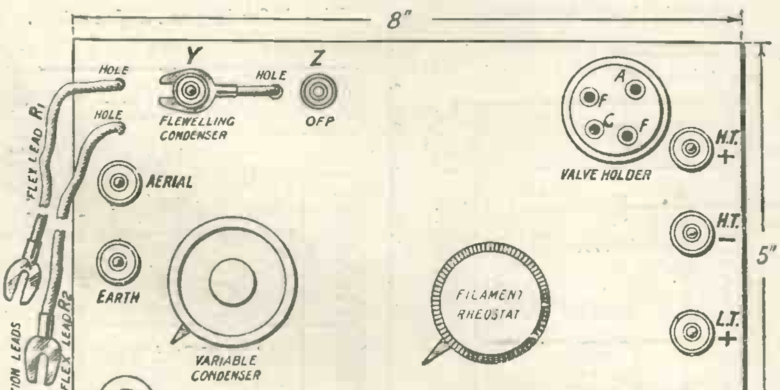


Fig. 3.—Plan of the top of the panel.

The Set as a "Haynes DX" Receiver.

With the set arranged as a "Haynes DX" receiver, a special type of basket coil was used for the aerial-earth-grid circuit. This special type of coil was the outcome of seeing a similar coil devised by Major C. E. Castellan, an experimenter with whom the present writer has worked for a number of years. The manner of making this special coil was as follows :—

Two circular discs of cardboard of radius 2½ in. were cut and fastened securely together with a couple of paper fasteners pushed through holes in the centre of the double disc, the two holes being an inch apart. Nine radial slits were then cut in the double disc. The "grid" coil was wound in the usual basket coil manner, under-over, under-over on the double card. The "aerial" coil however was bound *in between* the two discs and was almost completely out of sight. The wire used for the "aerial" coil was No. 22 D.C.C., and the wire for the "grid" coil was No. 28 D.C.C. When the coils had been wound, the paper fasteners were removed and the central portion of the cardboard cut away, leaving a hole of 1¼ in. diameter.

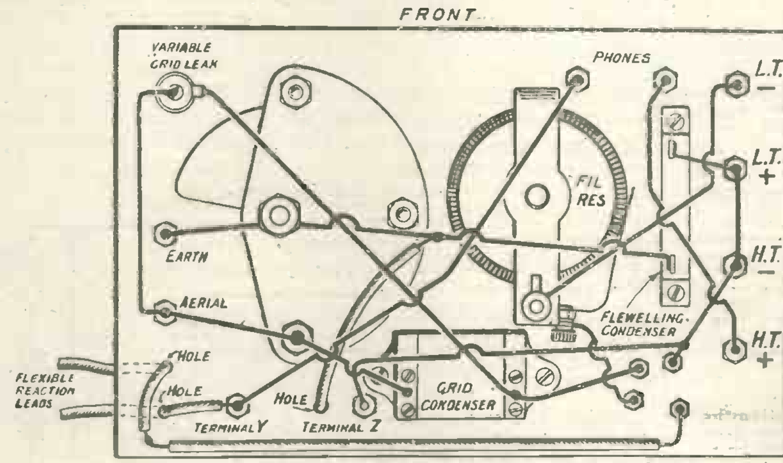


Fig. 4.—Wiring diagram of the back of panel.

Various proportions of turns for the "aerial" and "grid" coils were tried. Three coils were retained. Their proportions of "aerial" to "grid" were: (i) 1 to 3; (ii) 1 to 5; and (iii) 1 to 7. In each of these coils there were roughly 60 turns of "grid" coil, 30 on each side of the double disc. With the variable condenser described, these coils gave a range of wavelengths of approximately 350 to 500 metres.

(Continued on page 625.)

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100 ft. Aerial, 7/22 .. 3/3
Rubber Lead-In, 10 yds. 1/6
Basket Coil Holder and Plug 1/9
Do., 2-way on Stand .. 5/6
2-way for Igranic Coils.. 4/11
Various Designs do. 5/11, 6/11 & 7/-
Shaw's Genuine Hertzite 1/3
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Do., Extra Quality .. 1/8
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(All above with Nut.)
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Switch Arm, 12 Studs and Nuts 1/6
Ormond Fils. Resistance.. 2/6
Fixed Condensers, .001.. 1/2
Do., .0001 to .0005 .. 1/2
Do., .002 to .005, 1/3; .006 1/6
(Above best quality.)
Grid Leak and Condenser, .0003 .. .. .. 2/6
Ebonite Vario, D.S.C, 250/260 .. .. .. 4/11
Do., D.C.C. Ball Rotar ... 6/9
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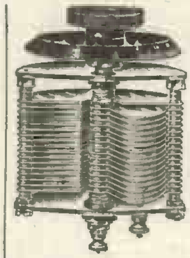

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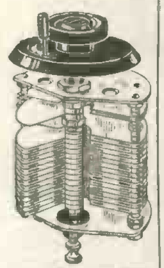

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The equivalent series resistance was measured at a radio frequency of 500 kilocycles with the condenser set at its maximum capacity AND WAS FOUND TO BE 0.05 OHMS.

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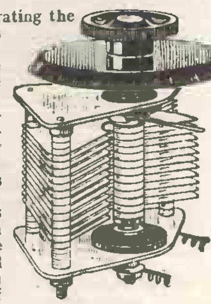

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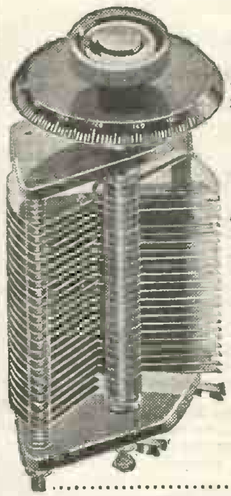

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16½ ,,	**Variable Tappings**	at **3/3** ,,
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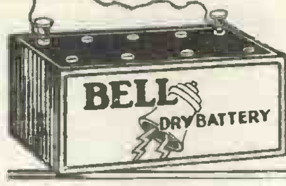
Two Wander Plugs supplied with each Variable Battery.



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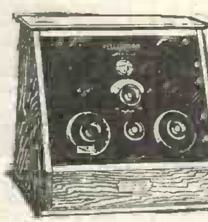

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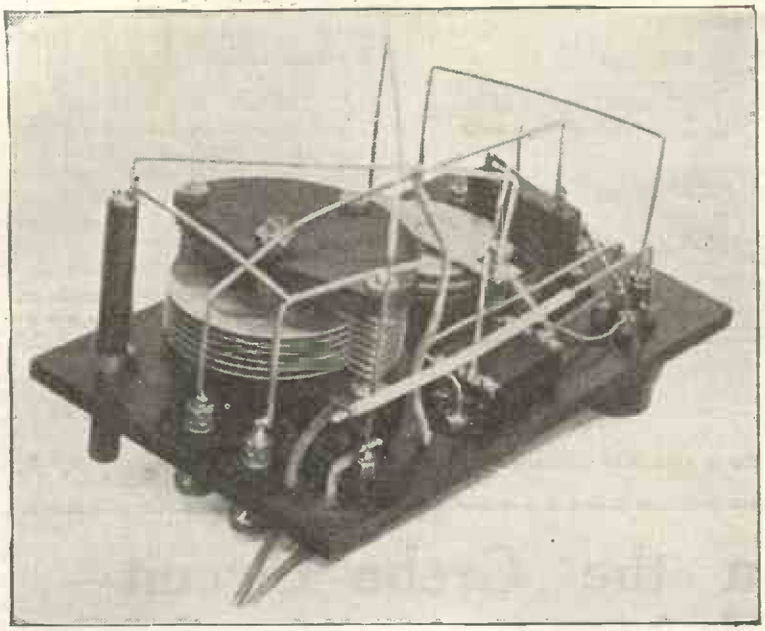


Fig. 5.—Photograph showing back of panel wiring.

(*Continued from page* 622.)

Coil (i) was found to be the best for long distance work, and Aberdeen at a distance of over 400 miles was picked up with this coil the first time it was used. Paris (450 metres) and Aberdeen were both picked up with coil (ii). The nearest station, 2LO, at 14 miles, appeared to be most powerful on coil (iii).

The reaction coils used in the experiments with the set as a "Haynes DX" receiver varied from 40 to 80 turns of No. 28 D.C.C. basket winding on cardboard discs.

Fig. 7 illustrates the aerial-earth-grid type of coil used with the Haynes circuit. Fig. 8 indicates the connections made from such a coil to the panel.

The Set as a Flewelling Receiver.

With the set in use as a Flewelling super-regenerative receiver, a basket coil of 40 turns of No. 22 D.C.C. proved suitable for the aerial-earth coil when it was desired to receive 2LO, the reaction coil consisting of 80 turns of No. 28 D.C.C. Excellent telephony was received with these coils when the earth lead was attached to the aerial terminal, there being no aerial. Slightly better results were obtained with an indoor aerial consisting of 15 ft. of No. 18 D.C.C. wire slung across a room.

The connections for using the set as a Flewelling receiver are given in Fig. 9. Very careful

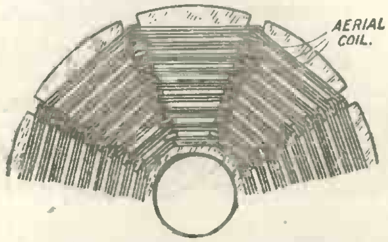


Fig. 7.—Diagram of the double spider type of coil which is used with this set.

adjustment of the variable grid leak was found to be the essential feature of tuning with the Flewelling circuit. The position of the reaction coil was also very critical.

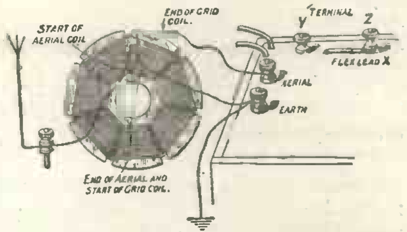


Fig. 8.—Diagram showing how to connect the Haynes coil to the panel.

A Modified Flewelling Receiver

The modified Flewelling circuit suggested is in reality a combination of the Flewelling and the Haynes circuits. The aerial-earth-grid coils used were the

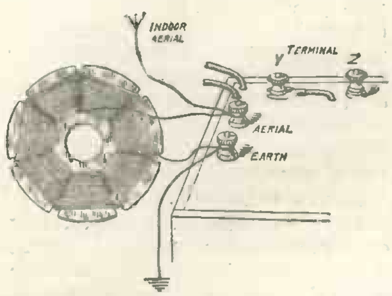


Fig. 9.—The connections for the Flewelling circuit.

same as those used with an outdoor aerial for the "Haynes DX" receiver. The reaction coil used consisted of 80 turns of No. 28 D.C.C. With the new type of coil already described, excellent telephony was received from 2LO at a distance of 14 miles, the indoor aerial again consisting of 15 feet

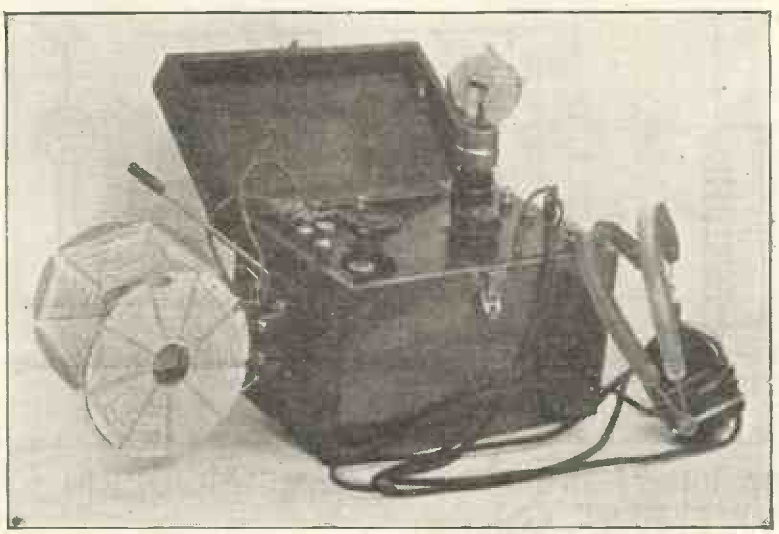


Fig. 6.—This photograph shows the set as it appears when it is ready for use.

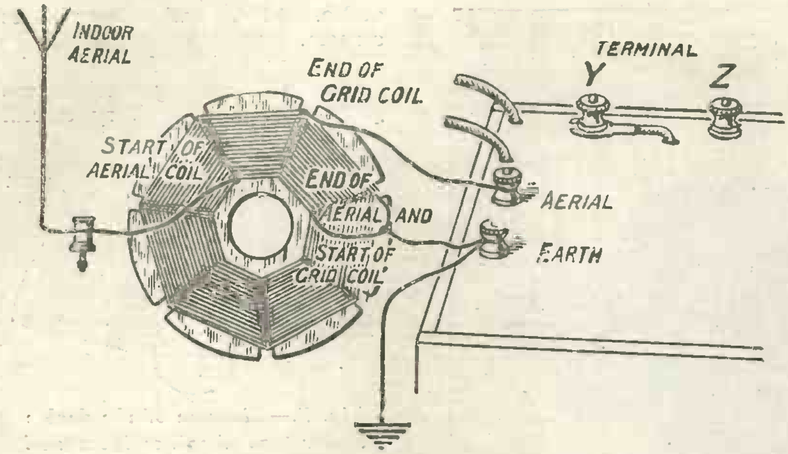


Fig. 10.—Showing the connections for a modified Flewelling.

of No. 18 D.C.C. wire. Coil (iii.), aerial to grid turns 1 to 7, gave the best results.

Further Experiments.

The receiver as described forms a convenient starting point for an interesting series of experiments. It is extremely likely that more efficient coils having different proportions of "aerial" to "grid" windings may be the outcome of further work with this receiver.

NOTE

Readers' reports on this and other sets will be welcomed

A Note on the Grebe Circuit Modification

DEAR SIR,—With Mr. Percy Harris' modifications of the Grebe C.R. 13, described in the March issue of MODERN WIRELESS, I am certain one could wish for no better result in high-frequency amplification, but to a certain extent you are entirely tied to its one use.

I have tried, if possible, to give something in the form of an all-purposes set, using the method described by him and keeping strictly to his instruction, in fact, making no actual alterations regarding its working. For those who have already constructed this set the additions can all be made from the outside of the present panel, which can be done by connecting the L.F. transformers to the terminals already used for the H.F. coils, remembering, of course, that these must be removed. The outside transformer secondary lead going to the rectifying valve being connected through a grid-leak and condenser.

For those who have not already constructed this panel I would suggest the instalment of four D.P.D.T. switches together with a grid-leak and condenser for each valve made, so that they can be shorted when not in use.

I am not in favour of switches as a rule, because they are in nearly every case the cause of dead-end effects.

The enclosed diagram is self-explanatory and shows clearly the entire elimination of dead-end effects.

Switching Arrangements

When switch No. 1 is in B position and switch No. 2 in D, switch No. 3 in F, and No. 4 in H, with the two first grid-leaks shorted, you have Mr. P. Harris' arrangement of the Grebe 13.

With switch No. 1 in A, and No. 2 in C, and No. 3 in E, and No. 4 in G, with the last two grid-leaks shorted, you have 1D, 2L, F.

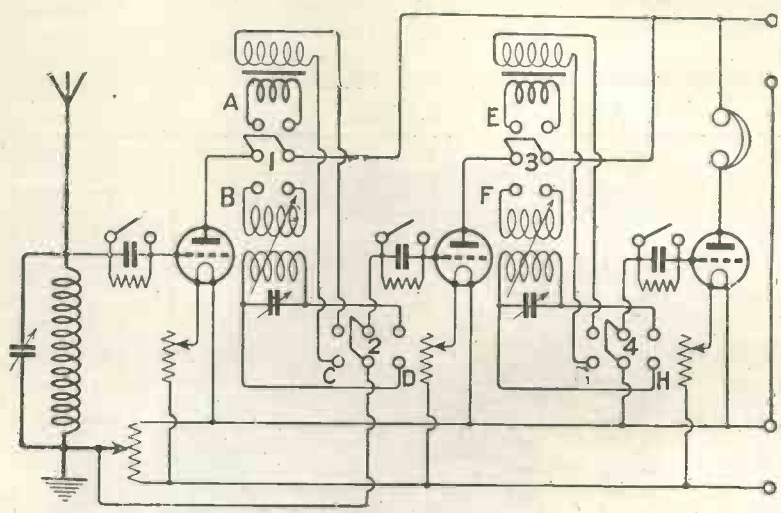
With switch No. 1 and 2 as mentioned at first, and No. 3 and 4 left in the last-mentioned position, you have with the first and last grid-leaks shorted 1 H.F., 1 Dec., 1 L.F.

Yours truly,

FRANK PEARSE.

Stockwell, S.W. 9.

March 11th, 1924.



Mr. Pearse's arrangement.

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3 VALVES	8 0 0	3 VALVES	10 0 0
4 VALVES	10 10 0	4 VALVES	13 0 0

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12 × 10 × ¼	7/6 ,,	10/6

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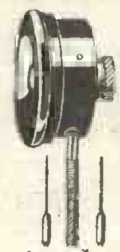

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More About the S.T.100 Star Circuit

By THE EDITOR

Many thousands were unable to secure the March issue and have asked for a further reproduction of the S.T. 100 Star circuit. This article will help them.

REPORTS from readers—which, by the way, are always greatly welcomed—confirm what I expected regarding the comparison between the ST.100 and the ST.100 Star circuit. The general opinion seems to indicate that the ST.100 Star does not give quite the same strength of signal as the ST.100, although there is really very little in it.

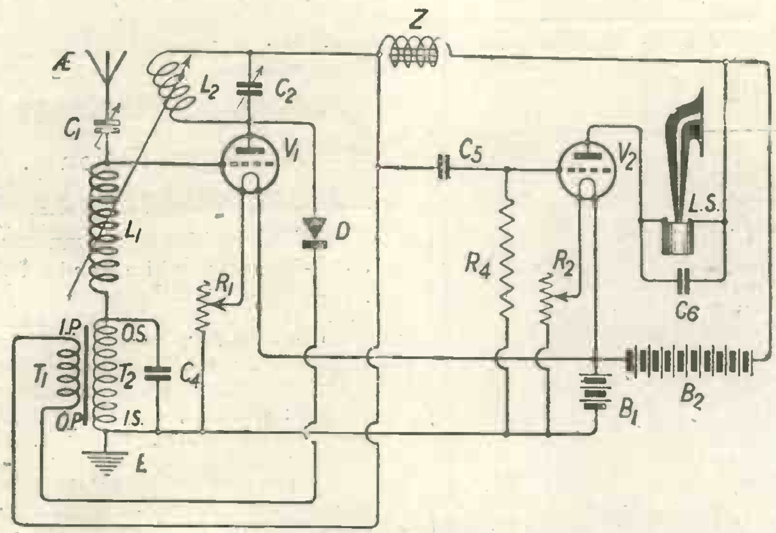


Fig. 1.—The S.T.100 Star circuit.

On the other hand, there are many who prefer the ST.100 Star. The newer circuit, no doubt, has several advantages of its own, which can only be fully appreciated after experience with both types of circuits.

As there will be a large number of readers of this issue who were disappointed at not being able to obtain the Spring Double Number of MODERN WIRELESS published last month, the ST.100 Star circuit is reproduced again in Fig. 1. It will be seen that the transformer, coupling the two valves in the ST.100, has been replaced by a choke coil Z, which is of a pattern obtainable from Messrs. Peto Scott Company, Radio Instruments, Burne-Jones and Co., Ltd. These chokes are of considerable utility in numerous other circuits, as well as the ST.100 Star.

In Fig. 1 the variable condensers, C_1 and C_2, may have a value of, 0.0005 μF, while C_4 has a value of 0.001 μF and C_5 a value of 0.002 μF. The condenser C_6 has a value of 0.004 μF, while the value of the leak R_4 does not seem to be very material, and may either be a grid-leak or a 100,000 ohm variable resistance. For broadcast wavelengths, L_1 will usually be a No. 75 plug-in coil, while L_2 is a No. 50 for wavelengths up to 400 metres, and a No. 75 for wavelengths above 400 metres. The high-tension battery should have a value of 100 volts, if possible, in the case of ordinary valves, and about 75 volts in the case of dull emitters.

In the case of some valves there is a possibility of a certain amount of distortion due to the second valve rectifying with its grid condenser. This may be overcome by using a circuit of the kind illustrated in Fig. 2. A grid battery B_3 is introduced so as to give both grids a negative potential, or bias. This will be found to cure the trouble.

A resistance of 50,000 to 100,000 ohms should be tried in place of R_4. It does not seem to matter

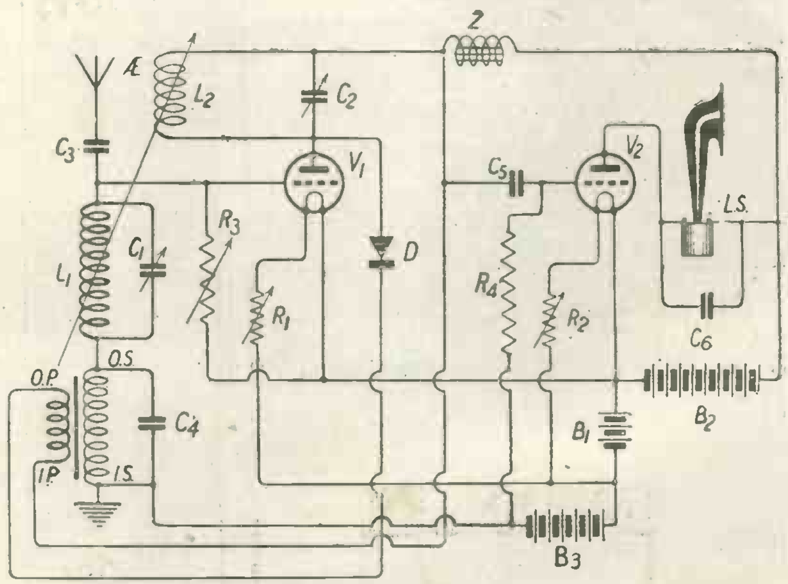


Fig. 2.—The addition of a grid-bias battery, as shown, is sometimes advisable.

very much what size of resistance is used for the gridleak, and generally it is possible to do without a gridleak at all, although when using very hard valves and the insulation of the set is perfect there is a tendency for the valve to "choke up."

Use of Resistance

Before arriving at the ST 100 Star circuit I carried out tests with a resistance for coupling the first and second valves, and the circuit I used is illustrated in Fig. 3. A resistance R_3, which is of the 100,000 ohm variable type, is connected in the position shown in place of the iron core choke coil, and I also tried connecting different sizes of condensers across this resistance. The condenser C_6, illustrated in Fig. 3, had a value of 0.001 μF, and quite good results were obtainable with this circuit.

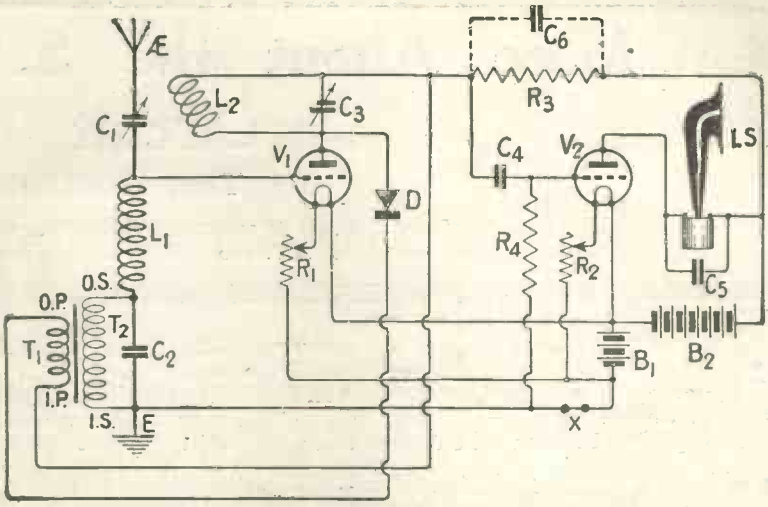
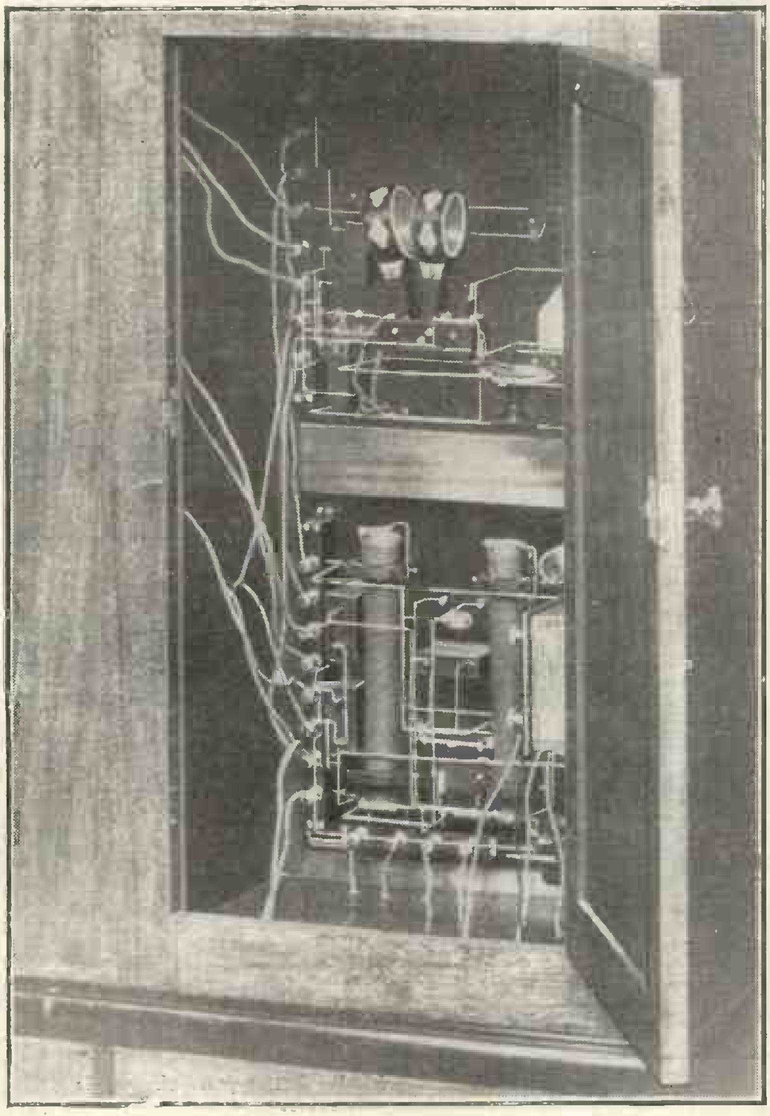


Fig. 3.—Resistance coupling between first and second valves in the S.T.100 Star circuit.



Interior of the King's receiver (see page 589).

An Appreciation

To the Editor of MODERN WIRELESS.

SIR,—I must write and tell you how pleased I am with my S.T. 100. I am situated three miles from 2 Z Y and the volume is terrific if I want it, but with the reaction loosely coupled the tone is perfect; in fact, everybody who has heard it remark about it. I might add that I get all stations. London comes in fine on the loud speaker when Manchester is off, of course. The components I have used are B.T.H. dull emitter valves, Lissenstat; Lissen transformers, Polar condensers and Polar cam vernier coil holder. I also use 80 volts H.T. with 6 volts grid bias.

Last week I constructed the S.T. 74, and on test I got Manchester with good strength on the loud speaker. This was made for my mother at Blackpool, so after test I decided that if it was not powerful enough to secure 2 ZY with any strength I would work my speaker in Manchester and let them have my S.T. 100, but that was not so. Manchester could he heard across the house and with the reaction coupled pretty loose.

I had not much time to try for other stations.

I might add that with the S.T. 74 in one night I received London, Birmingham, Bournemouth and Glasgow with good strength from Manchester.

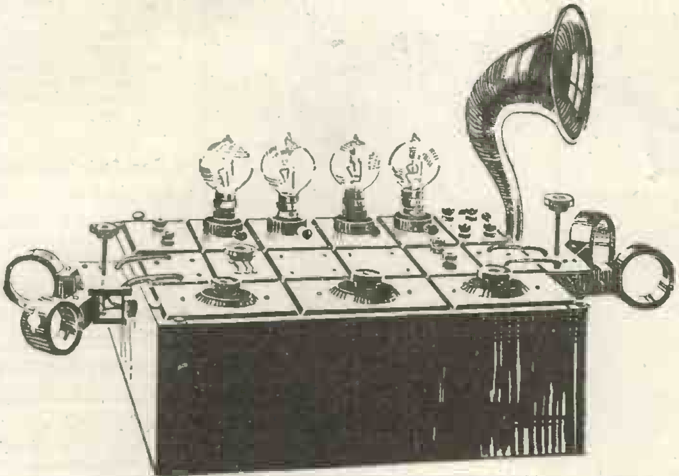
I am willing to help anyone in their endeavour to construct the S.T. 100.

I am, Yours,

S. C. BARNES.

Manchester.

"Simple to build— Difficult to beat."



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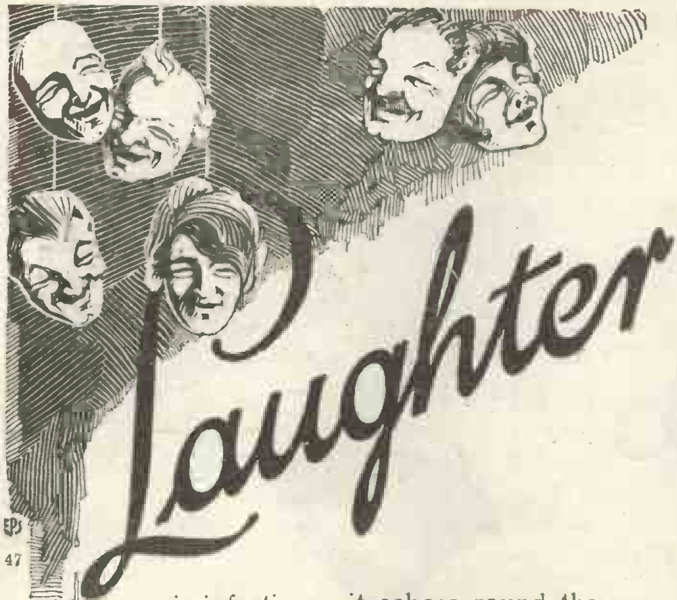

is infectious—it echoes round the room. A thousand people are laughing and enjoying the good stuff broadcasted. Why not end your wireless worries by getting a really good set at an extraordinarily reasonable price ?

The Fellophone Super 3 is shown below. This instrument is mounted in a well-finished mahogany case, and comprises 1 H.F. valve, 1 detector, and 1 L.F. valve. It permits the fullest reaction allowed by the P.M.G. and first-class reception of all British and Western Continental telephony is assured, even though the nearest Broadcasting station is working.

Complete with H.T. Battery, accumulators, 100 feet aerial with two insulators, and 1 pair 4,000 ohms headphones.

Price, £12.

Extras : B.B.C. tax £1 ; Marconi tax, £1 17s. 6d. and 3 valves.

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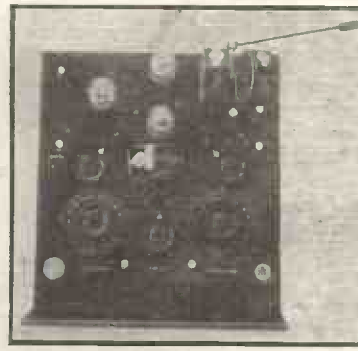

This efficient apparatus will receive all B.B.C. and most Continental Broadcasting Stations on Loud-Speaker. Numerous Testimonials have been received from thoroughly satisfied customers in all parts of the British Isles.

Price £10 10s. *(Marconi and B.B.C. Fees £2 17s. 6d. extra).*

Four - Valve Set £13 13s. Special Four - Valve Set £17 17s. (*With cut-out switches.*) *(Marconi and B.B.C. Royalties £3 15s. 0d. extra).*

Improved Wave-Trap, which, attached to any set, will cut out interference from any station although only ¼-mile away. 25/-, including plug-in coil. Please state wavelength to be eliminated.

The "N.S." Accumulator. This wonderful accumulator may be fully charged in one hour. It will not sulphate under any circumstances whatever. Write for particulars.

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By W. J. TURBERVILLE CREWE,

Hon. Sec. Golders Green Radio Society.

HAVE you noticed the amazing growth of a new power in the British Isles? A power which, since the relaxation of the regulations, has taken into its head to avail itself of the opportunity to make itself felt on every conceivable occasion! Of course you have!

I refer to the "Great Society of Howlers, Heterodyners and Oscillators" whose "local centres" are distributed throughout our land.

Jones, a few doors away, contracts the "Radio-fan fever." He knows nothing—or worse—he thinks he knows something about the principles of reception and hey! presto! he hoists an aerial as near the sky as possible and commandeers the services of the nearest water or gas main as his "earth."

All goes well! and Jones listens entranced to his local Broadcast Station. So far the neighbourhood is at peace. But, at length, the serpent steals into his paradise and whispers in his ear, "You are surely not content to listen only to 2LO (or 5SC as the case may be)! Broaden your mind and equip yourself to listen to the World at will!" And Jones falls to the temptation and forthwith delves into the mysteries of "valves," "tickler coils" (as our American friends call them) and the hundred and one gadgets which go to the building up of a potentially operated Receiving Station.

And then the trouble begins!

"I get all the eight Stations of the B.B.C. on *one* valve on the Loud Speaker," says Brown, who, boasting of his achievements, seeks to impress Jones with a sense of his knowledge; and, fired with enthusiasm, Jones returns home to attempt to do likewise. He discovers that by bringing two coils together the strength of the speech or music is tremendously increased until he can hear a mighty rushing wind. Flushed and excited, his trembling fingers draw the coils closer and he lets loose upon the ether the moans and howls of a thousand Tom-cats! He tries again! And again the terrible shrieks burst forth, perhaps this time with redoubled energy. He brings the coils yet closer together and he finds that the howls diminish in intensity—and so, incidentally, does the speech or music.

Now, Jones may think that it is only these howls and shrieks that are audible to everybody listening within a considerable radius; and seriously interfere with reception. He is probably unaware that these howls are not the main cause of the trouble. Fearfully, and for his own sake, he ceases squealing, but still hears the "rushing mighty wind!" Vainly hunting for stations by turning his condenser, he is a real and hated howler, although he may feel quite safe because he no longer hears the awful squawk.

I do not believe for one instant that anyone worthy of the name of Briton would willingly cause suffering and annoyance to his fellow creatures. But how is he to know that he is causing suffering and annoyance?

Well! there are numerous text-books which will educate him up to a point! There are Institutes where the Science of Radio-telegraphy and telephony is taught! The B.B.C. issue leaflets *gratis* upon the subject of Oscillation. But there is a mine of information lying just outside your door! I refer to your local Radio Society.

You may ask, "What is the use of a Radio Society? What does it do? What benefits shall I derive from joining it?"

"Here you may ascertain everything you do not know about Wireless for the asking!" I answer. The practical demonstrations and lectures, couched in the simplest of language, will give you knowledge. Your questions will be answered with authority. Your inquiries will be met with a sympathetic ear! Do not fear scorn at your ignorance—it is the only factor which is blissfully absent! And you will be a happier man—happier in the success of your own personal achievements and in the knowledge that you no longer cause suffering to your fellow creatures.

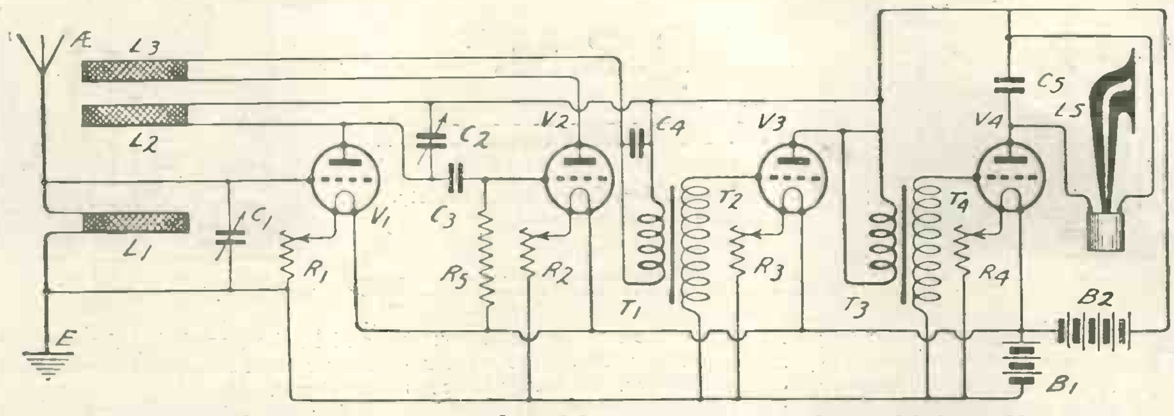
Let me paint one more picture before closing.

Suppose, just suppose, for one moment that you experience "interference" from the "other fellow" when you are listening. You talk about it when you meet others at your Society meetings; they also are experiencing "interference." You exchange notes as to time, wave length, etc., etc., and, together, you report it to your Secretary. The Committee take the matter up and some of the more advanced members work together to locate the offender. In a friendly way, and diplomatically, the offender is approached by the Society. Possibly the warning has no effect! The Society reports to a higher power—the Radio Society of Great Britain. This organisation takes the matter up and, perhaps as a last resource, reports to the Post Office. The whole point is that the nuisance is eventually stopped!

But, without your co-operation and my co-operation, no one would or could have taken any satisfactory action in the matter, and we should have gone on suffering, and grumbling, and Jones would still have continued in his ignorance!

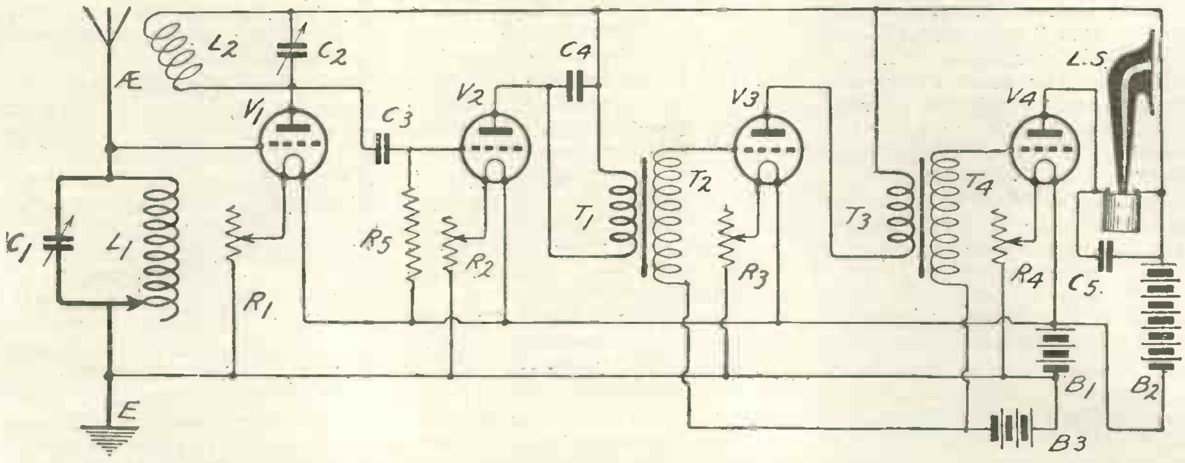
Your ambition is to progress, not to stand still! Well! Join your local Radio Society and help to preserve peace in the ether and destroy for ever this power for evil that has grown up amongst us!

Some Useful Multi-Valve Circuits



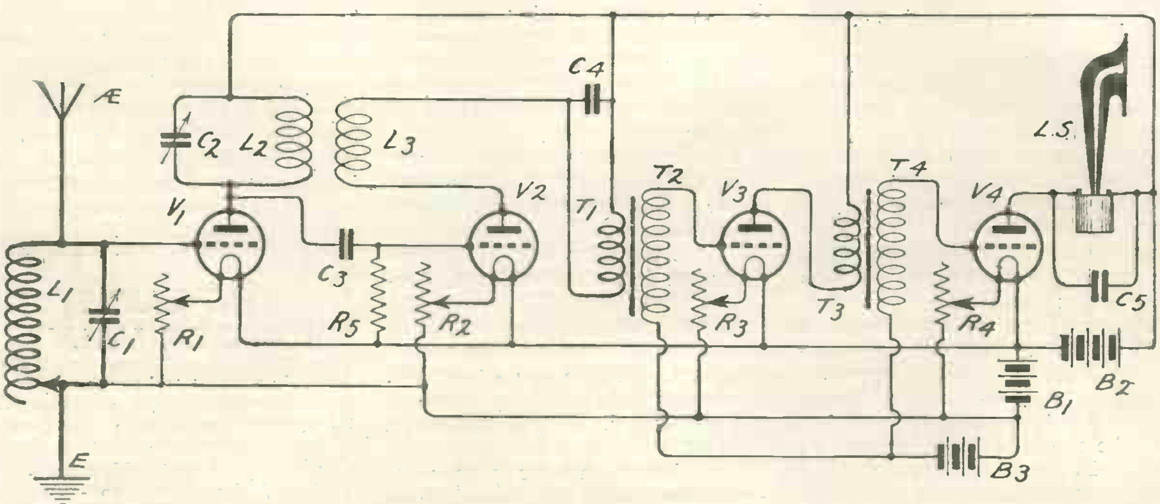
A four-valve double reaction receiver, L_1, L_2 and L_3 are mounted on a three-coil holder. V_1 is a high-frequency amplifier, V_2 is a detector, in the anode circuit of which we have the coil L_3, which is coupled to L_2. The valves V_3 and V_4 are note magnifiers.

Values: C_1, C_2=0.0005 μF. C_3=0.0003 μF. C_4=0.002 μF. C_5=0.05 μF. R_5=2 megohms.



A useful four-valve circuit. Reaction may be obtained by coupling L_2 to L_1. A grid bias battery B_3 may be included as shown.

Values: C_1, C_2=0.0005 μF. C_3=0.0003 μF. C_4=0.002 μF. C_5=0.05 μF. R_5=2 megohms.



A four-valve circuit employing reaction on to a tuned anode.

Values: C_1, C_2=0.0005 μF. C_3=0.0003 μF. C_4=0.002 μF. R_5=2 megohms.

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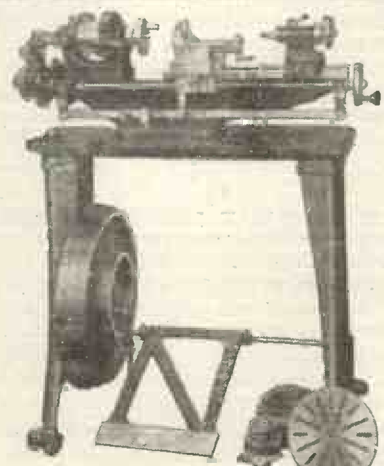

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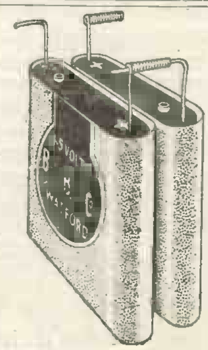

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Tested by Ourselves

The Woodhall L.F. Transformer

Messrs. Woodhall Wireless have submitted a sample of their latest pattern L.F. intervalve transformer. As we have had on a previous occasion to criticise adversely one point in an earlier pattern of this instrument, whilst finding on test a most satisfactory general performance, we were glad to have an opportunity of ascertaining how far this matter had been rectified. On test, with 500 volts D.C. from a "Meg" tester, between windings and from each winding to the frame, the insulation resistance was considerably over 100 megohms, which is quite unexceptionable. The exterior appearance of the instrument has not been changed; it is a large heavy one, with very substantial iron circuit having two narrow exposed air-gaps and ample windings. We were glad to note the handsome big terminals fitted, so convenient for amateur experimental work. An interesting feature in the design is that no bolts pass through the laminations of the core. The turns ratio is given as 4.1, and there are evidently an ample number of turns.

On actual test in reception, good amplification, free from distortion, was obtained, comparing favourably with the usual standards. It was silent in operation, and stood up well to a heavy plate current.

In its present form, this instrument can well be recommended for incorporation in receiving sets.

A Fine - Adjustment Two - Coil Holder

A two-coil holder with a fine-adjustment movement of an ingenious type is that sent for practical trial by Mr. N. V. Webber. In this instrument the moving coil has two distinct motions; one, in a linear manner, towards and away from the vertical fixed coil, by means of a coarse-thread screw and nut mechanism; the other a motion of rotation around a vertical axis, controlled apparently by a worm-and-wheel, the worm sliding with the coil-holder along a hexagonal shaft. Two knobs at the end, remote from the fixed coil, control these two motions. The effect of this double motion is that the coupling between the two coils can be reduced actually to zero, and then reversed, in an exceedingly smooth manner. At the same time, by a small angular rotation of the moving coil at any setting, a fine adjustment of coupling becomes available.

On practical trial in reception, the instrument was found to perform satisfactorily, a delicate control over reaction-coupling being possible. The action was not quite as smooth and free from back-lash as might be desired; no doubt this will be remedied in later patterns. The holder would take the larger sizes of ordinary plug-in coils.

The instrument was mounted on a small baseboard, $5\frac{3}{4}$ in. by $3\frac{1}{4}$ in., the control-knobs overhanging at one end. It was quite convenient for use on the table; or could be mounted, of course, on the top or side of a cabinet instrument. The connection to the moving coil from its terminals (at the far end of the instrument) was by substantial flex. Insulation and finish were observed to be of a high order.

Ferranti L.F. Intervalve Transformer

Messrs. Ferranti have submitted for test a sample of their Ferranti L.F. transformer. This is a well-finished instrument, showing signs of good workmanship and careful design. Thus, the iron core is fairly substantial, and no bolts pass through the laminations. Massive and convenient terminals are provided on a small ebonite panel on the top; whilst a soldering tag is fixed to the frame for earthing the latter when required. The transformer stands about 4 in. high, and occupies a space of $2\frac{1}{2}$ in. by 2 in.

The insulation-resistance, measured with the "Meg" tester on 500 volts D.C., was exceedingly good, both between windings and from windings to frame.

Compared in actual reception of telephony against standard makes, both in ordinary amplification with moderate plate voltage and in power amplification with heavy plate currents and extreme H.T. the transformer stood up well, and gave good amplification and freedom from distortion. It is evident that these instruments undergo a careful process of inspection at the works before being issued for sale; the impression that one received was that they can be adopted with every confidence.

Panel Switches

A neat and highly-finished form of filament lighting switch is that submitted by Messrs. S. Smith and Sons. The sample was a triple switch, with a plated front measuring 2¾ in. by 1¾ in., and requiring a clearance hole about 1⅝ in. by ⅞ in. in the panel to accommodate the barrels which house the working parts of the switch. A clearance of some 1¼ in. is required behind the panel. Small terminal screws, one for each valve-circuit, and a common bus-bar with small screws in it, provide the connections. The switches are actuated by small plated knobs, which pull out and push in. The "on" and "off" positions are clearly indicated by a loud click in operation, and are quite positive.

On test, the insulation was found excellent, and good contact was made. These switches would make an attractive and useful addition to a multi-valve panel.

"Push-Pull" L.F. Transformers

We have received from Messrs. Economic Electric Co., Ltd., sample of their L.F. transformers designed for the "push-pull" method of working. The equipment consists of two transformers, both with a middle tapping in one of the windings. The input transformer has the usual two primary connections for the plate of the valve, and for connection to the H.T. supply respectively. The secondary winding has one connection for the L.T. minus (or grid-bias cells); but two connections marked "grid." These are connected to the grids of two amplifying valves, which are worked, as it were, in parallel—though actually in opposite phases. The second instrument—a telephone-transformer, has a split primary winding, with connections for the two plates and a third terminal for connection to the H.T. supply. The secondary is a single winding for a 2,000 ohms loud speaker output.

The two transformers are similar in appearance, being small metal-cased instruments, of good finish. The plated terminals pass through insulating bushes in the metal case, and are clearly marked.

On actual trial, on local broadcasting, with an efficient single-valve receiver in front of the equipment, two hard R valves for the amplifying part, and proper grid-bias for the particular value of H.T. used, very clear and distortionless loud-speaking was obtained, though this was not extremely powerful. It was noticed that the reproduction was much more free from distortion when using the double arrangement than when using one amplifying valve alone. There was not much improvement in signal-strength by the use of extremely high plate voltage, of the order of "power amplification."

A H.F. Plug-in Transformer

From the Vector Electrical Company comes a plug-in H.F. transformer of the conventional type, with four pins to plug into valve-sockets for electrical connections. The model submitted was intended to cover the wave-lengths from 350 to 500 metres when the primary was tuned by a .0002 μF variable condenser in parallel with it.

On trial in a two-valve receiver with efficient but not particularly selective aerial tuning, the transformer was found to tune with a .0002 μF condenser of unusually low minimum capacity from 350 metres up, the 500 metre wave being reached with less than the full .0002 μF (actual—not nominal) capacity across the primary. With a variable condenser of average make, possessing a high minimum capacity, it might be found impossible to tune right down to Cardiff's wave. Amplification was everywhere quite satisfactory, approaching that with an efficient tuned-anode coupling; and selectivity was also of an unusually high order for a conventional type of H.F. transformer. The resistance of the primary winding was found unusually low; that of the secondary distinctly higher, though still a great deal less than is common in these instruments. Accordingly, this model gave far better results than are commonly observed in H.F. transformer couplings, but at the cost, as usual, of introducing some instability if too small a series condenser were used in the aerial circuit.

The B.B.C. stations and the Paris concert were readily picked up on the two valves. Bournemouth, at 13 miles from 2LO, came in at equal strength in a duet with London; Cardiff could be just read through London; whilst Birmingham was clear and free from jamming.

As we understand that the sample submitted was a rough experimental model, we will not comment on appearance or finish

Fellows' Junior Loud-Speaker

A loud-speaker of medium size and simple design has been submitted for practical test by Messrs.

Fellows. This, the Fellows Junior, has a 2,000 ohm single earpiece set in the base of a trumpet of the usual curved type, standing some 19 in. high. The magnets in this ear-piece are not adjustable and the diaphragm is small. The finish is in dull black. A twin braided connector (of rather inadequate length) is provided with the instrument.

On trial in a two-valve broadcast receiver, giving normally extremely pure reception of adequate loud-speaker strength, and in comparison with a reliable type of somewhat more elaborate design, quite good reception was obtained, though rather duller in tone and intensity than with the latter. As a test of sensitiveness, loud reception on a really efficient crystal set (at 13 miles from 2LO) was just readable on this loud-speaker at 6 ft. in a very quiet room.

A Grid-Leak Holder

Of the same style as the condenser-holder mentioned above is a grid-leak holder, for tubular type of grid-leaks with pointed ends, of about 2¼ in. length, made by the Grafton Electric Co. The ebonite base carries the necessary clips and terminals. It is well finished, and gives good insulation.

A Cat's Whisker.

Messrs. Willesford have sent for test a sample of their Multi-Point cat's whisker for crystal detectors of the galena type. This takes the form of a small brush of wires, formed into a solid shank at one end which is mounted in the holder and opened out somewhat at the end which makes contact with the crystal. Thus several points of contact are offered, and the chances of getting a good setting in some at least of these several points is considerably greater than with a single point.

In trial on local broadcasting on a standard efficient type of crystal receiver, and with a new sensitive crystal, it was found exceedingly easy to get a satisfactory setting of the cat's whisker—almost blind setting at random sufficed in most cases—so long as the brush was kept fairly small and short circuits to the crystal cup were avoided; better reception was obtained by trimming the brush so that the minimum number of points of wire touched the crystal at the same time.

"Clix" Terminals

An ingenious form of terminal of many uses is the "Clix" combined plug and socket, marketed by Messrs. Autoveyors Ltd., samples of which have been submitted for practical test.

A screwed brass socket, screwed externally with a No. 2 B.A. thread, has a taper tail with a coarse buttress spiral thread turned on it, which will plug into the socket of a fellow terminal with a secure grip, but is removable with great ease. The socket is also slotted for convenience in attaching wires. A coloured insulator locknut, or insulating bushes for mounting on wooden panels, which screw on it, enable this fitting to be used as a terminal, wander plug, switching or tapping device, multiple 'phone terminal (by pyramiding several) and for a great many other purposes. Thus connections can be made by other "Clix," both below and above the panel, or permanent connection can be made below by soldering in the usual way, when a neat plug-in fitting is obtained above.

For rapid change of wiring in experimental work, as well as for regular external connection to batteries, aerial and earth, etc., these terminals will find many applications.

A Switch of Minimum Capacity

Messrs. The Dubilier Condenser Co. (1921), Ltd., have submitted for test a sample of their "Minicap" key switches for panel mounting, which are designed especially with a view to minimising the stray capacities introduced by some types of switching-gear; in particular, for use in H.F. circuits.

This takes the form of a double-pole two-way switch, giving six terminals, each provided with a soldering tag. The operating key carries double contact pieces, which make a sound rubbing contact with the other pieces, connecting the centre to either of the two outer terminals, according to position, on each side. As the metal connectors are well spaced, the two sides can be used for different circuits, so that the switch is available for simple reversing, series-parallel, single or double circuit change over, control switch for extra H.F. or L.F. valves, etc.

On test, the switch was found to work exceedingly smoothly and make good contact in either position. The capacity between the two opposite sides of the switch proved to be approximately .000004 μF (4 micro-micro-farads) on measurement—therefore, quite negligible for all ordinary purposes. Between adjacent connectors it was even less.

With reasonably careful arrangement of wiring, there should be no difficulty introduced through the use of this switch in ordinary H.F. circuits through capacity effects.

The switch occupies a space of $1\frac{7}{8}$ in. by $\frac{7}{8}$ in. on the panel, and is about 3 in. long. The workmanship and finish were unexceptionable.

A Galena Crystal

Messrs. L. McMichael & Co., Ltd., have handed us for practical trial a sample of a crystal of the sensitive galena type, which on test in actual reception, both quantitatively (measurement of the total rectified carrier-wave) and by careful aural observation showed a rectifying power which compared well with the average good artificial galena. In a powerful dual circuit it stood up well.

The sensitive spots were so easy to find as to give one the impression of being almost continuous; and on breaking the crystal equally good surfaces were obtained.

A Useful H.T. Battery

We have received from Mr. C. A. Finchett a 60-volt battery for test.

The Finchett H.T. Battery with renewable units.

This, as shown in the photograph, is made up in a neat wooden cabinet of individual cells so arranged that in the case of any one failing it may be rapidly replaced. The cells are of ample size and therefore give far more satisfactory service than is the case with the small high tension batteries made up as miniature flash lamp cells.

The complete battery is sold for 17s. 6d. with renewal cells at 4d. each. Substantial terminals mounted on ebonite are provided, and the workmanship throughout is excellent. It should certainly appeal to all who are dissatisfied with the meagre yield of some of the small and shoddy high tension batteries now sold.


TYPE B5
3 V.
TYPE B4
6 V.
R Type
Filament Volts - - 4 volts
Filament Current - - 0.63 amps
Anode Volts - - 40-60 volts
B5 Type
Filament Volts - 2.5-3 volts
Filament Current - 0.06 amps
Anode Volts - 20-80 volts
B4 Type
Filament Volts - 6 volts
Filament Current - 0.25 amps
Anode Volts - 40-100 volts
B.T.H.
RADIO VALVES
THERE are no better valves in the world than the three illustrated above. The R valve for general purposes, the B5 valve (0.06 amps) for use with dry batteries, and the B4 power amplifying valve (0.25 amps) meet all requirements of experimenter and listener-in.
The amber-tinted bulb of the R type and B4 valves and the silvered bulb of the B5 valve are the outward and visible signs of a perfect vacuum. The colouring of the bulbs is an incidental result of a process which produces a high and permanent vacuum. Bear this point in mind and buy B.T.H valves always.
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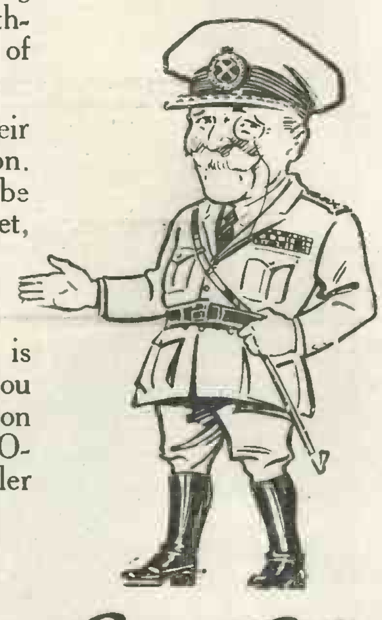
These two facts alone place GENERAL RADIOPHONES far above all others for efficiency—in addition they embody the finest materials, Duralumin Headbands for strength and lightness, Cobalt Steel Magnets for long life—they weigh complete only 7 ounces, and will fit any head, being instantly adjustable without the manipulation of screws and nuts.

Above all there is their marvellous reproduction. However satisfied you may be with your present headset, however difficult it may be to imagine anything better than the reception you are achieving, there is a big surprise in store for you the first time you don GENERAL RADIOPHONES. Ask your dealer for a demonstration.



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General Radio

Reflex Wireless Receivers in Theory and Practice

By JOHN SCOTT-TAGGART, F.Inst.P., A.M.I.E.E.

This article is the second of an important series dealing exhaustively with dual amplification in all its forms. A further instalment will appear next month.

THE remarks which have already been made in regard to the self-capacity of transformer windings will explain why an air-core choke coil is generally inserted in series with the telephone receivers or primary of an intervalve transformer through which the low-frequency currents pass.

Fig. 4 shows an amplifier circuit similar to Fig. 3 in general principles. It will be noted, however, that telephone receivers have been included in the anode circuit of the valve and that an air-core choke coil L_5, consisting of, say, 200 turns of wire wound on a 3 in. tube, is connected in the anode circuit of the valve. The low-frequency currents applied to the grid of the valve are amplified in the usual way, and the amplified currents will pass through L_5 unaffected and through the telephones T. The high-frequency currents, however, are very effectively choked back by the choke coil L_5, and they therefore go along the easier path which comprises the condenser C_2 and the inductance L_3, which is shown tuned by the condenser C_4. The disadvantage of the parallel arrangement in Fig. 3 is that the primary T_3 in actual practice has a substantial self-capacity which acts as a short circuit for the high-frequency currents. The result is that the currents which pass through C_2 and L_3 are not as calm as they would otherwise be. If, however, the choke coil is connected as shown in Fig. 4, practically the whole of the high-frequency currents will pass round the by-path circuit and will energise the circuit L_3 C_4 which is tuned to the frequency of the oscillations. It will be noticed that the bottom of the circuit L_3 C_4 is connected to the negative terminal of the filament accumulator B_1. The actual connection might be made to the positive terminal of B1 or to the positive terminal of the battery B_2 without making very much difference. The important point to bear in mind is that the low-frequency output circuit is to be separated from the high-frequency output circuit by means of a choke coil, or the choking effect of a transformer winding or telephone receivers.

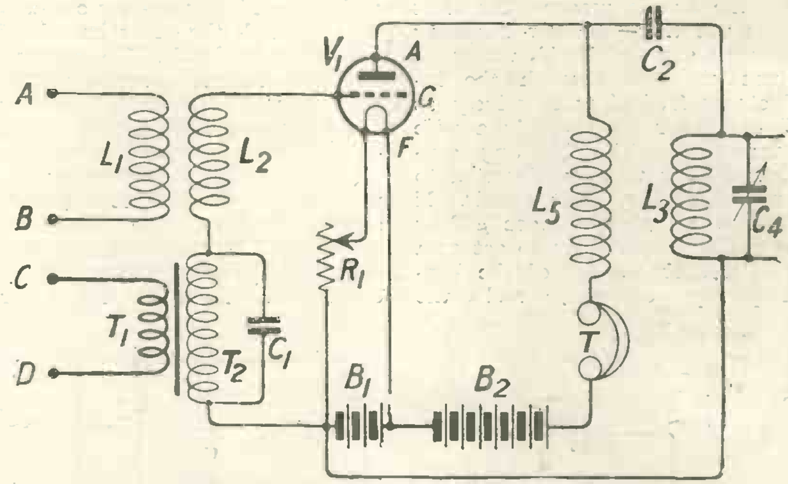

Fig. 4.—An amplifier circuit with series input and parallel output circuits.

In Fig. 4 we have shown the two output circuits divided. The same idea may be applied to the input circuits; Fig. 5 illustrates this. The high-frequency oscillations are applied by means of a transformer L_1 L_2 to the grid circuit of the valve, a condenser C_5 of, say, 0.0003 μF being connected in the position shown. The secondary T_2 of the iron-core transformer T_1 T_2 is connected across the grid and filament of the valve, a choke coil L_6, consisting of an air-core inductance, being connected in the position shown. This choke coil might be omitted, but owing to the self-capacity of the winding T_2 the high impedance of the latter winding will be rendered more or less ineffective and a partial short circuit of the high-frequency currents will occur. It is therefore desirable to connect a choke coil L_6 of small self-capacity in series with T_2. This choke coil will therefore prevent the high-frequency potentials which are communicated by the circuit L_2 C_3 to the grid G_1 from being

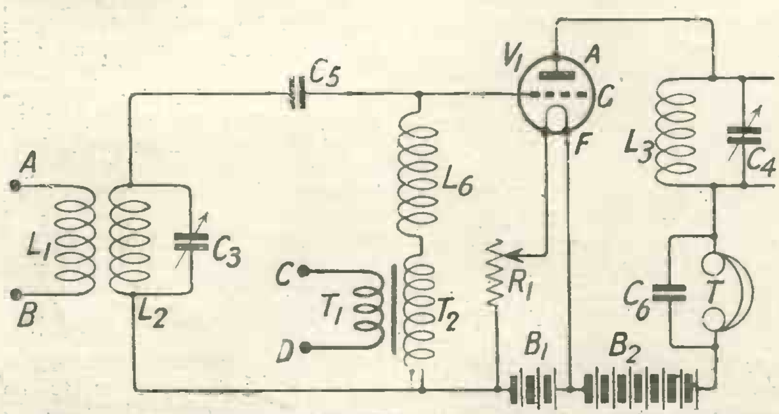

Fig. 5.—Dual amplifier with parallel input and series output circuits.

short circuited through the low-frequency supply circuit. The low-frequency currents to be amplified are applied to the terminals C D and are communicated to the grid through the transformer T_1 T_2. The coil L_6, of course, does not in any way affect the low-frequency potentials being applied to the grid G_1.

In this circuit the input circuits are in parallel; the condenser C_5 is inserted in the position shown for the simple reason that if it were not there the low-frequency currents supplied by T_2 would be short circuited through the inductance L_2 just as effectively as if the latter were simply a wire connection. The blocking condenser C_5 is therefore inserted to prevent such a short circuit. If C_5 has a value of 0.002 μ F or upwards, it will begin to act as a partial short circuit of the low-frequency currents, and the E.M.F.s of these will be reduced. It is also to our interests to see that the condenser C_5 is as small as possible while not offering too high a reactance to the high-frequency currents. The secondary L_2 is shown tuned by means of the condenser C_3.

In the anode circuit of the valve the high and low-frequency circuits are shown in series, the high-frequency circuit, instead of being a transformer, is shown as a tuned circuit L_3 C_4, which is tuned to the frequency of the high-frequency currents. The telephones T are shown being used to detect the amplified low-frequency currents, which simply pass through the inductance L_3 without in any way interfering with the high-frequency oscillations in the circuit L_3 C_4. The condenser C_2 has a capacity of about 0.002 μ F, and serves as a by-path condenser to the high-frequency currents in the anode circuit of the valve. A detector of some kind might be connected across L_3 C_4.

Fig. 6 is a circuit in which both the input circuits are in parallel, and also the output circuits. The left-hand side of the circuit in Fig. 6 is similar to the input circuit of the circuit just described, while the output circuits are of such a character that the low-frequency currents pass through one branch, while the high-frequency currents pass through the other branch of the output circuit. To prevent the high-frequency currents from passing round the telephones, or low-frequency circuit, the choke coil L_5 is connected in the position shown. The fixed condenser C_2 prevents the inductance L_3 from short circuiting the telephone circuit, and its value may be anything from about 0.0003 μ F to 0.002 μ F. Even at this latter value, a slight reduction in the telephone signal strength is usually appreciable, and therefore larger values for C_2 are not recommended. This condenser may be called the "coupling condenser," because it couples the oscillatory circuit L_3 C_4, which now replaces the original transformer winding, to the anode circuit of the valve. The steady anode current now passes through the telephone circuit and does not pass through L_3. The high-frequency currents, instead of passing through L_5 and T, go round the said path, C_2 L_3 C_4, and back to the filament, energising the circuit L_3 C_4 on the way.

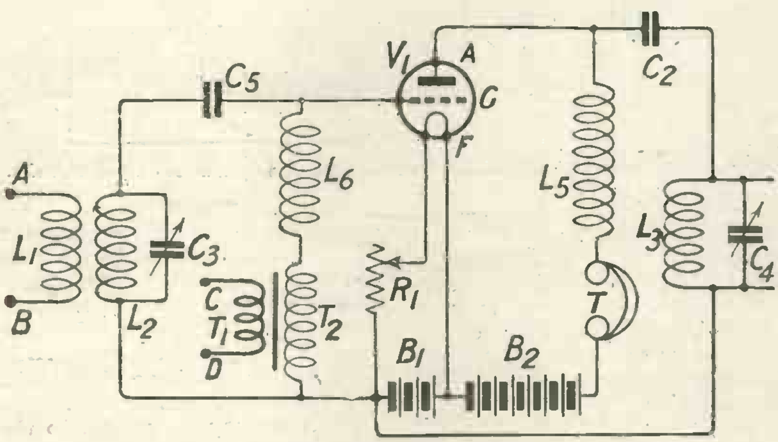

Fig. 6.—Here both input and output circuits are in parallel.

The bottom end of L_3 C_4 is connected in Fig. 6 to the negative terminal of the filament accumulator B_1, but connection might be made, with similar results, to the positive terminal of B_1, or to the positive terminal of B_2. Results would also be obtainable if the connection were made to the top side of the telephones T, but in the latter case the high-frequency currents would pass through the telephone circuit (the telephones would have, of course, to be shunted by a fixed condenser), and this would be exactly what we are trying to avoid.

The reasons for employing parallel connections will be better understood when we come to some practical circuits. Suffice it to say that, unlike many alternative arrangements, there are distinct reasons for using the parallel arrangement instead of the series method of connecting input and output circuits.

Dual Amplification and the Characteristics of the Valve

Generally speaking, a substantial emission is required from the filament of a valve to act as a dual amplifier. The reason is simple; the grid potential variations correspond to the sum of the amplitudes of the high and low-frequency currents. A long characteristic curve is therefore most desirable. A valve with small filament emission is not to be recommended.

A grid potential anode current characteristic curve is illustrated in Fig. 7. The normal operating point may be at either A, B, C or D; the point A is most undesirable because there is a steady grid current flowing which will introduce heavy damping into both the low-frequency input circuit and the high-frequency input circuit. This, moreover, will introduce a certain amount of distortion as well as the weakening of the input potentials. The points B and C are the best, provided the input currents are not of too large a magnitude. The point D is also, to a certain extent, undesirable, because when the grid becomes positive a grid current will flow, but when the grid is made negative by the input potentials, no grid current would flow. The result would be that damping would be introduced on the positive half-cycles of both high and low-frequency currents, and this would introduce a certain amount of distortion. This, however, would not be very appreciable, and if the grid currents in the valve are small the point would most likely be overlooked.

A more important consideration is a straightness of the characteristic curve along the portion to be utilised. The curve between D

(*Continued on page* 647.)

Reflex Wireless Receivers in Theory and Practice.

(*Continued from page* 644.)

and A should be as straight as possible in order to obtain faithful amplification without distortion. If the representative point on the characteristic curve travels round a bend, serious distortion will occur, due to the rectification effect. To the right of the points A, B, C and D we have shown a cycle of alternating current which we will assume is the type of currents supplied by the low-frequency input circuit. Above and below each of the points A, B, C and D we have shown dots on the characteristic curve, these indicating the maximum positive and negative changes in the anode current, due to the low-frequency cycle. When the grid potential is such that the anode current is at the higher dot above B, for example, we have to consider that at this moment a positive half-cycle may be applied to the grid by the high-frequency input circuit. If the high-

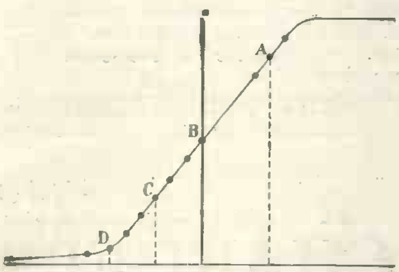

Fig. 7.—A grid potential anode current characteristic curve.

frequency currents are very feeble in relation to the low-frequency currents, we can ignore them from the point of view of studying the characteristic curve. If, on the other hand, the high-frequency currents are of a strength comparable to the low-frequency currents, we have to consider the amplitude of the positive half-cycle added to the amplitude of the positive half-cycle of the low-frequency currents. The same, of course, applies to the negative half-cycles of the two sets of currents. We have to select such a point on the characteristic curve that, if we add the two positive amplitudes together and the two negative amplitudes together, the representative point on the characteristic will not move off a straight portion. This is one of the first important rules in connection with dual amplification.

Stated briefly, the rule is that the characteristic curve should be selected and the point on the characteristic curve selected so that the representative point always keeps on a straight portion of the characteristic curve. If this is done the fullest amplification will be accorded to both the high and the low-frequency currents. If we operate the valve at some such point as A, or even sometimes C, we are in danger, if the high-frequency currents are of large amplitude, of over-running the valve in the sense that the representative point will, in the case of the positive or negative half-cycles, travel round a bend in the curve, the result being insufficient amplification and a considerable amount of distortion.

In dual amplification circuits, as in any other amplification circuit, it is desirable to have the characteristic curve to the left of the passing through zero grid volts. Under these conditions grid currents will be non-existent, and distortion from this cause will not arise.

Fig. 8 shows a characteristic curve which has been moved to the left-hand side of the line XY. This movement of the characteristic curve is effected by using a higher anode voltage. Instead of operating the grid potential at zero volts, which would bring us to saturation point on the characteristic curve, a negative potential, sufficient to bring the normal operating point to about the middle of the characteristic curve, is applied to the grid. In the Fig. 8, since the steepness at the points A, B and C is the same, the only question which affects our choice of the points A, B and C is the amplitude of the high and the low-frequency currents to be amplified. If the currents are of small amplitude the points A and C will give as good results as the point B, but if the latter point be used, one is certain that, under ordinary conditions, neither bend will be approached by the representative point.

Graphical Representation of Dual Amplification

A graphical representation of dual amplification is illustrated in Fig. 9. In the top line we have shown the high-frequency currents which are applied to the grid; the second line shows the low-frequency alternating currents. The actual nature of these two sets of current will depend upon whether spark signals, continuous wave signals, or modulated signals, such as telephony, are being received. The simplest case, however, is illustrated in Fig. 9. The third line shows the effect on the electron flow from the filament to the anode and round the anode circuit. It will be seen that although the general change in the anode current is a low-frequency one, yet superimposed on this low-frequency variation we have the exceedingly rapid radio frequency variation. The diagram is not intended to be to scale, but merely illustrates how the two sets of currents are combined in the anode current of the valve.

The fourth line shows how the low-frequency currents may be selected in the anode circuit. A method of doing this was shown in Fig. 6, in which a choke coil L_5 is used to choke back the high-frequency current variations which are superimposed on the low-frequency current variations, as shown in line 3, Fig. 9. The high-frequency variations which are choked back by L_5 pass round the other branch circuit and appear in the circuit L_3 C_4 entirely free from the low-frequency current variations. These selected high-frequency currents are shown in the fifth line of the Fig. 9 diagram. It

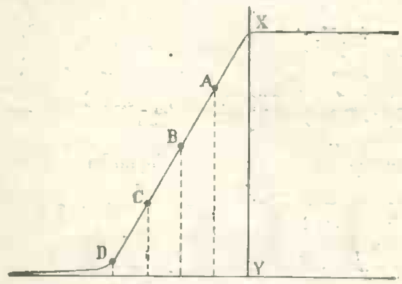

Fig. 8.—A characteristic curve on the left of the line XY.

will thus be seen that the currents only mix in the third line, *i.e.*, the anode circuit of the valve.

General Principle of Design of Dual Amplification Receivers

Before discussing in any detail the different kinds of dual amplification circuits and their operation, it is proposed to discuss one or two of the general principles governing reflex circuits.

As in all valve circuits, it is possible to substitute well-known equivalents in different parts of circuits and thereby to produce an almost infinite number of variations. In the case of dual circuits, however, there is always an uncertain property involved. One can never quite foresee what is going to happen, and a fixed condenser here or there which might not in any way affect the operation of an ordinary valve circuit will radically change the operation of a dual amplification circuit. With a given set of components, it might be definitely stated that such and such connections would be found most suitable. If, however, an experimenter were to wire up the circuit with different components, entirely different results would be obtained.

The great trouble with dual amplification circuits is that the valve, which carries out the two stages of amplification, always tend to oscillate at a low-frequency which will usually produce a buzzing noise in the telephone receivers or loud-speaker. This is the one great serious fault of dual amplification circuits, and various means have been suggested to prevent this effect taking place.

There are certain other simple rules which must be observed if the maximum signal strength is to be obtained and if the circuit is to be stable. The principal one of these, apart from the warning against having low-frequency reaction which may cause buzzing, is that batteries, telephones, loud-speaker, and the like should all be connected through earth so that their potential is fixed. All designers of wireless apparatus endeavour to prevent accumulators, high-tension batteries, telephones, potentiometers, and other similar pieces of apparatus, particularly those which are of substantial bulk, being placed in a circuit at a point at a high-frequency potential to earth. The same rules apply to dual amplification circuits, but in addition we have to add the rule that all such apparatus as that mentioned above should not be allowed to be at low-frequency potential to earth.

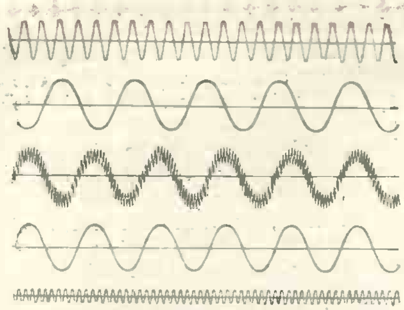

Fig. 9.—A graphical representation of dual amplification.

The "Family" Set.

To the Editor, MODERN WIRELESS

SIR,—I have constructed the "Four-valve family set" and I find it to be the finest one I have had. The whole of the construction was done from the blue prints, without any reference being made to the photos or working diagrams. This speaks for the clearness of the prints. Radiola, Brussels, Eiffel Tower and all the B.B.C. stations come in strong on *three valves.* I am using Marconi R bright filament valves run from a 4-volt 60 accumulator.

Wishing you every success with your publications, and assuring you that I will not fail to recommend the circuit to my numerous wireless friends.

I remain, yours faithfully,

F. H. WINGATE.

A NEW EDITION.

A new edition of "Practical Wireless Valve Circuits," by John Scott-Taggart, F.Inst.,P., A.M.I.E.E. has just been published which will make a special appeal to the experimenter. ALL working values are given for each circuit, so that each forms a complete guide for the constructor. The price of the book remains 2/6 (post free 2/8).

Single Valve Transmitting Circuits

By Dallas G. Bower.

An informative article for the transmitting beginner.

IT is in the opinion of the writer that the British radio amateur is very much behind other countries in the design of efficient transmitting circuits and the maintenance of good transmitters. Many experimenters are licensed for "artificial aerial" transmission, and a great deal of useful knowledge of valve transmitters can be obtained using the aforesaid dummy aerial. It is proposed in this short article to give a few details and circuit diagrams relating to single valve telephony transmitters. Single valve modulation is often abused, but providing correct constants are

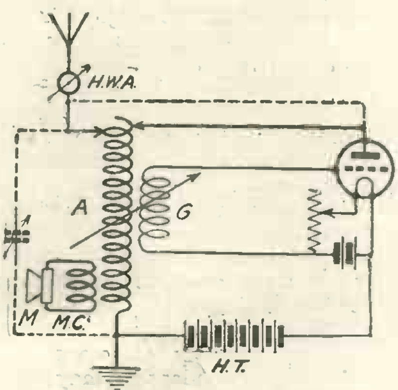

Fig. 1.—The simplest form of transmitting circuit.

taken into account, excellent speech can be obtained on all powers up to 16 watts. For larger powers such as 50 to 250 watts a control valve is of course necessary. Fig. 1 shows perhaps the simplest form of telephony transmitting circuit. It is presumed that the reader understands the function of a three-electrode valve as a producer of high frequency oscillations. Referring to Fig. 1, it will be seen that we have an inductance, A, across the positive high tension and the anode of the valve. Inductively couped to this is the grid-filament circuit inductance, G. A small inductance, M.C. (microphone coil) is coupled to the aerial inductance, A, in shunt with which is the microphone, M. It will be seen that we have a producer of pure continuous waves without the microphone or microphone coil.

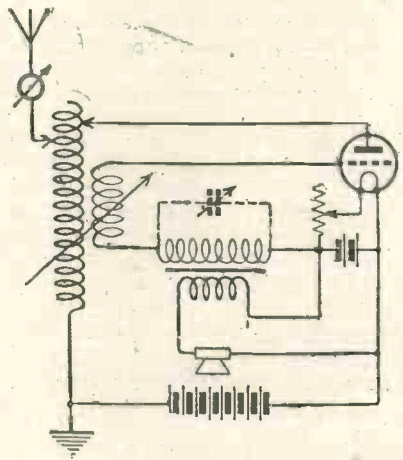

Fig. 2.—A simple circuit using "grid" control.

Now in speaking into the microphone we vary the resistance of the aerial circuit, hence we vary the amplitude of the oscillations produced by the valve. In fact we absorb energy from the aerial, and since this is so, the system is called absorbtion control or modulation. Excellent speech can be obtained on this system of modulation for short distances using low power. Power limitation is the chief disadvantage of the system. It is evident that a large output could not be sufficiently modulated by coupling a microphone in shunt with a coil to the aerial inductance. Again, on high radiation such as 2 to 5 amperes the microphone would become heated. As a last

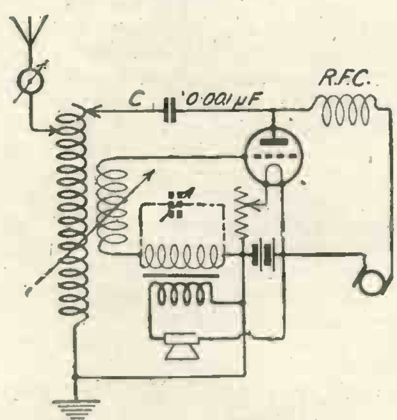

Fig. 3.—A transmitting circuit of the "Shunt Oscillator" type.

word to this circuit, the power input should not exceed 5 to 7 watts for efficient control, and the degree of coupling for the microphone control is most critical for best modulation. Coil A may be Burndept S3 or Igranic 35. Coil G, Burndept S4 or Igranic 75. Microphone coil, Burndept S1 or Igranic 25. The coil A is shown tapped, but this is not necessary if a variable capacity is used (shown dotted) in shunt with it. Under these conditions the anode tap goes to the aerial direct (shown dotted). With a 0.0005 m.f. variable condenser at maximum capacity, in shunt with a 35 Igranic coil, a wavelength of 400 metres will be obtained or thereabouts. The H.T. may be 100-200 volts dry cells, and the valve an Ediswan A.R. or a Mullard 0/5. Referring to

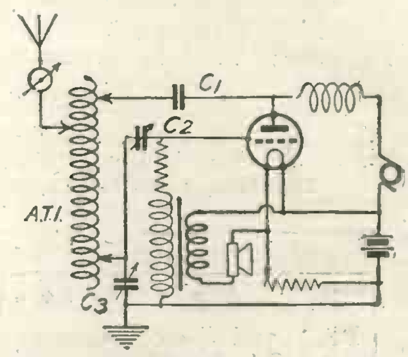

Fig. 4.—The "Colpitts" circuit with grid control for transmission of speech.

Fig. 2, it will be seen that we have the same oscillatory circuit as in Fig. 1 with the exception of the modulation transformer and the microphone in the grid circuit. It will be clearly obvious that any disturbance in the grid circuit of an oscillating valve will cause a disturbance in the anode circuit. Hence by causing fluctuations (by speaking into the microphone) in the grid circuit we cause a similar fluctuation in the anode circuit, and so vary the amplitude of the produced oscillations. The reason for the modulation transformer is to step-up the speech variations before imposing them on the grid of the valve, because if we placed the microphone directly in the grid circuit, variations produced on the grid voltage would be too small to successfully modulate the output from the anode circuit. This system of control is known as grid modulation. Very considerably more power can be modulated with this system, and very good speech can be obtained. Details cannot be given to any extent as to the type of instruments to use, as this depends upon the experimenter himself. The H.T. supply may be anything from 200-800 volts and the following valves may be used :—M.O. T15 or Mullard 0/10a. The modulation transformer may well be a "Ford" spark coil. These make most efficient modulation transformers. It will be seen from the diagram that the microphone current is obtained from the filament ignition accumulators. If this is found unsatisfactory a separate battery may be used. We now come to a type of circuit known as a "Shunt Oscillator" (Fig. 3).

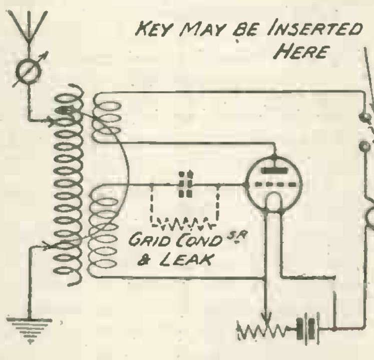

Fig. 5—A simple C. W. transmitter known as the "Series Meissnier" circuit.

Here we have the aerial inductance across the anode and filament of the valve, while the grid circuit inductance is inductively coupled to the aerial inductance. Grid modulation is employed in the circuit shown, although Heising or choke-control modulation is usually employed, but the choke-control circuit does not come within the scope of this article.

No grid resistance is shown in either Figs. 2 or 3. It will usually be found (in Fig. 2) that the windings of the secondary of the modulation transformer in shunt with a variable capacity of 0.0003 (shown dotted) will be sufficient. Special note must be taken of the condenser C (Fig. 3). This is known as the feed-condenser, and it will be clear to the reader that if this condenser were not there, the H.T. would become shorted. R.F.C. is a radio frequency choke coil and it serves to prevent H.F. currents getting back to the D.C. generator or other H.T. supply where they are likely to do serious damage. We now come to Fig. 4. This circuit is little used or even known in this country, and it is termed the "Colpitt's Capacity Coupler" transmitter. The circuit takes its name from its designer. It will be seen that the circuit functions on the shunt oscillator principle, the grid filament circuit being coupled to the aerial inductance by capacity instead of inductance. The circuit was primarily designed for C.W. working, but good results can be obtained incorporating grid control for modulation. The great advantage of the Colpitt's oscillator is the fact that a greater output with a given input is obtainable than with most other circuits. Values of components may be as follows :—A.T.I, the inductance may be wound on a former 6 in. in diameter 8 in. long, with Nos. 12 to 15 S.W.G., bare copper wire. The actual details of transmitting inductances cannot be given in full, as it largely depends upon the power to be used. The windings of the A.T.I, of Fig. 4 should be spaced from one half to the whole thickness of the wire with which it is wound. C1, fixed capacity of 0.001 m.f. It is necessary that this condenser should be of sufficent strength to withstand the full H.T. voltage, as of course a breakdown would mean a direct short-circuit to the H.T. supply. C2, variable capacity of 0.0005 m.f. C3, variable capacity of 0.001 m.f. Both these condensers may with advantage on higher powers have mica dielectrics. R is the grid resistance or leak and may have a resistance of 5000 ohms. The last circuit shown in Fig. 5 is that known as a Series Meissner circuit. It will be seen that the oscillator is similar to that of an ordinary loose coupled feed-back single valve receiving circuit. No particular advantages are obtainable with this transmitter except the very sharp tuning. It is essentially a C.W. circuit. Very exceptional long range results have been obtained with it, however, in America.

H.W.A. in all the circuits is a hot-wire ammeter. This is used in order to indicate the amount of current in the aerial system. A reliable make should be purchased, as many badly calibrated instruments are on the market. A cut-out switch is an advantage, as it will be readily understood that the meter offers resistance to the aerial current.

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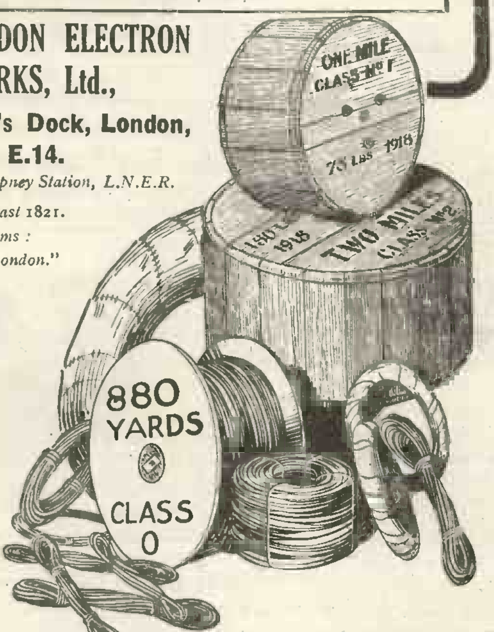

DUBILIER CONDENSERS

Constructional Chats

BY PHILIP R. COURSEY, B.Sc.

No. 4.

The "by-pass" Condenser.

In valve receiving sets it is common practice to connect a "by-pass" condenser across the primary winding of the first low frequency transformer, if one is used, or across the telephones if they are inserted directly in the anode circuit of the detector valve. The need for this condenser is particularly great when the detector valve is fitted with a reaction coil connected in its anode circuit.

The action of the by-pass condenser in such instances depends upon the electrical properties of the condenser and its consequent behaviour towards currents of different frequencies. The impedance offered by a condenser to the passage of an alternating current through it is, in the case of a good or efficient condenser, of the nature of an almost pure reactance. (Note: The term "*reactance*" is totally distinct from "*reaction*," the latter referring to the regenerative or feed-back effect which is possible with an amplifying valve, whereas the former is purely a numerical electrical quantity calculable from the constants of the circuit.) The reactance of a condenser subjected to a given alternating voltage is inversely proportional to the product of the capacity and the frequency. Hence an increase of either of these quantities means that less reactance or impedance is offered by the condenser to the passage of current through it.

Number 4a of this series shows how these properties are made use of in the case of the "by-pass" condenser. Note: No. 5 deals with the use of Grid Leaks; have you seen it?

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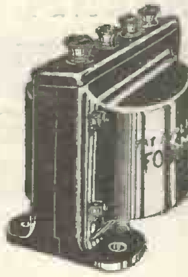

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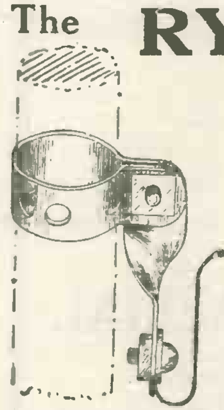

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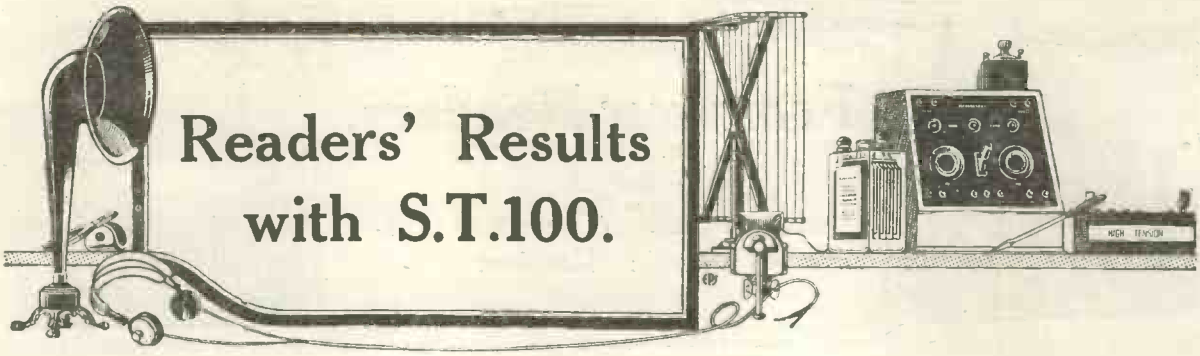


Readers' Results with S.T.100.

To the Editor of MODERN WIRELESS.

SIR,—Having recently installed an S.T. 100, I thought the following results would interest you. I have tuned in all B.B.C. stations, Aberdeen, 530 miles away, coming in in very good strength, and Cardiff especially loud.

On loud-speaker I have heard Cardiff, very good strength indeed, and it can be heard 20 feet from loud-speaker. Newcastle, Birmingham, Manchester, Bournemouth also can be heard, although the strength is not loud but quite clear. The following components were used: Dubilier fixed condensers, Ormonde variable condensers with Vernier adjustment, and also Ormonde rheostats, Royal transformers, Dubilier 100,000 ohms resistance, and Cossor valves, Baby Sterling loud-speaker. I think you will agree these results are excellent. May I thank you sincerely for giving constructors such a wonderful circuit.

Yours faithfully,

W. F. P. C.

Leigh-on-Sea.

P.S.—Of course, 2LO is very loud; on headphones it is too loud, and on loud-speaker can be heard all over the house.

SIR,—I set the S.T. 100 circuit up as soon as published in MODERN WIRELESS, and got splendid results on first trial, resulting in the dismantling of a 5-valver.

I have recommended S.T. 100 to at least a dozen of my friends—most of them quite ignorant of even the fundamentals of wireless, and they have succeeded in making sets which do justice to the loud-speaker, and that is more than a good few commerical 4-valve sets do in amateur hands.

But, how strange people are—these persons came to me, praising their sets, setting them against £50 sets, and thanking me earnestly for telling them of the circuit, but until reminded, it never entered their head that their thanks were due elsewhere, and that the circuit had to have an originator and also a publisher.

So on behalf of these and myself, please accept my thanks for S.T. 100, and also for many other articles contained in MODERN WIRELESS and "Wireless Weekly."

As regards this month's issue *re* the choke coil coupling of No. 2 valve in the Star S.T. 100. I have been using this for some considerable time and find very little difference from transformer coupling—less volume, but I think the tone is improved. On the whole the difference is hard to judge.

A point I have not seen published, but must be well known to most electricians, is that I have my accumulators in series with the drawing-room light at home and take my valve current from them at the same time—the negative supply main being earthed also does away with the usual earth connection in sets like S.T. 100. This method keeps my accumulators charged and is quite satisfactory for L.S. work, but for telephones the hum is *too* much. I have found, however, that by introducing the L.F. impulses behind a grid condenser the hum is absent.

LEO. K. HOLDEN.

Farnworth, Nr. Bolton.

To the Editor of MODERN WIRELESS.

DEAR SIR,—Having seen the letters of appreciation of your S.T.100 circuits, I noticed no one has ever reported reception of American broadcast direct on the S.T.100 proper—namely, one high, crystal, and two lows.

This has surprised me, having received KDKA's ordinary programme, 326 metres, on January 13. I wrote to them the same day, and received a confirmatory letter a few days ago.

This is the ordinary S.T.100 circuit receiving the local broadcast station, Manchester, 26 miles away, on full-sized Claritone loud-speaker, audible 100 yards away in the open air.

I am also able to receive all B.B.C. stations, F.L. Radiola, Posts and Telegraphs, Brussels, The Hague, Madrid, Rome, Croydon, French aircraft stations, and hosts of amateurs, these latter, of course, on 'phones.

The set is wired on ¼-in. plate-glass panel, of which I enclose a photograph; the centre valve is not used in this circuit.

I am now going to try your double dual circuit, and will report in due course.

Wishing you every success.

I remain, etc.,

HARRY TAYLOR.

St. Helens, Lancs.

P.S.—My only grumble is, the tuning is rather broad.

SIR,—I have pleasure in stating although surrounded by some of the highest mountains in Britain, and only 2½ miles from the foot of the highest (Ben Nevis), I have been amply rewarded in constructing the S.T. 100 wireless set as detailed in the No. 1 envelope. I am, I believe, the first in this district to construct this circuit, and have induced others to try it. I am more than satisfied with the results. I get most of the B.B. stations very clear and strong on the 'phones (three in number), but not strong enough for a loud speaker. I may have to add an amplifier for this purpose. I have not noticed that the "Omni" receiver has been put up in envelope form yet. I purpose making this one later on. I may add I have to use a 50 coil fixed with a 75 movable Igranic, with the constant aerial tuning as recommended, and yet I have not departed from this. With best wishes for your publications.

W. P.

Fort William, Fort Lochaber.

From our Readers.

Further Reports on Modern Wireless Transatlantic Receiver.

To the Editor of MODERN WIRELESS.

SIR,—I think that the following may be of interest to you. Having built your receiver and after adding two low-frequency valves, I have obtained the following results:

Aerial: 10 yards of wire, No. 20 D.C.C., stretched on the ceiling of a room, situated first floor. I receive all the English broadcasting stations on a loud-speaker, audible 50 *yards* from the loud-speaker. The make of the loud-speaker is "Lumiere" and requires a considerable amount of current to operate it. The Ecole supériéure des P.T.T., Radiola and Tower Eiffel, I receive *without aerial or earth, on loud-speaker audible* 30 *yards away*, With aerial (as above) 100 yards.

I find that with the condenser in series I receive a considerable amount of noise, like rushing water. This only occurs when reaction is used. In parallel with reaction reception is perfect. In series, without reaction, reception is perfect.

Should you desire to publish this you may do so as it may be of interest to the readers of your journal.

I might add that I am a regular reader of MODERN WIRELESS, and it is doubtless the first and finest journal of its kind.

I wish you every success in the future.

I remain, Sir,
Yours, etc.,
R. A. S. F.

Paris.

To the Editor of MODERN WIRELESS.

SIR,—I have completed your "Transatlantic" with note magnifying panel; and results are far beyond my expectations.

On the three valves alone, all B.B.C. stations come in with ease, most of them at L.S., *i.e.*, Amplion A.R. 19, and the Continental stations also at L.S. strength with the note mag. panel.

I find this set wonderfully selective and very sensitive, extremely smooth in working, in fact, noiseless. Of all the sets I have made or handled this is the most efficient.

Owing to the great demand, it was impossible to get McMichael transformers, but the matched ones from Spot Component Co., Chorley-cum-Hardy, Manchester, were all that could be desired.

Please accept my thanks and congratulations on the very excellent designed set, which, I think in my humble opinion, is the last word in a home-constructed set.

I am, yours faithfully,
G. TUDOR-WILLIAMS.

P.S.—I may add that Aberdare, S. Wales, is not an ideal spot for reception owing to the bad "blanketing" of the high mountains around us, but the Transatlantic surmounts all this.

To the Editor of MODERN WIRELESS.

SIR,—Having read with interest some comments on your Transatlantic set in the current issue of MODERN WIRELESS, perhaps it will interest you to know its performance in Northern Ireland. The set with its two valve note magnifier has been in daily use for two months now, using only four valves when listening to broadcasting on loud speaker (large).

I tried an inside aerial 7.22 enamelled wire round the ceiling. Glasgow, Newcastle, and Manchester audible 50 yards away on loud speaker. With frame aerial, 2 feet sides, 10 turns, 26 D.C.C. wire, the three stations above mentioned audible in fair-sized room on loud speaker using five valves. Without aerial or earth, just a No. 4 Burndept coil can hear most spark stations working on low wave lengths. I think these results are exceedingly splendid, living, as we do here, away from the B.B.C. altogether. I may add I have never been troubled with the set bursting into oscillation, although I am troubled with this noise from surrounding district.

Yours truly, H. S.
Lisburn, North Ireland.

To the Editor of MODERN WIRELESS.

SIR,—I notice one of your correspondents wish for experiences with "Transatlantic receiver."

I consider this one of the most interesting circuits I have yet tried for long-distance work, not excluding "S.T. 100" or "All concert receiver."

An outdoor aerial.—I have tuned-in all B.B.C. stations, all Paris stations and Hague. I have not yet got any other Continental stations in Europe on speech and music.

All these are perfectly audible and understandable, the weakest being Manchester.

America.—Music on first trial (before she was boxed and after we had got Bournemouth as guide to tuning) and several times since; earliest 11.55 p.m.

Quite strong to fading periodically other times strong and "X's" (statics, roars, etc.)

Indoor aerial.—Three wires across room, east to west. Bournemouth and Cardiff quite strong. No other station picked up yet, except French amateurs.

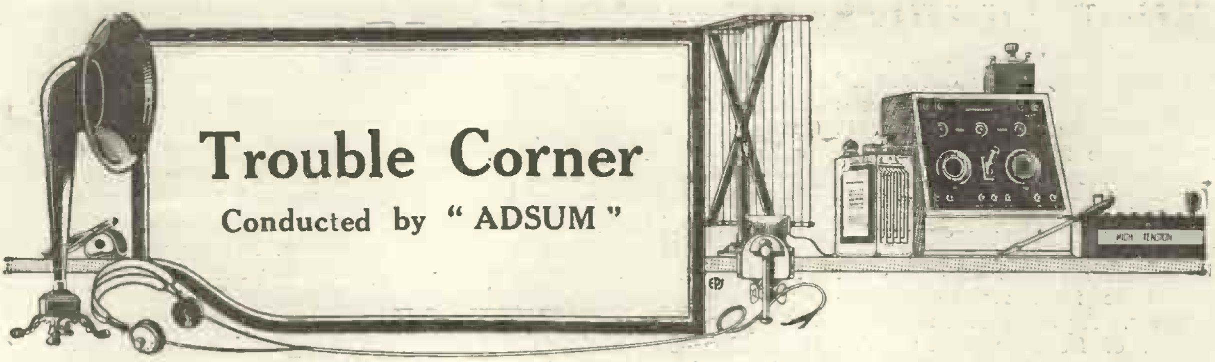
Loop aerial, 11 turns 2ft. 8in. sq. taped fifth turn; whole loop tuned by .001—75coil. 2LO fine strength; Bournemouth weak, but audible and understandable. Tuning very sharp. Reaction used in most cases, except 2LO and 5IT. 2LO can easily be tuned-out, except for Cardiff, Bournemouth, Manchester.

FL fine on loud-speaker; 2LF used. Radiola ditto, but often with spark interference.

I think we ought to thank you for some of the most interesting experimental and standard circuits.

A constant reader of both your journals from first number.

Yours truly,
H. E. HULL.
136, *Holland Park Avenue, W.*
March 12, 1924.



Trouble Corner

Conducted by " ADSUM "

Noises

WHEN a set has a noisy fit nine amateurs out of ten complain bitterly that atmospherics are abnormally bad or pour maledictions upon the harmonics of Leafield and Northolt, maintaining stoutly that the undercurrent of confused noises heard is chiefly due to " mush." Few wireless men would like to admit even the possibility that the cause of the uproar is to be found in the set itself. Yet in the vast majority of cases it is there. There is one culprit amongst wireless components which is usually the last to be suspected of misbehaving itself, though it is more prone than all the rest put together to be the cause of unsatisfactory reception. This culprit is the high tension battery. That it is troublesome is very largely due to neglect or to thoughtlessness. A battery is bought and wired up. It seems such a simple kind of affair that no particular attention is paid to it. It is merely switched on when the set is brought into operation and switched off when one closes down. In most cases no further thought is given to it until a great falling off in signal strength shows that a new one must be purchased.

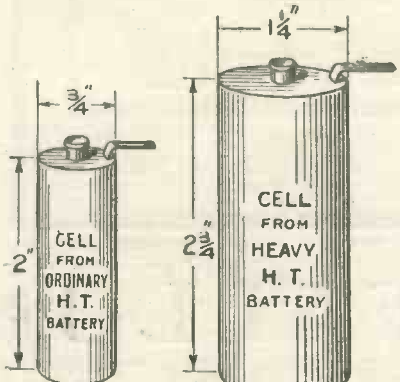


Fig. 1.—Showing the relative sizes of cells in two types of H.T. battery.

As a matter of fact, the subject of high tension batteries is one that deserves a certain amount of attention. If you pull to pieces, as doubtless you have done, one of the ordinary type (by which I mean a 66-volt battery weighing about 4½ lbs, or a 36 volter weighing about 2½ lbs.) you will find that it is made up of the same tiny cells which are used for pocket flashlamp batteries. In a well designed battery they are separated from each other by insulated layers of paraffin wax, cardboard or pitch, but if the battery is of the cheap job-line type insulation between cells will be poor. When this is the case cracklings and splutterings are as certain as death and taxes. Therefore do not try to economise on the H.T. battery if you wish for quiet reception. A further point is that in some cases, though the inter-cell insulation is quite good, the little zinc pots have nothing between them and the table or the floor upon which the battery rests but a layer of cardboard, which if it has not been well waxed will collect moisture from the air and soon become of very little use. It is a good tip always to improve the insulation of the bottom of the battery case. One way of doing it is to turn the battery upside down and to apply several layers of thick shellac varnish. Another is to keep a couple of old photographic plates from which the emulsion has been washed for the batteryto stand upon.

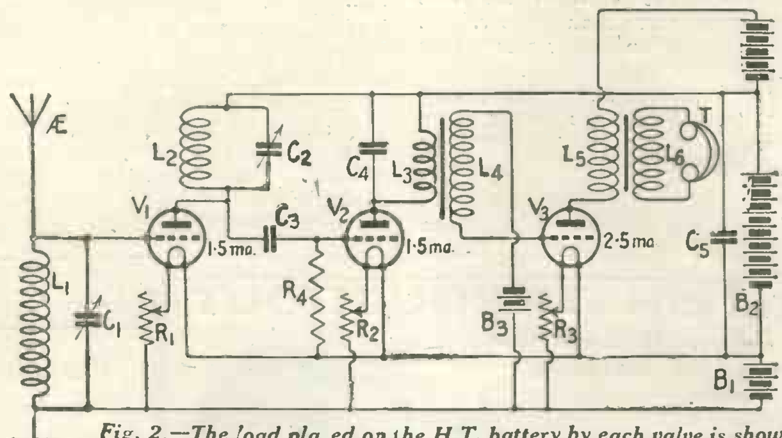


Fig. 2.—The load placed on the H.T. battery by each valve is shown against the valve. The power valve V_3 has an extra battery as it requires more current.

The Question of Size

Of very great importance is the size of the high tension battery; by this I mean not its voltage but its weight. It will not require long consideration to convince you that batteries made up of the little cells mentioned in the preceding paragraph are quite incapable of standing up to heavy loads continuously for any length of time. Yet one frequently sees these small batteries yoked to multi-valve sets and even occasionally being asked to work power amplifiers. The result is, of course, that they are noisy almost from the first.

The best way of tackling the high tension problem is to discover the average high tension current passed by the set, and then to procure a battery whose size is such that it is easily capable of standing up to this load. If you have a milliammeter it is of course the easiest thing in the world to discover the current required by your plate circuits. Those who are not so fortunate as to possess one will find that they are not far out if they allow from 1 to 1.5 milliamperes per valve. Thus a three-valve set will require from 3 to 4.5 milliamperes according to the valves and to the voltage applied to their plates. When extra high tension voltage is applied to the note magnifiers the allowance for each should be from 2.5 to 3 milliamperes. A power valve will place a load of from 12 to 25 milliamperes upon the battery, the figure again depending upon the make of the valve used and upon the plate E.M.F. Some years' experience of high tension batteries has served to convince me that the largest economic load for a battery of the flashlamp cell type is not more than 5 milliamperes, if the set is used on an average two hours a day. Batteries of this type are therefore not suitable for sets containing more than three valves. To use them on bigger sets means that the original E.M.F. falls off very rapidly, and that noisy reception begins to occur very shortly after a new battery has been installed.

A Whopper

For some time past I have been using a high tension battery which no one could accuse of smallness. This is the No. 924 made by Messrs. Siemens, which has a maximum E.M.F. of 120 and weighs no less than 27 lbs. The cells of which it is composed are just about three times as heavy as the little fellows in the ordinary battery, which means that they will stand up to at least four times the load without becoming overdone. These batteries sell at £2, which, when you consider that they will outlast four or five of smaller size, is by no means a high price. I generally use about 60 volts in the anode circuit. This enables me to place the wander plugs in the sockets labelled 0 and 58 on one day and in those marked 58 and 120 on the next. Hence each half of the battery is subjected to an equal amount of wear and tear and each has forty-six hours of rest for every two that it is worked. This keeps the battery perfectly quiet, though a load of as much as 30 milliamperes is sometimes put upon it. If you do not want to go in for a battery as big as this you can make up a very good one by connecting in series the required number of Ever-Ready No. 15 flashlamp batteries. These are made up of cells of about the same size as those used in the big Siemens 120-volter. They retail at 1s. 6d. each, so that the price of a battery made up with them works out at 4d. per volt.

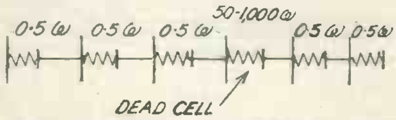


Fig. 3.—Illustrating the extra resistance introduced by a dead cell.

The Dead Cell

It should be remembered that the ordinary voltmeter test is of no use whatever for either high or low tension batteries unless they are under load when it is made. Both accumulators and dry batteries, though nearly run down, will pick up their E.M.F. considerably if given a period of rest, and should the voltmeter test be made before the set is brought into use after an interval of some hours since it was previously worked, the readings obtained may give no indication at all of the real state of affairs. Further, nothing like the correct reading of high tension voltage will be obtained if a voltmeter of the ordinary type reading up to, say, 100, is used. The only instrument that is of any use for taking the high tension voltage is a meter with a very high resistance. To test the battery out thoroughly it is best to go over it cell by cell with a small voltmeter after it has been in use for, say, a couple of hours. This test will not infrequently disclose the presence of one cell which is dead or very nearly so. Were the test to be made after a period of rest this cell might easily show a fairly respectable momentary E.M.F. Its condition would thus not be discovered and the owner of the set might well wonder why on earth it was that signal strength declined almost to the vanishing point soon after switching on. A dead cell in the middle of the battery offers a very high resistance indeed, and so cuts down the total voltage. Further, if a cell is badly run down its voltage will fluctuate considerably, causing corresponding small changes in the total output of the battery. These are quite sufficient to give rise to a very fair imitation of the most violent brand of atmospherics. Be on the look out, then, for the dead or nearly dead cell, and short circuit any whose voltage after use is a good deal lower than that of the others. Any cell which has dropped to one volt should be rejected at once.

A Curious Fault

A rather strange breakdown occurred the other day to a friend who uses a crystal set. So far as could be seen everything in the set itself was in order. All the connections were soldered and none of them had come loose. The coils were tested to see if a break or a short circuit had taken place in the windings, and came through

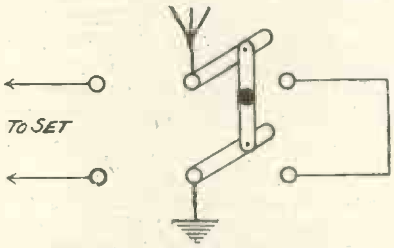


Fig. 4.—The connections to the change-over switch which caused the trouble.

the ordeal with flying colours. Each condenser also showed itself to be above suspicion. The telephones were all that they should be, and both aerial and earth were good. It was thought at first that the crystal, a particularly good piece of Herzite, might have become insensitive; but when another crystal was substituted the results were no better. What steps should be taken to find the seat of the trouble? The fault was eventually tracked down with the aid of a wavemeter, though should you be similarly troubled a testing buzzer will do just as well if a wavemeter is not available. It was found that when the buzzer wavemeter was placed close to the A.T.I. the set functioned as if it was in order except that when it was tuned first to 365 metres and then to 600 metres the settings of the A.T.I. were considerably higher than would have normally been required. The obvious inference was that something was wrong with either aerial or earth. Which was it? The buzzer of the wavemeter was connected to a gas pipe, the meter itself being taken some distance away. Directly connection was made the note was heard loudly in the telephones. The earth therefore was exonerated. An examination of the joint between aerial and down lead showed that there was nothing wrong there. The lead-in tube was found to be in order, and attention was then directed to a large switch used for earthing the aerial when the set was not in use. This was of the double pole change-over variety, mounted upon a thick porcelain base, the connections being as shown in Fig. 4. A careful examination showed that the fault lay in the connection between the down lead and the point of the switch to which it was attached. The down lead was of the 7-22 wire, and connection had been made by separating the strands and passing them round the attaching screw of the switch, four on one side and three on the other. They had simply slipped away from under

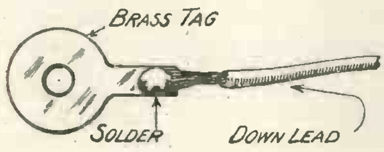


Fig. 5.—How the lead in joined to the brass tag.

the head of the screw, cutting out the aerial altogether. In the majority of switches made for earthing purposes the screw connections are not at all satisfactory for heavy stranded wire. To be safe it is best to dispense with them altogether and to solder all leads directly on to the clips. A similar fault may occur at the connection between the down lead and the outside end of the lead-in tube. A method which I found very effective for making this connection is shown in Fig. 5. The end of the wire is flattened with a hammer, and it is then soldered to the tail of a piece of sheet brass shaped as shown in the drawing. Plenty of solder must be used for the purpose so as to ensure a good connection, and it is essential to see that each individual strand is firmly fixed. The hole in the brass plate is now passed over the rod of the lead-in tube and a nut is turned tightly down. This gives a connection that is perfectly satisfactory so long as the contact surfaces are cleaned occasionally and the nut is not allowed to come loose.

So Simple

A fault which is at first sight most perplexing may be due to some perfectly ridiculous little defect in the set. One may spend long hours in looking for it and then kick oneself heartily when it is finally run to earth. Not long ago a clergyman living in the North of Scotland wrote to me to ask if I could help him in his trouble. His set, a three valver (HF, R, LF), had gone completely on strike, not so much as a dot coming from the phones. He had, he assured me, tested everything and found all in order. Finally in despair he had taken the whole set to pieces and remade it, only to find that the results were as before. It must have been a trying time for a clergyman unless he

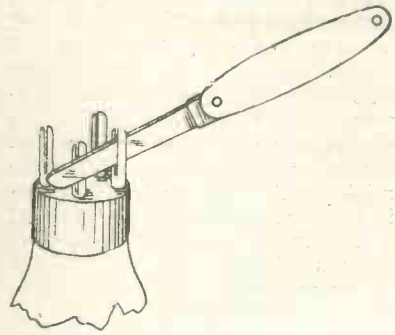


Fig. 6.—A means of warding off trouble.

was able to get his appropriate remarks made by proxy. On the following day I was in the middle of writing him a sympathetic letter embodying a few suggestions for a further search when the post arrived bringing another letter from him. In it he apologised for having troubled me and jubilantly recorded that he had at last succeeded in getting to the root of the matter. I confess that I was

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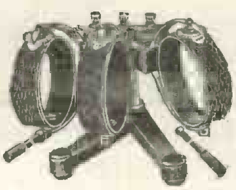

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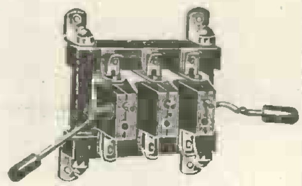
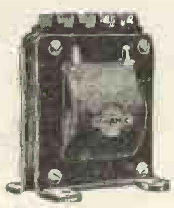


Panel Mounting Type.



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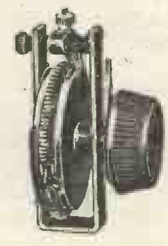

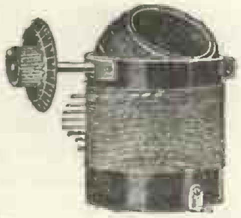

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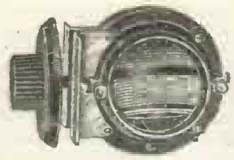
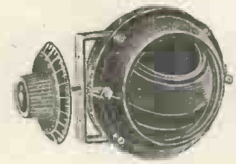


Type H.



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VARIOMETERS.

Made in the two types as illustrated. Type "H" for tuning the aerial circuit and type "S.R." for the anode circuit of a high-frequency valve. Both covering an approximate wavelength range of from 150 to 800 metres in their respective circuits, they accomplish all that could be desired in variometer tuning. Rotor and stator of hard moulded ebonite. Rotor externally and stator internally wound.

PRICES : Type H, 15/-, type S.R. 18/-

Complete in both cases with knob and dial.

Obtainable from all high-class dealers.

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quite as astonished as he must have been, when I read what he had to say. The whole trouble was due simply and solely to the fact that the plate pin of the rectifying valve required a little splaying out with the blade of a pocket knife. He had done this and all was well. One should not forget to perform this simple operation upon all valves as a matter of routine every now and then. It is as well to give the pins a rub over with a piece of old worn emery cloth in order to keep them bright. A dirty grid pin may be responsible for crackles that are not at all easy to trace to their source.

Receiving Two Messages at Once

To the Editor, MODERN WIRELESS.

SIR,—With reference to the report from the R.M.S. *Aquitania*, that the chief wireless operator has succeeded in receiving two wireless messages simultaneously on two aerials, it is interesting to recall that in his early experiments, in 1900, Senatore Marconi demonstrated the possibility of receiving two wireless messages on different wavelengths simultaneously with one aerial. Describing this achievement in the *Times* of October 4, 1900, Professor J. A. Fleming said :

"These experiments have been conducted between two stations, one in Poole in Dorset, and the other near St. Catherine's in the Isle of Wight. The two operators at St. Catherine's were instructed to send simultaneously two different wireless messages to Poole, and without delay or mistake the two were correctly recorded and printed down at the same time in Morse signals on the tapes of the two corresponding receivers at Poole.

"In this first demonstration each receiver was connected to its own independent aerial wire hung from the same mast. But greater wonders followed. Mr. Marconi placed the receivers at Poole one on the top of the other, and connected them both to one and the same wire, about 40 ft. in length, attached to a mast. I then asked to have two messages sent at the same moment by the operators at St. Catherine's, one in English and the other in French. Without failure each receiver at Poole rolled out its paper tape, the message in English perfect on one and that in French on the other. When it is realised that these visible dots and dashes are the results of trains of intermingled electric waves rushing with the speed of light across the intervening 30 miles, caught on one and the same short aerial wire, and disentangled and sorted out automatically by the two machines into intelligible messages in different languages, the wonder of it all cannot but strike the mind."

The method of using two or more aerials for the purpose of receiving a corresponding number of messages at the same time is well known, and is utilised where necessary by the Marconi Company both on land and at sea.

Yours faithfully,

W. W. BRADFIELD.

Joint General Manager.

The Marconi International Marine Communication Company, Limited, Marconi House, Strand.

An Experimental Crystal Detector

IN this article a detector is described which is made from small parts which may be procured from any dealer. Its operation is quite simple and efficient, and has the advantage of giving a large number of intantaneously adjusted selections. It is built upon the principle of two wheels revolving on their own centres in such a way as when they are turned round in either direction one of the cups on the circumference of the wheels come into contact.

Diagram No. 1 shows the general arrangement of the detector. The lower wheel is supplied with four crystal cups, and the upper wheel is supplied with two crystal cups and two cat-whiskers. We must first adjust the lower wheel. This

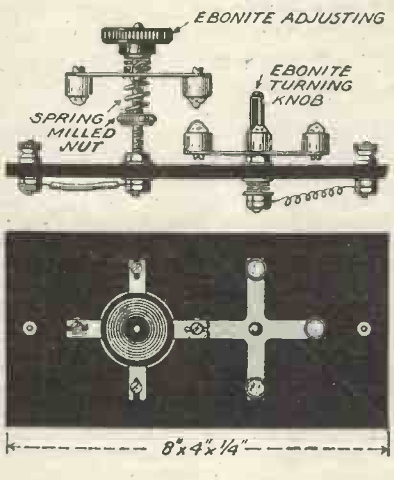


Fig. 1.—General arrangement of Detector.

is done by first making the wheel itself, as shown in diagram No. 2, which is cut from some springy brass. This is fixed to the base by means of a 2 B.A. spindle running through the centre of the wheel and clamped into position by means of a nut above and a nut below. A small projection of the 2 B.A. rod on the upper side is fitted with a small 2 B.A. bushed ebonite turning knob. Next fix the four crystal cups into the slots at the end of each spoke. Now place the 2 B.A. rod through the panel and fix by means of a washer, a spring washer and a further washer and a nut and a lock nut on the under-side of the panel. This completes the lower wheel.

The upper wheel itself is built up in a similar manner with the exception of the slots, in place of which are drilled four holes, as shown. In two of these holes, which are opposite, place two crystal cups, and in the other two holes place two cat-whiskers as shown in diagram No. 3. Now procure a piece of 2 B.A. rod and fix to the hole in the base in the position shown, by means of a nut on the upper side, and a washer, a nut,

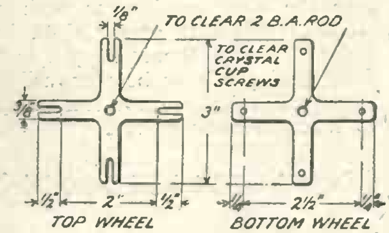


Fig. 2.—Details of the wheels.

and a lock nut on the under side. Next place a milled nut over the 2 B.A. rod, over which is also placed a spring of suitable tension. The wheel is then placed over this, when a washer, a spring washer, a further washer, and a 2 B.A. bushed ebonite knob are added. This knob is bushed and tapped right through.

This completes the fixing of the upper wheel. The milled nut which we first adjusted, is for the purpose of getting a suitable distance, according to the depth of the crystal cups or cat-whiskers. The ebonite adjusting knob when screwed down brings the cups or cat-whiskers into contact with the cups on the lower wheel, giving a good contact as regards fine pressure, the two springs working in opposition to each other. To operate, the desired cup or cat-whisker on the upper wheel is turned round until it has found the desired crystal on the lower wheel, and then adjusted by means of the cup.

A favourite combination of crystals is as follows:—On the lower wheel we may have Hertzite and Iron Pyrites, Zincite and Carborundum. On the upper wheel we may have Bornite and Molybdenite. The two cat-whiskers on the upper wheel may be fine gold and platinum. The Bornite and Molybdenite can be used in conjunction with the Zincite. The gold cat-whisker with the Hertzite, and the patinum cat-whisker with the Iron pyrites.

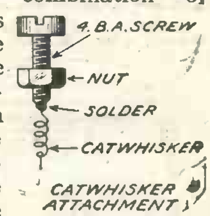
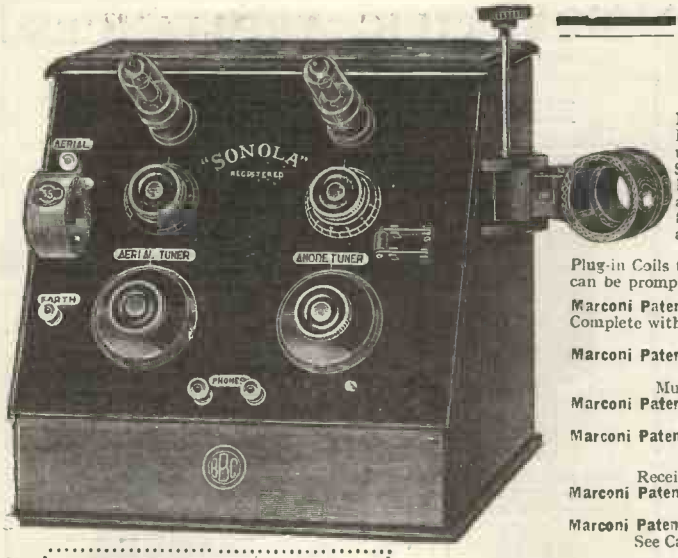


Fig. 3.—The Cat-whisker.

H.B.



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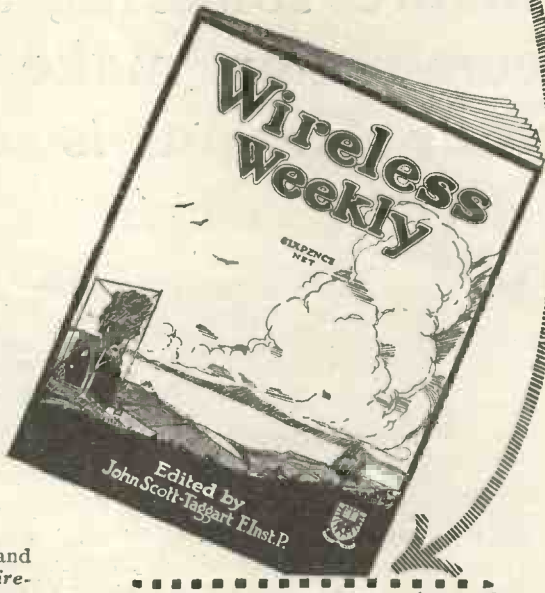

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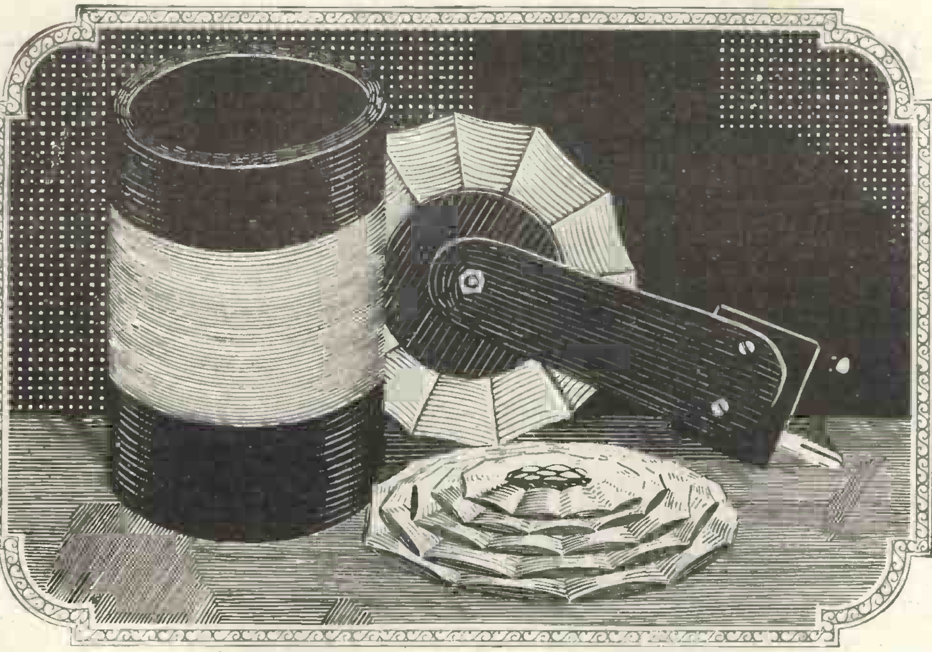

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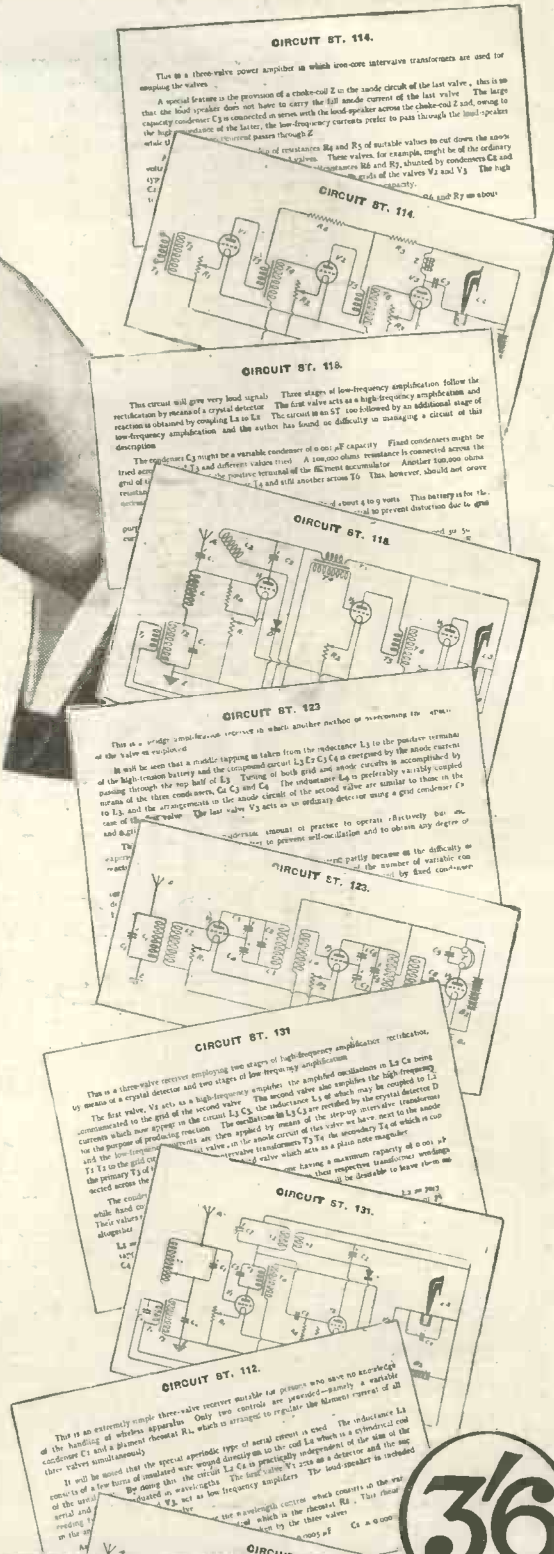

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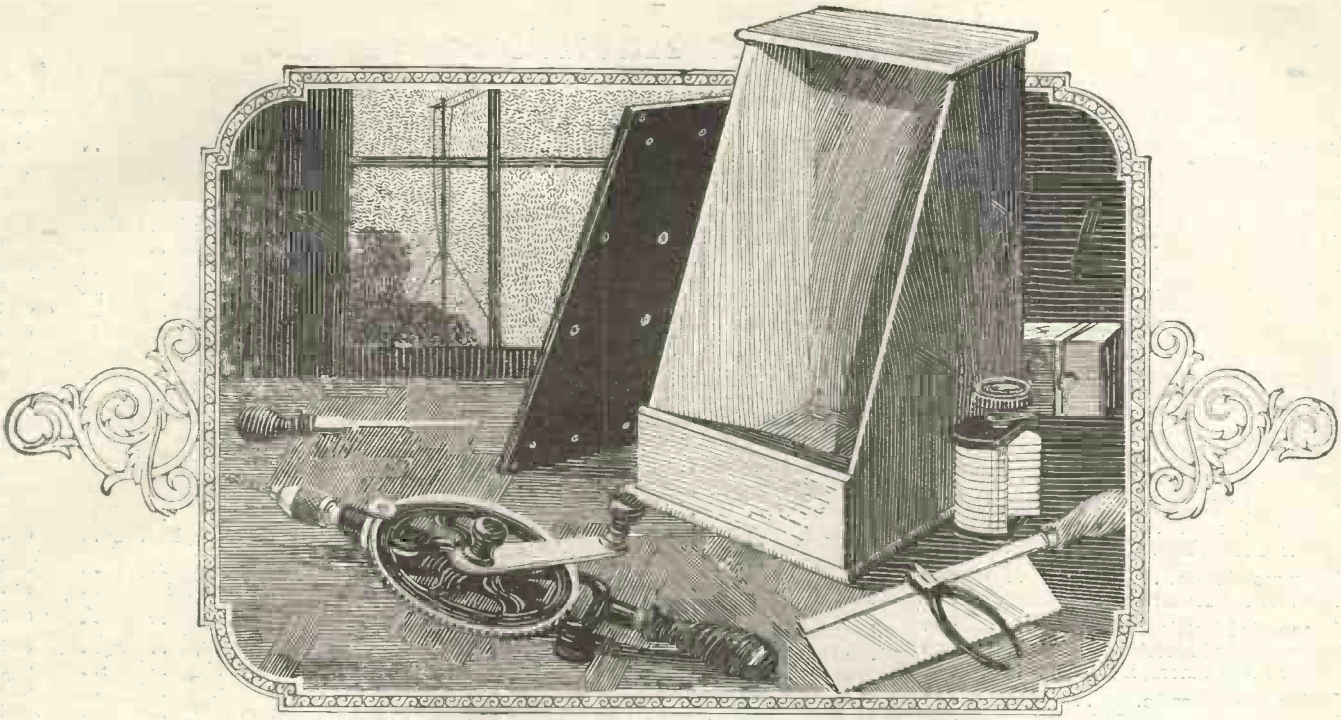

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