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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

THE ABUSE OF LOUD-SPEAKERS.

THE subject of the abuse of loud-speakers has been so much to the fore during the last week or so that we feel it would be out of place if we did not make some reference to the matter.

There have been several instances where cases of complaint against the use of loud-speakers have been brought to the Courts, and magistrates have said some very unkind things both about the loud-speakers themselves and those who use them. It is even reported that at Reading the local authorities have gone so far as to place a ban on the use of loud-speakers out of doors.

This sudden outcry seems to us to be very foolish. Of course, it is realised that in the summertime any sound-producing devices energised by one's neighbours are more noticeable than during the winter months, because windows are thrown open and the loud-speaker or the gramophone is frequently taken into the garden. In confined spaces indoors the owner of a wireless set, for his own comfort, usually limits the volume of sound from the loud-speaker, but once out of doors the tendency seems to be to run the loud-speaker to its utmost and make as much noise as possible without much attention to quality. We have every sympathy with the complaining neighbour, because it is not everyone who wants to be compelled to listen to broadcasting at any time; in fact, one of the charms of broadcasting is that you can listen-in or switch it off at will without causing any offence to those who are endeavouring to entertain you before the microphone.

What surprises us, however, is that the loud-speaker should have been singled out for so much special attention, whereas other forms of musical instrument, just as obnoxious when overdone, seem to be tolerated without objection being raised. Those who happen to live, for instance, near popular reaches of the river are subjected to an almost continuous entertainment from various gramophones right into the early hours of the morning, yet one seldom hears of serious complaints, nor do magistrates take half as much interest in chastising the owners of the gramophones as they appear to have done in cases where the complaints are against the use of loud-speakers.

If only more attention would be paid to the question of quality rather than quantity in reproduction, practically all the complaints would be satisfactorily met. No loud-speaker should ever be made to reproduce above natural strength. It should be remembered that those who speak at the microphone do so almost in a confidential way, and their voices are seldom raised above conversational strength; but too often when reproduced in a loud-speaker one would imagine that the speaker is addressing an open-air meeting or, at least, a crowded audience at the Albert Hall. The moment amplification is pushed so as to bring the voice beyond the strength of the original speech the quality must sound harsh and unnatural, and it is then that we may expect to irritate our neighbours.

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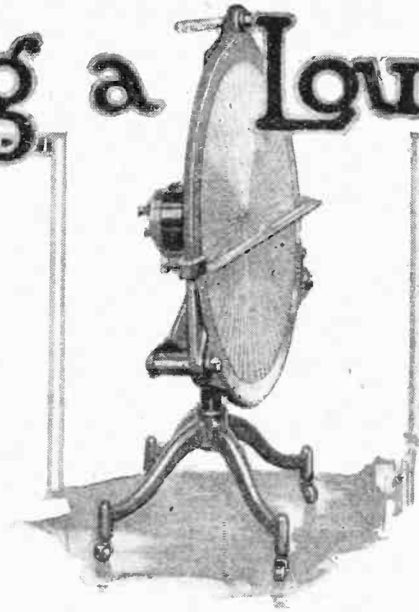
Building a Loud Speaker



Pleated Diaphragm with Coil Drive.

By
H. LLOYD, M.Eng.

IT is an indisputable fact that investigations into the improvement of the loud-speaking telephone have had to wait until the advent of Broadcasting has provided the impetus necessary for their diligent pursuit. It has been an unfortunate thing for Broadcasting itself, because the shortcomings of the loud-speaker have repeatedly and in many ways barred the path to complete success in the utilisation of the Broadcasting service. Most of the adverse criticisms of Broadcasting as an invention have been prompted by a disappointing experience of loud-speaker reception, and though there will always be many who are easily satisfied, just as there is still a steady demand for the cheap gramophone, Broadcasting will have to wait for its full measure of appreciation until the perfect loud-speaker has been attained, and heard by the critics who really matter.

The following details of construction have reference to a loud-speaker which was mentioned, and of which a photograph appeared, in an article by the writer, in a previous issue,[1] resulting in a number of enquiries from persons interested in obtaining the utmost realism in broadcast reception. One or two slight structural improvements have been effected since that date, but the instrument remains substantially the same, and has held its own up to the present against a number of others of various types. The use of the moving-coil principle side-tracks the troublesome resonance effect met with when a reed is involved, and since the restoring force on the diaphragm is very small, the resonant frequency is at too low a pitch to be objectionable. The dimensions of the diaphragm, which is clamped at its periphery, are large enough to prevent any serious loss in the low register by actual air-displacement from back to front, whilst a very good high-frequency response is retained, as evinced by the crispness of the consonants in speech. This diaphragm, too, gives very good damping, and only on one or two occasions in certain types of large hall has it been found desirable to apply a little extra damping to the centre, in the form of a small cushion of petroleum jelly, as described later.

[1] *The Wireless World*, Oct. 14th, 1925.

The Frame Casting.

The frame, which is of cast-iron, is illustrated in Fig. 1. It will be seen to consist of a ring, having an inside diameter of $19\frac{1}{4}$in., to which are attached the extremities of a substantial metal spider. At the centre of the spider there is a machined boss on which the movement of the loud-speaker is mounted. The pedestal is of rigid design, and is fitted with castors to facilitate the transference of the instrument from one room to another.

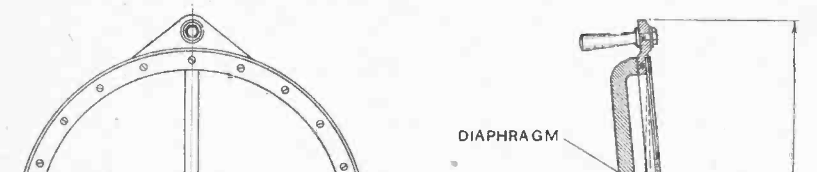


Fig. 1.—Leading dimensions of the cast-iron frame.

In preparing the castings, the ring was first taken in hand, and the three surfaces to receive the arms of the spider levelled up by filing. The three holes in the lugs were then drilled out to receive $\frac{5}{16}$in. bolts, and the ring mounted on the lathe face-plate to true up the recess on the front face. This recess is $\frac{1}{8}$in. deep and $1\frac{1}{8}$in. wide, and accommodates a clamping ring for securing the edge of the diaphragm. The clamping ring, shown in the figure, was made by forging a length of mild steel strip, $\frac{3}{32}$ in. × $1\frac{1}{8}$in., into a circle, and welding the ends together, kinks being carefully removed by hammering until the ring bedded evenly down all round on to the faced portion of the casting. Twenty-one $\frac{3}{16}$in. countersunk screws hold the ring in position. The spider was machined up in a somewhat similar manner to the ring

Building a Loud-speaker—

casting, its ends being first filed up, drilled to pass ¼in. screws, and mounted on the face-plate. The boss was bored out 2in. diameter, and faced where it was to receive the field-magnet. Two holes, ¼in. diameter, were drilled through the boss, 3in. apart, for holding the field-magnet casing to the frame. Finally, the spider was carefully located in a central position on the cast-iron ring, and holes drilled and tapped in the latter for its permanent attachment. Little need be said concerning the pedestal, the method of mounting the frame upon it being obvious. A slight tilt of about 10° from the vertical brings the centre of gravity of the complete assembly into a position giving stability, and contributing to convenience in lifting.

The Permanent Magnet.

Fig. 2 is a sectional view of the movement. The magnet carcase is of cast-iron, whilst the central core and ring-shaped pole-piece are conveniently made of soft iron. The annular air-gap between the poles is $\frac{1}{16}$in. wide, and it is important that the core be accurately centred in the hole. The magnetising coil was constructed on a temporary former from which it was removed after the usual procedure of baking with shellac varnish and taping, and was secured in position in the magnet carcase by a few thin wooden wedges driven in tightly between the core and the coil. The winding, which consumes about one ampere at six volts, requires 4½ lb. of No. 19 S.W.G. D.S.C. wire, and has 1,200 turns. The ends are brought out through two bushed holes in the casting to a small terminal block.

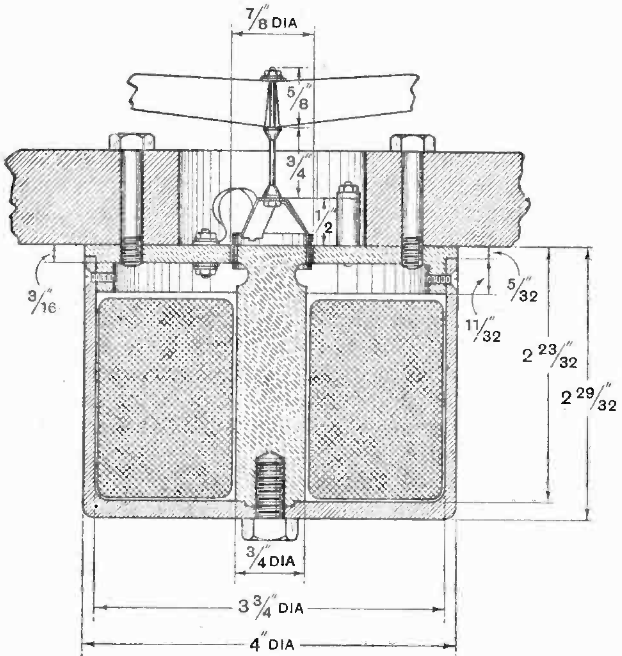


Fig. 2.—Section of the loud-speaker movement.

The drive coil is shown separately in Fig. 3. This component calls for some care in construction to ensure its ability to withstand severe vibration without developing rattle. When the signal currents traverse the winding of this coil, the turns of wire are impelled backwards and forwards due to the fact that they are immersed in an intense radial magnetic field. The force thus applied to the coil is transmitted to the diaphragm through the small bakelite bobbin, and if the wire is not very securely fastened at all points there will be relative motion and consequent failure in satisfactory performance. To construct this part of the movement, a short length of bakelite tube was turned down exactly to the dimensions given, and three slots cut near one end, equally spaced round the circumference. The easiest way to cut these slots is to drill a small hole, and open this out into a slot with a short piece of fretsaw blade, used in the manner of a keyhole saw. A little trimming of the edges with a fine file is then all that is necessary to result in a neat slot, about $\frac{3}{32}$in. × $\frac{1}{32}$in. A small spider was then cut from No. 26 S.W.G. aluminium sheet, with a central hole to take a No. 6B.A. screw, and after bending the arms in the fashion shown in the sketch, the ends were reduced with a file so that they were a good fit in the slots made in the bakelite tube. Slight inequalities in the sizes of the slots did not matter, as each arm of the spider was filed to fit its individual slot. The arms having been coaxed into position in the slots, the projecting ends were cut off about $\frac{1}{32}$in. from the outer surface of the tube, and bent upwards to grip it securely. The rod which operates the diaphragm was turned up from a piece of $\frac{3}{16}$in. duralumin rod, shouldered and screwed at each end to take a No. 6B.A. aluminium nut. Before attaching the rod to the moving coil, a strip of steel, 2 mils. thick and ¼in. wide, such as is used for feeler gauges, was drilled near one end and threaded over the screwed portion of the rod, so that when the spider was put on and the nut tightened up, it was clamped between the shoulder and the aluminium spider. A little thick celluloid varnish put on the adjacent surfaces before tightening up reduced to a minimum the possibility of anything shaking loose and causing a rattle. Finally, before winding the coil, the assembly was held in the lathe by the rod, and the arms of the spider gently bent with a small pair of pliers until the bakelite tube was exactly coaxial with the rod.

Winding the Moving Coil.

The winding consists of 104 turns of No. 40 S.W.G. S.S.C. copper wire, in four layers, the ends of the wire being passed through two small holes in the tube and soldered to the two strips of copper foil which convey the current. These two leads are each fastened to one of the arms of the aluminium spider by means of celluloid cement, a small strip of very thin silk ribbon being laid over and beneath the copper foil for insulation, and also to assist the cement in holding the leads securely to the aluminium. In length the leads are about 1½in., and are bent in an easy curve for attachment by soldering to the insulated studs in the pole piece. After winding the coil, several coats of celluloid varnish were applied to it, the varnish being allowed to run round and under the turned-up ends of the aluminium spider to make a good solid mechanical joint. When the varnish was quite hard, the coil was tested for continuity and insulation, and mounted in position on the pole piece. The small brass block and strap, which grip the end of the thin metal tongue, were placed in position over the two

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pieces of No. 6 B.A. brass studding let into the pole piece, and the nuts tightened up after carefully adjusting the position of the coil centrally with respect to the air-gap. Soldering the copper leads to their terminals completed this part of the construction.

Turning now to the diaphragm, the paper used was almost identical in weight and texture with the pages of *The Wireless World*. After storing the paper for several days in a dry room, four pieces were cut $10\frac{1}{4}$in. × $17\frac{1}{2}$in. Lines were then drawn at intervals of $\frac{1}{2}$in., parallel to the shorter side, and the sheets folded alternately backwards and forwards exactly along the ruled lines, the creases being made definite by rubbing along each fold with an ivory knife-handle. The four sheets were then attached end to end, using Seccotine evenly applied, with an overlap of $\frac{1}{2}$in., and the two extreme ends brought together and joined in the same way. The sheets must be matched up correctly in doing this, so that the pleats alternate uniformly all round; allowing for the four half-inch overlaps, there should be 136 pleats in all. The corrugated cylinder thus formed was then opened out like a parasol, and laid flat on the bench with a few small weights placed on it, whilst the frame was prepared to receive it.

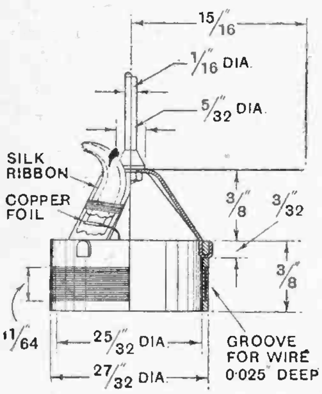


Fig. 3.—Details of the moving coil former showing flexible leads to the winding.

Final Adjustments.

In its first form, this loud-speaker had the diaphragm merely gripped between the bare metal surfaces of the cast-iron frame and the clamping ring, and it was soon found that a slight buzzing, apparent at certain frequencies, was due to the imperfect seating of the ring on the casting, allowing the paper to vibrate. Accordingly, the adjacent surfaces were faced with a thickness of baize, between which the edge of the diaphragm was clamped. Two strips of baize, $1\frac{1}{8}$in. wide and 68in. long, were cut and glued respectively to the frame and clamping ring. Placing the ring in position on the frame, the two thicknesses of baize were pierced at the screw-holes by means of a red-hot poker. In mounting the diaphragm in position, it was carefully centred before putting in the screws, so that the operating rod would locate itself correctly when the movement was fitted. Turning the frame over after screwing up the clamping ring, the pole piece, carrying the moving coil, was placed carefully on the centre boss, with the operating rod passing through the opening in the middle of the diaphragm, and the two set-screws seen in Fig. 1 tightened with a spanner. After seeing that the coil was still centred and would not foul the pole-piece, the frame was again turned over and a small quantity of melted Chatterton's Compound run round the rod, warming the rod itself with a soldering-iron, so that the compound penetrated right down amongst the closely gathered pleats of paper. Whilst the rod was still warm, the nut was replaced, a small cardboard washer being inserted between it and the diaphragm. It is only necessary for this nut to be finger-tight, for if the diaphragm beds properly down on to the shoulder of the rod, and the compound has flowed in amongst the folds of the paper, it will be quite secure against vibration. The diaphragm was now varnished with a preparation commonly used for the protection of metal against the effects of moisture, and known as "Spade Varnish." Two thin coats were applied to each side of the diaphragm, the frame being supported in a horizontal position until the varnish was dry.

Increasing Damping.

The method of fitting the magnet carcase is shown in Fig. 2, and if the work is done with reasonable accuracy there should be no fear of the coil fouling either of the pole-pieces during its movements.

A design for an output transformer suitable for operating this and other loud-speakers was given in the article previously referred to. An adequate core cross-section is essential when using low-impedance power valves taking a comparatively large anode current.

In conclusion, a few remarks on the operation of the loud-speaker may be of interest. It has occasionally been found useful, when working in certain halls having very pronounced resonance, to use the attachment shown in Fig. 4 It consists of a bar, fitted diametrically across the front of the loud-speaker, carrying a short piece of $\frac{3}{8}$in. brass rod capable of being adjusted into proximity with a small disc of aluminium mounted in the centre of the diaphragm. Between this disc and the end of the brass rod a pad of material can be interposed for the purpose of applying additional damping at the lower frequencies. The most effective "pad" has been a small quantity of vaseline, the distance between the end of the rod and the diaphragm being adjusted to give just the required degree of damping. The drive-coil will withstand a current of 0.5 amp. without serious overheating, but for ordinary use in a medium-sized sitting-room an average current of 30 milliamperes will give a very realistic rendering of most broadcast matter. For such purposes the last valve of the amplifier should be of the D.E.5A class, with not less than 150 volts on the anode. Proper volume control should be incorporated in the amplifier for the purpose of cutting speech down to its correct relative loudness level.

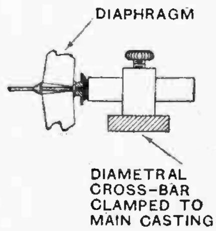
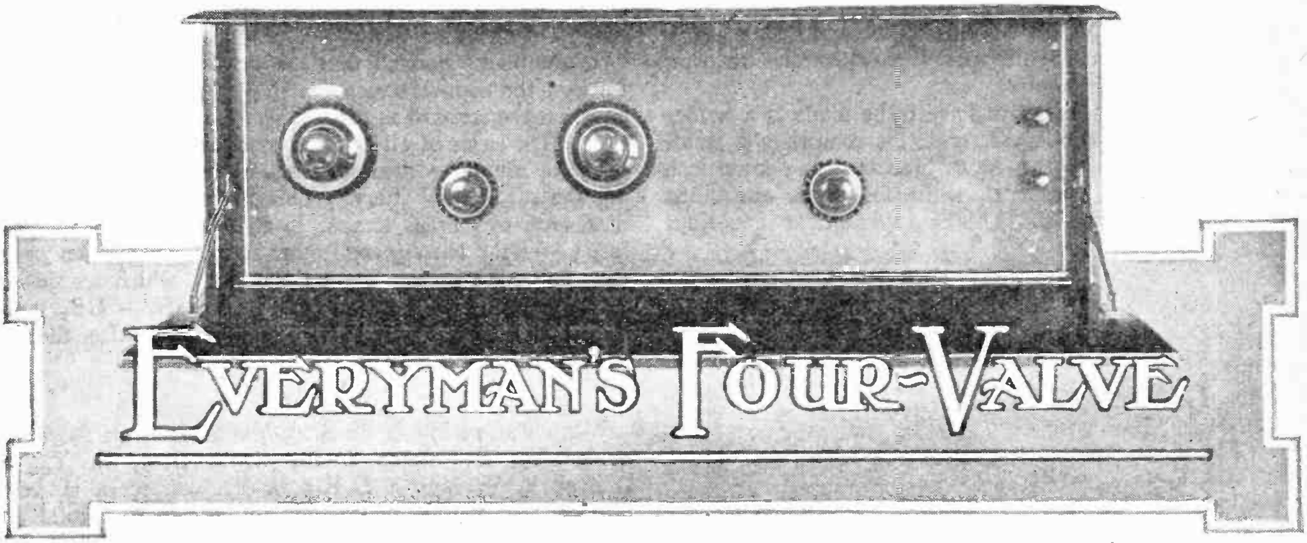


Fig. 4.—Attachment for providing additional damping for the diaphragm.

PORTABLE RECEIVER FOR DAVENTRY LOUD-SPEAKER RECEPTION.

Constructional Article will be included in next week's issue.



EVERYMAN'S FOUR-VALVE

Further Constructional Details and Operating Notes.

By W. JAMES.

(Concluded from page 116 of previous issue.)

In the first part of this article we dealt with the design of the receiver, describing in detail the function of each piece of apparatus. The set was designed to give the maximum amplification obtainable with four valves consistent with good quality reproduction, and it is an easy matter to tune in about a dozen stations at full loud-speaker strength. A further feature of the set is that it has only two controls, and is therefore very suitable for those who have little operating skill.

WITH the high-frequency transformers made and the parts assembled on the front ebonite panel, as described in the last issue of this journal, it only remains to screw the parts to the baseboard before the wiring can be started.

The baseboard measures 26in. × 8in. × ½in., and along one edge is screwed a piece of wood about ½in. square, as indicated in Fig. 11. This stiffens the baseboard, and provides a means for fixing the lower edge of the panel which is screwed to it.

In addition to the components, such as transformers, condensers, and resistances, which are screwed to the baseboard, it is necessary to fix a screen of copper between the two high-frequency transformers. This screen can be made from a sheet of copper of about No. 24 gauge. Its lower edge is turned over so that it can easily be screwed to the baseboard, and the top is bent over to remove the sharp edge; also, one end is bent over so that it can be screwed to the panel. A hole is drilled opposite the grid connection of V_1, a further hole being drilled to take a 4B.A. screw for earthing, as shown in the wiring diagram, Fig. 12.

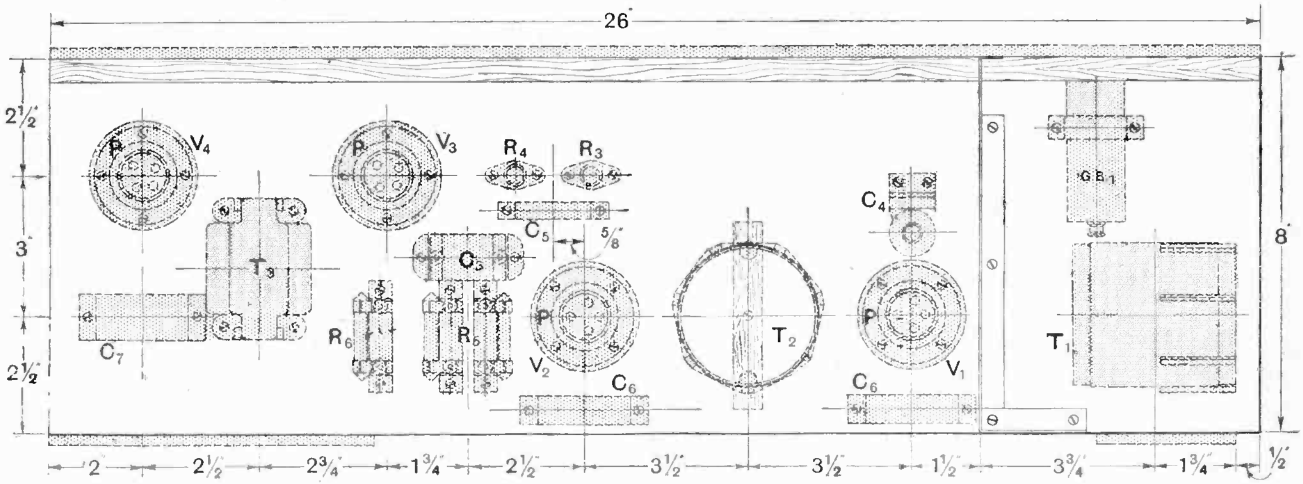


Fig. 10.—Arrangement of parts on the baseboard. C_4, balancing condenser (Gambrell); C_5, 0.0005 mfd.; C_6, 1 mfd.; C_7, 2 mfd.; R_3, R_4, fixed resistors of 15 and 7.5 ohms; R_5, grid leaks of 1 megohm each: R_6, 3 megohms: T_3, low-frequency transformer (Ferranti).

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It is necessary to cut a small piece out of the edge resting against the ebonite panel to clear the rheostat used as the volume control.

A further item which will have to be made is a holder for the balancing condenser, and this comprises a small strip of ebonite with two brass brackets; the lower one is screwed to the baseboard, while the upper one holds the balancing condenser. This is a convenient mounting,

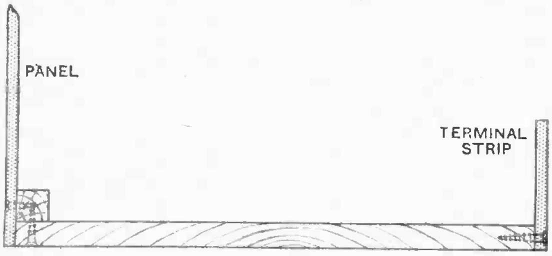


Fig. 11.—Method of securing panel and baseboard.

for the balancing condenser is then held in a position where it is easily adjusted during the initial trial of the set. In Fig. 10 the balancing condenser and its holder are marked C_4, the condenser itself facing the valve V_1.

Finally, a piece of wood about ½in. thick is placed below each valve holder; this is to raise the valve holder connections well above the baseboard, and is a great convenience, as it enables the filament wires to be run along the baseboard in a neat and orderly fashion.

Wiring Hints.

The important thing in a set of this type is to run the wires in such a way that there is no risk of moving them when inserting or withdrawing valves. It is, therefore, convenient to put all the filament wires and other power wires in Systoflex, and to run them along the baseboard and to bring them up at the valve contacts, rheostats, etc. Wires connecting the filament side of the condensers, the earth, and battery wires should also, as far as possible, be run along the baseboard. Only the wires connected to the grids of the valves and the high-frequency portions of the receiver should be run clear and in straight paths.

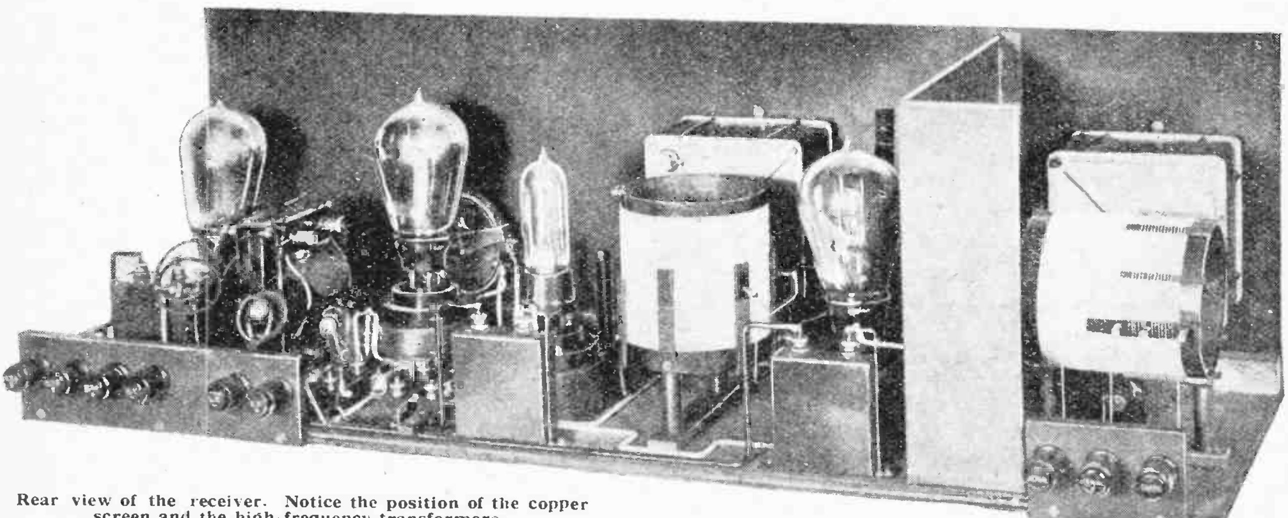
It should be noticed that the grid wire for V_1 passes through the copper screen, so that it must be insulated, and that the screen has three other (earth) wires connected to it. The cases of all by-pass condensers are earthed.

There are three flexible wires, which are for connecting the grid bias battery. This battery is fastened, by means of two brass straps, to the back of the cabinet just above the battery connection strip, as shown on page 110, July 28th issue. These three wires, which are shown in the wiring diagram, are marked + GB, $-$ GB_2, and $-$ GB_3, and can be cut to the correct length after the set is placed in the cabinet.

Testing.

When the wiring is finished, put a D.E.5b valve in holder V_1, a Cosmos SP18, Green Spot, in V_2, a D.E.5b in V_3, and a D.E.5 in V_4, connect a six-volt filament heating battery, and apply 150-160 volts to $H.T._1$ and $H.T._3$. For the detector apply about 90 volts at $H.T._2$. Also connect + GB to the positive side of the grid bias battery, $-$ GB_2 to negative 3 volts, and $-$ GB_3 to negative 12 volts.

The set will give maximum power when using these valves or valves of the same type. If it is desired to use valves of the two-volt class, a D.E.R. or SP18, Green Spot, may be used at V_1, V_2, and V_3, with a D.E.6 or S.P.18, Red Spot, at V_4. Other suitable valves are the P.M.1 and P.M.2, which may be used at V_1, V_2, and V_3, and at V_4 respectively. It should be remembered, however, that the two-volt valves will, in general, not be productive of anything like such good results as the six-volt valves recommended; for instance, the high-frequency transformer will amplify about twenty times with a D.E.R. valve as compared with nearly forty with a D.E.5b, the selectivity being about the same in the two cases. Also, the Ferranti low-frequency transformer used with a D.E.R. valve gives an amplification of about 30, whereas the amplification with a D.E.5b is about 60 for the same quality of reproduction.



Rear view of the receiver. Notice the position of the copper screen and the high-frequency transformers.

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It is very important to notice that the grid bias for the detector cannot be obtained from the fixed resistor when two- or four-volt valves are used throughout the set. If two-volt valves are used, it is necessary to remove the two resistors R_3 and R_4 and to join together the wires shown connected to the outer ends of these resistors. The wire shown connected to the junction of R_3 and R_4 should be taken to negative three volts on the grid bias battery.

set is perfectly balanced. But we do not wish to have a perfect balance; we wish to take advantage of the regenerative effects of the high-frequency inter-valve transformer, and yet not allow the input circuit to oscillate.

This can be done by turning on the volume control rheostat and tuning in a distant station; now slightly reset the balancing condenser, and notice whether the receiver oscillates. If it does not, make a further adjustment until the set is in its most sensitive state, but not oscillating. Tune in a signal at the lower as well as the

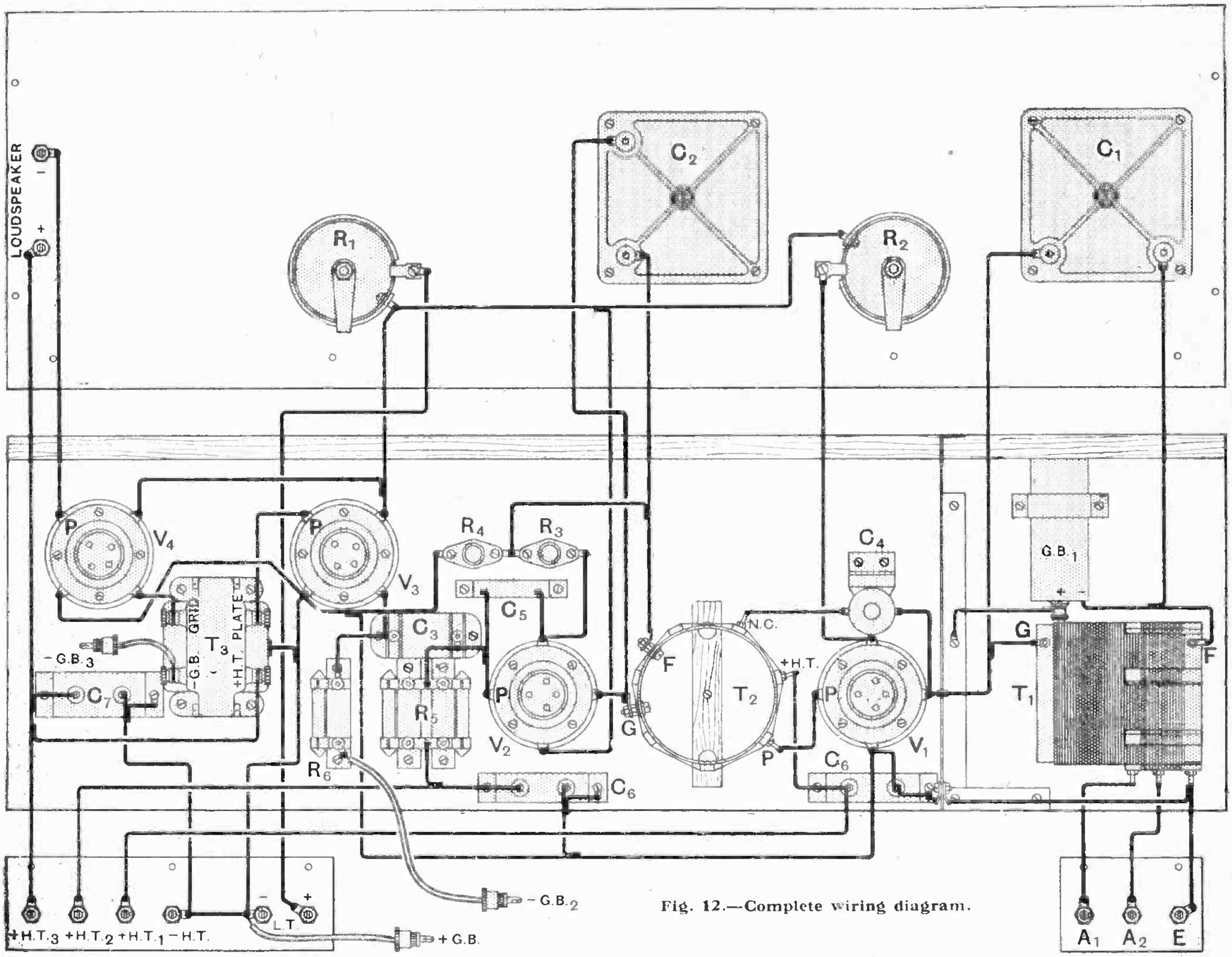


Fig. 12.—Complete wiring diagram.

Connect the earth to terminal E and the aerial to terminal A_2, and tune in the local station. Probably the set will oscillate. To stop this it is only necessary to adjust C_4, the filament rheostat and volume control rheostat being full on. Then tune in a weaker signal and make a further adjustment to the balancing condenser.

This condenser should be so set that the receiver does not oscillate at any wavelength, and a very good method to adopt is this. Tune in the local station and turn off the first valve by means of the volume control rheostat. This station will probably still be heard at good strength. Now adjust the balancing condenser until the signal disappears. At this position of the balancing condenser the higher wavelength end of the tuning dials, and make sure that there is no sign of self-oscillation. This adjustment is quite a simple one to make, and should only take a few minutes; once it is made there is no further need to touch the balancing condenser unless the first valve is changed.

The set will be found to be perfectly stable when the balancing condenser is correctly set; in fact, absolute stability can be obtained with the aerial and earth removed from the set, and it will probably be found possible to tune in one or two stations with the first coil acting as the aerial.

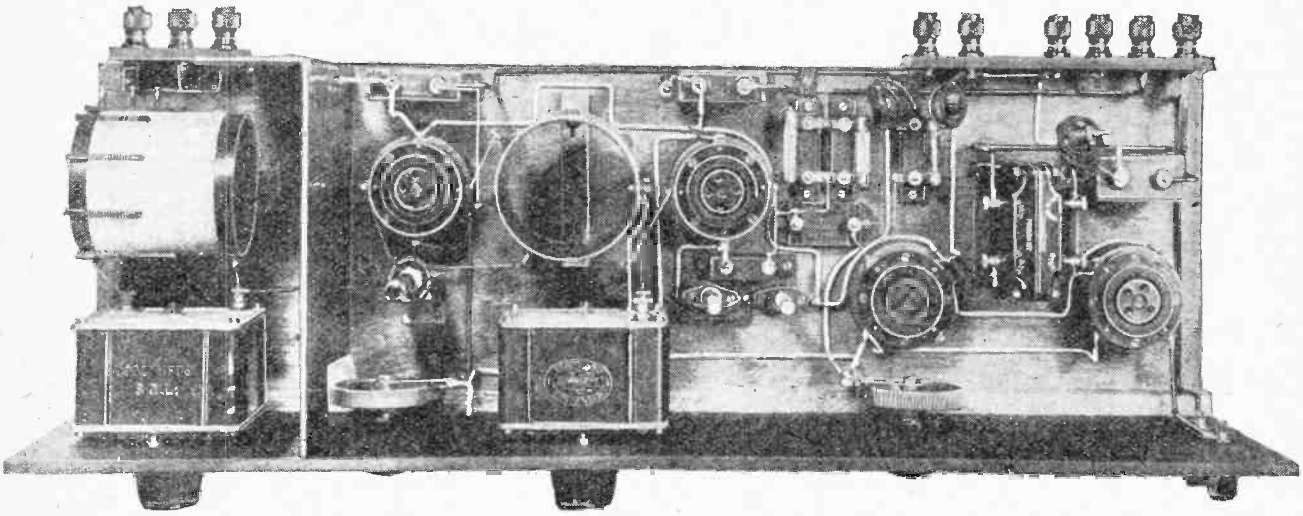
If tests are made, it will be found that the set is

Everyman's Four-valve.—

more selective with the aerial connected to A_2, and that the stations on the longer wavelengths are strengthened by using the connection A_1.

cannot be harmed by the application of this voltage. Valves of the two-volt class should, in general, not be worked with a plate voltage exceeding 120.

It will not be necessary to experiment with the plate



View of the set from above. All parts can be seen in this illustration.

There may be readers who will think that the plate voltage of 150-160 is rather high; it certainly is a high voltage, but it is well worth while to use plate voltages of this magnitude when valves of the power type are used, as their output is considerably increased. They voltages applied to any of the valves, except the detector. The best voltage for this valve should be found whilst listening to a weak signal. The voltage is not critical in any way, but different valves require different voltages for best results.

Calls Heard.

Extracts from Readers' Logs.

Weybridge.

Australia :—A 2BK, 2CM, 3BA, 3BD, 3BM, 3BQ, 3EF, 5BG, 6AG. New Zealand :—Z IXA, 2AC, 2BX, 2XA, 4AA, 4AC, 4AM, 4AS, 4AV. Argentine :—R AA8, AC8, DB2, KA9, U.S.A. :— U 6AMM, 6COW, 6OI, 6ZK. Brazil :—BZ 1AB, 1AC, 1AD, 1AJ, 1AK, 1AO, 1AQ, 1AR, 1AW, 1AX, 1BD, 1BI, 1IB, 2AJ, 2SP, 5AA, 5AB. South Africa :—O A3E, A4Z, A6N, 1SR. Uruguay :—1CD.

L. C. Snowden.

London, S.W.19.

Great Britain :—G 6YQ, 6YD, 6MU, 6JB, 6JH, 6JV, 6TD, 6HJ, 6RM, 6OS, 6EB, 5GW, 5IP, 5IY, 5SJ, 5NN, 5XM, 5YG, 5SS, 5FQ, 2YY, 2XY, 2OP, 6UG, 6OM, 2ET, 2BB, 2BH, 5XM, 2KA, 5BHU, 2BVO, 5NG, 6QA, GI 6YM, 6OU. Irish Free State :—GW 19B, 15B. France :—F 8AEZ, 8MAC, 8BU, 8WOR, 8WOZ, 8CM, 8UDI, 8AR, 8FL, 8JMS. Porto Rico :—4GE, 6UR, 4SA, 4RX. Chile :—3IJ, PR, 3IM. Santa Fé :—FI2. Morocco :—MAROC. Brazil :—BZ 1AF, 1AA, 1AB, 1AH, 1AP, 1AY, 1AX, 1AY, 1BF, 2AJ, 2SP. New Zealand :—Z 3AF, 2AE. French Indo-China :—FI 8QQ. India : Y CBK, CRP, 2BG. Tasmania : A 7CW. Uruguay :—JCP, 2AI, 2AF. Vequdinavia :—SSVM, SSMW, S 2ND. Belgium :—B S4, B2, J6, K7, KPL. Germany :—K 4LY, Y1, W3. Spain :— EAR2, EAR21. Italy :—I 1CR, 1CN. Holland :—N OWB, OWF, OPN, 2PZ. Austria :—O AA, AB. Russia :—R CR1.

U.S.A. :—U 2SY, 4XE, 2AR, 2XAF, WO1. Various :—RNL, GB1, GB2, FSCR4, V7A, B22, 1AC, GEFT, WGHM, TUK, U INO, 12NO, B82, LAO, TPB, T3.

(0-v-1).

M. F. Woodroffe.

South Normanton, Derbyshire.

(May 21st-June 21st.)

Australia :—A 2BQ, 2LM, 7CW. Argentine : -R BA1, KA9. Brazil :—BZ 1AB, 1AD, 1AF, 1AK, 1AL, 1AQ, 1AW, 1AX, 1AR, 1BD, 1BH, 1BI, 1QB, 1IB, 2AB, 2AF, 5AA, 5AB, 1SN. Chile :— CH 3IJ. Porto Rico :—PR 4JE. Sweden : SMTN, SMTO, SMVJ, SMVL, SMXV, SMWR, SMYC, SMYG, SMSY, 2NX, 2NS. Germany :—K P4, 4YA, 4BO, 4DL, I2, W3. France :—F 8AR, 8CA, 8CG, 8CDJ, 8EN, 8GSM, 8HZ, 8KF, 8LGM, 8IX, 8JN, 8LZ, 8MB, 8PRD, 8PHI, 8RVR, 8SSZ, 8WE, 8WW, 8UT, 8UDI, 8CT, 8TBY, 8HC, 8JX. Swiss :—H 9XA, 9YA, 9WA, 9KW. U.S.A. :—U 1AEP, 1ABT, 1AXX, 1BTR, 2AHM, 2ATC, 2AF, 2ACT, 2AHK, 2GV, 2HA, 2MCP, 2VO, 2XG, 3BTA, 3DS, 4PCK, 8DON, 9KZW, 3BWT, 1AER. Various :— GW 3ZZ, TUN 2AGB, AGC, SGL, NKF, 1DO, LPW, LPV, FFQ, SAB.

(0-v-1 Reinartz, indoor aerial) On 30 to 50 metres.

H. Bishop.

London, E.C.3.

(May, June and July.)

Great Britain :—G 5NJ, 6IA, 6UZ, 6BT, 2KZ, 5HJ, 5SZ, 2IT, 6OH, 6OX, 5BY, 5TZ, 5DA, 5UW, 6AH, 6MU, 6BU, 2CC, 5JW, 5MU, 6YU, 2NM, 6BD, 5ZA, 6VP, 5US, 6HF, 2VQ, 2SO, 6QD, 6TD, 2RA, 6RY, 6IZ, 6TW, 5PO. Italy :—I 1AX, 1GN, 1CO. U.S.A. :—U 2XAF, 2XAD, 2XG, WBZ.

(0-v-1) On 16 to 60 metres.

F. G. Pratt.

Amersham, Bucks.

Australia :—A 2BK, 2IJ, 2LM, 2TM, 3BD, 3BQ, 3EF, 3KB, 7HL. New Zealand :- Z 2AC, 2XA, 4AA, 4AK, 4AM. Canada :—C 1AR, 1ED, 2AX, 2BE, 3DS, 3JW, 3XI. U.S.A. :—U 4AG, 4BA, 4BU, 4CL, 4EO, 4HU, 4IZ, 4NI, 4PZ, 4QG, 4QY, 4SL, 4TN, 5AKL, 5AKN, 5AMN, 5JF, 5MQ, 5NJ, 5UK, 5YB, 9ABI, 9ADK, 9ADN, 9AOT, 9BBW, 9BWM, 9CHE, 9CPM, 9DPJ, 9DPL, 9DRS, 9EJI, 9KG. Brazil :—BZ 1AW, 1AP, 1BB, 1BD, 1IB, 2AB, 5AB, SQ1. Mexico :— M 1J. Tripoli :—DA 1TA.

(0-v-1) On 40 metres.

K. E. B. Jay
(G2BMM).

FREQUENCY AND WAVELENGTH.

Their Applications to Tuning Principles.

By N. P. VINCER-MINTER.

IN spite of the enormous spreading of "wireless" knowledge among the general public which has taken place during the past three years, one is constantly coming up against the hard, cold fact that such knowledge as is possessed by many recruits to wireless is purely superficial and chimerical, and that there are persons at large to-day who will cheerfully embark upon the design and construction of a complicated receiver with three H.F. stages (a most difficult proposition even for the experienced radio engineer), who in 1921 would approach even a simple electric bell with a feeling of awe at its mysteries and with fear in their hearts that if they tampered with it it might "explode."

Now it does not need much application by the average individual to acquire sufficient knowledge of any scientific subject to bamboozle his maiden aunt into a belief that he is a very great expert indeed, and entitled to take his place amongst the foremost savants in that particular subject: a few high-sounding terms like "asymmetrical conductivity" (O thrice-blessed phrase!) and the flaunting of one or two complicated-looking blue-prints will do the trick nicely. The good lady may well be excused, therefore, if, being thus blinded with science, she imagines that her male relative's opinion on any matter pertaining to radio is worthy of serious consideration even by Marconi himself.

Usually it will be found that the true facts of the case are that such a person as we have under discussion has accumulated a goodly store of technical jargon, and by the careful study of blue-prints has assimilated a sufficient working knowledge to enable him to build a receiver from printed instructions, and to add such complications, such as switches in the H.F. portion of the receiver, as will make him appear a man of profound knowledge to the uninitiated, but will at once reveal him to the true expert as an impostor who has not grasped even the very fundamentals of the very specialised branch of electrical engineering appertaining to radio transmission and reception. High-frequency electrical engineering, which concerns itself with wireless telegraphy and telephony, X-ray work and similar matters, is the most difficult of all the branches of electrical engineering and the one concerning which we have least knowledge and reliable data, and it is quite impossible for anybody to understand the principles of it and thereby be enabled to do useful experimental work before the simpler and more tangible subjects of D.C. and ordinary A.C. work have been thoroughly mastered. Yet it is scarcely too much to say that there are people in existence to-day spending a great deal of time and money in attempting to design and build complicated reflex superheterodyne receivers who fail to appreciate Ohm's law properly. One might with equal hope of success attempt to design and construct a motor car without a preliminary knowledge of the functioning of an internal-combustion engine.

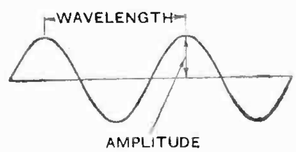


Fig. 1.—A convenient method of indicating wave motion visually is by a simple sine curve.

Where Angels Fear to Tread.

When one considers it calmly, it is really a very astounding state of affairs, because the very persons who seem to blunder haphazardly into designing and building complicated receivers are often the same people who are perfectly sane in all other matters, and are more often than not experts in their particular walk of life, and would be both amazed and amused at anyone who attempted without sufficient knowledge to perform a delicate and difficult operation in their particular sphere of activities. The Royal College of Surgeons would be considerably astonished if a case were brought to their notice of a layman attempting to perform an operation for appendicitis on a friend armed only with a blue-print and a carving knife. And yet there are quite a large number of that august body who rush into wireless "experimenting" equally ill-equipped. A stockbroker must be in a peculiarly suitable position to gaze sorrowfully on the follies of those who rush in with their speculations on a market where he, with all his knowledge and experience, would fear to tread; and yet the self-same man will wend his way homewards in the evening and at once proceed, without any real knowledge of what he is doing, to design the most elaborate receiver with double reflexing and switches galore, armed only with the same slight knowledge, not forgetting the blue-print. Strangely enough, in both cases the irresponsible dabbler sometimes "gets away with it."

Some time ago, in the course of an article on L.F. amplification, the writer expressed his wonderment at the firm hold which the old mistaken idea of placing the high-ratio transformer in the first stage, or of placing the transformer first in a combined transformer and choke or resistance amplifier, had obtained on the minds of even experienced amateurs.[1] It has several times been brought to his notice, however, since penning that article, that there are many other gaps to be found in the knowledge acquired by hardened set constructors. A full appreciation of the relationship between frequency and wavelength is surely the very rock upon which the whole edifice of wireless transmission and reception is erected, yet cases have been brought to the writer's notice in which dissatisfaction and surprise has been expressed by set-builders that their receivers are not sufficiently selective to separate Daventry on 1,600 metres and Radio-Paris on 1,750 metres. Enquiry has elicited the fact that their receivers cannot also separate London on 365 metres from Bournemouth on 385 metres, nor do their owners

[1] *The Wireless World*, May 26th, 1926, page 701.

Frequency and Wavelength.—

expect them to be so selective as to differentiate between stations 20 metres apart, but they do expect them to differentiate between the 90 metres separating Daventry and Radio-Paris. How people can expect a receiver to separate Daventry and Paris when they admittedly cannot separate London and Bournemouth, which are so much *farther* apart, is an indication of the confusion of wavelength with frequency. Surely it would be more logical to learn to walk before learning to run, and to build a receiver to accomplish the easier task of separating London and Bournemouth before the harder task of separating Daventry and Paris is attempted.

An Impossible Achievement.

For some time the writer was considerably puzzled by this unreasonable attitude of set-builders, until it suddenly dawned on him that these good people actually imagined that Daventry and Paris with 90 metres between them were farther apart than London and Bournemouth with 20 metres between them, and that the former pair had 4½ times the separation of the latter pair, whereas actually, of course, the positions are reversed, and London and Bournemouth have about 2½ times the separation of Daventry and Paris. One frequently hears the statement that such and such a receiver is so selective that it will completely separate stations only a few metres apart in wavelength. Such a statement is, of course, absolutely meaningless, because it would be quite impossible to separate a station working on 10,000 metres from one working on 10,010 metres, a metre separation of ten, whilst, on the other hand, it would be impossible *not* to separate a station working on one metre from one working on two metres, a metre separation of only one.

Not very long ago the writer saw in the columns of a well-known London journal a letter to the editor from a "harassed experimenter" demanding to know why the B.B.C. did not forsake their 300- to 500-metre waveband and occupy the two hundred metres between 20,000 and 20,200 metres, since that waveband appeared to be unoccupied. The author of that letter quite failed to appreciate that, so far from accommodating the twenty or so B.B.C. stations in the waveband proposed, not even one solitary station could be squeezed into that space.

An Apparent Absurdity.

He imagined, evidently, that because the present maximum wavelength was two hundred metres above the minimum wavelength, it was only necessary, if the minimum wavelength was raised to 20,000 metres, to place the maximum at 20,200. Actually, of course, if the minimum were raised to 20,000, and the maximum to ten million metres, it would actually be only possible to find room for one solitary broadcasting station in this ten-million-metre expanse of wavelengths! Probably the same individual would imagine that if the minimum wavelength were dropped to 100 metres, then the maximum would have to be fixed at 300 metres, and yet, of course, there is actually five times as much room between 100 metres and 300 metres as there is between 300 and 500 metres, and if the minimum wavelength of the B.B.C. were dropped to 100 metres the maximum would only need to be a little above 115 metres, since there is the same "room" in the 15 metres separating 100 and 115 metres as in the 200 metres separating 300 and 500 metres. Similarly, there is three times the space between 100 and 200 metres than exists between 200 and 300 metres, or, to carry it a step farther, we may say that there is more space between one and two metres than between two metres and ten million metres, or, indeed, any number of millions you like. Indeed, all the broadcasting stations ever likely to exist in the world could be comfortably accommodated between one and two metres without heterodyning each other, fifteen thousand being the actual number against the forty odd stations that can be accommodated in the present 300- to 500-metres wavelength.

Now to the uninitiated such statements must seem, on the face of them, to be absurd and far-fetched, and yet, of course, they are very profoundly true. And yet if anybody who has read as far as this is of opinion that the statements are untrue and that they are equivalent to stating that there is more room between one and two inches than between two inches and ten thousand miles, it is very obvious that he is far from appreciating the relationship of frequency and wavelength. What, then, is wavelength exactly, and how is it related to frequency? The problem is very simple, as we shall now proceed to see

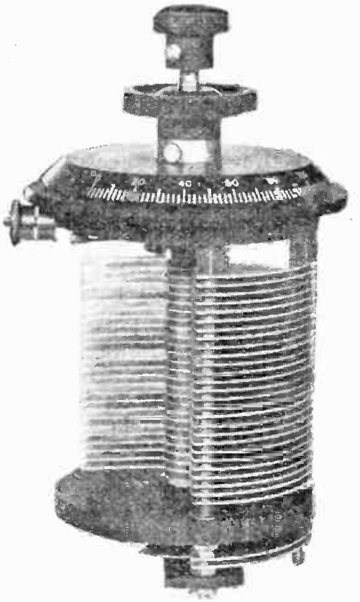
The Principles of Wave Motion.

The writer does not intend to give a lengthy dissertation on wave motion, nor does he intend to adopt the usual procedure of inciting readers to throw stones into neighbouring ponds and thereby run the risk of being apprehended by the commissioners of lunacy. He would merely point out that waves caused by dropping stones into water are purely surface waves and do not obey quite the same laws as waves set up in the air or in the ether, which are pressure waves. A wave created by a stone falling into water consists of a temporary raising of the level of the water surrounding the stone, this raising of the surrounding water being due to the temporary "dent" caused by the falling stone. After the stone has disappeared, water rushes in to fill the "dent," and although the actual particles of water move up and down for some time afterwards, no actual lateral shifting of the water takes place, but the wave motion is communicated to the surrounding water, and a wave or ripple is seen to travel outwards in an ever-increasing circle. To produce an air wave, which is a pressure wave actually in the medium and not on the surface of it, we can create a small explosion thus temporarily compressing the air immediately surrounding the source of the explosion. Although the actual air particles do not travel outwards, the temporary area of compressions travels outwards as wave motion in the form of a sphere of ever-increasing size, the area of compression being followed by an area of rarefaction, much the same as a surface wave towering above the normal level of the water is followed by an area of depression below the normal level. We cannot create wave motion in the ether by any physical explosion or movement, but must, as it were, create an electric explosion.

Now in the case of the production of air waves we

Frequency and Wavelength.—

need not create an actual explosion, but can set up waves by causing a tuning fork or other similar device to vibrate, and, similarly, by causing electrical vibrations or oscillations to surge up and down in our aerial system, we can produce ether waves. Now, although the production of surface waves on water are not quite parallel to the case of producing pressure waves in air or ether, we can very well use the visual waves of water to assist us in understanding wave motion in air or ether, which, of course, cannot be seen, although the former can, under special circumstances, be photographed. A straightforward sine curve representative of simple harmonic motion can, however, be used to represent wave motion and convey the idea of ether waves therefore partly because the curve is a pictorial representation of the general idea of a wave conceived by the average mind. Although in reality Fig. 1 is a sine curve representing simple harmonic motion, it looks so much like a cross-sectional drawing of the seaside wave of our childhood days that we can think of it as such if it assists us in our investigations.



The old type of semi-circular plate condenser which gave a straight line frequency reading.

So much for wave motion. Now for the moment let us forget waves, including that latest brain-wave of a real "world-beater" circuit, and imagine that we have a marvellous self-driven car, such as might have been conceived by the brain of H. G. Wells, which is capable of a speed of sixty miles *per second*, and is, moreover, capable only of travelling at that one speed, neither more nor less. If we start one of these marvellous machines from a given spot it is obvious that at the end of one second it will have travelled sixty miles, and that if we arrange to start another car off at each succeeding second we shall have a train of cars following each other at a separation between each of sixty miles.

The Mystery Unmasked.

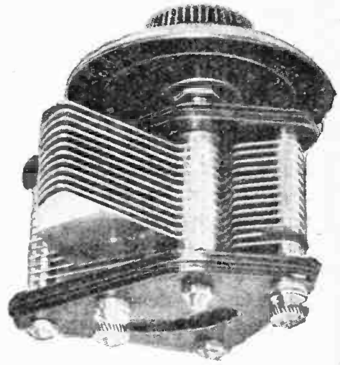
If we start the second car half a second after the first, it is obvious that the first car will have travelled only thirty miles, and if we follow on with another car every half second we shall have a string of cars with a separation of only thirty miles. Similarly, if we waited two seconds after the first car had started and kept this interval up, the car separation would be 120 miles. Thus we see that, by doubling the frequency with which we send off cars, we halve the separation between them, and by halving the frequency of despatch we double the distance separation. A brief consideration of this will reveal the fact that if we increase the frequency of despatch four times, we quarter the distance, and so on. Therefore we may say that the separation increases in geometrical progression as the frequency of despatch decreases also in geometrical progression and *vice versa*. It is obvious that, since the speed of sixty miles an hour is constant, we have only to know the frequency of despatch in order to find the separation distance from the formula:

$$\text{Separation distance} = \frac{60}{\text{Frequency of despatch}}$$

and if we know the separation distance and seek to know the frequency of despatch, we have only to use the formula:

$$\text{Frequency of despatch} = \frac{60}{\text{Separation distance.}}$$

If now we substitute the words "frequency in cycles per second" for "frequency of despatch," and "wavelength in metres" for "separation distance," we shall be getting nearer some idea of the relationship between frequency and wavelength. But what can we substitute for the "60 miles a second" constant? In other words, what is the velocity of an ether wave? Now, the velocity of a wave in air or ether is determined by the elasticity and density of the particular medium used, the actual formula used being $V = \sqrt{\frac{\text{Elasticity}}{\text{Density}}}$ This does not concern us, however; it is sufficient to say that the velocity of a wave in air is roughly 11,000ft. per second, or 700 miles per hour, whilst the velocity of an ether wave is 300,000,000 metres per second, or approximately 186,000 miles per second. These velocities are fixed and unchangeable, just as was the speed of our car. The ether wave, therefore, with its 300,000,000 metres per second speed, takes the place of our sixty-miles-per-second car, and the human agent who despatched the cars at two per second gives place to the oscillating energy in the aerial, which despatches the waves at several thousand or even million times per second. It is obvious, therefore, that if one solitary oscillation is produced in an aerial, a wave will leave the aerial, and at the end of one second will have travelled 300,000,000 metres, and if we repeat this oscillation every second, or, in other words, if our frequency is one cycle per second, we shall have a train of waves following each other at intervals of $10^8 \times 3$ metres, or in other words, a frequency of one gives us a wavelength of $10^8 \times 3$ metres.



The square law condenser shown here gives a straight line wavelength reading.

Suppose now we double our frequency and send off a wave every half second, it is obvious that the first wave

Frequency and Wavelength.—
will have only travelled 150,000,000 metres before the second wave starts off, and so there is only a frequency difference of one cycle per second between a wavelength of 300,000,000 metres and one of 150,000,000 metres. Similarly, if we again double our frequency to four cycles per second we shall have a wavelength of 75,000,000 metres, and so on, until we find that between a frequency of 150,000,000 cycles per second and 300,000,000 cycles per second there exists only a difference of one metre in wavelength. By turning things round we thus see that between wavelengths of 1 and 2 metres we have no fewer than 150 million cycles, and between a wavelength of 150 million metres and 300 million metres we have only one cycle difference. Since, of course, the true separation of stations is according to the frequency difference and not according to their wavelength difference, it will at once be obvious why there is more space between 1 and 2 metres than between 2 metres and an infinitely large number of metres. From our Wellsian motor car analogy we know that the formula for finding frequency is:

$$\text{Frequency in cycles per second} = \frac{300,000,000}{\text{Wavelength in metres}},$$

and for finding wavelength:

$$\text{Wavelength in metres} = \frac{300,000,000}{\text{Frequency in cycles per second}}.$$

By applying these formulæ we at once see that the frequency and wavelengths of the four stations we discussed earlier in this article, namely, Daventry, Radio-Paris, London, and Bournemouth, are as follow:—

					Cycles per second.
Radio-Paris :	Wavelength	1,750	metres,	frequency	171,428
Daventry :	,,	1,600	,,	,,	187,500
London :	,,	365	,,	,,	821,917
Bournemouth :	,,	385	,,	,,	779,220

Thus there are only 16,072 cycles separating Daventry and Paris, and 42,697 cycles, or about 2½ times as much, separating London and Bournemouth.

Selectivity.

Thus the following very important points emerge:

1. It is obvious that if a receiver cannot separate London and Bournemouth, it will certainly not separate Daventry and Paris.

2. The apparent broadness of tuning on the Daventry and Paris band of wavelengths, as compared with the normal broadcasting band, is explained, and, again, the apparent sharpness of tuning on short waves below 100 metres as compared with the B.B.C. band is clear.

3. The reason why the B.B.C. would not have the same room between, say, 500 and 700 metres as between 300 and 500, and, conversely, the reason why they would have much more room between 100 and 300 metres than between 300 and 500 metres.

4. The reason why a wavelength of 100 to 115 metres is roughly equal to one between 300 and 500 metres.

5. The reason why there is so much more "room" on the short waves than on the long waves.

6. The "meaninglessness" of stating that a receiver will separate stations so many metres apart in wavelength.

But there are one or two points which are not yet cleared up, namely, why could not even one station be included between 20,000 metres and 20,200 metres, and why do we say that not more than forty stations could be accommodated in the 400,000 cycles between 300 and 500 metres?

The reason is simple, namely, that frequencies ranging from about 30 to 10,000 cycles per second are audible to the human ear. Now, if we have two stations within the range of our receiver, one with a frequency of 1,000,000 per second, and the other with a frequency, say, of 1,001,000 or 999,000, there will be a frequency difference of 1,000 cycles between the two stations. These two frequencies start off, as it were, in step with each other, gradually get out of step, and then gradually get in step again, and then repeat the process all over again, this phenomenon forming what is known as a beat frequency equal to the difference between the two component frequencies—in this case 1,000 cycles. Now a frequency of one thousand per second causes an audible whistle to be heard. Two stations cannot, therefore, be operated at a frequency separation less than 10,000 cycles, the upper limit of audibility, if this heterodyne note is to be avoided. Of course, the same phenomenon occurs when a receiver is allowed to oscillate at a slightly different frequency from that radiated by a near-by transmitting station; the oscillating receiver acts as a small transmitter, and its radiations form a beat note with the radiations of the station in question, this note being audible in all receivers over a large area. If this receiver is oscillating at a frequency differing by more than 10,000 cycles from the transmitting station, no oscillations will be heard, although a beat note which is above the limits of audibility will be produced. This production of a "supersonic" beat frequency is, of course, made use of in the well-known supersonic heterodyne receiver.

Short-wave Shortcomings.

We see, then, that no station can be permitted to operate within 10,000 cycles of another station, unless, of course, those two stations are situated many thousands of miles apart. If readers will now take pencil and paper and work out the frequencies corresponding to 20,000 and 20,200 metres they will see the absurdity of asking the B.B.C. to transfer their twenty stations to that wavelength band. It will now be obvious to us why we can only crowd forty stations between 300 and 500 metres, since there are only forty spaces of 10,000 cycles each in the 400,000 cycles separating these two wavelengths.

It may well be asked why it is that, in view of the overcrowding of the European ether on the present allotted bands of wavelengths, as is shown by the large amount of heterodyning between stations that does exist, a descent is not made to, say, a band of wavelengths between 50 and 100 metres, where three hundred stations could be accommodated. The reason is, of course, that below 100 metres the frequencies become so high that the slightest stray capacity effects, which would be negligible on 400 metres, are sufficient to cause a receiver to become hopelessly inefficient and unstable. In brief, short wavelengths are too fickle and unreliable to be successfully adapted to broadcasting in our present state of knowledge.

Frequency and Wavelength.—It will be seen from the foregoing, therefore, that it is high time that a move was made to abandon the practice of talking about the wavelength of a station rather than its frequency, since frequency represents the true separation between stations. Unfortunately, however, the wavelength idea has taken such a firm hold on the general public that it would be difficult to uproot it. If a station were quoted to us as having a certain frequency, our minds would at once seek to turn it into wavelength in metres before we could get a concrete idea of the matter, just as we should all instinctively turn kilogrammes into pounds when making purchases if the present system of weights and measures were ousted in this country by the metric system. If we are in France we mentally turn francs into sterling when making a purchase, in order to get a clear idea of what we are spending. It is, after all, purely a question of habit, since we quite naturally discuss wavelengths in terms of metres, and if anyone told us that the wavelength of a certain station was 1,000ft. we should instinctively turn it into metres before being able to "visualise" the wavelength, equally as much as we should reverse the process if anybody told us that a certain monument was 100 metres high.

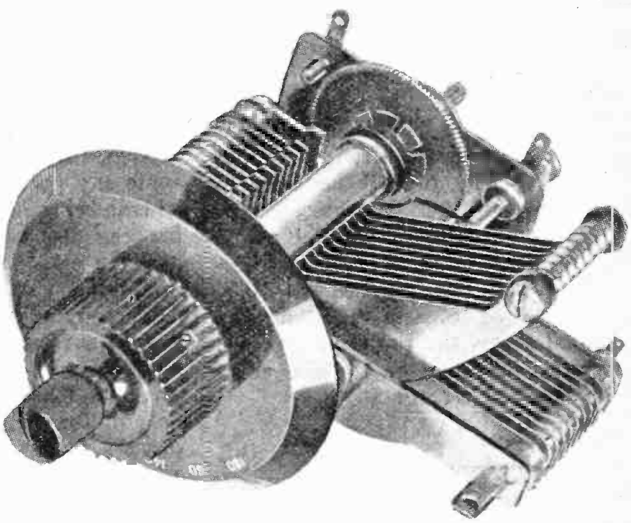
Advantages of the S.L.F. Condenser.

We are, however, getting somewhat nearer to the frequency ideal, as is evinced by the arrival in our midst of the straight-line frequency condenser. The original semi-circular plate-type condenser gave an increase in capacity in direct proportion to its dial readings, and hence was known as the straight-line capacity condenser. Since neither frequency nor wavelength is directly proportional to capacity, it was obvious that stations were not evenly spaced on the dial, but were, for the most part, crowded into the lower end of the scale. The actual formula for finding the wavelength in metres of a tuned circuit is $1885\sqrt{LC}$, where L is the inductance in microhenries, and C the capacity in microfarads. Later came the straight-line wavelength condenser, which gave a dial reading proportional to the wavelength, and was termed "square law," because the capacity increase was proportional to the square of the angle of rotation, and not directly as the angle, like the old straight-line capacity condenser. Since, as we have seen in this article, wavelength is very far from representing the true separation between stations, this condenser still failed to give us the stations equally spaced on the dial. It did possess the great advantage of a much lower minimum than the old type, thus enabling us to cover a bigger frequency range with a given coil.

A straight-line frequency condenser which *does* give us dial readings proportionate to the frequency or true separation between stations is really the only logical instrument to use, and doubtless in time the square law condenser will follow the old straight-line capacity condenser into the museum. It is to be noted, however, that the usual elongated plate construction of an S.L.F. condenser results in a large amount of room being taken up on the panel, and in America the old semi-circular plate condenser which takes up least room has made its appearance once more, but with plates whose thickness is not uniform, but adjusted in such a manner that a straight-line frequency effect is produced. By suitable design the old disadvantage of a high minimum which was a great drawback of the old-type semi-circular condenser has been overcome, and instruments of 0.0005 mfd. maximum capacity may be had which have a minimum of only 10 micro-microfarads. Doubtless British manufacturers will in time produce a more compact form of straight-line frequency condenser than is at present available.

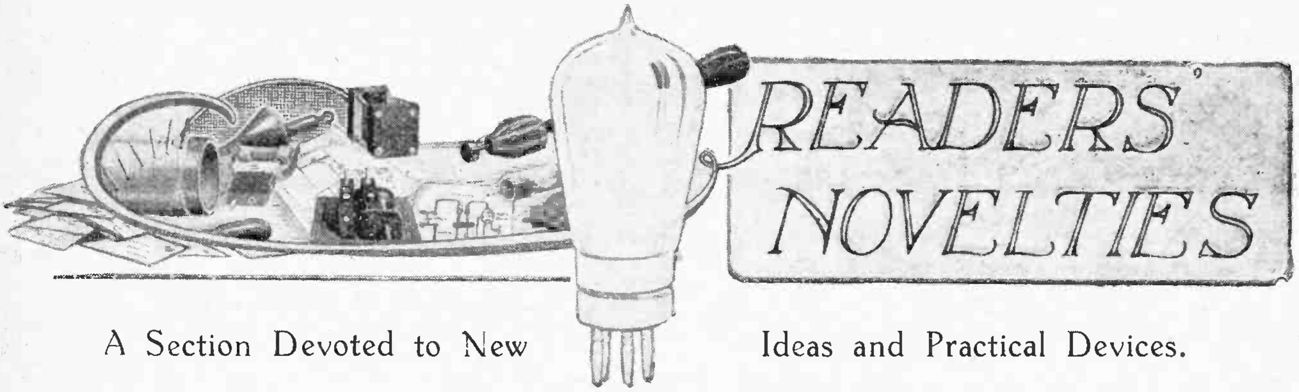
Minor Considerations.

Before finally leaving the subject of frequency and wavelength with the pious hope that he has cleared up a few difficulties for the semi-technical man, there are one or two minor points which the writer would like to deal with. The first is the reference in Fig. 1 to wave amplitude. This is, of course, nothing to do with frequency or wavelength, and is simply a convenient method of indicating the power of the transmitter as applied to the radiated wave. A high-powered transmitter will naturally produce a stronger compression of the ether in its immediate vicinity than will a lower-powered one, and



This condenser is the modern type which, by giving a straight line frequency reading, ensures that the dial readings obtained will be strictly proportional to the actual separation between stations.

this is conveniently indicated in the usual manner in Fig. 1, as the height and depth of the curve crests above and below the base line. The second point that should be mentioned is that frequency is not usually expressed in cycles per second, since the figures become so huge and unwieldy on the higher frequencies. It is more customary to use the kilocycle, which equals 1,000 cycles, as the unit of measurement. Thus Daventry is seldom seen quoted as having a frequency of 187,500 cycles, but as having a frequency of 187.5 k.c. Thus, if the formulæ for determining wavelength and frequency given earlier in this article are used, the result must be divided by 1,000 in order to bring the result to kilocycles, or, alternatively, it might be more convenient to use 300,000 as the numerator of the fraction instead of 300,000,000, and then, of course, one can work solely in kilocycles.

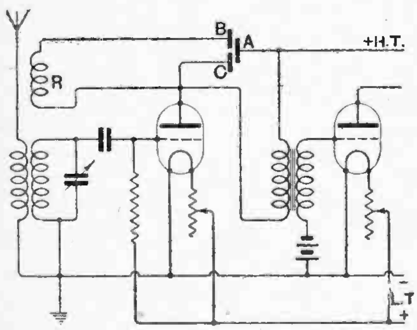


A Section Devoted to New Ideas and Practical Devices.

REACTION CONTROL.

A very fine control of reaction, and one which, moreover, does not upset the tuning of the detector valve grid circuit is shown in the accompanying sketch.

ABC is a double 0.0003 mfd. condenser. The fixed plates B and C are connected to opposite ends of a fixed reaction coil R. The moving plates A, which are connected together, are also connected to the H.T.+ tapping for the detector valve. The two halves AB and AC of the condenser are arranged so that as the capacity of AB increases in value that of AC decreases. AB, AC, are virtually in parallel across the primary P of the L.F. transformer, and thus replace the fixed condenser of 0.0003 mfd. usually shunted across the primary. As AB increases in value the reaction effect increases and *vice versa*.



Dual capacity control of reaction.

The method is especially suitable for a low-impedance, loose-coupled detector valve, as R has then a low value compared with that of the grid coil. So far as the circuit AB, R, CA is concerned, AB, CA are in series, and hence their maximum combined value is 0.00015 mfd. This, in conjunction with the low value of R compared with the grid coil, prevents any possibility of a heterodyne whistle being generated by interaction between the two circuits AB, R, CA and the grid coil when the valve is oscillating.

The coupling between R and the grid coil is not critical. Suitable values of coils, etc., for the 200-600 metre wave-band are: Grid coil, 50 turns on 3in. former, No. 26 D.C.C. condenser, 0.0005 mfd. maximum; R, 18-22 turns, depending on detector voltage, valve impedance, and coupling between R and the grid coil. The latter should, however, be fairly tight to keep the number of turns low.

The circuit should be adjusted so that the valve just oscillates when AB has its maximum value.—E. G. D.

oooo

Valves for Readers.

For every practical idea submitted by a reader and accepted for publication in this section the Editor will forward by post a receiving valve of British make.

TESTING TELEPHONE LEADS.

The failure of head telephones can often be traced to a "dis" in the telephone leads, but it is not generally realised that the faulty connection frequently exists between the ends of the leads and the terminal tags. Many perfectly good pairs of leads must have been discarded on this account, and it would seem that some form of test is desirable before actually throwing them away. This can be quite simply carried out by driving a sharp pin or needle through the braided wire about 1in. above each terminal tag. The telephone connections from the receiver are then made to the pins, when the phones will function properly if the leads themselves are in order.—D. J. L.

oooo

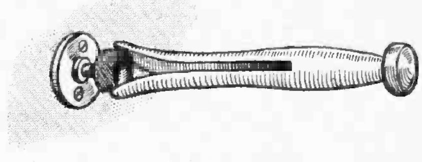
BRAIDED CABLES.

When using braided flexible cable it will be found that the braid frays in a very unseemly manner when the wire is cleaned for use. To overcome this defect drop on the frayed portion a few spots of molten Chatterton's compound, moulding the same into shape with moistened fingers.—R. H. B.

oooo

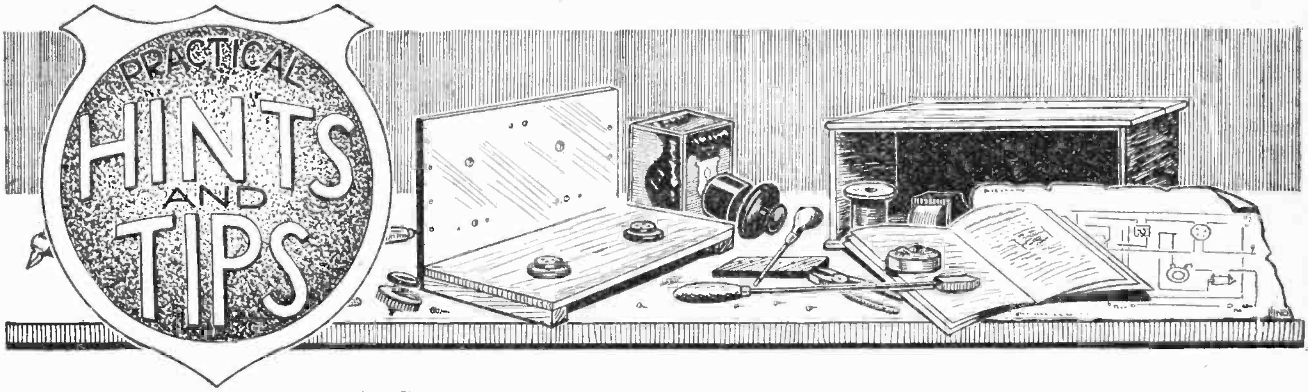
GRID LEAK ADJUSTMENT.

The variable grid leak is often extremely sensitive to hand capacity effects, even when the precaution has been taken of fixing the potential of the adjusting screw by connecting it to filament. In these circumstances the hand capacity effects may well mask any changes of signal strength or quality attendant upon the adjustment of the leak resistance.



Extension handle for grid leak adjustment.

The difficulties may be conveniently overcome by using an ordinary clothes-peg as an extension handle in the manner indicated in the sketch.—L. P.



A Section Mainly for the New Reader.

TELEPHONE CONNECTIONS.

It is almost universally known that telephones used with a valve receiver should be connected in the correct manner, but users of a crystal set seldom realise that a reversal of connections will sometimes result in an appreciable improvement in signal strength.

Telephones are always in their most sensitive condition when the spacing between the pole pieces and the diaphragm is as small as possible, and they should be connected in circuit so that the unidirectional current, due to rectification of a telephony carrier wave, flows through the windings in such a way that the attractive force exerted by the permanent magnets is increased. As to whether a clearly audible difference in signal strength is perceptible will depend largely on the construction of the phones, but it is worth while to try the effect of this reversal of connections.

o o o o

H.T. AND L.T. FROM D.C. MAINS.

In the issue of *The Wireless World* for June 30th, 1926, there was described a receiver fed entirely with smoothed D.C. current from public supply mains. Some readers, no doubt, will wish to adapt their existing sets to this arrangement, and will find it convenient to mount the necessary voltage-reducing and smoothing devices in a separate containing cabinet, wired as a unit for connection to the receiver.

The circuit diagram is given in Fig. 1, and it will be seen that both the choke L_1, a variable resistance, and three lamps are connected in series with the L.T. filament output; the sum of their separate resistances should be of a suitable value to reduce the current to the desired figure. In addition, the lamps act as a form of potential divider, regulating the H.T. voltage applied to the anodes. Where a higher voltage is required at the H.T. + 2 terminal, the lead from the choke L_2 should be joined to the side of the variable resistor which is connected to the first lamp.

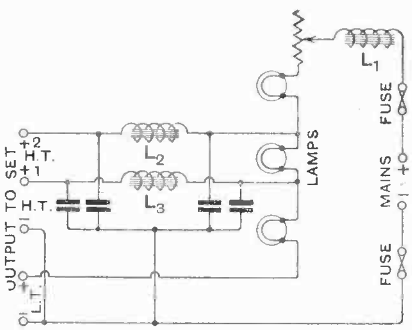


Fig. 1.—Filament and anode supply from the mains.

The chokes L_2, L_3, are of the usual pattern as sold for L.F. couplings, while the condensers should have capacities of at least 2 mfds. each. The choke L_1 (which will not always be necessary) must be capable of carrying the filament current without undue heating; the construction of this component, as well as of the wire-wound resistance, is fully described in the article referred to.

It should be noted that the plan of using the mains for heating filaments can only become moderately efficient when the valve filaments are wired in series, as by this method of connection the power wasted in heating up the external resistance is considerably reduced.

It is recommended that no attempt be made to obtain a grid-biasing voltage from the same source of power, as the conversion of an existing set will thereby be considerably complicated with very little gain, as dry cells used for this purpose have a very long life.

o o o o

IMPROVING THE AERIAL.

The fact that the aerial-earth system of a receiving station is of the utmost importance, and has a direct influence on range and volume of received signals, cannot be too strongly impressed upon all users of wireless apparatus. Even casual observation shows that there is great scope for improvement in this respect, and that the great majority of aerials are not nearly as good as they might be, even when the various difficulties which the average listener has to face are taken into consideration. It seems probable that this is due, not so much to indifference as to a lack of appreciation of the very important part played by this side of the receiving system.

The dweller in the country, who as a rule has ample space at his disposal, and is able to obtain a pole of respectable length both easily and cheaply, is, strange to say, seldom better equipped than is the townsman. The latter, generally with a broadcasting station in his immediate neighbourhood, may say that selectivity is better with a short and low aerial; this is hardly a valid argument, however, as selectivity can equally well be obtained by careful receiver design, and is in any case almost valueless if distant stations cannot be received at good strength even after the local transmitter has been eliminated. Incidentally, it may be noted that "shock excitation" of a receiver by strong signals from a near-by station, as received on an efficient aerial, may generally be prevented by a suitably loose coupling between the open and closed circuits, at the same time retaining a fair degree of overall sensitivity to weak signals.

It is not far short of the mark to say that a good aerial, as compared with an indifferent one, is equivalent to an efficient stage of high-frequency amplification, except from the point of view of selectivity. Considering the aspect of cost alone, it will clearly be an economy to lay out an extra pound or two on the aerial system if by doing so a valve, with its associated apparatus and upkeep costs, can be saved.

The reader may well ask, "What is a good aerial?" and the question may be almost adequately answered by simply saying "a high one." Height is the most important attribute, together with freedom from screening, good insulation, and a horizontal span up to the maximum length permitted by the Post Office regulations.

It cannot be definitely stated that an increase of a few feet in aerial height will invariably and automatically result in appreciably louder signals than before; such unqualified expressions of opinion on wireless matters are seldom permissible without an intimate knowledge of local conditions. In most cases, however, the effect of quite a small improvement in this respect will be clearly evident.

It may be added that users of crystal receivers, particularly those living at some distance from a station, will reap the greatest benefit from a good aerial.

oooo

MOUNTING TERMINALS ON EBONITE.

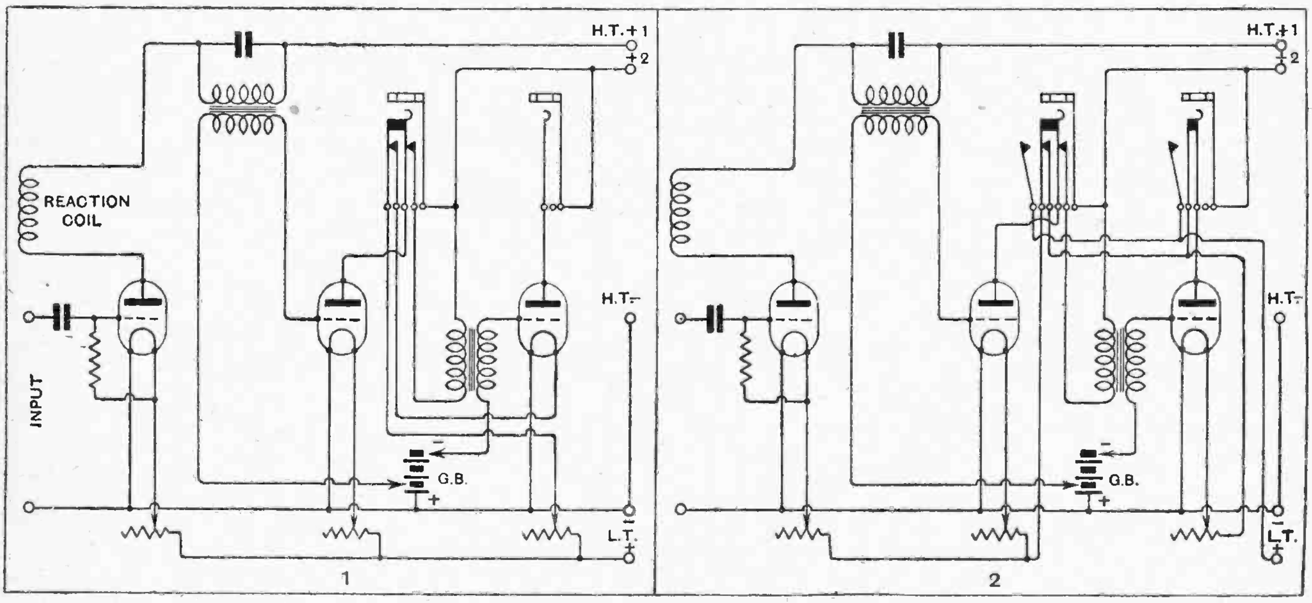
The majority of amateur constructors are accustomed to mount terminals on an ebonite panel by merely drilling a clearance hole to take the shank, and to secure it in position by means of one or two nuts. Unfortunately, terminals fitted in this way have an annoying tendency to work loose, particularly if any heat from the soldering iron is applied when wiring up. It is recommended, to overcome this trouble, that the hole should be tapped. A suitable taper tap for the 4 B.A. terminals in common use, a holder, and a Morse drill of the correct size (No. 32), are obtainable for two or three shillings, and their use will result in a more permanent job than will the usual procedure. The beginner should first try a few holes in a piece of waste ebonite, and will find that, by using a taper tap as recommended, a tightly fitting thread, which will hold the terminal securely, can easily be cut. One or two nuts and a washer should, of course, be put on to the shank after it has been screwed into position.

DISSECTED DIAGRAMS.

No. 38 (b.)—Switching an O-V-2 Receiver with Jacks.

(Continued from last issue.)

Two fairly simple arrangements, with automatic filament control, are shown below. More elaborate circuits, giving a number of possible combinations, can be devised (see "The Wireless World" for July 21st, page 107), but these can only be recommended to those with considerable experience.



By inserting the output plug in the first jack, the anode of the first L.F. valve is disconnected from the second transformer primary, and replaced by phones or loud speaker. At the same time the left-hand spring of the jack is moved, and breaks the filament circuit of the last valve, which is not in use. By transferring the plug to the second jack, all valves are placed in circuit. Filaments (except the last) must be turned on by their rheostats. In circuit No. 2—the insertion of the plug into the first jack automatically lights the filaments of the first two valves, and transfers the anode output of the first L.F. valve from transformer primary to phones. In the second position, all filaments are lighted, and the phones are connected in series with the anode of the second L.F. valve. The black rectangles represent insulated blocks through which movement is transmitted to the filament control springs.

Broadcast Brevities

NEWS FROM ALL QUARTERS.

By Our Special Correspondent.

"Oscillating Oscar."

"Stainless Stephen," entertainer, the friend of North Country listeners, will visit the Newcastle studio on August 10, when, with "Oscillating Oscar," he proposes to buy a motor car. Later, following a pianoforte broadcast by Olive Tomlinson, "Stephen," "Oscar" and the car will bring their amusing turn to a climax. By the way, the Leasingthorne Colliery Prize Band is to be in the Newcastle studio on August 14.

o o o o

The "Alternative Programme" Myth.

Dissatisfaction is still expressed in many quarters on the question of Daventry's programmes. When the high power station began operations it was understood that, besides serving a large number of crystal users outside the main station areas, 5XX would act as an alternative programme provider for London listeners. This rosy dream soon faded away, the alternative programme becoming a once-a-week luxury lasting, at the most, a couple of hours.

It is unlikely that any improvement will be forthcoming until the B.B.C. transmissions are reorganised. Will the British Broadcasting Commission stir in the matter?

o o o o

A Popular Symphony Concert.

On Wednesday, August 11th, Mr. Percy Pitt will conduct a symphony concert in the London Studio, which will include Beethoven's 6th Symphony and Elgar's Overture "In the South." The Musical programme will be continued at 10.25 p.m. by Mr. Stanford Robinson, when the orchestra and the wireless augmented chorus will give works by the well-known composer, Mr. Percy Grainger, which will include arrangements for accompanied and unaccompanied chorus in various folk songs and those ever-popular favourites "Shepherd's Hey" and "Mock Morris."

Concerts from Spain.

Mention of the Spanish industry of imitation pearls may not strike a responsive chord in the breasts of British wireless amateurs, but that is because few people are aware that this organisation controls and operates the well-known "Radio Catalana," EAJ13, at Barcelona. "Radio Catalana" can be heard nightly on 462 metres, and a perusal of its programme of bright and varied items suggests that these pearls, at all events, are the real thing. The evening transmissions extend from nine o'clock till midnight.

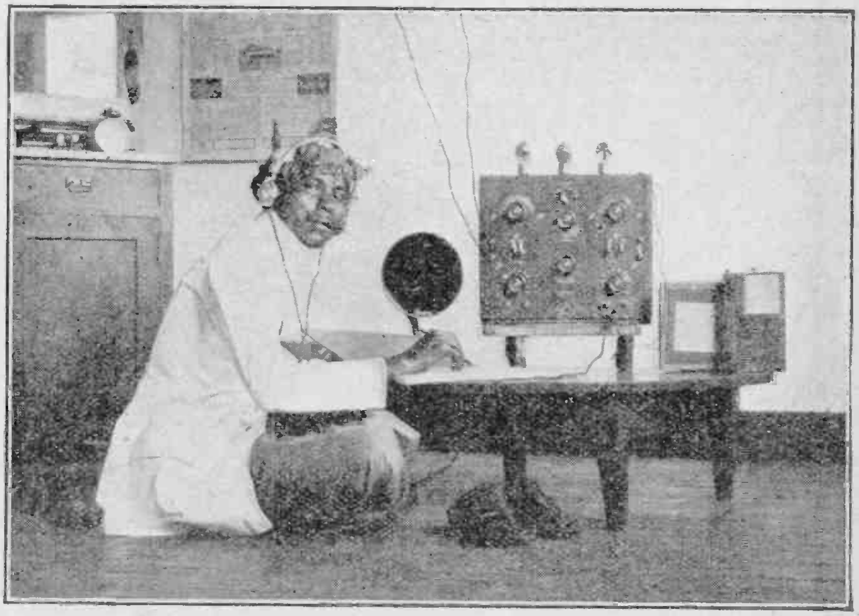
Hectic Enough.

The Vice-President of the United States declares that broadcasting will be the death of hectic oratory. But has General Dawes ever stood near a listener when the local howler tunes in?

o o o o

Broadcasting Copyright in France.

A broadcasting copyright case of unusual interest has arisen in Paris in connection with programmes from the Eiffel Tower. This famous station, the property of the French Department of Posts and Telegraphs, is sublet for the trans-



WIRELESS IN PENANG. A dusky enthusiast overseas who, as the proud possessor of a British wireless installation, is no doubt the envy of his neighbours.

mission of entertainment, etc. A new lessee has refused to sign the contract presented to him by the Society of Dramatic Authors and Composers, and while this organisation would have no difficulty in compelling a theatre manager to sign, its powers are less evident in regard to broadcasting.

Even so, the Society will probably enforce its claims in the courts.

oooo

Transmissions from the Vatican.

It is common knowledge that the Pope has shown great interest in wireless reception since the advent of broadcasting. Two large receivers are already installed in the Vatican, and on more than one occasion His Holiness has been moved to comment favourably on broadcast programmes.

Now, I learn, the Vatican is to be fitted with a transmitting installation in order that catholics all the world over (a pious but rather ambitious hope!) may hear the edicts of the Holy See.

oooo

Distance or Quality.

With wireless in its present stage of development, anybody who believes that long distance reception can be carried out *to perfection* during the summer months belongs to the same brotherhood of incorrigibles as the chappy out on a field day with a crystal and frame aerial. This being pretty generally recognised, we have two schools of thought on the subject.

oooo

August and January.

There is the noble army who believe that, in spite of atmospherics, mush, fading and kindred evils, long distance reception is still worth while. And why not? In picking up Rome on a hot August evening there is a greater glory than in tuning in KDKA at loud-speaker strength on a stormy night in January. All honour to those who succeed.

oooo

Good Loud-speaker Reproduction.

The other school of opinion renounces all thoughts of distant stations until autumn has set in. Effort is therefore concentrated on bringing local "sigs" to perfection, and this is the probable explanation of the fact that good loud-speaker reproduction of the local programme was never more general than at the present moment. Will this quality suffer when winter comes?

oooo

Tragic Death of an Announcer.

Broadcasting can hardly be numbered among the dangerous occupations. That certain risks do exist, however, is shown by the tragic death of Mr. Lester Wolfe, the announcer of WEBH, the broadcasting station of the Edgewater Beach Hotel, Chicago.

A few days ago Mr. Wolfe attempted to replace a blown out fuse, and in doing so received a shock which killed him instantly.

oooo

Canada's First Broadcast Service.

A tablet has been put up in Fort Rouge United Church, Winnipeg, to commemorate the broadcasting of a church service for the first time in Canada. This first wireless service, held on Easter Sunday, 1923, was transmitted by CKY, Winnipeg, the Manitoba Telephone System's station, and the operator was Mr. D. R. P. Coats. The tablet was paid for by subscription from listeners in the district.

oooo

Two Episodes.

The change for the better can be seen in the following items of conversation:—

Scene: Victorian Drawing Room.

Miss A. La! What a cat!

Miss B. Yes, she's a nasty, spiteful minx!

Scene: Georgian Drawing Room.

Miss C. Gee! What a cat!

Miss D. Yes; Professor Knowall, speaking from 2LO last night, was correct in describing the tiger as a member of the cat tribe; but, as you remark, what a cat! I dote on zoology, don't you?

oooo

The School for Anti-scandal.

The tittle tattle which the novelists love to associate with the average feminine tea party appears to be dying a slow death—at the hands of broadcasting! And lest we may imagine that this is because the ubiquitous loud-speaker merely stifles tea table talk, it is worth while pondering over a recent pronouncement by a London County Council education official.

"There has been a great change," he said, "in women's daily conversation in the last few years. It is growing more cultural, and I attribute the development to broadcasting. A large number of women—as compared with a few years ago—are studying psychology, philosophy and literature. Women are catching up men in these matters."

oooo

Chaos in the Air.

The recent decision of the Department of Justice in the United States that the Department of Commerce has no legal controlling power in the assignment of broadcasting licences and wavelengths has somewhat complicated the already existing problem of the apportionment of wavelengths.

Mr. Martin P. Rice, the Director of Broadcasting for the General Electric Company, believes that matters can be settled amicably by agreement between the stations concerned until regularised by new laws.

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In Memoriam.

A programme in honour of London's Territorials and as a reminder of the part played by them in the war will be broadcast on August 19th. A short address will be given by Lt.-Gen. Sir H. F. Jeudwine, Director-General of the Territorial Army, and the material for the war episodes represented has been supplied by the regiments concerned, thus ensuring its accuracy. The programme has been arranged by Amyas Young, and the performers include the London Radio Repertory Players, the 2LO Military Band, the Wireless Chorus, and the ever-popular "Roosters."

FUTURE FEATURES.

August 8th.

LONDON.—The London Chamber Orchestra conducted by Anthony Bernard.
BIRMINGHAM.—Requested Favourites.
BOURNEMOUTH.—Concert relayed from the Royal Bath Hotel.
GLASGOW.—The Band of H.M. 1st Batt. Scots Guards.
NEWCASTLE.—Light Orchestral Programme.

August 9th.

LONDON.—Excerpts from "Lionel and Clarissa"—a Comic Opera.
ABERDEEN.—Musical Romance (No. 3), a Competition for Listeners.
CARDIFF.—Lovers' Lyrics.

August 10th.

LONDON.—The Geoffrey Goodhart Sextet.
BIRMINGHAM.—Operatic Programme.
GLASGOW.—"What he Won."
MANCHESTER.—Welsh Programme.
NEWCASTLE.—Programme relayed from the Spa, Whitby.

August 11th.

LONDON.—Variety Programme.
BELFAST.—"An Elder of the Kirk," a play presented by the London Radio Repertory Players.
CARDIFF.—An Academy Programme given by Musicians from the Royal Academy of Music.
EDINBURGH.—Scottish Music and Humour.
MANCHESTER.—Round the Camp Fire.
SHEFFIELD.—Concert relayed from the Pavilion, Buxton.

August 12th.

LONDON.—The Band of H.M. 2nd Bn. The Queen's Own Royal West Kent Regiment.
BOURNEMOUTH.—"The Blind Beggars"—an Operetta by Offenbach.
BELFAST.—Northern Ireland District Military Tattoo relayed from Balmoral Show Ground.
NEWCASTLE.—Chamber Music.

August 13th.

LONDON.—Edward German Programme conducted by the Composer.
BIRMINGHAM.—"The Missing Link," presented by the London Radio Repertory Players.
MANCHESTER.—"A Model of Tact"—a Farce performed by the Station Dramatic Company.

August 14th.

LONDON.—"Saturday Night Revue."
BOURNEMOUTH.—Popular Programme relayed from the Winter Gardens.
NEWCASTLE.—The Leasingthorne Colliery Prize Band.

SIMPLE VALVE-TESTING UNIT.

Utilising a Single Instrument for Measuring Grid, Anode and Filament Voltages and Currents.

By C. HIRSHMAN.

IT is an only too frequent occurrence that an experimenter requiring to perform some tests on valves is debarred from so doing by the high cost of the required number of meters.

It is the object of this article to outline a simple design for a valve-testing set requiring but one measuring instrument. This instrument may be one of the precision type recently put on the market and specially designed for radio measurements. The type used by the author is illustrated in Fig. 1.[1]

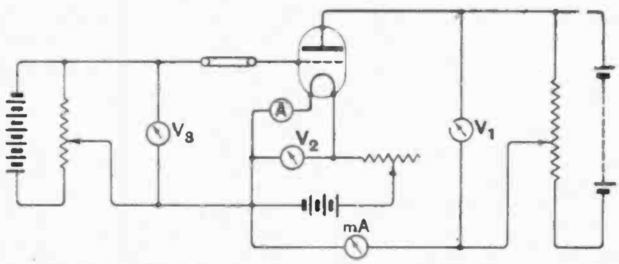

Fig. 2.—Typical valve-testing unit with independent measuring instruments.

By a suitable arrangement of switches, this single instrument is made to replace the five instruments with

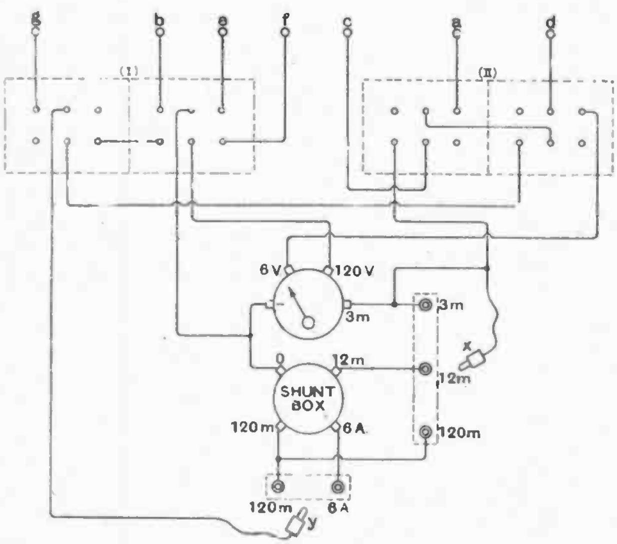

Fig. 3.—Connections of meter, shunt box and Dewar switches. When not measuring anode currents the plug (X) should be left either in the 3m. socket or in a dummy socket marked zero.

[1] Instruments of this type are obtainable from Messrs. F. C. Heayberd & Co., 8/9, Talbot Court, Eastcheap, E.C.3.

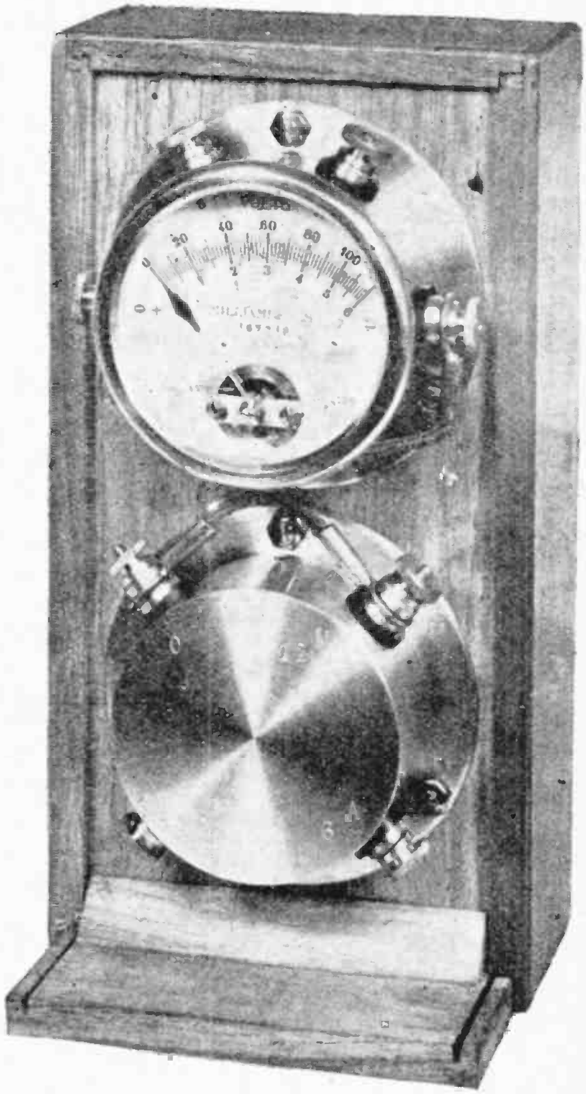

Fig. 1.—Multiple range D.C. instrument suitable for measuring valve constants.

their shunts of a complete valve-testing board represented in Fig. 2.

The particular switching arrangements are shown in Fig. 3. The two switches—(I) and (II)—are 12-point 3-position Dewar switches, which may be easily obtained

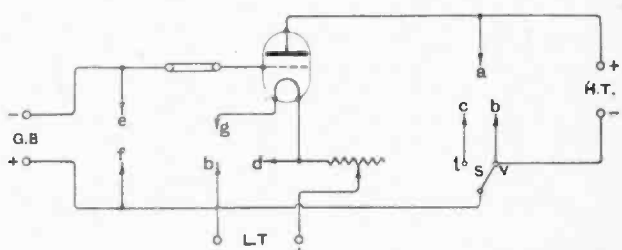

Fig. 4.—Complimentary circuit to Fig. 3. The two circuits should be joined at the points indicated by corresponding lettering.

Simple Valve-testing Unit.—from a dealer in ex-Government goods. The different ranges in plate and filament currents are obtained as will be seen by means of Clix plugs and sockets.

To complete the circuit, the leads *a*, *b*, *c*, *d*, *e*, *f*, and *g* are connected to the similar ones in Fig. 4. The switch S (which was a push-pull 2-way switch) must be

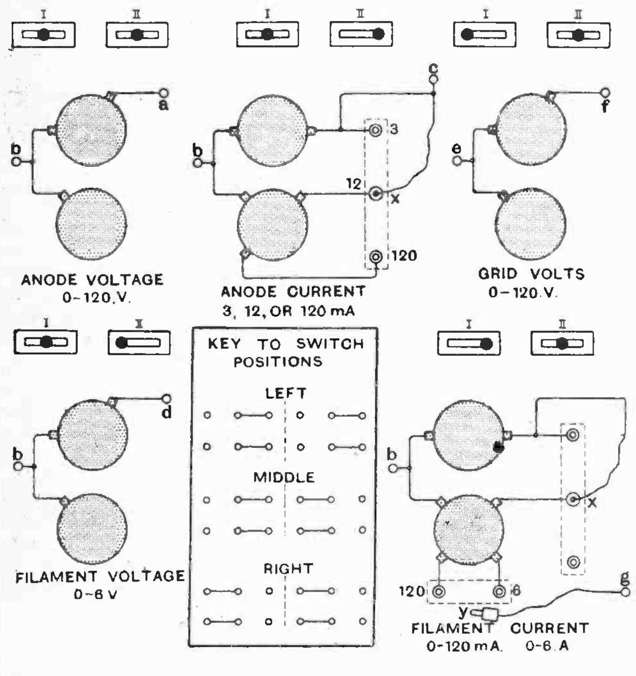

Fig. 5.—Switch positions and corresponding connections for measuring each of the five valve voltage and current constants. When measuring anode current in the 120 mA range, the plug (X) should be left in the 12m. socket and the 12m. and 120m. sockets shorted.

placed in the "i" position when measuring the plate current, otherwise no reading can be obtained. For all other measurements this switch is left in the position "v."

Turning now to the instrument itself, it is imperative that the terminal connected to the lead "b" and to the zero of the shunt box should be the negative one, otherwise the instrument will tend to read in the wrong direction. If this is not possible in the instrument used, the connections to the moving coil should be reversed.

With the above method of switching, the following ranges may be obtained :—

(1) Anode voltage :	0–120 volts		(resistance 40,000 ohms.)
(2) Filament voltage :	0–6	,,	(,, 2,000 ,,)
(3) Grid voltage :	0–120	,,	
(4) Anode current :	0–3	milliamperes	(small valves.)
	0–12	,,	(usual types.)
	0–120	,,	(power valves.)
(5) Filament current :	0–120	,,	(0.6 and 0.1 types.)
	0–6 amperes		(other types.)

The relative positions of the switches for obtaining the above are shown in Fig. 5. A suitable layout for the testing set and the method of connecting up the measuring instrument is illustrated in Fig. 6. The strap between the two terminals just above the valve socket is in the grid circuit, and when removed allows the connection of a microammeter for the measurement of grid current if required.

By the aid of the above testing set, the following standard characteristics may be obtained :—

(I) Anode current to grid voltage at different fixed anode voltages.
(II) Anode current to anode voltage at different fixed grid voltages. (From above the internal resistance and amplification factor can be obtained.)
(III) Variation of emission with filament voltage.
(IV) Variation of filament current with filament voltage.

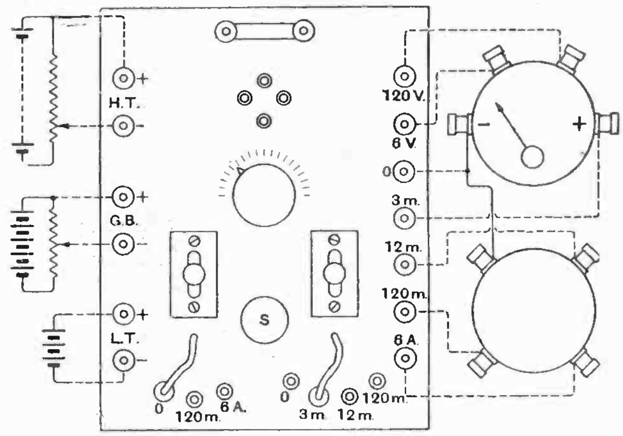

Fig. 6.—Suggested layout of valve testing panel showing external connections to the meter and supply batteries

The experimenter will find this testing unit a very useful addition to his laboratory, for while leaving the measuring instrument free for other work it may be quickly connected up for a valve test.

DUTCH RADIO ASSOCIATION ANNIVERSARY.

The N.V.V.R. Birthday Book.

THE Netherland Association for Radiotelegraphy celebrates the tenth anniversary of its formation by publishing a handsome and well-illustrated book containing a series of articles by well-known authoritative writers on Radiotelegraphy and telephony in all parts of the world, each in his own native language.

Additional interest is given to these articles by the excellent portraits of their respective authors and the copious illustrations which accompany them. The book is introduced to readers' notice by a letter written both in Dutch and French by M. A. Veder, who has been President of the N.V.V.R. since its formation, and by a foreword by M. C. E. Bongaerts, the Minister of Waterways.

There is a brief account of the work accomplished by amateurs in Holland and among the many contributors are Mr. E. F. W. Alexanderson, Count von Arco, Prof. Van de Bilt, General G. Ferrié, Dr. J. A. Fleming, and others equally well-known but too numerous to mention.

The book contains 403 pages, is profusely illustrated and has been carefully edited and compiled by MM. N. Veenstra and J. Corver.

CURRENT TOPICS

News of the Week—in Brief Review

AN AMATEUR DETECTIVE'S PARADISE.

Students of crime, we are told, can keep in touch with their special hobby in greater Cincinnati through the bulletins broadcast by the Police Department daily at 10.15 a.m. and 4.30 p.m. with additional emergency bulletins whenever required.

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WIRELESS FERTILISATION.

A tramway official in Nottingham claims that the growth of cucumber and tomato plants is greatly encouraged by the proximity of wireless aerials. He is now experimenting with special spiral aerials, and hopes for similar success in connection with other vegetables.

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JAMMING ON THE SOUTH COAST.

Listeners on the South Coast are still complaining of the jamming of B.B.C. programmes by the stations at Newhaven and Dieppe. It is understood that a new transmitter has been installed at the former station, working on a wavelength of 800 metres, and it is hoped that when this entirely replaces the old type of spark transmitter working on 300 metres, the trouble will cease.

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AUSTRALIAN BEAM STATIONS.

The administrative buildings, bungalows and club houses for the staff of the new beam station are nearing completion at Ballan and Rackbank in Victoria. Roads are being constructed and a water service prepared, while some of the operators are being trained at a special training school in Sydney. It is anticipated that the station will be opened for traffic before the end of the year.

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AMERICAN BROADCASTING COMPANY.

We understand that the Radio Corporation of America, the General Electric Company, and the Westinghouse Company are combining together to form the Broadcasting Company of America, which will control the principal broadcasting stations in the United States under one management. The R.C. of A. has purchased the well-known station WEAF from the American Telegraph Co. and the Broadcasting Co. already controls fourteen smaller stations.

PRESENTATION TO DR. J. A. FLEMING.

On the occasion of the retirement of Prof. J. A. Fleming from the Chair of Electrical Engineering at University College, London, which he has held for 42 years, his friends, colleagues and students wish to give expression of their personal affection and regard for him as well as their admiration for the distinguished services he has rendered to electrical science.

A committee has been formed, under the chairmanship of Mr. A. A. Campbell-Swinton, to receive subscriptions for a suitable gift which, with Dr. Fleming's approval, will take the form of a portrait to be placed in University College and of a replica to be given to Dr. Fleming himself, who wishes to offer it to the Institution of Electrical Engineers.

Prof. J. A. Fleming.

It is the desire of those who have initiated the movement that the Portrait Fund should be provided by a large number of relatively small subscriptions, and the committee suggest that no individual subscription should exceed the sum of five guineas. Any gift, however small, will be acceptable. Should the subscriptions to the Portrait Fund exceed the amount required, the Committee proposes to hand over the balance to the Fleming Endowment Fund that is being raised for the Department of Electrical Engineering in connection with the celebration of the centenary of the College.

Subscriptions should be sent to Prof. W. C. Clinton, University College, London, W.C.1.

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NO ESCAPE.

In the "good old days" it was possible to take a holiday in some few places—such as the Island of Sark—in blissful consciousness that you were out of the immediate range of the telegraph system and that, in stormy weather, even letters were unable to reach you. These happy days are now over, and there seems no place so isolated as to be immune from the possibilities of business interruptions. A city merchant visiting various towns in the North and, perhaps, enjoying a well-earned rest, has recently been recalled by an S.O.S. broadcast message to give evidence in the Law Courts.

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WIRELESS IN BOLIVIA.

The Postal Telegraph and Wireless Service of Bolivia will, from October 1st, 1926, be controlled and operated by Marconi's Wireless Telegraph Co., Ltd., who have secured this concession for a period of 25 years.

It will be recalled that in 1921 the Marconi Company took over the control of the Postal Telegraph and Wireless services of Peru, and by good re-organisation converted an annual deficit into a substantial surplus.

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HIGH-FREQUENCY SOUND WAVES.

Among the claims considered by the Royal Commission on Awards to Inventors is that of Prof. Langevin and Mr. Chilowsky for improvements in submarine signalling. Inaudible sound waves with a frequency of 10,000 to 200,000 vibrations per second are generated by means of the action of an electric current on certain crystals, and it is claimed that such waves can be concentrated in a narrow beam and used for signalling between one submarine and another or a surface vessel.

Mr. R. Horitz, K.C., representing the Admiralty, stated that about 30 vessels had now been fitted with experimental apparatus of this kind.

CLASSICAL MUSIC V. JAZZ.

Commenting on the final illustration in the recent debate between Sir Landon Ronald and Mr. Jack Hylton, when a jazz rendering of Sir Landon Ronald's well-known song, "Down in the Forest," was given by Mr. Hylton's band after it had been sung with the composer himself playing the accompaniment, the "Manchester Guardian" caustically remarks: "Had television been possible on this occasion it would have been interesting to see Sir Landon Ronald's face while the band played." We do not know whether the B.B.C. arranged for a flashlight photograph to be taken, but, if so, we have not yet been privileged to see a copy. Perhaps it was too terrifying for reproduction!

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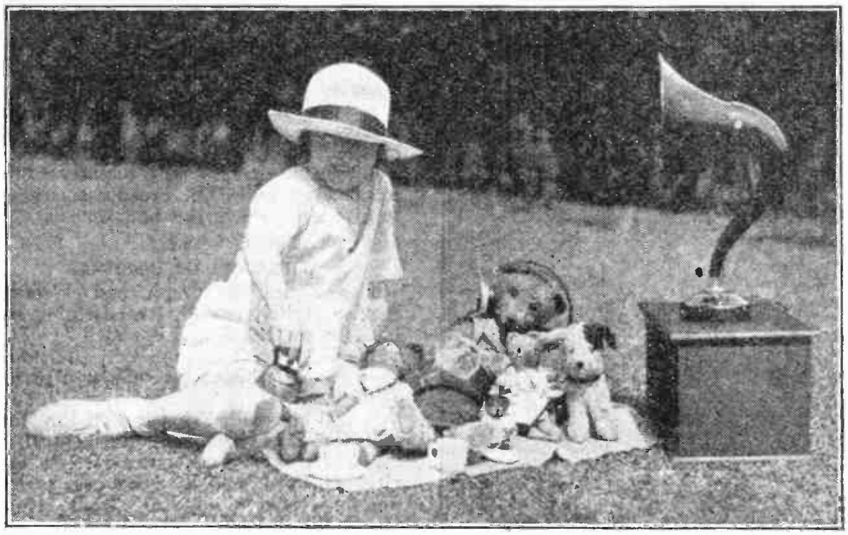
OUR DUMB FRIENDS.

The licensing question seems even now to offer problems to the enquiring mind. We have recently heard of a listener who objected to renewing his licence on the ground that his one valve had been sent to be repaired and had not yet been returned. This is a debatable point, but seems analogous to objecting to pay the licence for a watch dog temporarily deprived of his bark through canine tonsilitis or some other cause.



BABS AND HER PETS. A happy snap of the "family" enjoying their tea to afternoon music.

THE CLOSING OF FINSBURY TECHNICAL COLLEGE.

General regret will be felt that it has become necessary to close Finsbury Technical College owing to lack of funds.

Founded in 1878 by the City and Guilds of London Institute, it has for nearly fifty years maintained its position in the front rank of technical colleges under the guidance of such well-known men of science as Professors Ayrton, Perry, Sylvanus Thompson and Eccles. Many of Messrs. Ayrton and Perry's invaluable research work was carried out in the Finsbury laboratories, as were also Mrs. Ayrton's historic investigation of the electric arc, Prof. Thompson's work on cathode rays and various electrical and optical devices, and, of late years, Dr. W. H. Eccles' research in the realms of radio.

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FRANCE MAY FOLLOW BRITAIN'S EXAMPLE.

Listeners in France have hitherto only had to pay a small registration fee for each receiver, and no further licence. This is probably an enviable arrangement from the point of view of the B.C.L., but the broadcast stations, depending on private enterprise for their support, find it difficult to maintain the high standard they desire for their programmes and to pay expenses. The Government is, therefore, being asked to consider a system similar to that in operation in Great Britain.

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COMPACTNESS AND SIMPLICITY.

The general tendency, says a leading manufacturer, is for sets to become small, compact and more easily worked. Elaborate cabinets, with so many dials and knobs that the average listener is afraid to touch them, are disappearing, and we are getting down to utility. The lady of the house should be able to turn on the music as easily as she can turn on the gas or water without waiting for her husband to come home and adjust the set for her. The modern set, in fact, is less of a scientific instrument and more of a musical box.

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INTERNATIONAL FESTIVAL FOR AMATEURS.

The Amsterdam Radio Society, which was formed in February, 1924, is organising an International Radio-Amateur Festival which will be held in Amsterdam from September 18th to 26th.

Amateurs of every nationality are invited to send apparatus of their own construction to compete for the many valuable prizes offered by the Association, and it is hoped that the exhibition of this apparatus will prove an interesting demonstration of the methods prevailing in different countries and promote a friendly spirit of competition.

The Secretary of the International Radio Amateur Feest, Amsterdam, will be very pleased to send full particulars to anyone wishing to take part. Letters should be addressed to him at O.Z Achterburgwal 175, Amsterdam. All expenses for freights, insurance, etc., will be paid by the Association, whose aim is to encourage mutual good-fellowship between Dutch amateurs and their foreign friends.

WIRELESS AT WESTMINSTER.

(By our special Parliamentary Correspondent.)

PERSONNEL OF THE NEW B.B.C.

In reply to Mr. Wright, M.P., who asked whether, in order to safeguard the impartiality of the Broadcasting Service, the representation of all sections of political opinion would be secured on the body that would conduct that service, Sir W. Mitchell-Thomson replied that he was not yet in a position to make any announcement as regarded appointments to the new organisation. The need for securing impartiality in the broadcasting service would not be overlooked.

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BLIND SPOTS AND DISTANT SHIPS.

Replying to Lord Sandon regarding the ability of Rugby station to reach ships at sea and certain blind spots for reception, the Postmaster-General stated that the most difficult localities for reception appeared to be in the Eastern parts of the Pacific Ocean, between Honolulu and Valparaiso. The power of the transmissions from Rugby had been increased. All radiotelegrams were transmitted twice, once during the day and once during the night, and experience showed that the messages were regularly and reliably received during one or other of these transmissions by ships in all parts of the world.

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TRANSATLANTIC TELEPHONY FROM RUGBY.

In reply to a further question, the P.M.G. admitted that there were still certain technical difficulties to be overcome before a transatlantic wireless telephone service could be offered to the public, and no definite date could yet be fixed for the opening of such a service.

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SPEECHES AT THE G. B. SHAW DINNER.

Sir W. Mitchell-Thomson informed Sir Walter de Frece that there would have been no objection to the broadcasting of Mr. George Bernard Shaw's speech on the occasion of the dinner given to celebrate his 70th birthday if an assurance could have been given that argumentative political controversy would be avoided. Such an assurance could not be obtained and permission was accordingly refused.

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THE AMERICAN DEBT QUESTION.

Similar objections made it undesirable to allow the broadcasting of a dialogue on the American debt between the editor of a leading London paper and a well-known American journalist now in London.

WIRELESS CIRCUITS
in Theory and Practice.

18.—Reaction (continued).

By S. O. PEARSON, B.Sc., A.M.I.E.E.

IT was explained in Part 17 how the losses in the tuned grid circuit of a valve receiver could be compensated for to varying degrees by the use of reaction, and it was shown that the maximum signal strength when receiving telephony is obtained when critical reaction is employed. We now come to consider further aspects of reaction, chief among them being the effects of critical reaction on the quality of the received speech or music; but it will first be necessary to see what takes place in a valve circuit when too much reaction is employed and self-oscillation occurs at a slightly different frequency from that of the carrier wave of the received telephony.

Consider a simple receiving circuit such as that shown in Fig. 1. To begin with, let us assume that we are receiving the carrier wave only, from the local broadcasting station, as occurs during the intervals between the items of the programme, and suppose that the reaction is increased sufficiently to produce self-oscillation in the valve circuit. If the circuit is not tuned exactly to the same wavelength as the received carrier wave, the local oscillations will have a slightly different frequency from that of the carrier wave, and therefore two different oscillations of voltage of slightly different frequencies are being applied to the grid. It must be remembered that both of these sets of oscillations are high-frequency oscillations and far above the audible range. Either one of them acting alone on the grid would not produce any audible sounds in the telephones, but when they are both present together the familiar whistling sound may or may not be heard, according to the relative frequencies of the two sets of oscillations.

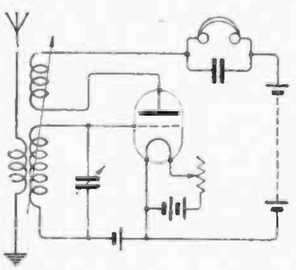


Fig. 1.—Simple receiving circuit with reaction.

Exactly why it is that two high-frequency oscillations in one circuit are capable of producing an audible note can be seen by considering the curves of Fig. 2. At (a) the two high-frequency voltages of slightly different frequency are plotted to the same time base, the two being exactly in step or in phase at the commencement of the time considered. Since they are not of quite the same frequency they gradually fall out of step as time passes, until at the instant A they are actually 180 degrees out of phase and are thus opposing each other. From this time onwards they gradually fall into step again and become completely in phase once more at the instant denoted by B, the oscillation of higher frequency having gained exactly one cycle on the one of lower frequency.

Now the voltage on the grid at any instant is equal to the sum of the two separate voltages at that instant, and consequently the actual variations of grid voltage are given by a curve obtained by adding together the two curves shown at (a). This resultant curve is given at (b) in Fig. 2. Note that it is a curve representing a high-frequency oscillation of varying amplitude or, in other words, a modulated high-frequency oscillation. Further, the amplitude, starting at a maximum value, falls to a minimum and then builds up to the maximum value again in the time taken for one of the high-frequency oscillations to gain exactly one cycle over the other. If the individual high-frequency oscillations are of equal amplitude the minimum amplitude of curve (b) is zero, but if the amplitudes of the two individual oscillations are unequal, then the minimum amplitude of curve (b) is equal to the difference between the amplitudes of the individual oscillations.

It will be seen that the contour of the amplitudes of the oscillations represented at (b) is a pure sine wave as indicated by the dotted lines, and the frequency of this wave is exactly equal to the difference between the frequencies of the two individual sets of oscillations in the grid circuit.

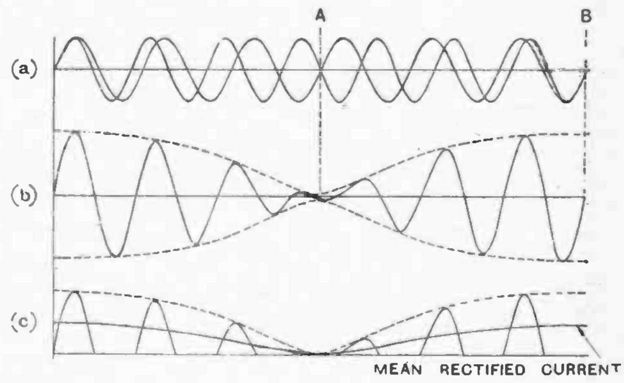


Fig. 2.—Curves illustrating the production of a beat note.

We see, then, that by combining two H.F. oscillations of slightly different frequency we obtain a modulated high-frequency oscillation exactly similar to the modulated waves sent out from the transmitting station when a pure sine wave of low-frequency modulation is employed. As the valve is acting as a detector all the negative half-waves of the corresponding oscillations in the plate circuit are cut off and the mean current in the telephones will vary according to the low-frequency pulsations, as shown at (c) in Fig. 2. This will give an audible note if the difference between the frequencies of the incoming oscillations and the local oscillations respec-

Wireless Circuits in Theory and Practice.—

tively is within the audible range of frequencies. By varying the frequency of the local oscillations the pitch of this note can be varied over the whole of the audible range, giving the well-known whistle. The low-frequency note produced by the interaction of the two high-frequency oscillations is called a " beat note," and the pulsations are called " beats."

Suppose that the carrier wave being received has a wavelength of 300 metres corresponding to a frequency of 1,000,000 cycles per second, and that the local oscillations are adjusted to a frequency of 999,000 or 1,001,000 cycles per second corresponding to a wavelength of 300.3 or 299.7 metres respectively. Then the beat note will have a frequency of 1,000 cycles per second. As the incoming oscillations have a frequency of 1,000,000 cycles per second, and the beat note a frequency of 1,000 it follows that in this case there are 1,000 high-frequency cycles to each cycle of the beat note. It should be noticed that no matter whether the frequency of the local oscillations is 1,000 cycles per second greater or 1,000 cycles per second less than that of the carrier wave, the pitch of the beat note will be the same. Thus if we had two sets of local oscillations, one having a frequency of 1,001,000 and the other a frequency of 999,000, we should get only a single beat note of 1,000 cycles per second.

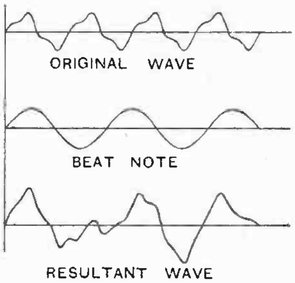


Fig. 3.—Curves showing the distorting effect of self-oscillation.

As the frequency of the local oscillations is varied gradually by turning the knob of the tuning condenser slowly round, the pitch of the beat note, when first heard, is very high and gradually gets lower as the circuit approaches more nearly into tune with the incoming oscillations. When the circuit is exactly in tune with the carrier wave the two sets of oscillations have exactly the same frequency and the resulting beat note has zero frequency, i.e., it disappears altogether. As the condenser knob is turned still further round, the beat note reappears and increases in pitch until it once more gets above the audible range.

Self-oscillation and Distortion.

In telephony the incoming oscillations are already modulated according to the wave shapes of the sounds to be reproduced and when a local oscillation is present as well, it combines with the received oscillations which are already varying in amplitude at an audible frequency. (We are assuming here that the local oscillations have a frequency slightly different from that of the carrier wave.) The resulting high-frequency curve is one whose variation of amplitude has very little resemblance to that of the original incoming wave, with the result that the sounds are very badly distorted, the extent of this distortion depending on the relative strengths of the carrier oscillations and the local oscillations.

Another explanation of the distortion could be given as follows: When the received oscillations are already modulated according to the wave-shapes of the sounds to be reproduced, the local oscillation produces the usual beat note of audible frequency, which in turn combines with the speech frequencies, giving a resultant low-frequency wave altogether different in shape from the true wave-shape representing the speech or music. These conditions are illustrated graphically by the curves of Fig. 3, where the top curve represents the true wave which would be obtained in the telephone circuit if no self-oscillation were present; the middle curve represents the beat note produced by interaction between the carrier wave and the local oscillations; and the bottom curve gives the resultant distorted wave due to the combining of the two upper curves.

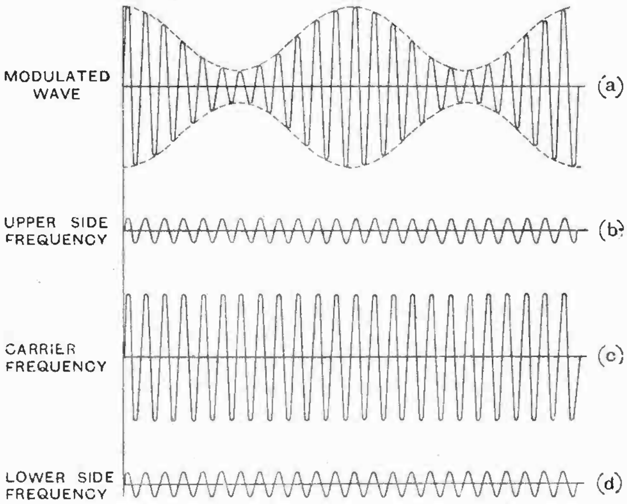


Fig. 4.—Modulated wave resolved into three component waves.

All those who have operated circuits employing reaction will have noticed that the music or speech is much deeper toned when the reaction is increased up to the point at which self-oscillation is just on the point of occurring, i.e., when critical reaction is used. The wave-shapes representing speech and music are very complex in form, but it can be shown that any wave-shape, however complex, can be resolved into a number of pure sine waves whose sum will give the wave-shape in question. The principal sine wave obtained in this manner is called the " fundamental " wave, and the remaining sine waves, whose frequencies are all exact multiples of the frequency of the fundamental, are called " harmonics." That harmonic, which has three times the frequency of the fundamental, is called the " third harmonic," and so on. In music the harmonics are called " overtones."

It follows then that the complex wave-forms of speech or music are really made up of a number of pure sine waves of various frequencies, so that in effect, the carrier wave is being modulated by a number of audio-frequency sine waves simultaneously, all these waves having different frequencies. Now when the " tone " of speech or music is deepened it means that the fundamentals and harmonics of lower frequency are being given relatively more prominence than the higher harmonics or higher overtones. This is exactly what happens in a valve circuit where reaction is critically adjusted, the lower frequencies being amplified to a greater extent than the higher ones,

Wireless Circuits in Theory and Practice.—

and in order to explain this it will be necessary to reconsider the nature of a modulated carrier wave from another point of view.

Side Frequencies.

Hitherto we have considered a modulated carrier wave merely as a high-frequency oscillation, of constant frequency, whose amplitude was varied at audio-frequency in accordance with the wave-shapes representing the speech or music; but actually a modulated oscillation consists of three or more high-frequency oscillations of different frequencies. This can be shown quite simply by considering a high-frequency oscillation which is being modulated by a pure sine wave of low frequency—that is, one in which the amplitude of the oscillations is being varied according to a sine law as indicated by the upper curve of Fig. 4. In connection with the production of beats considered above it was seen that two H.F. oscillations of slightly different frequency produced an audible note whose frequency was equal to the difference between the frequencies of the H.F. oscillations. Further, we saw that if we had two sets of local oscillations, one having a frequency of, say, f cycles per second greater, and the other f cycles per second less than that of the carrier, we should get only a single beat note of f cycles per second. Now in the case of the received modulated wave indicated in Fig. 4 (a), we can reverse this process and split up the modulated H.F. oscillation into three component high-frequency oscillations each of constant amplitude The first of these is the true carrier wave shown at (c) in Fig. 4. Let its frequency be F cycles per second. Then if f is the note frequency or frequency of the "beat note," the other two sets of H.F. oscillations shown at (b) and (d) will have frequencies of $(F + f)$ and $(F - f)$ cycles per second respectively. It is the interaction of these three waves which produces the modulated wave (a) by the principle of beats, the audible sound being actually a beat note.

In Fig. 4, the oscillations represented by the curves (b) and (d) are referred to as "side frequencies," that at (b) being the upper side frequency, and that at (d) the lower side frequency. For a very low-pitched note the side frequencies are almost equal in value to the frequency of the carrier wave, whereas for a high-pitched note the side frequencies are further removed from the carrier wave. In an actual telephony transmission the audio-frequency modulation consists not merely of a single sine wave but is made up of a number of sine waves of different frequencies. As before, we have the central carrier wave and a separate pair of side frequencies corresponding to each audio-frequency note or harmonic. Thus for a note represented by a more or less complex wave-form, which is made up of a number of fundamentals and harmonics covering a considerable range of audible frequencies, there will be a band of side frequencies on each side of the carrier, and these are called the "side-bands." So really, when we are receiving telephony we are actually receiving a large number of H.F. waves simultaneously, all having frequencies or wavelengths within a small band, the outer limits of which are determined by the highest pitched harmonic in the audio-frequency wave.

It was shown in Part 17 that when the reaction was critically adjusted the tuning became very sharp and the resonance curve very narrow and pointed. Suppose that such a circuit is tuned exactly to the carrier wave of a telephony transmission. Then the carrier wave itself will be received much more efficiently than the side frequencies; and those side frequencies which are nearer to the carrier frequency (representing low-pitched notes) are amplified to a much greater extent than the side frequencies which are furthest removed from the carrier wave (representing the highest-pitched notes). These conditions are clearly shown by the resonance curve of Fig. 5. Thus with sharp tuning the lower-pitched notes are given greater prominence than the higher ones, and the speech or music has a deeper tone. This is sometimes an advantage, as in the case where a low-frequency transformer which has a tendency to augment the higher-pitched notes, forms part of the circuit.

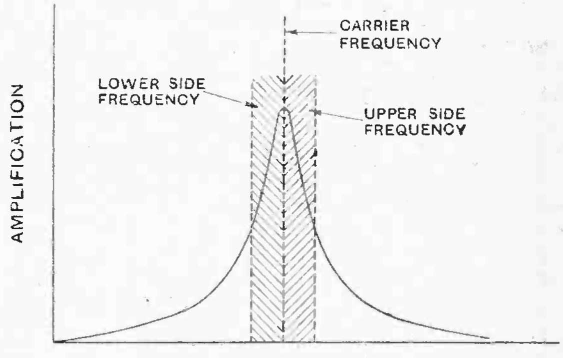
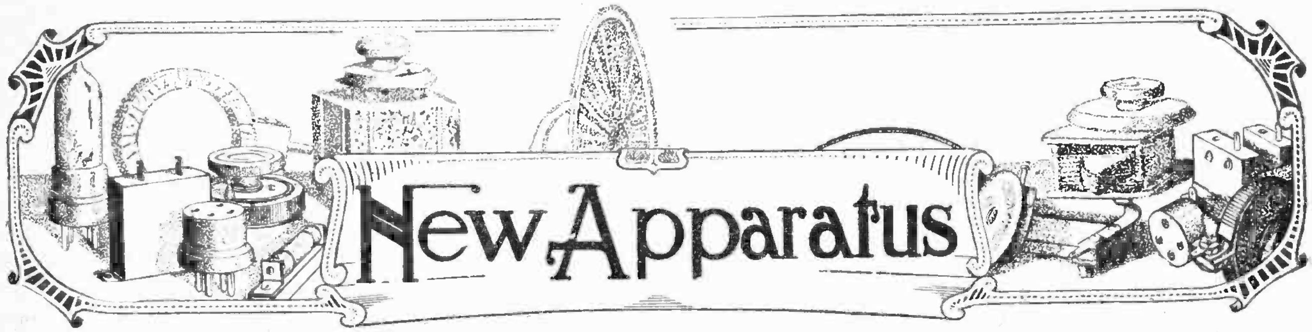


Fig. 5.—Resonance curve showing that side frequencies are amplified to varying degrees according to their proximity to the carrier frequency.

The low-toned effect will only be obtained when the receiving circuit is tuned to the carrier wave; if the circuit is slightly detuned from the carrier wave so as to be in tune with one of the outer side frequencies the quality of the speech or music changes altogether, becoming thin and sharp. For the best results as regards quality in broadcast reception the tuning should not be too sharp and critical reaction should not be employed; broader tuning gives a more uniform reception of all the frequencies represented in the low-frequency wave.

Side-band Telephony.

There is one form of telephony transmission in which the carrier wave itself is suppressed altogether at the transmitting station and only the side frequencies are sent out. These side frequencies are picked up by the receiving apparatus, but if an ordinary receiver were used the sounds obtained from the telephones would be quite unintelligible. To reproduce the original sounds entering the microphone the equivalent of the carrier wave has to be reintroduced at the receiver in the form of a local oscillation. This forms beats with the incoming side frequencies, the beats themselves representing the sounds. This type of transmission is not suitable for music on account of the great difficulty in making the frequency of the local oscillations exactly equal to that of the suppressed carrier wave.

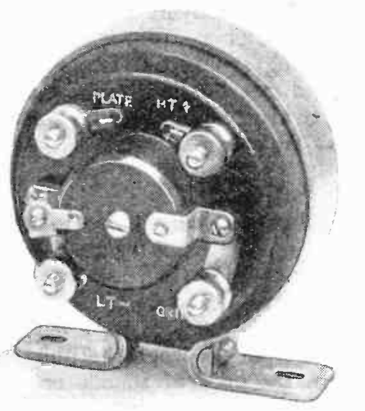


A Review of the Latest Products of the Manufacturers.

THE WATMEL AUTOCHOKE.

The idea of incorporating in a single unit the apparatus necessary for providing choke L.F. coupling will be readily appreciated. The choke, coupling condenser and grid leak can be completely wired together so as to present four terminals for connecting to the H.T. positive, the plate, the grid and L.T. negative, rendering the unit readily interchangeable with an intervalve transformer. Choke coupling is capable of maintaining a high degree of quality when employed in a speech amplifier, owing to the considerable inductance of the winding connected in the plate circuit, while the grid leak is virtually in shunt across the winding. The absence of a step-up ratio, however, limits the extent of amplification, as compared with transformer coupling, though by a suitable choice of valves a satisfactory degree of magnification is obtainable.

The Watmel Autochoke, a product of Watmel Wireless Co., Ltd., 332a, Goswell Road, London, E.C., is not a simple choke coupling unit, inasmuch as only a portion of the winding is connected in the valve plate circuit. The aim is apparently to obtain a step-up ratio, as with transformer coupling, yet



An auto-transformer for intervalve coupling fitted as a complete unit with coupling condenser.

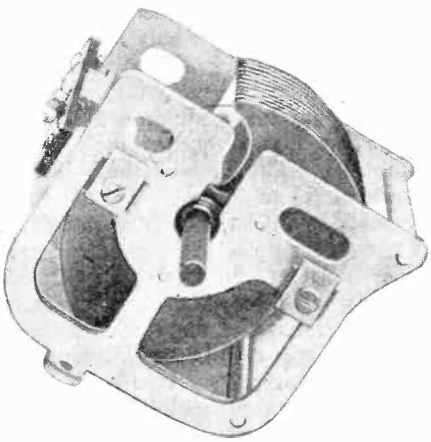
maintaining a reasonably high value of primary inductance without creating a coil of exaggerated dimensions possessing excessive self-capacity. Measurement reveals the primary inductance to be of the order of 20 henries, an exceedingly high value, bearing in mind that many intervalve transformers possess a primary inductance of only about 5 henries. The secondary inductance, that is, the inductance of the total winding, is 153 henries, showing the turns step-up ratio to be about 1 to 4.

As to construction, the unit is certainly attractive, the grid leak and condenser, the latter having mica dielectric, being contained under an ebonite cover and mounted on a polished ebonite plate carrying the terminals. The cylindrical case forms the closed magnetic core and is built up in two sections exactly similar. Instead of the usual carefully laminated core so generally adopted, the two sections are of cast iron, cleanly machined to fit tightly and pulled closely together by a central screw, no provision being made to break up the magnetic circuit to eliminate eddy currents. Externally, the case is finished a dull black, whilst the substantial brass clip used for mounting is nickel plated, and looks well. For securing the unit to the panel or baseboard, slots are provided instead of holes, a simple yet extremely useful feature for making allowance for any error when marking out the positions for the fixing screws.

THE CLEARTRON "DIKAST" CONDENSER.

It would seem to have been the endeavour of many condenser manufacturers during the past few years to produce a variable condenser having cast sets of plates. In striving to make a really low loss condenser, the use of cast plates eliminates the dangers of imperfect connections, sometimes met with when stamped plates are clamped together between spacing washers.

The Cleartron Radio Co., 1, Charing Cross, London, S.W.1, in conjunction with S. A. Lamplugh, Kings Road, Tyseley, Birmingham, have recently produced what is probably the first British condenser having diecast plates. Judging by the light weight of the condenser the plates are machine cast, probably from a form of aluminium alloy. Hitherto, the successful casting of condenser plates has been carried out with alloys, which expand during cooling, such as type metal, and the use of an aluminium alloy, though generally not so suited to small jobs, does undoubtedly produce a clean cast. The moving plates in this instance are cast around the centre spindle, whilst the fixed plates are provided with lugs, which are attached to two Bakelite strips, well arranged to limit dielectric loss to a minimum. Other than the two screws used for securing these strips, all fixings are made by riveting, the framework being apparently built up before the moving plates are brought into position.



Cleartron condenser with diecast plates.

The bearings are of simple form, one consisting of a depression in a hard spring washer, held accurately in position between three pegs on the frame, while the other is an adjustable bush. The bearing faces are conical, no actual bearing being obtained on the spindle itself, but rather on the tapering ends of the diecast moving plates.

FRAME AERIAL WIRE.

The London Electric Wire Company and Smiths Ltd., Playhouse Yard, Golden Lane, London, E.C.1., now manufacture a useful multistrand conductor suitable for frame aerial construction. It has a silk braided covering and is obtainable in various colours. The trade name is "Lewcos" wire.

Another recent product is "Lewcoflex," which is a multistrand flexible wire covered with vulcanised india rubber which will be found suitable for making the connections to moving parts such as coil holders and rotating inductances.

PIONEERS of WIRELESS

BY ELLISON HAWKS F.R.A.S

23.—Preece Installs the First Practical Wireless System.

IN June, 1892, a Royal Commission, which had been appointed to enquire into the practicability of electric communication between the shore and lighthouse and lightships, authorised Sir William Preece to proceed with his proposed scheme in order to test the theories he had formed as a result of his numerous experiments with induction, some of which were described in the last instalment of this series.

Experiments in the Bristol Channel.

The Bristol Channel was selected as a suitable place for the experiment, for here are two islands, Flatholm and Steepholm, distant from the mainland (Lavernock Point) 3 and 5 miles respectively. Communication was easily established over the shorter distance (3.3 miles), but between Lavernock and Steepholm (5.35 miles) conversation was found to be impossible, and Morse signals, although perceptible, were unreadable.

In March, 1898, Sir William's system was permanently established between Lavernock Point and Flatholm, and was handed over to the War Office. A few months later S. Evershed's relays were added to work a call bell, making the system "complete and practical," as it was then described.

In the meantime Sir William was experimenting and signalling in the Bristol Channel from a steam launch, which carried an insulated copper wire half a mile in length. One end was attached to a buoy, so that it could be stretched either above the water or submerged. Near the shore, signals were well received both with the wire above and under the water. At a distance of a mile, however, signals were only received when the wire was out of the water. Sir William concluded that electromagnetic waves are either dissipated in the sea-water, or that they are reflected from the surface of the water as are rays of light.

Sir William Preece.

Further experiments were made (in 1894) near Frodsham, in Cheshire, and in the Highlands at Loch Ness, where it was found possible to send Morse signals, as before, and also to carry on a telephonic conversation without wires over a distance of 1¼ miles. Indeed, sounds in the receiver were so loud that they were sufficient to "call up" the distant operator! A voltage of 140 (100 dry cells) was used in these latter experiments, two Bell telephones being employed as receivers, and simple granular-carbon Deckert's microphones as transmitters. Experiments were also carried out successfully between Arran and Kintyre, across Kilbrannan Sound. Here two parallel lines, four miles apart, were used, together with two insulated wires laid along each coast, 500ft. above sea level and 5 miles apart.

So far the transmissions had been only of an experimental nature, but on March 30th, 1895, the cable between the Isle of Mull and the mainland, about 2 miles away (near Oban), broke down. For a week, until the cable was repaired, communication was maintained without difficulty by laying an insulated wire, 1½ miles in length, along the ground from Morven, on the Argyllshire coast, while on Mull the telegraph wire (about 2 miles in length) between Craignure and Aros was used. The ordinary commercial service was carried on by these means, about 160 public messages being exchanged, including a Press telegram of 120 words.

Although Preece's system gave great promise, its limitations were soon realised. As the distance between the two wires increased, the length of the wires had to be increased also, and it was found to be necessary for the length of each wire to be roughly equal to the distance between the two. Thus, although quite successful for communication over short distances, this system was useless for long-distance work, on account of the great lengths of wire necessary for its successful working.

Communication with Lighthouses.

In 1899 Preece experimented in the Menai Straits, telephoning without wires from Anglesey to the lighthouse on the Skerries rocks, nearly 3 miles distant. This was accomplished by erecting a wire, 750 yards in length, across the Skerries, and erecting on the Anglesey shore a second wire, 3½ miles in length. At each end of both wires copper plates were sunk in the sea. Telephonic and telegraphic communication was also established between the lighthouse on Rathlin Island (off the north coast of Ireland) and the mainland, 8 miles away.

Pioneers of Wireless.—

As a result of his long research and numerous experiments, Sir William arrived at definite conclusions in regard to the part played by the earth in electromagnetic operations. The earth, he stated, acts simply as a conductor, and, as a rule, a very poor conductor, deriving its conducting property principally from the moisture it contains. He stated it to be his opinion that "although communication across space has thus been proved to be practicable in certain conditions, these conditions do not exist in the case of isolated lighthouses and lightships, cases for which it was specially desired to provide. The length of the secondary [wire] must be considerable, and, for good effects, at least equal to the distance separating the two conductors. Moreover, the apparatus to be used on each circuit is cumbrous and costly, and it may be more economical to lay an ordinary submarine cable.

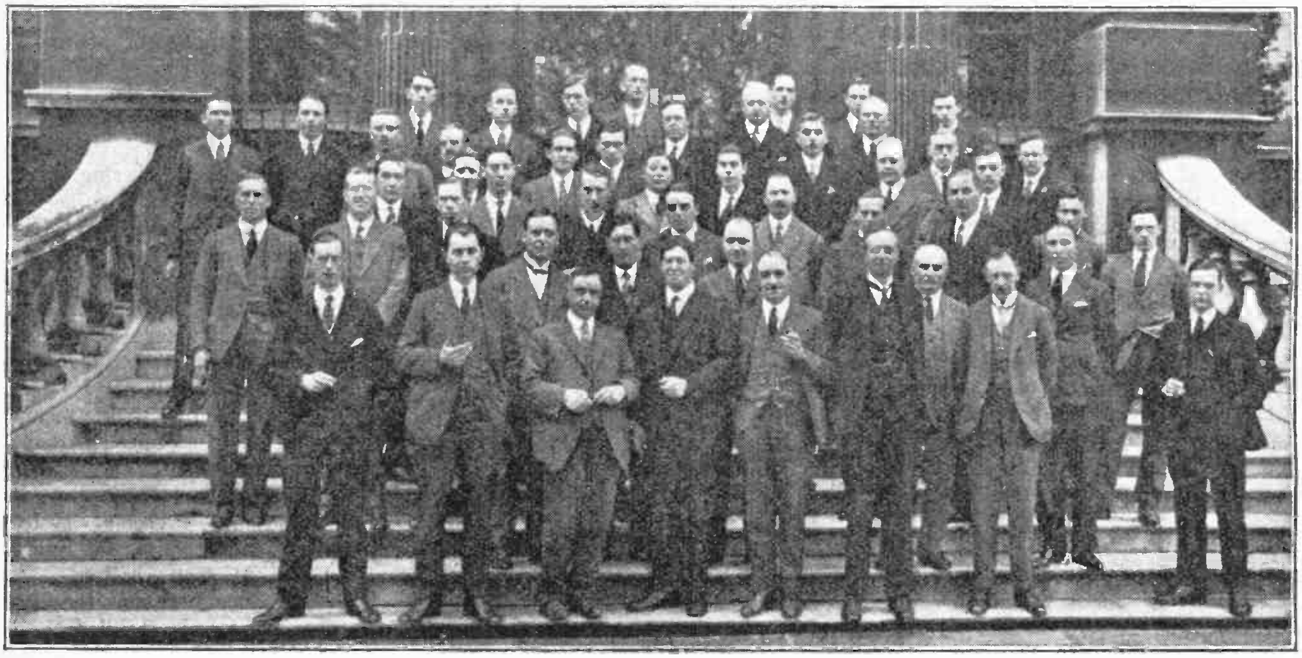
"Still, communication is possible even between England and France, across the Channel, and it may happen that between islands where the channels are rough and ragged, the bottom rocky, and the tides fierce, the system may be financially possible. It is, however, in time of war that it may become useful. It is possible to communicate with a beleaguered city either from the sea or on the land, or between armies separated by rivers, or even by enemies.

"As these waves are transmitted by the ether, they are independent of day or night, of fog, or snow, or rain, and therefore, if by any means a lighthouse can flash its indicating signals by electromagnetic disturbances through space, ships could find out their positions in spite of darkness and of weather. Fog would lose one of its terrors, and electricity become a great life-saving agency."

That Preece realised that there might be great possibilities in wireless communication is clear from a striking address he delivered (February 23rd, 1894) before the Royal Society of Arts. On this occasion he gave an account of its experiments extending over the previous ten years, and gave rein to his imagination when he concluded by saying:

"Although this short paper is confined to a description of a simple practical system of communicating across terrestrial space, one cannot help speculating as to what may occur through planetary space. Strange, mysterious sounds are heard on all long telephone lines when the earth is used as a return, especially in the calm stillness of night. Earth currents are found in telegraph circuits, and the *aurora borealis* lights up our northern sky when the sun's photosphere is disturbed by spots. The sun's surface must at such times be violently disturbed by electrical storms, and as oscillations are set up and radiated through space, in sympathy with those required to affect telephones, it is not a wild dream to say that we may hear on this earth a 'thunderstorm' in the sun.

"If any of the planets be populated with beings like ourselves, having the gift of language and the knowledge to adopt the great forces of Nature to their wants, then, if they could oscillate immense stores of electrical energy to and fro, in telegraphic order, it would be possible for us to hold commune by telephone with the people of Mars."



Above we reproduce a photograph, taken on June 25th last, of a group of members of the Transmitter and Relay Section of the Radio Society of Great Britain. In the front of the group, reading from left to right, can be recognised: A. W. Hambling, Member of Committee, T. & R. (2MK). Maurice Child, Hon. Sec., R.S.G.B., Member of Committee, T. & R. (2DC). E. J. Simmonds, Member of Committee, T. & R. (2OD). H. Bevan Swift, A.M.I.E.E., Chairman, T. & R. (2TI). F. L. Hogg, Member of Committee, T. & R. (2SH). Gerald Marcuse, Hon. Sec., T. & R. (2NM). J. A. J. Cooper (with pipe), Editor T. & R. Bulletin and Member of Committee, T. & R. (5TR). J. E. Nickless, Member of Committee, T. & R. (2KT). J. H. Reeves, Member of Council, R.S.G.B. (6HQ). Other well-known transmitters in the group who will be recognised by their friends, are: A. D. Gay (6NF); F. H. Haynes (2DY); A. Hinderlich; S. K. Lewer (6LJ); M. F. J. Samuel (5HS); C. W. Goyder (2SZ); and L. H. Thomas (6QB). We understand that copies of this photograph can be obtained, post free, from the Radio Society of Great Britain, price 6s. unmounted, or 8s. mounted. The size of the photograph is 19in. by 10½in.

AERIAL FILTER CIRCUITS.

Experiments with a Simple Method of Improving Unselective Receivers.

By P. D. TYERS.

THE large number of broadcast stations operating on proximate wavelengths necessitates the use of a receiver of great selectivity when any attempt is made to listen to distant stations. The problem of selectivity under these conditions is rendered more difficult by the fact that the signals, that is, speech and music, extend over a comparatively wide area marked by the upper and lower side bands. There are two general methods of reception which are used at the present time with satisfactory results. They are respectively the superheterodyne, or frequency-changing method, and the use of a balanced or neutrodyne multivalve amplifier, each stage being tuned to the desired frequency. Both methods necessitate the use of a comparatively large number of valves, and from an amateur point of view are somewhat expensive, both in initial outlay and running costs.

The writer has recently conducted some experiments on rather different lines with a view to obtaining great selectivity while employing only one or two valves. In the early days of wireless telegraphy, in which communication was carried out by spark transmitters, selectivity was obtained merely by the use of a number of coupled tuned circuits, the early Marconi multiple tuner being a typical example of such a tuner. The problem of separating a number of spark stations without a valve receiver was even greater than of separating a number of broadcasting stations, since the decrement in the former case was in many cases much greater. It seemed, then, that it might be possible by the use of some form of multiple tuner in conjunction with, perhaps, a two-valve receiver, to produce sufficient selectivity to obtain results similar to those given by a multivalve neutrodyne set.

The following laboratory experiments were first of all conducted. A local source of fairly highly damped oscillations was provided by means of a suitably adjusted shunted buzzer wavemeter. The actual effective waveband was found to be greater than that obtained with an ordinary modulated continuous wave. A tuned circuit, consisting of an inductance in parallel with a variable capacity, was connected to a rectifier and a microammeter, which was used to measure the rectified current. The tuned circuit was brought into resonance with the oscillations, and the oscillator was weakly coupled to the tuned circuit, the rectified current being measured. The wavelength of the generator was then varied by about 4 metres. The coupling was kept constant and the change in rectified current was noted. As might be expected, this was very small, showing that the selectivity of the system was exceedingly poor. This is due, of course, to the fact that the damping of the tuned circuit is high owing to the comparatively low resistance connected across it due to the rectifier and the microammeter. This arrangement is shown diagrammatically in Fig. 1.

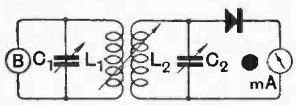


Fig. 1.—Buzzer wavemeter loosely coupled to a tuned rectifier.

The circuit shown in Fig. 2 was next connected. Here the generator is coupled by a few turns T to an aerial and earth circuit containing a tuned circuit L_1 C_1, tuned to the same frequency as that of the oscillations. The tuned circuit L_1 C_1 was then weakly coupled to the measuring circuit L_2 C_2, and the rectified current at resonance was again recorded. The generator was then detuned through the same wavelength range, that is, about 4 metres, and the change in rectified current again measured. This time there was an appreciable diminution in current, showing that the system had become more selective. The diminution, however, was not great enough to be of any practical value, since, as will be seen from the tables below, the rectified current from two signals of equal intensity only a few metres apart were both of the same order, indicating, of course, that one would interfere with the other. The circuit of Fig. 2, of course, is an ordinary loose-coupled receiver, and the difference in rectified current on detuning contained in the arrangements of Fig. 1 and Fig. 2 is an indication of the effect of using an ordinary loose-coupled

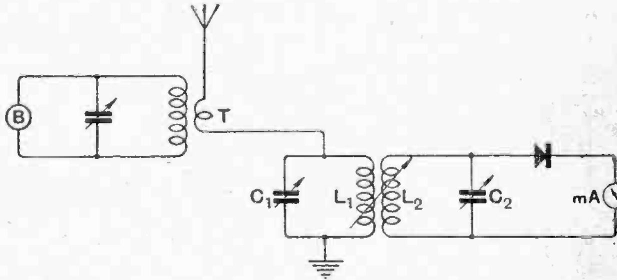


Fig. 2.—Circuit to demonstrate the improved selectivity obtained with a coupled aerial circuit

TABLE I.

	First Experiment.	Second Experiment.	Third Experiment.
Rectified current at resonance (microamps.)	10·0	10·0	10·0
Rectified current retuned, direct coupled	9·5	9·0	9·0
Rectified current retuned, loose coupled	8·1	6·0	7·4
First filter	4·2	2·5	3·2
Second filter	2·4	1·5	2·0

Aerial Filter Circuits.—
aerial circuit. As the arrangement of Fig. 2 was obviously insufficiently selective, some form of filter had next to be tried.

Since the experiments were being conducted with a view to obtaining some form of practical tuner, the filter arrangement obviously had to be as simple and straightforward as possible; an intermediate resonant circuit was then inserted between L_1 C_1 and L_2 C_2, the arrangement being shown in Fig. 3. The normal and correct method of inserting an intermediate resonance circuit is shown in Fig. 4, and simply consists in including a link. This results in there being no direct coupling between the circuits X and Z, but coupling between X and Y and Y and Z. To insert a link of this nature in an aerial tuning system which is to be used with plug-in coils is obviously far too complicated, and accordingly the system shown in Fig. 3 was adopted, the circuits L_1 C_1 and L_2 C_2 being placed sufficiently far apart to prevent any substantial coupling between the two, moderately tight coupling existing between L_1 C_1 and L_3 C_3, and L_3 C_3 and L_2 C_2. The three tuned circuits were brought into resonance, and the rectified current again measured. The generator was then detuned through the same frequency, and the change in rectified current again measured. This time a very appreciable change was obtained, the current falling to about one-third of the value at resonance. Another filter circuit L_4 C_4 was then introduced between L_3 C_3 and L_2 C_2, and similar measurements were again taken. This time it was found that the rectified current out of resonance was about a quarter of that obtained at resonance. This result appeared promising, since merely by introducing two filter circuits the received current just off resonance can be very materially reduced. It must be remembered that the experiments were made on a form of transmission which was exceedingly "broad," and that the damping in the final circuit in which measurements were taken was very high. Obviously, then, it appeared that if the two filter circuits were introduced between the aerial circuit and an ordinary two-valve high-frequency and detector receiver employing reaction, on ordinary broadcast signals the selectivity would be increased to a very much greater extent.

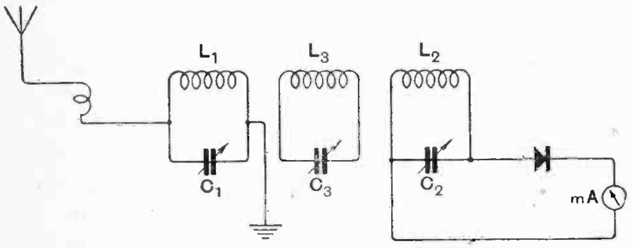


Fig. 3.—Tuned intermediate circuit inserted between the aerial and secondary (rectifier) circuit.

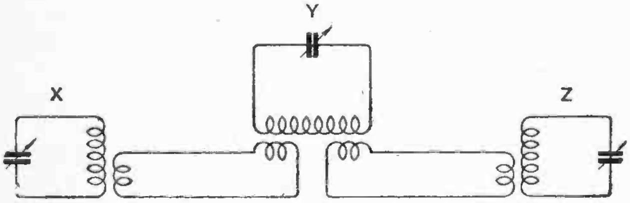


Fig. 4.—A more efficient method of coupling the intermediate circuit.

The selectivity which is obtained with a series of cascaded resonance circuits depends upon the coupling between the various resonance circuits, and also the damping of the circuits. Several sets of readings on various wavelengths were taken, and will be found tabulated. The inductances and capacities used in these tests were not of the ultra low-loss type, and some tests made subsequently showed that the results could be improved by using better inductances and capacities. Readers who are fond of solving simultaneous differential equations may care to examine mathematically a system such as that shown in Fig. 3, with a view to determining the optimum coupling, but little useful purpose will be served, since it can be determined empirically with far less trouble.

The filter system was then tested on actual broadcast signals, and the receiver shown in Fig. 5 was employed. This consists of a centre tap neutrodyne circuit with reaction from the anode circuit of the detector valve. A loose-coupled aerial system was used, a series condenser being inserted in the aerial lead, the circuit being tuned to resonance by means of a variable condenser in parallel with the aerial tuning coil. The receiver was then neutrodyned, and adjusted so as to be perfectly stable. The London broadcast station was then tuned-in, the receiver being situated about 12 miles away. A wavemeter was then adjusted to the wavelength of the Bournemouth station, and the receiver brought into resonance. By using the full reaction on to the anode coil the station could be clearly heard, but there was still a certain amount of interference from London. An aerial filter circuit was then introduced between the aerial coil and the closed circuit of the receiver. Fairly tight coupling was employed between the three circuits, and when the filter circuit was brought into resonance with the Bournemouth station it was found that the signal strength had not diminished by any appreciable amount. At the same time there was not the slightest trace of the London station. Moreover, moving the variable condenser which tunes the filter through about 2 degrees, completely eliminated the Bournemouth station. During the initial

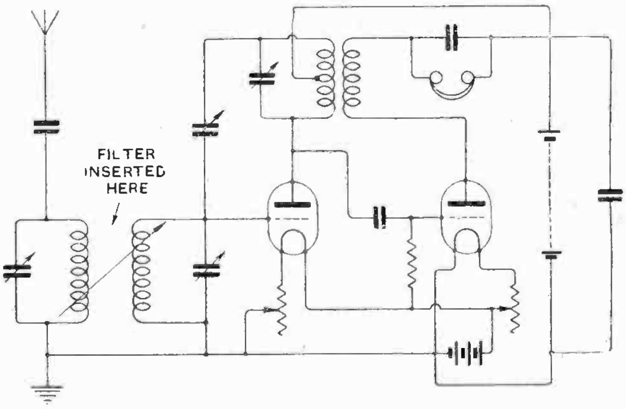


Fig. 5.—Neutrodyne circuit used for selectivity tests on broadcast wavelengths.

Aerial Filter Circuits.—

search without the filter no trace of any station was heard between London and Bournemouth, but by tuning to an intermediate wavelength only a few metres above London an unidentified foreign station, apparently speaking in German, could be heard clearly, without the remotest trace of London or Bournemouth. This, it should be remembered, was with only one filter.

It is believed that at close ranges to a broadcast station with an ordinary two-valve receiver employing a tuned anode coupled H.F. valve and detector that difficulty is experienced even in receiving without interference a station such as Madrid, which is about 8 metres above London. Here, again, it was perfectly simple to receive Madrid without a trace of London or any other station even nearer in wavelength. It was found that by using two filters, three stations could be received over a wavelength range represented by 2 degrees, on the condenser tuning the anode circuit of the first valve. Selectivity of this nature, of course, would have been utterly unobtainable without the use of filters. This fact was quickly demonstrated by connecting the aerial directly to the grid of the first valve, when nothing but the most powerful station could be heard.

Low-loss Components Essential.

The success of a filter system of this nature depends, of course, upon using low-loss condensers and coils. It is interesting to note that in making the initial experiments two coils were used in the filter of somewhat doubtful origin. They were of the wide, well-spaced, basket type, and appeared to be reasonably efficient. It was found, however, that the tuning was absolutely flat, and the signal strength was diminished to about a quarter of what it should have been. Examination of the coils did not reveal anything in the nature of short-circuited turns, and, accordingly, they were disconnected from their mounts, as faulty insulation was suspected. This, however, was not the case, and it was found eventually that the trouble was due entirely to dielectric losses, due to the substance in which the coils had been dipped. Incidentally, the insulation resistance between the covering and the wire itself was of the order of less than 1 megohm. Obviously, the lower the losses the greater will be the selectivity, but experiments showed that it was possible to obtain quite good results with moderately efficient coils and condensers.

Selectivity at Low Cost.

In the writer's opinion the experiments proved quite conclusively that it is not necessary to use a multi-stage neutrodyne or superheterodyne receiver in order to obtain useful selectivity, although, of course, it is not suggested that the selectivity of the aerial filter system is as good as that obtained with the types of receivers mentioned. Further, the results obtained appeared to be better than those given by the use of series or parallel rejector or acceptor circuits, or wave traps used and connected in the conventional manner. The cost of the filter circuit is negligible, being confined to two or three variable condensers, which can be obtained for less than 10s. each, and two or three good tuning coils, of which the cost is negligible if home-made. Some further conception of the selectivity of the arrangement may be obtained when it is mentioned that if even one of the circuits is out of resonance, it is practically impossible to pick up any station at all, except, perhaps, a trace of the local broadcast station.

TRADE NOTES.

Wireless Panels.

"Sindanyo," an insulating material which makes excellent panels for wireless purposes, is described in a handsome brochure issued by the manufacturers, Messrs. Turner Brothers, Asbestos Co., Ltd., Rochdale. Particulars will be gladly supplied by the firm.

o o o o

Sylverex Crystals.

We are informed that, owing to a fire breaking out at the Sylverex factory, at Hatton Garden, stocks of Sylverex Crystal and Permanent Detectors carried there were destroyed.

Ample stocks for present demands are, we understand, held at the Head Office, at 41, High Holborn, W.C.1, where all direct orders can be dealt with immediately. The Trade can supply as usual.

o o o o

B.T.H. Valves and Sets.

When purchasing a new valve, the wireless user appreciates a maximum amount of information concerning its characteristics, etc. In this connection the British Thomson-Houston Co., Ltd., are to be congratulated on the very comprehensive information which has been prepared and printed on neat slips for inclusion in each valve carton. The slips are printed in different colours, varying according to the type of valve dealt with.

The B.T.H. Co. announces many reductions in the prices of radio apparatus.

o o o o

Varley Magnet Co.

The Varley Magnet Co., which is well known as a subsidiary Company of Oliver Pell Control Ltd., is now marketing Varley Bi-Duplex Wire-wound Anode Resistances. This firm is not connected in any way with the Varley Radio Co., and we find that there has been a little confusion owing to the similarity in name.

Catalogues Received.

Creed and Co. (Telegraph Works, Croydon). Illustrated booklet descriptive of the application of Creed apparatus to Radio Telegraphy.

Globe Engineering Co., Ltd. (Brighouse, Eng.). List No. 14, giving particulars of Battery Charging Motor Generators, Switchboards and Charging Panels.

Marconi's Wireless Telegraphy Co., Ltd. (Marconi House, Strand, W.C.2.) Leaflet No. 1,056, providing an illustrated description of the Marconi Recording Receiver, Type R.g.3. for general services.

A. F. Bulgin and Co. (9-11, Cursitor Street, London, E.C.4). List No. 104, describing *Decko* Radio Products. List No. 105, dealing with *Competa* Radio products.

Marconiphone Co., Ltd. (210-212, Tottenham Court Road, London, W.1.). Publication No. 364F (3rd Reprint)—a comprehensive catalogue with illustrations of Marconiphone and Sterling Radio Receivers, Accessories and Components.

M.A.P. Company (246, Gt. Lister Street, Birmingham). Catalogue of turned parts, terminals, plugs, sockets, etc.

L. McMichael, Ltd. (Wexham Road, Slough, Bucks). Comprehensive booklet, with diagrams and illustrations, relating to the MH *Dimic* Coil.

A.F.A. Accumulators Ltd. (9a, Diana Place, Euston Road, London, N.W.1.). List No. 20, dealing with A.F.A. accumulators, also "Duros" cells for use with dull emitter valves.

The Ever-Ready Company (Great Britain) Ltd. (Hercules Place, Holloway, London, N.7.). Illustrated particulars of the *Ever-Ready* 20 volt H.T. wireless accumulator.

The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

THREE-VALVE LONG RANGE RECEIVER.

Sir,—With reference to Mr. James' recent design of "A Three-Valve Long Range Receiver," published in your issue of 26th May, I have recently constructed this set, and the very least I can do is to express my keen appreciation. Frankly, I am astonished, even as a "practised hand," at what can be done with this 3-valver.

Mr. James, I think, is to be congratulated, as, in my humble opinion, this design, while, of course, it shows the usual care and originality of all "W. W." work, marks a distinct advance in H.F. amplification and selectivity.

The greatest care was taken in duplicating every detail of the layout, etc., which is no doubt of some importance, as well as the correct valves, grid bias, etc.

By the way, I find the best H.T. value for H.F. and detector to be 80 and not 60, as stated. This, of course, may be due to some individual characteristic of the particular valves I have. I have often observed big differences in valves of the same make and type.

The power obtained on distance is very good, and for selective qualities I can only say that it is easy to bring in Edinburgh practically free from 2DE at one mile from the latter, at good loud-speaker strength.

I have observed that at no time do you publish "reports" from readers as to their results, and while appreciating your probable reasons for this, I do think it of some value to give from time to time a summary of any exceptional performance just as a standard of comparison.[1]

My complete log for the set so far (during 2 days' use) is 17 stations, all tuned on the loud-speaker at varying strengths. These were nearly all got in daylight on an indifferent aerial.

Dundee. J. S. MACHARDY.

[1] [The publication of readers' reports on the satisfactory results obtained with *Wireless World* sets would take up considerable space. The only purpose in publishing such letters would be to inspire confidence of readers in the sets described, and this we confidently believe is already assured.—Ed.]

COMMUNICATION ON LOW POWER.

Sir,—As the owner of a low-power station I was delighted to read the letter from Mr. Exeter in the July 21st issue. I agree with him that reduction of power after contact has been established may be interesting but of little value. Some days before the publication of his letter I had written to a member of the Committee of the T. and R Section, R.S.G.B., with regard to QRP tests. I suggested that during a whole week in, say, October, no British station should use more than 10 watts input, and that a list of stations which would be active should be sent to as many foreign journals as possible, and the greatest publicity be given to the tests so that positive results might be obtained. I am of the opinion that, as our short-wave band is so crowded, those stations which use high power and have been in communication with DX countries, should close down for one week and allow the QRP stations every chance of "getting over," and not merely reduce power to the 10 watts.

As results obtained on lower power at 6YW have been reported from time to time in the wireless journals, may I state that the power stated was in every case the power used to establish contact. I place no value on any other method of using low power.

For the benefit of any of your readers who think high power necessary to establish contact I give the names of the countries with which I have been in communication on low power. These details are not given because of any wish to boast, as I am fully aware that much better work may be done by anyone with more patience and time.

2 *watts on* 45 *metres.*—All Britain, Irish Free State, France, Belgium, Holland, Germany, Sweden, Spain, East Prussia, and Porto Rico (R4).

4 *watts on* 45 *metres.*—Italy, Denmark, Poland, Finland, Tunis, Madeira, Canadian 1st district (R5).

6 *watts on* 45 *metres.*—U.S.A. 1st district (R6 to R4), Arctic Circle (LAIA), Austria and Portugal. Heard in Ontario and Indiana. On 7 watts I kept a schedule with GX-6MU until he arrived in Sydney (C.B.); lowest QRK was R5.

Hoping that all transmitters will give their support to this scheme of low power tests. T. P. ALLEN, M.Sc.

Belfast. (Gi6YW).

THE MELTING POT OF BROADCASTING.

Sir,—With the general tenor of your remarks under the heading of "The Melting Pot of Broadcasting" most readers will, presumably, agree, and one feels a real sympathy with the manufacturer who has to produce apparatus for coming seasons under such handicaps.

There is one aspect, however, which I think should be emphasised. There are different localities with conditions peculiar to themselves each calling for some consideration from the manufacturer, though inevitably adding to his problems. No part of the country offers a better field for the sale of good wireless receivers than the South of England, because here are many thousands of moneyed and retired people able to purchase, and with full time at their disposal to *enjoy*, "wireless."

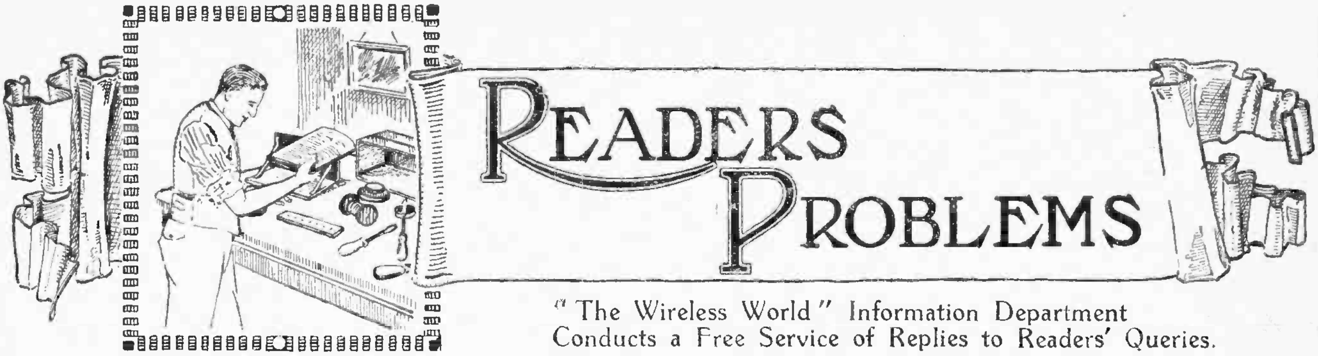
I stress the word "enjoy" because, *on the ordinary broadcast band*, this is just what they cannot do owing to the growing prevalence of Morse signals, which no set will cut out. Just think of a middle-aged couple, with no taste for experimenting or technicalities, but with some appreciation of the arts, listening to a first-class item, when, unceremoniously, their nerves are suddenly set jangling by spark interruption; this happening, with only short intervals of ether-clearness, whenever they attempt to listen. What do they do? Scrap the radio, and buy a modern gramophone. This has occurred in several cases to my knowledge.

There *is* one salvation, though—Daventry. Thanks to 5XX the South Coast can and does enjoy excellent reception. 200-600 metre receivers, "Daventry coils extra" (and therefore, perhaps, unbought—extras are hated), were sold to lots of people who now naturally say: "I don't care for the wireless."

Except for "fans" and "hams" the type of outfit called for in the South in quantity is, in my opinion, detector (5XX can be received here well on crystal, given good aerial-earth conditions) followed by a resistance-capacity couplied amplifier designed for cone loud-speaker reception on Daventry only, and where possible working direct from the electric mains. Once tuned permanently there would be nothing to do except switch on (batteries are a terrible bugbear to elderly people).

I am convinced that the average discriminating potential broadcast listener, with the money and time at his disposal, wants quality of programme *and* reception, simplicity, and no trouble, and is no more likely to tolerate interfering signals than he would permit a noisy child in the concert room. Daventry alone offers anything approaching such reception here.

Hove, Sussex. W. M. CARR.



"The Wireless World" Information Department Conducts a Free Service of Replies to Readers' Queries.

Questions should be concisely worded, and headed "Information Department." Each separate question must be accompanied by a stamped addressed envelope for postal reply.

Reaction with a Crystal Receiver.

I was very interested in the reply given to "G.R.I." in your issue of July 14th, in which a circuit was given using a separate reaction valve. I have been wondering whether a similar principle could be applied to a crystal receiver and two-stage L.F. amplifier using a separate reaction valve, both to increase signal strength on the local station and to extend the range of the set to the other stations. M. R.

The scheme which you propose is a perfectly feasible one, and is, indeed, used in a number of highly successful commercial receivers. We give the circuit in Fig. 1. Here it will be noticed that we have the conventional arrangement of a crystal receiver and L.F. amplifier with the addition of the grid-filament path of an extra valve shunted across the tuned circuit, the plate coil being coupled to the grid coil to produce reaction effects. It is undoubted that a crystal rectifier is productive of superior quality to that given by any form of valve rectifier, and a crystal followed by two stages of transformer-coupled L.F. is a very popular combination for good quality loud-speaker reception of the local station. Unfortunately the useful loud-speaker range of such an arrangement is very limited, and it will be found that the addition of the separate reaction valve will be very useful in increasing both range and quality, since the quality from the loud-speaker will not be good if the input to the crystal detector is small. It might rightly be asked, Why not use an H.F. stage? The reason is that the amplification given by the *average* H.F. stage is small, partly owing to the fact of the difficulties of designing a really efficient H.F. stage, and partly owing to the damping produced by the crystal. A reaction valve is a far simpler arrangement for the average man to set up, and there is much more likelihood of his obtaining a greater percentage of efficiency from it than from an H.F. stage. It is, in fact, more foolproof. Furthermore, by the application of reaction one can counteract the evils of damping produced both by the aerial and by the shunted crystal, and so not only increase both range and signal strength, but increase also the selectivity of the receiver. An H.F. stage followed by a crystal is never very selective, even if suitable tapping arrangements are made to alleviate crystal damping. By the correct use of a separate reaction valve, however, this damping can be removed.

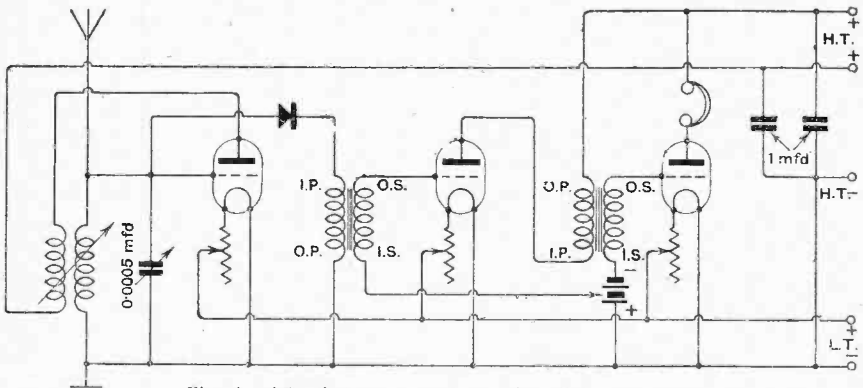


Fig. 1.—Adapting a separate reaction valve to a crystal rectifier.

Again, it may be asked why not use an H.F. valve with the tuned anode coil coupled back to the grid coil, and so obtain both H.F. amplification and reaction? If we do this, however, we are causing the valve to perform two functions simultaneously, and so shall lose in efficiency in the manner pointed out to G.R.I. It will be seen, therefore, that the separate reaction valve is undoubtedly the most convenient and efficient method of increasing the range and selectivity of a crystal receiver.

With regard to the reception of other stations, it may be confidently anticipated that this circuit will have about the same range as a conventional regenerative detector followed by two L.F. stages, except that quality will be very much better, owing to the use of crystal rectification.

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Operating a Loud-speaker without Valves.

I live in close proximity to a broadcasting station, and wish to construct a receiver to operate a loud-speaker at fair volume from that station, but I am deterred by the expense of maintaining the valves and batteries necessary for this purpose. Is there no way of accomplishing this without the use of valves? H. W. P.

Since you are living close to a broadcasting station it is probable that you will obtain loud headphone signals from an ordinary crystal receiver, and if this is the case, it is certainly possible for you to operate a loud-speaker efficiently without the use of valves by coupling a good microphone amplifier to a crystal receiver. In practice it will be found that the amplification obtainable with a good microphone amplifier is rather more than that obtained by a valve, but rather less than obtained by a two-valve amplifier, and it will be seen, therefore, that if you are close to a broadcasting station ample volume will be provided.

You are, however, strongly advised to purchase a good commercial microphone amplifier, such as those manufactured by Messrs. S. G. Brown, Ltd., and on no account to attempt to construct one yourself. The construction of a successful microphone amplifier is rather beyond the scope of the average amateur, and home-made instruments are usually not only noisy and erratic, but productive of very little actual amplification. A good commercial article is reliable and foolproof, and needs little or no attention. A six-volt battery is required for operating the amplifier, but since the current consumed is only a few milliamperes, it will be seen that the upkeep of the battery will present no great problem, as even the dullest of dull-emitter valves calls for a filament current of 60 milliamperes. An accumulator is quite unnecessary, and four dry cells should operate the amplifier for many months, and thus the cost of upkeep will be absurdly low. Alternatively, four Leclanche cells such as are used for electric bell operating may be employed.

The firm we have mentioned above also manufacture a loud-speaker and microphone amplifier built as one unit ready for connection to any existing crystal receiver in which good headphone signals are already obtained.

The principle of a microphone amplifier is quite straightforward. It consists virtually of a telephone ear-piece mounted close up against the mouthpiece of a microphone. The microphone is connected in series with a 6-volt battery and the primary of a microphone transformer. The input terminals of the amplifier, which have to be joined up to the output terminals of the crystal receiver, are connected internally to an earpiece. The signals from the earpiece are passed directly to the microphone and amplifier, and are thus passed out to the loud-speaker, the output terminals of the amplifier being internally connected to the secondary of the microphone transformer. Needless to say, the individual components of this amplifier are suitably connected together and mounted as one unit.

It should be pointed out that a microphone amplifier is not suitable for coupling to the output of an existing valve receiver in which very strong signals are already received, because the small microphone "button" incorporated in the instrument will not stand a very heavy input without "blasting" and so producing distortion similar to that produced by most amateur constructed microphone amplifiers operating under normal conditions. The quality provided by a good microphone amplifier operating from a crystal receiver is quite good. In cases where signals from the crystal receiver are very weak, such as when the receiver is situated at a good distance from the broadcasting station, a loud-speaker cannot be operated, but the instrument can in these cases be used with good effect for bringing up the weak signals to comfortable intensity for operating several pairs of headphones. Microphone amplifiers are much used in the construction of instruments designed for the conversational convenience of people who are partially deaf.

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A Unique Circuit.

Some time ago you published full constructional details of a receiver employing a special method of reaction control in which it was claimed that adjustment of reaction made not the slightest difference to tuning adjustment. I shall be glad if you can repeat this circuit, as I have mislaid the issue in which this circuit was dealt with. E. P.

This receiver was described in full detail on page 903 of our issue dated

December 23rd, 1925, and was primarily intended for short wave work, but is equally suitable for the broadcasting wavelengths. We repeat the circuit in Fig. 2. It is well known that the ordinary swinging coil method of reaction has the disadvantage that a readjustment of the tuning control is necessary every time the reaction coil is moved. In the Reinartz and Hartley circuits, where reaction is controlled by a condenser, this disadvantage is much less pronounced, but is nevertheless still very troublesome. For this circuit a modification of the Hartley circuit is used, the small "neutrodyne" type of reaction condenser being replaced by a fixed condenser of

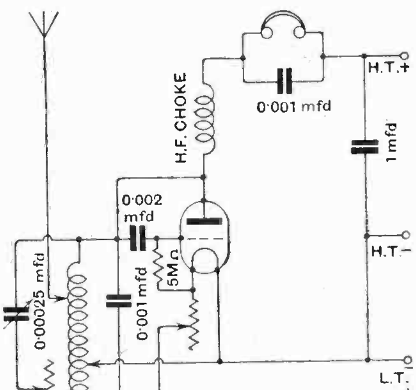

Fig. 2.—An easily controlled short wave circuit of high efficiency.

.001 mfd. capacity. The effect of this is that normally the circuit would oscillate perpetually. This is obviated by deliberately introducing a small amount of resistance in series with the tuning condenser. This resistance should be variable and under critical control, and requires to have a maximum value of about 5 ohms on wavelengths below 100 metres. It is essential, however, that the rheostat should possess a minimum of inductance and capacity, and therefore the ordinary wire-wound instrument will not do, one of the carbon compression types of resistance being necessary. In operating the circuit shown in Fig. 2, the aerial tapping must first be arranged according to the degree of selectivity required, whilst a rough adjustment of reaction must be made with the filament tapping. This should be adjusted so that oscillation occurs somewhere within the "range" of the rheostat controlling reaction. It will then be found that any adjustment of reaction made by varying the rheostat will have not the slightest effect on tuning, an achievement beyond the scope of any instrument fitted with even the most carefully designed Reinartz control. Below 100 metres the H.F. choke may be constructed by winding 150 turns of 36 D.S.C. on a former 1⅝ inches in diameter.

On the normal broadcasting band of wavelengths, any of the ordinary commercial chokes which are upon the market will be satisfactory. The rheostat should be of the 30-ohm carbon compression type on all wavelengths above 100 metres, 5 ohms sufficing below this wavelength. On the broadcasting band of wavelengths, of course, it is necessary to make an earth connection to L.T. −, and even on the short waves either an earth or a counterpoise might be tried.

○○○○

Efficiency of an H.F. Choke.

In your reply to M. B. C. in the "Readers' Problems" section of your March 17th issue, you stated that the H.F. choke connected in the plate circuit of a Reinartz or similar circuit in order to produce reaction effect need not be of high efficiency. Does this statement apply equally when a choke is used in a choke coupled H.F. amplifier? D. M. H.

Whilst, of course, it is perfectly true that the choke used in the plate circuit of the detector valve need not be of high efficiency, since the only requirements are that it shall provide a sufficient feed back to produce reaction effects, it is by no means true if it is to be connected in the plate circuit of an H.F. valve for amplification purposes. On the contrary, it is necessary that the choke be of the highest possible efficiency. That is to say, it must possess a maximum of inductance and a minimum of self-capacity. It is necessary, in fact, to aim at an inductance of about 0.5 henry, and a self-capacity not exceeding 0.00001 mfd. in order that a high impedance may be offered to the frequencies at which the instrument is to be operated. Now the ordinary commercial H.F. choke, which is sold mainly for the purpose of being used in a Reinartz circuit, has an inductance of only about 0.05 henry, ample for the Reinartz circuit, but of little use for H.F. amplification. Full constructional details of a high-efficiency choke were given on page 307 of the February 24th issue of this journal.

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

PORTABLES AND PORTABILITY.

WHY is it that portable wireless receivers have not gained in popularity to the extent which might reasonably have been expected? We are in the midst of our fifth summer of broadcasting, and yet if we consider the increase in the number of users of broadcast receivers there has probably been a very small comparative increase in interest in the use of portable receivers for out-door occasions.

Wireless provides an exceptionally convenient means for carrying musical entertainment with you on holiday or on the river, or, in fact, anywhere in circumstances where such entertainment is likely to be most acceptable. To explain the reasons for the lack of interest shown in portable receivers one must probably inquire in several different directions. First and foremost we must blame the designers of the average portable set which can be bought to-day for having neglected to appreciate what really constitutes portability. There are great possibilities in making an efficient broadcast receiver a really portable affair, and yet there are many sets sold to-day for *general* purposes which, with their batteries and equipment complete, weigh considerably less than the average set sold as *portable*. There is really no reason why satisfactory sets should not be devised commercially which could be carried about without requiring the services of a pack mule for transport.

Secondly, there seems to have been very little attempt to accustom the public to the advantages and the pleasure to be derived from a portable set for summer use. Those who do from time to time show an interest in portable sets often express the view that they have never had the opportunity of seeing one, although they are perfectly familiar with ordinary types of receivers. The manufacturers must draw the attention of the public to the merits of wireless out-of-doors before they can expect to create a demand for portable sets.

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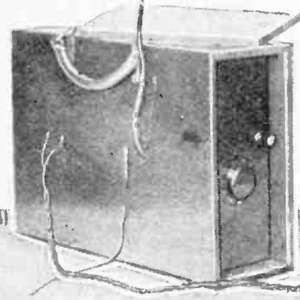
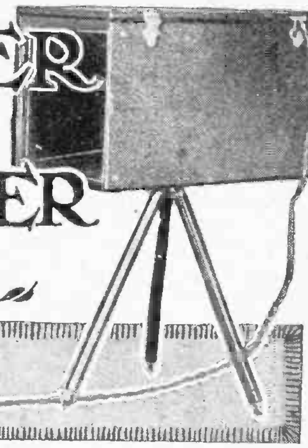
Thirdly, the public seem concerned because they regard a wireless set as a very delicate piece of apparatus which will not stand transporting without risk of breakage. Here, again, there is really no need for anxiety because, properly designed, and with the valves suitably mounted, a set should be capable of as much knocking about as the average box in which it is contained will resist. As to batteries, it must be expected that if weight is to be cut down to a minimum smaller accumulators and batteries will be used than would ordinarily be put into service for a set at home, but some sacrifice must be made for a gain in portability, and, provided the accumulator for a portable set is charged regularly, there should be no risk of being let down through any failure from this source.

We believe that if a real effort were made by manufacturers to cater for and cultivate interest in portable receivers through the summer months that the popularity would increase enormously and would provide interest in broadcasting in a new sphere.

It only requires that the public should acquire the portable-set habit to make broadcasting even more of an attraction than it is at present.



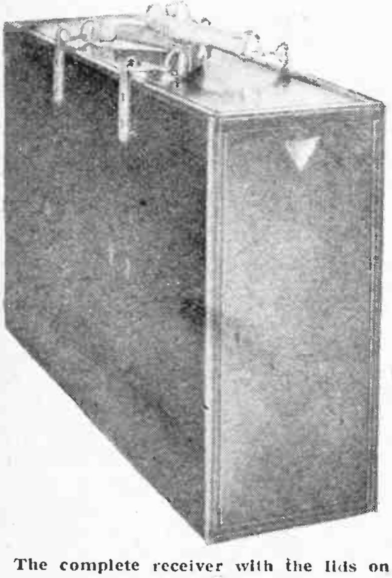
PORTABLE RECEIVER for LOUD SPEAKER WORK



A Set for Daventry.

By W. JAMES.

THIS three-valve portable receiver was designed for the loud-speaker reception of Daventry only, it being estimated that the set will be sufficiently powerful to work a loud-speaker at satisfactory volume anywhere in the country, when used with an outdoor aerial. The volume obtained will, of course, depend to a considerable extent on the type of aerial used and on the valves employed in the receiver. A small aerial will not be likely to give anywhere near such good results as a large high aerial, and for this reason a 200ft. length of rubber-covered flexible wire is taken with the set and used as a temporary aerial when possible. An indoor aerial, which will give reasonable results when used for the reception of 300-500 metre broadcast, is usually not such a good aerial in proportion when used for Daventry, for the reason that Daventry uses a much longer wavelength. This fact should be remembered when about to rig up a temporary aerial for the set.

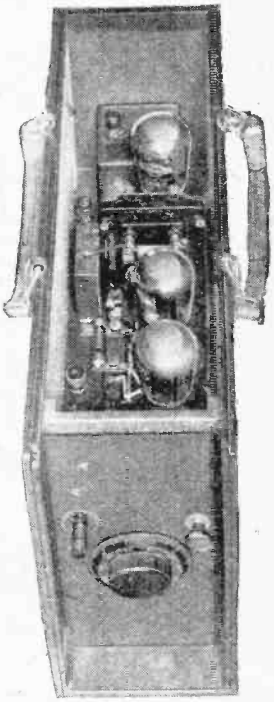


The complete receiver with the lids on

The receiver proper, a 2-volt unspillable accumulator and a 60-volt dry cell plate circuit battery, are accommodated in a wooden case fitted with handles for carrying. This case measures about 16in. x 11in. x 5in., which is quite small, and the receiver can be carried almost any distance with little effort. To complete the outfit a portable loud-speaker and a length of rubber-covered flexible wire for an aerial and earth or counterpoise are required.

Choosing Valves.

Now the accumulator used is rated at 2 volts 20 actual ampere hours (40 ampere hours at intermittent rates). It is, therefore, necessary to consider very carefully the type of valve that can best be employed, for it is possible to choose valves taking about 0.1 ampere or valves requiring 0.3 ampere To some extent the *best valve* will depend on how long an interval can be allowed to elapse between accumulator charges. If frequent charges are not objected to, we can choose the valves on a volume basis, for then we shall obtain the maximum amplification from the set; if, on the other hand, we choose valves of the 0.1 ampere type we are almost certain to have far weaker signals.



The receiver with the two lids removed.

As an illustration of this point we can compare the effect of using two different types of valve as the detector —the Cosmos SP18 Green Spot and the Marconi DE2 L.F. The SP18 Green Spot has an amplification factor of 15 with an A.C. resistance of 17,000 ohms, while the DE2 L.F. valve has an amplification factor of 7 with an A.C. resistance of 22,000 ohms. Used with the Ferranti 3.5 to 1 transformer, the SP18 valve will give just over twice the amplification, the quality being, if anything, a little better than when the

Portable Receiver for Loud-Speaker Work.—

DE2 valve is used, because it has a little lower A.C. resistance. But the SP18 takes a filament current of 0.3 ampere as compared with 0.12 ampere for the DE2; hence we see that low filament current consumption is had in this particular instance, which is, however, quite typical, at the expense of signal strength.

The High Frequency Valve.

When we consider the high frequency stage we find an almost similar state of affairs with, however, a single exception. If the circuit, Fig. 1, is examined it will be seen that the anode coil is tapped at its centre, the tuning condenser being connected across its outer ends. One end of the coil is connected to the anode of the high-frequency valve, the other end to a balancing condenser, and the centre tap to the positive terminal of the H.T. battery. Now the amplification obtained from this stage depends upon the ratio of the effective resistance of the tuned anode circuit to the A.C. resistance of the valve.

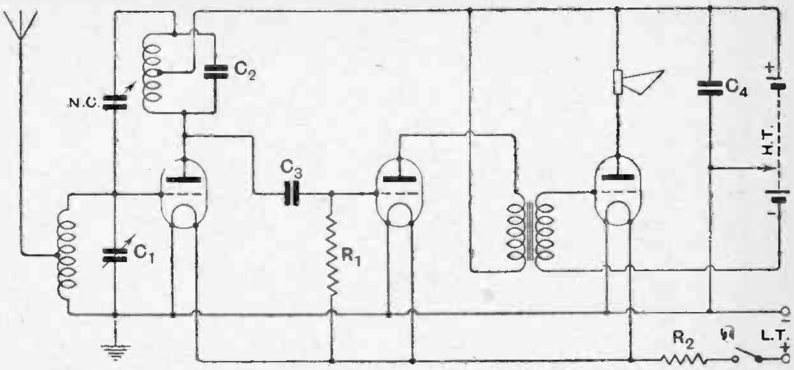


Fig. 1.—Theoretical connections. C_1, 0.0005 mfd.; NC, balancing condenser; C_2, wire wound condenser; C_3, 0.0003 mfd.; C_4, one mfd.; R_1, 2 megohms; R_2, 0.3 ohm.

As is well known, the effective resistance of a tuned circuit depends on its capacity, inductance, loss resistance, and the load thrown on it. We have as a load the grid circuit of the detector, although this is connected across half the coil only. We have also to remember that the whole of the effective resistance of the anode circuit when tuned is not connected to the anode of the valve because the coil has positive H.T. joined to its centre. Now a Dimic coil is used and the circuit, as it is connected, has an effective resistance of about 60,000 ohms at the wavelength of Daventry.

Let us see the approximate amplification obtainable when various valves are used. With an SP18 Green Spot we obtain about 11; an SP18 Blue Spot with an amplification factor of 35 and A.C. resistance of 75,000 ohms will give us about 16; a Marconi DE2 H.F., with its amplification factor of 12 and A.C. resistance of 45,000 ohms, will give us 7; a DER will give us 6, and so on. The best valve to use in the high-frequency stage, then,

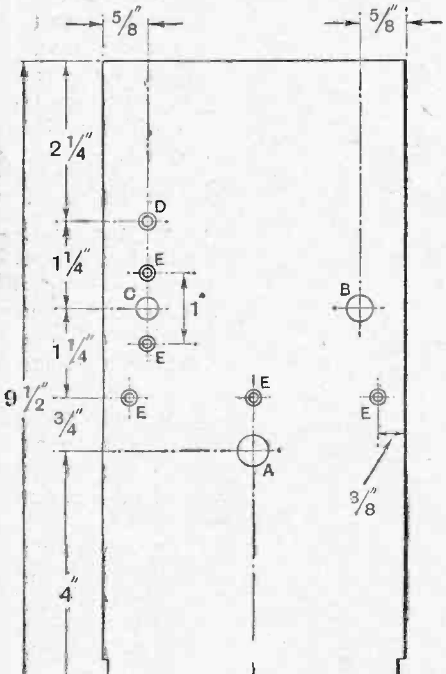


Fig. 2a.—Drilling of the ebonite front panel. A= 7/16"; B= 3/8"; C= 5/16"; D= 5/32" countersunk for No. 4 BA screws; E= 1/8" countersunk for No. 6 BA screws.

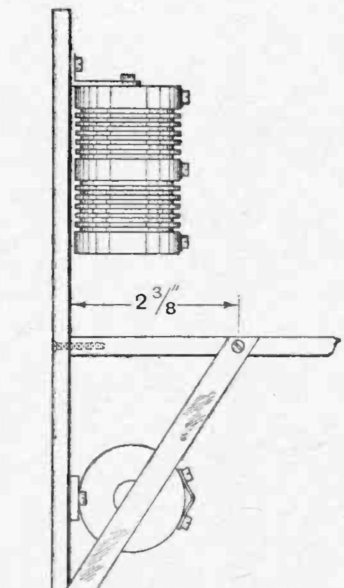


Fig. 2b.—Method of fixing sub-panel to front panel, showing the position of the aerial and high-frequency intervalve coupling coils.

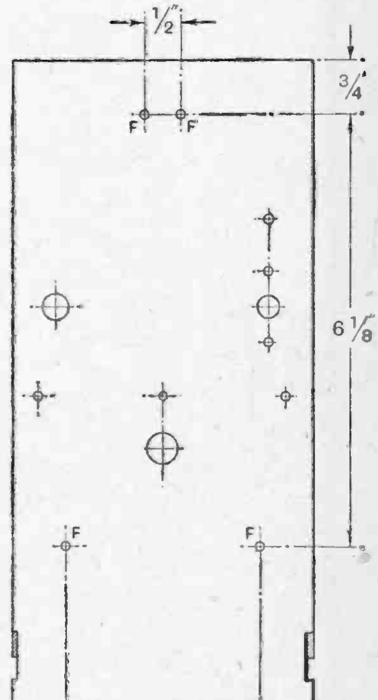


Fig. 2c.—Drilling of back of front panel. F=Tapped 6 BA.

Portable Receiver for Loud-Speaker Work.—

is the SP18 Blue Spot, for this gives an amplification of about 16 and takes a filament current of less than 0.1 ampere.

For the output valve we can use a valve which requires a grid bias of about negative 3 volts, with an anode voltage of 60; a suitable valve would be a DER, SP18 Red Spot, or Mullard PM2. Mullard PM valves can be used throughout if desired, and very good results obtained if the correct valves of this series are chosen. Use a PM2 for the output stage and a PM1 for the detector and the high-frequency amplifier.

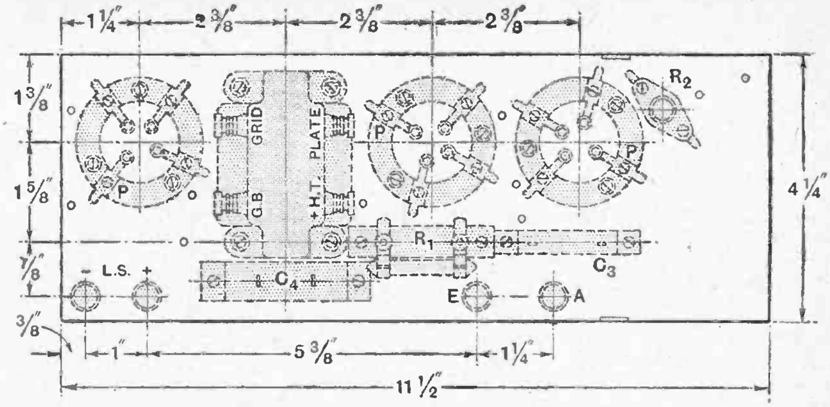
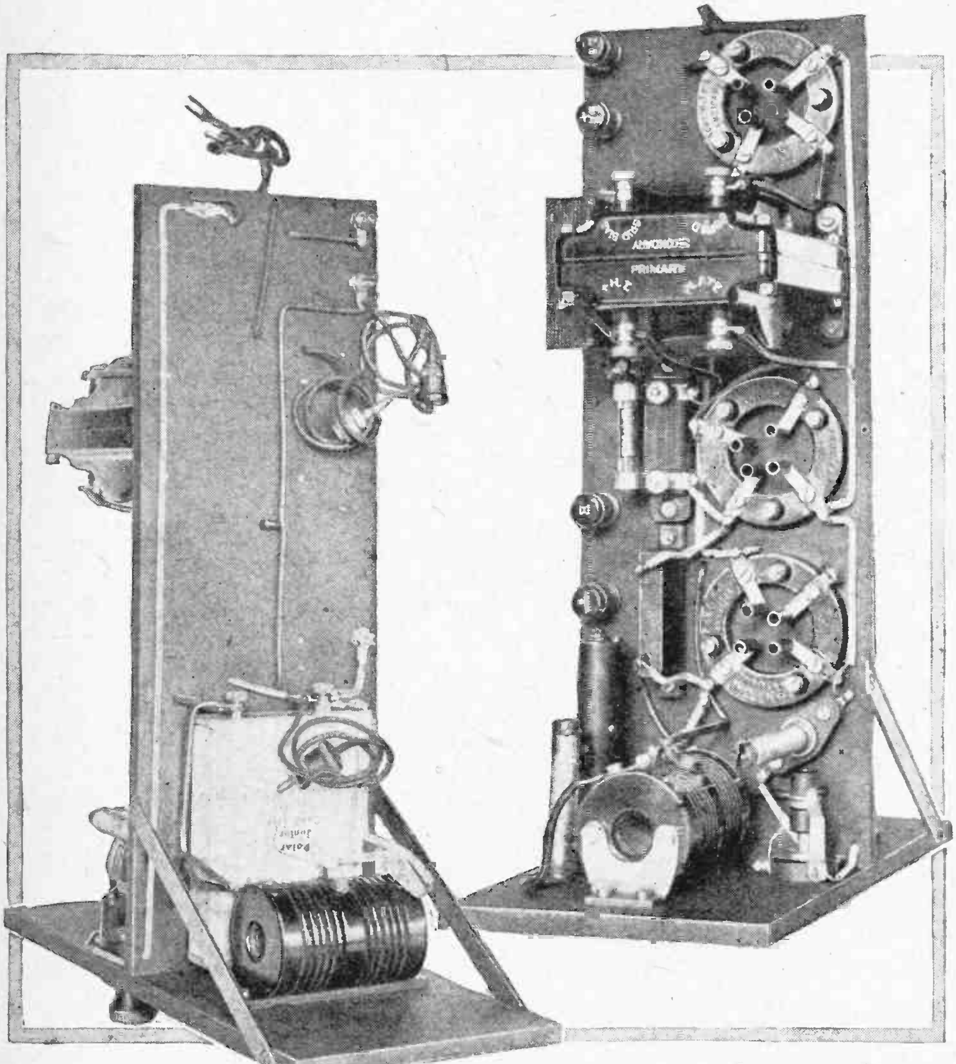


Fig. 3.—Position of parts on the sub-panel

Details of the Circuit.

If the circuit of Fig. 1 is examined, it will be seen that the aerial is connected to the centre of the aerial tuning coil, and this is tuned with a 0.0005 mfd. variable condenser. Connecting the aerial in this way increases the selectivity of the set and improves the signal strength because a step-up effect is obtained. In the anode circuit of the first valve is the tapped anode coil referred to above with a balancing condenser NC. Now this condenser can be set to give perfect stability with a given aerial and yet be of such a value relative to the grid-anode capacity that a useful regenerative effect is secured. The knob of this balancing condenser is, therefore, arranged to project through the front panel in order that it may be turned and the condenser adjusted to suit the varying aerials which will be connected to the set.

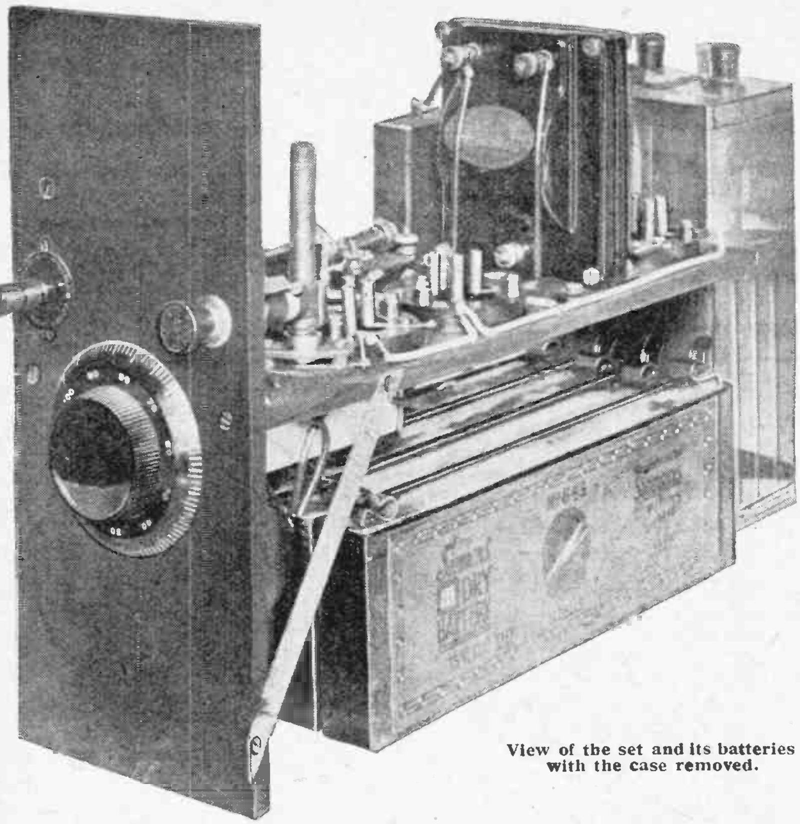


Left, view of the underside of the receiver, showing the aerial tuning condenser and aerial coil. Right, view looking down on the set.

Fixed-tune Anode Circuit.

For simplicity the anode coil is tuned with a condenser of the semi-variable type, comprising a brass tube having a covering of mica, and over this a layer of tinned copper wire with its turns soldered together. Thus the capacity of this condenser can be adjusted by altering the amount of wire wrapped on the outside of the tube.

The capacity required to tune the coil to Daventry is, roughly, 0.000125 mfd., and the condenser is best adjusted whilst listening to a transmission from the station. With the anode circuit tuned to Daventry there is only one wavelength adjustment to be made when tuning—that of the aerial circuit. Two savings are thus effected by using a wire-wound condenser in-



View of the set and its batteries with the case removed.

stead of an ordinary tuning condenser; we save space and cost.

No adjustable filament rheostats are used in this set, but the filament circuit contains an "on" and "off" switch and a fixed resistor. The value of the resistor used has to be sufficient to reduce the voltage of the accumulator to about 1.8, that is, about 0.2 volt has to be wasted when the accumulator is fresh. The fixed resistance used should, therefore, have a value of about 0.3 ohm assuming the filament current to be about 0.7 ampere; when the voltage of the accumulator falls, or when louder signals are required, the resistor unit may be removed and a short-circuit plug inserted in its place. Incidentally, a 0.75 ohm resistor will have to be purchased, as this is the nearest size; wire can be removed from it to give the correct value.

Alternatively, a length of resistance wire can be coiled up and permanently joined in circuit.

Constructing the Set.

Turning now to the construction of the receiver, we have a front panel and a sub-panel to carry the parts. The front panel carries the tuning condenser, balancing condenser, and the filament "on" and "off" switch, and on its rear side are screwed the two Dimic coils. The aerial coil is the lower one of the two and is mounted horizontally, whilst the anode coil is mounted vertically and above it. These two coils are fixed with brass brackets, as indicated in Fig. 2b, which also shows the method of screwing the sub-panel to the front panel by means of two brass straps. Two drawings of the front panel are given, Fig. 2a being of the front of this panel, and Fig. 2c of the back of the panel.

Details of the ebonite sub-panel will be found in Fig. 3. These parts comprise three valve-holders, grid condenser and leak, Ferranti transformer, fixed resistor and holder, dry cell battery condenser, and terminals for

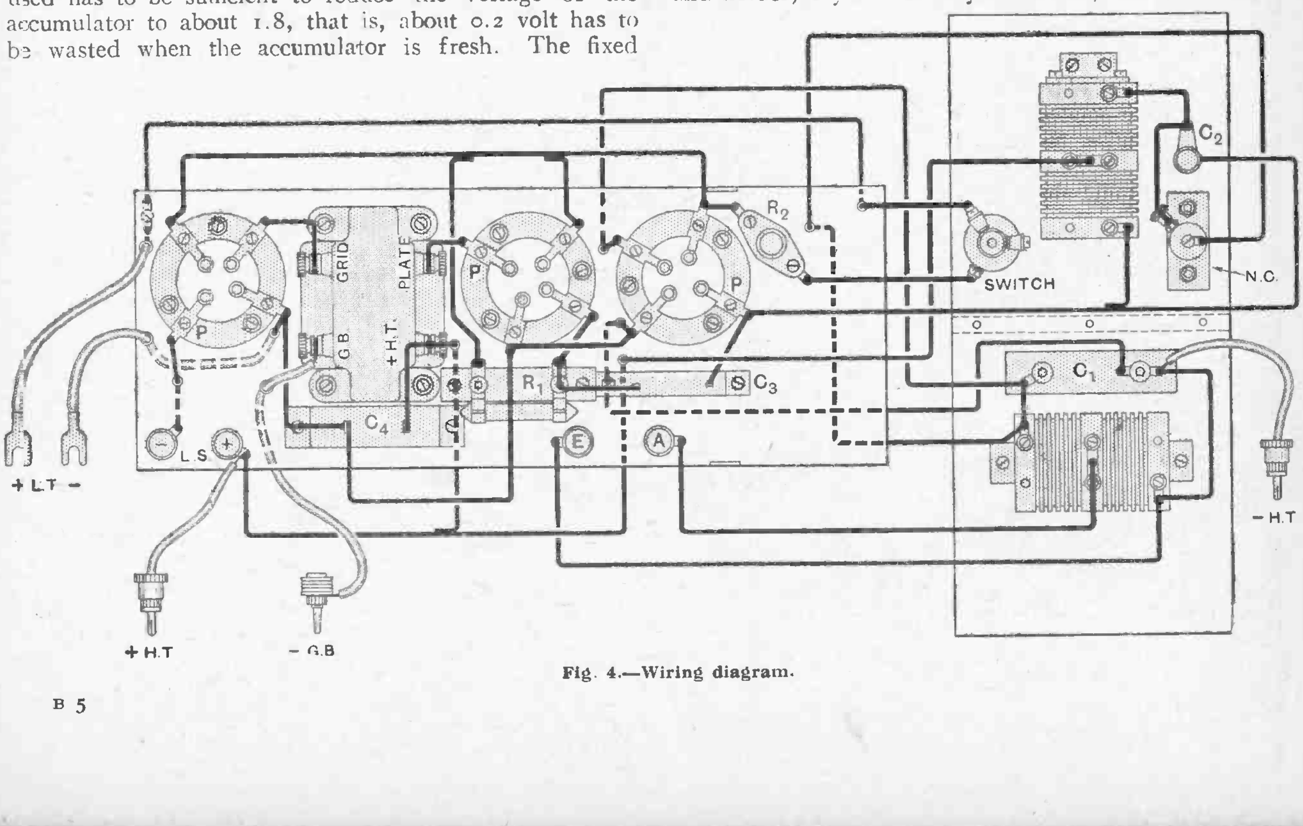


Fig. 4.—Wiring diagram.

LIST OF PARTS REQUIRED.

3 Valve holders (Bowyer-Lowe Co., Ltd., Letchworth).
1 Fixed condenser, 1 mfd. (Telegraph Condenser Co., Ltd.).
1 Fixed condenser, 0·0003 mfd. (Dubilier Condenser Co., Ltd.).
1 Grid Leak, 2 megohms and holder (Dubilier Condenser Co., Ltd.).
1 Tubular condenser, 0·0005 mfd. (Marconiphone Co., Ltd.).
1 Polar Junior condenser, 0·0005 (Radio Communication Co., Ltd, 34-35, Norfolk Street, Strand, London, W.C.2).
1 Lissen "On" and "Off" switch (Lissen, Ltd.).
1 Fixed resistor, 0·75 ohm, and holder (Burndept Wireless, Ltd.).
1 Ferranti transformer AF3 (Ferranti Ltd., Hollinwood, Lancs.).
1 Neutrovernia (Gambrell Bros., Ltd.).
1 2 volt unspillable accumulator, Exide D.O.4 type (Chloride Electrical Storage Co., Ltd.).
4-15 volt batteries (Siemens Bros. & Co., Ltd., Woolwich).
4 M type terminals (Belling & Lee, Ltd.).
2 Ebonite panels 11½" × 4¼" × ¼" and 9½" × 4½" × ¼" respectively.
2 No. 3 Dimic coils (McMichael, Ltd.).
1 Carrying case with straps.
Wire, screws, etc.

Approximate cost £7 10s. od.

the aerial, earth and loud-speaker. Holes are drilled through the sub-panel to take screws for fixing these parts, and further holes are provided for connecting wires.

The wiring diagram, Fig. 4, gives all necessary details. The wiring is a very simple job, for the majority of the wires can be run in Systoflex along the surface of the sub-panel. When wires run along the underside of this panel they should be covered to prevent accidental contact with the dry cell battery when putting the set and batteries in the case Five flexible wires are provided, two for the filament accumulator, two for the plate circuit, positive, and negative, and one for the grid bias. The grid bias is obtained by connecting the grid bias wire to the negative terminal of the dry cell battery and the negative H.T. wire to positive 3 volts of this battery. The positive H.T. wire is, of course, connected to the positive terminal of the H.T. Battery.

Connect the flexible wires before putting the set and batteries in the case.

Full details of the case and the two sliding lids will be found in Figs. 5 and 6. It should be noticed that four holes are provided, opposite the aerial and loud-speaker terminals, and that means are provided for retaining the accumulator.

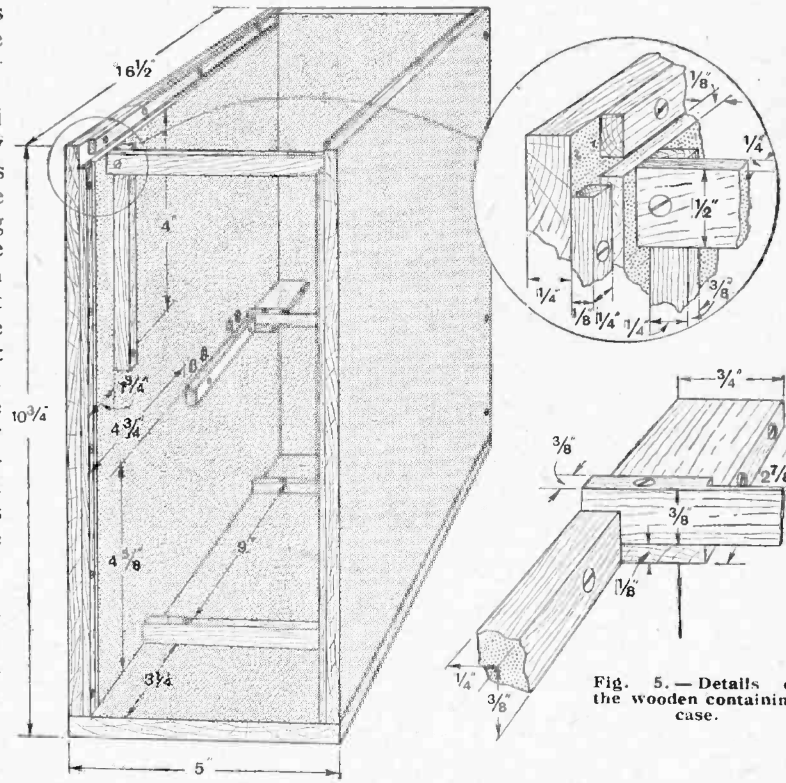


Fig. 5.—Details of the wooden containing case.

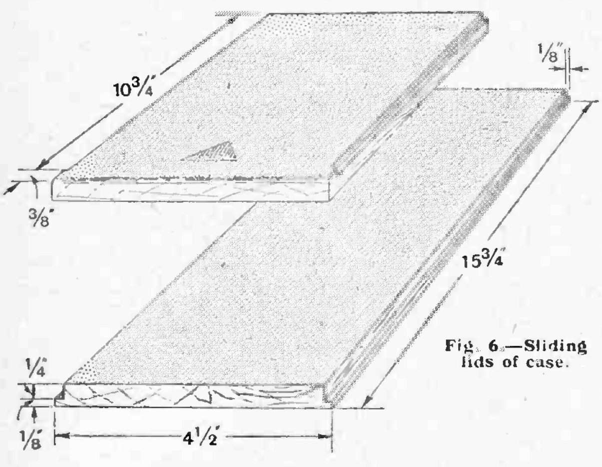


Fig. 6.—Sliding lids of case.

When the set is completed, connect the aerial and earth and listen for Daventry. It will be necessary to remove turns of wire from the wire-wound anode condenser, and the final adjustment to this condenser should be done rather carefully if maximum signal strength is to be obtained. It will be found that as this condenser is adjusted to bring the anode circuit more nearly in tune with the aerial circuit which is set for Daventry's wavelength there will be a greater tendency for the set to oscillate. Actual oscillation can, of course, be prevented by adjusting the balancing condenser.

The adjustment of the balancing condenser for best results will depend on the nature of the aerial and earth used and will, obviously, have to be readjusted every time the aerial is changed. The receiver will give very good quality reproduction although, of course, it is not designed to give very loud signals as we are limited to 60 volts H.T. and a grid bias of negative 3 for the last valve.

WIRELESS SIGNAL FADING.

A Simple Method of Measurement and Some of the Results Obtained.

By PROF. E. V. APPLETON, M.A., D.Sc.

IN a recent article[1] I described a simple method of studying the signal variations known as "fading." The method involves the use of a fairly sensitive galvanometer in conjunction with any type of radio-frequency amplifier, and is specially suited to the amateur observer. In the present article I propose to discuss the method in somewhat greater detail, and give some examples of the results recently obtained by means of it.

In the previous article, referred to above, mention was made of the comparative merits of the galvanometric and audibility methods of estimating signal intensities. The former possesses three great advantages over the latter. The method involving the use of the galvanometer is (a) more accurate; (b) more sensitive; and (c) more easily interpreted than the audibility method. The last-mentioned advantage is probably the most important, for, as most students of high-frequency phenomena will readily admit, it is one thing to make radio measurements, but it is quite another thing to be quite sure what one is really measuring. If we make audibility measurements of signal intensity it is very difficult to allow for the variations in the strengths of modulation produced by speakers, vocalists and instrumentalists at the microphone. Moreover, since there are often short intervals when the carrier wave is not modulated it is obvious that audibility measurements cannot be completely continuous. Now the galvanometer method gives us a measure of the intensity of the received carrier wave, and, in the case of the short-wave stations of the B.B.C., the galvanometer deflection is hardly affected at all by modulation. This is no doubt due to the fact that the carrier wave intensity is very strong indeed compared with that of the side bands due to modulation. In the case of Daventry signals the effect of modulation is more pronounced, especially if the galvanometer has a short period, and measurements are a little more difficult. Usually, if the observer watches the galvanometer in the day-time he is able to recognise the rapid fluctuations due to modulation and so is able to separate the effects of modulation and true fading when both are present.

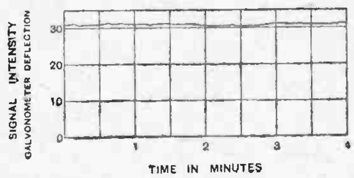


Fig. 1a.—Variation of signal strength from 2LO recorded at Potters Bar with the circuit of Fig. 1b.

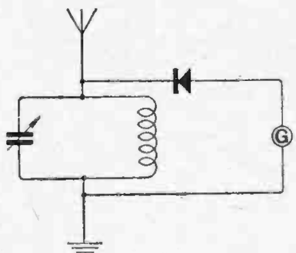


Fig. 1b.—Circuit used for signal strength measurements.

Signal intensity measurements of B.B.C. stations have been made at Cambridge during the last few years by Mr. M. A. F. Barnett and the writer using a circuit similar to that shown in *The Wireless World*, April 21st, 1926, Fig. 1, page 581, and have emphasised the great difference between day and night conditions. In considering these results it will be most convenient to consider the effects at three receiving stations of gradually increasing distances from the transmitter. For the B.B.C. wavelengths (300-500 metres) very little difference is noted in the signal intensity during day or night within about 10 miles from the transmitter. This means that experimenters who can get London on a crystal set will not experience marked variation of signal intensity due to "fading." What variations exist must be due mainly to fluctuations of intensity of the transmitter. That such fluctuations are small is shown by the accompanying graph Fig. 1a, which illustrates the signal intensity of 2LO made at Potters Bar using an ordinary broadcasting aerial with crystal and galvanometer (see Fig. 1b). But at greater distances (e.g., 50 miles) the phenomena are different, and here one begins to obtain very definite evidence of the difference between day and night conditions. During the day the signal intensity is fairly constant, the curves obtained being, in fact, very similar to

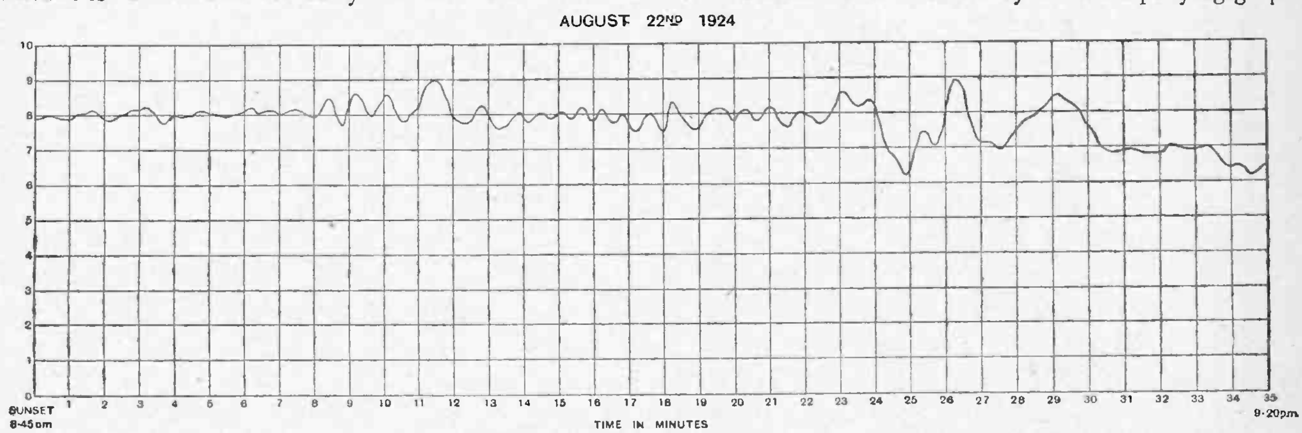


Fig. 2.—Variation of signal strength from 2LO recorded at Cambridge. At this distance the fluctuations are more marked than those of Fig. 1a.

[1] *The Wireless World*, April 21st, 1926.

Wireless Signal Fading.—

those obtained both by night and by day at shorter distances. But, about sunset, variations begin and continue throughout the dark hours. These variations are not large, and are not usually detected in the telephones or loud-speaker, but they are very definite and seem to show a fairly definite periodicity. A curve illustrating this is shown in Fig. 2. It represents readings taken by Mr. Barnett at Cambridge on 2LO, beginning at sunset (8.45 p.m.) on August 2nd, 1924, and continuing for 35 minutes. Two points about the curve are worthy of note. In the first place it will be seen that although signal variations take place after sunset the mean value remains fairly constant, and is, as a matter of fact, equal to the steady day value. Secondly, the signal variations become on the whole greater as the time advances. Further reference will be made to these points below.

Effect of Increasing Distance.

At still greater distances, up to about 100 miles, galvanometer measurements show that similar changes take place, but, with increasing distance, the percentage change of signal strength becomes much greater, so that at about 100-150 miles the signal intensity very often reaches zero at night. In such cases we get the audible fading noticed by many listeners in long-distance reception in which the signal disappears entirely periodically, but grows again sometimes to uncomfortable volume a minute later. At still greater distances the day-time signal is very small for overland transmission, but after sunset a great increase in strength is obtained. Here the mean night-time value is many times the day value. In such cases the galvanometer reading for a certain amplifier setting of sensitivity will be practically zero during the day-time, but will rise to 30 to 50 divisions at night. Here again changes in intensity take place which, though usually not so marked relatively as at the slightly shorter distances, make reception sometimes unsatisfactory.

When these phenomena were first discovered a theory was put forward to explain them. This theory was based on the ionized layer hypothesis which had been previously put forward by Kennelly and Heaviside, and had been used by Eccles and Larmor to explain long-distance transmission. In the older applications of the ionized layer theory it had only been necessary to assume that the layer "reflected" back waves at a very low grazing angle, so that the effects of the layer were detectable only at great distances. But for the case under discussion it was necessary to assume that the layer could "reflect" waves impinging on it at almost normal incidence. If such a possibility be admitted (and further experiments designed to test the ionized layer showed that the hypothesis is correct), we see that there are two ways in which waves may reach a receiving station even at short distances. This point is illustrated in Fig. 3, where two rays (the ground ray and the atmospheric ray) are shown as proceeding from the transmitter T to the receiver R. The ground ray is equally strong both by day and by night, but the atmospheric ray is only prominent at night. This appears to be due to increase in the height of the layer at night, when the ionization in the lower atmosphere, produced by solar action in the day, disappears, due to recombination of ions. When the layer is high the electricity in it is free and can "reflect" the waves without absorbing them.

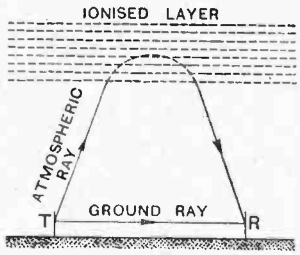


Fig. 3.—Paths of direct and reflected waves emanating from the transmitter.

Interference Effects.

To explain the effects of the two rays (ground and atmospheric) at different distances we have to consider their relative intensities. At short distances the direct ground ray is much stronger than the atmospheric ray, so that signals are constant both by night and day. At greater distances the signal is of medium strength and is constant during the day, being due to the ground ray, but at night, when the atmospheric ray becomes appreciable, the two sets of waves, ground and atmospheric, interfere and are sometimes in step and at other times out of step. This accounts for the maxima and minima of signal intensity indicated in Fig. 2. With increasing distance these variations at night increase, so that at a certain distance the effects of ground and atmospheric rays are equal. In such a case, when the two sets of waves are out of step, we get a complete disappearance of signal. At such distances "fading" is at its worst, and reaches a stage where reception is seriously affected.

At still greater distance the weak ground ray received during the day-time is often so much attenuated that reception becomes difficult, if not impossible. But after sunset the atmospheric ray becomes relatively very strong and reception is carried out by means of it. We can thus say that the reception of distant broadcasting stations at night is carried out almost wholly by atmospheric assistance.

CATALOGUES RECEIVED.

Wright & Weaire, Ltd., 740, High Road, Tottenham, N.17. "Wearite" components, switches, anode resistances, coils, variometers, etc.

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Electradix Radios, 218, Upper Thames Street, E.C.4. All kinds of components, measuring instruments, receivers, loud-speakers, transmitters, electric drills, heaters, tools, etc.

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Burne-Jones & Co., Ltd., Magnum House, 296, Borough High Street, S.E.1. Leaflet of Magnum Radio Products, including tapped H.F. chokes, transformers, resistances, screened coils, formers and resistors.

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The Voltron Co., 75, City Road, E.C.1. Voltron dull-emitter valves, 1.8 and 3.5 volts.

Ward & Goldstone, Frederick Road, Pendleton, Manchester. Catalogue No. R/114, of Goltone sets and components, including high-tension battery eliminators suitable for either A.C. or D.C. supply and various charging appliances.

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Climax Radio Electric, Ltd., Quill Works, Putney, S.W.15, and 257, High Holborn, W.C.1. Leaflet describing Climax Auto-Bat H.T. supply units, Auto-Bat transformers, special choke and potential divider, with circuit diagram.

HINTS and TIPS for NEW READERS

A Section Devoted to the Practical Assistance of the Beginner.

FAULT FINDING

The location of a fault in a receiver is facilitated if some means are available for narrowing down the field of search by isolating the probable source of the trouble to one or two valves or their circuits. Such a plan is easily possible in a set where provision is made for inserting the telephones in the anode circuit of the detector valve. If good signals, of the strength to be expected without L.F. amplification, are obtained with this connection, it may logically be assumed that the detecting and H.F. circuits (if any) are in order, and that the fault is in the L.F. amplifying portion of the receiver.

Where there is no form of switching for placing the telephones in the desired position, the tiresome operation of disconnecting leads in what may be somewhat inaccessible positions may often be avoided by noticing the effect of "making" and "breaking" the grid bias connection of the first L.F. valve by temporarily removing the lead from the battery. Normally, a distinct "click" will be heard in the loud-speaker or phones when the circuit is completed or broken, indicating that the amplifier is probably in order. The test is admittedly a rough one, but will, as a rule, show a serious fault, such as a break in the transformer windings, or a failure of the valves.

If an anode rectifying valve is used, a slightly more thorough test may be made by intermittently breaking the grid circuit, which, again, may most conveniently be done at the bias battery, used for this form of detection. The production of clicks of normal loudness will tend to show that there is no serious breakdown in either the detecting or L.F. amplifying part of the receiver.

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USING A TWO-RANGE VOLTMETER.

A voltmeter with a double scale, reading from 0-6 and from 0-120 volts, is probably the most useful measuring instrument for the average amateur, providing, as it does, a means for checking L.T., H.T., and grid bias voltages. If it is to give a really useful indication of the condition of the high-tension battery, however, its windings should be of high resistance, otherwise more harm than good may result from its use.

Those generally sold for wireless purposes have three terminals, marked –, + 6, and + 120. To take a reading, the negative side of the battery is joined to the common – terminal, and the positive side to the appropriate + terminal. Care should be taken not to connect the high-tension battery across the low-voltage terminals, or the meter may be injured.

To obviate this possibility, and to reduce the risk of damaging the instrument by mechanical shocks, it may be mounted permanently in the receiver, adopting the system of connections shown in Fig. 1. A double-pole change-over switch and two single-pole stud switches are arranged to connect the low-voltage terminals across any valve filament at will, and also to connect the high-voltage terminals across any section of the H.T. battery. An additional stud, connected to the positive L.T. battery lead, may with advantage be added to the low-tension selector switch, in order that the total voltage across this battery may also be ascertained.

It will be noticed, on reference to the diagram, that alternate "dead"

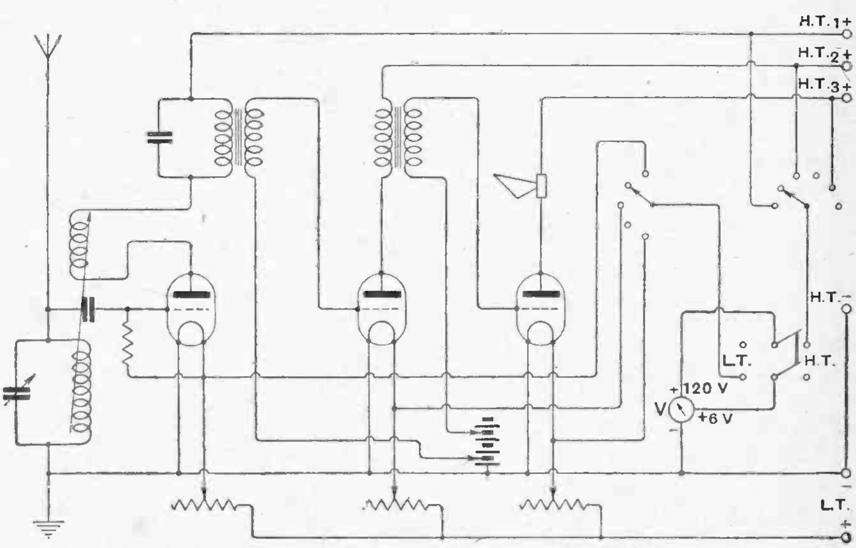

Fig. 1.—Connections for a double-range voltmeter.

studs are shown; this is to avoid a possible short-circuit caused by the brush of the switch making simultaneous contact with two "live" studs while traversing the switch.

When fitting a voltmeter to a receiver containing a large number of valves it may be inconvenient to make provision for connecting the meter across each individual valve filament. In such sets, however, it is usual only to provide rheostats for groups of two or three valves of the same type, and the instrument can conveniently be wired so that the voltage across each group of valves may be read.

Care should be taken to obtain a voltmeter with a common negative terminal; those with a common positive require a very elaborate system of switching, and are quite unsuitable for use in this manner.

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A SINGLE-WIRE LOUD-SPEAKER EXTENSION.

The use of a single-wire extension lead, generally in conjunction with an anode choke and large capacity condenser (the so-called "filter circuit"), has been discussed in this journal on several occasions. The ease with which a long single lead may be installed is a point in favour

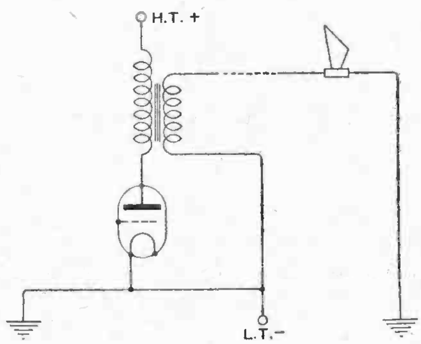


Fig. 2.—A low-resistance loud-speaker with single extension wire.

of this arrangement, as an uncovered wire, carried on insulators similar to those used for telephone lines, can often be put up with much less trouble than the more usual twin leads, which require a high degree of insulation, particularly if connected directly in the anode circuit of the last valve. Even if the single wire is covered with an insulated sheathing, and carried inconspicuously along a skirting board or elsewhere, possibly in close proximity to earthed objects, the total capacity thus introduced across the loud-speaker terminals will be considerably less than if twin conductors are used in the normal manner.

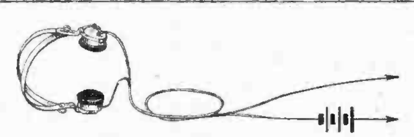
A similar form of connection may be used for a low-resistance loud-speaker in conjunction with an output transformer, as shown in Fig. 2. The series condenser required for the choke output circuit will not be necessary in this case, as the secondary winding of the transformer, which carries pulsating low-frequency currents only, is insulated from the H.T. battery.

As has already been pointed out, the "earth" connection at the distant point need not be of high efficiency, but should be of fairly low resistance compared with that of the loud-speaker itself.

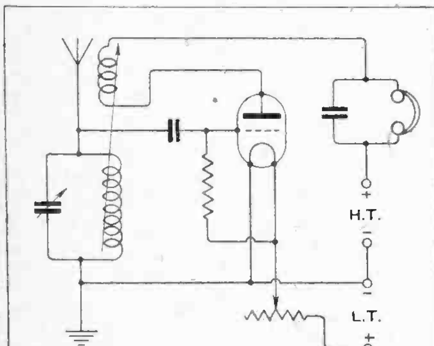
DISSECTED DIAGRAMS.

No. 39.—Point-to-point Tests of a Single-valve Receiver.

It is proposed to show, in a short series of diagrams, of which the first appears below, how simple tests for continuity and insulation may be applied at the points where breakdowns are most likely to occur. Phones and a small dry battery may be used as an indicating device, and should be connected up as shown.

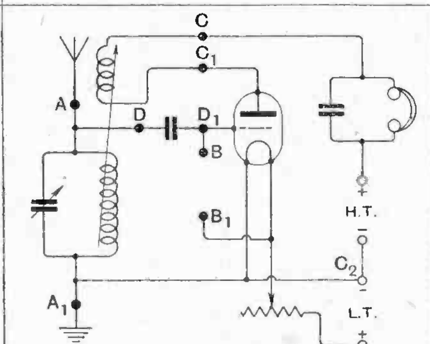


TELEPHONES AND DRY BATTERIES CONNECTED FOR TESTING



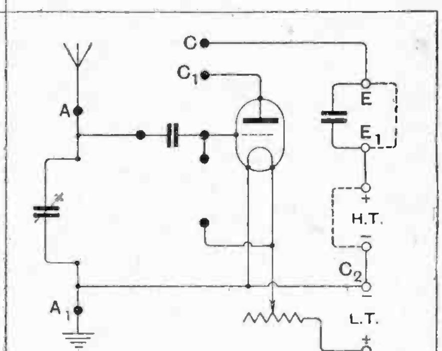
1

The circuit diagram of a single-valve receiver, with reaction. The tests to be suggested apply more particularly to a set which has developed a fault after having functioned satisfactorily. Generally speaking, it will not be necessary to interfere with the wiring. Faults in any other type of set may conveniently be located by fairly obvious modifications of this method. Batteries should be disconnected.



2

When the testing circuit is applied across points marked A and A_1, the production of clicks in the phones will indicate continuity through the aerial coil. No loud clicks across B and B_1 (with grid leak removed) will suggest adequate insulation of the grid circuit, while a further test across D and D_1 checks the insulation of the grid condenser. A test across C and C_1 shows continuity through the reaction coil.



3

A further application of the testing circuit across points A and A_1, with aerial coil removed, provides a test for short-circuits in the tuning condenser, between C and C_2 (with battery and phone terminals short-circuited and reaction coil removed) of the plate circuit, and between C_1 and C_2 of the general insulation of the anode of the valve. A test between E and E_1 will show a short-circuit in the by-pass condenser.

VALVE CHARACTERISTIC SURFACES.

Investigating the Best Working Conditions for a Valve Oscillator.

By E. H. HARWOOD, Wh.Sc., B.Sc., A.C.G.I.

In order to visualise the working of a three-electrode valve or triode and to ensure efficient operation the use of some sort of characteristic is necessary. The most usual ones met with to-day are the anode current-grid volts curves. They are generally given with a constant filament temperature and a variable anode voltage. In this way a family of curves is obtained which may be used as an aid to satisfactory operation.

If the triode is being considered as a generator of oscillations, however, these curves become a little awkward to use owing to the fluctuation of the anode voltage, and we meet a case where three variables occur—one, the anode current, dependent, and two independent variables, the grid and anode voltages. (The filament temperature will always be assumed constant.)

Expressing this by symbols

$$I_a = f(V_g, V_a)$$

where

I_a represents anode current.
V_g represents grid volts
V_a represents anode volts.

Just as we can represent the relations between two variables by means of plane curves, so in a similar manner we represent the relation between three variables by means of a surface. Hence it is obvious that a triode has a characteristic surface, and in this article an endeavour will be made to show its form. It is felt that the use of the characteristic surface of a triode may assist in a physical conception of its working, more especially when used as an oscillator.

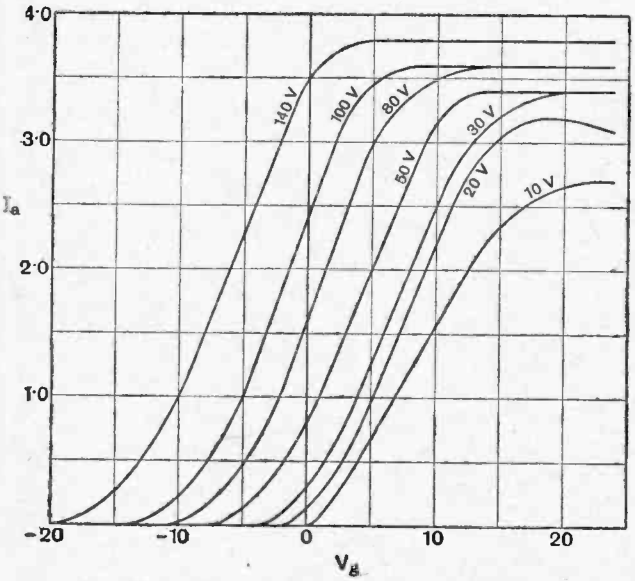


Fig. 1.—Family of grid volt-anode current characteristics for Mullard "ORA" valve.

Let us revert to the usual grid volts—anode current curves. These are of the form given in Fig. 1. Those given are the curves for an ordinary Mullard "Ora" bright emitter. Two points are worth mentioning although they are common knowledge. As the anode voltage is

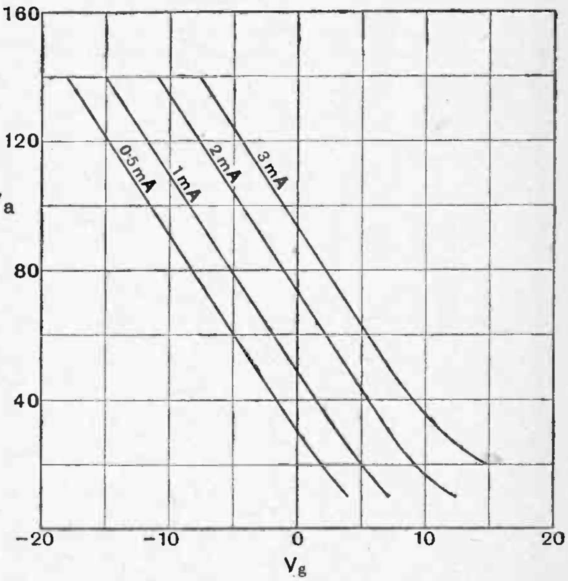


Fig. 2.—Grid volt-anode volt curves for constant anode currents.

increased the family moves to the left, and that at low anode voltages there is a distinct falling off of anode current due to the increasing counter attraction of the grid. The characteristics may be drawn in a different form, i.e., that showing the relation between grid volts and anode volts. The arbitrary constant for the family is then the anode current. These curves are shown in Fig. 2 for the triode quoted above.

Derivation of the Surface.

We can now proceed to combine these sets of families of plane curves into one characteristic surface.

Imagine the three co-ordinate axes to be erected mutually at right angles, as shown in Fig. 3. These will represent the axes of the three variables, I_a, V_a and V_g, respectively. Planes representing the variation of I_a with V_g for a constant anode voltage will be parallel to OI_a and OV_g, and their curved surfaces will be of the shape of the usual I_a-V_g characteristic. Thus the curve for a value of $V_a = 20$ will be placed back along the OV_a axes by a distance representing 20 volts. In this way any number of these planes may be put in, and the appearance is that shown in Fig. 4. In order to secure definition all positive grid voltages beyond 24 are neglected.

If desired, similar planes parallel to OV_g, OV_a plane may be put in representing change of V_g against V_a with

Valve Characteristic Surfaces.—
constant anode currents. These planes will intersect the previous ones at right angles. Evidently the surface embracing all the curved edges of the planes is the characteristic surface required. The greater the number of planes taken the more nearly can the true surface be judged. A convenient method of determining this surface is to fill in the spaces between the planes with paraffin wax or plaster of Paris and then mould up to suit the edges of the planes.

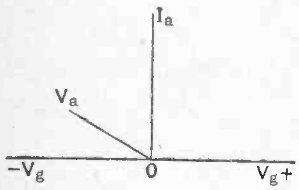


Fig 3.—Axes of anode volts, anode current and grid volts arranged mutually at right angles for plotting the characteristic surface.

A photograph of the surface characteristic for the Mullard "Ora" previously mentioned is given in Fig. 5.

Properties of the Surface.

Three main features are apparent from the observation of the model.

A.—*The zero anode current plane.*

This extends away indefinitely to the left, joining the body of the model by a line roughly at 45° to the I_a, V_a axes. In this region the influence of the steady anode potential is not sufficient to overcome the repulsive action of the negative grid, and no anode current flows. This cut-off effect naturally becomes non-existent when the grid becomes positive.

B.—*The useful working surface.*

This surface emerges from the zero anode current plane and is inclined to all axes. It is this surface which is commonly used in amplifiers, and which should therefore be as plane as possible in order to avoid distortion of the input. With a positive grid and two values of anode voltage this working surface departs from its more or less plane form and turns almost parallel to the V_g-I_a plane. With very small values of anode potential this region merges into the grid voltage axis.

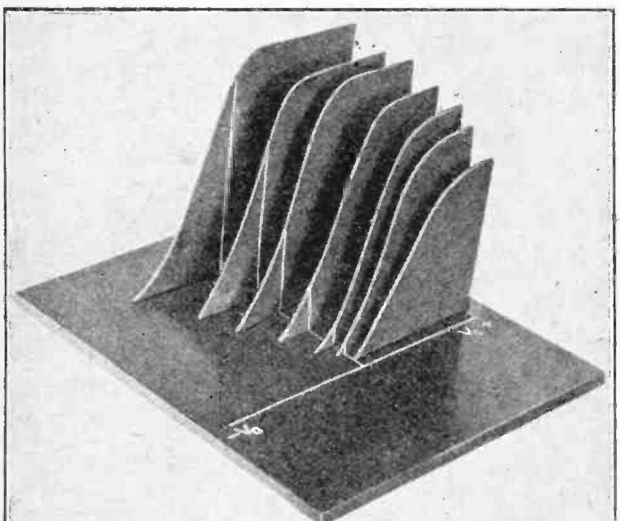


Fig. 4.—Model showing the development of a characteristic surface from the grid volt–anode current curves of Fig. 1.

Rectification by means of the curvature of the characteristic is usually carried out on the bend uniting the zero anode current plane to the working plane, and the sharper the junction between these planes the greater will be the change in mean anode current through the recording device.

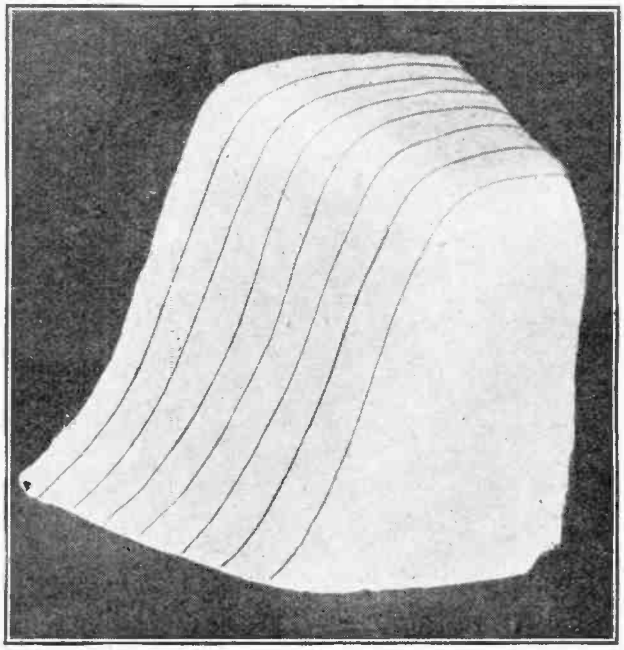


Fig. 5.—Plaster of Paris model of the characteristic surface of a Mullard "ORA" valve.

C.—*The saturation area.*

When the anode becomes so strongly positive that all the electrons emitted from the filament are attracted to it no further increase of anode potential can possibly increase the filament-anode flow of electrons. In other words, the saturation current corresponding to that particular filament temperature has been reached. Note that the greater the negative potential on the grid the greater is the value of anode voltage necessary to secure saturation.

The working plane is joined to the saturation area by means of a curved surface similar to that joining it to the zero anode current plane.

If desired, this top curve may be used for rectification in a similar manner to that of the bottom curved surface. In rectification the anode potential remains sensibly constant and the use of a characteristic surface is quite unnecessary, since all the working is concerned solely with one plane of the characteristic.

It is now proposed to discuss very briefly the characteristic surface with reference to amplifying and oscillating triodes.

Triode Used as an Amplifier.

It is fairly obvious that, provided the working surface is plane and no grid current is allowed to flow, we shall get undistorted wave shape amplification.

Valve Characteristic Surfaces.—

Grid current flows, in general, when the grid becomes positive, and hence we can rope off the surface to the right of the zero grid volts axis as "taboo" for undistorted amplification.

It is now only necessary to fix our static points within the plane working surface so that the application of the signal does not cause the characteristic point to wander round the top and bottom curved surfaces, i.e., we must limit our anode current range, which, in turn, is governed by the grid voltage swing.

The initial static point is fixed by the steady grid bias and anode voltage. The effect of grid bias is here seen to be in getting the static point away from the forbidden grid current area. Excess of negative bias is, however, as bad as the lack of it, for in that case the static point will have to shift lower down the working plane, and hence distortion will ensue due to the signal sweeping down the lower bend.

With resistance capacity amplifiers the working trace will fall away from the characteristic curves for the particular anode battery voltage, since as I_a increases so does the drop on the anode resistance increase, and hence the effective anode voltage will decrease. The representative point will thus gradually shift to lower anode characteristics as the anode current increases.

Fig. 6.—Model showing the areas into which the characteristic surface may be subdivided. A=zero anode current plane; B=useful working surface; C=saturation area.

Triode Used as an Oscillator.

With an oscillating triode somewhat similar conditions prevail. As the oscillation passes through each cycle so the effective anode voltage varies due to the drop on the inductance of the oscillatory circuit. Hence we should expect to get a working trace similar to that for a resistance coupled amplifier. This would be the case if the oscillatory circuit had no resistance. Any resistance in the main oscillating circuit, however, introduces into the anode current a small out-of-phase component, and the anode current is then not quite in phase with the anode volts. This makes the representative point describe an ellipse on the characteristic surface similar to that indicated in the photograph.

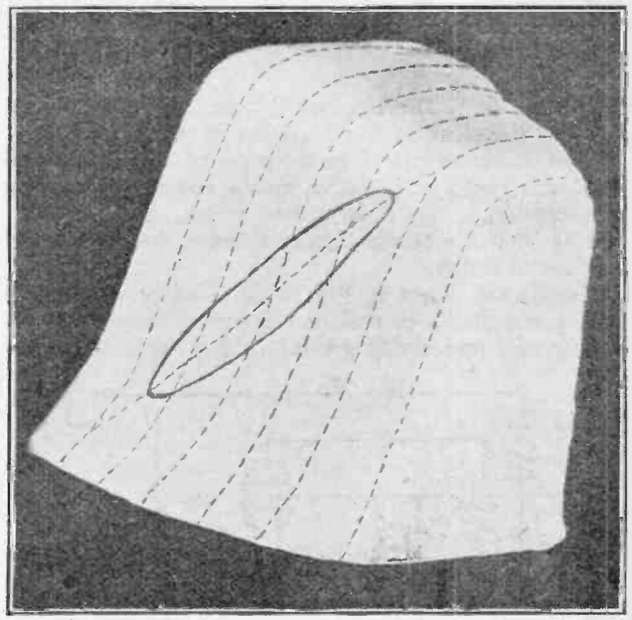


Fig. 7.—Characteristic ellipse of a valve oscillator.

Adjusting Grid and Anode Voltages.

Let us assume that the static potentials of grid and anode are such that the representative point is in the centre of the working plane. Any small disturbance will then set up oscillations which will increase in amplitude until the point moves off the plane part.

This limiting action can occur in three ways :—

1. By the elliptical trace going into the saturation area.
2. By the ellipse reaching down to the zero anode current plane.
3. By the ellipse cutting into the "small anode potential" surface (at the front of the model).

To get as large an oscillatory current as possible it is therefore evident that we should have the static potentials adjusted so that the anode before oscillation is half that at the saturation plane; the grid must therefore have a fairly large negative bias. The avoidance of grid current is not usually very important.

These simple observations may easily be extended, but sufficient has probably been said to indicate a possible alternative to the usual characteristic plane curves, and one which, for certain conditions, may be better.

I should like to express my thanks to Mr. C. D. Butler, B.Sc., A.C.G.I., for his invaluable help in making the models.

SENSITIVE VALVE RELAY.

By G. G. BLAKE, M.I.E.E., A.Inst.P.

IN 1921 J. J. Dowling, of Dublin University, showed that the effect of a steady current passing through a galvanometer placed in the plate circuit of a thermionic valve could be cancelled out by connecting a second circuit through the same galvanometer, and passing a current from a separate battery through the latter in the opposite direction.

The circuit shown in Fig. 1 is an adaptation of this idea, but contains several new features, simplifying the arrangement and giving greater facility for easy control.

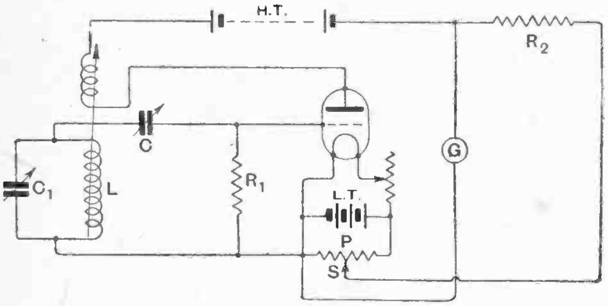


Fig. 1—Method of utilising the L.T. battery to balance out the D.C. component of the anode current in the galvanometer G

Instead of employing a separate battery in the shunt circuit to oppose the plate circuit current through the galvanometer, a potentiometer P is fitted across the L.T. battery. By careful adjustment of the slider S, the current fed through resistance R_2 to the galvanometer G in one direction can be approximately balanced against the plate current passing through the galvanometer in the opposite direction, so that only a very small galvanometer reading is obtained. After this approximate adjustment has been made, the galvanometer reading can be brought to absolute zero by fine adjustment of the variable grid condenser C.

This circuit, no doubt, has many possible applications, both for wireless and other electrical purposes. Once the galvanometer is set at zero with the valve oscillating, the slightest variation in the capacity of the tuning condenser C_1, or the inductance L, will displace the galvanometer needle several divisions. Again, if a variable grid leak be employed instead of the fixed grid leak R_1, the slightest variation in its value will be recorded by galvanometer movements.

Useful Applications.

The author has made use of this circuit for the two following purposes :—

(1) To operate a relay by means of a beam of light by replacing the grid leak by a light sensitive selenium cell, connected to a tapping on the H.T. battery instead of to the negative side of the L.T. battery as shown, and by replacing the galvanometer by a sensitive relay. The latter was successfully operated by means of the unfocussed light from a 32 c.p. lamp about 30 yards distant.

(2) To operate a relay in order to record Morse signals of only moderate strength received by means of a single detector valve.

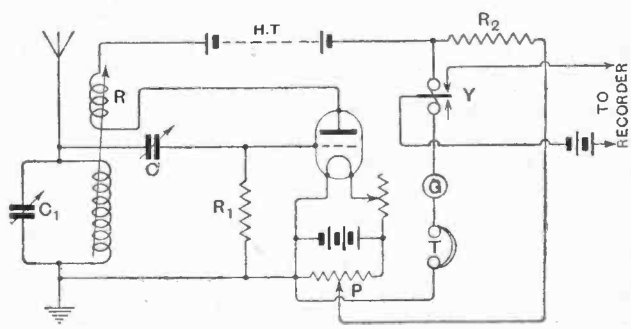


Fig. 2.—Relay circuit developed from Fig. 1.

Fig. 2 is a diagram showing the connections employed. The galvanometer circuit, as will be seen, includes telephones T and relay Y. The station to be recorded is first tuned in by ear. The galvanometer G is then roughly adjusted to zero, and then carefully set by critical adjustment of condenser C. If the signals are strong both the telephones and galvanometer can be left in circuit. When it is desired to record weak signals, the two latter instruments can be removed, and the critical adjustment of the relay again finally set by further adjustment of condenser C.

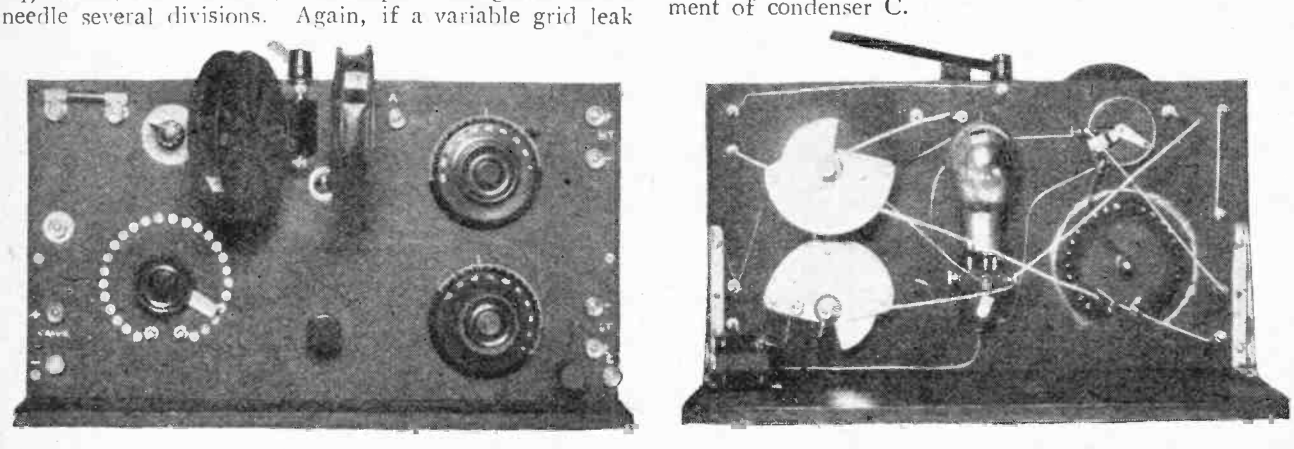
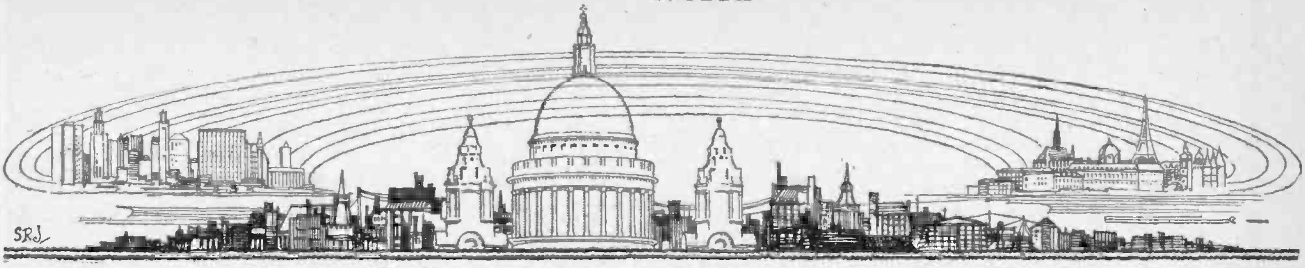


Fig. 3.—Front and rear views of the relay unit in practical form.



CURRENT TOPICS

Events of the Week in Brief Review.

AIR PORT WIRELESS.

Plans have been drawn up for the general reorganisation of wireless facilities at Croydon Aerodrome.

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THE AWAKENING.

Mrs. Bowyer, of Blackfriars, was fined 1s. with 40s. costs at the Tower Bridge Police Court last week for damaging a wireless set owned by a fellow resident. Mrs. Bowyer explained that the noise from the loud-speaker interrupted her sleep on Sunday afternoon.

oooo

MARCONI CONTRACT IN BOLIVIA.

A contract has been signed between the Government of Bolivia and Marconi's Wireless Telegraph Co., Ltd., whereby the company will, as from October 1st, 1926, control and operate for a period of 25 years the postal, telegraph and wireless in that country.

oooo

NEW AIR ROUTE.

Work is proceeding with the installation of wireless stations on the main stages of the projected Imperial Airways route between Egypt and India, according to the annual report on the progress of civil aviation during the past year. The wireless and meteorological organisation is being established with the aid of the Royal Air Force.

oooo

A WORLD BEATER.

Surely the most enthusiastic wireless amateur in the world must be Mr. Eppa W. Darne (3BWT), of Washington, D.C., who proudly declares that he has not missed transmitting for a single night during the last five years. Mr. Darne has communicated with amateurs in North and South America, Europe, Africa, South Africa, Australia, New Zealand and Asia.

oooo

UP-TO-DATE HOLLAND.

The coming autumn promises a record number of wireless exhibitions, not only in Europe but in America. From Holland comes the news that the third annual Dutch Radio Exhibition, promoted by *Radio Wereld*, will be held from October 2nd to 11th with the co-operation of the National Association of Radio Traders and Manufacturers, in the People's Palace, Amsterdam

ANOTHER TELEVISION DEVELOPMENT?

Remarkable developments in television are foreshadowed by the news of experiments now being conducted at the Radium Institute, at Malmaison, near Paris, by M. Belin and M. Holweck.

It is claimed that apparatus will be produced whereby a person at a wireless receiver will be enabled to see the features of the speaker on a screen.

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PROGRESS IN CANADA.

The figures published by the Dominion Bureau of Statistics show a satisfactory progress of the radio industry in Canada during 1925. The number of licences issued was 134,486 as compared with 91,996 in 1924, and it is estimated that one person in every 42 has a receiving licence in the Province of Manitoba, one in every 49 in Ontario, and one in every 112 in Quebec. The value of the wireless apparatus manufactured in 1925 exceeded $5\frac{1}{2}$ million dollars as compared with a little over 3 million dollars in the preceding year.

HAVE YOU HEARD PORSGRUND?

The Norwegian broadcasting station at Porsgrund, which operates on 434 metres, has increased its power from 0.2 to 1 kilowatt.

oooo

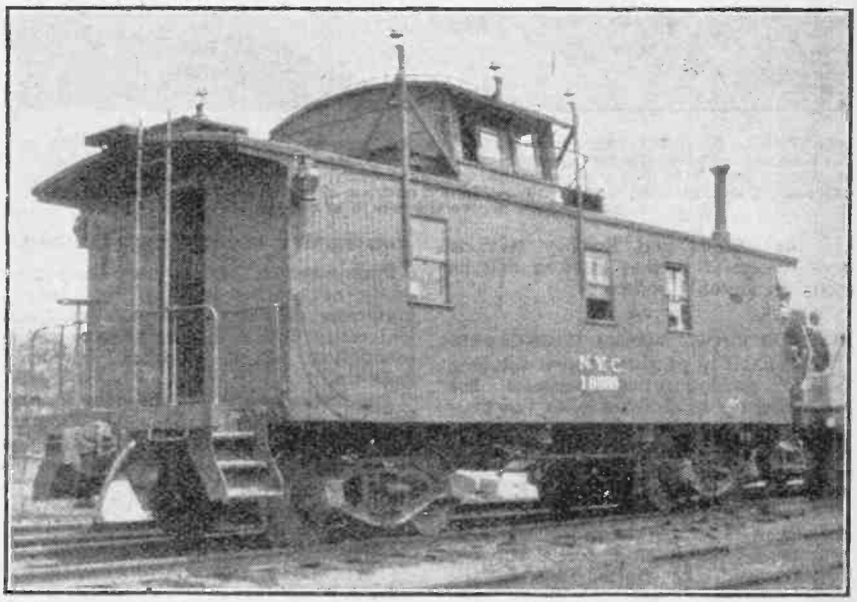
PHYSICAL JERKS BY RADIO.

A campaign has been initiated by *The Daily News* urging the B.B.C. to broadcast health exercises between seven and eight o'clock every morning. Listeners using headphones are advised to lengthen the leads.

oooo

AMATEURS ALL THE WORLD OVER.

There are now more than fifty countries in the world where amateur transmitters are actively engaged in two-way international communication, and the number is increasing almost daily. The problem of finding nationality indicating prefixes to their call signs is becoming rather bewildering. The letters Y and R are each used by two different countries, while Portugal and Madeira share the letter P.



WIRELESS ON AMERICAN FREIGHT TRAINS. Successful experiments have been conducted on the New York Central Railway in securing radio communication between guard and driver on a freight train over a mile long. The telephony sets contained in the engine and guard's van each consisted of a 50-watt oscillator, 50-watt modulator and $7\frac{1}{2}$-watt speech simplifier, a wavelength of 115 metres being employed. The photograph shows the guard's van with its special antenna system.

A BRITON IN BORNEO.

Early last week Mr. J. A. Partridge (2KF), of Wimbledon, succeeded in communicating by C.W. with Mr. Grey, an Englishman operating the Kuching station SK2 in Borneo. Mr. Grey stated that he had been attempting to get in touch with England for six weeks without success. Unfortunately transmission was spoilt after half an hour by jamming from two Brazilian stations.

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INDIAN BROADCASTING.

The erection of powerful broadcasting stations in Bengal and Bombay is the first aim of the new Indian Broadcasting Company, Ltd., the prospectus of which has just been issued. Of the authorised capital of fifteen lakhs of rupees (about £112,000), 62,500 are being issued now, 60,000 to the public and 2,500 reserved for wireless apparatus importers who are members of the company.

If the Bengal and Bombay stations prove successful further stations will be erected at suitable points.

oooo

AMATEUR SHORT WAVES VINDICATED.

The reliability of short waves for long distance communication purposes has been definitely established with the completion of a series of tests between American and Australian amateurs, according to a statement issued by the Wireless Institute of Australia.

Commenting on the regularity and accuracy with which 500-word messages were passed back and forth between Australia and the United States, the Australian report says: "These tests have definitely proved that amateurs can handle bulk traffic with absolute accuracy across the Pacific, a fact that has not until now been admitted by other than amateur wireless interests."

WHEN BIG BEN ERRS.

The Astronomer Royal has issued an interesting statement regarding the accuracy of the famous Westminster clock during the past year. On 95 occasions the error of the return signal at Greenwich Observatory was not greater than one-fifth of one second; on 98 occasions it was between 0.3 and 0.5 seconds; on 81 occasions it was between 0.6 and 1 second. It was greater than one second on 29 occasions, but never exceeded 2 seconds on any of the 306 days on which signals were received.

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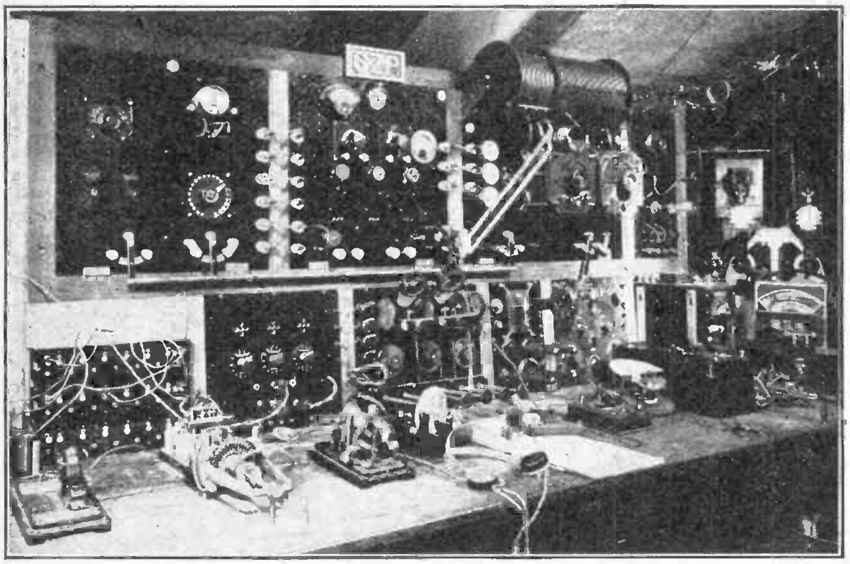
NEW B.B.C. APPOINTMENT.

We learn of the recent appointment of Mr. Ralph Judson, formerly Publicity Manager of the Radio Communication Company, to the staff of the B.B.C. as assistant to Mr. G. V. Rice on *The Radio Times*.



AMATEUR TRANSMITTING STATION 6 ZP, operated by Mr. George Pailin, at Manchester. The equipment is sectioned into a number of panels, including modulator, oscillator and drive oscillator, transmitting wavemeter, and various receiving sets. An interesting change-over switch, consisting of a number of levers linked together by a bar, can be seen across the centre of the set.

UNIVERSITY COURSE BY WIRELESS.

Paris listeners are to have the opportunity of hearing lectures by eminent professors at the Sorbonne, the Paris University Council having sanctioned the foundation of a wireless telephony institute.

The institute will be opened in November, and a proposal is made that listeners should be entitled to sit for examinations on the subjects dealt with, certificates being awarded in the same way as to university students.

oooo

WIRELESS AND A HURRICANE.

Soon after the hurricane which swept Nassau (Bahamas) a few days ago, damaging houses and wrecking ships, wireless communication was established, enabling the islands to keep in touch with the outside world.

THE STATUS OF THE WIRELESS OPERATOR.

The legal position of the wireless operator on board ship was made clear by a decision reached last week by the Industrial Court.

According to this decision, the time necessary for the overhaul, repair, and (or) renewals of the installation and wireless clerical work which cannot be accomplished at sea shall be the first call upon the time of the operator while in port, and he shall not be employed on cargo and (or) clerical duties where interference is caused to the wireless service.

A new schedule of monthly rates of pay has been issued ranging from £19 per month on large Class I vessels to £7 per month on vessels of Class III.

WIRELESS AT WESTMINSTER.

(By Our Special Correspondent.)

THE NOISY LOUD-SPEAKER.

In the House of Commons last week Mr. Day asked the Home Secretary if he would suggest to local authorities the advisability of bye-laws being adopted with a view to the nuisance occasioned by the use of loud-speakers in gardens or open spaces being abated. Sir William Joynson-Hicks said it would not be proper for him to intervene in a matter of that kind. It was for the local authority to consider whether a substantial nuisance existed in their district which would be dealt with by bye-law.

oooo

INTERFERENCE ON SOUTH COAST.

Mr. Day asked the Postmaster-General if his attention had been drawn to the interference occasioned on the South Coast to wireless reception owing to the operation of Morse signalling from the Newhaven station; and whether he would cause the wavelengths of the Newhaven and Dieppe stations to be raised to 800 metres in order to avoid such interference.

Sir W. Mitchell-Thomson said that traffic was already exchanged between these stations on the 800 metres wave, although the 300 metres wave was used for obtaining the attention of the Dieppe station, which kept watch on that wavelength only.

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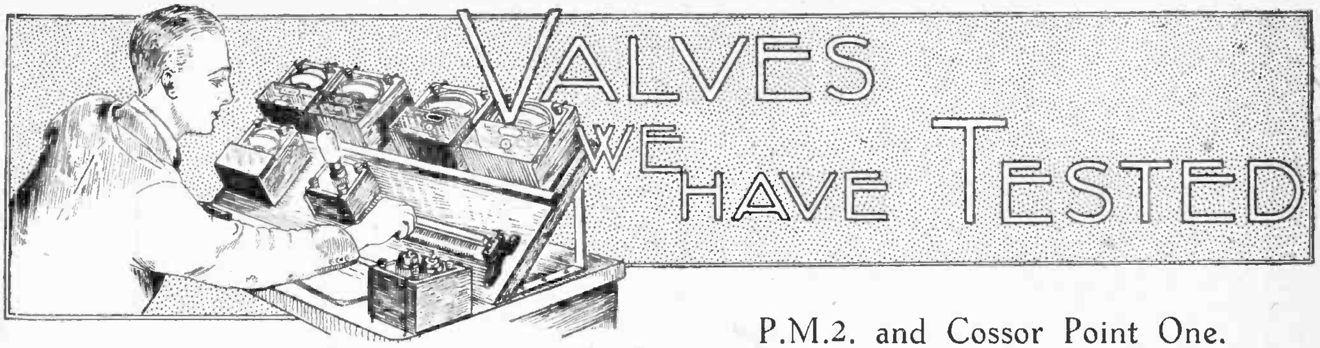
JAMMING FROM SHIPS' SPARK SETS.

Mr. Day then asked the Postmaster-General if he was aware of the annoyance experienced by wireless listeners in coastal districts owing to the use of spark transmitters by ships; and whether any action would be taken with a view to abating this form of annoyance.

The Postmaster-General said he was aware that wireless communication between ships and shore did at times interfere with broadcast reception, especially when unselective receiving apparatus was used. The abolition of spark transmission from ships would require international agreement, and he hoped that it might be possible to achieve this when financial conditions at home and abroad in the shipping industry improved. Meanwhile, however, improvement could be effected by making receiving apparatus more selective.

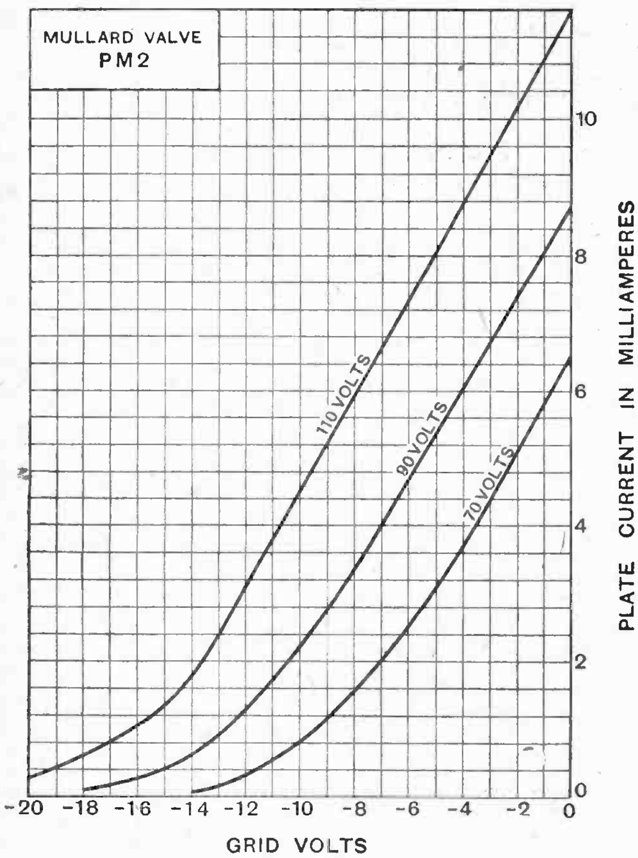


P.M.2. and Cossor Point One.

Mullard 2-volt P.M. Power Valve.

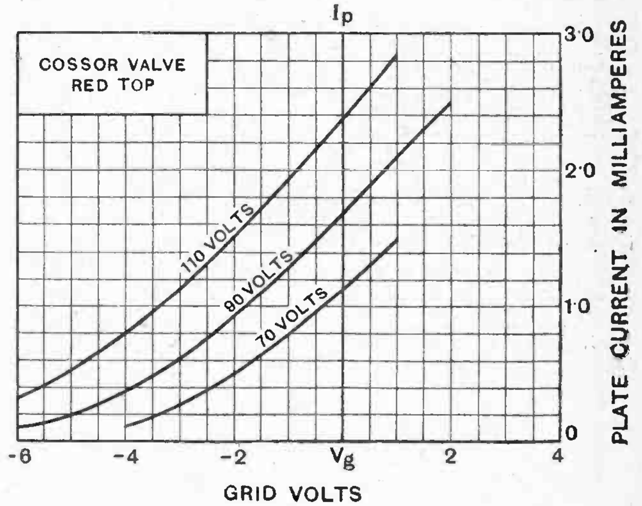
INCLUDED in the "P.M." series of valves manufactured by the Mullard Radio Valve Co. is a 2-volt power valve. Valves in this series differ in their construction from the more usual type in that the flattened cylindrical anode is set up horizontally, while the filament traverses between the grid as two loops in a horizontal plane. The series includes valves for all receiving requirements and working with various filament voltages, though a feature of all P.M. type valves is the use of the oxide-coated filament.

As a power valve for loud-speaker operation, as well as for use in a first stage low-frequency amplifier, the P.M.2 is well suited. It gives a mean amplification of about 5.5 with an impedance of 7,700 ohms. At a plate potential of 90 volts the negative bias should be about 4.5 volts, and the straight part of the characteristic curve provides for ample voltage swing. The valve can be recommended for use in a two-stage L.F. amplifier fitted preferably with transformers having a step-up ratio of 2 or perhaps 3 to 1. The makers specify normal working H.T. potentials of between 50 and 100, the filament voltage is from 1.4 to 1.8, and the filament current was found to be 0.15 amp. at 1.8 volt, showing that the valve is exceedingly economical to run, while the filament is quite robust. No glow is visible when the valve is in use.



MULLARD P.M.2.

Mean amplification factor μ	...	5.45.
Mean working slope	...	0.705 mA. per grid volt.
Mean differential resistance R_o	...	7,700 ohms.
Filament current	...	0.15 amp. at 1.8 volt.



COSSOR POINT ONE (RED TOP).

Mean amplification factor μ	...	12.5.
Mean working slope	...	0.42 mA. per grid volt.
Mean differential resistance R_o	...	30,000 ohms.
Filament current	...	0.1 amp. at 1.8 volt.

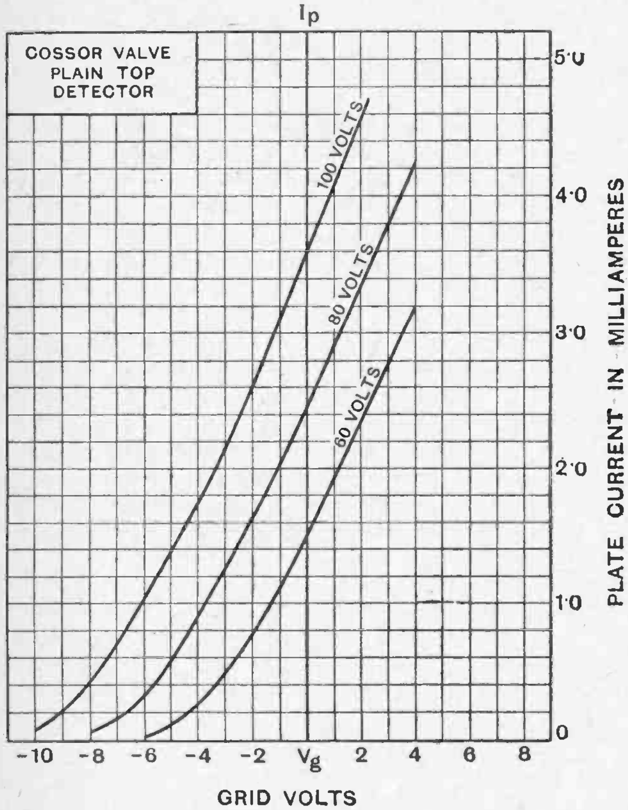
Cossor "Point One" H.F. and Detector Valves.

The recent development in the design of Cossor valves is of importance. Several changes have been made from time to time in the method adopted for supporting the electrodes, and undoubtedly the hooded plate form of construction presents difficulties as regards manufacture, and also as to obtaining rigid and robust mounting.

It is evident at first sight that in the three valves in the

Valves we have Tested.—

new series classified as the "Point One Group" are embodied certain interesting modifications. The method of supporting the filament, always a difficult matter, makes use of a small insulating collect clamped into the top of the hooded plate, to which the centre of the filament is hooked by means of a small wire loop. The supporting wire is coiled at one end after passing through the top of the insulator, so as to produce the necessary tension on the filament loop to allow for expansion and contraction.



Cossor Point One (Plain Top).

Mean amplification factor μ ...	8.7.
Mean working slope	0.43 mA. per grid volt.
Mean differential resistance R_a ...	20,200 ohms.
Filament current	0.1 amp. at 1.8 volt.

The grid is wire wound in the usual manner, every turn being spot welded to a wire support, and the plate, which in the earlier Cossor valves more resembled half a sphere, may be regarded as a flattened cylinder similar to that used in many other makes of valve but closed over at one end, a feature in design which is probably beneficial.

The glass work and the setting up of the supporting wires in the glass pinch is excellently carried out. The glass bulbs are now pipless and of attractive shape. The base is cleanly moulded, and a gap is arranged between the four pins to reduce leakage and capacities.

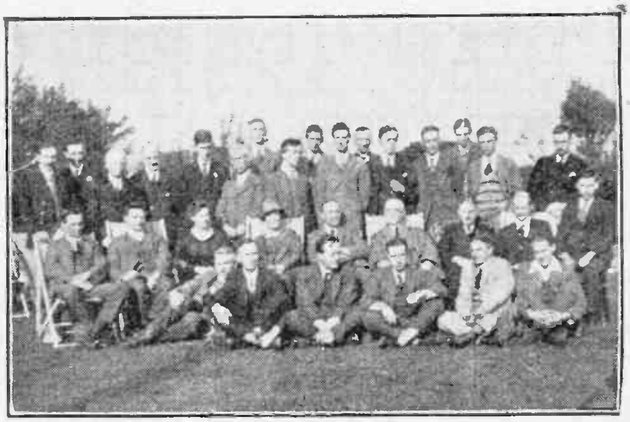
The new filament operates on an extremely low filament voltage, and at a potential of 1.5 volts passes a current of only 0.1 amp. Thus a 2-volt accumulator or two dry cells are suitable for filament heating, connected through the standard rheostat of 5 to 8 ohms. After the filament has reached a certain initial temperature, no increase in signal strength is obtainable by raising the adjustment of filament current to exceed the normal.

The results of tests applied to the H.F. and detector valves of this series (the red top and the plain top) are given in the accompanying curves and tables, in which the main working slope refers to the change of plate current obtained over the working range by a change of

Valves of the new Cossor "Point One" class. The H.F. valve (red top) and Detector valve (plain top).

one volt on the grid. Mean differential resistance, sometimes called internal impedance, is measured at the centre of the useful part of the characteristic; thus, for valves which are used as H.F. amplifiers or detectors, this resistance value is determined with the grid volts at zero and for the maximum plate voltage used. Characteristics for valves which are essentially intended for L.F. amplifiers are only given for negative values of grid volts, as these are the only useful values, since grid current must be eliminated for obtaining distortionless amplification.

MAKING THE MOST OF SUMMER.



Members of the Sheffield and District Wireless Society photographed on the lawn at "Woodville," Hope, the residence of the Secretary, after a successful but strenuous field day. "The cup that cheers" formed a fitting conclusion to the afternoon's activities

PRACTICAL DIRECTION-FINDING.

The Construction and Calibration of an Accurate Direction-finder for Amateur Use.

By R. L. SMITH ROSE, Ph.D., M.Sc., A.M.I.E.E., and R. H. BARFIELD, M.Sc., A.C.G.I.

IT is well known that at the present time there are several systems by which wireless transmissions can be used for the determination of the directions and positions of fixed points. Of these systems, one class employs a direction-finding receiver for the determination of the direction of arrival of wireless waves from any given transmitting station. Three types of this direction-finder are now made commercially for use either on land or on board ship, and they are being employed to a continually increasing extent for navigation purposes.

It is not generally realised, however, that a simple frame-coil direction-finder, having as great an accuracy as those manufactured commercially, can easily be constructed by the average experimenter at comparatively small cost, and in such a manner as not to occupy a great deal of space. The addition of such a direction-finder to the experimenter's wireless equipment has several advantages. In the first place, by enabling the direction of arrival of incoming signals to be determined, it greatly assists in the identification of the transmissions from distant and unknown stations. Secondly, a directional frame coil receiver is frequently invaluable in ordinary reception work, on account of the possibility it provides of cutting out unwanted or interfering signals. Lastly, the possession of a direction-finder opens up a large field of research in the study of the strange phenomena of wandering bearings and "night effect," which can be observed with such an instrument. In this connection the direction-finder forms a powerful means of attacking the problem of the propagation of wireless waves over the earth's surface, to which so much of modern scientific research is being devoted.

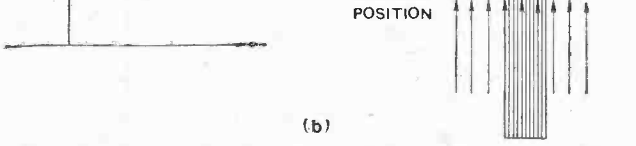
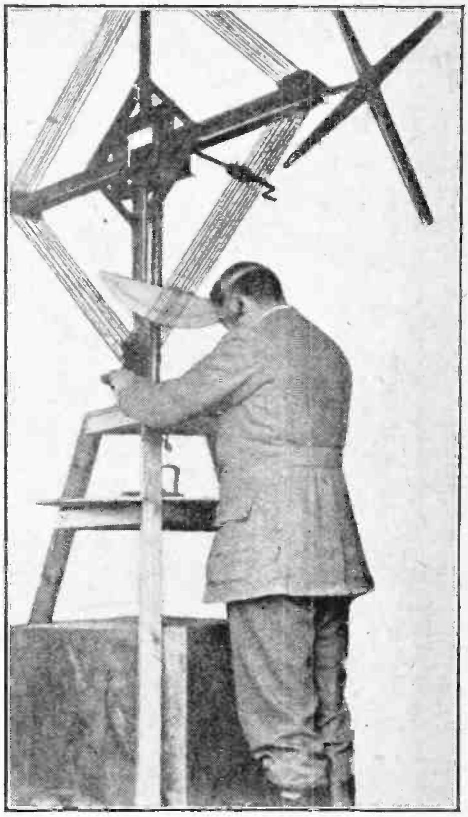


Fig. 1.—Diagram showing relation between the direction of a frame coil and the magnetic field of an arriving wave in the maximum and minimum signal positions.



The complete direction-finder in operation.

In the present article, therefore, it is proposed to give an account of the principles and details of construction of an accurate direction-finder, which can be operated on the broadcasting band of wavelengths and which can be constructed at comparatively small cost.

Principle of the Single Frame Coil Direction-finder.

Although the theory of operation of the simple direction-finder of the single-coil type is now well known, a very brief account of it is given here for the benefit of those who approach the subject for the first time. If a vertical plane loop or coil of wire be used for the reception of wireless signals, the E.M.F. induced in the coil is proportional to the amount of magnetic flux of the arriving waves linking the coil. Now, in a wireless wave travelling over the earth's surface, the magnetic force is horizontal and at right angles to the direction of travel. Consequently, as may be seen from the plan view of the frame coil given in Fig. 1 (a), the coil will have the greatest number of lines of magnetic force passing through it when it is placed with its plane pointing towards the distant transmitter. In this position, therefore, the signal E.M.F. induced in the coil will be a maximum. If the coil is now rotated about a vertical axis, the number of lines of magnetic force linking the coil, and so the E.M.F. induced therein, will decrease, until when the plane of the coil is at right angles to the direction of arrival of the waves, as in Fig. 1 (b), no signal E.M.F. will be received by the coil. On consideration of the matter it is easy to see that for any position of the coil, the strength of the received signals

Practical Direction-finding.—

is proportional to the cosine of the angle between the plane of the coil and the direction of the transmitting station. From this cosine law it can be deduced that the rate of change of signal strength, upon which the accuracy for determining direction depends, is greatest when the coil is in the zero signal position. Hence in the use of such a closed coil receiver as a direction-finder, the coil is simply rotated until the signals vanish, when it is known that the direction of the transmitter is perpendicular to the plane of the coil. With weak signals or an insensitive receiver, the signals may disappear for a rotation of the coil through several degrees. In this case the coil is slowly rotated in each direction in turn until the signals just become audible, and the mid-point of the arc so determined will then indicate the direction of arrival of the incoming waves.

When it comes to applying the above theoretical principles to practice some very serious difficulties are encountered, particularly on wavelengths below about 1,000 metres. It is well known that a frame coil is relatively inefficient compared to an open aerial for reception purposes, and it is consequently necessary to employ an extremely sensitive amplifier with a coil, if any appreciable reception range is to be obtained. As a result of the use of such an amplifier, various stray E.M.F.s are picked up on different parts of the receiving system, so that unless very special precautions are taken a large amount of signal is frequently received even when the coil is set in its minimum or zero position. This signal is partly due to direct pick-up from the waves by leads, tuned coils, or other circuits forming part of the receiver and amplifier, but frequently a large portion of it is due to the coil acting as a vertical open antenna. Fortunately, it is possible to arrange screens around the coil and its receiver in such a manner as to eliminate these spurious effects without appreciably altering the pick-up of the coil from the magnetic field of the waves. Many of the constructional details of the apparatus about to be described are concerned with the correct arrangement of the screens, which it will now be appreciated play an important part in the operation of the direction-finder. For the purpose of description, the complete instrument is conveniently divided into two parts: the frame coil with its screen for the elimination of the antenna effect, and the receiver, comprising the tuning circuits, amplifier, and batteries, all contained within a screened box to avoid the direct pick-up effect already mentioned.

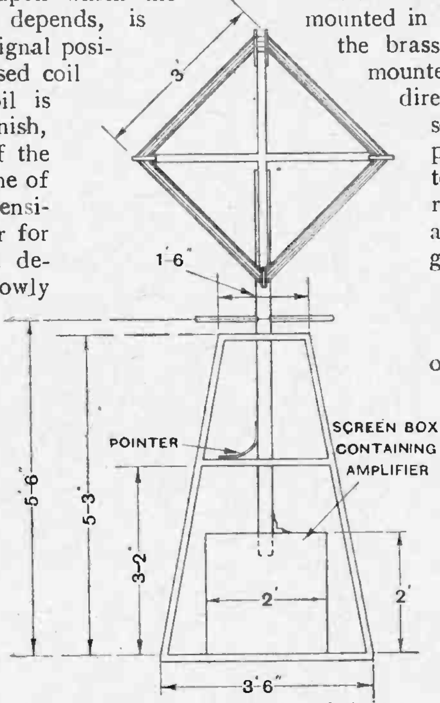


Fig. 2.—General arrangement of the complete direction-finder.

General Arrangement of Apparatus.

The general arrangement of the complete apparatus is shown in the photograph in the title of this article, which also shows the rotating coil being operated for the taking of a wireless bearing.

The receiving coil is square, being wound on a wooden X-shaped frame with one of its diagonals vertical. This is clamped to the vertical axis, consisting of a brass tube 1½in. in diameter, through which pass the leads from the coil to the receiving apparatus. This axis is carried in two sets of ball bearings which are mounted in a tripod stand. A pointer attached to the brass axis moves over a graduated scale mounted on a platform on the tripod, and the direction of the coil can be read from this scale. The lower part of the brass tube passes through a clearance hole in the top of the screened box containing the remainder of the receiving apparatus, and the tube and box are connected together by a short length of flexible wire.

Frame Coil and Screen.

Details of the coil construction and of the screen surrounding it can be seen from the diagrams forming Fig. 3. From Fig. 3 (a) it is seen that an ebonite plate is attached to the end of the arm of the wooden framework, this plate being drilled to carry the wires forming the turns of the coil and the surrounding screen. The top arm carries two of these ebonite plates, as shown in Fig. 3 (b), and the remaining arms one each as in Fig. 3 (c). The receiving coil consists of six turns of No. 20 S.W.G. bare hard-drawn copper wire, which are passed through the six holes in the centre of the plates. Surrounding this coil and supported in the outer ring of holes in the ebonite plates are the wires forming the screen. These wires are twelve in number, with a spacing of ⅛in., and each consists of a single-turn loop, electrically interrupted by a small gap at the top of the coil, Figs. 3 (b) and (c).

An important detail in a set of this kind is the method

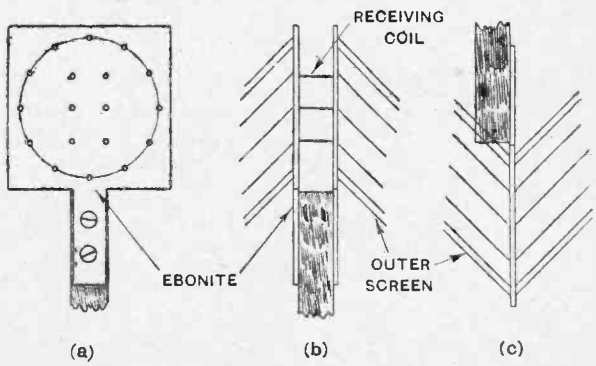


Fig. 3.—Ebonite spacing plates for receiving coil and screen.

of carrying the leads from the coil to the tuning components. The method adopted in the present case is shown in Fig. 4. The wires of the screen are all connected together at the bottom corner of the coil, and the junction is connected by several wires to the brass tube which forms the axis of the set. The leads from the coil terminals are then taken through into the interior of the

Practical Direction-finding.—

pipe in such a way that the short, exposed portion is partially surrounded by these screen connecting wires. Inside the tube the bare wire leads are kept away from each other and from the tube walls by placing them under tension between ebonite discs, as shown in Fig. 4. By this means the effective shunt capacity between the leads is reduced to a minimum.

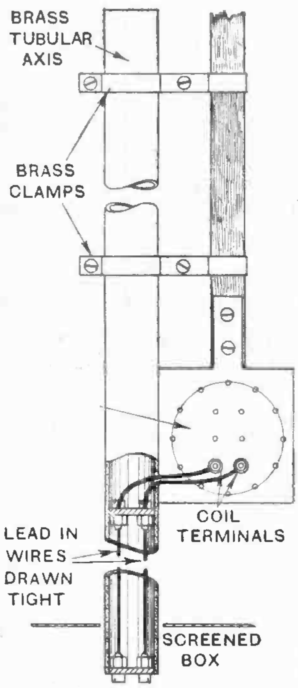


Fig. 4.—Method of mounting frame coil, showing arrangement for taking leads inside screening tube to amplifier.

In the construction described above it will be observed that the whole of the receiving apparatus and its connecting leads are enclosed by a vertical metallic screen, so that it is impossible for the electric field of the wireless waves to act upon the system.[1] At the same time, however, owing to the fact that no part of the wire screen forms a closed circuit, the receiving properties of the coil, which depend upon the magnetic field of the waves, are in no way impaired.

The whole of the apparatus for tuning and amplifying the incoming signals is contained in the screened box at the base of the tripod which carries the coil. The vertical brass tube containing the leads from the coil passes through a hole of slightly larger diameter in the top of the box and projects a few inches within it. Flexible leads are taken from the pair of terminals at the end of the tube to the primary tuning circuit. The screening box itself is a cube with a side of two feet, and is provided with a well-fitting lid at the front.[2] The box and lid are both double-lined with tinned iron sheet, and all joints are very carefully lapped and soldered to make good electrical contact. The lid is provided with brass springs round the inside edge to make good contact with the box, and only two small holes (⅜in. dia.) are drilled in the lid for the purpose of bringing out the control handles for the receiver. A view of the screened box with the lid on and in position at the base of the tripod supporting the direction-finder is shown in Fig. 5; while Fig. 6 is a photograph of the box with the lid removed, showing the tuner and amplifier within. It is probable that for ordinary use a single lining of tinned sheet iron would be adequate for the construction of this screening box, but in the case of the direction-finder which is actually being described, extreme precision was necessary, and the precaution of a double lining was justifiable.

Receiver Circuit.

The circuit employed with this direction-finder is given in Fig. 7, which is drawn in a schematic manner to show the general layout of the apparatus and the positions of the screens, etc. A coupled-circuit tuner is employed, so that the primary frame circuit is completed by a tuning condenser and a suitable coil, which is coupled to a secondary coil tuned by a second condenser. A supersonic heterodyne receiver, with 6 to 8 valves, is suitable for this apparatus, provided that it is well designed, and, while being sensitive to incoming signals, does not give a background of "mush." In the photograph in Fig. 7 the top shelf contains a combined tuner and first oscillator panel, while the intermediate and audio-frequency amplifier, with the requisite detector valves, are in the lower half of the box. Some of the commercial forms of supersonic receiver are also suitable for use with this direction-finder when they are provided with the necessary coupling coils and a primary variable condenser.

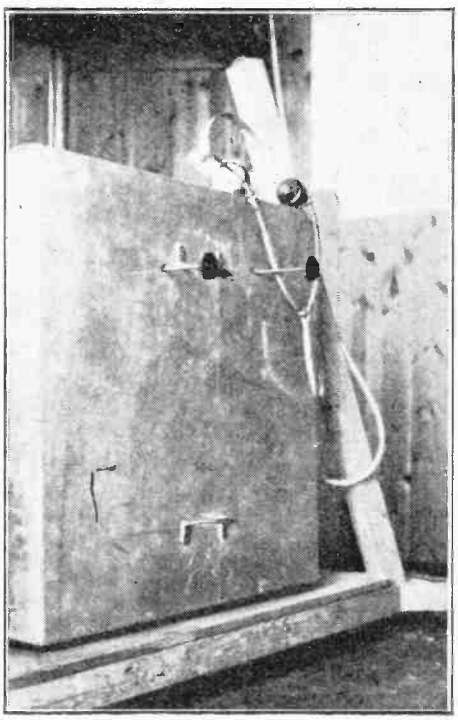


Fig. 5.—Exterior of screened box, showing extension handles for tuning controls.

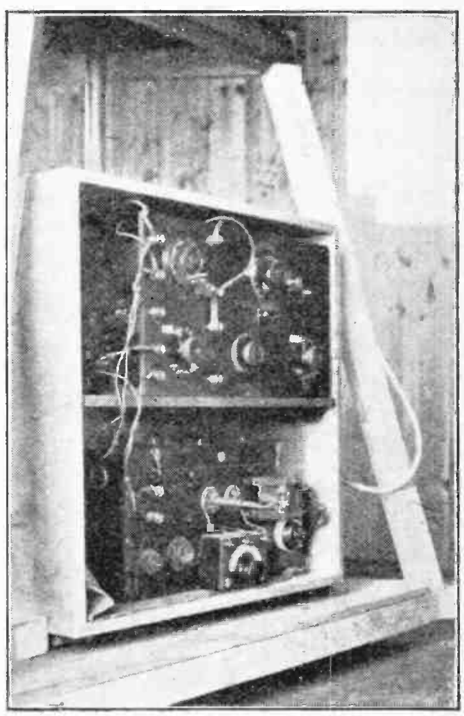


Fig. 6.—Interior of screened receiver.

[1] For an explanation of the behaviour of electric and magnetic screens, see *The Wireless World*, January 13th, 1926, page 61.

[2] This screening box is of the type described and illustrated on page 699 of *The Wireless World* for November 18th, 1925.

Practical Direction-finding.—

The normal tuning condenser on the receiver is then used to tune the secondary coil instead of directly tuning the frame. All batteries for the amplifier are contained within, and at the back of the box. Incidentally, it may be pointed out that, apart from its necessity in a direction-finder, the complete screening of the intermediate-frequency amplifier eliminates any long-wave interference due to direct pick-up on the intervalve transformers; while the use of a coupled circuit between the frame and receiver considerably reduces the effect of the E.M.F. injected directly into the frame by powerful transmissions at the intermediate frequency. Users of supersonic heterodyne receivers in which no special precautions are taken to reduce the above effects will appreciate the advantages to be gained by their elimination.

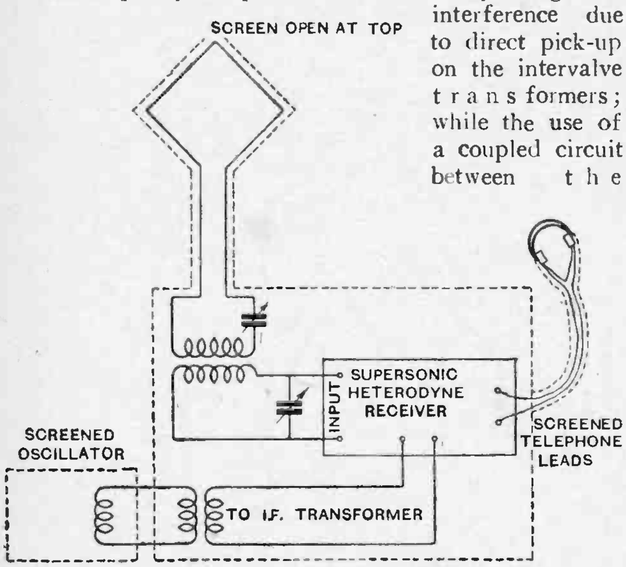


Fig. 7.—Schematic diagram of connections of the complete direction-finder.

From the last stage of the receiver telephone leads are brought out as a twin flexible conductor screened with braided copper wire which is connected to the tin box. This screened lead is carried all the way up to the telephone receivers, where the screen is connected to the headband. By this means the operator himself is connected to the screen and so is prevented from contributing to any direct pick-up effect from the arriving waves.

Local Oscillator.

Such a receiver as the above is quite suitable for interrupted or modulated continuous waves, including telephony. While directions can be determined on telephonic or broadcasting transmissions, they are somewhat unsatisfactory owing to the inherently varying amplitude of the modulation. It is always much better to heterodyne the carrier wave and produce an audible beat note which is utilised for the taking of bearings. Since most broadcasting stations only modulate to about 10 per cent. of the amplitude of the carrier wave, it will be appreciated that a great gain in sensitivity for reception is gained by the use of the carrier wave in this manner. This is very noticeable in practice, for while a bearing observation may be made on the carrier wave with a swing of the coil through the minimum of only about one degree, the actual telephony may be quite inaudible over an arc of 10 degrees. A further advantage of the addition of the heterodyne is, of course, that the direction-finder is immediately available for operation on continuous wave telegraphic transmissions. Now, with the supersonic type of receiver, the heterodyne operation is conveniently carried out at the intermediate frequency, although it can, if desired, be carried out at the original high frequency. The advantage of using the former is that, once the second oscillator required for this purpose has been adjusted to beat with a frequency corresponding to that of the intermediate frequency transformers, no further adjustment is required for any change of the original wavelength. When the second oscillator is run at the original frequency, it must be continually readjusted for each change in tuning of the whole receiver. In the direction-finder under discussion, the second oscillator is operated at the intermediate frequency, and is formed of a separately screened unit connected by a variable coupling to the first stage of the intermediate frequency amplifier, as depicted in Fig. 7.

Calibration.

Having completed the direction-finder, a number of tests should then be carried out to ascertain the accuracy for the taking of bearings and the magnitude of any local errors in the resulting directions due to the immediate surroundings. By means of a good magnetic compass the scale of the direction-finder is first set to read zero when the plane of the coil is pointing east and west; the scale reading of the instrument when in use will then give the apparent direction of the transmitting station or its reciprocal (*i.e.*, ± 180°). In operating the set, both primary and secondary circuits should be carefully tuned and the audible beat note adjusted to a convenient pitch. The coil is then rotated to find the minimum signal position, which under good conditions and with a strong signal should be so sharp that a movement of the coil of from one-half to one degree in either direction causes a marked increase in signal strength. Having observed the scale reading in this position, the coil is rotated through 180°, and the position of the second minimum observed. In the case of the direction-finder described above, the angle between these two minima is never more than one degree different from 180°, and the difference is usually less than one-half degree. Such a test may be

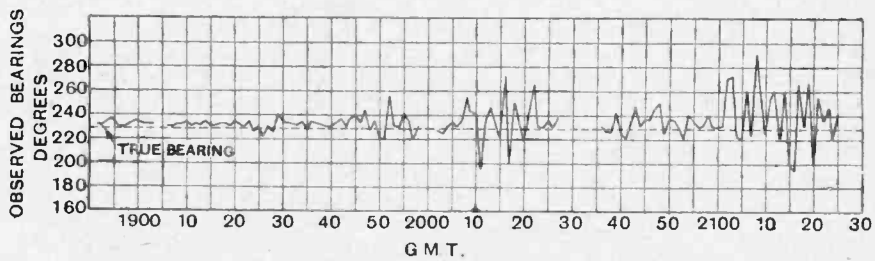


Fig. 8.—Observations of bearings of the Bournemouth station from Teddington during a sunset period.

Practical Direction-finding.—
considered to show satisfactorily that all error-causing E.M.F.s have been successfully eliminated, and that the apparatus is working correctly as a direction-finder. The mean of the two minima, with the appropriate 180° correction, gives the apparent direction of arrival of the waves being received.

The actual direction-finder forming the subject of this article is installed in a wooden hut situated in a field surrounded by trees. To ascertain the effect of the latter on the direction of arrival of wireless waves, observations of the bearings of a number of broadcasting stations were made under stable daylight conditions. In this manner the difference between the true and observed bearing was found for a number of different directions of arrival of waves, this difference being the fixed local error of the direction-finder. In the case under discussion this error varied from −0.7° to +4.4° for the different broadcasting stations. This class of error, however, is not serious, as observation shows that it remains constant over a long period, and when desired the direction-finder can always be recalibrated on the same transmitting stations. The errors can be tabulated or plotted in the form of a graph, and this can be used to apply a correction to the scale reading whenever an observation is made on a transmission from an unknown station. In this manner bearings can be taken to an accuracy of one or two degrees under stable daylight conditions.

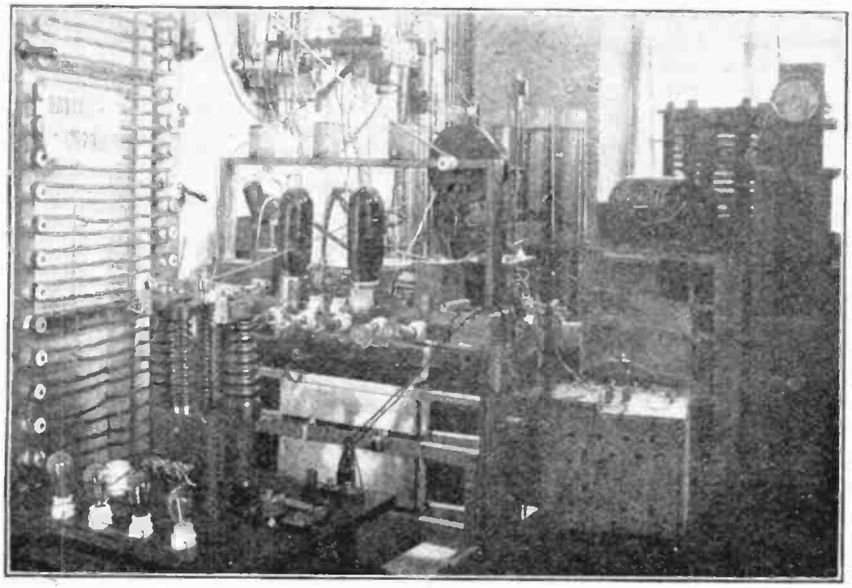
Systematic Observations.

The direction-finder which has been described in this article has been employed in a long series of experiments in which the observations of the apparent direction of arrival of wireless waves, as recorded by such an instrument, played an important part. In these experiments directional observations were made on the transmissions from several broadcasting stations both by day and night, the carrier wave from these stations being used as a continuous wave transmission, as already described. These systematic experiments were usually carried out over continuous periods of from two to four hours, during which observations were made at minute or half-minute intervals. In such experiments conducted at ranges of more than thirty miles overland, it is usually found that, whereas in the day time the apparent bearing remains constant to within one or, at most, two degrees, at night the bearings are subject to very erratic variations, ranging over a large number of degrees. Accompanying these variations it is also frequently found that the signal minimum upon which the observation is made becomes blurred or ill-defined, making an accurate reading very difficult. These occurrences are the well-known phenomena of "night-effect" in wireless direction-finding, which has been widely investigated in recent years.

A Typical Example.

A typical example of the manner in which these variations take place is shown by the graph in Fig. 8, which shows the results of the observations of bearings of the Bournemouth broadcasting station, taken on a direction-finder at a distance of 77 miles over a period of about two and a half hours. It is to be noted that the variations have begun at an hour or more before sunset, although these are fairly small in amplitude. As sunset is approached and passed, the variations become much greater in magnitude, having an extreme range of nearly 100° during this particular test. From such a diagram it might appear that the direction of arrival of the waves sometimes deviates by more than 50° from the true great-circle path between transmitter and receiver. This, however, is not the case; for it has now been conclusively demonstrated that the apparent change in bearing is produced by a wave travelling from transmitter to receiver *via* the upper regions of the earth's atmosphere, and thus arriving at an inclined angle to the earth's surface. In order that such a wave may cause an apparent variation in bearing on a direction-finder, it must have its plane of polarisation rotated from its normal position, *i.e.*, the electric force in the wave must be horizontal. This rotation is brought about by the action of the ionised portion of the upper atmosphere through which the waves pass.

From a systematic study of the observations to be obtained in this manner with such a direction-finder, much can be learned about the mode of operation of such waves, and of the important part played by the upper atmosphere in normal wireless communication.



SHORT-WAVE DEVELOPMENTS IN RUSSIA.

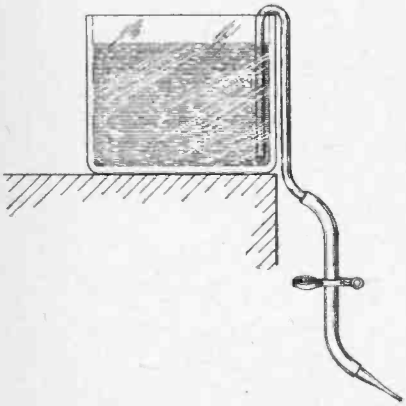
THE short-wave transmitter at Nishni-Novgorod which is shown in our photograph has been installed for research in connection with the development of high-power transmitting valves. Transmissions are on 80-110 metres with a power of 15 kW in the aerial.

NOVELTIES FROM OUR READERS

A Section Devoted to New Ideas and Practical Devices.

FILLING ACCUMULATOR CELLS.

The filling of the cells of a large accumulator H.T. battery is a tedious business unless some device is employed such as that shown in the sketch.



Device for filling H.T. accumulator cells.

The vessel containing the acid is placed on a shelf above the battery, and acid is syphoned down through glass and rubber tubing to a fine jet made by drawing out a short piece of glass tubing. An ordinary chemical pinch-cock fixed to the rubber tubing gives perfect control over the flow of acid, the whole arrangement being vastly superior to the usual acid bottle and glass funnel.—R. P. A.

o o o o

LOUD-SPEAKER HORNS.

Wireless experimenters who may happen to possess one of the new H.M.V. gramophones will find the acoustic properties of the sound conduit of great assistance in enhancing the lower musical tones for loud-speaker reproduction.

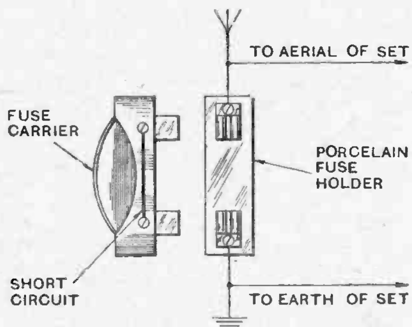
If the movement of the loud-speaker already in use is not suitable, one of the many loud-speaker attachments on the market may be employed. The combination gives a particularly deep and rich quality comparable to the best diaphragm loud-speakers.—H. J. R.

o o o o

EARTHING SWITCH.

Standard porcelain fuse holders make excellent earthing switches for use out of doors on account of the high surface insulation which is maintained under all weather conditions.

The diagram shows how the fuse holder should be connected in circuit. The aerial and earth, and also the aerial and earth leads to the set, are connected to the spring clips of the fuse holder, while the blades on the



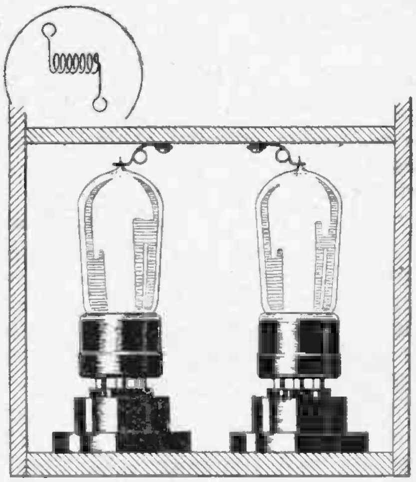
Fuse holder converted for use as a lightning switch.

fuse carrier are short-circuited by a piece of thick copper wire or strip. —G. J. R.

> **Valves for Readers.**
>
> **For every practical idea submitted by a reader and accepted for publication in this section the Editor will forward by post a receiving valve of British make.**

VALVES IN PORTABLE SETS.

In portable receivers of compact design valves are apt to be damaged through striking adjacent components in transit due to the large lateral movement allowed by the average



Protecting valves from vibration in a portable receiver.

anti-vibration valve holder. Where the valves are contained in a separate compartment, or where the lid of the receiver when closed is in close proximity to the pip of the valve, a small coil spring may be fitted as shown to prevent undue movement of the valve. If a strong spring is found to be necessary to hold the valve in position, it should be released on reaching the destination and before commencing reception by lifting off the loop and turning the spring to one side, otherwise microphonic noises may be transmitted to the valve *via* the top of the valve compartment and the thick coils of the spring. If the spring is light, on the other hand, vibrations will be effectively absorbed, and signals may be received with the spring in position.—M. C. C.

PIONEERS of WIRELESS

BY ELLISON HAWKS F.R.A.S

24.—Benjamin Franklin and the Leyden Jar.

As every one of our readers no doubt knows, one of the fundamental principles of wireless is based on the phenomenon demonstrated by the Leyden jar, and before we pass on to deal with the discoveries of Hertz and his successors, it will perhaps be of interest to mention the earlier work in connection with the electric spark.

Credit for the discovery of the Leyden jar has been variously claimed for Musschenbröck, a celebrated professor of Leyden; for Cuneus, a rich citizen of Leyden, and for Von Kleist, Dean of the Cathedral at Kamin, in Pomerania. Von Kleist, at any rate, has priority in the matter of making his discovery public, but his account (dated November 4th, 1745) is somewhat obscure.

"When a nail or piece of brass wire is put into a small apothecary's phial and electrified," he wrote, "remarkable effects follow, but the phial must be very dry and warm. I commonly rub it over beforehand with a finger on which I put some powdered chalk. If a little mercury or a few drops of spirits of wine can be put into it, the experiment succeeds the better. As soon as this phial and nail are removed from the electrifying glass, or the prime conductor to which it hath been exposed is taken away, it throws out a pencil of flame so strong that with this burning machine in my hands, I have taken above sixty steps in walking about my room. When it is electrified strongly I can take it into another room, and then fire spirits of wine with it.

"If while it is electrifying I put my finger or a piece of gold, which I hold in my hand, to the nail, I receive a shock that stuns my arms and shoulders. A tin tube, or a man placed upon electrics, is electrified much more strongly by this means than in the common way. When I present this phial and nail to a tin tube fifteen feet in length nothing but experience can make a person believe how strongly it is electrified. Two thin glasses have been broken by the shock. . . ."

Benjamin Franklin.

The Experiments of Cuneus and Musschenbröck.

In January, 1746, Cuneus accidentally made a similar discovery. He was working with Musschenbröck and Allamand, who had noticed that electrified bodies quickly lost their charge, which they supposed was abstracted by the air itself. In carrying out subsequent experiments, Cuneus held the glass jar in one hand, and disengaging the wire from the electrical machine, received a shock that filled him with the utmost consternation and caused him to drop the glass jar. Musschenbröck repeated the experiment, and in a letter to Reaumur said that he lost his breath and was two days before he recovered from the effects of the shock and the terror, adding that he would not repeat the experiment for the whole kingdom of France! On the other hand, Boze seems to have desired to become the first electrical martyr, expressing the wish that he might die by the shock so that the account of his death might furnish a paper for the memoirs of the French Academy.

Apart from some experiments in regard to the transmission and velocity of electricity, the Leyden jar was regarded as being little more than a toy. The original experiments were repeated everywhere and excited general wonder as being "a prodigy of nature and philosophy." Large numbers of "electricians" wandered over Europe, enriching themselves by selling shocks to all and sundry, and French kings were amused by the electrification of chains of monks and guardsmen, all of whom "jumped together" as the circuit was completed!

Franklin: Scientist and Statesman.

The theory of the Leyden jar remained obscure and was not elucidated until investigated by Franklin, that remarkable combination of scientist and statesman.

Benjamin Franklin was born at Boston, U.S.A., on January 17th, 1706. His ancestors had resided on their own property at Ecton, Northamptonshire, for three hundred years, but Franklin's father emigrated to New England in 1685. Benjamin was intended for the church, but his inclinations did not lie in this direction. He was very fond of reading and studied everything that came in his way. His knowledge was soon considerable, and the story is told how, as a boy, he once astonished

Pioneers of Wireless.—

his parents with the statement that he had just swallowed some "acephalous molluscs." His father laid hold of him in great alarm and called for help, and in spite of Benjamin's protests his mother poured half a gallon of hot water down his throat, and he was held upside down for the "poison" to run out. As soon as the boy could speak he explained that "acephalous molluscs" were only oysters, after which his father took a strap and gave him a sound "larruping"!

The Kite Experiment.

Franklin's attention was first directed to electricity in 1746 when he saw some experiments, which, however, were but imperfectly carried out. He repeated them himself and soon after announced his theory of the identity of lightning and electricity. In 1750 he suggested the use of pointed iron rods as lightning conductors, to draw lightning down from the clouds without noise or danger, and two years later his historic experiment with a kite resulted. This was carried out in connection with a Leyden jar, to which the string was connected. Franklin flew his kite during a thunderstorm and the string acted in a similar manner to a lightning conductor, the Leyden jar being charged by the difference in potential between the clouds and the earth.

Franklin discovered the method of cascade connection that greatly increased the total discharge current of the Leyden jar, and he also proved that the charges in a Leyden jar accumulate, not on the surface of the jar, but on the metallic coating. The experiment by which he showed this is both interesting and beautiful. He first charged a jar and then, insulating it, removed the cork and the wire by which the electricity was conveyed from the charging machine to the inside of the jar. On examining these and finding them free from electricity, he poured out the water into another jar, also insulated. This water was also found to be free from electricity. Fresh water was introduced into the charged jar in place of that poured out, and on placing one hand on the outside coating and the other in the water, a shock was received, which was as strong as if no change had been made in the jar since it was first charged.

It is interesting to remember that no material change has been made in the form of the Leyden jar from the date of its invention. In its early form it consisted of a glass jar, coated inside and out with tin foil, and in its modern form the only alteration made is to use a coating of electrolytically deposited copper in place of the tin foil.

The Leyden jar, in another form, known as a condenser, plays an important part in wireless transmission and reception. This intimate link with "Ben" Franklin is of particular interest, for when Marconi first signalled from England to America he used a large battery of Leyden jars. These later were replaced with condensers, and of these we shall have something more to say in a subsequent article.

NEXT INSTALMENT.
Hertz and his Epoch-making Discovery.

TRANSMITTING NOTES AND QUERIES.

General Notes.

Mr. F. A. Mayer (G 2LZ) tells us that on the morning of July 27th he heard the schooner "Morrissey" (VOQ) sending out a distress call on 36 metres. He endeavoured to get in touch with her, but was not successful. Shortly afterwards he heard Z 4AA, F. D. Bell, Otago, calling VOQ and the schooner gave a position somewhere off Newfoundland. Subsequently, when Mr. Mayer was working with Z 4AR, W. G. Wilkinson, Roslyn, he learnt that Miss Bell was operating Z 4AA when she got into touch with VOQ. The distress call was reported to the New Zealand Government, who sent particulars by cable to Washington.

oooo

Mr. P. J. McGee, the Senior Operator on the s.s. "Bowdoin" attached to the McMillan Arctic Expedition, states that his wavelength is 39.7 metres and that he will welcome reports on his signals. The call-sign of s.s. "Bowdoin" is WNP (Wireless North Pole) and not WPN as printed in error in our issue of July 28th.

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A correspondent asks if anyone can give him the wavelength and QRA of the following stations:—AGB, AGC, PCRR, ZHC, PKX, GC, and GBK.

oooo

Another correspondent asks if anyone can give him the name, call-sign and exact wavelength of a station sending "CAG" constantly on crystal-controlled C.W. The wavelength is between 39 and 40 metres.

QRA's Wanted.

G 2AHM, G 2ARM, G 2BKU, B 5A, B 82, F2, I TA, I 1CJ, K 8T, NDC, PC PP, PC 2P, U83, V4J, U2XG, A 3EN, P 1AW.

oooo

Listeners' Reports.

Apropos the suggestion made in our issue of May 5th that transmitters should agree upon some simple code to signify the nature of the reports (if any) that they desire, we would draw attention to the letter from Mr. W. Gilbert Taylor in our Correspondence columns.

oooo

American Amateurs.

Mr. W. R. Chaplin (U 9DUD), 5887, Theodosia Avenue, St. Louis, Mo., and Mr. Frank Macik (U 6BBQ), 194, S. El Moleno Avenue, Pasadena, California, will appreciate reports from any listeners in Great Britain. Mr. R. L. Amsbury (U 6CIX), 317, N. Friend Avenue, Whittier, California, would like to arrange tests with some British amateur. His transmitting power is 250 watts, and he often hears G 2KF and G 2SZ.

New Call-signs Allotted and Stations Identified.

G 5LH	(ex 2AWK), F. Thompson, 16, Stratford Grove, Heaton, Newcastle-on-Tyne, transmits on 45 and 90 metres with a hand-generator.
G 6NR	R. S. Roberts, 92, Arlington Road, N.W.1.
G 2AOL	E. Bateman, "Monkleigh," Hove Park Road, Hove.
G 2BLY	(ex 5AP), A. J. Hill, Pevensey Bay.
G 2BXX	(Art. A.), C. Q. Marks, 143, Sinclair Drive, Langside, Glasgow.
G 2BYQ	W. Ford, 155, Briercliffe Road, Burnley, Lancs.
G 5GZ	(ex 2BAS), J. Geary, Landore, Swansea.
G 5LU	(ex 2BCL), D. T. Blunden & C. F. Scruby, 8, Penrith Road, Basingstoke. Transmit on 23, 45 and 150-200 metres.
G 6NZ	L. E. Newnham, 14, Silchester Road, Copnor, Portsmouth. Transmits on 23, 45, and 90 metres and will welcome all reports. (This call-sign formerly belonged to W. B. Chivers, Birmingham).
D 7XF	E. Hyllested, 80, Österbrogade, Copenhagen.
I 1GN	E. Gnesutta, Via Donizetti 45, Milan. (change of address).
O A4Z	J. S. Streeter, "Wood Green," Liesbeek Road Rosebank, Cape Town. (Change of address.)
P 3OR	O. Cunha, Rua de S. Luzia 85, Funchal, Madeira.
R A19	The University, Tomsk, Siberia.

We are indebted to our Argentine contemporary, *Revista Telegrafia*, for the following South American stations:—

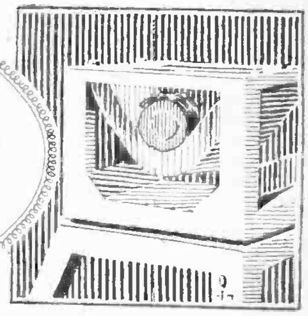
PERU.

2OA	L. Anciaux, Arequipa (50 watts).
2OB	W. Weecks ,, (5 ,,).
3OA	C. A. Gilardi ,, (10 ,,).

BRAZIL.

2AM	J. Cancela, São Paulo.
SQ 1B	Broadcasting Radio Club of Brazil, Rio de Janeiro (500 watts on 320 metres wavelength).

Broadcast Brevities



News from All Quarters: By Our Special Correspondent.

The New Wavelengths.

At the moment of going to Press important news comes to hand regarding wavelength changes which will come into force on or about September 15th. It is understood on reliable authority that the wavelengths will be fixed as follows :—

Aberdeen ... ... } Birmingham ... ... }	491.8 metres
Glasgow	405.4 ,,
Belfast	326.1 ,,
London	361.4 ,,
Newcastle ...	312.5 ,,
Manchester ...	384.6 ,,
Bournemouth ...	306.1 ,,
Cardiff (unchanged)	

It will be seen that the biggest jumps occur in the case of Belfast, Newcastle and Bournemouth, the first-named being altered by over 100 metres. In spite of the fact that Aberdeen and Birmingham share a wavelength, it is confidently anticipated that no interference will be caused.

oooo

A Human "Aquarium."

The artistes and announcers in the special broadcasting studio to be erected at the National Radio Exhibition, Olympia, in September, will enjoy about as much privacy as goldfish. Large glass windows will be let in the studio walls so that the general public will be able to witness typical studio performances.

From this "aquarium" famous artistes will broadcast during the day, and the various "uncles" and "aunties" will be seen in the flesh.

oooo

Auntie's Rival Attraction.

A similar arrangement, it will be remembered, obtained at the Ideal Home Exhibition early this year; but at the September Exhibition the control room will also be visible, an important item to readers of *The Wireless World*. Many of us, I feel sure, would prefer to watch the deft-fingered engineer at control rather than the most charming of microphonic aunts.

oooo

When Music Hath No Charms.

There must be quite a number of wireless amateurs who are bored to death by "difficult" music simply because they haven't time to study it. At the moment of writing science has still failed to provide us with more than 24 hours a day, and in the circumstances there is a limit to what can be accomplished by one individual.

And yet, many listeners whose attentions are primarily devoted to experimental work would glean a good deal of extra pleasure from the programmes if more of the music were intelligible.

oooo

A Commonsense Move.

In this connection an interesting move will be made by the B.B.C. at the end of September by the inauguration of a weekly half-hour, to be held on Mondays, devoted to an illustrated description of the music to be broadcast during the ensuing week. Various celebrities will conduct these "Musical Talks," and the pianoforte and the gramophone will both be enlisted to explain knotty points as they arise.

The talks will probably be timed to take place between 6.30 and 7, a period at present occupied by dance music.

oooo

A Delicate Question.

Opinions are necessarily diverse on what constitutes an ideal "Holiday Talk." Some people incline towards the view that talks are superfluous at this time of the year; there is, however, a considerable demand for talks of the out-of-door variety, provided that the subjects are treated breezily and without a hint of the class-room or lecture theatre about them.

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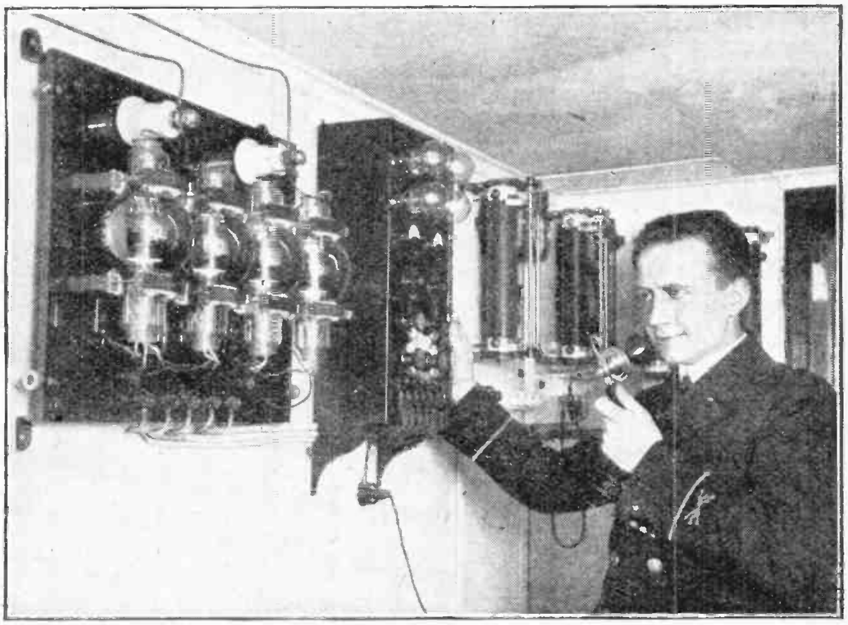
Holiday Spirit at Bournemouth.

Bournemouth, I see, is stepping forward boldly with a programme of holiday talks, chiefly of the topo-



BROADCASTING FROM A SHIP. Part of the wireless telephony installation on board the Swedish motorship "Gripsholm," from which the President of the Swedish-American line recently delivered an address. The speech was picked up in Sweden and re-broadcast throughout the country. The microphone is connected to a two-stage push pull amplifier and the four modulator valves are seen on the left.

graphical kind. During the present month well-known authorities will discourse on "The New Forest," "Dorset," "Yachting," "Hampshire Literature," and other topics of a like nature. Will listeners be appreciative?

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Britain's Best Station.

Bournemouth, by the way, appears to be the most popular British station among listeners on the Continent, if we may judge from the enthusiastic reports received not only from France and Belgium, but also Spain. The Hampshire station is heard more clearly in Madrid than either Daventry or London, despite its comparatively low power.

The probable explanation is that 6BM, of all the British stations, occupies by far the most favourable site. To what extent luck was mingled with judgment when the site was originally chosen in 1922 will probably remain a mystery.

oooo

Classics v. Jazz.

It may come as a surprise to many to learn that, so far as the votes of correspondents are concerned, classical music won a decisive victory over jazz on the occasion of the recent debate conducted by Sir Landon Ronald and Mr. Jack Hylton. I am told that Savoy Hill received 568 communications in favour of the classical effort as against 172 championing jazz. 88 listeners wrote in non-committal fashion.

oooo

Politics Without Bias.

While the exclusion from the microphone of violently controversial subjects is generally accepted as a wise precaution, certain questions could probably be ventilated in such a manner that, while strife would be avoided, the public would obtain enlightenment on many perplexing topics of the day.

For instance, numbers of listeners would welcome descriptions of the many bewildering Bills which come before Parliament every week. If the B.B.C. were to broadcast regularly a brief and interesting *resumé* of some of these Bills, many people who lack the time or opportunity to follow political activities very closely would find such talks of real benefit. The idea seems worthy of attention.

oooo

Time, Gentlemen!

On certain occasions the job of broadcast announcer can be one of the most embarrassing in existence. Not long ago 2LO was transmitting an "outside" broadcast in the form of a sermon by an eminent Nonconformist divine at a well-known place of worship. The sermon and closing hymn were scheduled for conclusion at a definite hour. Five minutes before this time a celebrated artist entered the waiting room at 2LO, preparatory to giving a performance. The announcer on duty listened anxiously for indications that the sermon was coming to an end, but when the hour struck the preacher seemed to be warming up to his subject! And the famous artist in the waiting room began to show signs of artistic temperament.

FUTURE FEATURES.

Sunday, August 15th.

LONDON.—Royal Tank Corps Band; Albert Sandler.
BIRMINGHAM.—Symphony Concert.
GLASGOW.—Notable Anniversaries.
MANCHESTER.—Symphony Concert.
NEWCASTLE. — Sidonie Goossens, Harp.

Monday, August 16th.

LONDON.—"The White Chateau," by Reginald Berkeley.
ABERDEEN. — Joseph Farrington, bass.
CARDIFF.—Folk Songs and Tunes.
GLASGOW. — Shakespearean Programme.

Tuesday, August 17th.

LONDON AND DAVENTRY. — Radio Dance.
BIRMINGHAM.—Variety.
BOURNEMOUTH.—Light British Programme.
MANCHESTER. — "Lest Auld Acquaintance Be Forgot."
NEWCASTLE.—Frank Gomez and Municipal Orchestra.

Wednesday, August 18th.

LONDON.—Poetry Reading.
ABERDEEN.—Scottish Programme.
BELFAST.—Moments Musicaux.
MANCHESTER. — Buxton Gardens Night.
NEWCASTLE. — "Electric Sparks" Concert Party.

Thursday, August 19th.

LONDON.—Programme devoted to London's Territorials.
BIRMINGHAM.—5IT Radio Players.
BOURNEMOUTH. — English and French Light Opera.
BELFAST.—"South America."
CARDIFF.—5WA's Sunshine Carnival.
GLASGOW.—Symphony Concert.

Friday, August 20th.

LONDON.—Variety. "Rigoletto."
MANCHESTER.—Recital of Robert Herrick's Songs.

Saturday, August 21st.

LONDON.—Piano Recital by Leff Pouishnoff.
ABERDEEN.—Light Music and Song.
BIRMINGHAM.—Park Concert.
BOURNEMOUTH. — Scottish Programme.
CARDIFF.—Some Old Favourites.

A Lucky Pause.

At ten minutes past the hour the announcer was in a state of —er—acute perspiration, the celebrity at his elbow evincing a desire to be shown the way to go home. Meanwhile the preacher expounded Holy Writ with perfect composure.

The announcer was not far from despair at seventeen minutes past the hour when suddenly, by a lucky chance, the preacher paused at the close of an appropriate sentence. Out came the switch. The celebrated artist was then prevailed upon to proceed and the announcer was able to partake of a much needed drink of water.

oooo

The Announcer's Responsibility.

The problem of maintaining schedule time has always been a thorn in the flesh of the B.B.C. A hitch will sometimes occur in the most carefully planned programme; a piece of music may last longer than was anticipated, and in the case of outside broadcasts, anything may happen. The sole responsibility for altering the programme to compensate for these minor disasters rests with the announcer. Announcing is not always a "posh" job.

oooo

Seaside Nights.

The approval which greeted the recent "Brighton" night, when the municipal band and other local interests furnished an S.B. programme, has prompted the B.B.C. to organise a series of similar fixtures provided by other watering places. The next of these—Margate night—will be held on September 10th. In a short introductory talk, the Mayor, Councillor T. D. Wood, will deal with the history of the town. A programme provided by a concert party will be relayed from the Westbrook Pavilion, and this will be followed by open air band performances, the municipal orchestra and other attractions.

"Eastbourne night" will be held on September 24th.

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Twenty Thousand Pounds.

For relay purposes on Margate night nearly three miles of land line will be specially laid by the Post Office.

Land line work of this description furnishes the Government with a regular source of revenue from broadcasting in addition to the capital made on the surplus from every wireless licence. I learn from Headquarters, in fact, that the amount paid annually to the Post Office in respect of land lines for S.B. purposes falls little short of £20,000.

oooo

Broadcast Receivers in Prison.

In view of the many reforms brought about in prison administration during the last decade it seems rather surprising that nothing has been done to equip penitentiaries with broadcast receiving apparatus, although the question has been raised in Parliament.

Recent experience has shown that prison occupants, especially those whose sentences have run for several years, are strangely curious regarding an innovation which is entirely foreign to them. Lectures on broadcasting have recently been delivered in Maidstone and other prisons.

NEW APPARATUS

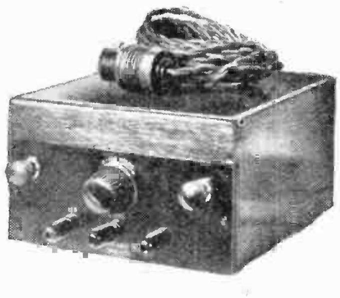
A Review of the Latest Products of the Manufacturers.

"EKCO" H.T. UNIT.

It is only during the past few months that manufacturers have devoted their attention to the production of H.T. battery eliminators working from D.C. and A.C. supplies.

The construction of an eliminator working from D.C. mains is comparatively simple, and the performance of any set depends essentially upon the smoothing inductances and condensers being adequate in size. In some models the potentiometer resistance is shunted across the supply mains, the required voltages tapped off along the resistance and passed to the output terminals through iron core inductances and shunted by large-capacity reservoir condensers.

Another type which usually works well



Ekco H.T. Unit type V2A designed for supplying an output potential of roughly 120 volts and also a detector potential up to 100 volts, which can be critically controlled by means of a variable high resistance. Two additional terminals provide for connecting a blocking condenser in the earth lead of the receiver.

and is undoubtedly more economical to run consists of merely connecting large smoothing chokes to the main leads, followed by large parallel connected condensers, the voltage developed at the output terminals being controlled by means of series-connected resistances. It is this system which is employed in the "Ekco" unit manufactured by E. K. Cole, 505, London Road, Westcliff-on-Sea.

In both of the systems the H.T. potential developed at the output terminals will depend upon the amount of current taken by the receiver, and although the potentiometer arrangement is less variable in this respect, it would seem desirable for an adjustment to be included in the unit, so that the potential can be critically regulated. Without making the instrument too complicated, a single adjusting knob is fitted to the unit, which critically controls the potential fed to the detector valve, while the potential required for operating the low-frequency stages and where considerable voltage latitude is permissible the output is approximately regulated by means of a series-connected high resistance of fixed value.

The performance of any device of this sort depends very much upon the extent of ripple present in the supply. For instance, in some districts, where perhaps a storage battery is used to equalise the load at different times of the day, it will be found that the use of smoothing equipment is scarcely wanted, providing that the eliminator is not used at the end of a main feeder which is also supplying current to motors having unsuitably designed fields and armatures. The instrument was tested on a supply on which D.C. current is derived from a sub-station equipped with motor generators converting A.C. to D.C., and when connected to a three-valve set consisting of one high-frequency stage and operating a small loud-speaker no hum was discernible.

When using telephone receivers listening to a distant station, a very slight hum was present and was perhaps rendered evident by changing over to an accumulator H.T. battery by means of a three-pole two-position switch.

The unit is a good practical proposition, and can be relied upon to properly fulfil the purpose for which it is designed.

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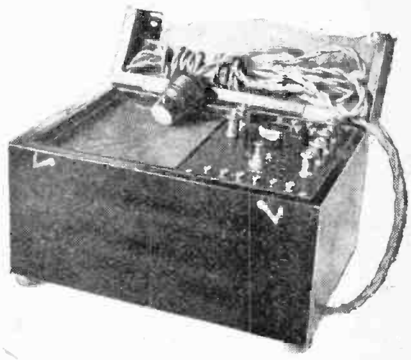
A COMPLETE BATTERY ELIMINATOR.

Probably the first instrument of its type to appear on the British market is the Regentone complete battery eliminator, built by the Regent Radio Supply Co., 45, Fleet Street, London, E.C.4, in which provision is made for obtaining, in addition to a variable H.T. potential, a range of grid biasing potentials and filament heating current.

The use of this instrument removes completely the need for all batteries when D.C. supply is available.

In general principle a large, well-ventilated resistance wound on a frame is connected in series with the filament output terminals, and the filament current is controlled by means of a variable shunt resistance. The H.T. and grid biasing potentials are obtained by the potentiometer method, and by means of a number of tappings potentials of 20 to 140 are obtainable in 20-volt steps, while the grid bias increases by steps of 2 volts up to −10. The arrangement of the various circuits has been well considered to obviate the difficulties that would arise when using the instrument on public supply services differing as regards the polarity of the earth-connected lead. The aerial and earth terminals are fed through the instrument, so that protecting condensers are thrown in circuit to avoid the dangers of earthing the mains through the receiving set.

The instrument is attractively finished, the instrument panel being of Mahoganite, which looks well when used with bronze



The Regentone battery eliminator when connected to a D.C. supply provides a filament heating current up to 0.5 amp. as well as critically controllable plate and grid biasing potentials.

finish fittings, the engraving being filled in in gold.

The performance of the instrument, as with all other D.C. battery eliminators, depends very much upon the nature of the supply. The smoothing equipment being liberal, the instrument can be successfully used for loud-speaker reception from the local station, and in the majority of cases will be entirely satisfactory for general long-distance work with sensitive receiving sets and using telephone receivers.

The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

WHEN QSL'S ARE WANTED.

Sir,—When receiving amateur transmissions it is always very puzzling to know whether or not a QSL card reporting reception is desired, and it would I think be a good idea if transmitters would give some indication during their working.

They must often be experimenting with a new circuit, or with some object in view other than mere distance, when reports from quite close at hand would be useful; on the other hand when working with 10 or 20 watts for distance only, local QSL's are no doubt a nuisance, but the listener is obviously often unable to discriminate.

A single letter, which could be chosen and inserted, say, after a call or when signing off, would inform listeners that reports would be welcomed, and to extend the idea figures could be placed after the letter, denoting distances from which the transmitter desires his reports. Thus, say, "A 500" inserted in some part of the transmission would mean that reports from distances of 500 miles and over are wanted, the letter alone indicating that QSL's from far or near would be welcome.

I am sure that some such arrangement would result in the transmitters receiving far lesser quantities of mere "wall-paper," would be a help to the pockets of those courteous friends who "always QSL" and promote better feeling between amateurs of all countries.

Beckenham, Kent. W. GILBERT TAYLOR.

TRANSMITTER FATIGUE.

Sir,—I was very greatly interested in the letter appearing in your issue of July 14th, from "Observer at Sea." He voices to a great extent my own thoughts, and confirms my observations over a period of years.

Having had a little experience in radio matters, one is always conscious of being swayed between two extremes of thought, dogmatism on the one hand, and on the other a dangerous jumping to conclusions. It is so simple to push out a new branch theory, or rather to offer a new theoretical explanation of an observed phenomenon; but also it is even simpler to quash this latest brain wave by a little logical application of expanded text book facts.

On this account I offer no explanation whatever of this freakishness in transmitters, but I do insist that my facts, however puzzling, are as stated, and are the result of very careful observation at my experimental station at Monkseaton, one mile N.W. of G.C.C.

In the case of the following stations the effect was almost exactly the same, namely, that for approximately five to six weeks after they opened signals were strong and steady, that is, no difficulty was found in raising them above the interference background in 'phones, and in most cases on loud-speaker also; then in a day or two fading commenced and signals receded into the background.

These are the stations:—2LO (Marconi House), 2LO (Oxford Street), Manchester (old), Manchester (new), Cardiff, Birmingham, Bournemouth, Aberdeen, Chelmsford and Daventry.

The most striking case was Birmingham; the old American transmitter at first gave really excellent signals, then after five weeks fading started and signals fell right off until it was very problematical whether one would raise him at all; then the station was moved to another site (I am not sure if the new transmitter was hitched up then or later), and once again 5IT boomed, only to fade away once again after the customary "good signal" period. Over-modulation and overloading of plant for engineer tests at once present themselves as feasible explanations of louder signals, but they do not (as your correspondent remarks) account for the absence of fading as we understand it from modern theory, nor does increased H.F. resistance of aerial.

There might be something in the species of electronic saturation of the "earth," which "Observer" suggests; but I leave it to such of your "high brow" readers who are interested in the matter to give us their views on this puzzling phenomenon. JAMES B. WALKER.

Bishop Auckland.

COMMUNICATION OF LOW POWER.

Sir,—With reference to the letter on low power transmission by Mr. Exeter (6YK) in your issue of 21st July, I am absolutely in agreement with him and think it would be of great interest to a number of amateurs if some tests could be arranged on the lines suggested by him. It is, of course, a very simple matter to become QSO with a station and then reduce power, but this, in my opinion, is no test at all.

I would suggest that if possible some tests could be arranged whereby the maximum power was, shall we say, about three watts, and that the supply of H.T should be either dry battery or D.C. mains. Further, I think that generators should not be allowed and the voltage should not exceed 200 volts. I for one should be most glad to partake in any tests that can be arranged, as I am perfectly sure that some very useful data could be obtained if arrangements could be made for these tests. I would suggest a wavelength of 45 metres.

Headingley, Leeds. K. D. F. TOWNEND (6TY).

INTERFERENCE FROM A CRYSTAL SET.

Sir,—On several occasions recently, while listening round on my set, I have picked up voices, etc., which I thought at first to be due to a distant station. As, however, tuning was extremely flat and sounds could only be heard while the set was oscillating it was evidently not this. A test showed that it was not caused by induction from a loud-speaker extension.

Further experiment showed it to be due to a crystal set next door, which was evidently left permanently connected to aerial and earth. Presumably the effect of people speaking near the phones was to vary the amount of radiated energy absorbed by the crystal set and so reproduce speech in the oscillating set. I wonder if any other readers have experienced this form of interference, which, fortunately, only occurs during oscillation? It is certainly an argument for owners of crystal sets to earth their aerials. R. SMETZER.

Clapham Common, S.W.11.

"The Wireless World" Information Department
Conducts a Free Service of Replies to Readers' Queries.

Questions should be concisely worded, and headed "Information Department." Each separate question must be accompanied by a stamped addressed envelope for postal reply.

The Question of H.T. Tappings.

Is it absolutely necessary to use a separate H.T.+ tapping for each valve? I am building a conventional four-valve receiver employing the usual 1-v-2 circuit, and am told that I shall get much greater efficiency if I use four H.T.+ tappings. Since this entails the purchase of extra 1 mfd. shunting condensers, I am wondering whether the efficiency gained will be worth the extra expense. A. D.

There is not the slightest need for you to use more than two H.T.+ tappings, the idea that a separate tapping is necessary for each valve being a complete mistake. Your two L.F. valves should of course be power valves, and since practically all power valves function best when operated on about 120 volts H.T., there is not the slightest reason why your two final valves should not share a common H.T.+ tapping. For H.F. and detector work it will be found that nearly all valves are rated at from 40 to 60 volts H.T. irrespective of which function they are intended to perform, and your first two valves may therefore be fed from the same H.T.+ tapping, thus leaving only two tappings for your four-valve set. In all except superheterodyne receivers there is no reason at all why there should be more than two H.T.+ tappings, whilst even in an elaborate superheterodyne the only extra tapping that is really necessary is one supplying the oscillator valve.

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The Colpitt's Circuit.

I am very interested in the Hartley circuit which was used in the receiver described on page 77 of your July 21st issue. I have a standard "Western Electric" totally enclosed frame aerial, however, in which it is impossible to take a centre tapping without pulling the instrument to pieces, and wish to know, therefore, if it is possible to pick up this centre tapping electrically, by means of balancing condensers, instead of making an actual mechanical tapping. A.P.W.

The scheme which you propose is perfectly feasible, and in Fig. 1 (a) we give the necessary circuit diagram. This particular modification of the Hartley circuit is usually known as the Colpitt's circuit, although there are various other forms of the circuit which also bear the same name. Two neutralising condensers are connected across the frame aerial, and the filament tapping is taken between the two. These condensers must be carefully adjusted so that the electrical centre of the circuit occurs at the junction between the two condensers. Once set, they need not be touched again.

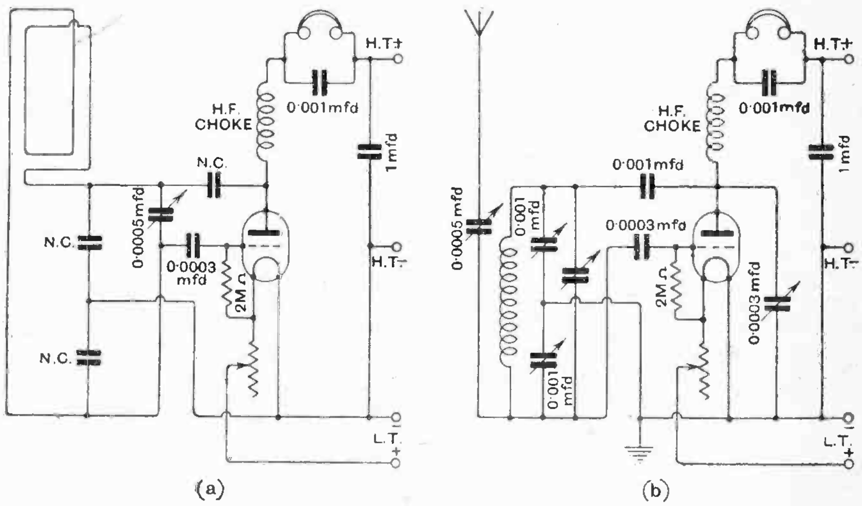

Fig. 1.—Modified Colpitt's circuit adapted (a) for frame aerial reception, (b) for open aerial reception.

The third neutralising condenser, connected to the plate of the valve, is, of course, for the control of reaction in the normal manner. The H.F. choke may consist of any of the commercial chokes that are upon the market.

Fig. 1 (b) shows the method of adapting the scheme to an ordinary open aerial system, using a standard plug-in coil. Here, however, still further modifications are shown. The method of reaction control used is the Schnell system described on page 140 of our July 28th issue, instead of the Hartley system shown in Fig. 1 (a). Also a capacitatively coupled aerial circuit is used to increase selectivity in the manner described on page 542 of our April 7th issue. It will be noticed that instead of using two neutralising condensers for picking up the centre tapping, use is made of a dual-circuit tuning condenser in which the two halves of the condenser are matched. It should be pointed out that, since the two halves of the condenser are in series, it is necessary that each half have a maximum capacity of 0.001 mfd., in order that the maximum resultant capacity shunted across the coil be the customary 0.0005 mfd., otherwise the band of wavelengths covered by one coil will be small. If such a dual condenser is used, the extra variable condenser shunting the whole coil is unnecessary. If, however, use is made of a three-electrode bridge condenser, such as the "Devicon," in which each moving electrode is controlled separately, then, of course, the two halves of this condenser can only be used for balancing, and tuning must be carried out by the extra condenser. With the dual condenser, of course, both tuning and balancing are carried out by the same condenser.

Of course, by using a centre-tapped coil such as the "Dimic" the balancing condensers would be eliminated. The only type of ordinary plug-in coil having a centre tapping which is at present on the market, however, is the "Gambrell."

It should be pointed out that the two methods of reaction control shown in Fig. 1 (a) and Fig. 1 (b) are interchangeable, as are also the two systems of obtaining the centre tapping.

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The Roberts Reflex Neutrodyne.

I am very interested in the Roberts reflex neutrodyne circuit, and understand that this has been dealt with in your journal several times in the course of the past year, but, being a new reader, I have not the references. I have obtained several back numbers of "The Wireless World," and shall be glad, therefore, if you will give me the page numbers where I can find information about this circuit.
T. E. S.

This two-valve receiver was first published by Dr. Van Roberts in the American magazine, "Radio Broadcast," for December, 1924, and aroused great interest in that country. It was modified for the use of British listeners, and a full constructional article published on page 2 of the July 1st, 1925, issue of *The Wireless World*, subsequent information appearing on page 46 of the July 8th issue, page 171, August 5th issue, page 271, August 26th issue, page 322, February 24th, 1926, issue, and page 789 of the June 9th issue. As a result of a considerable amount of experience and experiment, the whole receiver was redesigned and published on page 833 of our June 23rd issue by Mr. H. F. Smith. In America also important modifications have been made to the original receiver, and various modified designs have been published from time to time in "Radio Broadcast," and special coils and complete sets of parts for the revised American version of this receiver can be obtained from the Rothermel Radio Corporation of Great Britain, Ltd., 24, Maddox Street, Regent Street, London, W.1.

It is most important, when using this receiver, that the correct type of valves be used in each stage if efficiency and stability are to be assured. The filament voltage of the valves is immaterial, provided that a low-impedance valve be used in the reflex stage, whilst, of course, a high-impedance valve is suitable for the detector. Speaking broadly, the impedance of the reflex valve should not exceed 10,000 ohms. If attempts are made to use a high-impedance or so-called "H.F." valve in this stage, the range will be poor, and the set will be extremely difficult to neutralise, whilst quality will be greatly impaired.

With regard to the range, volume, and quality of loud-speaker reproduction associated with this receiver, concerning which greatly conflicting opinions appear to exist, it is obvious that the range and selectivity cannot exceed that given by a well-designed three-valve receiver employing one H.F. and one L.F. stage, whilst loud-speaker volume can never exceed that which would be provided by one transformer-coupled L.F. stage. Exactly similar considerations apply, of course, with regard to quality of reproduction.

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"Music Without Muffling" Again.

I have read with very great interest the article on page 217 of your February 1st issue, wherein is described a method of using the loud-speaker in a position remote from the receiver, employing only a single wire extension. I am desirous of listening-in on telephones in a summer-house about thirty yards from the house, in which I have a crystal receiver permanently installed. I should like to know, therefore, what type of choke to purchase for constructing the unit, since it is to be used following a crystal instead of a valve. R.D.R.

Fortunately there is no need whatever for you to go to the expense of purchasing a special choke, since you can dispense entirely with the unit by following the circuit diagram given in

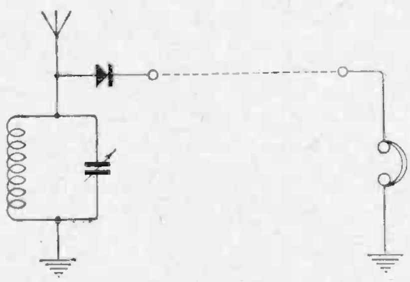

Fig. 2.—Single wire extension applied to a crystal receiver.

Fig. 2. The only reason why a choke and condenser must be employed if a single-wire extension system has to be adapted to a valve receiver is because of the necessity of feeding a high positive potential to the anode of the valve. This potential must be fed through an impedance—*i.e.*, either through telephones or loud-speaker, or through a choke if the former are required to be used at a distance from the receiver. The 1 mfd. condenser is then necessary to prevent the H.T. battery being short-circuited to earth. With a crystal receiver, however, the H.T. battery and therefore the necessity of a choke and condenser, disappears and permits us to use the simpler circuit illustrated in Fig. 2. The connection should actually be made to that telephone terminal of the existing receiver which is internally connected to the crystal or catwhisker, the other telephone terminal, which will be connected internally to the earth terminal of the receiver, being left blank.

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When are Shunting Condensers Superfluous?

I am building a four-valve receiver, comprising one stage of H.F. and two stages of transformer coupled low-frequency amplification. As, however, I definitely intend to use an accumulator as my source of H.T. supply, is it still necessary to shunt a 1 mfd. condenser from each H.T.+ tapping to the common H.T.–? C. T. C.

If you are intending to use an H.T. accumulator, it can definitely be said that such condensers would be superfluous. The purpose of these condensers is to act as a low impedance path for all oscillatory currents whether H.F. or L.F. Now the ordinary dry cell H.T. battery has a considerable ohmic resistance, and this resistance will be the same at all A.C. frequencies and to D.C. current, as was explained in the "articlet" entitled "Resistance or Impedance?" on page 900 of our June 30th issue. Since there is a certain portion of the H.T. battery which is common to the anode circuits of all valves, we have in effect a resistance common to all valves. The result is that A.C. potentials at varying frequencies will be set up across the resistance, and since these are common to several valve anode circuits, energy will be handed back, and so cause instability if not actual howling. By means of 1 mfd condensers, we offer a low impedance path to all oscillatory energy. In fact, such a condenser acts as a virtual short-circuit to oscillatory current. Now the impedance of a 1 mfd. condenser at the lowest frequency which the average receiver is capable of dealing with, namely, the 100 cycles, is about 1,600 ohms, and the H.T. accumulator, unlike the dry cell battery, has a very low internal resistance, and thus offers to all frequencies a path of far lower impedance than do the shunting condensers. Consequently, such condensers are superfluous, the internal resistance of the battery being sufficiently low to prevent any serious difference of potential being set up across it by the pulsating currents of various frequencies traversing the valve anode circuits.

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

WHO NEUTRALISED FIRST?

MUCH as we deprecate a controversy between ourselves and our contemporaries, yet where a question of special interest and importance to our readers arises we feel that it is our duty to make comment and express our views for the information of our readers. No journal, in our opinion, would be performing its proper function adequately if it neglected to touch upon matters for the reason that a difference of opinion might exist between itself and a contemporary, especially where that contemporary is not entirely disinterested.

Professor Hazeltine, whose name has been associated with the neutrodyne, has come over to this country on a visit, as we announced in a recent issue. His visit has quite naturally served to focus the attention of wireless circles on the subject of neutralised or balanced circuits, and it may be here mentioned that the term "neutrodyne" is a registered name employed by the Corporation in America which controls certain patents relating to the stabilisation of high-frequency circuits of which Professor Hazeltine is the author. The term "neutrodyne" has since come to be used in a very general way to describe stabilised H.F. circuits in general, although it must be remembered that this registered name, being the property of the Hazeltine Corporation, may not legitimately be employed by competing manufacturers any more than the name "Bovril" could be used by rival purveyors of a kindred product to that for which that name was registered.

Professor Hazeltine has taken out several patents relating to the stabilisation of circuits, the earliest being in America, dated in August, 1919, followed by others in December, 1920, and December, 1923. Professor Hazeltine's British Patents are dated April 5th, 1923.

Prior to this date, namely, on January 2nd, 1923, Mr. J. Scott-Taggart took out a patent in this country on the subject of neutralising high-frequency valve amplifiers, and this patent was subsequently purchased by the Hazeltine Corporation in America.

We are not particularly concerned with the patent position in America, but where the question of the patent position here is involved every section of wireless users is intimately interested.

Soon after the arrival of Professor Hazeltine in this country a week or two ago he was entertained to luncheon by *The Wireless Dealer*, a trade paper owned by the Radio Press, Ltd., and edited by Mr. Scott-Taggart. Representatives of the trade were present, and at this luncheon Professor Hazeltine made a statement regarding the patent position here and in America in respect of the patents owned by his Corporation. The report of the speeches of Professor Hazeltine and members of the Radio Press staff at that luncheon which appeared in the journals of the Radio Press, together with the editorial matter relative to the subject which has been printed is, in our opinion, calculated to lead the reader to suppose that the broad principle of stabilising H.F. circuits is entirely covered by the patents of Professor Hazeltine in America and Mr. Scott-Taggart in this country.

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If such a state of affairs were established, it would mean that every manufacturer in this country who desired to utilise circuits employing methods for neutralising capacity and magnetic coupling would have to do so subject to licence from the Hazeltine Corporation of America. But before any manufacturer recognised such patent claims he would require that they should be established, and to do so is usually an extremely difficult matter where another inventor is already in the field with a patent relating to a similar subject. This is precisely the case in the present instance, for in 1918 the B.T.H. Co. in this country took out a patent the subject-matter of which was communicated to them by the General Electric Company of America, the inventor in this instance being Mr. Rice. This patent, by arrangement between the B.T.H. Co. and the Marconi Co. here, is included in the general licence agreement under which the Marconi Co. authorises manufacturers here to utilise its patents in the construction of broadcast reception apparatus. This means, of course, that any manufacturer licensed under the Marconi general licence can construct broadcast receivers employing the principles of neutralisation as set forth in this B.T.H. patent of 1918, which is numbered 119,365. An examination of this specification reveals that it is quite broad in its claims, and the author shows a thorough understanding of the principles involved.

The B.T.H. Patent.

In discussing the invention in the patent specification, it is stated :—

"Our present invention relates to the amplification of electric currents of small intensity and especially currents such as are produced in an antenna by received radio signals. More particularly it relates to the use of electron discharge relays, detectors, or amplifiers, of the type employing an incandescent cathode, an anode and a grid enclosed in an evacuated envelope, for receiving radio signals.

"It has been found that under certain conditions a device of the above type produces oscillatory currents in the circuits associated therewith, and in many cases the oscillatory currents so produced interfere with the efficient reception, amplification, and detection of the signals to be received.

"The object of our invention is to avoid the undesired production of oscillatory currents when such a device is used either as an amplifier or detector, or to serve both functions.

"It has been ascertained that the production of oscillatory currents by such a device is due to the coupling which is always present between the grid and plate circuits. This coupling is of two kinds, electromagnetic and electrostatic. When the plate and grid circuits both contain air core inductances which are not magnetically shielded from each other there will be a large leakage flux between the two and electromagnetic transfer of energy from the plate circuit to the grid circuit which may be sufficient to produce oscillations in the circuits even though the coils may be located at some distance from each other. There is in any case a certain electrostatic coupling between the two circuits by reason of the capacity between the electrodes and the capacities to ground of the circuits. This coupling alone may also be sufficient to produce oscillations. It has been proposed to neutralise the electromagnetic coupling by a second electromagnetic coupling in the opposite direction. This coupling may also be made great enough to compensate for the capacity coupling, but in case it is so arranged it will be correct only for one particular frequency and in case the tuning of either of the circuits is varied the degree of the coupling also will have to be varied.

"In carrying our invention into effect we overcome the electromagnetic coupling between the circuits which is present when air core inductances are used by enclosing the inductances in separate metal boxes. We also overcome the effect of the electrostatic coupling by impressing upon the circuits electromotive forces equal to and opposite in direction to those impressed thereon by reason of the natural capacity coupling and thereby neutralise the effect of this coupling. When this compensation is once adjusted it is effective for all frequencies to which the circuits may be tuned."

The Claims.

The figures which accompany the specification show the employment of methods of stabilising one or several valve stages. Having described the nature of the invention, the specification concludes with several claims, the first two and most important of which we give below :—

(1) In a radio receiving system, an electron discharge amplifier having resonant grid and plate circuits and means for compensating for the capacity coupling between said circuits and thereby preventing the generation of oscillatory currents in said circuits which interfere with the reception of desired signals.

(2) In a radio receiving system an electron discharge amplifier having grid and plate circuits with natural capacity coupling between the circuits and containing inductances which are so arranged as to avoid any magnetic coupling between the two circuits, and means for impressing upon the grid circuit from the plate circuit an electromotive force equal and opposite to that impressed by the natural capacity coupling between the two circuits.

Professor Hazeltine, according to our contemporary *Wireless*, is reported to have stated in an interview in July that "The Scott-Taggart invention is the master patent on the neutrodyne in this country. It is the keystone of the position." The precise meaning which Professor Hazeltine intended to convey in this statement depends largely upon whether he here employed the word "neutrodyne" in a general sense or in reference to the specific circuits for which the trade name "neutrodyne" was registered. In either case the use of the expression "master patent" is very bold indeed, as such a term is only applicable to a patent which is in the fortunate position of unquestionable priority in date and subject matter, and on which all patents embodying modifications and minor inventions relating to the same subject are dependent; in fact, a master patent may be looked upon as the father of a family and relative subsequent patents as his children.

When we come to read in detail the specification of the patent taken out by Mr. Scott-Taggart on January 2nd, 1923, which is numbered 217,971, the first point that strikes us is that a definite reference is made therein to the B.T.H. patent of 1918 in these words: "We are aware of Specification No. 119,365, and we make no claim to anything described or claimed therein." Such an admission of an earlier patent in any patent specification must be regarded as an acknowledgment on the part of the author of the existence of some prior claims having reference to the same subject, and by making enquiries, which anyone is entitled to do, at the British Patent Office, we find that this B.T.H. patent and others were cited against Mr. Scott-Taggart when he applied for his own patent. This, no doubt, restricted the ambit of his claims, as, in fact, becomes apparent when we read through the claims themselves. For the information of our readers we set forth the principal claims below. Other claims which follow in the specification are dependent on these.

The Claims of Patent No. 217,971.

(1) A radio frequency amplifier in which the currents are amplified by a plurality of stages of amplification involving a plurality of tuned circuits, a condenser, or condensers, being connected so as to produce a reverse reaction effect to counteract the tendency of the amplifier to generate oscillations.

(2) A wireless receiver in which the incoming waves produce radio frequency currents which are amplified by a plurality of stages of amplification involving a plurality of tuned circuits, a condenser, or condensers, being connected so as to produce a reverse reaction effect to counteract the tendency of the amplifier to generate oscillations.

(3) A wireless receiver in which the incoming high-frequency currents are amplified by a plurality of valves in cascade, a plurality of the intervalve coupling arrangements comprising circuits tuned, or approximately tuned, to the incoming wavelength, and in which the amplifier circuits are maintained in a stable non-oscillating condition by the connection of a condenser, or condensers, to produce reverse reaction effects.

(4) A wireless receiver in which the incoming high-frequency currents are amplified by a plurality of valves in cascade coupled together in two cases at least, by the aid of circuits tuned, or approximately tuned, to the incoming wavelength, and in which condensers are used, in the case of at least two valves, to feed back output currents of the valves to their respective input circuits so as to lessen the natural reaction effect in the valves concerned.

(5) A wireless receiver in which the incoming high-frequency currents are amplified by a plurality of three-electrode valves in cascade coupled together, in two cases at least, by the aid of circuits tuned, or approximately tuned, to the incoming wavelength, and in which a condenser is connected across the grid of an amplifying valve and a point on the anode output circuit or circuits such that the potentials at this point tend to neutralise the self-oscillation tendency of the valve, this stabilising connection being made in the case of at least two amplifying valves.

(6) A wireless receiver in which the incoming high-frequency currents are amplified by a plurality of three-electrode valves in cascade coupled in at least two cases by means of a radio-frequency transformer having tuned primary and/or secondary, a condenser, in the case of each of the amplifying valves, being connected across a point on the secondary of each transformer and a point on the grid circuit of the valve in front of the transformer.

Comments.

It will be seen that in no case does Mr. Scott-Taggart claim the use of a single-stage radio frequency amplifier employing methods for stabilising, but instead he refers in every instance to a *plurality of stages* of amplification.

It must be remembered that in this country the British Patent Office does not accept responsibility for the validity of the claims of any patent granted, so that neither the owners of the B.T.H. patent nor the Scott-Taggart patent are really in a position to assert the validity of their claims unless such validity has been upheld as the result of an action in the Courts, but so long as the Marconi Company under its general licence authorises manufacturers to construct apparatus employing the methods of stabilisation set forth in the B.T.H. patent above referred to, and so long as manufacturers do not go outside the scope of that patent any question of infringement of other patents would be a matter for the attention of the Marconi Company, *and would not affect the licensed manufacturer manufacturing within the scope of the Marconi patents, because, under the terms of the agreement with the Marconi Company, he is protected from any liability in respect of claims for infringement by other patent owners.*

We doubt whether anyone is in a position to define the precise position of patents relating to stabilisation of high-frequency circuits. At some future date the matter may be thrashed out in the Courts. In the meantime it is, perhaps, only natural that those who own patents should take whatever steps they can to emphasise the importance of their own claims. We certainly would not attempt to exercise what are the proper functions of a Court of Law by defining the relative scope of existing patents, but we desire to put the position before our readers in an unbiassed manner.

THE OLYMPIA EXHIBITION.

WE are drawing near to the date of the opening of the annual Wireless Show, which this year will be held at Olympia from September 4th to 18th. This Exhibition will undoubtedly be on a much bigger scale than hitherto and, owing to changes in the organisation, it will, for the first time, be an all-embracing exhibition, open to every British manufacturer and trader.

Judging even from the information which is available at this stage, there is a prospect of a larger proportion than ever before of new apparatus, embodying most recent developments, but it will be realised that many manufacturers are keeping very quiet about their new designs until the exhibition opens.

It is already apparent that during the coming season a range of apparatus will be produced that will undoubtedly arouse the enthusiasm of both amateur and listener. *The Wireless World* will review the exhibition in detail, and everyone interested in wireless should make certain of being able to visit Olympia during the period of the show.

Four Sets in One for the All-wave Enthusiast.

By N. P. VINCER-MINTER.

ANYONE who has had many dealings with those members of the community who have adopted for their heraldic emblem the somewhat strange device of a soldering-iron rampant on a field of flux with crackling noises quartered, to wit, the noble army of home constructors, cannot fail to have heard them one and all declare at some period of their soul-destroying career a firm determination to build a "final" set. Now this somewhat cryptic utterance merely means that, after many moons of travail in constructing all the many "junkodyne" and "stuntoflex" receivers designed both by themselves and by those who ought to know better, and after imbibing carefully all the valuable technical information imparted by the advertisement pages of journals, both lay and technical, they have at length decided to gather together all the acquired experience both of themselves and others, and put it into the design and construction of one final and supreme "Titanic Ten," which will, as the advertisements say, receive broadcasting, "from anywhere, at any time, and in any place."

The "Perfect" Set.

Now, like the war that was to end war, such a scheme looks very well on paper, but in practice is apt to be distinctly disappointing. The usual fate of these "Titanic" sets is poignantly exemplified in the career of the ill-fated vessel of that name. Let it be said as definitely as possible that there is no "perfect" set on the market to-day; that is to say, that there is no set which money can buy, no matter at what price, and no set which ingenuity can construct, no matter how many valves are used, which will receive distant stations with the same constancy, regularity, and certainty, and the same quality as it will receive the local station. There is yet another type of person who says that he does not intend to buy or build a receiver at present, but is going to sit down and wait until the perfect set comes along. He would be well advised, in the writer's opinion, to see that the chair he chooses be a comfortable and well-padded one, for he will have to sit in it for a very long time. In brief, although rapid strides are being made in the solution of the problem of efficient H.F. amplification, we have still a long road to travel before we reach perfection.

Undoubtedly the solution of the problem of reliable and constant reception of distant stations lies, for the immediate future, and possibly also for the "intermediate" future, in the development of the H.F.

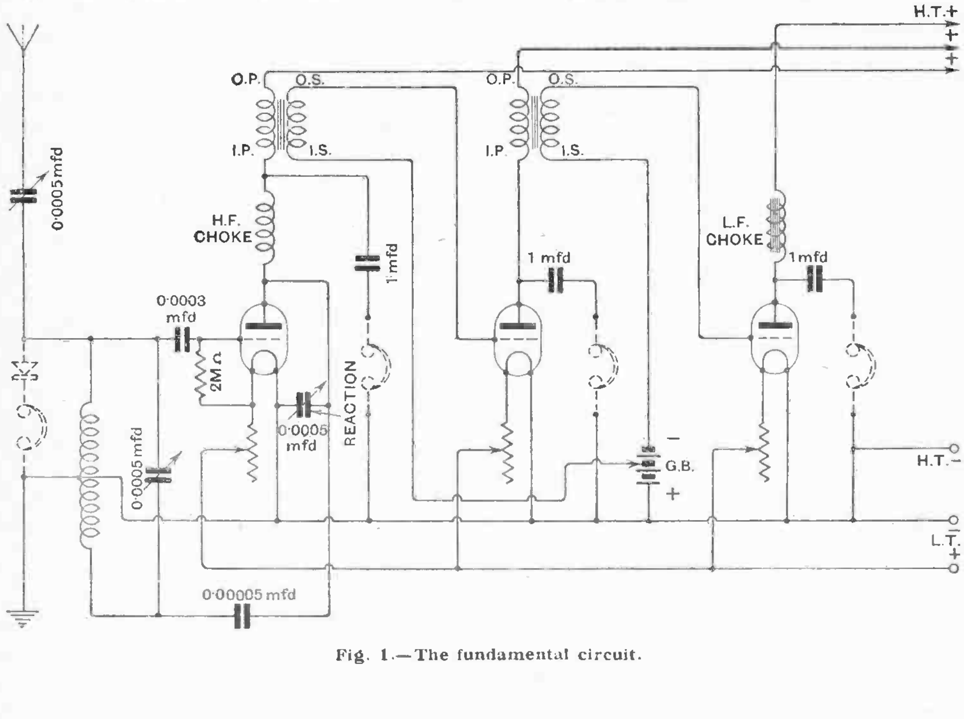
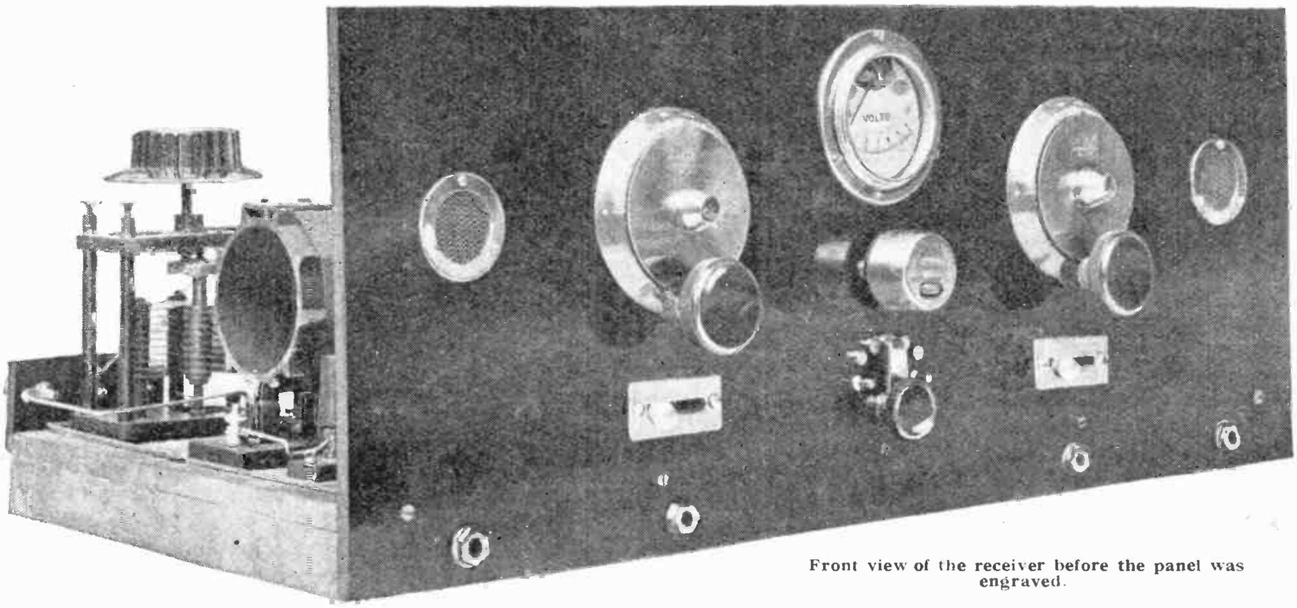


Fig. 1.—The fundamental circuit.

Universal Three Valve Receiver.—
amplifier. As for the more distant future, it is somewhat unsafe to prophesy, but probably we may find that some genius will arise who will tame the super-regenerative receiver; for undoubtedly, once H.F. perfection is attained, the next step will be to reduce the number of valves, because, although the growing tendency to use the electric light mains, no less than the modern dull-emitter, will solve the question of L.T. and H.T. supply, yet the use of a large number of valves with their ever-present risk of accidental breakage and consequent renewal, will always be hanging like a financial sword of Damocles over the head of the unfortunate multi-valve user.

The solution of this problem can very well be left until we have produced a nearly perfect straight H.F. amplifier. When the time does come to tackle it, however, there will be two paths offered to the investigator. The first will be the production of an efficient reflex receiver, the great stumbling-block at present being the necessity of shunting H.F. by-passing condensers across L.F. devices, such as transformer secondaries, which, in order to "reflex" back the L.F. energy, must necessarily be introduced into the H.F. part of the circuit.



Front view of the receiver before the panel was engraved.

Rocks that Wreck Reflexing.

If the value of the shunting capacities is too small, we upset the H.F. functioning of the circuit, whilst if they are unduly large, a severe loss of quality in the L.F. amplifier occurs. Indeed, this trouble is so pronounced that some makers of high-class L.F. transformers to-day deliberately discourage the use of their products in reflex circuits, lest the consequent loss of quality be wrongly laid at the door of their L.F. transformer. The second line of investigation, which may well in the end prove the most promising, lies in the direction of super-regeneration, concerning which there is surprisingly little reliable data at present. At the moment, however, we are very far from attaining our ideal in the realms of straight H.F. amplification, and until this has been done it is of little use attempting to produce a super-efficient reflex receiver.

Progress Without Penury.

The modern H.F. receiver, then, whether it takes the form of a superheterodyne or a straight, neutralised circuit, can be relied upon to bring in the nearer broadcasting stations with reasonable reliability at any time, whilst, when conditions are good, it will give a very good account of itself in bringing in distant stations, but at present the *reliable* daylight range of even a multi-H.F. stage receiver is surprisingly limited. Now, undoubtedly improvement in our knowledge of H.F. amplification is proceeding at such a pace that the harassed set constructor has no sooner completed the construction of one "world-beater" than the H.F. portion of it is put out of date by the production of some even more efficient form of H.F. coupling. But one fact emerges very clearly, and that is, that it is always the H.F. portion of the receiver which has to take the count, the detector and L.F. portion remaining unaltered. From this fact, therefore, it is quite logical to deduce that the detector and L.F. portion of the receiver has attained a fair measure of finality. Now this is quite true, and it is safe to say that L.F. amplifier design has reached such a pitch of perfection that it waits upon the loud-speaker, and it is of little use attempting to still further improve the former until drastic reform has taken place in the design of the latter. Hitherto the development of the L.F. amplifier has been held up by the lack of properly designed transformers, etc. To-day, however, there is not the slightest excuse for lack of either quality or quantity in the output of an L.F. amplifier, proper valves and coupling devices being readily obtainable. We can, therefore, venture to commence constructing our final set as far as rectification and L.F. amplification is concerned, but in the realms of H.F. we are confronted with the possibility of having drastically to revise matters about

Universal Three Valve Receiver.—
once every three months in order to keep step with modern progress.

Surely then, the logical process would be to build a detector and L.F. receiver in which were embodied all the best ideas of modern design and all the best components, and to make this set so flexible that it could be used on either an outdoor or an indoor aerial or on a frame, and so that it would be possible to couple it up quickly to any type of modern H.F. amplifier. Now, if this is done, we can well afford to use an expensive panel, and to lock up expensive transformers, 1 mfd. fixed condensers, etc., in our receiver, since we would know that this receiver would not be put out of date by the next advance in H.F. amplification. We could make up our H.F. amplifier with less expensive panels and with less care for appearance and add to our detector and L.F. receiver as desired, and could revise the H.F. amplifier from time to time without upsetting our expensive and beautifully constructed main set. If, on the contrary, we built a receiver straight away embodying two or more H.F. stages, together with an efficient L.F. amplifier, and used an expensive panel and cabinet, we should be confronted with the possibility of having to scrap our expensive panel and cabinet in a few months, in order to rebuild the set in accordance with the progress made in H.F. amplifier design. Furthermore, we should have no set to carry on with for ordinary entertainment purposes whilst our receiver was in the throes of reconstruction.

A Versatile Circuit.

The writer has, therefore, endeavoured in the present receiver to offer a solution of the "final" set problem which will be of distinct benefit to the enthusiastic and progressive amateur. Let no man be misled by the title of the receiver, however. It lays claim to its name because it is universal in its application to a frame aerial or any type of open aerial or to the output of any H.F. amplifier; because the output of a superheterodyne or any other receiver complete with detector can be instantly plugged into the input of the L.F. amplifier, using either one or two valves; because it enables crystal or alternative grid or anode valve rectification to be used with or without L.F. amplification; because, also, telephones can be used on the crystal or detector valve at the same time as a loud-speaker is being used after either the first or second L.F. amplifier, and many other features which will be discussed later. Therein, then, lies its claim to the title of "universal," and it must not, therefore, be confused with sets of the "All-universe de luxe" or the "Wigan Six" type.

When designing the receiver, therefore, the writer set before him the following ideals, and experimented considerably in the matter of the best way of attaining them:

The receiver must—

(1) Be sensitive and selective.
(2) Have a smooth control over reaction.
(3) Be adaptable to all wavelengths, from 20 metres upwards.

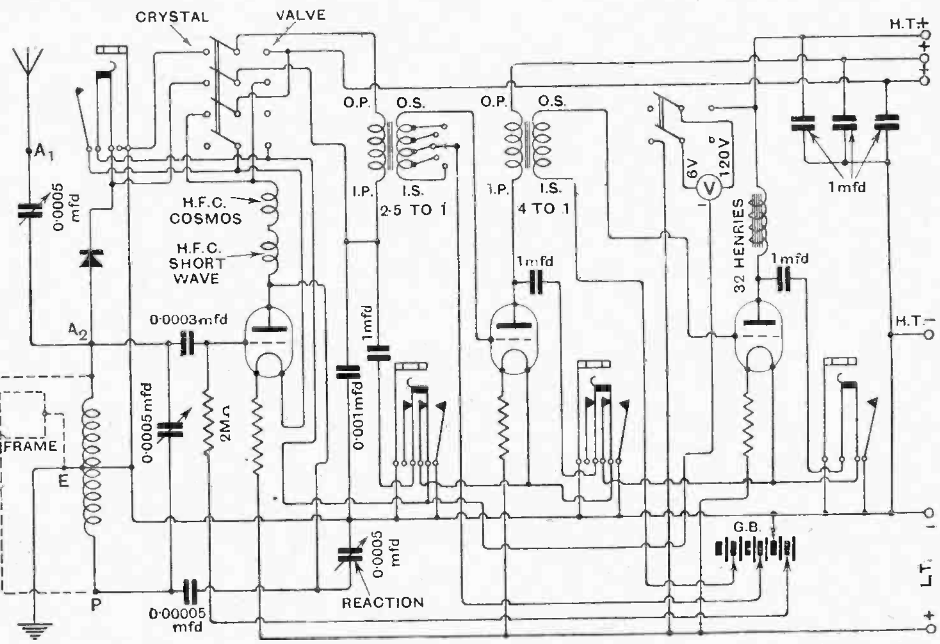


Fig. 2.—Diagram of the actual circuit employed.

(4) Be capable of having an outdoor or indoor open aerial, a frame, or an H.F. amplifier placed in front of it.
(5) Be so constructed that the amplifier portion could be used after any existing receiver.
(6) Give ample volume and good quality.
(7) Have a fine control over volume.
(8) Possess the ability of being used with crystal or alternative grid or anode valve rectification.
(9) Finally, be simple to tune, and easily adaptable in respect of points 3, 4, and 8.

The detector portion of the receiver was first tackled, and it was finally decided to use a particular modification of the Hartley circuit, which is usually known as the Schnell circuit. This Schnell circuit was originally published in the pages of the American magazine *Q.S.T.* as a short-wave receiver, and is attributable to F. H. Schnell, President of the American Radio Relay League, but was later combined with the Hartley circuit in order to produce an efficient all-wave receiver, and the result was the evolution of a remarkably efficient single-valve receiver which functioned equally well on almost any wavelength, to which, of course, any type of L.F. amplifier could be connected in the usual manner. Now, the writer dwelt at some length on the theory of the Reinartz receiver in the April 28th and June 16th issues of this journal, and pointed out its great advantages, from the

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point of view of getting distant stations, over the conventional type of reaction receiver. This effect was entirely due to the exceedingly smooth reaction control obtained. Good as that is, however, the writer must confess that the Hartley circuit, or, rather, the Schnell modification of it, is still better, and, as a result of careful tests, he did not hesitate long in choosing this circuit for this receiver.

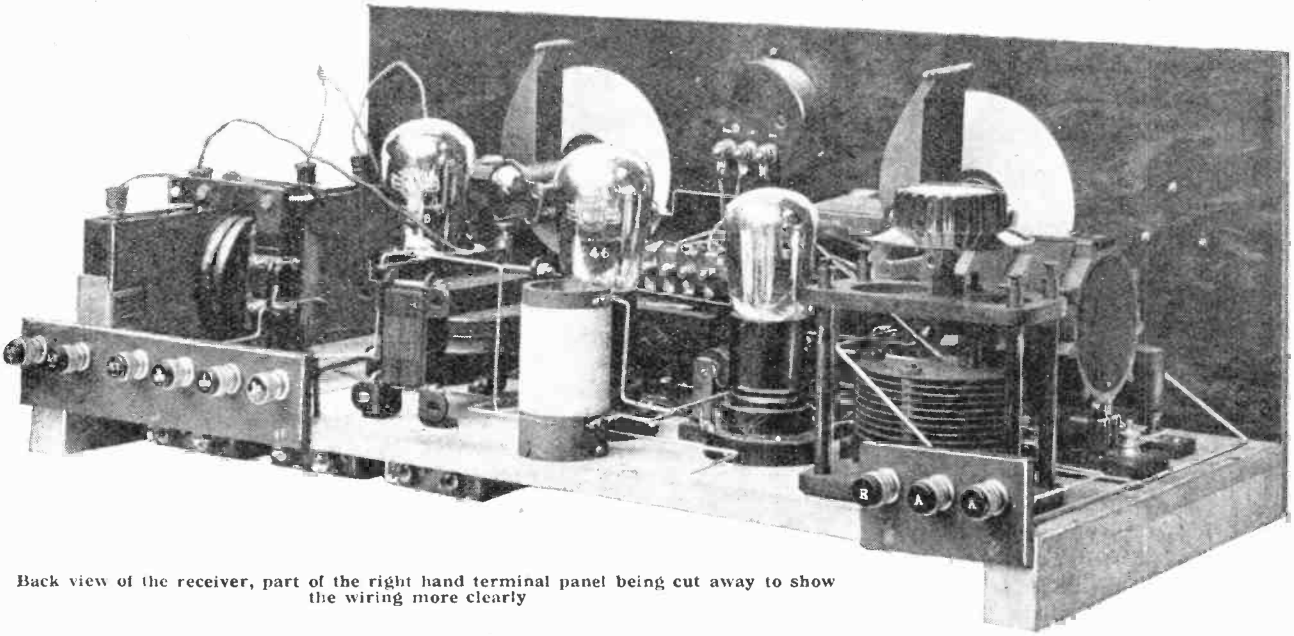
The Schnell Circuit.

The action of the circuit can quickly be grasped if a careful study is made of the fundamental circuit in Fig. 1, ignoring for the moment the variable condenser in series with the aerial coil, and the L.F. amplifier portion, which will be discussed later. Here we have a centre tapped coil, the whole of which, including its usual parallel tuning condenser, is connected across between the grid and plate of the condenser, the centre tapping being taken to the negative side of the filament, and to earth. It will be noted that the plate end of the coil (marked P in Fig. 2) is actually connected to the valve anode through a 0.00005 mfd. fixed condenser. Let us assume for the moment that this condenser is not there. It will at once be seen that this will mean that the plate of the valve is directly connected through the tuning coil to the filament negative. In other words, the H.T. battery will be short-circuited *via* the L.F. transformer primary (or the telephones if no L.F. amplifier is used), the H.F. choke, and part of the tuning coil. This is easily prevented by putting in a blocking condenser, but why so small a value as 0.00005 mfd.? We shall soon see. Let us suppose for the moment that it is a 1 mfd. condenser. We must remember, in order to understand matters, that the H.F. energy pent up on the plate, as it were, is always trying to escape round some external circuit to filament negative, and it will, like human beings, take the easiest path, that is, the path of least resistance, or impedance as we call it when dealing with any currents other than D.C. Moreover, if two or more paths of different impedance are offered to it, it will divide itself in strict proportion to the ratios between the impedances of the alternative paths.

Now there are two paths for the H.F. current from the plate of the valve to filament negative, one *via* the H.F. choke and transformer primary and one *via* the 1 mfd. condenser. Now, the H.F. choke, because it *is* a choke, offers a high impedance to H.F. In fact, it acts practically as a wireless policeman with his hand up, and very little H.F. escapes that way. The baffled H.F., indignant, as it were, at being thus held up in the main street, looks around like a motor 'bus to see if there is any side street through which it can, as it were, short-circuit the policeman. Is there such a street?

The H.F. Traffic Problem.

There most surely is, namely, the 1 mfd. condenser, which offers an absurdly low impedance to the passage of the H.F. Practically all our H.F. motor 'buses, therefore, escape down this side street, and only a few nimble "cyclists" dive under the arm of the watchful policeman, and escape down "Choke Street," the policeman being somewhat too corpulent to catch them, the "corpulency" of the policeman being represented by the self-capacity of the H.F. choke, through which some H.F. energy does escape. We can, if we like, find out the exact ratio of current passing through the condenser and through the choke. Let us assume that we are dealing with a wavelength of 300 metres (*i.e.*, a frequency of one million cycles per second)[1], and the choke has an inductance of 55 millihenries $\left(\frac{55}{1,000}\right.$ henries). We know that the impedance of a choke in ohms equals $2\pi fL$, where f is the frequency in cycles



Back view of the receiver, part of the right hand terminal panel being cut away to show the wiring more clearly

[1] See page 149, *The Wireless World*, August 4th, 1926.

Three-valve Universal Receiver.—

per second and L the inductance in henries. This gives us $2\pi \times 10^6 \times \frac{55}{1,000}$, which equals 345,714 ohms approximately. We know, also, that the impedance of a condenser equals $\frac{1}{2\pi f C}$, where C=capacity in farads, the other symbols being as before. This gives us $\frac{1}{2\pi \times 10^6 \times 10^{-6}}$ = one-seventh of an ohm approximately. Obviously, then, our traffic policeman must be an old and experienced hand and no "strike special," whilst, on the other hand, the side streets must be capable of taking a great deal of traffic. We should have understood enough by now to pension off the policeman, and consider matters in electrical terms only.

The Electrical Parallel.

We have seen that practically all the H.F. passes through the condenser, and this will cause the set to

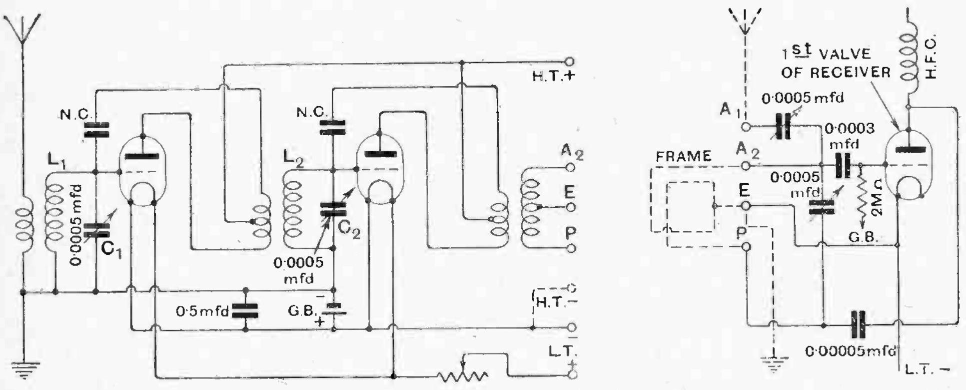


Fig. 3.—This diagram clearly shows the method of coupling an aerial and earth, a frame, or a neutrodyne amplifier to the receiver.

oscillate perpetually. Now suppose we connect a 0.0005 mfd. condenser in parallel with the choke. This will have the effect of practically short-circuiting the choke from the point of view of H.F. energy, and we can consider now that we have two condensers, one of 0.0005 mfd. and one of 1 mfd., through which the H.F. can pass. The greater part of the H.F. will, however, still pass through the 1 mfd. condenser. Now suppose we substitute a 0.0005 mfd. condenser for the 1 mfd. instrument, we shall then have two 0.0005 mfd. condensers, or, in other words, two paths of equal impedance, and the H.F. will divide equally between them. But the receiver will still oscillate with only half the available H.F. being fed back, and actually we must have very much less than half the current fed back to the P end of the tuning coil before there is insufficient to produce actual oscillation. Actually the writer has found that with a 0.0005 mfd. condenser across the choke it is necessary to reduce the blocking condenser to a value of 0.00005 mfd. (50 micro-microfarads) before oscillation will stop. Now suppose we reduce the shunting condenser across the choke to about 0.0003 mfd., we shall be increasing the impedance of this path, and so the current will re-divide itself again, and less will flow through the condenser shunting the choke *and more through the 0.00005 mfd. condenser.* Therefore, oscillation will start again. If, therefore, we can use a 0.0005 mfd. *variable* condenser across the choke, we shall have a very excellent and smooth reaction control. This is what has actually been done in this receiver, and the 0.0005 mfd. reaction condenser shown is shunted from the plate of the valve to filament negative, thus shunting the transformer primary and H.T. battery, as well as the H.F. choke, which is all to the good. It might be thought that the H.F. choke is merely a passenger, and we need only have the reaction condenser to provide a variable impedance path, but, of course, a moment's thought will show that the H.F. choke is necessary to carry the steady H.T. direct current.

Such, then, is the Schnell modification of the Hartley circuit, and a very good circuit, too. It will be seen from Fig. 1 that we can readily connect a crystal and a pair of telephones across from the grid end of the coil to earth and thus have a very effective crystal set which will give far louder signals and far greater selectivity than the average crystal set, in which the crystal and telephones are shunted across the whole coil.

Now a word about the 0.0005 mfd. condenser in series with the aerial. This must definitely not be considered as a device for tuning. It must be considered purely and simply as a capacitative coupling between aerial and grid coil, and this condenser should be only used at such a time as it is definitely desired to change the aerial coupling in order to increase or decrease selectivity, and should never be used when it is desired merely to change the wavelength to which the circuit is tuned, this being the function of the parallel condenser. It must not be confused with the old and unsound system of using a series-parallel switch and one condenser, where, of course, the condenser had to do all the tuning. This system was bad because, when the condenser was in series, we unavoidably altered the aerial coupling every time we desired to make a small change in the wavelength to which the circuit was tuned. Now the usual system of coupling the aerial is magnetic rather than capacitative, using a so-called aperiodic aerial coil. This system of capacity coupling, however, gives equally good selectivity, and possesses the additional advantages that it is more flexible, is better adapted to the needs of the circuit we are using here, and prevents the complication of having an extra coil to change when passing from the London to the Daventry wavelength. The exact setting of the condenser depends on the dimensions of the aerial used, the degree of selectivity desired, and within certain wide limits on the wavelength to be received. Used on the average aerial, it should be set to a value

Three-valve Universal Receiver.—

of about 0.0001 mfd. for the normal B.B.C. wavelengths, the value being somewhat less if a powerful local station is to be eliminated. On Daventry it should be set to almost its full value. On the very short waves, on the contrary, it should be set to almost its minimum position. Thus this condenser need only be altered when the tuning coil is changed. When using a short indoor aerial, connection should be made to A_2 in Fig. 2, and not to A_1 as in the case of a large outdoor aerial. A moment's thought will make it clear to us also that if we desire to use a frame it can be done very simply by removing the coil and connecting the frame as shown by dotted lines in Fig. 2. It is necessary, of course, that an approximate centre tapping should be made on the frame. For Daventry either a large frame of about fifty turns may be used, or an ordinary broadcast frame may be "loaded" to this wavelength. Note, however, that in order to preserve our centre tapping we must not put just one big loading coil in one "leg" of the frame, but must use two smaller coils in each outside lead, but none, of course, in the centre tapping lead.

Transformer Ratio and Impedance.

Now for the L.F. amplifier. The writer has already devoted a complete article to the question of coupling L.F. valves,[1] and in that article he proved that in order to obtain satisfactorily even amplification of all frequencies it is necessary that the impedance connected in the external anode circuit must be considerably greater than the internal impedance of the valve. Now our detector valve should be a medium- or high-impedance valve, because such a valve is usually a better rectifier than a low-impedance valve, and because also, by avoiding a low-impedance valve, we lessen the drain on the H.T. battery. If, therefore, our detector valve is of high impedance, it follows that our external impedance must be very high. We can use a resistance which has the disadvantage of requiring a high H.T. value, and of giving low amplification per stage, only about 90 per cent. of the valve amplification factor, in fact. We can use a choke which must have at least 80 henries inductance in order to give us the desired impedance. But, although we get over the difficulty of a high H.T. voltage, we get no greater amplification. If we could get a choke, however, with an inductance of 80 henries, and wind over it a second winding having, say, twice the number of turns of wire, we should then get an amplification of 90 per cent. of the valve amplification factor multiplied by two. But why not wind five times the number of turns in the second winding and thus still further increase the amount of amplification, Simply because the total bulk of the wire would be so great that we should shunt away the higher musical frequencies by the excessive self-capacity thus introduced. We cannot lessen the number of turns on the first winding in order to increase the ratio, because it would lessen the inductance and thus the impedance obtained would not greatly exceed the high valve impedance, and this excess of external over internal impedance is, as the writer has already pointed out, absolutely vital to good quality. (Unfortunately, this reprehensible practice is very rife among the less reputable manufacturers.) Actually owing to the large number of turns necessary to give 80 henries in the first winding, we cannot put more than about two or three times the number of turns on the secondary before self-capacity comes into play. Therefore, we are limited to a transformer ratio of about 2.5 to 1, for the choke with a secondary superimposed winding which we have been discussing is nothing more or less than an intervalve transformer.

[1] *The Wireless World*, May 26th, 1926, page 701.

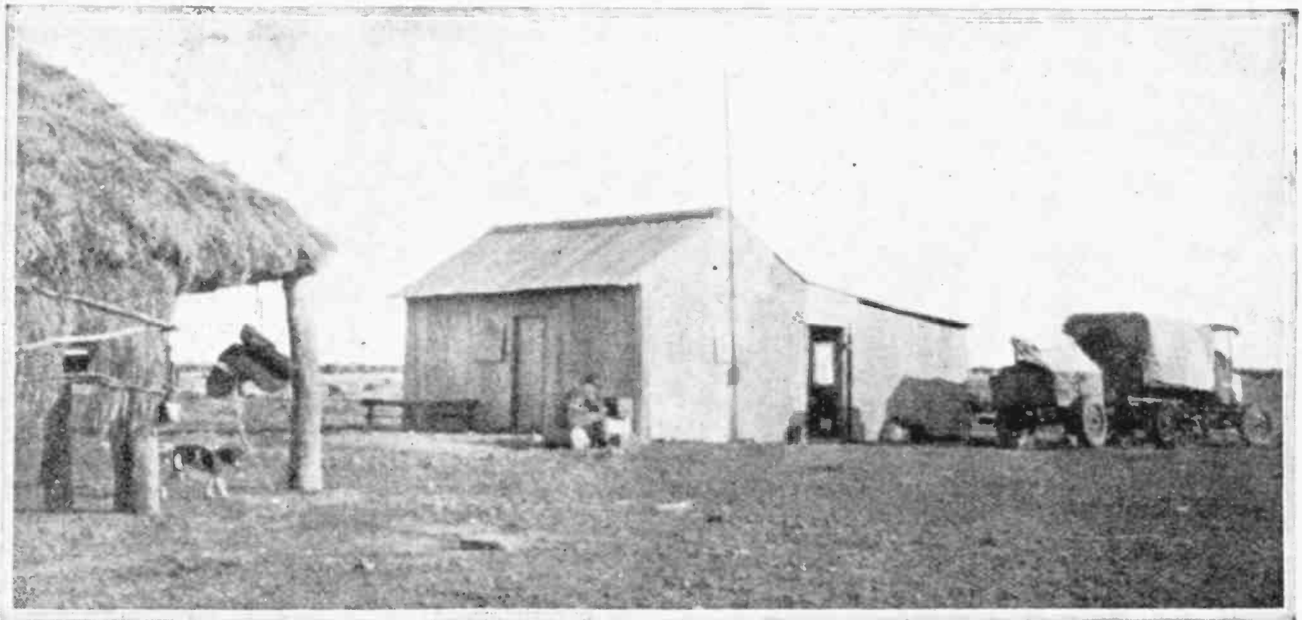
Choice of L.F. Valves.

Now our next, or first L.F., valve must be a low-impedance valve in order to prevent another form of distortion, known as valve overload distortion Actually the impedance should be about 8,000 ohms. Now the important consideration emerges that since we have involuntarily reduced our internal valve impedance, we can reduce our external impedance and still have the same ratio of internal to external impedance as in the case of the detector valve.

Therefore, our transformer need not have so great a primary inductance, and we can reduce from 80 to say 50 henries. This means we have less wire on our primary, and so can put more wire on the secondary without increasing the total bulk of wire, and therefore without making the self-capacity any greater than in the case of our 80-henry transformer. In other words, we can use a higher ratio and get a greater voltage step-up. Actually we can go up to about 4 to 1 before self-capacity begins to make itself evident again. Now we have used a high-impedance valve of about 30,000 ohms for the detector, such, for instance, as the D.E.5B, whilst we found that, in order to prevent overload distortion, we had to use a low-impedance valve of about 8,000 ohms impedance, such as the D.E.5, for the first L.F. valve, because the lower the valve impedance the greater the power it will handle without distorting. If we are fairly close to a broadcasting station we may find that signals will be so strong that even a D.E.5 will be overloaded if we use it in the last stage, and we may find it necessary, therefore, to use a valve of still lower impedance, say about 4,000 ohms, like the D.E.5A in the output stage. We are not going to put our telephone in the plate circuit of this valve for reasons to be stated later, but are going to use a choke filter circuit. But as our final valve is of still lower impedance than the lowest valve, we can still further reduce the value of the external impedance and keep the original ratio between internal and external impedance. Instead of using 50 henries inductance we only require about 30 henries, although, for reasons to be stated later, we shall want to use an iron core of somewhat larger cross-sectional area than in the usual intervalve coupling choke.

Having thus dealt with the actual circuit employed, and considered all too briefly the principles underlying the design of a theoretically sound L.F. amplifier, we are now in a position to briefly consider one or two minor matters, such as the method of switching employed, and we can then pass on to the practical constructional details, but not this week.

(To be concluded.)



WIRELESS IN THE WILDS.

With a Gambrell Set in the Australian Bush.

By MICHAEL TERRY, F.R.G.S., F.R.A.I., F.R.C.I.

THE wireless equipment used on my expedition through Northern Australia was a compact receiving set put up by Messrs. Gambrell Bros. It comprised a single circuit tuner with one stage of high-frequency amplification, the circuit being on the neutralised tuned anode principle. There was also one stage of low-frequency amplification and a detector valve, the whole being tuned by Gambrell detachable coils and variable condensers. The set was built into a special box carrying the high and low tension batteries; spares were clamped at the back of the set. The three valves were of the dull emitter 0.06 amp. type, and throughout the months the set was in use the two dry cells of 1.5 volts each and the H.T. battery of 60 volts needed no attention.

Temporary Aerials.

The aerial was 100 feet in length, insulated flexible copper wire, with two porcelain insulators at each end, attached to ropes for slinging purposes. Using a hammer or spanner as slinging weight, Prescott, who had sole charge of this part of our activities, used to throw the ropes over convenient tree forks. Sometimes he was able to fix his aerial 30 or 40 feet in the air; more often it was considerably lower. The earth was simply a roll about 20 feet long of rabbit-proof wire netting, with the earth wire soldered to it. It was kept in contact with the ground by logs or stones, and, whenever possible, water was thrown on it to aid contact. The alternative of fixing the earth wire to a steel creeper track of one of the Guy cars was tried, but this gave much poorer results.

And yet with these crude conveniences most remarkable results were obtained. At the first camp on the Katherine River, Morsing of ships and atmospherics were too bad to let Prescott pick up any of the southern stations—Melbourne, Adelaide, and Perth. At the first long camp—Champagne Camp—in approximately 15° south latitude, he picked up 3LO Melbourne for the first time at real strength. This was roughly 1,800 miles away. Onward from this place time signals, to check chronometers for survey work, were picked up regularly, while broadcast programmes from Adelaide and Melbourne were seldom silent.

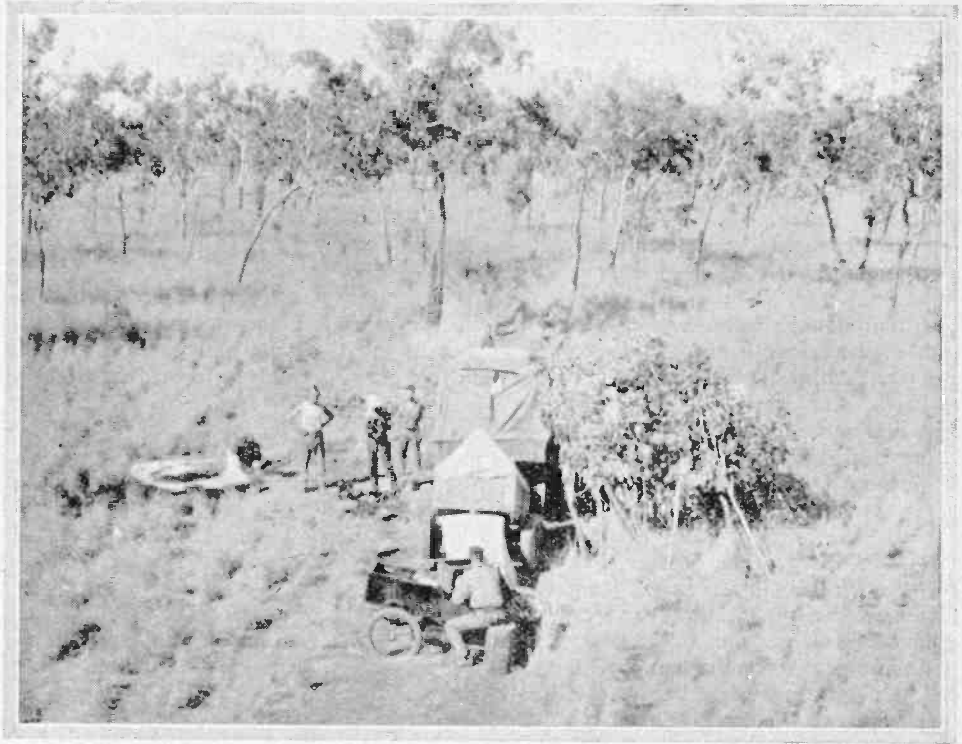
Reception used to vary considerably with the smallest change of locality. This inconsistency was so marked that at one camp the headphones could be laid on the set for use as miniature loud-speakers, and yet only a few miles away the faintest sounds were obtained only with the greatest difficulty.

Listening-in for the First Time.

The human side of our wireless activities was varied as it was strong. No one was more impressed or delighted with his first wireless concert than Smitheram, our mineralogist, an old prospector, who is one of the few remaining that knew Kalgoorlie in the earliest days of its gold boom. His enthusiasm was boundless. Years dropped from his shoulders like weights from a shelf. When music came in he beat time with his hands; when speech was heard he talked with the announcer. He fairly "went off the deep end" in his joyous acclamation of the first jazz music he had heard. The consistent appreciation he showed thereafter made me feel that, had the set been valueless for any other use, it had been worth while bringing it solely for the joy it brought to Smitheram.

Wireless in the Wilds.—

As for we other more sophisticated beings, we were not altogether unstirred by the event. It was rather weird to hear voices from surroundings we all knew so well coming to the quietness of the Bush by the bright camp fire.



Champagne Camp with the receiving set in the foreground.

A Japanese Station.

Prescott frequently picked up telephony in an Oriental voice that none of us could recognise. The general intonation resembled Japanese, and once music, like the orchestra that used to play on the lake at Wembley, came in strongly. Nothing could be proved by the wavelength, so until Perth was reached after the trip this had to be a matter of vague conjecture. However, it now seems almost a certainty that the Japanese station, OAK, was the source.

One evening three stations using very nearly the same waves were picked up. Their broadcastings came tumbling in on top of each other, too confusing to separate or dissect. Perhaps the most interesting evening was the one that a French voice was heard. Can it be that Prescott picked up Bordeaux? I do not know of a nearer telephony transmitting station than there. And anyone who dares to suggest we may have been listening to a French lesson from Melbourne will not be believed. That would be far too commonplace.

Listening-in at the South Esk Tablelands in Warburton's Great Sandy Desert.

At Wave Hill Station, where a large transmitting station has been erected, a most amusing incident took place. Prescott was always a most popular arrival, for the stockmen knew his set held pleasures new and untried. At this station, as elsewhere, his first concern on arrival was to find slinging places for the aerial. Then after dark he would gather around him a group of bushmen, curious and expectant. On this occasion, with the three valves glowing dull, he tuned in to Melbourne. Luckily, music was being broadcast; the audience waxed enthusiastic, each for his turn at the headphones. In the middle of this entertainment Prescott was called away; a new arrival, getting over-keen to hear the music, pushed his

Wireless in the Wilds.—
way to the set. He searched round the box looking everywhere for something that should have been there—but was not.

"What's the matter, Fred?" he was asked.

"This is the funniest machine I've come across"—he scratched his head, unearthed a brainwave, and exclaimed, "Here! I know how to work these things. Where's the handle?"

A roar of laughter greeted this announcement, for it was clear he imagined it to be some freakish model of gramophone.

At Wallamunga waterhole in Sturt Creek, 30 miles south of Inverway Station, we received 3LO with great strength. Although the aerial was scarcely 20 feet above the earth, and despite the great distance from Melbourne, during the last hour of the programme it was plainly audible on two valves.

Black Magic.

At Billiluna Station, just to the north of Gregory's Inland Sea, some lengths of galvanised iron piping were screwed together for aerial uprights. With these helps good results were obtained. Adelaide broadcasting came in strongly, and just after sundown bedtime stories could be heard. For several nights musical programmes were clearly received.

To the blacks at the homestead this wireless was indeed magic. After some persuasion one was induced to listen-in. Instead of leaping away with a howl and fleeing in crazy madness to the Bush he took it all very quietly and in a philosophical manner At Smitheram's suggestion some explanation was given, to aid an artful purpose.

"White fellar longa big fellar Gubbermint, him talk longa you."

"Yu-i," the black replied, meaning "Yes."

I continued: "Suppose 'm black fellar make'm trouble longa motor car, big fellar Gubbermint him hear 'em you all about. You savee?"

Again understanding was signified by "Yu-i."

"Big fellar Gubbermint him send 'em big mob police, make 'm big mob trouble."

Once more came the inevitable "Yu-i."

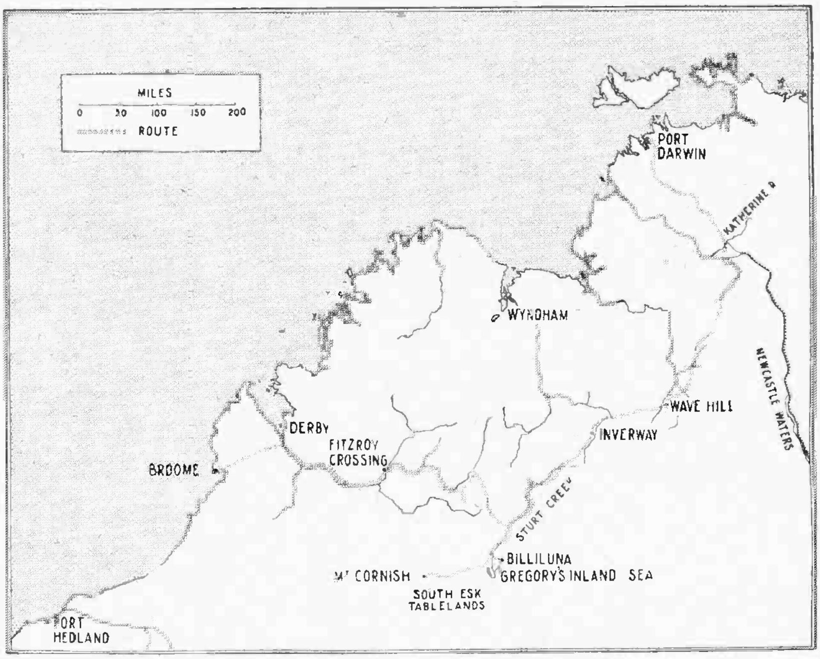
After all, this logic was sound to their simple minds. No doubt they reasoned that if a man can talk to them he can also hear them—planning good or evil.

On the way to the coast, having penetrated into the great Sand Plains as far as Mount Cornish, we halted for a couple of days at Ruby Plains, a cattle station homestead where two white men had settled down. The following day Prescott and one of the owners got into an argument as to the day of the week. Oliver protested it was Sunday, while our surveyor stuck to his guns that it was Saturday. Long did they wrangle, each producing tons of evidence to support his claim. At last eventide came, and with it the nightly bond with the world. Prescott tuned in to Melbourne, and after various announcements which could not be held to prove the day of the week, news came in giving the names of the winners of the race that afternoon. Well, in Australia everyone knows the dates of races, so there could no longer be any doubt as to the correctness of Prescott's claim; it *was* Saturday.

The following evening we got the church service from Saint Bartholomew's at Adelaide, and it was so incredibly clear that I'll swear I heard the coins dropping into the offertory plate!

Atmospherics.

By the time we had arrived at Fitzroy Crossing the thunderstorms which herald the coming of the monsoonal rains had become so insistent that atmospherics almost deafened one. It might be possible to pick up a station just after sundown, but as the evening lengthened the cracklings increased, rendering further efforts of no avail.



Map showing route followed by the expedition.

Needless to say, all station owners were highly impressed with the advantages of wireless reception, and I feel that this pioneer demonstration will result in quite a number of sets being purchased by them.

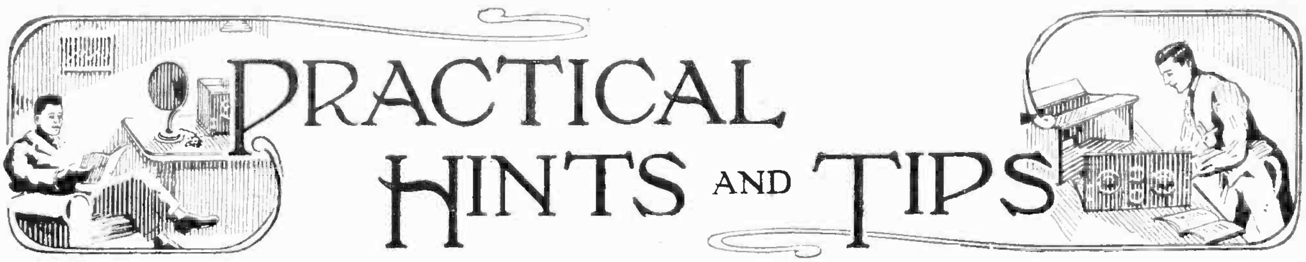
And, in conclusion, it is interesting to say that Prescott has now bought this set for his own private use, thus paying Messrs. Gambrell Bros. unspoken tribute of the highest degree.

CHEAPER VALVES.

Important reductions in the price of Osram valves took place as from Monday last, August 16th.

The following table shows at a glance the alterations in price:—

			Old Price.	New Price.
For 2-volt accumulators ..	D E 2	H.F. and L.F. ..	15/6	14/0
" 4-volt " ..	D E 3 / D E 3B		16/6	14/0
" " " " ..	D E Q	..	27/6	25/0
" " " " ..	D E 4			
For 6-volt " ..	D E 8	H.F. and L.F.	22/6	18/6
" " " " ..	D E 5			
" " " " ..	D E 5B			
" " " " ..	D E 5A	..	26/0	22/6



A Section Mainly for the New Reader.

A TWO-CIRCUIT TUNER.

A form of coupled-circuit tuner, which has some practical advantages, particularly where metallic screening is used, is shown in Fig. 1. The arrangement is not widely known among amateurs, but has been utilised in commercial apparatus for some time.

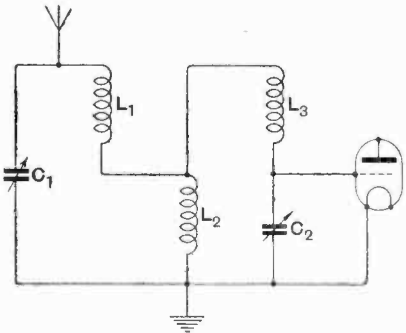


Fig. 1.—An auto-coupled two-circuit tuner.

The inductances L_1 and L_3 act as the main tuning coils for the aerial and secondary circuits respectively, while L_2, which is common to both circuits, acts as a coupling coil; as this inductance is reduced, the coupling is loosened, and, to obtain fine control, it should be tapped at intervals, although rough adjustments may be made by using plug-in coils of different sizes.

Magnetic interaction must be avoided as far as possible, and, as suggested above, some form of screening is desirable; the three coils may with advantage be enclosed in separate compartments.

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INTERFERENCE FROM ELECTRIC MAINS.

It is often found that the installation of a long extension lead for phones or loud-speaker to a room other than that in which the receiver is fitted results in the production of an annoying "hum," due to induction effects from the lighting wires, which may be near to, and more or less parallel with, this extension. As far as local reception is concerned, at any rate, this trouble may sometimes be overcome by entirely disconnecting the normal "earth," and using the extension as a form of counterpoise. If its length is comparable with that of the aerial, it may operate fairly efficiently in this capacity, and, provided there is a reserve of signal strength available, the reduction of volume due to the use of even a very inefficient counterpoise may still be tolerated. A consideration of the circuit diagrams of the great majority of receivers, whether crystal or valve, will show that the phone leads are already connected (through the H.T. by-pass condenser) to the normal earth point, although occasionally, when a coupled aerial circuit is used, it will be necessary to connect the low-potential end of the primary coil to the L.T. battery lead. These remarks hardly apply when a telephone transformer is used.

If, when trying this device, it is found that the "hum" is either considerably reduced, or entirely eliminated, but that signal strength has also suffered a great reduction, the amateur will do well to consider the erection of a counterpoise of full size and conventional design, which will in all probability have the desired effect.

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SELECTIVE CRYSTAL RECEIVERS.

Further to previous remarks made on the above subject in this section of *The Wireless World*, it may interest those who wish to improve an existing set with a minimum of trouble to know that the simple circuit suggested in Fig. 2 is capable of giving good results in this respect with the simplest apparatus.

The condenser C_1, in series with the aerial, should be regarded rather as a coupling than a tuning device. Selectivity will be increased as its capacity is decreased. A variable condenser with a maximum capacity of 0.0003 mfd., or a fixed one of some 0.0001 mfd., may be used.

A change in the total capacity of the condensers C_2, C_3, shunting the tuning coil, will have an exactly opposite effect, and an increase will result in improved selectivity, due to a reduction of the oscillating voltage applied to the crystal, which will thus take a reduced current, and impose less damping on the tuned circuit. It is, therefore, necessary to use a fairly small series condenser and inductance, with a large parallel capacity.

It is hardly possible to make very definite suggestions as to suitable values; these will depend largely on the constants of the aerial-earth system and the effective resistance of the crystal. If this latter is of the popular treated galena type, a shunting capacity of 0.001 mfd. or more may be necessary, and to obviate the necessity of obtaining a special variable condenser for the purpose, it is suggested that a fixed one (C_3 in the diagram) should be connected as shown.

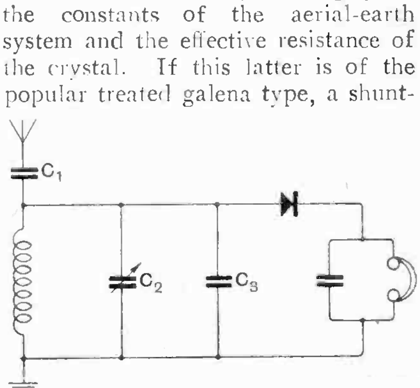

Fig. 2.—Reducing aerial and crystal damping.

It may sometimes be necessary to make a compromise between volume and selectivity by decreasing and increasing the capacities of the series and parallel condensers beyond the point at which signal strength is at a maximum. The most suitable adjustments can easily be found by trial.

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MOUNTING A VARIOMETER DIAL.

A practical difficulty exists in mounting certain variometers, as it is sometimes impossible, without an actual test, to set the indicating dial in such a way that an increase of scale reading shows a corresponding increase of wavelength. If this operation is carried out in a haphazard manner, it may possibly be found that, as the pointer is moved from zero to maximum, the wavelength of the circuit of which the variometer forms a part is decreased. This is admittedly not a matter of vast importance, but the operation of a set working in this way is likely to be confusing—unless, perhaps, we all adopt the more logical procedure of always thinking in terms of frequency rather than wavelength.

Obviously, it will not be a difficult matter to decide if the dial is correctly set on its spindle when it is possible to tune-in to two stations of which the wavelengths are fairly accurately known, but it may be useful to know that this information may easily be ascertained without a wavemeter, even in the case of the simplest crystal set, which may seldom receive signals except from one station.

Assuming that the variometer is used for tuning the aerial circuit, a variable condenser should be inserted in series with it, and a signal tuned in, noting carefully the scale readings of both condenser and variometer. The condenser capacity should now be decreased until signals are appreciably reduced in strength, and then the variometer dial should be turned until they again reach maximum. If the reading of this latter dial has now increased, it may be assumed that the component is correctly mounted. If this is not the case, it will be necessary to remove the dial and to turn the rotor through 180 degrees before refixing it.

This method of testing is, of course, not necessary when the coils are exposed in such a way that the direction of both windings can be traced visually.

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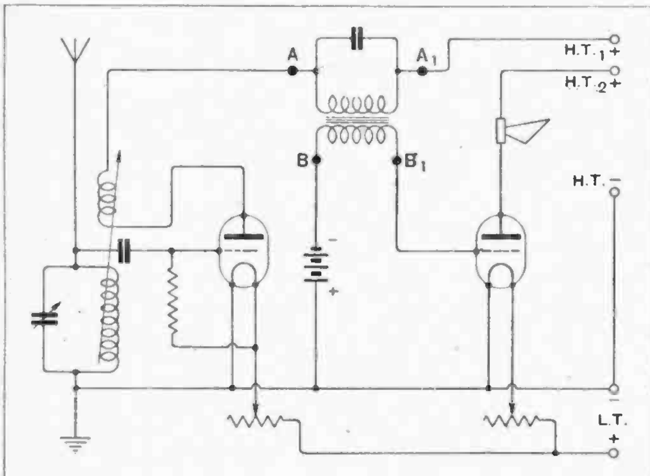
A "REINARTZ" HINT.

Trouble is sometimes experienced with a Reinartz type of receiver, operating on the longer wavelengths, through a resonance effect due to the presence of the usual H.F. choke in the anode circuit of the detector valve. If this choke, with the incidental capacities associated with it, has a natural wavelength approximating to that of the desired signal (a condition not infrequently obtaining in practice), it will often be found that uncontrollable oscillations are generally produced. The trouble may, of course, be overcome by altering the inductive value of the choke, but the more simple alternative of removing the fixed condenser across the phones or transformer primary may first be tried.

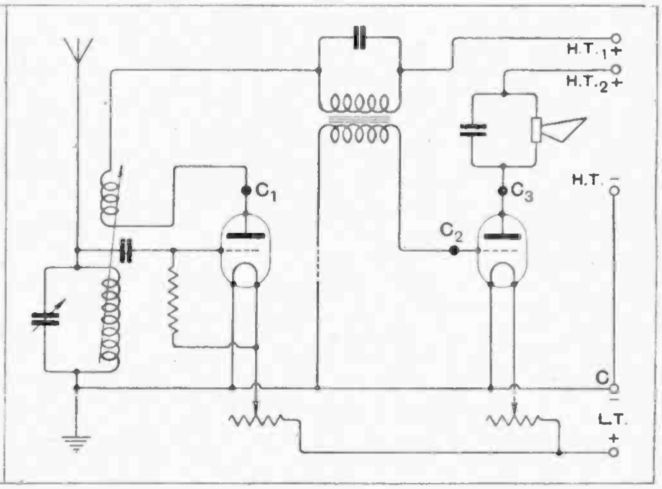
DISSECTED DIAGRAMS.

No. 40.—Point-to-point Tests of a Detector L.F. Receiver.

It is proposed to show, in a short series of diagrams, how simple tests for continuity and insulation may be applied at the points where breakdowns are most likely to occur. These tests are more particularly applicable to a receiver which has developed a fault after having functioned satisfactorily. A pair of phones and a small dry battery may be used as an indicating device, and should be connected up as shown in last week's issue.



It is assumed that the tests of the detector valve circuits, as shown in last week's issue, have already been applied, without showing the source of the trouble. The fault may very possibly be in the transformer windings, so the testing circuit should be applied across points A and A_1, and also B and B_1. Failure to obtain loud clicks will indicate a breakdown. The by-pass condenser may be disconnected and tested separately. Test also for insulation between windings across A and B, or A_1 and B_1. Batteries should be disconnected.



An additional test for continuity in the complete anode circuit of the detector valve may be made between C_1 and the H.T.1+ terminal, while the insulation of the grid, of the L.F. valve may be checked by testing between C_2 and C, with grid bias battery disconnected. There should be continuity between C_3 and the H.T.2+ terminal, with loud-speaker connected, but no click, except that due to the charging up of the by-pass condenser, when this is removed. The insulation resistance between C_3 and C should be high.

SHORT-WAVE TRANSMISSIONS.

The following list has been compiled from information received from various sources and at various times. Few of the stations undertake transmissions at regular stated hours, and the times of working have therefore been omitted. Many are, of course, only of a temporary nature for test and research purpose and may now be discontinued.

The Editor will welcome information concerning additions and amendments for inclusion in future lists.

Wave-length.		Call-sign.	Station.
13.0	metres.	POF	Nauen.
15.0	„	U2XAW	G.E. Co., Schenectady, N.Y.
17.0	„	NKF	Naval Lab., Bellevue, Anacostia.
18.0	„	POF	Nauen.
20.0	„	NAL	Navy Yard, Washington, D.C.
—	„	NEPQ	U.S. s/s "Relief."
—	„	POX	Nauen.
20–30	„	NAL	Navy Yard, Washington, D.C.
20.8	„	NKF	Naval Lab., Bellevue, Anacostia.
21.0	„	U2XAD	G.E. Co., Schenectady, N.Y.
22.0	„	WIK	New Brunswick.
23.0	„	F FW	Sainte Assise. (Commercial Traffic with Buenos Aires.)
25.0	„	G2YT	Poldhu.
—	„	PCMM	Ministry of P. & T., The Hague.
—	„	POY	Nauen.
25.6	„	NKF	Naval Lab., Bellevue, Anacostia.
26.0	„	AGA	Nauen. (Traffic with Argentine.)
—	„	POX	Nauen. (Traffic with Argentine.)
28.0	„	POW	Nauen. (Traffic with Argentine.)
29.0	„	OCNG	Nogent le Rotrou.
30.0	„	F8GA	Clichy. (Testing Station of S.F.R.)
—	„	U2XI	Schenectady, N.Y.
30.6	„	NAL	Navy Yard, Washington, D.C.
32.0	„	G2YT	Poldhu.
—	„	LY	Bordeaux Lafayette. (Time Signal 0800 and 2000 G.M.T.)
—	„	OCNG	Nogent le Rotrou.
33.0	„	OCDJ	Issy les Moulins. (Weather reports "Météo Europe" at 1008-1028.
35.0	„	U2XI	Schenectady, N.Y.
—	„	WQO	Rocky Point, N.Y.
—	„	WGY	G.E.C., Schenectady, N.Y.
35.03	„	QO	Rocky Point, N.Y.
36.0	„	LPZ	Buenos Aires.
37–40	„	NPU	Tutuila, Samoa.
38.0	„	U2XI	Schenectady, N.Y.
39.0	„	OCMV	Mont Valerien, near Paris. (Transmits at 1000, 1100, 1230, 1330, 1600, 1900, 2000, 2100 and 2200 G.M.T.)
40.0	metres.	NAJ	Great Lakes, Illinois.
—	„	NAS	Pensacola, Fla.
—	„	NOSN	U.S. Submarine Base, Coco Solo, Panama.
—	„	NPG	S Francisco, Calif.
—	„	NQW	U.S. s/s "Mexico."
—	„	NRRL	U.S. s/s "Seattle."
—	„	U1XAO	Belfast, Maine.
41.0	„	NKF	Naval Laboratory, Bellevue, Anacostia.
42.0	„	F FW	Sainte Assise. (Commercial Traffic with Buenos Aires.)
—	„	PCUU	Dutch Colonial Ministry, The Hague.
43.0	„	NPG	San Francisco, California.
43.02	„	WIZ	New Brunswick, N.J. (20 k.w.)
44.0	„	KZA	Los Angeles, Calif.
—	„	KZB	Los Angeles, Calif. Portable.
45.0	„	NPG	San Francisco, California.
—	„	OCNG	Nogent le Rotrou.
45–47	„	YZ	Fort d'Issy.
—	„	ZZ	Fort d'Issy. (Portable.)
46.0	„	OCMV	Mont Valerien, near Paris. (At 1000, 1100, 1230, 1330, 1600, 1900, 2000, 2100 and 2200 G.M.T.)
47.0	„	POZ	Nauen.
48.0	„	OCNG	Nogent le Rotrou. (TestingStation.)
—	„	OCTU	Tunis le Casbah. (Weather Report "Météo Tunis" at 2130 G.M.T.)
49.0	„	NPM	Honolulu.
—	„	WHD	Sharon, Pa.
50.0	„	AIN	Casablanca, Ain. Bordja. (Weather reports "Météo Maroc" at 0830 and 0930 G.M.T.)
—	„	NKF	Naval Lab., Bellevue, Anacostia.
—	„	WBZ	Springfield, Mass. (Westinghouse Co., 20 k.w.)
51.5	„	WQN	Rocky Point, N.Y. (R.C. of A., 20 k.w.)
53.0	„	NPU	Tutuila, Samoa.
—	„	ZWT	Bremerhaven.
54.0	metres.	NBA	Balboa, Panama Canal Zone.
54.4	„	NKF	Naval Lab., Bellevue, Anacostia.
54.5	„	WQN	Rocky Point, N.Y. (R.C. of A., 20 k.w.)
56.0	„	KFKX	Hastings. Nebr.
57.0	„	WQN	Rocky Point, N.Y. (R.C. of A 20 k.w.)
58.0	„	OCBV	Beyrouth.
58.79	„	KDKA	East Pittsburg, Pa. (Westinghouse Co.)
59.0	„	KDC	Casper, Wyoming. (Illinois Pipe Line.)
60.0	„	G2YT	Poldhu.
—	„	U1XAO	Belfast, Maine.
67.0	„	U8XS	E. Pittsburg, Pa.
68.0	„	NPO	Cavite, Philippine Isles.
68.4	„	WRB	Miami, Florida. (Florida Radio Teleg. Co., 100 watts.)
—	„	WRP	Miami, Florida. (Florida Radio Teleg. Co., 5 watts.)
70.0	„	—	Cadiz.
—	„	—	Matagora.
—	„	POX	Nauen.
70-84.5	„	NERM	U.S. s/s "Los Angeles."
70.5	„	NQG	San Diego, Calif.
71.0	„	NKF	Naval Lab., Bellevue, Anacostia.
71.5	„	NPL	U.S. Training Ship, San Diego, Calif.
72.0	„	OCNG	Nogent le Rotrou.
72.0	„	OCDB	Djibouti, French Somaliland.
74.0	„	WIR	New Brunswick, N.J. (R.C. of A.)
75.0	„	F8GB	Saint Assise.
—	„	LY	Bordeaux Lafayette. (Time Signal at 0800 and 2000.)
—	„	NIRX	U.S. s/s "Canopus."
—	„	NUGB	U.S. s/s "Pope."
—	„	WGN	Rocky Point, N.Y.
76.0	„	NAJ	Great Lakes, Ill.
—	„	POX	Nauen.
77.5	„	NFV	U.S. Marine Corps, Quantico, Va.
80.0	„	NEL	Lakehurst, N.J.
—	„	U2XAC	G.E. Co., Schenectady, N.Y.
81.0	„	NPG	S. Francisco, Calif.
81.5	„	NKF	Naval Lab., Bellevue, Anacostia.

Wave-length.		Call-sign.	Station.
83.0	metres.	RDW	Moscow.
84.0	„	NKF	Naval Lab., Bellevue, Anacostia.
86.0	„	NQC	San Diego, Calif.
90.0	„	KIO	Kahuku, Hawaii. (R.C. of A.)
—	„	U1XAO	Belfast, Maine.
—	„	U6XO	Kahuku, Hawaii.
92.0	„	G2YT	Poldhu.
94.0	„	G2YT	Poldhu.
95.0	„	KEL	Bolinas, Calif. (R.C. of A.)
96.0	„	U8XS	East Pittsburg, Pa.
99.0	„	KET	Bolinas, Calif.
—	„	U6XI	Bolinas, Calif.
100.0	„	NAM	Norfolk, Va.
—	„	POX	Nauen.
—	„	SOJ	Brazilian s/s "Jaquarão."
—	„	U2XI	Schenectady, N.Y.
103.0	„	WGH	Tuckerton, N.J. (R.C. of A.)
105.0	„	WHU	U.S. s/s "Big Bill."
107.0	„	U2XI	Schenectady, N.Y.
109.0	„	U2XK	G.E.C., Schenectady, N.Y.
110.0	„	KFHV	U.S. s/s "Facile."
—	„	KFVT	U.S. s/s "Eloise."
—	„	KFWJ	U.S. s/s "Gallavant."
112.0	„	U1XAO	Belfast, Maine.
115.0	„	KFWK	U.S. s/s "Nirvana."
115.3	„	KFVB	U.S. s/s "Bridget."
119–149	„	NDF	U.S. s/s "West Virginia."
—	„	NEDJ	U.S. s/s "California."
120.0	„	U1XAO	Belfast, Maine.
133.0	„	WDYC	Detroit, Mich. (Detroit Yacht Club.)
135.0	„	WJF	Rochester, N.Y.
137.0	„	WBI	Frankville, Pa. (Pennsylvania Power & Light Co., 200 watts.)
—	„	WCJ	Hazleton, Pa. (Pennsylvania Power & Light Co., 100 watts.)
—	„	WDS	Pottsville, Pa. (Pennsylvania Power & Light Co., 500 watts.)
—	„	WHC	Allenton, Pa. (Pennsylvania Power & Light Co., 200 watts.)
—	„	WLF	Wilsonville, Pa. (Pennsylvania Power & Light Co., 200 watts.)
—	„	WPH	Williamsfort, Pa. (Pennsylvania Power & Light Co., 200 watts.)
—	„	WOY	Springvale, Pa. (West Pennsylvania Power Co., 100 watts.)
140.0	metres.	KFWR	S. Benito, Tex. (Rio Grande Radio Supply, 10 watts.)
—	„	KFWS	Brownsville, Tex. (Rio Grande Radio Supply, 10 watts.)
—	„	KPG	Quanah, Tex. (Quanah Light & Ice Co., 250 watts.)
—	„	KPK	Lawton, Okla. (South-western Light & Power Co., portable, 100 watts.)
—	„	KPP	Lawton, Okla. (South-western Light & Power Co., portable, 250 watts.)
—	„	KPR	Oklahoma City. (South-western Light & Power Co., portable, 250 watts.)
—	„	WAV	Dearborn, Mich. (Ford Motor Co., 500 watts.)
—	„	WDY	Iron Mountains, Mich. (Ford Motor Co., 500 watts.)
—	„	WDYC	Detroit, Mich. (Detroit Yacht Club, 500 watts.)
—	„	WGF	Flint, Mich. (F. D. Fallain, 500 watts.)
142.0	„	WJBF	Charleroi, Pa. (West Pennsylvania Power Co., 100 watts.)
143.0	„	KGA	Oakland, Calif.
—	„	KTA	San Francisco, Calif.
—	„	WAV	Dearborn, Mich. (Ford Motor Co., 500 watts.)
—	„	WEQ	Baltimore, Maryland. (Board of Fire Commissioners, 250 watts.)
—	„	WJH	Washington, D.C. (Potomac Electric Power, 50 watts.)
—	„	WJX	Washington, D.C. (Potomac Electric Power, 50 watts.)
—	„	WWED	Stannard Rock Light Stn., Mich.
—	„	WWEE	Marquette Light Stn., Mich.
145.0	„	WJF	Rochester, N.Y.
—	„	WWEB	Duluth Range Rear Light Stn., Minnesota.
154.0	metres.	WWEC	Superior Entry Light Stn., Wis.
146.0	„	KDBF	U.S. s/s "Eagle."
—	„	KDBG	U.S. s/s "Edris."
—	„	KFJG	U.S. s/s "Wanderer."
146.0	„	KFKW	U.S. s/s "Spray III."
—	„	KFPA	U.S. Fireboat, No. 31. (Boston Fire Dept.)
—	„	KFPC	U.S. Fireboat, No. 44. (Boston Fire Dept.)
—	„	KFPD	U.S. Fireboat, No. 47. (Boston Fire Dept.)
—	„	KFTU	U.S. s/s "Skylark II." (G. H. Philips.)
—	„	KFV	Los Angeles, Calif. (L.A. Co., Forestry Dept., 300 watts.)
—	„	KFZ	Los Angeles, Calif. (Russell Reed, 50 watts.)
—	„	KGV	Los Angeles, Calif. (Russell Reed, 50 watts.)
—	„	KGZ	Los Angeles, Calif. (Russell Reed, portable, 50 watts.)
—	„	KJA	Pysht, Wash. (Merrill & Ring Lumber Co., 5 watts.)
—	„	KJU	Culver City, Calif. (C. B. De Mille, 50 watts.)
146.0	metres.	KVP	Dallas, Tex. (Dallas Fire Dept., 100 w.)
—	„	KYI	Culver City, Calif.
—	„	KYJ	Culver City, Calif.
—	„	KYX	Los Angeles, Calif. (Pratt & Dutro, portable, 500 watts.)
146.0	metres.	KYY	Los Angeles, Calif. (L. A. Forestry Dept. 500 w.)
—	„	KZI	Hollywood, Calif. (Pratt & Dutro, 500 watts.)
—	„	KZY	Culver City, Calif.
—	„	U6XO	Kahuku, Hawaii.
—	„	WEY	Boston, Mass. (Boston Fire Dept., 5 watts.)
150.0	metres.	GFSY	British s/s "Siamese Prince."
—	„	GQS	British s/s "Lady Brassey."
—	„	KDNY	U.S. s/s "Favorite." (Panama Canal.)
—	„	KULG	U.S. s/s "Darien." (Panama Canal.)
—	„	NITZ	U.S. s/s "Sturgeon Bay."

BRITISH ASSOCIATION MEETING.

Lectures by Captain P. P. Eckersley and Mr. J. C. Stobart.

CAPTAIN ECKERSLEY LOOKS AHEAD.

ON Friday evening, August 6th, Captain P. P. Eckersley, chief engineer to the British Broadcasting Co., gave a lecture in the Town Hall, Oxford, dealing with the future of broadcasting. The early part of the lecture related to the beginnings of broadcasting in Great Britain and America, and Capt. Eckersley told the now familiar story of the work of a few enthusiasts at the early experimental station at Chelmsford, which was temporarily cut short by the decision of the then Postmaster-General. Following on this there came the rapid development of broadcasting in America, where everybody who cared was allowed to broadcast—a policy being adopted there even to-day. Subsequently came the formation of the British Broadcasting Co. on its present basis, and Captain Eckersley related how the policy of national broadcasting has been developed here, as contrasted with the policy in America, and, he added, the British Broadcasting Co. to-day is the admiration of the world, even including America. The intention from the first had been that private individuals should not make profit out of the undertaking, hence the participation of the Postmaster-General in the control of the Company so far as the financial side is concerned, leaving the company with a fixed amount of revenue and a fixed maximum dividend. At the moment, said Captain Eckersley, it did not matter to the Company whether no more licences were issued, because it had reached its maximum of £500,000 per annum revenue.

Future Status of the B.B.C.

Speaking of the future of the B.B.C., Captain Eckersley referred to the report of the Government Committee on how the B.B.C. should be constituted in the future. The Press, he added, had already nominated every prominent member of Society as Chairman of the new body. As a matter of fact, a Chairman had not yet been appointed, but the Report of the Committee indicated how the Company would be constituted in future. Personally, he knew no more about the matter than reading the published Report, but many people had come to him and told him that in future he would be a Government servant; some had almost suggested that he would be wearing a peaked cap! As a matter of fact, reading the report, as any member of the public could read it, he could not see necessarily that they would be under Government control. In fact, he should say that the undertaking would be less under Government control than at present, because, as he saw it, the idea underlying the future of broadcasting was that there should be no privileges, but, on the other hand, there would be no restrictions. In his opinion, only on that idea could broadcasting go ahead. If broadcasting was to be restricted—if Bernard Shaw was to be forbidden to speak because he might be controversial, an awful thing!—that would be restricting a new art which was being very carefully watched by those in charge of it. Moreover, in the past, there had been an excuse to say that the income of the B.B.C. had been restricted, and he hoped that in the future the very simple idea would be adopted by the Government that, if people have subscribed towards a service, that money should go towards that service. He could not understand why it was necessary to restrict the income of the B.B.C. as it was at present. The Company could deal with an income many times greater than its present, and deal with it efficiently in the public interest. He hoped that in the future the whole idea would be to give this service to the public without restriction; on the other hand, no privileges were wanted. On that idea, he was perfecrly certain that the new Corporation, which was only to remove a technical anomaly in the present Board, would be able to go ahead on the lines he had indicated.

Technical Policy of To-morrow.

Capt. Eckersley's remarks on the technical policy of the B.B.C. were much the same as those he made at Southampton last year, how the aim had been to increase the area for the crystal user, what he then called the crystal area—a term he has now abandoned for service area. In order to carry out this idea to the full, the obvious thing was to increase the number of stations from the present twenty-one main and relay stations; indeed, to erect forty-two, but that was not a simple matter. At present, however, the urban areas had been covered in such a manner that 85 per cent. of users could get an uninterrupted programme, and the next step was to deal with the country areas. Work upon that was proceeding.

Eliminating Interference.

Passing to the problem presented by many stations all over Europe working upon different wavelengths so close together that they caused interference with each other, Captain Eckersley again referred to the work of the Geneva Conference upon allocation of wavelengths, and said that this scheme will be put into force on September 15th. At the present moment there were two hundred broadcast stations erected or projected, and one hundred of these stations were to be relegated to common wavelengths, being sufficiently far apart not to interfere with each other. For the rest, every country had been given a certain number of exclusive wavelengths, so that they could pursue their own uninterrupted course of development. Nine exclusive wavelengths had been given to Great Britain, and for the rest the relay stations here would have to share wavelengths in the way already indicated. This scheme meant considerable sacrifice on the part of all countries but he regarded it as extremely satisfactory that such an arrangement should have been come to.

After indicating the new wavelengths for the stations of the B.B.C., which have already been published, Cap-

British Association Meeting.—tain Eckersley visualised the future of wireless in which a combination of wireless and line telephony will enable the whole of the world to be linked up, so that public men in any part, speaking upon world topics, would be heard simultaneously all over the world in this way. That, he added, would be a great factor in maintaining world peace. This prospect of linking up the world by means of wireless and line telephony might be possible in ten or fifteen years; at any rate, that was as he saw things at the moment, although he might be quite wrong. After all, why need we stop at linking up various parts of one country? Why should not all countries be linked up in the same way? It was here that one of the great possibilities of wireless in conjunction with line telephony was to be looked for. As an instance, he suggested that in the case of this country a speech could be delivered in London, and sent, say, to Poldhu by wire, transmitted thence across the Atlantic by the beam system, picked up on the other side and sent forward by line, and then broadcast by wireless to the people of Canada. In the same way, the message could be sent eastwards partly by wireless and partly by line telephony, and distributed subsequently by wireless in South Africa and Australia and the Continental countries also, and in that way the whole world could listen to the important events in any particular country.

CAPTAIN P. P. ECKERSLEY, chief engineer of the B.B.C., whose speech at the B.A. meeting dealt with some interesting future developments.

MR. J. C. STOBART, Director of Education to the B.B.C., whose remarks emphasised the value of broadcasting as a unique instrument of education.

BROADCAST EDUCATION.

The part which wireless is playing and will in future play in education was dealt with in an address before Section L (Education) of the British Association on Friday, August 6th, by Mr. J. C. Stobart, Director of Education to the British Broadcasting Co. At the beginning of his address, Mr. Stobart said that as the company would shortly be changing its status, it should be placed on record that it was the managing director of a limited company who conceived the sphere of broadcasting to include a definite responsibility towards education. At the present time there was scarcely one broadcast station in the world which did not use this instrument to some extent for educational purposes; and even the American stations, which were regarded as purely commercial undertakings, had their definite educational programmes. The same could be said of France, Belgium, Germany, Holland and other countries. Nevertheless, Great Britain, in a quiet and informal way, perhaps, had been and still is a pioneer in educational broadcasting. Even before 1922, the year when the B.B.C. was formed, there had been some experimental work at the Writtle station. Later, after the formation of the B.B.C., steps were taken in each centre where there were stations to form advisory educational committees composed of leading local educationists, whose advice and co-operation was invited. A further step forward was taken in 1924, when a successful demonstration was given before the Board of Education, and shortly afterwards Mr. Stobart was lent from the Board of Education to act as Director of Education to the B.B.C. It was quickly found, however, that the work involved more than the spare time services of a director of education, and steps were taken for Mr. Stobart to resign from the Board of Education and devote his whole time to the task.

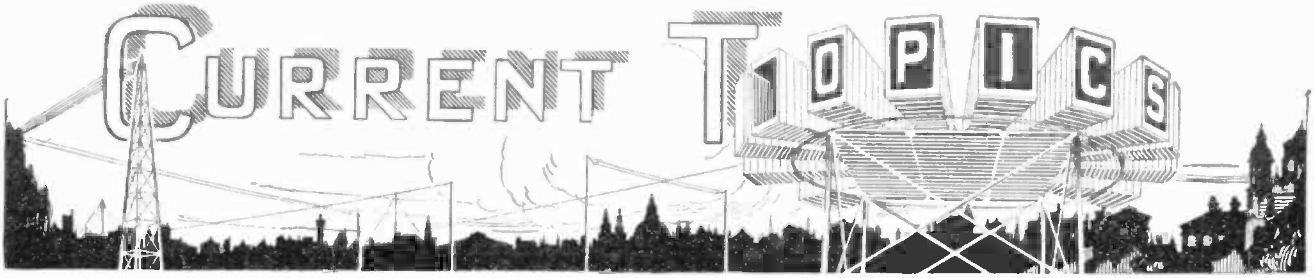
Lines of Development.

During 1924 experiments were carried out in the technique of broadcast to schools, and during those experiments those carrying them out were painfully aware of the fact that anything in the nature of failure would irretrievably damage the whole of the future prospects of the use of wireless for educational purposes. General culture, adult education and school transmissions were the three main lines of development, and as regards the last-named it was satisfactory that only one educational authority reported definitely against the advantages of wireless for school transmissions. Considerable progress was being made with school transmission, because more than 1,000 schools in the area of the London and Daventry stations have installed wireless and are using the transmissions as part of their regular curriculum.

Broadcasting Inspiration.

It had often been asked whether this form of education was really effective. Whilst agreeing that set lessons are perhaps the main feature of all education, there was that great feature of education, inspiration, and in no way could that better be effected than by listening to lectures by the greatest experts in their particular subjects. Therefore, he claimed that wireless could do an important and necessary service to all grades of education by the spread of the area of expert inspiration. Another part of the educational programme of the B.B.C. was evening continuation school work and adult education, and an extensive programme was being mapped out on these lines.

The next step forward should be the formation of listening classes possibly in connection with the rural libraries scheme, and negotiations are already in train to that end. Moreover, in a few months there would be increased facilities from the Post Office, which would enable alternative programmes to be submitted, thus allowing more educational matter to be broadcast.



Events of the Week in Brief Review.

STILL GOING STRONG.

Contrary to rumours which spread through Paris last week, the Eiffel Tower broadcasting service continues without interruption.

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AN APPROPRIATE PRESENT.

A complete wireless installation has been presented to the Farnborough and Cove War Memorial Hospital by public subscription under the auspices of the Royal Aircraft Establishment Benevolent Fund.

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RAILWAY BROADCASTING ANNIVERSARY.

The Canadian National Railways have just celebrated the first anniversary of the inauguration of the broadcasting system extending from Quebec to Vancouver.

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A PHYSICAL JERKS THEORY.

It is whispered in certain circles that the Government refused to sanction a special grant to the B.B.C. for broadcasting early morning physical exercises because such a course would encourage oscillation.

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THE WAITING LIST.

More than 630 organisations in the U.S.A. are reported to have applied for broadcasting licences. According to the latest statement issued by Secretary Hoover, a licence will be granted in each case on the completion of the station, but not before.

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MUSIC AND RADIO.

In the early days of wireless its modern association with matters musical could hardly have been foreseen. The alliance is now so complete that we have the spectacle of wireless journals including musical sections as a regular feature, and it is interesting to observe that *The Irish Radio Review* has actually changed its name to *The Irish Radio and Musical Review*. It is published at the original address, 179, Great Brunswick Street, Dublin.

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INDEXES AND BINDING CASES.

The index for Volume XVIII. of *The Wireless World* is now ready, and a copy will be sent to any reader on application to the publishers.

Binding cases for the same volume can also be supplied, price 2s. 10d. post free.

THE VERY WORST?

In a film now going the rounds of New York one of the characters curses another with the wish that all his children shall be radio announcers.

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THE CHANNEL SWIM.

Wireless was used to report Miss Ederle's victory over the Channel on August 8th.

The tug *Alsace*, which accompanied the swimmer, was equipped by the Marconi International Marine Communication Co., Ltd., with a Marconi ¼ kilowatt quenched spark set, by means of which newspaper reports of her progress were despatched at regular intervals, and transmitted by the direct Marconi service to America.

Readers of the *Chicago Tribune* and a large group of other American newspapers were thus enabled to follow the progress of the swim through successive editions with the least possible delay.

WHY NOT?

A new road in Los Angeles has been named after the local broadcasting station, and is known as "KNX Boulevard."

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WIRELESS AS A BUSINESS ASSET.

Envisaging a future when every office will have its wireless telephone, the well-known business training school "Instituut Schoevers," at the Hague, has installed a wireless telephone receiver for the instruction of its pupils.

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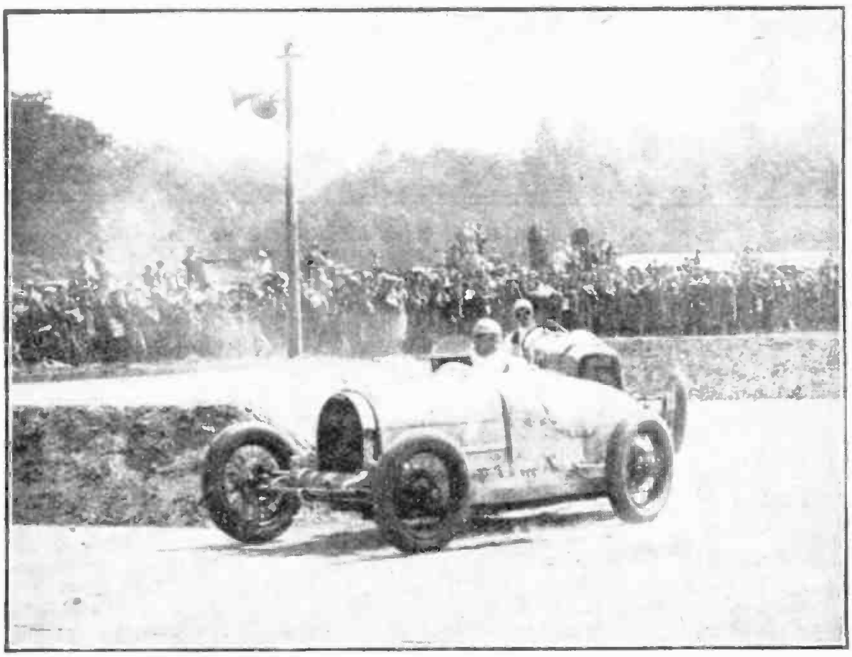
TELEVISION BEGINS.

Listeners in the London district who hear a droning sound on 200 metres will probably be hearing the transmission of the face of Captain Hutchinson, the business director of Television, Limited, at Motograph House, St. Martin's Lane, London. The Post Office has granted the first two licences for wireless television to the above-named company, using the



SPREADING THE NEWS AT BROOKLANDS. An exciting moment during the Grand Prix at Brooklands last Saturday week. Loud-speakers, distributed round the famous course, proved invaluable for acquainting the spectators with the progress of the race. Broadcast music from 2LO was also received.

Baird "Televisor," and regular transmissions of vision are now taking place between the company's head office and Green Gables, Harrow, where an experimental station is situated.

At present living faces and scenes are being sent from London to Harrow, but a certain amount of interference is being experienced on the 200-metre wavelength.

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DR. FOURNIER D'ALBE AND ESPERANTO.

At the Esperanto Congress in Edinburgh on August 4th Dr. Fournier d'Albe discussed the future of wireless. He expressed the belief that Esperanto would be adopted by every large transmission station as an auxiliary language, especially in transmitting important news.

Among real possibilities of wireless progress he mentioned a world clock that would be capable of controlling timepieces everywhere by special signals sent out every minute; wireless charts showing the distribution of weather for a hundred miles around the central station; wireless locating code signals for the use of aircraft capable of showing their position in a fog; and television, which would enable people to watch distant events while they were actually happening.

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RUSSIA'S RADIO RUSH.

Nearly a quarter of a million broadcast receivers are now registered in Soviet Russia, and the number is stated to be increasing at the rate of 25,000 per month. Plans are prepared for the erection of a 100-kilowatt broadcasting station at Moscow and 30-kilowatt stations at Novo-Sibirst and Tashkent.

WIRELESS IN CAMP. Members of the First Aid Nursing Yeomanry in camp at Brookwood. They have evidently solved the problem of remaining cheerful under canvas even during an English summer.

THE USUAL SNAG.

"Dedicated to public service" is the description attaching to a new American broadcasting station with the call sign WHAP, which will permit the transmission of neither jazz nor advertising matter. It would be refreshing to hear such a station, but unfortunately the power is only 500 watts.

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IRISH WIRELESS MANUFACTURERS.

At a meeting of prominent radio manufacturers and wholesalers held in Dublin on July 26th it was unanimously decided to form an Irish Association of Radio Manufacturers and Wholesalers for the purpose of promoting and protecting the interests of the radio trade in the Irish Free State.

A temporary committee was elected for the purpose of drawing up articles of association. The Association proposes to hold a wireless exhibition in the early autumn.

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WIRELESS AND THE BLIND.

The provision of wireless sets for the blind is mentioned in the annual report for 1925-6 of the National Institute for the Blind.

Up to the present time 158 sets and 282 pairs of headphones have been presented, 117 licences have been provided, and 26 aerials have been erected. Readers of the report are asked to send old sets or discarded headphones to the Secretary-General of the Institute. In so doing they will be bringing untold joy into the homes of many blind men and women.

EMANCIPATION IN DENMARK.

Official recognition has at last been accorded the Danish amateur transmitter, and a schedule of available wavelengths has been prepared by the Government. Amateurs may now transmit on 15 metres, from 43 to 47 metres, 70 to 75 metres, and from 95 to 115 metres. Power is restricted to 100 watts. The licence fee of 20 kroner (about £1) has been purposely put at a low figure to encourage amateur short-wave development.

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EUROPEAN WAVELENGTH CHANGES.

In view of the changes about to take place in the wavelengths of the British broadcasting stations—the list was published in last week's *Wireless World*—readers may be interested in the alterations which will be made in the wavelengths of Continental stations at about the same time.

The more important changes are shown below, the old wavelengths appearing in brackets :—

Oslo	370.4	(382)
Berlin	483.9	(505)
Paris P.T.T.	447.8	(458)
Petit Parisien	340.9	(358)
Madrid	375	(373)
Madrid II.	577	(392)
Rome	422.6	(425)
Hamburg	428	(392)
Vienna	517.2	(590)
San Sebastian	272.7	(343)
Stockholm	416.7	(427)
Berne	411	(435)

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PRINCE OF WALES AND EARLY WIRELESS EXPERIMENT.

An excellent illustration of the patient methods accompanying true scientific research was referred to by H.R.H. the Prince of Wales in his speech before the British Association at Oxford on August 4th :—

"The period of preparation by research before science can offer the world some new benefit may be long," said the Prince, "but the scientific machine is always running quietly in the laboratory. There is an example ready to our hands. We recall the introduction of wireless telegraphy and telephony as a scientific gift of quite recent years. Do we all realise that it was here in Oxford, at the meeting of the British Association so long ago as 1894, that the first public demonstration of wireless signalling by means of electro-magnetic waves was given by Sir Oliver Lodge? It was the work of science to develop the methods then demonstrated until they have been brought to their present marvellous uses. On the other hand, it is often the case, whether in industrial or agricultural, domestic or whatever application, that science has knowledge at command, awaiting use, long before mankind can be brought actually to apply it. Though we have quickened, we are not yet so quick in the uptake of the results of applied scientific research as, for example, some of our commercial competitors. The public support of scientific research, upon all these grounds, should be accorded freely, with understanding, and with patience."

RELAY FOR REMOTE CONTROL.

Combined Earthing and Battery Switch.

It is often inconvenient to have a wireless set in the same room as the loud-speaker or 'phones, and a switch to control the set from any point is useful. The relay was devised to fulfil this function, and constructed from "odds and ends" which most experimenters are likely to possess.

Fig. 1 shows a diagrammatic view of the relay. It consists essentially of an electric bell movement from which the hammer knob has been cut and the wire bent to dip into a cup containing mercury.

The spring contact on the armature has a small bend made in it about half an inch from the free end. Above the spring is pivoted a sector made of ⅛in. sheet iron, held by the spring in the position shown. At the top of the sector is a projection which, when in the off position, rests against the pole of another bell coil fixed horizontally.

Operation of the Relay.

When a current is passed through the two lower coils the armature is attracted, and contact is made in the mercury cup, also the sector moves round, under gravity, and maintains the armature in this position, after the current is switched off. During this process the projection on the sector has, of course, moved away from the top magnet.

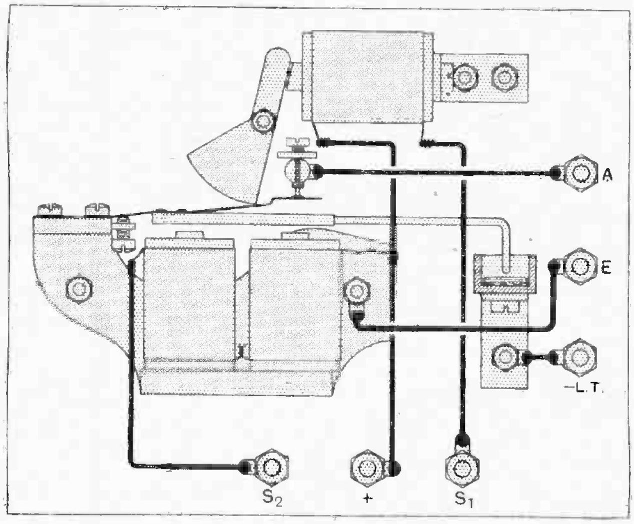


Fig. 1.—Diagrammatic layout and wiring diagram of relay.

To release, a current is passed through the top coil, so drawing the sector back into its original position and allowing the armature to rise and break contact in the mercury cup.

This form of control only necessitates the use of two extra leads, beside the 'phone leads, from the set, and any number of control points may be employed.

Fig. 2 shows the arrangement of connections to an ordinary set.

The armature is connected to earth and the negative side of the filaments, and the mercury cup to the negative pole of the accumulator. The ordinary contact screw of the bell, if left in position, may be connected to the aerial, so that when the switch is in the "off" position it becomes connected to earth. The two electro magnet windings are joined in series, the centre point and the two ends being brought out to terminals. The centre point is connected in series with the control battery, which may be of the flash lamp type, to one of the 'phone leads which serves as the "return." Wires are

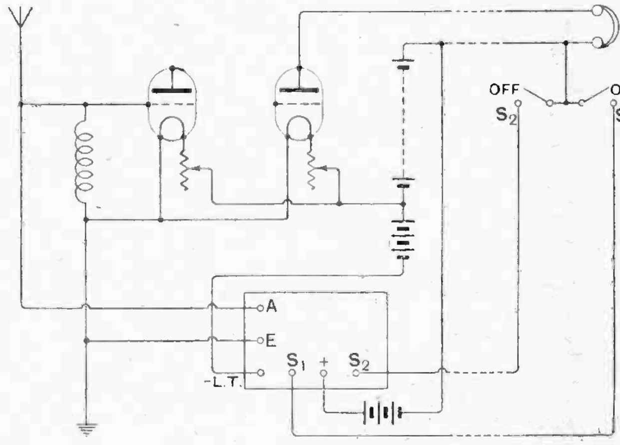


Fig. 2.—Connections of the relay in the receiving circuit.

taken from the two ends of the coils to the fixed contacts of the control keys, the moving contacts of which are connected to the 'phone lead.

The two press-buttons may well be mounted on a block together with the 'phone terminals, and fixed in any convenient position.

Insulation.

Since the H.T. is connected to the windings through the 'phone lead, when the connections described are employed, the insulation of the coils to earth should be tested before use.

The apparatus has been in use for a considerable time and gives satisfaction, the only fault being the tendency of the mercury to splash from the cup. This may be remedied by using a deeper and more enclosed cup, or, to some extent, by fixing a shield on the moving contact arm.

H. E. J.

TELEARCHICS.

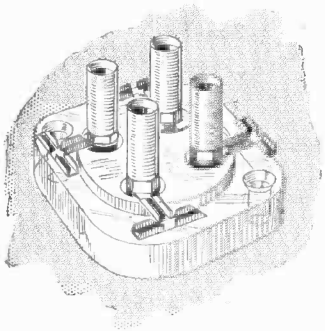
A SERIES of articles on Telearchics—the science of the wireless control of distant machinery—will shortly commence in this journal.

The series will include practical constructional articles as well as dealing theoretically with forms of control, such as heat rays, visible light, and radio waves.

A Review of the Latest Products of the Manufacturers.

GLASS VALVE HOLDER.

Probably in no other component is perfect insulation more important than in the valve holder, while the insulating material must possess dielectric properties at least equal to those of the insulation employed in the tuned circuit. How often do we find a grid or plate circuit tuned with a low loss condenser and air-spaced coil connected directly across the grid and filament, or plate and filament pins of a valve holder composed of doubtful insulating material?



Glass as an insulator in component construction. The Netaglass valve holder.

An original form of valve holder is now on the market, manufactured by E. A. Wood, 100, Aston Road, Birmingham, mounted entirely upon glass of good dielectric and insulating properties. The glass used is known as Netaglass, and has dull surface, accounting for the fact that its insulating properties still remain good even when covered by a film of moisture.

It is interesting to note that glass can now be moulded with the precision necessary for the setting up of valve pins, which calls for extreme accuracy. The pins are screwed up tightly into the glass and are absolutely rigid, yet a valve will engage on the holder with a good sliding fit. Three-way tinned connecting tags are fitted to each pin, and a pair of nickelled raised headed screws are supplied for attaching to the baseboard.

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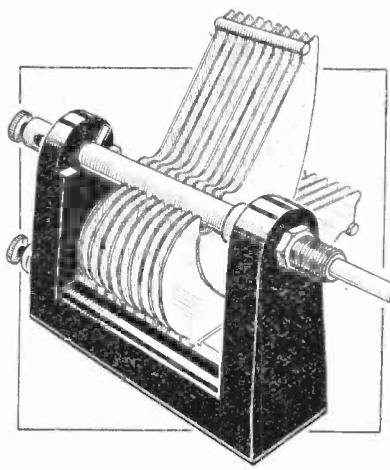
FORMO STRAIGHT LINE FREQUENCY CONDENSER.

Among the recent products of the Formo Company, Crown Works, Cricklewood, London, N.W.2, is a straight line frequency condenser built to an entirely new and original design.

The bearings, instead of being attached to the end plates, are carried on a substantial insulating moulding, an arrangement which easily provides for setting up the bearings perfectly in line. The fixed plates also are bolted to the inside face of the moulding, and thus, in the event of rough treatment, the plates will always remain parallel. Both sets of plates are of brass, secured into slots on a brass bar and spindle, thus obviating the use of spacing washers and ensuring perfect electrical connection. The plates are also bonded across at the ends with small brass bars. The main bearing is of ample length, and the plates are kept in alignment by means of a bush at the lower end of the condenser, which also forms part of one of the connecting terminals.



The new condenser design adopted by the Formo Company.

The condenser is strongly made, well finished, and of good appearance. A tapped hole is provided in the insulating moulding to supplement the usual one-hole fixing.

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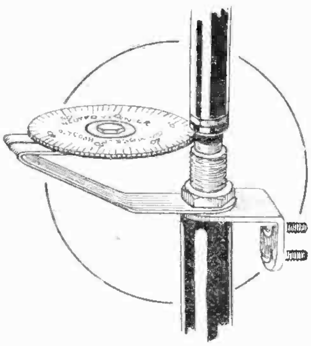
BALANCING CONDENSER WITH INDICATING DIAL.

The Gambrell Neutrovernia balancing condenser is designed either for mounting on the instrument panel by means of one-hole fixing, so that the operating handle projects, or a small stiff bracket can be made use of so that it mounts flatly behind the panel.

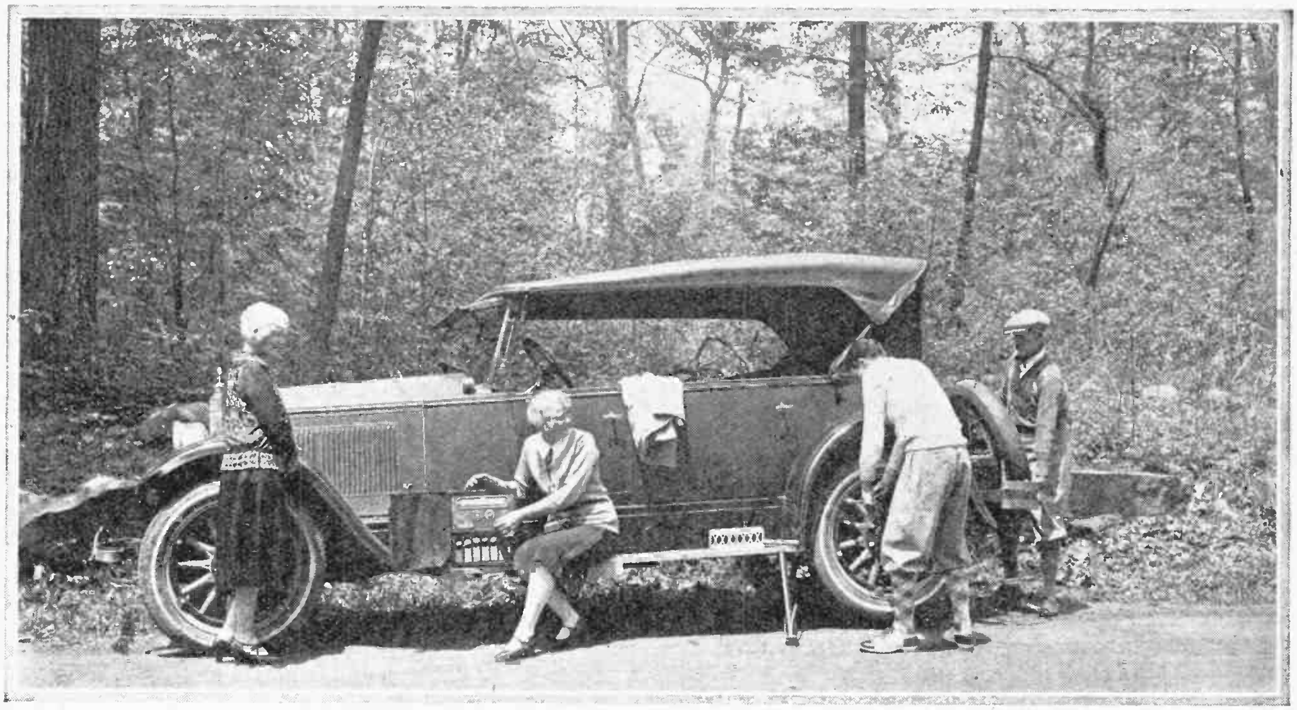
The condenser is arranged so that the capacity change is proportional to the extent of rotation of the knob throughout the entire adjustment. The maximum and minimum capacities are approximately 2 and 38 micromicrofarads respectively, and as the total adjustment is accomplished in six complete revolutions of the knob, each turn represents about 6 micromicrofarads.



The Gambrell balancing condenser with indicating dial. Ten degrees on the scale is equal to one revolution of the knob or a capacity change of approximately 6 micromicrofarads.

The moving element of the condenser is cylindrical, and the fixed tubular, the former being advanced into the latter by means of a quick acting screw. A positive stop is provided at the positions of maximum and minimum setting. This form of condenser is to be preferred to the well-known type in which the distance between disc-shaped plates is controlled by a threaded spindle, and where the capacity change increases rapidly as the plates become near together.

For indicating the setting of the Neutrovernia condenser a dial is now obtainable, consisting simply of a spring bracket carrying a silvered engraved scale and driven by means of a friction pinion secured to the condenser spindle. As it is often desired to vary the extent of self-oscillation set up in the amplifying stages of a stabilised receiver, the dial will be useful for showing the correct setting for restoring the condition of balance.



SUMMER RADIO IN AMERICA.

An Outline of Broadcast Conditions as They Are To-day.

By A. DINSDALE.

BROADCASTING as we know it to-day was first started in America, and this summer finds the radio industry very well organised along clearly defined lines, and enjoying in a large measure that degree of stability aimed at in every industry. Heretofore public interest in broadcasting has been largely seasonal, with a very decided slump in the summer time.

Several factors contributed to cause this slump. Summer in America is usually so hot that people do not care to stay indoors more than they can help, so they forsake their homes in favour of motor touring, camping, fishing, and hunting expeditions. Atmospherics are generally pretty bad in summer, so that in the past it was not worth while to add to the weight of luggage by including a portable set in the summer vacationist's outfit.

The Constitution of the Service.

With their penchant for careful sales analysis, the American business men engaged in the radio industry plotted their sales in curves and set to work to find ways and means of flattening the winter peak and raising the summer trough, with a view to the ultimate achievement of the straight line sales curve which represents stability. They speedily came to the conclusion that the solution of this problem does not lie so much in the improvement of receiving sets as in the improvement of broadcasting stations and programmes, that is, in the service rendered to the listener.

The first broadcasting station to commence regular operation in America was built and operated by private enterprise for the free entertainment of all who cared to listen. This principle has been adhered to throughout the development of the service, until at the present day there are 566 broadcasting stations in operation in the United States. The aim of the owners of most of these stations is to convey to the public a message which usually takes the form of indirect advertising, which they call "obtaining the goodwill of the public."

These owners may be divided roughly into two classes: those who are actively engaged in the radio industry, and the opportunists. This latter class includes every conceivable sort of business or institution, such as departmental stores, churches, municipal authorities, general utility corporations (street-car companies, electric power companies, etc.), colleges, newspapers and periodicals, hotels, etc. This class merely uses radio as a means to an end, supplying in return only entertainment programmes which may be good, bad, or indifferent.

The first-mentioned class is the only one which may be said to supply a sound foundation to the structure of broadcasting. It is directly in their interests to raise the level of the service to the highest possible degree, for unless the service is satisfactory, public interest in it will wane, and sales of receiving apparatus will dwindle. Since the listening public continually becomes more critical and exacting, station operators who are also radio manufacturers have a strong and continuous incentive to

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improve the service as a whole. By far the greatest problem in this connection is the technical one of the efficient distribution or broadcasting of entertainment already available from sources outside the radio industry.

Improving the Service.

The opportunist has neither the interest nor the incentive to solve this problem, so he leaves it to the manufacturer to whom it is a matter of life or death, and who has both the facilities and the resources at his command.

Visualising the situation from this angle, it is not difficult to understand the general trend of progress. The minor stations, which are all run by opportunists, have stood still technically, except in some cases where more up-to-date gear has been installed, as and when developed by the pioneering manufacturers. The principal stations, however, have made constant progress in the matter of their technical equipment and power. In the latter word lies the secret of improved service, according to responsible opinion in America to-day.

Whilst many American stations use only a few watts of power, the majority of the minor stations employ 500 watts output. The principal stations, however, are continually piling kilowatt upon kilowatt. Thus, there are fifteen 5 kW. stations, five 10 kW., one 20 kW., and two 50 kW. stations now in operation, scattered about from one end of the country to the other. This may be taken as evidence of increasing appreciation on the part of the manufacturer station operators, that only by increasing the power of the stations can the listener be guaranteed perfect reception all the year round under all conditions of atmospheric and other disturbances. Since designers of receiving sets have so far failed to produce simple means of eliminating such interference, the only alternative, in the opinion of the pioneers is to swamp it, and they have backed their opinion by radiating a total of 200 kilowatts more energy this summer than they did last year.

Other Improvements.

Along with increased power have come many technical improvements in the transmitters and receivers, and better programmes. In the past year great strides have been made in the direction of improving the tonal qualities of receivers and their associated loud-speakers. The small L.F. transformer of former years has at last given place to one of much more generous proportions, comparable with our own, giving a straight line amplification curve over a wide range of frequencies, and choke coupling of the last stage is becoming more popular.

Improvements have also been made in valves, special types now being available for detection and for the last L.F. stage. The new detector (UX200A) is a gas-filled valve of great sensitiveness, and the L.F. power valve (UX171) is capable of delivering a plate current of 20 milliamperes with a plate voltage of only 180 volts and a grid bias of 40.5 volts.

Loud-speakers have also received a great deal of attention, especially those of the cone type. These latter are now so universally used as to almost entirely supplant the older horn type. They have been increased in size up to three feet in diameter.

Since the whole mechanism of broadcasting has thus progressed simultaneously, the time is ripe and the way clear for the introduction of better programmes, and this has recently been done with results which, though to be expected, are none the less somewhat surprising. The average broadcast listener in America to-day has forsaken his single valve "blooper" or multi-valve, multi-control set, unstable and difficult to handle, for, in most cases, a 5-valve neutrodyne, well stablised and working well within the limits of the valves and with a minimum of controls.

With such a set he is content to tune in to one of the local high power stations and rest there. All modern sets are fitted with a volume control device, and the listener is now very well versed, not only in the use of this useful control, but in the art of tuning-in as well, and in a very short time he has his living-room comfortably filled with excellent music, perfectly performed, perfectly reproduced, and entirely free from interruptions.

A.C. Main Receivers.

Under such conditions it is small wonder that he no longer spends his evening hours hunting for DX and making things unpleasant for his neighbours. There is still a certain amount of that sort of thing, of course, but it seems to be rapidly dying out, and the range of the nuisance caused by the oscillating receiver is considerably reduced on account of the swamping effect of the high power employed by the broadcasting stations.

One of the bugbears of radio is the question of batteries, both L.T. and H.T. Where electric light is available (and that is almost everywhere) American listeners are becoming converted in ever-increasing numbers to the use of battery eliminators, many efficient makes of which are now available at low cost for supplying both L.T. and H.T. at any desired voltage from the 110-volt A.C. system which is almost universal throughout the United States.

Summer Attractions.

Radio has thus been elevated from the position of a toy to be occasionally played with, and often annoyed by, to the status of a real and welcome entertainer, and a really potent factor in the life of the home. Such being the case, it is not surprising to note that radio cannot now be so easily dispensed with during the summer months, especially as summer programmes of a very attractive nature are put on the air by the broadcasters.

For the benefit of the holiday-makers hidden away in camps near streams or lakes in isolated sections of the country, an extended service of news bulletins is broadcast to keep city dwellers, temporarily separated from their morning and evening papers, *au courant* with the world's affairs. A much greater amount of dance music is also included in the programmes for the benefit of these same people, who can thus spend much of their time dancing in the open.

Summer-time not only means outdoor life for the radio audience, but also for the radio staffs of the broadcasting stations. Programme directors are keen to take advantage of all possible outdoor events, sending their microphones and pick-up wires far and wide in search of band music, outdoor orchestras, and musical societies. Then,

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too, the radio reporters are kept busy all the summer, carrying their microphones to the important sporting events, special ceremonies, national affairs, and other out-door happenings, furnishing up-to-the-minute news and word pictures to the radio audience. The keynote of the American summer-time programme is maximum entertainment, in keeping with summer-time thoughts and moods.

The two 50 kW. stations previously mentioned are situated at Bound Brook, New Jersey, and Schenectady, New York, and are thus able efficiently to serve a great expanse of what is probably the most crowded territory in the country. To give some indication of the range of these stations, it may be stated that signals of comfortable headphone strength can be heard from them on a three-valve set at a distance of 1,000 miles in daylight.

Portable Sets.

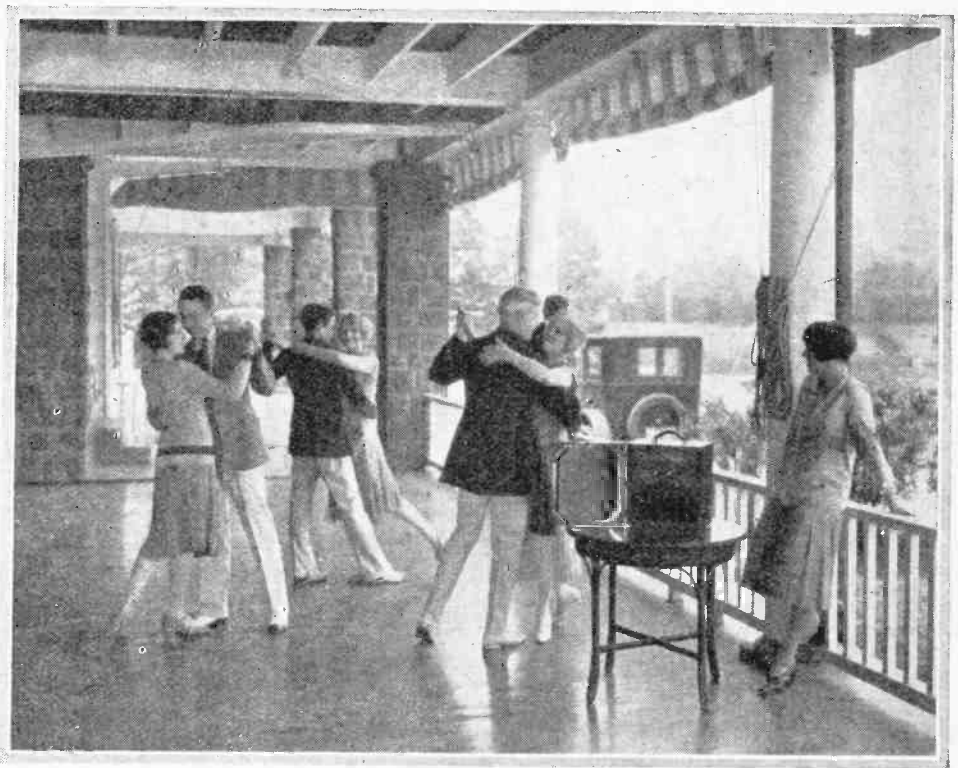
For the reception of these summer-time programmes from the high-power stations, the efficient and really portable self-contained receiver has arrived, progress in its design having run concurrently with the steady improvement of receivers for use in the home. The type of circuit most favoured for portable work is the superheterodyne, equipped with dry cell valves, all batteries, frame aerial, and built-in loud-speaker. It is remarkable how so much apparatus has been enclosed in carrying cases of reasonable dimensions and weight, whilst still preserving the excellent reproduction qualities of the non-portable sets.

One reason for the popularity of the superheterodyne for portable work in America is the potent one that it makes possible the use of a frame aerial, the directional properties of which co-operate with the added power of the broadcasting stations, and the acoustical properties of the loud-speakers to minimise to a negligible extent the effects of the prevailing summer-time static.

The Lull Before the Storm.

Such is the structure of American broadcasting as it is to-day; a structure built up in its entirety by the controlling body, the radio industry itself, at its own expense. This expense has been ever-increasing, not only on account of the increased cost of equipment, but also on account of the cost of programmes. At first, volunteer artists supplied most of the programme material, but with the increasing need for the improvement of programmes, paid artists had to be engaged, and with the continuance of the improvement the expense in this direction continually increases.

From time to time the question has been asked in America: "How is this elaborate structure of service to be permanently supported?" There is no direct tax upon the listener, as there is in countries where there is governmental operation of broadcasting. Since no solution to the problem has been forthcoming, it is now becoming apparent that, tired of waiting for a solution, it has begun to solve itself, for it is clear that without broadcasting there can be no radio industry!


Portable music for the evening's dance.

It is obvious that the radio manufacturers are under the necessity of supplying suitable programmes to the purchasers of their merchandise, so that their return for the money spent is not quite so indirect as it seems at first sight. The opportunist who merely wishes to broadcast for the purpose of advertising himself also recognises this fact to a greater or less extent, depending upon his business and circumstances, and the value of broadcasting to such persons is admirably reflected by the waiting list, running into hundreds, of applicants for wave assignments in the now completely filed broadcast band of wavelengths.

A Startling Development.

It is conceivable that a time may come in America when the opportunist may be swamped or driven out of broadcasting, either by agreement with the radio industry or due to lack of public support, thus leaving the field entirely clear for the still further and freer development of broadcasting by the industry itself, with the co-opera-

Summer Radio in America.—
tion, perhaps, of some of those who now operate some of the minor stations.

This process of elimination is likely to be precipitated by an unprecedented legal situation which has recently arisen.

As already stated, there are 566 broadcasting stations at present in operation. The Department of Commerce, which issues transmitting licences, have on file over 600 applications for further broadcasting licences from various concerns which are anxious to take a place in the ether, but there is no room left.

Besides these applications, there have been many others from stations already on the air who want either to increase their power or change their wavelength, or both. These applications have also had to be turned down, with the result that many stations operating on the lower wavelengths (below 300 metres) have been very discontented, for their programmes are inaudible to a large number of listeners whose sets do not tune below 300 metres.

Department of Commerce Loses its Case.

This discontent found concrete expression recently when a well-known radio firm in Chicago[1] decided to defy the Department of Commerce, and shifted its wavelength up to a band which has been reserved, by international agreement, for Canadian stations. The Department of Commerce took the firm in question to court, and the case was watched with keen interest by the entire American radio industry, for its significance was clearly realised.

After dragging through various courts for a long time, the case eventually came before the Attorney-General in the District of Columbia, and he ruled that the Department of Commerce had no power to enforce its radio regulations.

Immediately this decision was made known, two alternative Bills were placed before Congress, either of which, if passed, would have given Secretary Hoover, of the Department of Commerce, absolute power to handle adequately the increasingly difficult problem of broadcasting. Congress, however, failed to pass either of these Bills before going into recess towards the end of June, and, following this failure, the Department of Justice, during the first week in July, stripped Secretary Hoover of all power to enforce his rules of the air for broadcasting stations.

The Scramble for Wavelengths.

Thus, American broadcasting is at the moment entirely undisciplined, and likely to remain in this condition until Congress reassembles in December, unless certain plans materialise.

The immediate result of this state of affairs was that within a week of the ruling of the Department of Justice many of the discontented stations commenced to move their wavelengths up nearer the middle of the broadcast waveband, and, in some cases, to increase their power. This action has not, in most cases, produced any serious local interference, for it is obvious that it would not be to anybody's advantage for a station to usurp the wavelength of another station in close proximity. The change has been made with much greater care, the choice, in most cases, falling on the wavelength allotted to another station situated in some far distant part of the country, thus causing no local interference with either station, but considerably interfering with listeners situated in the country districts midway between them.

Chaotic Results.

The result, from the point of view of these listeners, therefore, is that the air is in a state of chaos.

Stations in the vicinity of New York to obey the impulse towards higher wavelengths include WRNY, WMSG, WBNY, and WBBR, and an entirely new station commenced operations in one of the New York boroughs. In explaining the arrival on the air of this station, the Chief Radio Inspector for the district said that the application for this licence was the first to come in after the ruling of the Department of Justice, and in view of the ruling, he had no power to refuse to grant it.

Obviously, if this state of affairs is allowed to continue indefinitely, the American public will soon become entirely disgusted with broadcasting and discontinue its support. Established and responsible broadcasters realise this, and are of the opinion that salvation must come from within, pending outside action by the Government, and they have already intimated that they will not submit tamely to what they term "outlaw interference."

A Temporary Solution.

With this end in view they are holding a conference amongst themselves some time during the month of August, at which they expect to decide upon a concerted course of action. The opinion has already been expressed that this sort of interference is a local matter, relief from which may be sought in the local courts, either by means of restraining orders, injunctions, or a suit to suppress a public nuisance. This opinion is founded upon the belief that broadcasting stations, the artists who contribute to their programmes, and even owners of receiving sets, have certain rights of property, custom, and goodwill, at least under the American system of broadcasting.

These property rights, it is believed, would find recognition in the courts even though the Attorney-General's opinion *has* abolished Federal jurisdiction and the old restraints on indiscriminate broadcasting on unauthorised wavelengths.

For some time there has been a sentiment among broadcast stations with a reputation to maintain to organise for mutual protection against all forms of ether pirating, and it is thought by some that the action of the "wave-jumpers" at the present time will crystallise the movement, whereupon it may be quite possible to handle the situation by self-regulation without having recourse to the courts.

The whole situation, though full of interest for those interested in radio the whole world over, bids fair to do a considerable amount of damage to the American radio industry, and retard the evolutionary progress of broadcasting in America as outlined by the writer in his previous article, unless prompt and effective action is taken by the broadcasters themselves.

[1] Zenith Radio Corp.

WIRELESS CIRCUITS
in Theory and Practice.

19.—Reaction (continued).

By S. O. PEARSON, B.Sc., A.M.I.E.E.

WITH a single valve receiving circuit there are quite a number of ways in which reaction or regeneration may be obtained. The simplest and best known method is that in which a coil is connected in the plate circuit of the valve and inductively coupled to the tuned grid circuit, this arrangement having been taken as an example in discussing the principle of reaction in the previous instalment. The grid and filament of the valve may be connected directly across the aerial tuning inductance as shown at (*a*) in Fig. 1, the reaction coil being inductively coupled to the aerial coil; or the tuned grid circuit may be loosely coupled to the aerial and the reaction coil inductively coupled to the grid coil L as shown at (*b*). The latter method has considerable advantage over the former in several respects. Firstly, the loose coupling between the grid and aerial coils leads to greater selectivity and elimination of interference. Secondly, if excessive reaction should be used accidentally and self-oscillation should occur whilst tuning in with the plain aerial circuit shown at (*a*), the local oscillations are actually generated in the aerial circuit and considerable interference may be caused with the reception of near-by stations.

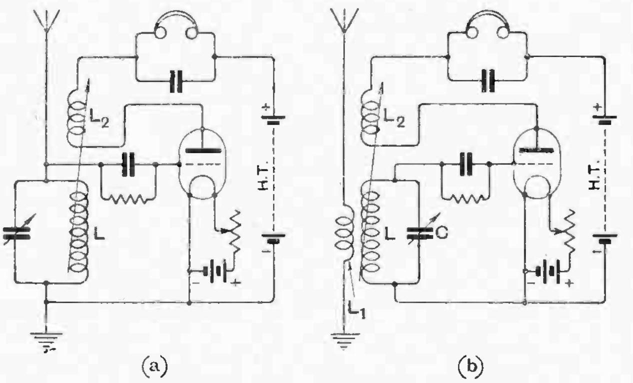


Fig. 1.—Simple receiving circuits with reaction.

Loading Effects of the Aerial.

It will be found also that when the aerial circuit is loosely coupled to the tuned grid circuit, reaction is obtained much more easily; that is to say, the reaction coil need not be brought so close up to the tuning coil to produce critical reaction, or fewer turns can be used in the reaction coil. When the aerial and earth are directly connected to the tuned grid circuit, the reaction has to be increased to a much greater extent to produce the desired critical reaction. This is partly because the aerial circuit possesses considerable resistance and acts as a resistance load on the tuned circuit, and partly because the phase relationships between the various voltages are not so favourable, thus requiring greater reaction to compensate for the losses and for the undesired phase displacement between the incoming signal voltage and the induced voltage from the reaction coil. The same remarks can be applied to the case where the aerial circuit is very tightly coupled to the grid circuit. In the last two cases more turns will be required on the reaction coil. When the loading effect is very heavy, it is sometimes found impossible to obtain the requisite reaction at all, even by increasing the number of turns on the reaction coil, because there is a limit beyond which the number of turns cannot be increased without changing the conditions altogether. For instance, if the reaction coil has too many turns, its self-capacity, together with stray capacities in various parts of the circuit, will tune it to a wavelength approximating in value to that of the main tuned circuit or even greater. Under these conditions, when the reaction coupling is tightened sufficiently to produce self-oscillation, these oscillations will usually correspond to the wavelength to which the reaction coil is tuned, and not to the wavelength of the signals being received. The result is that the signals are not strengthened at all, and may even be weakened. For this and other reasons given below the reaction coil should contain only just sufficient turns to produce the required degree of reaction, and the circuit should be designed so that not more than about two-thirds of the number of turns on the main tuning coil will be necessary on the reaction coil to produce adequate reaction.

Overlap.

It is often found, on trying out a newly constructed set for the first time, that, as the reaction is gradually increased, powerful self-oscillation will suddenly commence, indicated by a loud " pop " in the telephones and resulting in a loud whistle if the receiver is approximately tuned to a broadcasting station, and that the reaction control knob has to be turned back through a considerable angle before the oscillation will cease, *i.e.*, there is present what may be termed a certain amount of " backlash " or " overlap." Under these conditions it is almost impossible to obtain critical reaction. One gradually and very carefully increases the reaction, and after several attempts perhaps succeeds in setting it so that self-oscillation is almost on the point of occurring and the signals are fairly loud—and then probably the act of removing the hand from the control knob will cause the commencement of violent oscillation! Or perhaps the hand has been successfully withdrawn when a slight breeze, causing the aerial to swing, will be sufficient to start the oscillations. An extra loud signal would have exactly the same effect.

Wireless Circuits in Theory and Practice.—

For satisfactory working and easy tuning it is essential for the reaction control to be "smooth"; as the reaction is gradually increased the set should "slide into self oscillation" without any pop in the telephones, and on again slowly reducing the reaction coupling, the oscillations should die down gradually and cease at the same setting of the control knob at which they commenced. The causes of overlap are usually (*a*) unsuitable voltages on the grid and plate of the valve, (*b*) unsuitable value

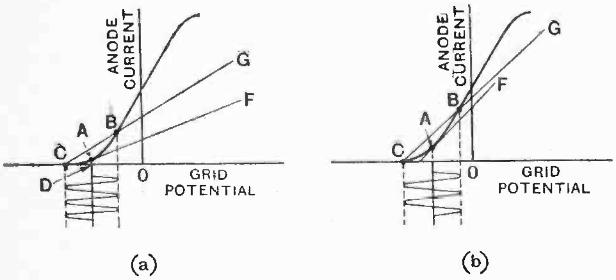


Fig. 2.—Anode characteristic curves showing the effect on signal strength of different values of grid bias and input amplitude.

of grid leak (if any) in the grid circuit, and (*c*) too many turns on the reaction coil.

The reason for overlap can be very clearly seen by considering the case where a single valve is used, employing simple anode rectification. The grid voltage is given a negative bias to make the valve operate at the lower bend in the anode characteristic curve corresponding to the voltage applied to the plate. If this negative bias is excessive, overlap will result, and the reason for this is made evident by the diagram of Fig. 2 (*a*) giving the anode characteristic curve of the valve. The grid bias is adjusted so that the valve is operating at the point A on the characteristic curve. When no signal is being received and no reaction is used, the plate current will have a steady value denoted by AD. The slope of the curve at the point A is indicated by the line AF, and any weak signal will be amplified to an extent proportional to the slope of this line. Suppose now that a strong signal is being received as shown by the sine wave of grid voltage in the diagram. The valve now operates over the portion of the anode characteristic curve between the points B and C and the *average* slope of the characteristic between these limits is given approximately by the line CBG. Note that CBG is steeper than AF, and, therefore, the stronger signal is amplified to a greater extent than the weaker one.

Suppose now that the reaction is gradually increased whilst a weak signal is being received. As the critical value of reaction is approached, the signal voltage applied to the grid is increased, with the result that the voltage amplification factor is increased as explained above. *In effect this is exactly the same as increasing the reaction coupling*, and, therefore, the signal voltage goes on increasing until powerful self-oscillation occurs, even though the coupling is not tightened any further. Operating over a wide range, the average amplification given by the valve itself is much higher, and accounts for the oscillations building up to such strength, although the reaction coupling has not been increased beyond the critical value required to start the oscillations. Since the valve is now operating with a higher average amplification constant, the reaction coupling will have to be decreased to some extent below the critical starting position before the self-oscillation ceases, and the cessation will be sudden, producing a thud or pop in the telephones. Thus a certain amount of overlap is present in this case, due to the fact that the amplifying power of the valve (used as a detector) increases as the amplitude of the oscillations applied to the grid are increased, the circuit being in an unstable condition as regards reaction.

That this overlap is due to too high a value of negative grid bias can be seen from Fig. 2 (*b*), which represents the anode characteristic of the same valve, but with a lower value of negative bias applied to the grid. As before, the line AF represents the slope of the curve at the operating point A. It will be seen that for a strong signal operating the valve between the points B and C on the characteristic curve, the average slope of the curve between B and C is less steep than at the point A. Thus, as the signal strength increases, the amplifying power of the valve *decreases*, and the unstable condition no longer exists, and smooth reaction control will be obtained if no other conditions militate against it, such, for instance, as bad proportioning of the coils.

In the case of grid rectification it is not only important to employ the correct grid bias to suit the plate voltage used, but to have a suitable value of grid leak. As in the previous case, smooth reaction will not be obtained if the amplifying power of the valve increases as the signal voltage increases. In either case the best values are found by trial. When the valve is used purely as an amplifier, it should be operated over the straight portion of its anode characteristic curve and no unstable effects will be introduced. It should be mentioned that in this case operation

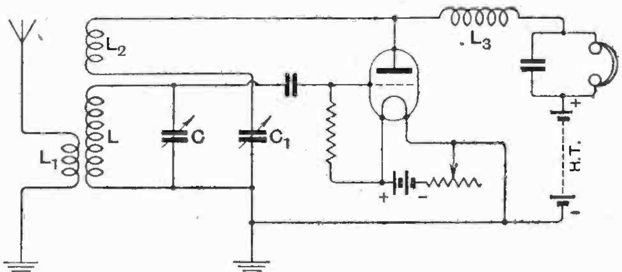


Fig. 3.—Receiving circuit with parallel feed for the reaction circuit. The degree of reaction is controlled by the condenser C_1, the coupling between L and L_2 being fixed.

occurs over the steepest portion of the curve and therefore the greatest possible amplifying power of the valve is obtained, with the result that the reaction coil can have fewer turns compared with one used with a valve acting as a rectifier.

Effect of Reaction Coupling on Tuning.

If such a circuit as that shown in Fig. 1 is carefully tuned to a more or less weak signal, it is found that when the reaction is altered the tuning is upset to some extent, and the tuning condenser has to be readjusted every time the reaction is changed. This is due to two main causes: first, change of effective inductance of the tuning coil due

Wireless Circuits in Theory and Practice.—
to the presence of the reaction coil carrying a current of equal frequency, and secondly, due to the capacity effects between the two coils. The tuning coil and the reaction coil coupled together constitute a sort of high-frequency transformer, but the current in the reaction coil is not only due to transformer action, but also to the amplifying action of the valve. However, it is a well-known property of the transformer that when a current flows in the secondary winding the reactance of the primary apparently changes, and this change can be calculated if the ratio of the currents and the reactance of the secondary winding are known. This means that the proximity of the reaction coil, carrying a current equal in frequency to that in the tuned circuit, changes the effective reactance and inductance of the latter, with the result that the frequency and the wavelength are changed. The extent of the change is dependent on the mutual inductance between the coils and therefore on the coupling. Increasing the coupling lowers the effective inductance, and therefore decreases the wavelength. The change also depends upon the phase relation between the currents in the two coils: if they are 90° out of phase no change of frequency would be produced by altering the reaction coupling. In Part 17 it was shown that the best conditions for reaction were obtained when these two currents were 90° out of phase; but this can only occur when the plate circuit is absolutely non-inductive, an impossible condition when a reaction coil is included.

Stray Capacity Effects.

With many circuits, especially when used on short wavelengths, the electrostatic capacity between the hand of the operator and certain parts of the apparatus may make tuning very difficult. In some instances where a signal has been tuned in, the operator cannot withdraw his hand from the control panel without the tuning being so badly upset that the signal disappears altogether. Hand capacity effects are only noticeable when the circuit is sharply tuned, employing critical reaction, a condition necessary for the reception of weak signals. This capacity effect seems to be particularly pronounced with the simple circuit discussed above.

The capacity effect takes place between the hands and those parts of the tuned circuit which are at a high-frequency potential with respect to earth. It is not always practicable to employ long extension handles to the controls, so that a circuit must be so arranged and the parts of a set so laid out that the hands do not come into close proximity with any parts which have a high-frequency potential to earth. An earthed metal screen between the operator and the apparatus, mounted behind the panel, is always of great advantage if it can be arranged. If this is to be done, then no condenser spindles or other parts at a high-frequency potential can be brought to the front of the panel.

An Ideal Circuit.

A reaction circuit particularly suitable for mounting behind a screened panel is shown in Fig. 3. Here we have the aerial circuit inductively coupled by the coil L_1 to the main tuning coil L, which is tuned to the incoming signal by the variable condenser C. The spindle and moving plates of this condenser are connected to the negative leg of the valve filament, which is earthed. The reaction coil L_2 is connected in series with a second variable condenser C_1, between the plate of the valve and the negative leg of the filament, the spindle of this condenser also being earthed. The reaction coil itself is fixed in position relatively to the tuning coil, and reaction is adjusted by means of the condenser C_1, which, when varied, alters both the phase angle and magnitude of the current in the reaction coil.

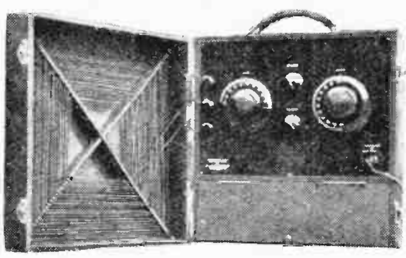
The H.T. is applied to the plate of the valve through the telephones, and a high-frequency choke L_3. Under working conditions the rectified low-frequency component of the plate current passes freely through the H.F. choke and actuates the telephones, whereas the H.F. choke offers a high impedance to the high-frequency component of the plate current, forcing it to pass through the reaction coil L_2 and *via* the reaction condenser C_1 back to the filament. There are only three control knobs, including the filament rheostat, and as the spindles of all three are joined to the negative leg of the filament they may be brought through an earthed screen mounted behind the panel.

The couplings between L_1 and L and between L_2 and L are fixed, and therefore the three coils may be wound on a single cylindrical former with the portion L in the middle. For a selective receiver the number of turns on the aerial coil L_1 should be about 25 per cent. of the number on the main tuning coil L and the reaction coil would require about 30 per cent., the actual number being best found by trial. This circuit is particularly suitable for short wavelengths, and will be found very efficient if low-loss air-spaced coils are employed.

A THREE-VALVE PORTABLE RECEIVER.

THE accompanying illustration shows an interesting three-valve portable receiver which we have recently had the opportunity of testing. The set is entirely self-contained, with batteries and headphones housed beneath the panel in the compartment provided. It has been well designed and gives good quality over a very good range from a main broadcasting station.

Good telephone results are obtainable up to approximately 20 miles from London, whilst for several miles there is ample power with operation of a loud-speaker. The weight is not excessive, considering that the set is entirely self-contained, the total being between 30 and 35 lb. It is contained in a leather case of convenient dimensions for carrying.



Carrs' Portabout.

The set is certainly amongst the best of the portable commercial receivers which we have had the opportunity of testing. It is manufactured by Messrs. James W. Carr and Co., Ltd., of 35, Queen Victoria Street, London, E.C.4.

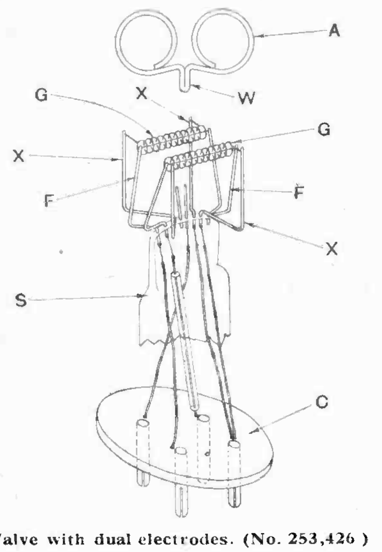
Recent Inventions

The following extracts are prepared, with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

Dual Valve. No. 253,426.

Application Date, November 26th, 1925.

W. G. Freudenthal and L. Kremner describe in the above patent a valve with two sets of electrodes on the lines indicated by the accompanying illustration. The anode A is preferably made in the form of two cylinders welded together at W, or fixed in any other convenient



Valve with dual electrodes. (No. 253,426)

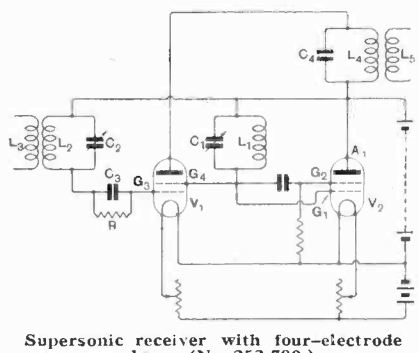
manner. Two grids G, which are centrally disposed within the two anodes, are fixed to supports X, while filaments F are arranged along the axes of the two grids. The filaments, which are arranged in parallel, are connected to other supports, all the supports being fixed to a glass foot S, the whole being mounted in the usual glass bulb provided with a four-pin cap C.

○○○○

A Supersonic Circuit. (No. 252,789).

Application date March 5th, 1925.

A rather interesting supersonic circuit employing two four-electrode valves is described by H. Andrews and the Dubilier Condenser Co., Ltd., in the above British patent. One four-electrode valve V_2 is used to generate a source of local oscillations and a circuit L_1 C_1 is connected between the anode and the inner grid G_1. Another four-electrode valve V_1 has incoming signal voltages applied to it by means of a coupling device L_3 L_2, L_2 being tuned by a condenser C_2, the usual grid condenser C_3 and grid resistance R being shown. The oscillations which are generated in the circuit L_1 C_1 are transferred to the outer grid G_4 of the valve V_1. The anode circuit of the valve V_1 contains a tuned circuit L_4 C_4. It will be seen that voltages applied to the inner grid G_3 of the valve V_1 will control the steady anode current, while the steady anode current will also be controlled by the voltages applied to the outer grid G_4 from the generating valve V_2. In other words, a modulation effect is obtained, and a beat frequency equivalent to the difference of the incoming oscillations and the locally produced oscillations will occur in the anode circuit of the valve V_1. These variations will produce potentials across the tuned circuit L_4 C_4, from whence they can be transferred by an inductance L_5 to an intermediate amplifier. A modification of the



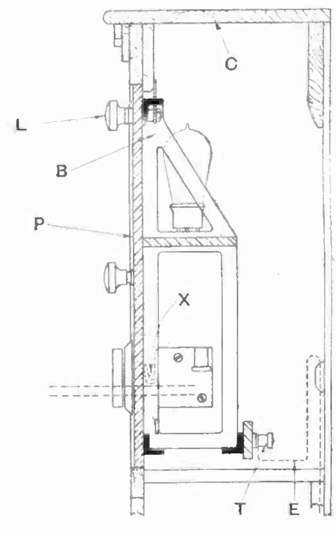
Supersonic receiver with four-electrode valves (No. 252,789)

patent specification is the use of only one valve in which the inner grid and the anode are used for producing the local oscillations, while the incoming oscillations are applied to the outer grid and the beat frequency is obtained in a tuned circuit connected directly in the anode circuit.

Cabinet Mounting. No. 253,348.

Application Date, May 29th, 1925.

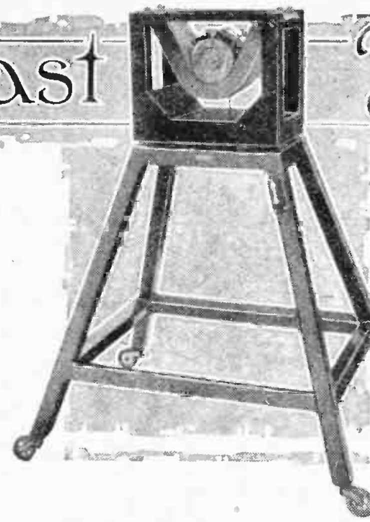
Another system of cabinet mounting is described in the above British Patent by T. E. Haywood, T. A. E. Haywood, and A. Haywood. The object of the invention is again to facilitate accessibility to the interior of a receiving set. This time the cabinet C is provided with a



Components mounted on swinging panel. (No. 253,348.)

panel P, to which is fixed a bracket framework B, which carries the components of the set. The panel P is pivoted at the base at X, and is maintained normally in position by means of a lock L operated by a knob. Flexible leads E are provided between the back of the cabinet and the terminals T of the set. In order to expose the contents of the cabinet, the lock L is turned and the front panel is tilted forward about the pivot X, the pivot being so arranged that if desired the whole front panel can be withdrawn. The specification is fairly detailed, and contains considerable information as to the mounting of the pivot and its associated devices.

Broadcast Brevities



By Our Special Correspondent.

NEWS FROM ALL QUARTERS.

The Civil Servant Idea.

Will the broadcast announcer of 1927 wear a crown badge and a peaked cap? From Savoy Hill I gather that the answer is in the negative. The employees of the British Broadcasting Corporation, it is stated, will not become Civil Servants, although there are many on the present staff who would relish Government bonuses and pensions!

Incidentally, the story that Captain Eckersley has been offered a Post Office job contains as much truth as many other yarns adorning the present summer season.

oooo

The Winter Time Schedule.

With the approach of winter a reshuffling of broadcasting programmes becomes necessary. On and after September 20th, therefore, the evening timetable at 2LO will be based on the following schedule :—

p.m.	
7.0	... First News Bulletin.
7.10	... Talk.
7.25	... Light music.
7.40	... Topical Talk or music (depending on programme to follow).
8.0	... Main programme
9.20	... Talk.
9.45	... Musical recital, similar to the series now beginning at 7.25 p.m.
10.0	... Second News Bulletin.
10-15-11.0	Mondays, Wednesdays and Fridays : General Programme.
10.15-10.30	Tuesdays, Thursdays and Saturdays : " Feature."
10.30-12.0	Dance music.

The provincial stations will follow practically the same time-table.

oooo

Dominion Premiers to Broadcast?

During the Imperial Ministers' Conference, to be held in London in October, it is expected that the premiers will each take a turn before the microphone.

oooo

Laughter and Applause.

Being funny before the microphone, except in an unintentional way, is an extraordinarily difficult task, as most listeners must have realised. Out of kindness to the comedian, the B.B.C. long ago introduced the studio audience, composed of a few select souls who readily assisted the performer to create " atmosphere " by laughing and clapping at appropriate moments. The other evening, however, the audience was omitted, a fact which was not appreciated by the comedian (a celebrated artist) until he had launched his first joke. It is said that he had difficulty in finishing his turn.

The studio audience is being retained.

oooo

FUTURE FEATURES.

Sunday, August 22nd.

LONDON.—Star Ballad Concert.
ABERDEEN.—Choral and Orchestral Programme.
CARDIFF.—Joseph Farrington, bass.

Monday, August 23rd.

LONDON.—Mystery Play.
BIRMINGHAM.—Community Singing Concert.
BOURNEMOUTH.—Light Operatic programme relayed from Winter Gardens.
BELFAST.—Band of 1st West Yorkshire Regt.

Tuesday, August 24th.

LONDON.—" The Sea Affair and Harry Binns," by Corbett Smith.
MANCHESTER.—" The Pied Piper of Hamelin."
NEWCASTLE.—Frank Gomez and Municipal Orchestra from Whitby.

Wednesday, August 25th.

ABERDEEN.—" What He Won," a Play.
BIRMINGHAM.—Astra Desmond, contralto.
CARDIFF.—Footlight Flickers.
GLASGOW.—Scottish National Players.

Thursday, August 26th.

LONDON.—Lay Vicars of Westminster Abbey.
BELFAST.—Ballet Music by the Orchestra.

Friday, August 27th.

LONDON.—J. H. Squire Celeste Octet.
BIRMINGHAM.—Jupiter Mars, Entertainer.
CARDIFF.—Helena Millais.
GLASGOW.—London Radio Repertory Players.

Saturday, August 28th.

LONDON.—Mystery Play.
BOURNEMOUTH.—Jock Walker, Scottish Entertainer.

Answer to Correspondent.

ANXIOUS (Aberdeen.)—Unfortunately, your hopes are likely to remain unfulfilled. Although, as you remark, the Aberdeen station will shortly share a wavelength with Birmingham, there is no indication that Aberdonians will in consequence enjoy the privilege of cheaper licences.

oooo

Operatic Pot Pourri.

The demand for variety in a broadcast programme is being recognised by the Birmingham Station Director. On August 31st an " Opera Night " will be held, during which excerpts will be given from no fewer than four operas. The selections are as follows: Act IV. of Aïda," Act I. of " Il Trovatore," Act V. of " Faust," and Act II of " Figaro." The performances will be given by members of " The Three Counties School of Opera " under the direction of the popular Mr. Joe Lewis.

oooo

Chopping and Changing.

Apropos of the forthcoming changes in wavelength among the B.B.C. stations, it is worth remembering that the broadcasting stations in America are never happy unless they can change both power and wavelength at frequent intervals. The continual trend is in the direction of higher power. America now has fifteen 5-kilowatt stations, five 10-kilowatt stations, one of 20 kilowatts and two of 50 kilowatts.

High power is aimed at not so much for obtaining greater distance (though the U.S. craze for distance still exists), but in order to overcome atmospherics, which are much more prevalent over there than in peaceful Europe. Then, again, with so many stations " on the air," there is a natural inclination in many quarters to " shout down the other fellow." At the present moment the American ether sounds rather like the parrot cage at the Zoo.

oooo

Tricks of the Microphone.

The microphone plays many strange tricks, particularly with orchestral instruments. One of the principal sufferers is the drum, the sound of which, even on a good loud-speaker, sometimes reminds one of a Scotsman testing a faulty half-crown. One of the first musical critics to point out the deficiency of the microphone in this respect was Mr. Filson Young, who suggested that a better drum sound for broadcasting purposes would be provided by a pizzicato on the 'cello.

oooo

The "Marimbaphone" and its Cousin.

A move is now being made to evolve new orchestral instruments specially suitable for broadcasting, and this evening (Wednesday) we shall have an opportunity of listening to two of these weird and wonderful productions. One of them, the "Marimbaphone," is described to me as a kind of *de luxe* xylophone with the resonator carefully adjusted so as to give sustained effects of a bell-like quality. The "Spielophone," a kind of second cousin, which will also be played this evening at the London station, does not give the sustained effect. It is a higher pitched instrument without a resonator, and I gather that it gives off sounds rather like those from a stick run along a metal paling Anyway, we shall see, or rather, hear

oooo

Warm Work.

Lounging in a punt on a warm summer evening and listening to an orchestral programme on the loud-speaker brings a good many of us precious near bliss. But how often do we cast a thought to the orchestral gentleman in shirt sleeves sweltering in an artificially-lighted studio without a window and with very little ventilation.

oooo

Air Shafts.

The question of studio ventilation has never been satisfactorily answered, for the reason that, where air can reach, so can sound. Open windows in the early studios were often a source of amusement to listeners, particularly when an *obbligato* was provided by the syrens of Thames tugs. Each of the present studios at Savoy Hill is fitted with an air shaft, but the studio temperature after an orchestra has been in occupation for about twenty minutes suggests that somebody corpulent must have mistaken the shaft for the exit.

WHICH DO YOU PREFER ? Correspondence still reaches the B.B.C. concerning the debate on "Classical or Jazz Music?" at 2LO on July 20th. Mr. Jack Hylton, who championed jazz, is seen above with his band.

oooo

Changing Studios.

The only method of securing ventilation which has proved satisfactory is to change studios as often as possible, and this is done to such an extent that at 2LO four separate studios are sometimes used in one evening.

But has the B.B.C. ever entertained the idea of releasing oxygen into a hot studio? Or is it feared that a whiff or two in excess might introduce a note of unwanted hilarity? Perhaps an experiment with oxygen could be conducted during a comic turn?

oooo

English and French Light Opera.

To-morrow (Thursday) Bournemouth listeners will have an opportunity of comparing the respective merits of English and French light opera. The English examples will be taken from the works of Sullivan and German, while the French school will be represented by Offenbach and Messager.

oooo

Cardiff or Bristol?

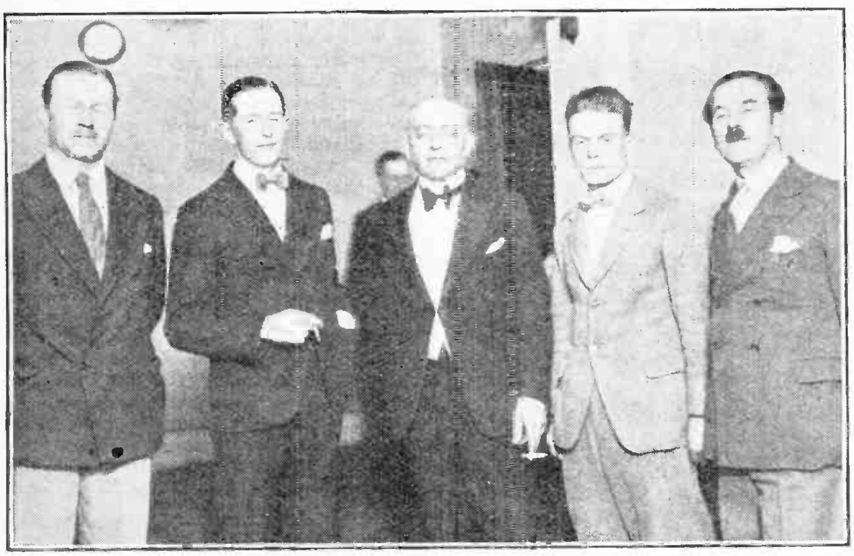
Rumour has been busy lately with the tale that when the British Broadcasting Corporation introduces the new regional system, the Cardiff station will be scrapped or transferred to Bristol. This is a marvellous piece of prognostication, when we consider that the Corporation has not yet been granted a charter, and does not, in fact, exist.

Apart from this, however, when the new regional scheme does come to be discussed in the new year, a certain amount of controversy may centre round the question of whether the regional station for Wales and the South-west should be situated at Cardiff or Bristol. In favour of the latter town it will probably be contended that Bristol may be able to supply superior programme talent.

oooo

New Savoy Dance Band.

"The Romaine Four" (who are, in fact, five) are to appear regularly at the Savoy from now onwards, having taken the place occupied last year by the "Selma Four." They will broadcast dance music in turn with the Savoy Orpheans and Tango bands. The pianist is the well-known jazz pianist Barry Mill.



THE CLASSICS were upheld by Sir Landon Ronald, who is seen in the photograph with members of the Wireless Orchestra. 568 letters were received at Savoy Hill in favour of the classics as against 172 for jazz

PIONEERS of WIRELESS

BY ELLISON HAWKS F.R.A.S.

25.—Hertz and His Epoch-making Discovery.

UNTIL the time of Sir William Preece's experiments two methods had been used by investigators in their attempts to solve the problem of wireless. The first was the system of *conduction*, as represented by the system of Morse, and the second *induction*, used by several workers, but with most success by Preece. Towards the end of the nineteenth century, however, both these systems were superseded by a third, *radiation*, made practicable by the discovery of the possibility of radiating electromagnetic waves through space. This system followed the discovery by Hertz, of Munich, of the waves that bear his name.

Heinrich Rudolf Hertz was born at Hamburg on February 22nd, 1857, and during his schooldays cherished the ambition to become an engineer. When 20 years of age he studied at Munich with this profession in view, but he soon found that he was more interested in physics than in practical mechanics. Accordingly he changed his plans, and well it is for science and the world in general that he did so. He read original treatises by the famous physicists of the past, attended lectures, and experimented to the full extent of his time. His studies were thorough and his interest keen, and it is no wonder that when he went to Berlin University he soon attracted attention. Here he won a prize for the best solution of a difficult electrical problem and became the favourite pupil of Helmholtz, for whom he acted as assistant from 1880-3, and carried out many difficult and original researches in physics under his guidance and inspiration.

Heinrich Rudolf Hertz.

In 1883 Hertz devoted some time to a study of Clerk Maxwell's electromagnetic theory. This theory showed that if a conductor is electrically charged or discharged with sufficient suddenness, it must emit electrical waves in the ether. Although Clerk Maxwell thus predicted the existence of the waves, and even calculated their rate of travel, their length, and other essential data, their existence remained unproved until 1888. In that year Hertz announced to the world his epoch-making discoveries, which brilliantly demonstrated the truth of Clerk Maxwell's conception.

We shall refer again in a future article to the genius of Clerk Maxwell, and must confine ourselves now to the practical work of Hertz.

Hertz' Apparatus.

The apparatus he used in his experiments was called an "oscillator," and consisted of two parts: the "exciter" and the "resonator." The exciter was formed by mounting a metal plate at the ends of two metal rods, the other ends of which terminated in metal balls separated by a distance of about half an inch. The rods were connected to the terminals of the secondary winding of an induction coil. By these means they were charged so that a spark was caused to jump across the gap separating the two balls. The resonator was formed by a wire, bent to a circular shape, but having a small gap, the ends also terminating in two small metal balls. This wire ring was placed a short distance away from the exciter. When the latter was set in action, sparks were seen to jump across the gap in the resonator, although the latter was not connected in any way with the oscillator.

Not only did Hertz demonstrate the existence of the electric waves, but he also proved them to vary in length from an inch to 1,000 miles, and ascertained their rate of travel to be identical with that of light. He showed also that they possess all the characteristics of light, and they they may be reflected, refracted, and even polarised. In short, he demonstrated beyond all doubt that light and electrical waves are identical in their essential qualities. It is interesting to learn that all this important experimental work was carried out in a small room.

Hertz died in 1894, before his work had borne the full fruit of Marconi's subsequent development. Of his discovery Sir Oliver Lodge has truly said: "He effected an achievement that will hand his name down to posterity as the founder of an epoch in experimental physics."

The discovery of the Hertzian waves had scarcely been announced when Huber, a German engineer, suggested that they might be used as a means of communicating

Pioneers of Wireless.—

without wires. Remarkable though it seems, Hertz did not realise the full significance of his discovery, and at once discouraged the suggestion. The idea was thus left to others to develop, and Hertz missed an opportunity of adding still further to his fame.

Hertz was a modest man with a particularly kind and charming nature. Following his great discoveries he was appointed Professor of Physics at Bonn, where he continued his electrical studies. He narrowly missed discovering the X-ray, which actually streamed unnoticed from his vacuum tubes during some of his experiments!

It was a great loss to science when this great man died (on January 1st, 1894) at the early age of 37.

NEXT INSTALMENT.
D. E. Hughes and His Work.

CALLS HEARD

Streatham.
Great Britain:—G 5BY, 6KB, 5BW, 2BM, 2BL, 2VS, 2VT, 2AF, 5ZY, 5OX, 2KD, 2SP, ZAAA, 5OM, 5IS, 2CA, 5PY, 5CU, 2ZO, 6QB, 2KV, 6ZZ, 2VM, 6RO, 6MB, 2SC, 5UN, 6KR, 6KB, 2NM, 5BM, 2KB, 2ZB, 6HU, 6NM. Belgium:—B 4IEA, 4NX. France:—F 8AB, 8FM. Switzerland:—H NX. Finland:—S 7NS. Australia:—A 3OF.
(0-v-1) on 20 to 200 metres.
D. H. C. Rudd (2BWR).

Windsor.
(June 20th-July 12th.)
Great Britain:—G 2AJ, 2BZ, 2CO, 2DB, 2IT, 2KL, 2LD, 2NM, 2SW, 2SZ, 2TZ, 2YD, 5BY, 5JW, 5KP, 5LF, 5MS, 5SZ, 5TZ, 6MU, 6YV. France:—F 8BA, 8CA, 8CBH, 8CL, 8EZ, 8FBH, 8FR, 8FRX, 8GK, 8GM, 8JRT, 8JS, 8KOA, 8LMH, 8MN, 8RA, 8RF, 8UT, 8VVD, OCTU, OCMV, OCNG. Italy:—I 1AK, 1AW, 1BI, 1MM, 1IB. Sweden:—SMUV, SMUK. Miscellaneous:—21, F2, 1A, 1X, U2, R2, B7, OBL, 4VU, N33, 5NET, 20EAR, AGC, 7GP, OPX, OTA, OWC.
(0-v-1) On 20 to 100 metres.
A. S. Watford (2BVK).

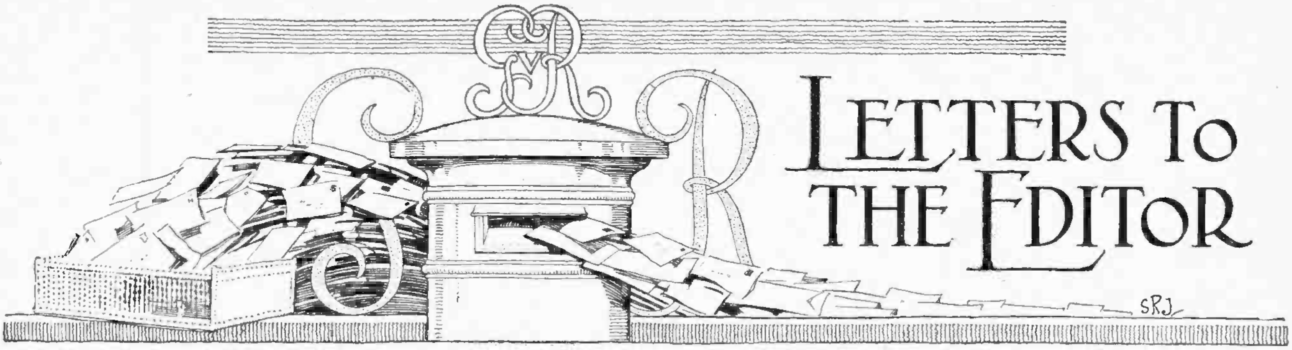
London, W.1.
(July 5th-30th.)
Great Britain:—G 2JB, 2NT, 2SO, 2SR, 2TR, 2VJ, 5DA, 5BV, 5GQ, 5HJ, 5RH, 5TD, 6CI, 60X, 6RY, 6YR. Italy:—I 1AX, 1BA, 1GW. Denmark:—D 7BD, 7EW, 7GP, 7MT, 7XU, 7ZM. Sweden:—SMTO, SMUS, SMUV, SMWQ, SMWR, SMXR, SMYG. Finland:—S 2CO, 2NM, 2NS. Spain:—EAR10, EAR20. Portugal:—P 1AW. Austria:—Ö WA. Poland:—T PAV. Russia:—R RP, 1NN. U.S.A.:—U 1AAE, 1AAY, 1ALR, 1AMS, 1AXA, 1BIE, 1BIG, 1BK, 1BZC, 1CCX, 1CCZ, 1CH, 1CNP, 1KK, 1LC, 1MV, 1ON, 1XV, 2APV, 2CUA, 2AQW, 2CXL, 2MD, 2MM, 2NF, 2UO, 3CJN, 4II, 8BAY, 8BZT, 8CDV, 8DIA, 9EGH. Porto Rico:—PR 4JA, 4JE. Canada:—C 1AM, 1AR, 3CS. Brazil:—BZ 1AO, 1AQ, 1AW, 1AX, 2AA, 5AB. Cuba:—Q 8KP. Trans-Jordania:—TJ CRJ. Various:—NOT, NRK, WNP, SGL, AC8.
(0-v-1) 25 to 50 metres.
M. W. Pilpel (G2BZC).

Northwood, Middlesex.
(June, 1926.)
Great Britain:—G 5GU, 2NL, 2CS, 2JB, 5GQ, 5AR, 5MF, 5MU, 5SI, 6HF, 6BR, 6OX, 6TD, 6IA, 6CI, 6QB, 6KO, 6IV, 6IZ, BVJ, LMR.
Northern Ireland: GI 6MU, 2IT.
Irish Free State:—GW 11B, 18B.
France: F 8JYZ, 8DDH, 8PY, 8PAX, 8FBH, 8NOX, 8IU, 8EZ, 8YK, 8UDI, 8JR, 8BRI, 8ZDO.
Belgium:—B G33, V33, 08, S5, H5, B8, K8, B1, J3, 4BS, 4AA.
Denmark:—D 7EW, 7MT, 7AH, 7BX.
Finland:—S 2CO, 2NX, 2NS, 2NM, 2NL.
Sweden:—SMXV, SMUA, SMTH, SMYG.
Holland:—N OFP, OBL, PCK4, PJC.
Portugal:—P 1AE, 1AK.
Luxembourg:—L 1AG, 1JW.
Germany:—K 4DU, W9.
Austria:—Ö SL, WA.
Switzerland:—H 9XA.
Italy:—I 1BK, ISRA.
U.S.A.:—U 1AZD, 1AEF, 1ADE, 1AXA, 1AXX, 1AW, 1AMB, 1AAO, 1BEZ, 1BWY, 1BQT, 1BOA, 1BIE, 1CNA, 1CIB, 1CKP, 1CVL, 1CH, 1HN, 1ON, 1QC, 1RF, 1LJ, 1MV, 1DL, 1UW, 1XV, 2AHM, 2ARY, 2ATC, 2ASQ, 2BSL, 2BL, 2CGB, 2CJD, 2CXL, 2FF, 2LE, 2NM, 2NZ, 2MZ, 2LS, 2PY, 3AAI, 3BKT, 3BMS, 3BVA, 3CU, 3DG, 3QG, 3PI, 3PS, 3WF, 3ZM, 4ASK, 4BY, 4IZ, 4JR, 4QI, 4SB, 4UX, 4VQ, 4XE, 6OI, 8AVL, 8AIP, 8BCE, 8BMH, 8BPM, 8BF, 8DBB, 8DHW, 8DJF, 8DME, 8ZAE, 9BPB, 9DWJ.
Canada:—C 1AR, 1DD, 1ED, 2CG, 3KP.
Brazil:—BZ 1AD, 1AF, 1AJ, 1AP, 1AW, 1IB, 2AA, 3AA, 5AB, PND.
Various:—NISS, NTT, NBA, NKF, KEGK, NRK, NEA, Y1CD, XC51, CH 3LJ, YS 7XX, R AF1, FA 8RIT, EAR28, SUC2.
(0-v-1.) J. C. Wilson.

Bolton, Ontario.
Belgium:—B B2, J2, O8, P7, T2, W1. Denmark:—D 7EC. France:—F 8AIX, 8BF, 8CA, 8CT, 8DD, 8DK, 8DP, 8EE, 8GI, 8GRA, 8HU, 8IP, 8JD, 8JF, 8JN, 8NN, 8OZ, 8PM, 8ST, 8SX, 8YD, 8YOR, 8ZO. Great Britain:—G 2CC, 2FM, 2FU, 2KF, 2KZ, 2NB, 2NM, 2OD, 2QB, 2SZ, 2WJ, 5AT, 5DH, 5GV, 5HS, 5KO, 5LF, 5LB, 5LS, 5MH, 5MO, 5PM, 5SZ, 5VL, 6AH, 6AL, 6KL. Northern Ireland:—GI 6ST, 6TB, 6MU, 6YW. Switzerland:—H 9AD. Italy:—I 1AW, 1AS, 1BD, 1BW, 1MA, 1NO, 1GW, 1ER, 1LP, 1RM, 1RP, 1RT. Germany:—K I8, Y5, Y8. Madeira:—P 3CO, 3GB, 3QB. Porto Rico:—PR 4UR. Morocco:—FM 8MB. Austria:—Ö AR, BE, DA, FH, KK, TM, TW, WA.
Miss M. C. Cross. (C 3QT).

Leigh, Lancashire.
(July 11th to July 27th.)
U.S.A.:—U 1ADM, 1AJB, 1AJP, 1AMJ, 1AND, 1ANK, 1APU, 1AXX, 1AAY, 1AVL, 1BCN, 1BEO, 1BIZ, 1BJ, 1BJK, 1BM, 1BZ, 1CJ, 1CMK, 1CMX, 1EJ, 1IJ, 1KA, 1KG, 1MV, 1MY, 1PM, 1QB, 1QC, 1STA, 1TR, 1QW, 1WC, 2AIB, 2AIM, 2AJ, 2AK, 2AMJ, 2AQW, 2AYN, 2BAA, 2BUM, 2CCL, 2CJD, 2CP, 2CYX, 2MU, 2TB, 2TG, 2VA, 3AFQ, 3BVA, 3BWT, 3CJN, 3DO, 3NI, 3ZO, 4BX, 4CJ, 4PF, 4RR, 5AMN, 6CX, 7CS, 8AHC, 8AS, 8ATV, 8BF, 8BO, 8BRC, 8BSD, 8CBR, 8CCQ, 8CSV, 8CYI, 8EW, 8RA, 8RC, 8RH, 8JQ, 9BDQ, 9EJI.
Various:—NBA, RA 19ADRE, NOT, FOA, D 7M, A 3BV, O WA, O 2A5O, RXY, AGB, CN CG, Q NPW, KEL, WTZ, AGC, SUC2, P 19B, C 1BE, Q 8KP, R 8AF, M 8RA.
(0-v-1.) On 15-75 metres.
W. R. Stainton.

Moseley, Birmingham.
(August 1st.)
Argentine:—R DB2, GA2, HA2. Australia:—A 2LM, 5KN. Brazil:—BZ 1AF, 1AR, 1AW, 1BI, 2AB, 2AJ, 9QA. Mexico:—M 1J. New Zealand:—Z 4AA, 4AM. Porto Rico:—PR 4JA. Uruguay:—Y 2AK. U.S.A.:—U 1CJC, 2MM, 2OM, 3CDV, 4BY, 4RM, WGY, VOQ.
(0-v-1 Reinartz) on 30 to 45 metres.
K. B. Davis.



LETTERS TO THE EDITOR

The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

INTERFERENCE FROM ELECTRICAL CIRCUITS.

Sir,—It is regrettable to learn from the letter of Mr. Hughes, in your issue of July 21st, that certain cinema proprietors should take up a selfish attitude in refusing to assist listeners in abating interference which is definitely proved to be emanating from their electrical equipment. However, it is fortunate that not all proprietors are as mean as the one of Mr. Hughes' experience.

Severe interference has always been experienced in nearby receivers from the machinery at our local cinema. The proprietor was eventually approached on the subject and readily granted permission for experiments to be conducted on his apparatus with a view to abating the trouble.

The local branch of the Wireless League forthwith produced the necessary funds for experimental apparatus, and at the same time officially thanked the proprietor for his courtesy. The actual installation of apparatus was placed in the hands of his usual electrical contractor, that he might be assured that his machinery would be in capable hands during experiments.

Up to the present the only experiment that has been tried is that of shunting large condensers across the input of the motor and the output of the generator which is driven by the former and supplies current to the arc in the projecting lantern.

The effect of this arrangement has been to reduce sparking at the commutator with a consequent reduction of interference to about a half of its original strength. Incidentally the proprietor benefits from decreased wear on his commutator brushes.

At the time of writing all bare cables are being bonded in earthed tubing, and a further improvement in the reduction of radiation is hoped for.

For the benefit of all concerned, it would be of interest to know how others have solved this problem of eliminating radiation from electrical machinery as there seems to be no written information on the subject?

A. D. TROUNSON,
Vice-Chairman of the
Redruth Branch of the Wireless League.

Redruth, Cornwall.

SINGING BEFORE THE MICROPHONE.

Sir,—Now that wireless speakers have been drilled in the niceties of pronunciation, what of the sins of the singers?

When a speaker used one of two alternative pronunciations for a word the listener-in did at least know what he meant. Can the same be said of the impression left by certain singers' songs?

It may appear incredible, but it is a fact that there are wireless singers to-day who actually do not trouble about the words of the songs they sing. They think of the voice, of how they can arrange for a particular effect, and the result of all this posturing is quite disastrous for the unhappy listener-in.

"Nerves" are another frequent cause of failure. I myself do not broadcast, but in my gramophone work I sing into a microphone, and I am never nervous there unless I have been away for a time, and then I take perhaps an hour before I get into my stride.

Many wireless singers, on the other hand, do get a fit of nerves when they remember the millions who are listening to them, and that makes them go for the song with much too much voice. Now, economy in voice is the greatest asset of a wireless artist. A whisper is heard where a shout would become a blur, and the singer from whom the listener-in hears every word is the one who sings quietly at the microphone mouth.

Surely a little gentle supervision here would be at least as welcome to listeners-in as the selection of the more correct of two correct pronunciations of "idyll"?

Ealing, W.5. PETER DAWSON.

DO TRANSMITTING STATIONS SUFFER FROM FATIGUE?

Sir,—On page 68 of the July 14th issue there is a very interesting article signed "Observer at Sea" on the question, "Do Transmitting Stations Suffer from Fatigue?"

While it seems strange to think that there could be some form of fatigue or other condition simulating fatigue, yet those of us who have been associated with radio cannot help but feel that there may be something in this argument. I very decidedly agree with the writer that when new stations come on the air, either for regular code transmission or for broadcasting, that they seem to be much better during the first month or two than they do at six months or a year later. I have noted this in particular with several of our American high-power broadcasting stations. We are inclined to think that it is the season, or weather conditions, as we are more apt to put it. There is no more reason for this belief than for the corrosion or fatigue theory.

It would be a great service if experiments could be carried on and this fatigue or corrosion effect actually measured. I feel that the writer of your article is to be complimented for the very clear manner in which he has described the situation.

Cambridge, Mass., U.S.A. H. B. RICHMOND,
General Radio Company.

Sir,—I wonder if any of your readers have an explanation of the following phenomenon, which I and several other Danish transmitters have noticed. You hear a station calling CQ or "Test" at a strength of, say, R7. You answer him, and get in touch with him, but when he replies his strength is much reduced, say to R4, and often QSS becomes bad. This I have experienced quite often; also as regards reports on my own station. I am always very careful to keep my power constant during a test, and I use a starting rheostat in the filament circuit of my transmitting valve to ensure constancy of filament current each time I change over to transmission, so I am convinced that the reduction in strength at the other end is not caused by alterations in my transmitter. In no case have signals become stronger on coming back. My mention of this was suggested by reading in your correspondence columns about transmitters that get tired.

I have been glad to see the increased interest in Morse, evinced by letters from your readers on the subject. The way I learnt Morse was to listen on 600 metres for half an hour every evening and write down anything I heard. I started learning on my first crystal set, but for listeners with valve sets I would recommend listening to slow Wheatstone transmissions on 4000-5000 metres C.W.; there are always plenty of stations, and one of them is sure to be working slowly. I would also recommend this to transmitting amateurs, as it is an excellent way of catching the rhythm of "Morse as it should be done." For beginners it is recommended to listen to something a little quicker than can be written down with ease. The most important thing is instantly to skip signs or letters which are not recognised at once, otherwise ten other signs may have passed in the meantime. It should be remembered that one has no right to make use of matter received, except in the case of Press messages or weather reports.

JAMES STEFFENSEN (D7JS).

Fakse Ladeplads, Denmark.

FREQUENCY AND WAVELENGTHS.

Sir,—Two articles of interest and, in my view, importance have recently appeared: firstly, that entitled "Frequency and Wavelength," by Mr. Vincer-Minter, on pp. 149-153 of the August 4th issue of *The Wireless World;* and secondly, an official statement by the B.B.C. on page 254 of *The Radio Times* dated August 6th under the heading "The Geneva Plan." From the latter we see that wavelengths between 200 and 600 metres have been so allocated that a frequency difference of exactly 10,000 cycles exists between any two stations or group of stations, and we further notice that a wavelength difference of 11.8 metres is necessary to do this at the 600-metre end of the scale, whereas only 1.3 metres difference is required at 200 metres. Surely there could be no more convincing argument for the use of (*a*) the frequency scale instead of the wavelength scale when describing a station's transmission and (*b*) corrected straight-line frequency condensers.

There will be exactly 101 clear wavelengths from 200 to 600 metres inclusive, just as there are 101 marks on a dial scribed from 0-100; it follows, therefore, that if we go to the trouble of apportioning the inductance and capacity of our tuning circuits with sufficient care, and use suitable variable condensers, that each division on the condenser dial will represent a Geneva

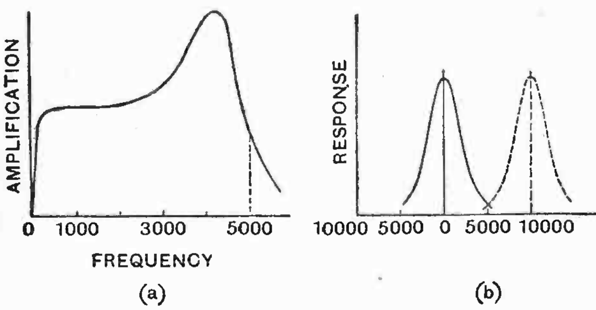


Fig. 1.—Transformer characteristic and response curves referred to by Mr. Kingsbury.

wavelength; or, to put it less optimistically, each Geneva wavelength will be separated from its neighbour by approximately the space between adjacent divisions on the condenser dials. This would appear to be an ideal worth striving for. If dials were marked 50-150 instead of 0-100 we should have a very fair calibration in frequency÷10,000.

In connection with the S.L.F. condenser, just how long will it be before we have a selection of condensers retaining the semi-circular rotor blade and having a modified stator plate? In my opinion the present trend is incorrect for several reasons, the chief of which is the wastage of valuable space. When two H.F. stages are used involving three tuned circuits this wastage becomes chronic.

One further point: if wavelengths are to be separated by only 10,000 cycles a real general purpose set, *i.e.*, good for DX and local transmissions, requires L.F. transformers with a curve in accordance with Fig. 1 (a) in order to give a satisfactory final output from an H.F. response curve in the nature of Fig. 1 (b), which will be necessary to separate two adjacent stations of comparable strength. I believe it is fatally easy to obtain a curve like Fig. 1 (a) from a low ratio transformer where leakage is present. Perhaps some enterprising manufacturer will market a transformer for this specific purpose. Needless to say, such a transformer must not cut off seriously at more than say 100 cycles at the low end of the scale.

D. KINGSBURY.

London, S.W.20.

COMMUNICATION ON LOW POWER.

Sir,—I think the suggestion of Mr. Exeter and Mr. Allen (Gi6YW) that a low power test be arranged among the British transmitters is an excellent idea.

I suggest that all amateurs who wish to take part in this test send in their names and call sign to the organiser, agreeing to use not more than ten watts, and that a list of these stations be published in the various wireless journals.

To-day I am writing to the Transmitter and Relay Section of the R.S.G.B. asking them if it will be possible for them to arrange the test, which should last about one week in October or November, for conditions are usually pretty good during these months.

Although conditions are not too good at present, I should like to mention that I have recently worked a station within the Arctic Circle and one in North Africa on 6 watts (R6 and R5), and have also worked Belgium and Ireland on 0.5 of a watt.

I don't think the high-power amateurs will mind resting for a week, and hope that they will take part in the tests themselves, using low power, as it will show up the really efficient stations, and all will have equal chances.

Hoping this very interesting test will be arranged shortly and be supported by all amateurs.

T. A. STUDLEY (G5TD).

Harrow.

PORTABLES AND PORTABILITY.

Sir,—With regard to your Editorial in the week's issue, may I say that, in my opinion, one great fault designers make over portable receivers is not paying more attention to the containing case. The use of aluminium or duralumin, not only for the outside case but for the internal shelves and struts, would not only keep down the weight considerably, but would save space. Metal approximately $\frac{3}{16}$in. thickness will (when properly designed) successfully replace heavy $\frac{1}{2}$in. wood. Admitted it will cost a little more, but people who can afford to possess portables are not likely to worry about this little extra cost.

Another advantage is that the whole case can be used as a screen, which is very necessary when H.F. apparatus is packed up close.

FRANK W. GIBSON.

London, N.3.

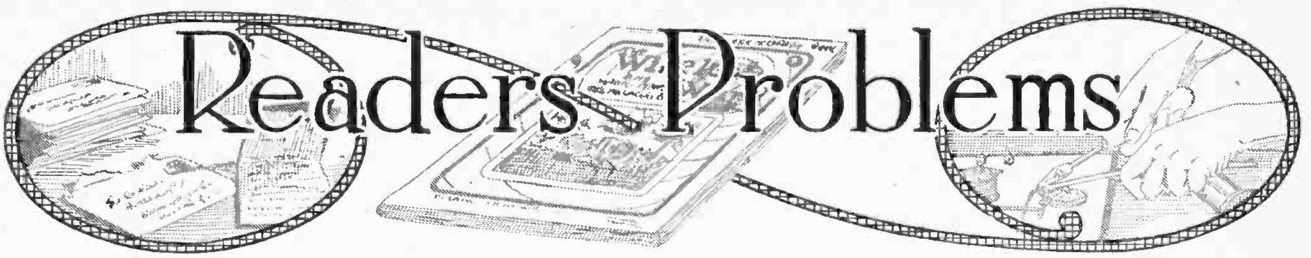
DEFECTS IN INTERVALVE TRANSFORMERS.

Sir,—I have read with great interest a letter in a recent copy of *The Wireless World* on the possible causes of breakdown in transformer and telephone windings, and I thought my experience with them may be of interest to you.

The cause of this breakdown puzzled me for some time, so I decided to carefully take down some windings and examine them. The first thing I noticed was that the points of fracture were in most cases accompanied by a small amount of green corrosion. This led me to think that some sort of electrolysis had taken place at this point. I then examined the fracture with a microscope, which confirmed my belief of electrolysis having taken place. I think the cause of this is as follows: The enamel on the wire fractures quite easily when bent on a radius of $\frac{1}{4}$in., and then examined by the microscope. I think that, due to potential difference existing between turns near together, and the presence of moisture at the fracture, electrolysis takes place, and finally breaks down the wire. In most cases before the breakdown becomes complete the offending winding will cause an intermittent circuit, this being due to varying resistances at the point of corrosion.

ARTHUR G. LONG.

Wotton-under-Edge, Glos.



"The Wireless World" Information Department Conducts a Free Service of Replies to Readers' Queries.

Questions should be concisely worded, and headed "Information Department." Each separate question must be accompanied by a stamped addressed envelope for postal reply.

Switching L.F. Amplifiers.

Some time ago you published a diagram of a three-valve receiver in which an exceptionally simple and efficient switching arrangement for using either one, two, or three valves, was given. Would it be possible to modify this arrangement so that the loud-speaker could be used after the final valve, whilst at the same time a pair of telephones was being used after the first valve? T. U. C.

The circuit to which you refer was published on page 434 of our March 17th issue, and the modification which you propose could very well be used without complicating matters or upsetting the simplicity of the original switching arrangements. We reproduce in Fig. 1 the original circuit with the necessary additions shown in dotted lines. It will readily be seen that the loud-speaker can be used following the first, second or third valves, according to the degree of volume required, whilst the telephones can be used simultaneously after any valve, without either loud-speaker or telephones interfering with each other. At the same time either loud-speaker or telephones can be used at a distance from the receiver, using a single wire extension in the manner described on page 217 of our Feb. 10th issue. By using this method of switching the impedance connected in the anode circuit of any valve (i.e., the transformer primaries) is not changed, thus eliminating one undesirable feature, which is a prolific source of distortion with the more customary switching arrangement. The simplicity of wiring in Fig. 1 also eliminates yet another cause of distortion, which occurs when complicated switching of the transformer primaries is adopted, namely the shunting away of the higher musical frequencies and harmonics by the extraneous capacity effects thus introduced across the transformer primaries. At the same time, by keeping the steady H.T. current out of the loud-speaker and telephone windings, not only is all risk of their breakdown or demagnetisation averted, but the possibility of magnetic saturation of the loud-speaker, which was discussed on page 754 of our June 2nd issue, is eliminated.

It must not be forgotten that a blank stud must be inserted between each "live" stud of the switches, otherwise a section of the H.T. battery will be short-circuited through the transformer primaries when passing over from one stud to the other.

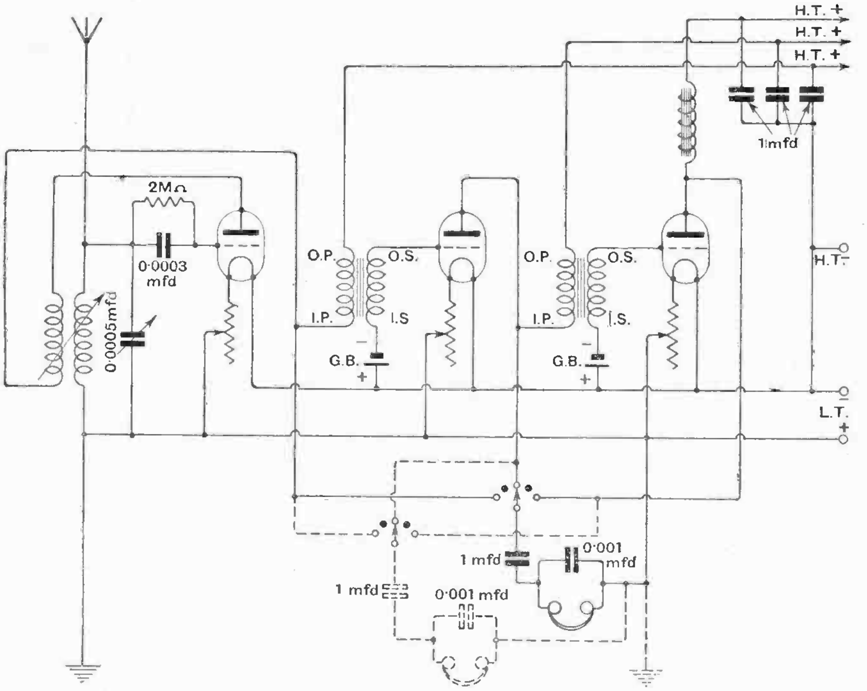


Fig. 1.—A simple and efficient method of L.F. switching.

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A Controversial Matter.

Can you give me a definite ruling concerning the correct values of anode resistance, grid coupling condenser and grid leak to use in a resistance-coupled amplifier, since there appears to be much conflict of opinion on these points? D. H. K.

For best results the value of the anode resistance should be about five times the impedance of the valve in whose anode circuit it is connected. That is to say, if it follows a D.E.5B valve used either as a detector or first L.F., its value should be about 150,000 ohms, because the valve impedance is 30,000 ohms. Should the resistance follow the second L.F. valve (which should be of the low impedance type, such as the D.E.5, if valve overload distortion is to be avoided), it need only have a value of 30,000 ohms or so. The resistance should be wire-wound in order to obviate crackling noises which occur in a composition resistance after a fairly brief period of use, due to disintegration of the graphite or similar material of which it is constructed, by the passage of the steady anode current. It should be wound as noninductively as possible in order to obviate any resonance effects, and should have as low a value of self-capacity as possible, in order to avoid the shunting away of the higher musical frequencies.

The grid condenser and leak values are not critical, a value of 0.1 mfd. for the former and of 0.5 MΩ for the latter being suitable. In general, however, the grid condenser should not have a less value than 0.05 mfd. It is advisable, although not absolutely essential, that the dielectric be of mica and not paper. The paper dielectric is quite able to withstand the voltage of the H.T. battery (which is, of course, across it) without actually breaking down, but it is apt to become somewhat leaky, thus causing the grid of the succeeding valve to become positive, and so cause grid current distortion.

It is realised that the modern tendency among experimenters is to use anode resistances of one to three megohms, coupling condensers of 0.0005 mfd., and 5 to 10 MΩ grid leaks, in conjunction with special values of high impedance and high amplification factor. Indeed, full details of such an arrangement were given on page 395 of the issue of this journal for September 23rd, 1925. Whilst such a scheme is worthy of very serious consideration by the experimenter, it is scarcely so simple and trouble-free as many suppose, and at any rate until suitable valves are produced it is far better to adhere to the old and well-tried system which even the beginner is assured of getting to function satisfactorily, provided that he follows the details given in a reliable constructional article.

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Controlling Volume by a Tapped Choke.

I am very interested in the method of volume control using a tapped anode resistance used in the power amplifier described on page 480 of your March 31st issue. I am building a straightforward detector and 2 L.F. receiver, but I wish if possible to use a choke instead of a resistance in the first stage, provided that this will not prevent me from using the same method of volume control. I shall be glad, therefore, if you will give me the necessary circuit diagram, if you think my project feasible. T. D. A.

Your idea is perfectly sound, and you only need to substitute a tapped choke in place of the tapped 150,000 ohm anode resistance used in the original instrument.

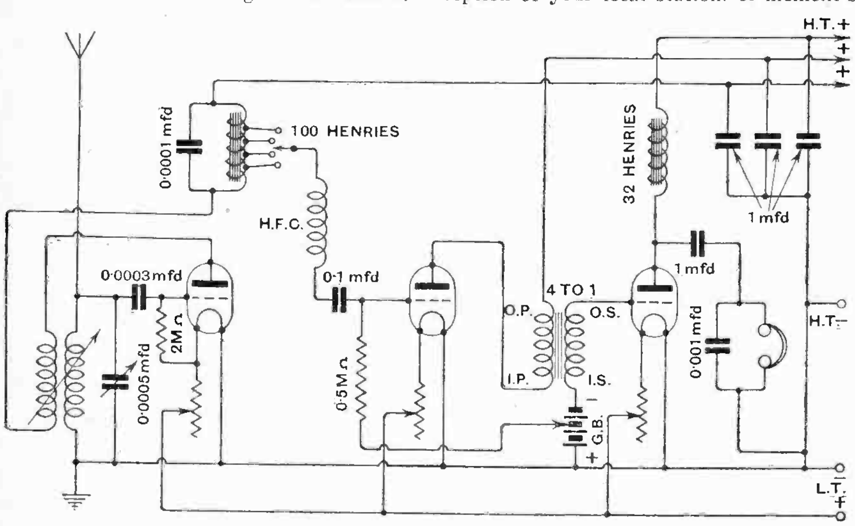

Fig. 2.—Controlling volume by a tapped choke.

The choke should, of course, have a high value of inductance, about 100 henries being suitable. A choke with suitable tappings can be obtained from Messrs. W. G. Pye & Co., Ltd., Granta Works, Montague Road, Cambridge. We give the diagram you require in Fig. 2. Do not forget to insert the H.F. choke, the necessity of which is dealt with on page 701 of our May 26th issue. Any of the various commercial H.F. chokes which are upon the market will serve the purpose excellently and will be suitable either for the normal B.B.C. or the Daventry wavelength.

The 0.1 mfd. coupling condenser should preferably have a mica dielectric. These may now be obtained from the T.C.C. Company.

With regard to the fixed condenser shunting the choke, this is, of course, for the purpose of by-passing the H.F. component of the current in the anode of the detector valve. It should be kept as low as is compatible with the duty it has to perform, and need not exceed a value of 0.0001 mfd. on the broadcasting wavelengths.

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Efficiency or Inefficiency.

I am contemplating the purchase of a neutrodyne receiver employing two stages of H.F., a detector, and two transformer-coupled L.F. stages. As evidence of its high efficiency, the vendor has informed me that at ten miles from 2LO the receiver will give good loud-speaker results without any form of aerial or earth connection. I shall be glad if you could advise me whether I shall be correct in taking this as conclusive evidence of its efficiency. B. W. L.

The fact that the receiver will bring in 2LO on the loud-speaker at a distance of ten miles without aerial, earth, or frame is, on the contrary, proof that the receiver is very badly designed indeed, and will be of little use for anything but reception of your local station. A moment's thought will make it clear that, no matter how selective are the actual tuning circuits, and no matter how loosely the aerial is coupled for the purpose of selectivity, you will never succeed in eliminating the local station. The trouble is that the coils in the receiver are acting as miniature frame aerials, and before the receiver would be satisfactory it would be necessary to redesign it completely and screen the coils and H.F. transformers in the manner illustrated from time to time in connection with receivers described in this journal. What would constitute fairly reliable evidence of the efficiency of a long-distance receiver would be that at, say, two miles from 2LO it was quite impossible to hear that station at all with the aerial and earth removed, provided, of course, that the receiver had previously been shown to function satisfactorily with the aerial and earth connected.

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Why Very Long Waves are Useless for Broadcasting.

I have been very interested in reading the article on "Wavelength and Frequency" published in your August 4th issue, but there is one question which I cannot work out satisfactorily for myself, and that is, supposing a broadcasting station were to operate on 30,000 metres, what is the nearest wavelength on either side of this wavelength on which another station could be permitted to work without mutual interference? E. W. B.

From the formula given in the original article, we find that a wavelength of 30,000 metres is equal to 10 kilocycles. It was proved in that article that the smallest permissible separation between stations is 10 kilocycles. Therefore, the two stations on either side of this hypothetical station must have a carrier wave frequency of 10+10 k.c. and 10−10 k.c., or, in other words, 20 k.c. or 0 k.c. If a station has a frequency of 20 k.c., then its wavelength is 15,000 metres, and if a station has a frequency of 0 k.c. its wavelength is, of course, infinite. In practice, therefore, we could only place a station on one side of this 30,000-metre station in the wavelength band, and this one station would have to have a wavelength of 15,000 metres less than 30,000 metres, or, in other words, a wavelength of 15,000 metres.

Apart from this consideration, of course, it would be impossible to operate any broadcasting station on a wavelength of 30,000 metres. The reason is that this wavelength represents a frequency of 10 k.c., or 10,000 cycles. Now, 10,000 cycles is just within the audible range of frequencies, and it would be possible to just hear the carrier wave as a very high-pitched whistle. It would, however, not be permissible to operate a broadcasting station even on, say, 25,000 metres, which is equal to a frequency of 12,000 cycles. For, although the carrier wave on 12,000 cycles would be outside the range of audibility, it must not be forgotten that the side bands occupy a space of 10,000 cycles, that is, 5,000 cycles on each side of the carrier-wave frequency. Therefore, the side bands of a broadcasting station on 25,000 metres would spread from 7,000 cycles to 17,000 cycles, but this would mean that that portion of the side bands between 7,000 and 10,000 metres would be audible without rectification, and some very curious results would occur.

The Wireless World

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THE B.B.C. POSITION.

It is gratifying to see that we are by no means alone in our opinions as to the highly unsatisfactory position in which the Government has left broadcasting since the recommendations of the Broadcasting Committee were published.

The daily Press, and, in particular, *The Daily Mail*, have put forward strong and persistent arguments in favour of the public being informed as to the names of the commissioners already appointed by the Government to comprise the future broadcasting authority, and a statement defining the scope of this new authority and indicating what its policy will be.

As You Were.

Our enquiries at the offices of the B.B.C. and elsewhere indicate that even the B.B.C. themselves are just as much in the dark as ever as to their future. The publication of the proposed revision of wavelengths for Europe is a welcome change from the secretive attitude which has been adopted regarding future developments in broadcasting in almost every other direction. In our opinion, by waiting till the new Parliamentary session, the time will be all too short for giving the public a full opportunity of indicating to the Government their wishes with regard to the broadcasting service.

Status of Mr. Reith.

We are convinced that no arrangement come to will meet with the approval of the public which does not establish Mr. Reith, the pioneer of broadcasting in this country, in a position which gives him at least as much authority and control over the destinies of the organisation as he has had in the past. He has unquestionably proved his worth and capabilities during the most difficult period of the existence of the B.B.C., and if now he is to be limited in his activities or in any way handicapped by a meddlesome higher authority, we should regard it as little short of a dishonourable treatment of one who has served so well.

B.B.C. Finances.

As to the vexed question of the finances of the B.B.C., we feel that, in view of the extreme necessities of the Treasury, it is not unreasonable that some proportion of the revenue derived from licences should be appropriated, but the extent of the appropriation must be clearly defined, and it is impossible at this stage to budget accurately for the future expenditure of the B.B.C., especially in view of the reorganisation of stations and wavelengths to provide alternative programmes on the plan already announced.

A Suggested Basis

Under these circumstances, the present policy of the Post Office of limiting the B.B.C. revenue to £500,000 is an unfair and unbusinesslike method to have adopted. As the number of licences taken out increases, so the public is justified in expecting that the service of broadcasting will improve, particularly in respect of the programmes; so that in our opinion the only fair basis for deciding upon the revenue of the B.B.C. to be appropriated by the Government would be

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for a percentage to be definitely fixed at, say (for the purpose of argument), an amount not exceeding 25 per cent. The whole of the remainder should be at the disposal of the broadcasting commissioners, and, to guard against any handicap to the B.B.C., the appropriation of the percentage by the Government should not take effect until after a guaranteed minimum is available for broadcasting.

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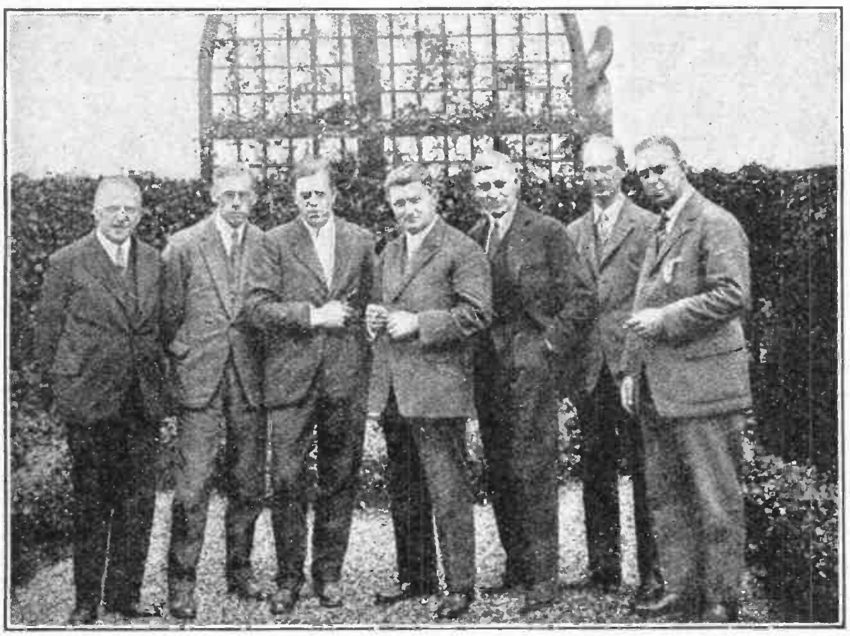
THE NEUTRODYNE AGAIN.

WE see that in an article by Mr. Scott-Taggart in the current issue of a contemporary, a statement is made which we quote :—

"In June, 1923, I introduced to the British Public the Neutrodyne method of reception."

At the risk of appearing contradictory, we would point out that some months prior to this date the Hazeltine Neutrodyne system was well known in this country, and we might refer our readers to the issue of *The Wireless World*, dated April 21st, 1923, in which an article running into five pages deals in detail with the principles, and since this was the first description published in this country it would appear that it was *The Wireless World* which "introduced to the British public the Neutrodyne method of reception."



Members of the Technical Committee of the Union Internationale de Radiophonie photographed recently on the Continent on the occasion of the meeting when the new wavelengths for European broadcasting stations were considered and approved. The names, reading from left to right, are :—Mr. Steinbach (Czechoslovakia) : Mr. Divoire (Secretary) : Capt. Eckersley (Great Britain) : Mr. Braillard (President) : M. Gendron (France) : Mr. Lemoine (Sweden) : Mr. Van der Pol (Holland).

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LOW POWER TRANSMITTING TESTS.

WE are very pleased to see that the proposal made by a correspondent in *The Wireless World* recently, that tests should be conducted by transmitters to ascertain the minimum power on which they could work over given distances, is receiving such strong support from the transmitting fraternity. Amateurs have already contributed largely to our knowledge of the usefulness and capabilities of short waves, but we believe no systematic tests have yet been conducted employing minimum power. We understand that the Transmitter and Relay Section of the Radio Society of Great Britain is keenly interested, and will shortly make an announcement regarding the organisation of tests of this nature. Meanwhile, we continue to receive numerous letters from transmitters, all keen to participate.

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THE "EVERYMAN'S FOUR-VALVE."

ALMOST sooner than one would have expected it possible to obtain the parts and construct the set, we are receiving by every post letters from readers who have made up the "Everyman's 4-Valve." All these letters are prompted spontaneously as a result of the enthusiasm which is felt as soon as the finished set is operated. It is not our usual practice to extol our own products, but in this case, in the interests of our readers who want the very best, we feel that we should state that our wide experience of sets of every description enables us to agree confidently with the expression of opinion given by one of our readers, after handling the set for two days, that "it is the best 4-valve receiver that exists," and we believe that no reader will want to miss what is undoubtedly the set of the season.

The enthusiastic reports which, even at this early stage, we have had from our readers give us great satisfaction, for it must not be forgotten that the design of this receiver is the outcome of very considerable time and care devoted in our laboratory to its preparation. Perhaps the outstanding features which most appeal to the general reader are the extreme simplicity of construction and the even greater ease of operation.

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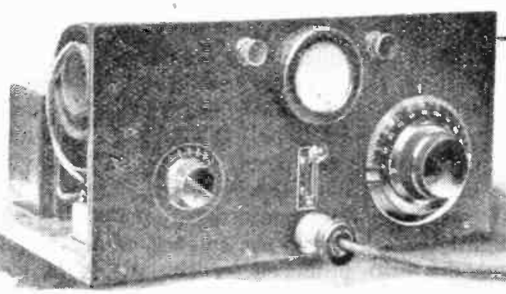
THE GENEVA SCHEME.

THE recommendations of the Technical Committee of the Geneva International Broadcasting Bureau have taken the form which has been generally anticipated; many groups of stations each with a common wavelength have been formed.

Under the new scheme 16 wavelengths are allotted to groups of stations, totalling some 120, so situated geographically as to preclude as far as possible any possibility of mutual interference.

It would seem to us that the grouping of stations is likely to lead to some trouble, especially where it is desired to listen to a station in a group when one is situated approximately mid-way between any two, but no doubt the engineers responsible have considered the possibilities very carefully. At this juncture we can but wait and see and hope for the best, trusting to the judgment of those responsible for drawing up the plan.

Low Power Transmitter-Receiver For Two-way Working



Easily Operated Two-valve Telephony Set Working on 90 Metres.

By F. H. HAYNES.

IN the process of conducting tests between transmitting stations communication invariably breaks down as adjustments are made. It is exceedingly difficult to make any drastic change in the equipment without losing touch, this resulting in much delay, unnecessary transmission, and the inability to pass observations to the other station. Experimental work is greatly facilitated, of course, where a land line telephone service is available.

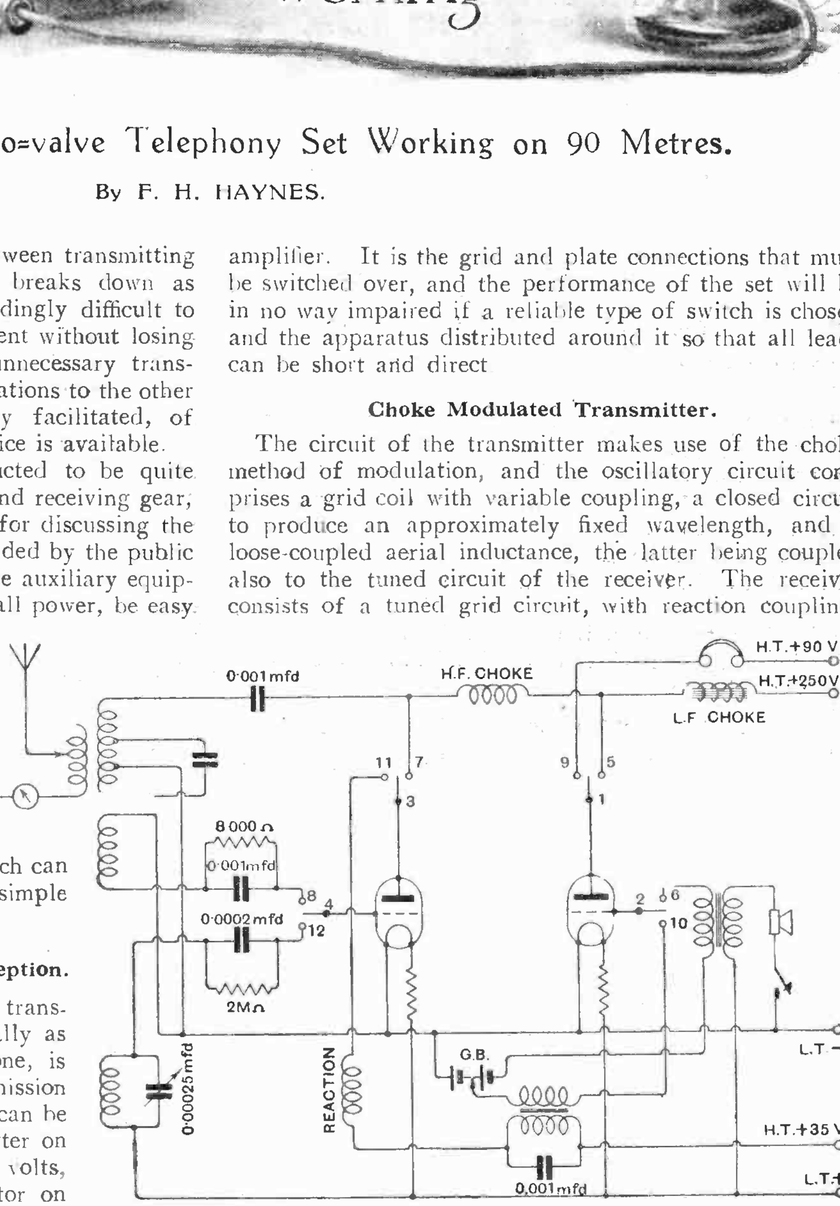
Auxiliary sets of apparatus, constructed to be quite independent of the main transmitting and receiving gear, will provide an almost greater facility for discussing the tests in hand than can probably be provided by the public telephone service. For this purpose, the auxiliary equipments must be inexpensive, consume small power, be easy to operate, and reliable. Duplex working would be an advantage, and although it can be carried out by using two wavelengths of, say, 90 and 150 metres, the extra complication renders such a system perhaps not quite so reliable, and, at any rate, not so convenient to set up as ordinary two-way working which can be carried on without a hitch, given a simple change over from transmit to receive.

Some Valves for Transmission and Reception.

The principal feature of a combined transmitter and receiver, developed essentially as a substitute for the land line telephone, is that the same valves are used for transmission and reception. The D.E.5 type valve can be used quite well as a low-power transmitter on potentials of between 150 and 250 volts, whilst it is equally useful as a detector on about 35 volts, using leaky grid condenser rectification. The modulating valve recommended is a D.E.5A., which, by suitable switching arrangements, will serve as an L.F. amplifier. It is the grid and plate connections that must be switched over, and the performance of the set will be in no way impaired if a reliable type of switch is chosen and the apparatus distributed around it so that all leads can be short and direct

Choke Modulated Transmitter.

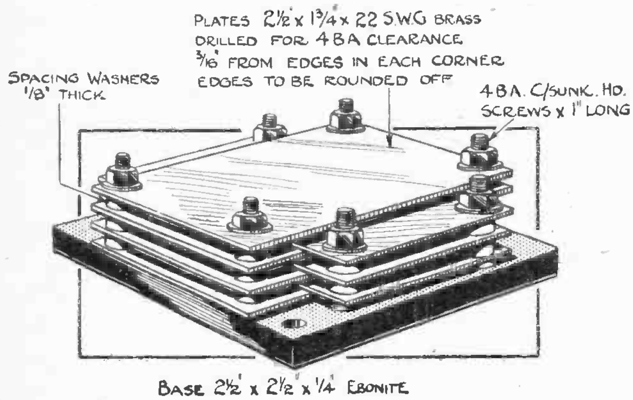
The circuit of the transmitter makes use of the choke method of modulation, and the oscillatory circuit comprises a grid coil with variable coupling, a closed circuit to produce an approximately fixed wavelength, and a loose-coupled aerial inductance, the latter being coupled also to the tuned circuit of the receiver. The receiver consists of a tuned grid circuit, with reaction coupling,



The same valves are used for reception as for low power transmission and a four pole switch transfers the grid and plate connections. For working over a limited range D.F.A.1, D.E.5, B.4, or P.V.5D.E., type valves are suitable and for higher power the L.S.5 may be used. The transmitting circuit is choke modulated and the receiver comprises a detector valve and L.F. stage.

Low Power Transmitter-Receiver.—

and a transformer coupled L.F. amplifying stage. To tune the aerial a seven-point switch adjusts the number of turns in circuit, and the set can, in fact, be operated on any aerial consisting of between 50ft. and 100ft. of wire, and having a capacity of more than 0.0001 mfd., and not greater than 0.0003 mfd. The normal wavelength is 90 metres, which was given in this particular instrument when 11 closed circuit turns were connected across the closed circuit condenser, which has a capacity of 0.00014 mfd. Appreciable changes in wavelength



THE CLOSED CIRCUIT CONDENSER OF THE TRANSMITTER. It is easily built up of brass plates bolted together with 4 B.A. screws. Sharp edges should be removed and the plates bonded together by a strip of brass on one edge of each set.

are produced, however, as the grid coil is rotated, but when once set up no further adjustment of grid coupling is required, even when changing over from one aerial to another. The anode tap is connected to the top of the coil, and, as will be found with most loose-coupled transmitting circuits working on wavelengths below 100 metres, the full inductance can, if required, form the closed circuit without the provision of additional turns for connecting the anode tap.

Fixed Reaction Coupling.

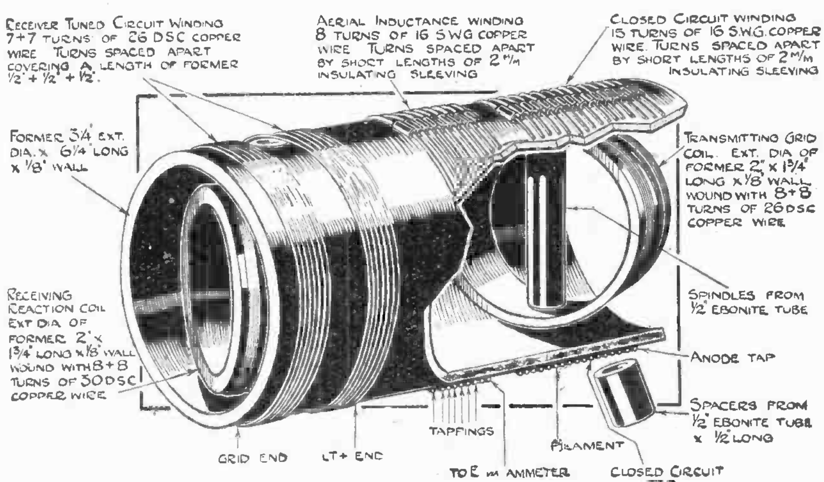
An adjustable reaction coil is used on the receiving side, but when the coupling is once set, and using a given H.T. potential, no further alteration of coupling is necessary, as the closed circuit is tuned over the bigger part of its scale. Searching with the closed circuit condenser is not intended, and a movement of a few degrees only is required to allow for small changes of wavelength.

When constructing a transmitting set one finds that there are very few ready-made components available, and, in consequence, the tuning inductance, the closed circuit condenser, the speech choke, the H.F. choke, the grid leak resistance, and the microphone transformer all need to be made up.

Perfect insulation is required between the turns of the coil, and to prevent dielectric loss by the use of unsatisfactory insulating material, turns must be, as far as possible, air spaced. Amateurs sometimes find difficulty in building a coil in which the turns of wire are carried in holes on strips of insulating material, and a simpler method has therefore been devised. The wire, No. 16 hard-drawn copper, is measured off, straightened by stretching, and pieces of insulating sleeving, ¼in. in length, are threaded on. The number of pieces is six times the number of turns, that is, about 50 for the aerial coil and 96 for the oscillatory circuit. The wire is pulled tight as the ebonite former is rotated, sliding the pieces of sleeving along so that they lie in line at intervals of one-sixth of the circumference. Air spacing is thus obtained between the turns, which are slightly raised above the surface of the ebonite former, and the grip produced by the pieces of sleeving will prevent the turns from slipping.

The wire should be cleaned before winding and pulled tightly all the while. A straight edge can be used to force the pieces of sleeving in line after the coil is finished, the beginning and finished ends merely hooking into holes in the ebonite. If desired, a coating of shellac varnish may be applied to hold the insulating pieces together and to prevent the wire from becoming tarnished, though the varnish should be kept away from that part of the aerial inductance where the tapping leads are to be soldered.

Full details for preparing the former before winding can be taken from the accompanying drawing, and it might be mentioned that care must be taken in setting out the positions for the holes, making sure that they are exactly diametrically opposite. If a ½in. twist drill is not available for making the holes, the size may be reduced to ⅜in. or even ¼in., using ⅜in. or ¼in. ebonite rod for the spindles, though ½in. is given so that the coils will remain firmly in position. All of the finer wires are terminated by threading through pairs of small holes and semi-flexible leads, consisting of six strands of No. 36 soldered to the ends of the two moving coils, the flexible leads being held firmly at the point of connection. The



THE TUNING INDUCTANCES. Uniform air spacing between the turns of the transmitting inductances is obtained by the use of short pieces of insulating sleeving which assist in keeping the turns securely in position and lifting the wire slightly above the face of the former. The reaction and grid coupling coil formers are just a tight fit on the ebonite spindles.

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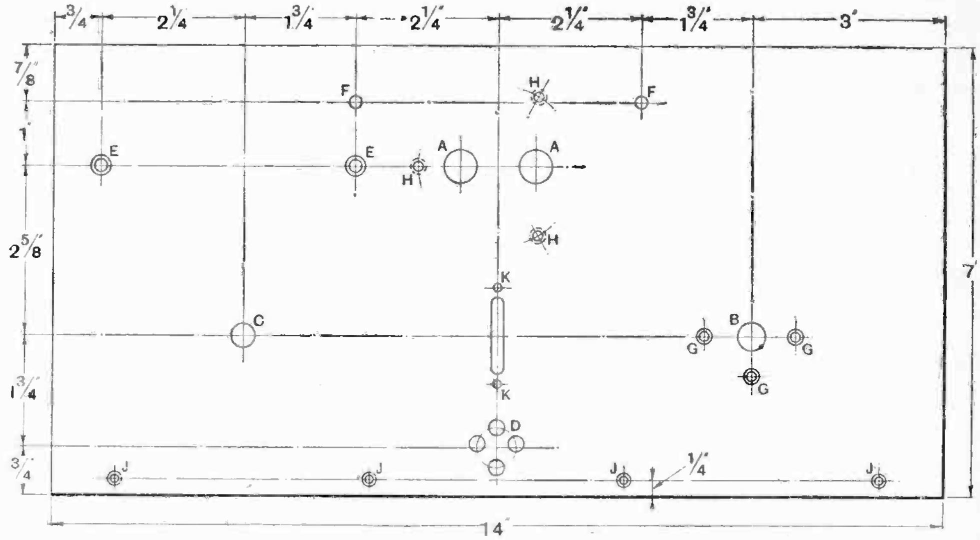
coil is attached to the panel with ebonite spacers and 2 B.A. countersunk-headed screws and back nuts, one being slightly cut away to give clearance for the end turns of the transmitting coil, and the other is attached at a position between the aerial and receiving circuit windings.

The amount of wire required for the aerial and closed circuits is 8ft. and 14ft. respectively, although lengths slightly in excess of these should be measured off. The inductance of the aerial coil is 12 microhenries, and the closed circuit 27 microhenries. On the grid coil of the transmitter sixteen turns of No. 26 D.S.C. are wound in two sections, each turn being spaced by a distance equal to its thickness. The closed circuit of the receiver consists of fourteen turns wound in two ½in. sections, so as to leave the spindle of the reaction coil free for withdrawal if necessary. There are sixteen turns of No. 30 D.S.C. on the reaction coil wound in two sections with turns touching.



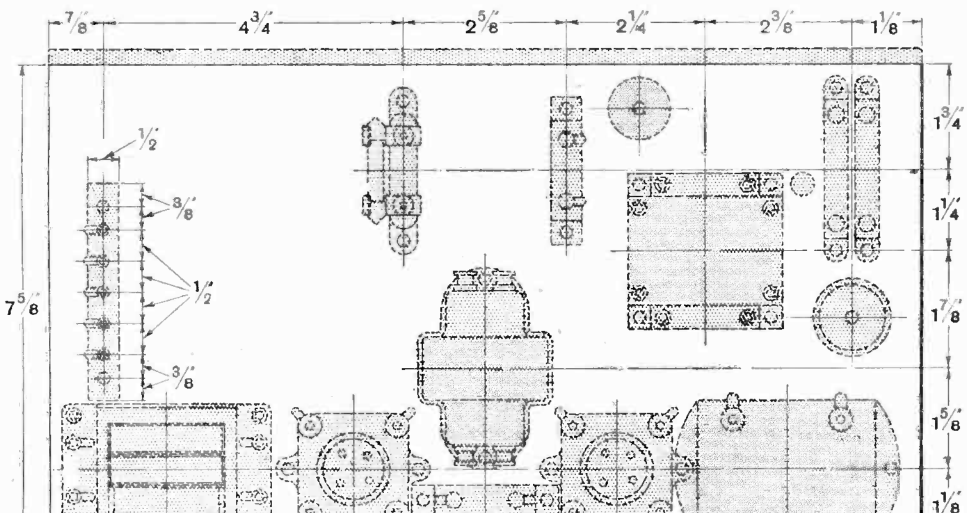
FRONT PANEL. Sizes of holes. A, 1/2" or to give clearance for the ammeter terminals. B, centre hole for condenser 7/16". D, 1/4" to take the Athol valve holder sockets (reversed). E, 7/32" to accomodate 2 B.A. countersunk screws. F, 7/32" holes for terminals. G, 5/32" for holding down screws for the condenser, 4 B.A. and drilled according to template. H, 5/32" for ammeter screws. J, 1/8" and countersunk for No. 4 wood screws. K, 1/8".

Closed Circuit Condenser.

One of the simplest methods for constructing a closed circuit air dielectric condenser is to make use of rectangular brass plates assembled with ends projecting alternately from either side. Hard brass sheet, No. 26 S.W.G. is used for making the plates, which are reduced to size by breaking off at heavy scratch lines, obviating the curled-up edge which results when snips are employed. The brass must, of course, be hard-rolled if this process is to be followed.

Holes are made in the corners to give easy clearance to 4 B.A. screws, and the positions must be accurately located, or difficulty will be experienced when assembling. It is advisable to anneal the plates by heating to a dull red heat and quenching in water, which removes springiness, so that when hammered with a mallet they can be made perfectly flat. The plates must be made bright with emery-paper and the sharp edges removed. The drawing shows the method of assembly, and one or two thin washers can be used to adjust the spacing.

Countersunk holes are made on the underside of the ebonite base piece to recess the heads of the screws. Each set of plates should be bonded together by soldering a piece of No. 16 wire, or thin strip of brass, down the edges. A liberal dielectric thickness is required between the plates, and actual sparking will take place at points where they are too near together.



BASEBOARD LAYOUT. The components can be identified by reference to the wiring diagram.

Modulation Choke.

To obtain a reactance at least equal to four times the impedance of the modulating valve, the inductance of the choke coil will need to be not less than 15 henries, assuming the use of a D.E.5A. modulating valve and a speech frequency of 200 cycles. With a D.E.5

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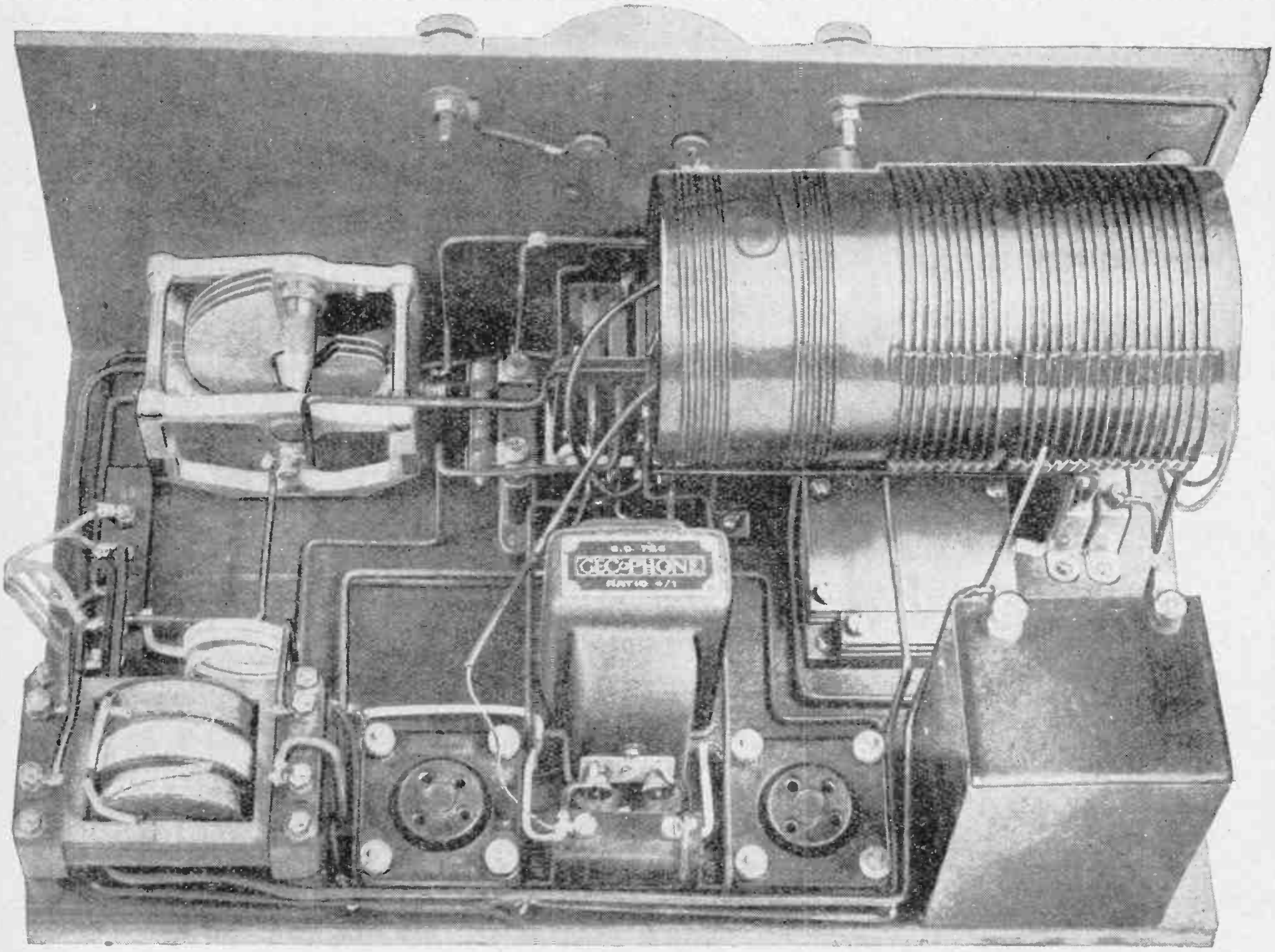
type valve, and, as the oscillator is a D.E.5, a choke having a value of 20 to 30 henries is desirable. If an old intervalve transformer is available, particularly one having a core of liberal cross section, such as a Marconi "Ideal," the sections can be rewound with No. 38 S.S.C. so as to form one complete spool.

A speech choke can be purchased already made up and consisting of some 10,000 turns of No. 38 enamel-covered wire on a core somewhat larger than the average intervalve transformer. An ordinary H.T. smoothing choke of liberal size, such as is supplied for the construction of battery eliminators, will, however, serve the purpose.



REAR VIEW. Showing the arrangement of the components. The wiring as far as possible should be kept down to the face of the baseboard. The vertical wire from the closed circuit condenser is provided in readiness for tuning the transmitter.

Microphone Transformer.

Another component to be made up is the microphone transformer, and, although this part can be obtained to order, it is not a difficult matter to adapt, say, a Marconi "Ideal Junior" by substituting a new primary. This transformer consists of three sections, and the primary spool, which is in the centre, is rewound full with No. 28 D.S.C., the secondary winding being left undisturbed. The new primary winding is suitable for use with the high-resistance solid back type of microphone, although it will work almost equally well with practically any form; the winding being liberal will prevent noises arising from arcing in the microphone. An Igranic low-ratio transformer can be rewound in this way, or any other intervalve transformer in which the primary winding is assembled as a separate section.

Transmitter Grid Leak.

The grid leak of the transmitter, which in conjunction with the grid condenser is used for biassing the oscillator valve, has a value of between 8,000 and 10,000 ohms with a grid condenser of 0.001 mfd. It consists of 40 yards of No. 47 D.S.C. Eureka wire. The required length should be measured off, folded back double, and wound double on a small spool, so that the winding is practically non-inductive. Such a resistance is inexpensive to purchase.

Radio-Frequency Choke.

A piece of ebonite tube 2in. in length by 1½in. in diameter carries the winding forming the radio-frequency

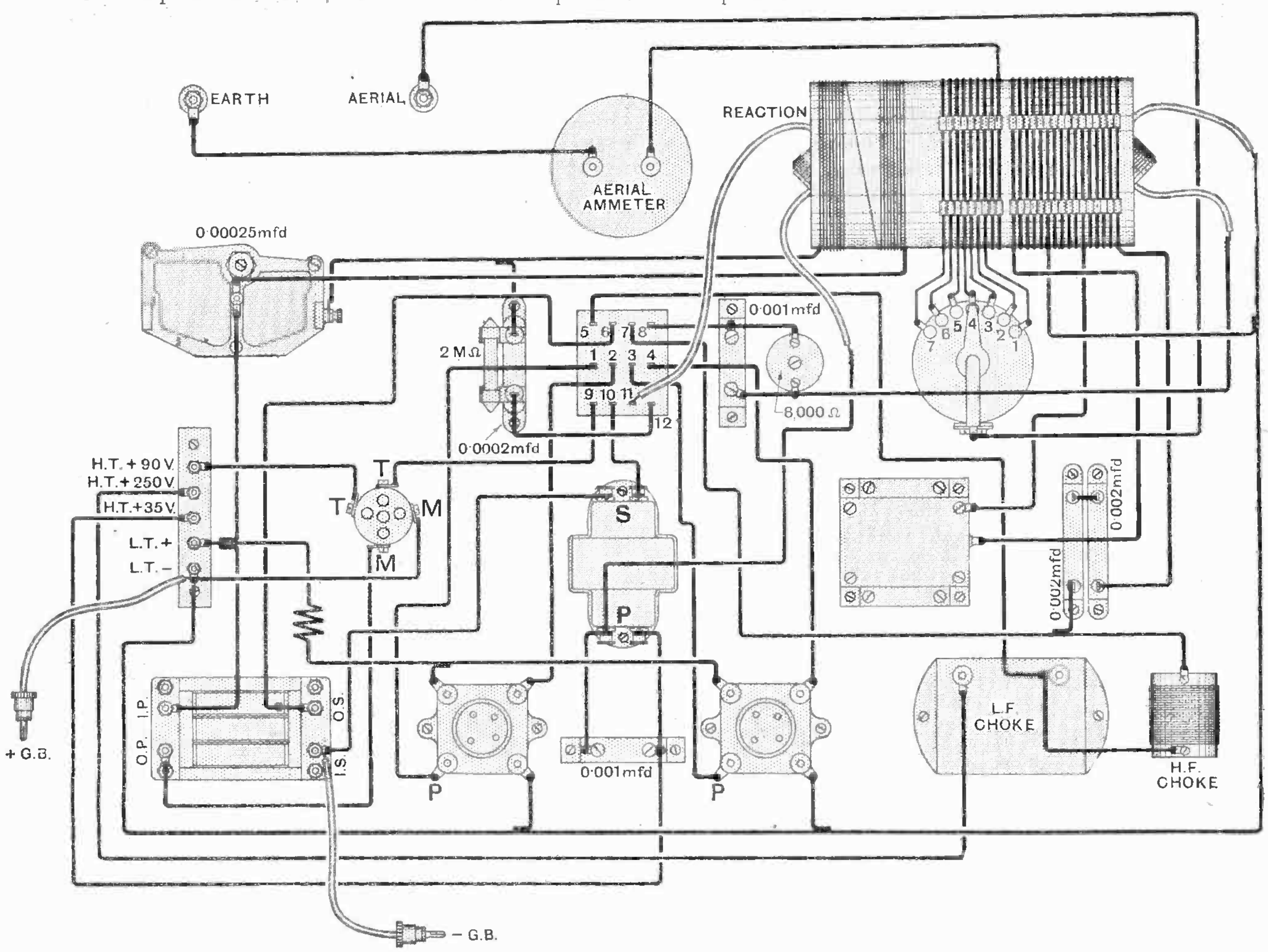
Low Power Transmitter-Receiver.—
choke. It has an inductance of about 2,000 microhenries, and consists of a single layer of No. 40 D.S.C.

Assembly.

With all components to hand, the microphone transformer, the two valve holders with transformer primary condenser placed between them, the modulating choke, the radio-frequency choke, the two grid condensers and leaks, and the feed condenser may be secured to the baseboard, together with a five-contact connecting strip for the battery leads. In addition, a piece of $\frac{3}{8}$in. ebonite rod, some $2\frac{3}{4}$in. in height, is set up from the base to give support to the wires connecting to the flexible leads of the transmitter grid coil.

The front panel is made up and the various components mitting inductance, must be wired together with the ammeter and terminals before the panel is attached to the baseboard.

Wiring-up is invariably the most difficult task in making a set, and in this instance, where compactness has been a consideration, the only permissible method consists of using straight lengths of No. 16 tinned wire, carried in insulating sleeving. The sleeving is slipped over the wire and subsequently bent to shape. To facilitate the connecting of the wires to the switch, the intervalve transformer is not screwed in position until the entire winding is completed, except for the transformer connections. A small iron will be needed to make these final connections, together with those made to the valve socket and used for connecting the telephone receivers and microphone.



PRACTICAL WIRING. Use No. 16 tinned wire in sleeving. The reference numbers show the operation of the change-over switch by turning to the theoretical circuit diagram.

secured in position. The aerial ammeter shown is an ex-Government instrument of a type easily obtainable from dealers, and has a range up to 1.5 amperes. Meters are obtainable, reading only to 0.5 amp., and although probably more suitable for such a low power set the low reading instrument has a higher resistance.

The seven-point switch, which is particularly suitable owing to its design for tapping the turns of a trans-

The table type telephone set is an ex-Government one, a four-way cord being substituted for the three-way with which these instruments are fitted and terminated in a valve base. The pole pieces of the receiver were rewound with No. 46 S.S.C. wire. Other types of microphones are obtainable, one form of which is provided with a swinging arm, which may be screwed to the side of the cabinet, connected up by flexible wire, the valve

PARTS REQUIRED.

Panel 14in. × 7in. × ¼in., baseboard and cabinet (Ward T. Lock, 15, St. Peter's Terrace, Bath).
Ebonite Tube, 6¼in. in length by 3¼in. diameter; also 4in. in length by 2in. diameter. 1ft., ½in. diameter, with ¼in. hole.
Miscellaneous wire and sleeving as stated.
Intervalve transformer ratio 1 to 4 (G.E.C.).
Modulation choke (Richard Bundy, 13, New Road, Ponders End, Middlesex).
Microphone transformer (Marconi Ideal Junior 1 : 4, with rewound primary).
2 Valve holders (Benjamin).
Valve holder (Athol).
Tuning condenser, 0·00025 mfd.
Slow motion dial (Rothermel Radio Corporation, 24-26, Maddox Street, London, W.1).
2 Condensers, 0·001 mfd. (Dubilier, type 620).
2 Condensers, 0·002 mfd. (Dubilier, type 577).
1 Grid condenser with clips (T.C.C.).
Grid leak, 2 megohms (Dubilier).
Aerial hot wire ammeter (Electradix Radio, 218, Upper Thames Street, London, E.C.4, or T. W. Thompson & Co., 39, London Street, Greenwich, S.E.10).
4-pole change-over switch (Utility).
6-way cable (Lewco London Electric Co. and Smiths, Ltd.).
7-point switch with arrow knob (Rothermel).
Brass, screws, spacing washers, connecting tags, etc.

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socket being substituted by a jack fitted with additional contacts for closing the microphone circuit when the telephones are plugged in.

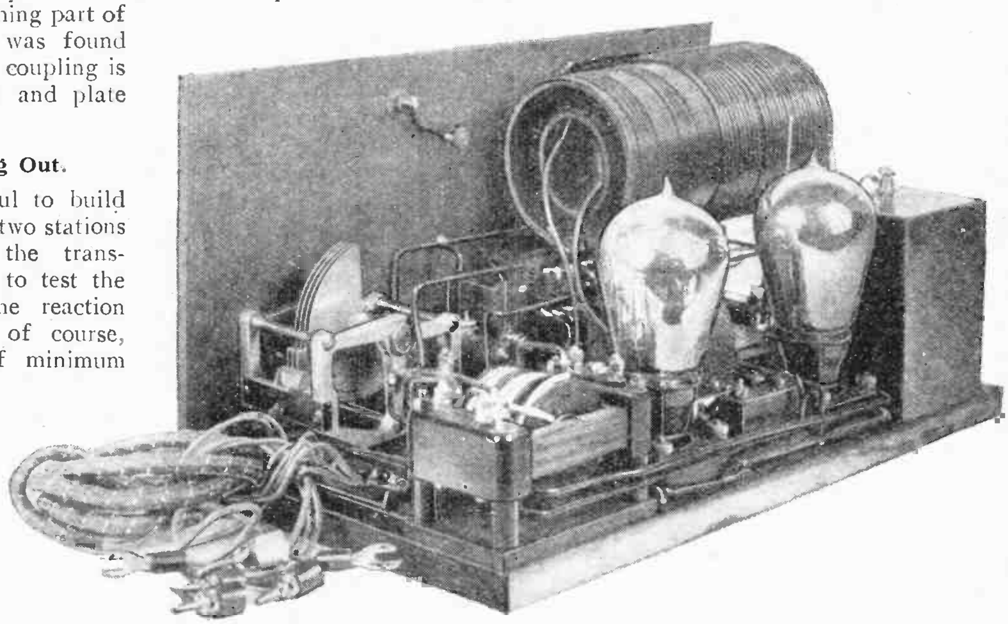
To avoid the use of filament rheostats, the connection from the L.T. positive to the valve holders is made with No. 26 Eureka wire carried in sleeving, an additional 3 or 4 inches being coiled to provide the required resistance. It was originally intended to connect up the grid battery with leads forming part of the battery cable, but it was found that by so doing additional coupling is produced between the grid and plate circuits.

Adjusting and Testing Out.

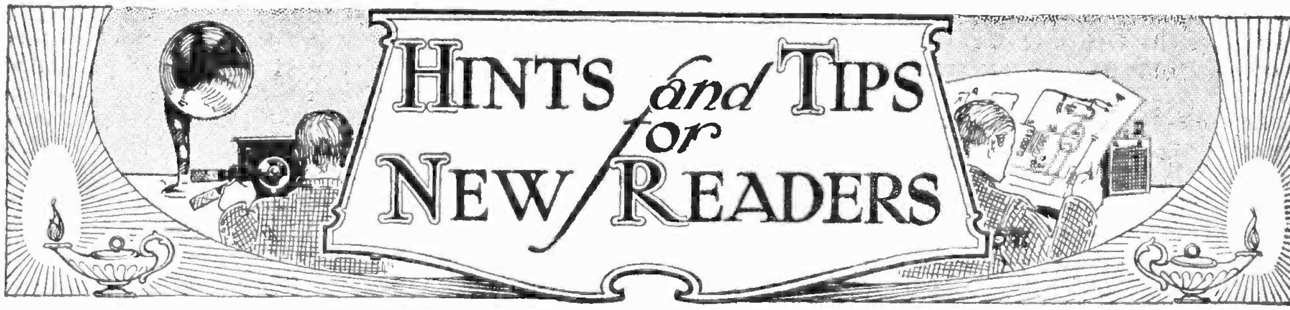
It will be found helpful to build the two sets comprising the two stations simultaneously, so that the transmitter of one can be used to test the receiver of the other. The reaction coil of the receiver is, of course, brought to a position of minimum coupling consistent with obtaining silent oscillation over the working range of the tuning condenser, and as an ordinary two-valve short-wave receiver will put up a good performance.

The best method of getting the transmitter going is to insert only the oscillator valve and connect a milliammeter in the H.T. battery lead. Temporarily connect the closed circuit tap to the middle of the coil and rotate the grid circuit inductance until self-oscillation is produced, as indicated by a decrease in the reading of the milliammeter. A 0.0003 mfd. variable condenser connected across the aerial and earth terminals should then give a reading on the aerial ammeter and give rise to an increase in the plate current. Connected to the aerial a reading will be obtainable on the ammeter by adjusting the tapping switch, and although only small the meter serves merely as an indicator. A reading of just over 0.1 amp. was obtained on 90 metres when the set was connected to an aerial having a capacity of 0.00018 mfd.

A conservative estimate of the range of communication is 10 to 20 miles, depending upon aerial dimensions and local conditions. Having only a single dial, the set is exceedingly simple to operate. The transmitters of the two stations are not tuned to exactly the same wavelength, so that the grid circuits of the receivers may be detuned from the transmitters. The movable coupling coils will take up positions almost at right angles to each other. A filament switch is not fitted as the writer preferred to connect a simple high-resistance telephone switchboard-type relay across the primary winding of the microphone transformer, with its contacts in the positive filament lead, so that when the receiver is removed from the hook the microphone circuit is closed and the filament supply switched on. Thus, with a prearranged time for calls, correspondence can be conducted, the only adjustment necessary, perhaps, is that of slightly rotating the vernier dial for best speech, communication being facilitated by the simple change-over from transmit to receive.



THE COMPLETE INSTRUMENT. A cable is used for connecting the batteries, and the filament circuit can be closed by a simple relay connected to the microphone leads.



A Section Devoted to the Practical Assistance of the Beginner.

A SIMPLE LOUD-SPEAKER SET.

Now that valves of high magnification and comparative high efficiency are coming on the market, it is worth while to consider the circuit shown in Fig. 1 as the basis of a receiver for working a loud-speaker on signals from the local station. The principal advantages of the arrangement lie in its simplicity and the high quality of reproduction obtainable with inexpensive components. It should be clearly stated, however, that the combination of a "bottom bend" detector valve, without reaction, and with one resistance-coupled L.F. stage, is only capable of giving really adequate loud-speaker volume when used under conditions where a plain crystal set gives signals just audible (if not distinguishable) with the ear-pieces held at a distance of a few inches from the ears.

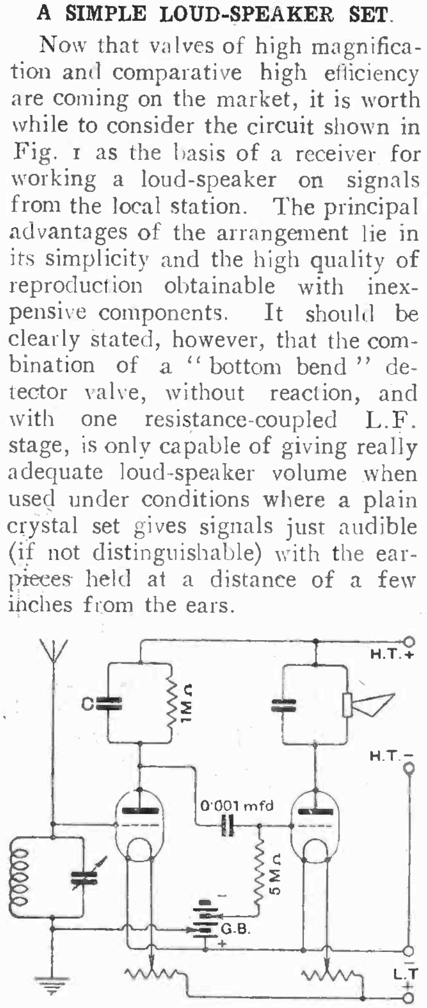


Fig. 1.—A simple and inexpensive receiver.

Although, as already stated, the necessary components are essentially low in cost, it must not be assumed that parts of poor quality can be used. Due to the fact that both the grid and anode resistances have unusually high values, it is essential that the insulation throughout should be as nearly perfect as is possible. The anode resistance may be of the tubular "metalised" type sold for use as grid leaks. Its value should be unaffected by change of voltage.

The by-pass condenser C, which is shunted across the anode resistance, should have a very low value. In practice a capacity of 0.00005 mfd. is generally sufficient, and a considerable increase over this figure will result in a perceptible lowering of tone, as well as a reduction in volume. This is due to the fact that at the higher audible frequencies the condenser tends to act as a partial short-circuit across the resistance, with a consequent reduction of the voltage applied to the grid circuit of the next valve. Incidentally, this property of the shunting condenser may be turned to good account when dealing with a loud-speaker which tends to reproduce a higher note with undue emphasis. As already suggested, the detector valve should have a very high amplification factor, while a small power valve is recommended as a L.F. amplifier. With an applied H.T. voltage up to the maximum recommended by the manufacturers, a detector will also operate at its best on a high anode voltage, and there is little point in providing a separate H.T. connection for this valve.

The receiver may be further simplified by substituting an aerial tuning variometer for the coil and condenser combination shown.

oooo

VISUAL INDICATION OF DISTORTION.

The uses of a double-range voltmeter were discussed in this section of *The Wireless World* for August 11th, where it was shown how the instrument could be permanently installed in a receiving set and, by a moderately simple switching device, could be made to show the voltage across either the L.T. battery or any valve filament, or, alternatively, across any section of the high-tension battery.

By adopting the slightly more complicated arrangement shown in Fig. 2, which necessitates the use of an extra three-pole change-over switch, it is possible to make the meter serve as a visual indicator of that form of distortion caused by overloading in the last L.F. valve, in addition to the performance of its usual functions. It may seem that the presence of distortion is sufficiently evident to render unnecessary the use of any special device, but experience shows that it is by no means easy to decide by ear whether poor quality of reproduction is due to what is usually described as frequency distortion or amplitude distortion. These expressions are almost

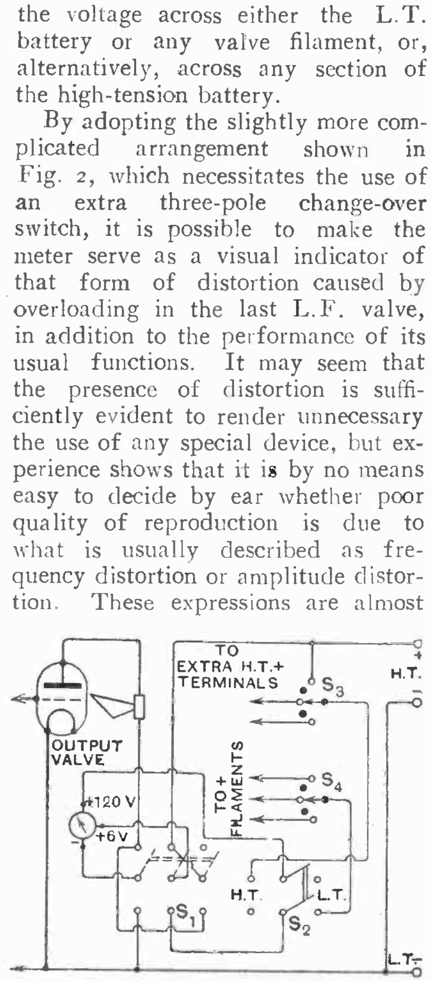


Fig. 2.—Switching arrangements for a double range voltmeter.

self-explanatory; the former refers to that form of distortion caused by an unequal amplification of the different frequencies which make up musical and other sounds, and the latter to overloading of one or more of the L.F. amplifying valves by the application to the grid circuits of greater voltage swings than can be adequately handled, either on account of the natural limitations of the valves, or the fact that the steady working voltages are incorrectly chosen.

As has been pointed out at various times in the pages of this journal, amplitude distortion in any L.F valve may be made evident by observing the needle of a milliammeter connected in its anode circuit while signals are being received. If appreciable "kicks" or movements of the needle are noticed, it can safely be assumed that the valve in whose anode circuit the meter is connected is being overloaded or incorrectly operated; in other words, that the incoming signals are giving rise to voltage swings of sufficient amplitude to make its grid so positive that a flow of grid current is started, or so negative that a rectification effect is produced, due to encroachment on to the lower band of the characteristic curve.

Almost any current-indicating device of sufficient sensitivity can serve in this capacity, and a moving-coil voltmeter, such as is under discussion, taking some 15 milliamperes for a full-scale deflection, is quite suitable. The low-voltage section should be used, as its resistance, though fairly high, is low in comparison with that of the loud-speaker windings, which are in series with it.

Referring to the circuit diagram, it will be seen that the position of the three-pole switch S_1 decides whether the voltmeter is to be used as an overload indicator, or as a measuring device. In the "up" position the low-voltage section (– and + 6-volt terminals) is connected directly in series with the anode of the output valve, the loud-speaker, and the H.T. battery, while the moving of this switch to the "down" position will connect the negative terminal of the meter to the common negative battery lead, also joining the alternative positive terminals to either the H.T. or L.T. distributing switches, depending on the position of the change-over switch S_2. At the same time, the third pole of the switch S_1 completes the valve anode circuit.

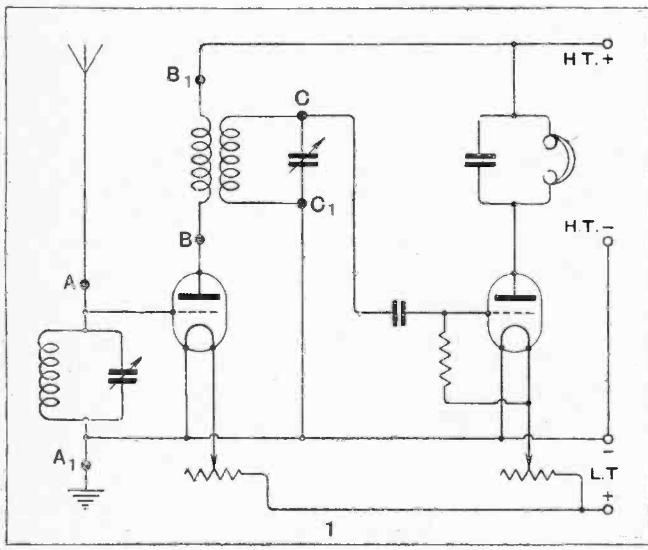
It should be carefully noted that the switch S_2 must be in the "neutral" position when the meter is acting as an overload indicator.

A useful indication of the emission of the valve is also provided, although, of course, the reading will only be comparative. A considerably reduced deflection, under usual operating conditions, will indicate that the emissive properties of the filament have fallen off.

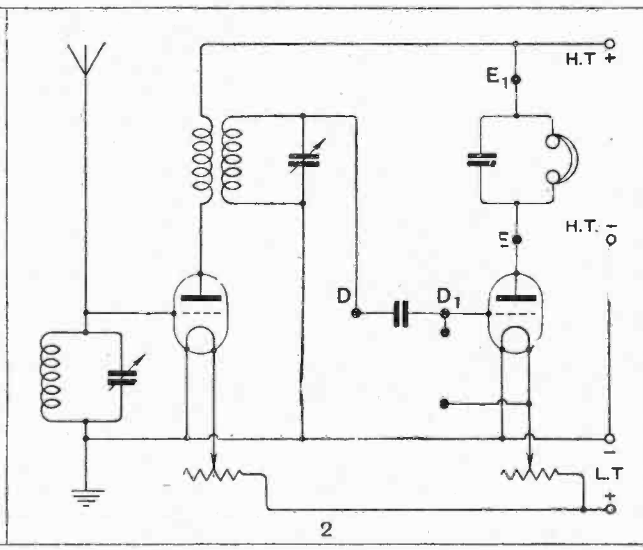
DISSECTED DIAGRAMS.

No. 41.—Point-to-point Tests of an H.F. and Detector Receiver.

A few simple tests, which will facilitate the location of faults, are shown below. These tests are more particularly applicable to a receiver which has developed a fault after having functioned satisfactorily, but may often be of assistance in detecting a defective component or bad connection in a newly constructed set. A pair of phones with a small dry battery may be used as an indicating device. Batteries should be disconnected before testing. It is assumed that the valve filament circuits are intact.



Application of the testing circuit across A and A_1 will indicate continuity through the aerial coil and its connections, and, with this coil removed, will show a short circuit in the tuning condenser, which should be rotated. A possible internal contact between grid and filament of the valve will also be shown. Tests of the H.F. transformer primary are made between B and B_1 and of the secondary between C and C_1. Insulation between the windings is tested between B and C. The continuity of the whole H.F. anode circuit is indicated by a test between B and H.T.+ terminal, and insulation of the anode between B and L.T.–.



The grid condenser is tested across D and D_1, with leak removed (only a faint click, due to the flow of charging current, should be heard). The insulation of plate and grid of the detector valve may be tested between E and L.T.— and D_1 and L.T.— respectively, remembering that in the case of the grid test the capacity click will still be heard, as the condenser remains in circuit. The phone by-pass condenser is tested across E and E_1 (with phones removed), while the continuity of the complete anode circuit (with phones connected or terminals shorted) is shown by applying a test between E and the H.T.+ terminal.

TELEARCHICS.

The Wireless Control of Machinery.

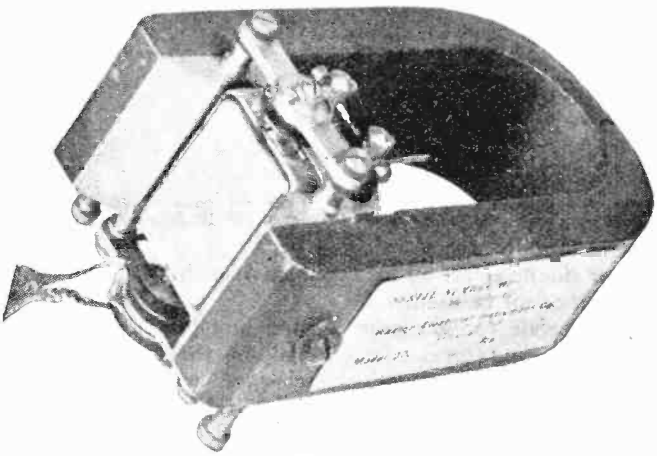
By A. P. CASTELLAIN, B.Sc., A.C.G.I., D.I.C.

IN this series of articles the writer intends not only to deal with the theoretical aspect of Telearchics, but also proposes to give practical constructional details to enable the reader to carry out simple and instructive experiments in distant control, and also details of how to make at least one wirelessly controlled model.

There is very little of a definite nature published about Telearchics, probably because most of its applications are for war purposes—and, in fact, as far as the writer is aware, there has been no definite name for the subject at all, so that he proposes to call it *Telearchics* (lit., distant control).

Methods of Distant Control.

The thought of controlling a piece of machinery from a distance is a very fascinating one, more especially so if the machinery is complicated. There are many ways of obtaining this control, depending on the nature and action of the machinery, and perhaps the most obvious way is by direct mechanical manipulation of the controls on the machine itself by means of wires or rods to the operator—an ordinary railway signal forms a good illustration of this method.



A very sensative relay—the Weston, which operates on about 40 microamperes and controls up to about 50 milliamperes.

By going a step further, machinery may be controlled by direct electrical means, the connection between the operator and the machinery being in this case an electric cable—as an example of this, when a big civil engineering work, such as a dam, has been completed and is to be formally opened, this is usually done by the mere pressing of a button by the official concerned, which would perhaps control the opening of several sluices.

In the next class of controlling arrangements the material connection between the operator and the machine is eliminated, and this is where the control becomes much more interesting.

There are many forms of this type of control, but before proceeding to describe some of these it would perhaps be as well to get a clear idea of just how much or how little apparatus at the receiving end is necessary to be controlled from the transmitting end.

We all know how easy it is to turn on an electric light by means of a switch. What we have to do to control the light in this case is to arrange sufficient apparatus at the receiving end to turn the switch on. It is also possible to start up a large electric power station by turning on a switch of the same size as the light switch just referred to—readers who visited Wembley last year will no doubt remember that something of this sort was shown there—thus, if we have the same apparatus which would operate the switch we can start up the power station.

Fig. 1.—Showing the fundamental arrangements for distant control. C=actual control; T=generator of ether waves; R=receiver of ether waves; D=detector of ether waves; A=apparatus to be controlled.

The point illustrated here is that the apparatus directly concerned with receiving the distant control is not necessarily any different or more complicated when a large amount of power has to be controlled than when a small amount of power is controlled. In short, then, if it is possible to close a switch of some sort at the receiving end, be it ever so small and light, then it is possible to control any amount and form of power that can be operated by switching.

Relays in Series.

The method of dealing with large powers is quite simple and is as follows: Suppose the first switch (controlled by the transmitter) closes a circuit consisting of a small cell and a coil which operates a larger and more robust switch, which in turn deals with a current many times that which operates the first switch. When No. 1 switch closes, the coil of No. 2 is energised and No. 2 switch closes and may, if desired, operate a No. 3 switch which could be quite a large one—and this process can be extended.

Switches such as these, which control currents many times larger than those by which they are operated, are called *relays*.

Various relays are illustrated in the photographs, which show types taking from 40 microamperes (the Weston Relay) to the large train contactors controlling hundreds of amperes.

The wireless "self-starter," described by the writer in a previous issue of this journal[1] gives an illustration of the use of relays in series. The operating current of the first relay is about 40 microamperes, while the valve

[1] *The Wireless World*, June 10th, 1925.

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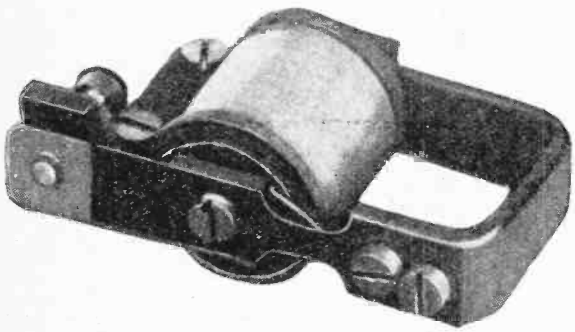
current controlled is 1.6 amperes—*i.e.*, a ratio of 40,000 obtained by two relays.

It should be clear by now that in order to control any apparatus operated by switching or any combination of switches, all that is necessary to control directly from the transmitting end is one or more sensitive relays.



A more robust relay, operating on about 40 milliamperes and controlling up to about 6 amperes.

In all distant control arrangements there are two main parts, namely (1) the apparatus for transmission and reception of the controlling energy, and (2) the apparatus to be controlled.

Part (1), with which we are immediately concerned, may be further subdivided into: (*a*) the apparatus for producing the controlling energy; (*b*) apparatus for controlling this at the transmitting end; and (*c*) apparatus for receiving and detecting the controlling energy at the receiving end.

The ether of space forms a possible link between all objects—in our universe, at any rate—and thus the controlling energy may conveniently be in the form of ether vibrations, though earth conduction and sound waves have been used, with little success, however.

There are various kinds of ether vibrations, differing merely in the rapidity of vibration (frequency), and consequently in their outward effects, and the best known are:

X-rays,
Ultra-violet rays,
Visible light,
Heat or infra red rays,
Radio waves,

in order of frequency, X-rays being the highest and radio waves the lowest frequency.

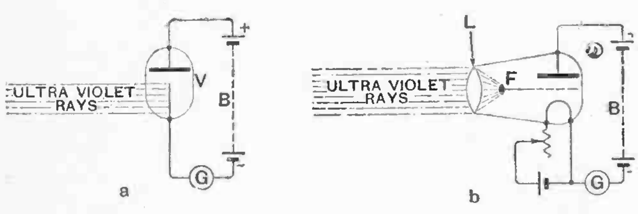


Fig. 2.—Ultra-violet detectors (a) simple form (b) suggested improved form. V=evacuated quartz bulb containing a flat anode and pointed, or wire, cathode on which the ultra violet-rays fall; B=battery of 100 to 300 volts; G=current detector In the improved form (b) L=quartz-lens; F="cathode" at focus of lens directly connected to grid of valve.

The fundamental arrangements for distant control may be diagrammatically summarised as shown in Fig. 1.

For the present, at any rate, the writer intends to deal only with ether wave control, leaving out sound and earth conduction, as this form (or, rather, forms, for there are many) is by far the most interesting and successful.

Having now briefly discussed what kinds of control energy are available, we will proceed to study each of them a little more in detail.

X-rays.

It is rather doubtful if these would be of any use as a form of control energy, since they are absorbed in a comparatively short distance by the air—in other words, the range of control by X-rays would only be of the order of a few feet at most. The detector for X-rays might depend for its action on the ionising effect of these rays, or perhaps on fluorescent effect of certain substances in the presence of X-rays, the latter effect being used in conjunction with a light sensitive cell. In any case, however, X-rays do not seem to be a practical form of control energy.

Ultra-violet Rays.

These are sometimes called actinic or photographic rays, owing to their action on a photographic plate. Here again it is rather doubtful if these rays are much use for control, as they are considerably absorbed by the atmosphere, though to nothing like the extent that X-rays are.

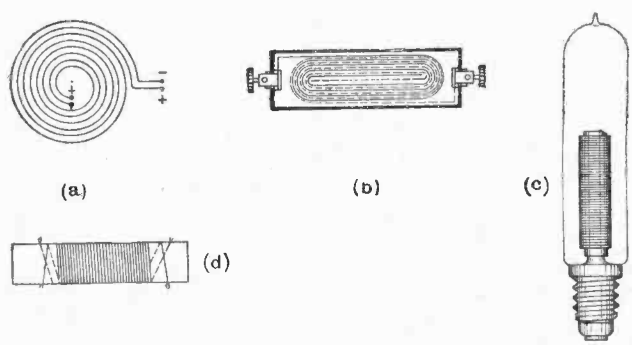


Fig. 3.—Various forms of selenium cell as constructed by the following workers: (a) Siemens, (b) Mercadier, (c) Ruhmer-Bronk, (d) Weinhold.

For the detector, an arrangement like that sketched in Fig. 2a could be used.

It depends for its action on the fact that ultra-violet light has a powerful effect in helping the discharge of electrons from a negatively charged conductor. In Fig. 2 ultra-violet rays are allowed to fall on the cathode, causing it to emit electrons which travel to the positively charged anode to form an electric current. This current is likely to be fairly small, and in Fig. 2b the writer suggests an improved ultra-violet detector in the form of an ordinary thermionic valve, with the grid connected inside the vacuum to a conductor placed at the focus of a quartz lens. In the ordinary way, the plate current would be extremely small, owing to the grid becoming negatively charged with electrons (the ordinary "free grid" effect), but when ultra-violet light is allowed to fall on the quartz lens, some of the electrons on the grid would be freed to go to the plate, thus reducing the negative charge on the grid and increasing the plate current. As a practical detail, the bulb of the detector would probably have to be made of fused silica in order to seal on to the quartz lens, which is used as it offers

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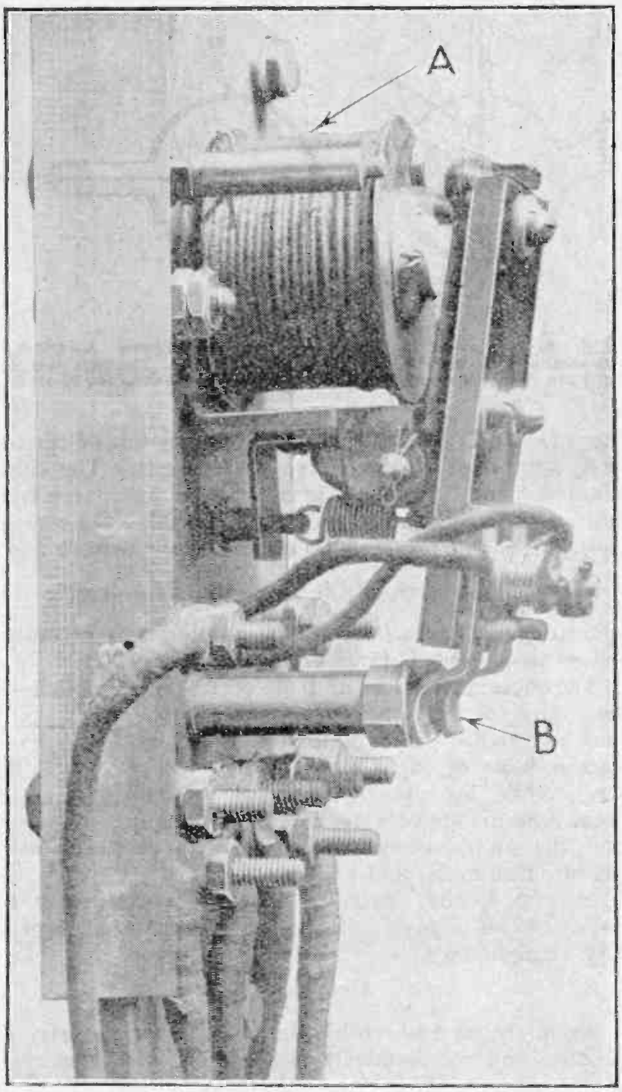
very little obstruction to ultra-violet light, while ordinary glass almost completely cuts it out.

The generators of ultra-violet rays most commonly used are the tungsten arc (*i.e.*, an electric arc between



A small relay (Hewitt Co) on a mercury arc rectifier—this handles up to about 20 amperes.

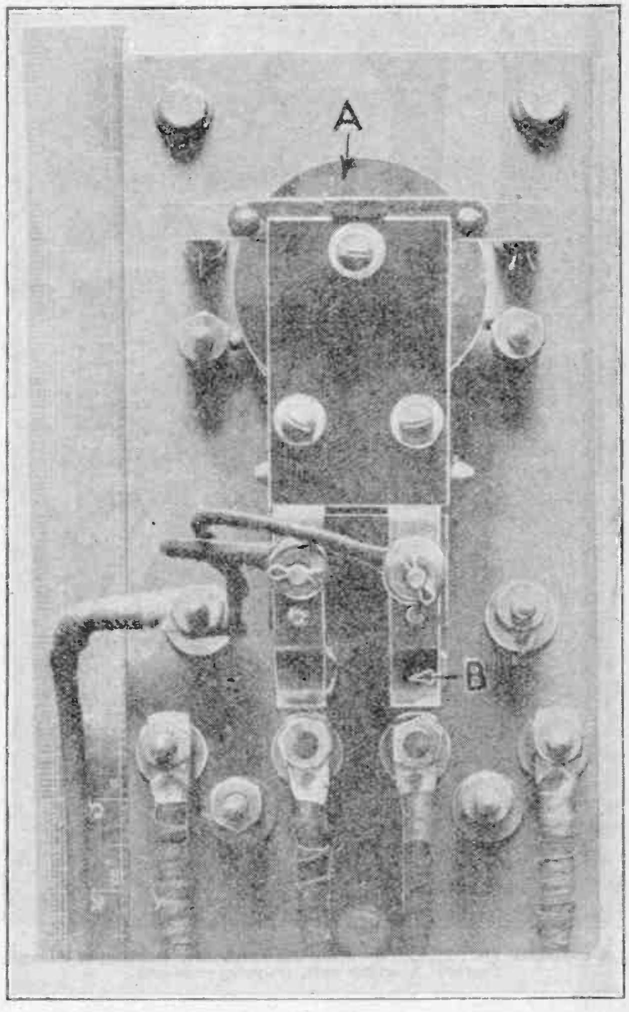
tungsten rods) or the mercury vapour lamp; thus ultra-violet rays form a useful method of control over short distances, and have the advantages of invisibility, inaudibility, and simplicity of production and detection, but they have the disadvantage of being capable of producing nasty burns on the operator, especially after long exposure, though this could no doubt be got over by suitable screening.

Visible Light.

This is by far the easiest form of ether energy to produce and receive, since the human body is directly sensitive to it. Strictly speaking, we cannot exclude the human "detector" in telearchics, but it has been decided to do so in this series of articles. The visible waves represent the colours of the rainbow, from violet at one end, to red at the other, and, apart from their optical and chemical effects, they are capable of producing changes in the electrical properties of several substances. The best known of these substances is selenium, which changes its electrical resistance when light falls upon it.

Various forms of selenium cells, as they are called, are shown in Fig. 3 (a), (b), (c), and (d), but the principle of all of them is the same, *i.e.*, a layer of selenium between two conductors, usually platinum wire.

The average resistance of these selenium cells is, say about five thousand ohms in the dark, and when the cel is brightly illuminated the resistance may be about thre thousand ohms. However, some cells have a mucl



Another view of the relay. A=relay coil, B=relay contacts.

higher resistance than this, but give about the same percentage variation in resistance when illuminated.

One peculiar property of selenium is the "lag" or delay between a change in intensity of the illumination and the corresponding change in the resistance of the

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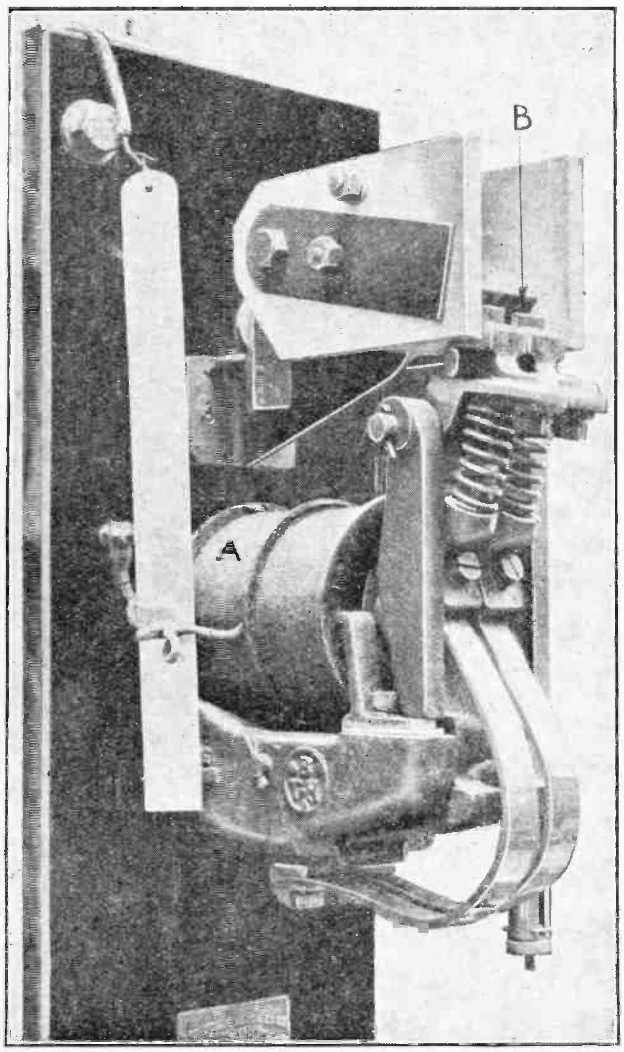
selenium—in other words, the selenium cell takes an appreciable time to respond to variations of light intensity, and, furthermore, it behaves as though it became tired after a time, and takes longer to respond, and then does not respond so much. This effect makes selenium unsuitable where very rapid variations of light are necessary for control work—in light telephony, for example—but quite suitable for operating machinery by differentiating simply between light and dark—such as would be obtained by using a shutter in front of the transmitting light.



A contactor (B.T.H. Co) used for the automatic starting of a large motor. A=relay coil, B=relay contacts.

Visible light also has the property of causing certain metallic substances, such as sodium, potassium, and rubidium, to emit electrons, the number of electrons emitted in this way depending, for monochromatic (*i.e.*, single frequency) light, only on the intensity of the light. These electrons are conveniently emitted in a vacuum in which is placed a collecting plate charged to a high positive potential with respect to the emitting electrode—the whole arrangement being called a photoelectric cell. Fig. 4a and 4b show diagrammatically the arrangement of the elements in a photoelectric cell. Since their action depends on the emission of electrons *in vacuo*, there is, to all intents and purposes, no time lag whatever between

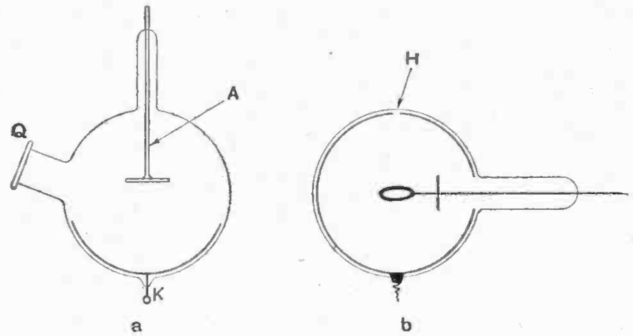


Fig. 4.—Photoelectric cells. Q=quartz window, A=anode, K=cathode, H=hole in cathode for rays to enter. The rays in type (b) are reflected many times inside the cell and thus the effect is increased.

the variation in light intensity and the variation of current (*i.e.*, number of electrons) through the cell. The chief disadvantage of the photoelectric cell for machinery control work is the small current available—the current through the cell being of the order of 10^{-8} ampere (*i.e.*, $\frac{1}{100 \text{ million}}$ ampere), which means that considerable amplification by means of valve amplifiers is necessary before the current is large enough to be useful.

The great advantages of light control are simplicity—especially for the transmitter—and selectivity, since quite a narrow beam of light may be used, while the disadvantages from some points of view are: first, that an uninterrupted path between transmitter and receiver is necessary, and, secondly, that the control may be obvious to an observer with no special apparatus—especially at night time.

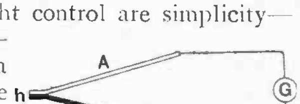


Fig. 5.—Thermo-junction circuit.

Heat Rays.

As in the case of visible light, heat rays are easy to produce and comparatively easy to receive. The usual

Fig. 6.—Arrangement of apparatus for heat-ray control.

detector for radiant heat is called a thermo-couple, and consists essentially of two wires or rods of dissimilar conductors, A, B, joined to each other at one end and through some current-indicating device, G, at the other (see Fig. 5).

If the joined end, *h*, of the conductors is heated, and the other junctions kept cool, then a current will flow round the circuit.

If several thermo-couples are joined in series in order to obtain greater sensitivity to heat rays, then the arrange-

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ment is called a thermopile. The detector for heat rays is thus quite simple, and the sensitivity depends on the sensitivity of the indicating instrument G (Fig. 5).

As in the case of visible light, heat rays may be concentrated by means of a curved mirror—usually parabolic in shape—and thus the possible distance of control with a given receiver and transmitter greatly increased, and a diagram for a heat ray control scheme is given in Fig. 6.

Again, as in the case of light rays, it is necessary to have an uninterrupted path between transmitter and receiver, so that a simple metallic shutter (S, Fig. 6), placed so as to obstruct the path of the heat rays, will give sufficient control. Heat rays have the same advantages and disadvantages as visible light, with the exception that they are practically secret, *i.e.*, not obvious to an observer, unless he is in the direct path of the rays.

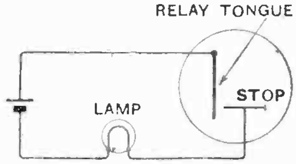


Fig. 7.—Local circuit controlled by relay.

Radio Waves.

Control by radio waves is completely electrical, and thus it would seem to be much simpler than mixed forms of control, but, in fact, this is not entirely so, for the very simple reason that, in general, radio waves are non-directive—at least, to the same extent as the shorter ether waves—and thus additional apparatus at both transmitting and receiving ends has usually to be used to obtain secrecy, or more than one control.

However, where secrecy does not matter, and only one control is required, control by radio waves is very simple, as the experiment given below will show.

Many readers will be able to carry out the following interesting experiment in distant control.

The apparatus required is not of a special nature, and in its simplest form consists of a valve receiving set (a single-valve detector is quite sufficient) and a crystal or another valve detector set and a Weston relay. No aerial or earth is required.

The method is simply this—the valve set is made to oscillate (preferably *not* on the broadcast band) by coupling up the reaction coil until loud clicks are heard in the phones on touching and on releasing the aerial terminal of the set.

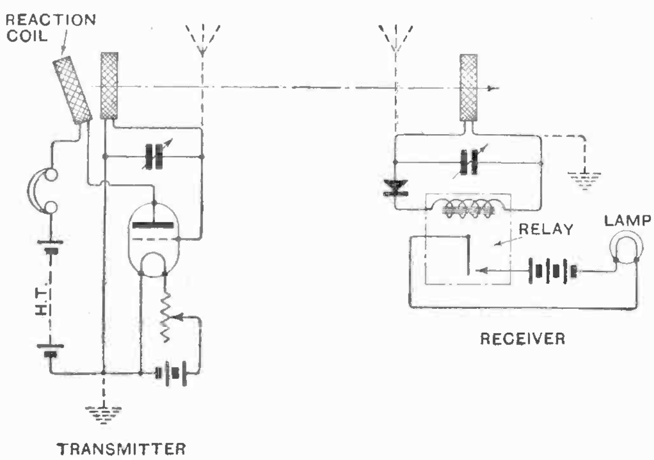
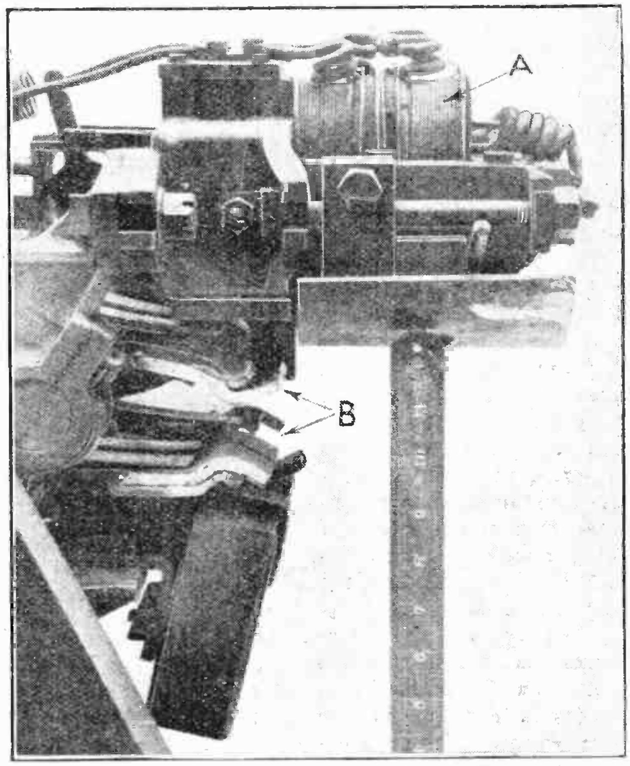


Fig. 8.—Arrangement of apparatus for control by radio waves.

The Weston relay is connected in place of the phones in the crystal set, and the latter placed fairly near the first set and tuned until the relay tongue moves over to a stop.



A contactor (Siemens) as used on an electric train. This deals with currents of the order of hundreds of amperes. A=relay coils, B=relay contacts.

If the relay tongue and the stop to which it moves are connected in circuit with a small $4\frac{1}{2}$-volt flash lamp battery and a flash lamp or bell, then the lamp will light, or the bell will ring (see Fig. 7).

If the valve is prevented from oscillating by switching off its filament supply, then the relay tongue will move to its normal position away from the stop, and the lamp or bell will stop working. Thus by switching on a valve at the transmitting end a lamp may be lit or a bell rung several feet away with very simple apparatus.

A Simple Experiment.

The demonstration is still more convincing if carried out between two rooms with all doors shut. By fixing up little aerials and counterpoises (or earths, if possible), the range of operation may be extended quite considerably. For those who like circuits, one is given in Fig. 8.

The author strongly advises those who have, or who can borrow, sufficient apparatus to try this experiment—it is most amusing and mystifying to those who do not know how it is done, besides being instructive to those who do.

Telearchics.—

This little illustration is of one of the simplest forms of distant control by radio, and its main drawback is that any transmitter operating on the same wavelength can operate the receiver, provided that the received power is enough, thus the control from any given transmitter is not absolute.

In order to increase the immunity of the receiver from unwanted currents, such devices as frame or "beam" transmitters and receivers could be used, but the disadvantages of bulk would most probably outweigh the slight increase of selectivity obtained.

Another simpler and better method is to modulate the carrier wave of the transmitter and arrange matters at the receiving end so that these modulations only affect the relay. This may be done by passing the rectified received current through a suitable transformer into a condenser-leak arrangement (of which more hereafter), instead of directly through the relay windings.

The output of the transformer is taken through another rectifier on to the relay (as in Fig. 9) in one arrangement, which gives extremely good selectivity, *i.e.*, freedom from interference.

The transmitter would send a continuous wave on (say) 200 metres, which would be modulated by a buzzer or other suitable device. The control would be obtained by switching the buzzer on and off. At the receiving end

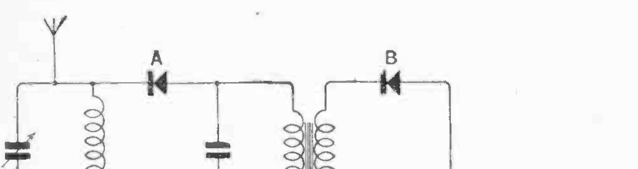
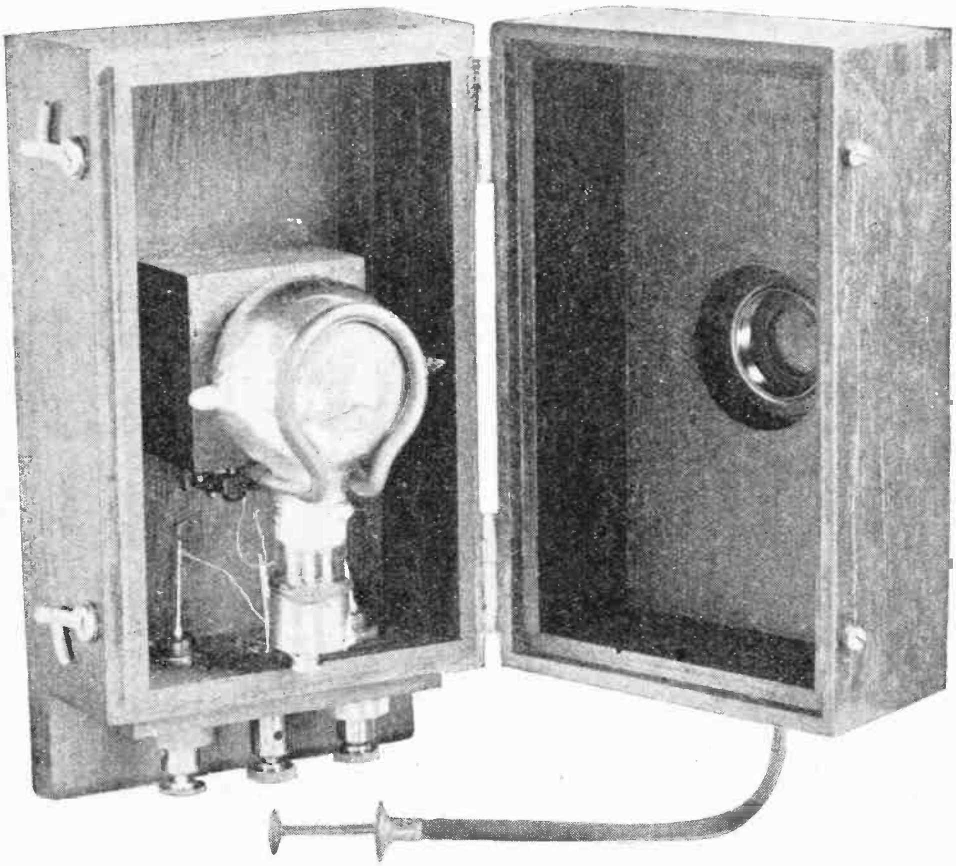


Fig. 9.—Method of obtaining increased selectivity by double rectification.

the first rectifier, A, would give a current of the buzzer frequency through the transformer primary. If this were passed through the relay windings, as in the first arrangement, all that could happen is that the relay tongue would vibrate and most probably would never touch the stop, and so operate the local circuit—at any rate, if it did, the latter would only be operated intermittently.

By inserting a transformer and another rectifier, B, the relay may be operated just as in the first case, since



Photoelectric cell, with its containing-box—as constructed by the Cambridge Instrument Company, Ltd.

we now have the same conditions, although the frequency of the current is different in the two cases.

It is obvious that, for another transmitter to control the receiver, it must not only be transmitting on the same wavelength, but it must also be modulated like the correct transmitter.

By tuning and loose coupling the transformer [1] between the two rectifiers to the buzzer frequency we still further increase the selectivity, for unless the modulating frequency is that to which the transformer is tuned, the second rectifier, B, will receive practically no current from the transformer.

It is easy to see that, by using several tuned transformers in series—say, for example, tuned to 500, 1,100, 1,700, 2,300, 2,900 cycles—at the receiving end, five special buzzers at the transmitting end all modulating the transmitter independently at these frequencies, we have a means of controlling five different relays at the receiving end *using one wavelength only*. Fig. 10 shows this.

Yet another way to obtain increased selectivity and

[1] See an article on this subject by the writer in *The Wireless World*, May 20th, 1925.

Telearchies.—
several controls on one wavelength is to modulate the carrier wave for different lengths of time according to the control required.

Thus to operate control No. 1 the transmitter might be

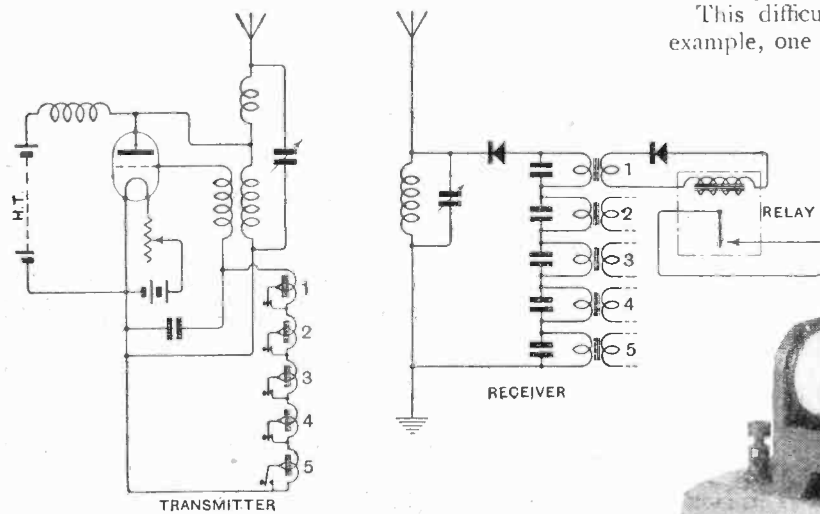
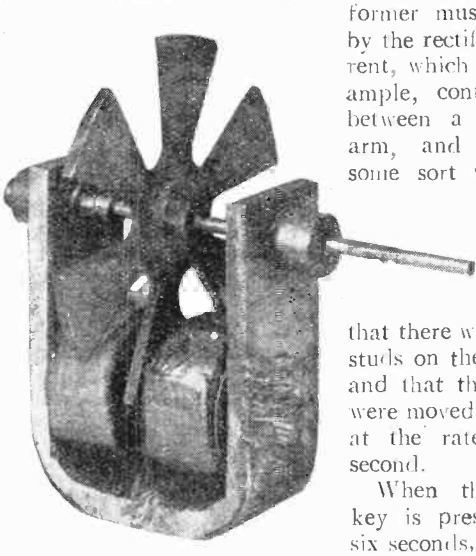


Fig. 10.—Operating five separate controls from one wavelength.

kept on or modulated for, say, one second's duration, while a signal of five seconds might be required for control No. 2, and so on. So far, so good—the transmitter end is very simple. At the receiving end an apparatus sensitive to duration of signal must be employed, and here several means suggest themselves.

It is fairly obvious that the time sensitive device must follow the usual detector in the receiver, so that the former must be operated by the rectified signal current, which might, for example, control a clutch between a rotary switch arm, and a motor of some sort which is kept running at a constant speed.



A small Synchronous motor.

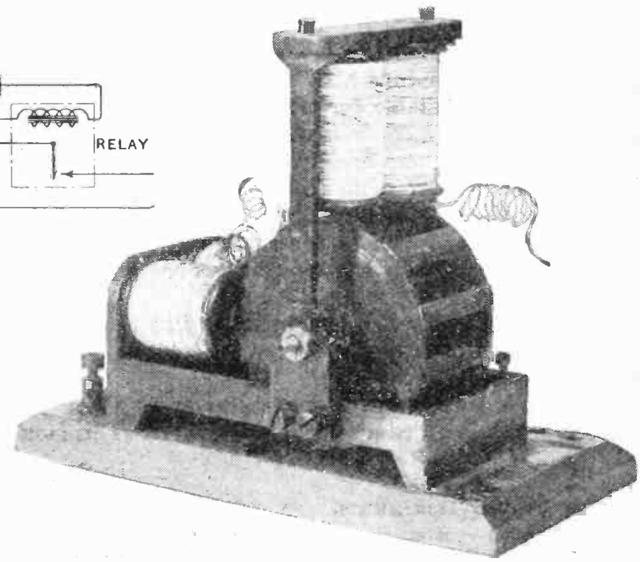
Suppose, for example, that there were ten contact studs on the rotary switch and that the contact arm were moved over the studs at the rate of one per second.

When the transmitter key is pressed for, say, six seconds, what happens is as follows: As soon as the key is pressed, relay No. 1 (which is a delicate one, such as a Weston) operates, which closes the circuit of a more robust relay, No. 2.

The latter switches on the current to a magnetic clutch between the motor and the rotary switch, and the switch arm commences to move and carries on till No. 6 stud is reached. By this time six seconds have elapsed, and the transmitter key is released, thus disconnecting the magnetic clutch and leaving the switch arm on stud No. 6.

There is one snag in this type of control—the switch arm passes over studs Nos. 1 to 5 to get to No. 6, but it will only stay on each for a little over half a second.

This difficulty may be got over in several ways; for example, one way would be to make no connection to the



Another small synchronous motor. These particular motors were designed to run from a tuning fork and are not suitable for running in the plate circuit of a receiving valve.

switch arm until it had reached its desired stud, *i.e.*, to use one signal to obtain connections for control No. 6, and another signal to operate control No. 6 for as long as desired.

This second signal might quite well be a buzzer modulation of the transmitter carrier wave—this need not be large enough to operate relay No. 1, but would operate No. 3 and thus No. 4 in Fig. 11. In this arrangement

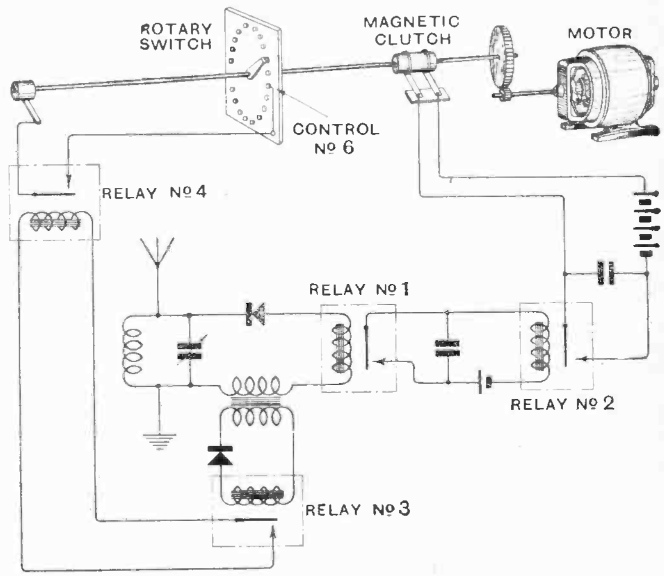


Fig. 11.—Typical arrangement of apparatus for step-by-step multi-control on one wavelength.

Telearchics.—

relay No. 3 should be more sensitive than relay No. 1. No doubt very many better modifications will occur to the reader, but this will serve as an illustration of one type of time control.

Another simpler type depends for its operation on the fact that a condenser of given capacity charged up to any voltage takes a perfectly definite time to discharge itself to a given percentage of the initial voltage when connected across a given resistance.

So far all the controls have been of the relay or switch type, which are suitable for most purposes.

However, it may be desired to control the speed of a small motor within very fine limits indeed—a case in point is where two similar motors at transmitter and receiver end are required to keep absolutely at the same speed—it may not matter whether the actual speed varies so long as both the motors vary together and not one a little later than the other.

It is almost impossible, and certainly impracticable, to obtain this control by switching, but there is a very simple way of doing it without.

There is a certain type of motor, driven by alternating current, which is called a *synchronous* motor. This motor is nothing more or less than an alternator, or generator of alternating current, and the interesting point about it is that its speed as a motor depends entirely on the frequency of the alternating current supplied to it.

Thus, suppose one of these motors of suitable construction ran at 1,500 revs. per min. with a 50-cycle supply (*i.e.*, 50 complete alternations per second), then it would run at 3,000 revs. per minute with a 100-cycle and at 4,500 revs. per minute with a 150-cycle supply, and so on.

It is only necessary to supply the same frequency to transmitter and receiver motors (assuming they are of similar construction) to make them run at the same speed, *i.e.*, it is only necessary to transmit the *frequency* and not a large number of signals, hence, provided the motors are of suitable construction, quite large and rapid fluctuations of frequency will alter both motors together.

Many important uses can be made of this type of control.

Small motors may be constructed of the general forms illustrated in the photographs, which work very well over a range of frequencies, and it is also possible to construct motors for use direct in the plate circuit of a suitable valve.

(*To be continued.*)

TRANSMITTERS' NOTES AND QUERIES.

German Amateur Transmitters.

The German postal authorities have decided to allot the following wave-bands to amateur experimenters :—

8-10, 37-42, 60-65, and 95-100 metres.

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Schooner "Morrissey."

With reference to the note on page 200 of our issue of August 11th, in which we recorded the relaying of a distress call from VOQ to Washington *via* New Zealand, we understand that the Schooner "Morrissey" was successfully brought out of danger after a struggle lasting 48 hours.

We understand that the operator on board the schooner *Morrissey* has provisionally set aside the following times at which he will be free to reply to amateur stations: 1130 to 1200 and 1730 to 1800 G.M.T. on 20 metres; 1330 to 1400 and 1700 to 1730 G.M.T. on 33 metres.

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French Short-Wave Station.

OCTN, at Mourillon, Toulon, is sending out daily during the week the following signals: From 1530 to 1540 G.M.T. letter "A" on 20 metres; from 1545 to 1555, letter "B" on 33 metres; from 1600 to 1610 letter "C" on 57 metres. Detailed reports from listeners will be welcomed.

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Amateur Station in Belgian Congo.

Mr. B. J. Axten (G 2VJ) reports that on Monday, August 2nd, between 10 and 11 p.m. (BST), he heard CB F2 calling, and established communication. F2, who gave his address as Kinshasa, Belgian Congo, was transmitting on 35 metres, and reported Mr. Axten's signals as R4 and a good note. G 2VJ was working on 45 metres, with an input of 19 watts, and could hear F2 on a loud-speaker at about R5 strength. Mr. Axten could not continue the intercommunication for long, as BZ 1AD (P. S. Chermont, Rio de Janeiro) was calling him at the same time.

On the previous Saturday and Sunday G 2VJ had been in communication with AI 1CW, Capt. Filippini, of the Directorate of Posts and Telegraphs in Tripoli, and at about 5 a.m. on Thursday, 5th inst., was able to relay a message from U 2APV, J. L. Berliant, at Hempstead, N.Y., to GI 2IT, B. Walsh, in Armagh.

Mr. J. C. Martin (G 2BLM), 94, Little Heath Road, Foleshill, Coventry, informs us that he has received a card from U 1AJX for forwarding to "Mr. D. A. Perkins, Essex," and will be glad if any listener to whom this very vague address is applicable will communicate with him.

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Australian Amateurs.

Mr. D. B. Knock, whose station G 6XG was once so well known to British amateurs, is now in Sydney, New South Wales, where his call-sign is A 2NO, and his address 102, Cremorne Road, Cremorne, Sydney. He is transmitting on about 34.5 metres with a good R.A.C. note at about 2100 G.M.T., and will welcome reports from any British listeners.

A 3KB, Mr. A. L. H. Kissick, 7, McFarland Street, Brunswick, Melbourne, is going to increase his power to 150 watts, using a Z4 ($\frac{1}{4}$ kW.) valve, and will be glad if anyone hearing him on about 35 metres will call him.

A 5LO (ex 5AY), Mr. W. H. Barber, 50, Somerset Avenue, Cumberland, South Australia, uses an input of 15 watts and transmits on 34.5 metres from 1600-1800 and 0400-0700 G.M.T. He had already worked with Belgian and French stations, and would like to get into communication with British stations.

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American Amateur.

Mr. J. Taylor, U 6DAQ, 1,431, Stanley Avenue, Hollywood, California, is transmitting on 38 metres, using 30 watts input to a $7\frac{1}{2}$ watt valve, and wishes to get into touch with "G" stations.

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South African Time Signals.

The Slangkop wireless station, which sends out time signals from the Royal Observatory, Cape Town, is to adopt the modified Onogo system as used in the French stations.

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New Call-Signs Allotted and Stations Identified.

G 5LI C. Liversidge, Oxley Woodhouse, Huddersfield.

G 5SS Stretford & District Radio Society, The Cottage, Derby Farm, Derbyshire Lane, Stretford, Manchester. Transmits on 8 metres.

G 6JH J. Hartley, Jnr., 21, Plymouth Grove, Manchester, transmits on 8 metres and will be pleased to hear from any British or Foreign amateur willing to co-operate in experiments.

GW 11C B. Bradshaw, Littleton, Ashfield Road, Ranelagh, Dublin.

GW 12C W. T. Elder, The Square, Listowel, Kerry.

GW 13C E. C. Boursin, Church Street, Listowel, Kerry.

KY 1VP (Kenya Colony). Monomark address: BM/BGL3, London, W.C.1.

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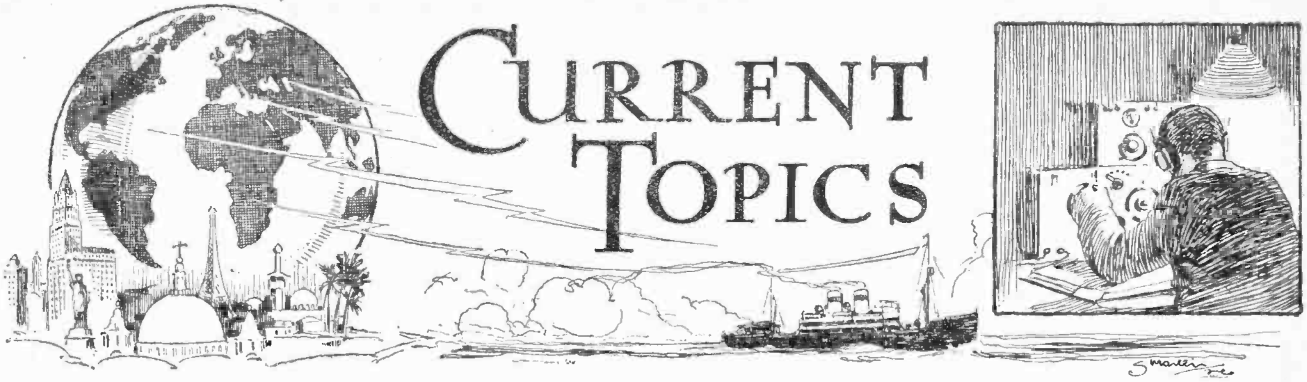
QRA's Wanted.

A 3EN KGBB RDX8 U 5ZAZ UM 8ST XCD.



Events of the Week in Brief Review.

NO MORE PIRATES?

Free State listeners are jubilant over the reduction of the licence fee from £1 to 10s.

WIRELESS FOR RAILWAY SIGNALLING.

The French railway administration, alarmed by the recent succession of train accidents, is reported to be examining the application of wireless to signalling.

UP-TO-DATE PRAGUE.

Loud-speakers to announce the departures of trains are shortly to be introduced at the Masaryk Station, Prague. The instruments will be placed in each of the waiting-rooms and also in the café.

WHERE MERE MAN EXCELS.

Ten thousand American listeners have indicated that women are less suitable as broadcast announcers than men. A *questionnaire* distributed by the Radio Corporation of America received replies 99.3 per cent. of which expressed the opinion that the feminine voice, while admirable for singing and certain "spoken pieces," was unsuitable for announcing.

ANOTHER PROBLEM FOR GENEVA.

Hungarian peasants are protesting against the growth of broadcasting stations in Europe, believing that these are responsible for the spell of bad weather now spoiling their crops.

RURAL RADIO IN U.S.

Approximately 553,000 farms in the U.S.A. are equipped with wireless sets for receiving market quotations. Broadcasting stations are maintained by twenty-four agricultural colleges, and information intended for farmers is also transmitted by nearly a hundred commercial and private broadcasters.

TOO SENSITIVE.

Over-sensitivity, the U.S. Bureau of Standards finds, can be as great a curse as the other thing. Equipment was recently devised which proved so sensitive that it could not be worked while anyone, except the operator, was in the building in which it was housed. The set has been dismantled.

WIRELESS FOR JAPANESE RAILWAYS?

With the idea of installing wireless on Japanese trains, M. Kikojico Suzuki, of the Japanese Government Railways, is carrying out a special tour of the Canadian National System, on which many trains are radio-equipped.

GERMAN RADIO SCHOOL.

Under the auspices of the German Department of Education a "radio school" is being established at the university town of Jena. Systematic instruction will be broadcast in mathematics, chemistry, physics, and modern languages.

VIENNA-AMSTERDAM WIRELESS LINK.

An official wireless telegraph service has been inaugurated between Vienna and Amsterdam. The first communication was a complimentary message from the Austrian President Hainisch to Queen Wilhelmina.

EXHIBITION AT BELFAST.

A wireless exhibition is to be held in the Ulster Hall, Belfast, from September 7th to 11th.

WIRELESS AND FILM PRODUCTION.

In the production of a recent film at Los Angeles in which century-old frigates manœuvred in battle formation, the movements of the "fleet" were directed entirely by wireless telephony.

R.A.F. SHORT SERVICE COMMISSIONS.

In announcing that further appointments to short service flying commissions will be made in September, the Air Ministry points out that a practical knowledge of mechanical matters forms a good basis for training future pilots for the Force. Applications for forms and regulations with regard to these commissions should be addressed in writing to the Secretary, Air Ministry, Adastral House, Kingsway, W.C.2.

IN ESSEX WITH A PORTABLE TRANSMITTER. On August 15th the Essex group of wireless societies held a successful field day on Childerditch Common, near Brentwood. The photograph shows an interested group round the Ilford Society's portable transmitter which effected two-way communication with several amateur stations. Other societies represented were Leyton, Wanstead, Southend and Colchester.

AFTER THE BRITISH PLAN.

Swiss listeners now pay a tax of 12 francs per annum. A portion of the licence receipts are allotted to the broadcasting stations.

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NEW STATIONS FOR DENMARK?

The Danish Post and Telegraph Department is considering plans for the erection of a new broadcasting station at Kallundborg, in the north-west of Zealand, to operate with a power of 5 or 6 kilowatts.

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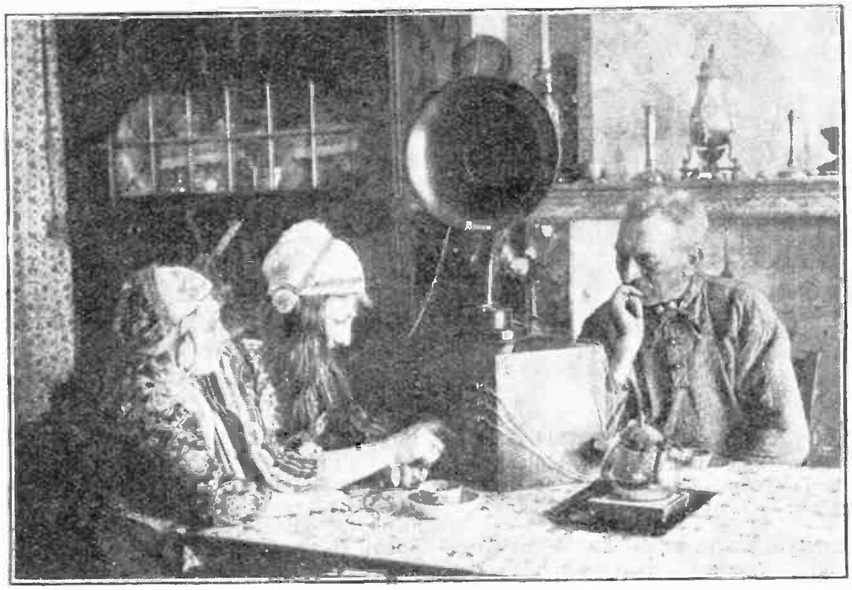
HOLLAND'S BROADCASTING DIFFICULTIES.

The possibility that Holland may find herself without a useful wavelength band after the sitting of the International Radio Conference at Washington in 1927 is causing disquietude in Dutch wireless circles.

In face of demands for a really national broadcasting service, the former Minister of Posts and Telegraphs, M. Bongaerts, some time ago composed a Royal Commission of representatives from all political and religious quarters. The Commission's report has met with severe criticism, but remains, nevertheless, the only base upon which M. Bongaert's successor, M. Van der Vegte, can found the Bill which he will introduce for regulating Dutch broadcasting. Meanwhile (it is argued), unless Holland immediately adopts waves of between 200 and 600 and between 1,300 and 1,800 metres it may be difficult to claim a useful wavelength later on. In other words, the delay in legislation is considered dangerous.

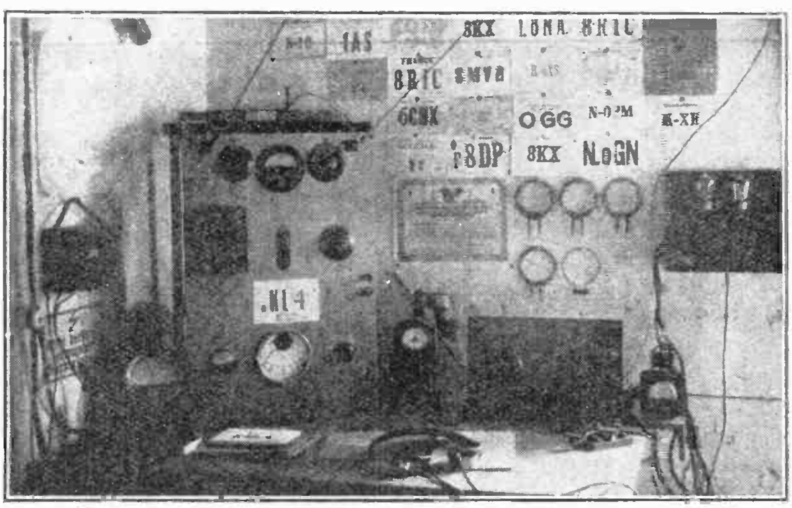


WILL THEY BE AS HAPPY NEXT YEAR? A peaceful scene in a Dutch homestead. Holland, however, is faced with broadcasting problems which are causing anxiety in wireless circles. The situation is described on this page.

A SAFE MOVE.

Having discovered that interference is being caused with Bournemouth's transmissions, Radio Toulouse has decided to change its wavelength from 389.6 metres to 430 metres, as from September 15th. By that time Bournemouth's wavelength will be 306.1 metres!

Radio Toulouse is becoming one of the most popular stations in France and is frequently heard in Britain.



A TRANSMITTER IN THE FATHERLAND. Scrupulous neatness would appear to be the watchword of the well-known German amateur, KL4, whose station is seen above.

EXHIBITION VOGUE SPREADS.

An important wireless exhibition will open at Marseilles on September 25th next. It will form part of the second Foire-Exposition, and will be under the patronage of the local wireless traders and the Manufacturers' Union.

SHORT WAVES IN TRANSATLANTIC FLIGHT.

Capt. Rene Fonck, the American airman who hopes to fly the Atlantic during the present month, has equipped his plane with a low-power short-wave transmitter, in addition to the standard apparatus carried. With the short wave set, using the call sign WOP, Capt. Fonck hopes to maintain communication with amateurs throughout the flight. Unfortunately we are without particulars regarding wavelength to be employed.

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GETTING JOBS BY WIRELESS.

The idea recently adopted in Germany of assisting the unemployed by means of broadcast announcements is now being pursued by Radio Toulouse (Radiophonie du Midi). A few minutes every evening are set apart for announcements concerning situations wanted, and any person seeking work may enlist this service free of charge. It has to be remembered, of course, that the percentage of unemployed in France is extremely low, otherwise such a service would be impossible.

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"TELEVISOR" MODEL ON VIEW.

We understand that a model of the television apparatus invented by Mr. John L. Baird will shortly be on view at the Science Museum, South Kensington.

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PIEZO-ELECTRIC SOUND BEACON.

Trials have been conducted at Calais with a new sound beacon, devised by Professor Langevin, in which two signals are sent out simultaneously, one of high frequency from a quartz oscillator, and one from an ordinary wireless transmitter. From the time log observed in the reception of the two signals ships are able to determine their distance from the beacon.

One drawback to the system is that vessels desiring to benefit must be equipped with special apparatus, a condition which is hardly likely to recommend itself to shipowners.

PIONEERS of WIRELESS

BY ELLISON HAWKS F.R.A.S

26.—D. E. Hughes and His Work.

ALTHOUGH Hertz is generally acclaimed the discoverer of the electromagnetic waves that to-day bear his name, actually they were discovered and used some years earlier by a British scientist, D. E. Hughes Although this is now a well-established fact, the earlier discovery was at the time regarded as being so impossible that it was not generally announced, and to Hertz is rightly accorded the honour of being the first publicly to make known the existence of the waves.

David Edward Hughes was born in London on May 16th, 1830. When seven years of age his family emigrated to Virginia, and he received his early education at St. Joseph's College, Kentucky. Here he attained some distinction in music and philosophy, but later his attention was directed to improving the telegraph. For two years he worked on improvements to the type-printing telegraph, and at 26 years of age invented an entirely new machine. This was taken up in America at once, and although England would have none of it, France took up the invention with eagerness, and bestowed honours and riches upon the inventor.

Prof. David Edward Hughes.

Unknowingly Discovers Hertzian Waves.

After living some years in Paris, Hughes came to London and, soon after, invented his microphone. This at once took the place of the Bell transmitter and made the telephone a commercial success.

Following this invention Hughes next brought out his inductance balance. He noticed that sometimes he could not get a perfect balance in this instrument, through apparent want of insulation in the coils. Investigating the matter, he found that the real cause was a loose contact in some part of the circuit. He then connected up the microphone and found that a sound was caused in the telephone both when the microphone was placed directly in the circuit and when placed several feet away from the balance, through the coils of which an intermittent current was passing.

After numerous experiments he found that "the effect was entirely caused by the extra current, produced in the primary coil of the induction balance." He discovered also that "an interrupted current in any coil gave out at each interruption such intense extra current that the whole atmosphere in the room (or in several rooms distant) would have a momentary invisible charge, which became evident if a microphonic joint was used as a receiver with a telephone."

Experiments Witnessed by Eminent Scientists.

Further experiments were carried out with a view to discovering "the best form of receiver for these invisible electric waves, which evidently permeated great distances, and through all apparent obstacles, such as walls, etc."

In his experiments he transmitted signals from one room to another in his house in Portland Street, London. As the greatest range possible in these circumstances was about 60ft. he obtained a greater range by "putting the transmitter in operation and walking up and down Great Portland Street with the receiver in my hand and with the telephone to my ear." We are not told what passers-by thought of the learned scientist, apparently wandering aimlessly about with a telephone receiver held to his ear, but doubtless they had their own ideas! Hughes found that the strength of the signals increased slightly for a distance of 60 yards, and then gradually diminished, until at 500 yards they no longer could be heard with certainty.

Between 1879 and 1888 several leading scientists were invited to see the results obtained. Those who witnessed the "aerial transmissions," as Hughes named them, included Sir Wm. H. Preece; the President of the Royal Society; Professor Dewar; and other eminent men of science. Hughes tells us that "they all saw experiments by means of the extra current produced from a small coil and received upon a semi-metallic microphone, the results being heard on a telephone in connection with the receiving microphone."

Sir William Crookes also witnessed Hughes' experiments (in December, 1879) and (in 1892) wrote:—

Pioneers of Wireless.—

"Even now telegraphing without wires is possible within a restricted radius of a few hundred yards. Some years ago I assisted at experiments where messages were transmitted from one part of a house to another without intervening wires."

An Unfortunate Discouragement.

In February, 1880, Hughes' experiments were witnessed by Mr. Spottiswoode, the President of the Royal Society, and his two secretaries, Professors Huxley and Stokes. At first they expressed their astonishment at the experiments, which were most successful, but after three hours' work Professor Stokes said he could not accept the inventor's theory that the results were due to electric waves, as all the results could be explained by known electromagnetic induction effects.

"I was so discouraged," wrote Professor Hughes, "at being unable to convince them of the truth of these aerial electric waves that I actually refused to write a paper on the subject [for the Royal Society] until I was better prepared to demonstrate the existence of these waves, and I continued my experiments for some years in the hopes of arriving at a perfect scientific demonstration of the existence of aerial electric waves, produced by a spark from the extra currents in coils, or from frictional electricity, or from secondary coils."

Hughes Leaves his Fortune to Charity.

Thanks to the discouragement of Sir George Stokes, Hughes' great discovery was lost to the world. Indeed, had not Sir William Crookes written a paper on the subject, and so caused the scientific world to demand the name of the author of the seemingly incredible experiments, which revealed the "bewildering possibility of telegraphy without wires, posts, cables, or any of our present costly apparatus," we should probably never have heard of Hughes' experiments in this connection, for even in 1899 he was unwilling to publish any details of his work.

From his microphone and other inventions Hughes realised a considerable fortune, and it is pleasing to record that when he died (in London on January 22nd, 1900) he left the bulk of £400,000 to the London hospitals.

NEXT INSTALMENT.
The Genius of Clerk Maxwell.

TRADE NOTES.

"Mellowtone" Balloons.

Have you found a "Mellowtone" balloon? At the Droitwich Agricultural Show a few days ago a number of small gas-filled balloons were released, each bearing the inscription, "For best wireless reception use only the Mellowtone Receivers."

In connection with this enterprising form of publicity, Messrs. The Midland Radiotelephone Manufacturers Ltd., Brettell Lane Works, Stourbridge, the manufacturers of "Mellowtone" wireless apparatus, announce that they will be pleased to award a complete set of Mellowtone couplers, value 24s., to the finder of the balloon, holding a broadcasting receiving licence, who can give satisfactory proof that the balloon had travelled a greater distance than any other.

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Music by the Wayside.

Readers in the West of England should keep a look-out for the new Mullard demonstration van now touring that part of the country. Free entertainments are given from the van, which carries a multi-valve "P.D." receiver, and two "power" type Amplion loud-speakers.

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New Climax Loud-Speaker.

A new hornless loud-speaker for which interesting claims are made is the Climax "Chello." It is stated that the instrument gives a wonderfully natural and intimate impression, on account of the unusually large diaphragm employed.

Cheaper Ebonite.

Messrs. Trelleborg Ebonite Works, Ltd., Audrey House, Ely Place, London, E.C.1, draw attention to reduced prices of Trelleborg ebonite panels.

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Building a "Super Het."

A fascinating brochure, which virtually amounts to a short text-book on the theory, operation and construction of a seven-valve superheterodyne receiver, has been issued by Messrs. L. McMichael, Ltd., Wexham Road, Slough, Bucks. Photographs, diagrams and a tuning chart are included, and information is given on soldering and other practical matters. The particular receiver dealt with is the MH Seven Valve Supersonic Heterodyne, which can either be purchased complete or as a constructional outfit.

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Burndept Anti-phonic Valve Holder.

A substantial price reduction has been effected in the case of the Burndept anti-phonic valve holder, which is now available at 2s. 9d. instead of 5s. In drawing attention to the enormous demand which exists for the anti-phonic valve holder, the manufacturers state that the reduction in price will not, of course, affect the high quality of the component.

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Mullard's New Premises.

The Mullard Wireless Service Co. Ltd., owing to the great expansion of their business, have moved into new premises at Mullard House, 21, Denmark Street, London, W.C.2, where ample stocks will be carried and prompt delivery ensured by a large service of new delivery vans. The telephone number is Gerrard 5633.

CATALOGUES RECEIVED.

The Foolproof Patent Accumulator Co., Ltd. (Market Harborough). Pamphlets dealing with the "Lion" H.T. and L.T. accumulators, with details of construction and price.

Radio Communication Co., Ltd. (Barnes, London, S.W.13). Polar catalogue covering the range of Polar sets, amplifiers, accessories and components.

A. C. Cossor, Ltd. (Highbury Grove, London, N.5). Leaflet describing the Cossor constructional system of co-axial mounting in valve manufacture.

Lisenin Wireless Co. (Connaught House, 1a, Edgware Road, Marble Arch, London, W.2). Pamphlet describing the Lisenin positive grip terminals, sockets and plugs.

Igranic Electric Co., Ltd. (149, Queen Victoria Street, London, E.C.). Publication No. 6229, giving diagrams for jack switching. Publication No. 6232, a catalogue of Igranic radio accessories (56 pp.), including list of European broadcasting stations showing combinations of Igranic honeycomb coils.

Marconi's Wireless Telegraph Co., Ltd. (Marconi House, Strand, London, W.C.2.). Leaflet giving details of the Marconi highly selective receiver, Type R.G.6b, intended for telegraph and telephone signals in connection with naval, military and other services. Leaflet No. 1058, containing an illustrated description of the frame aerial direction finder, Type 11F, and direction finder repeater compass.

Universal Three Valve Receiver

An All-purpose Receiver Tuning from 20 to 20,000 Metres.

By N. P. VINCER-MINTER.

(Continued from page 215 of the August 18th issue.)

In the first part of this article we discussed briefly the theoretical principles underlying the Schnell modification of the Hartley circuit, which is used in this receiver, and at the same time went into the vexed question of the correct transformer ratio to use in each stage of a low-frequency amplifier with particular reference to this receiver. This week we consider, among other things, the question of correct switching arrangements, and finally pass on to the constructional details.

IN the first place, it is necessary for us to consider what switching arrangements we are going to use for cutting out unwanted valves, for we shall not always require to be using a loud-speaker. It is obvious from the technical considerations which we discussed last week in connection with the L.F. amplifier that the ordinary switching arrangements will not do. The ordinary method, for instance, if applied to the receiver, would mean that when it was desired to eliminate the final valve the plate circuit of valve No. 2 would be disconnected from its carefully chosen 50-henry inductance and connected to the 32-henry output inductance, or worse still, if it was desired to cut out both L.F. valves, the high-impedance detector valve would be disconnected from its 80-henry inductance and connected to a comparatively low inductance of 32-henries (far too low for the internal valve impedance), thus upsetting all our careful precautions in choosing the correct high ratio of external circuit impedance to internal valve impedance and causing a very considerable sacrifice in quality.

Jacks or Switches?

Now the ordinary jacking system is equally bad, if not worse, from this point of view, because it might result in the telephones or loud-speaker (which are usually of only 5 to 10 henries inductance) being connected directly in the plate circuit of the detector valve. We can, however, easily work out a switching arrangement which will not alter our carefully chosen external impedance values, and this is clearly shown in Fig. 1, which is really self-explanatory. This is undoubtedly the simplest arrangement of all, and if we provide three pairs of telephones or loud-speaker terminals we require no switches or jacks at all. A receiver using such a "switching" system was described by the writer in this journal just over a year ago, in the issue dated August 19th, 1925. It is, however, undoubtedly inconvenient constantly to have to connect and disconnect telephones or loud-speaker, and some form of switching is essential. If actual switches are desired, a very simple arrangement can be evolved which, incidentally, was illustrated and described on page 243 of last week's issue of this journal. However, jacks undoubtedly provide a much more flexible method, since arrangements can be made for filament switching so that only those valves light up which are actually in use, and the method shown in Fig. 2, which is perfectly satisfactory, was decided upon.

Loud-speaker Connections.

Now it will be noticed that in order to employ the switching system used in Fig. 2 it is essential to use a choke filter circuit for the final valve, but this is not the main reason why the loud-speaker is kept out of the plate circuit of the valve. Nor is it because there is a risk of the loud-speaker or telephone windings being damaged by the passage of steady plate current, although on this account alone a choke filter circuit is advisable. The main reason is that the iron magnet core of the ordinary loud-speaker is apt to become saturated under the influence of the plate current of a power valve, because the core is of necessity small, and if magnetic saturation sets in, both quality and volume will be sacrificed. It can be avoided by keeping the steady plate current out of the loud-speaker or telephone windings, and passing it through a choke. This matter was, however, fully gone into by the writer in his article entitled "Coupling L.F. Valves," published in the

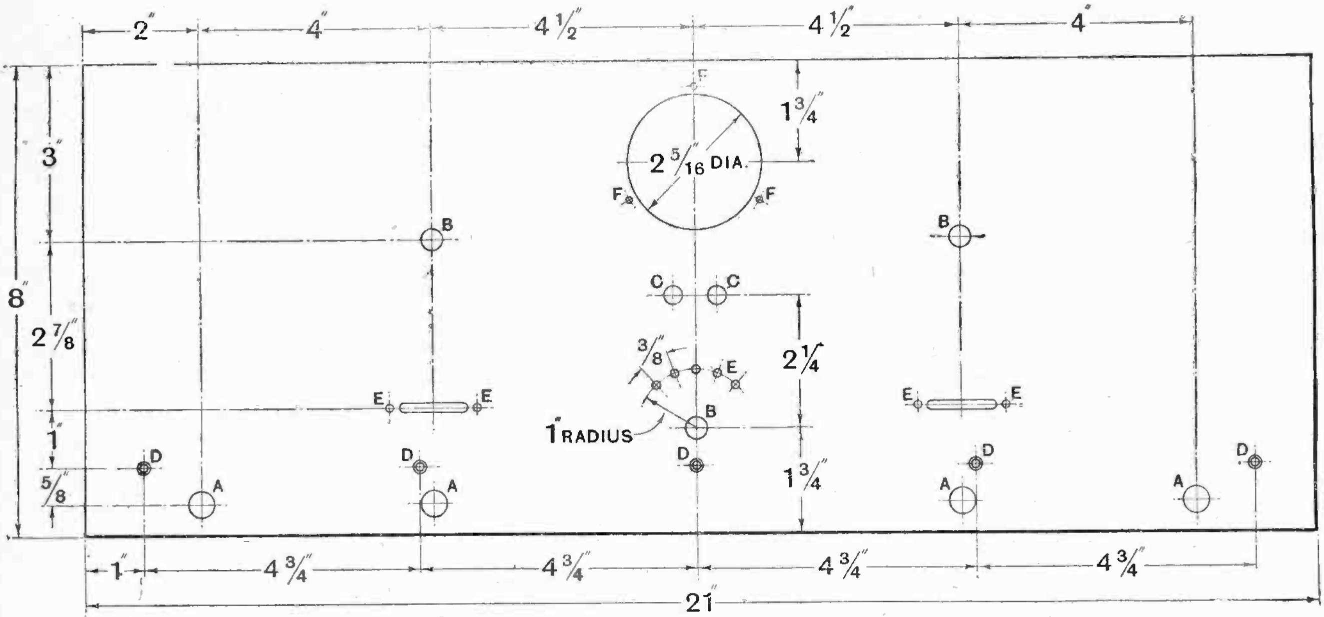

Fig. 4.—Dimensional details of the front panel. Drilling sizes are as follow: A, 7/16 in. dia.; B, 3/8 in. dia.; C, 5/16 in. dia.; D, 1/8 in. dia. countersunk for No. 4 woodscrews; E, 1/8 in. dia.; F, 3/32 in. dia.

May 26th issue, and also in greater detail on page 745 of the June 2nd issue.

Volume Control.

With regard to the question of volume control, it is obvious that we must have a much finer control over volume than is obtainable by cutting out an L.F. stage, and moreover, the volume control must not have any effect on tone. One method of controlling volume is to shunt a variable resistance across the loud-speaker. But if overload distortion is experienced, it is probable that both loud-speaker and L.F. valves are overloaded, and consequently distortion will occur. The only place for the volume control, therefore, is in front of the first L.F. valve. The system here used is the same as that described by the writer in the March 31st issue of this journal, in conjunction with a tapped anode resistance. The system there described is, however, equally applicable to a choke or transformer secondary.

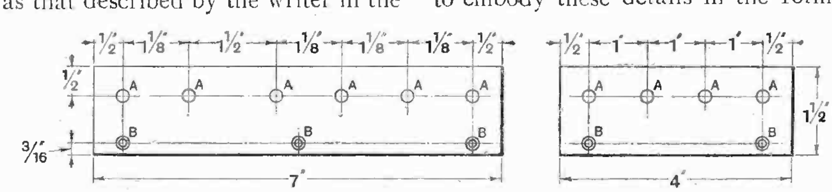

Fig. 5.—Drilling details of the terminal strips. Drilling sizes are as follow: A, 7/32 in. dia.; B, 1/8 in. dia. and countersunk for No. 4 woodscrews.

It will be noticed that a double reading voltmeter has been included for the purpose of ascertaining the state of both H.T. and L.T. batteries. In the writer's opinion, the use of a double range voltmeter in a modern receiver is absolutely indispensable. A very large percentage of the distortion experienced by owners of loud-speaker receivers is due to an H.T. battery whose voltage has fallen off. With this instrument the state of both H.T. and L.T. batteries can be seen at a glance. When a telephone plug is not inserted in any jack, the voltmeter as well as the valves is automatically switched off. On inserting the telephone plug into any one of the three valve jacks (but not in the crystal jack) the voltage of either H.T. or L.T. battery can be read by moving the switch over to either side, leaving the switch in the middle, putting the voltmeter out of action. It can, if desired, be left over to the L.T. side (but not the H.T. side) throughout the whole period, when the valves are in use, and no harm will be done to the meter or batteries.

Having now considered all the technical points embodied in the design of the receiver, we are now in a position to consider the various combinations which can be obtained by the various jacks and switches, the necessary manipulation of the latter necessary to obtain these combinations, and the method by which these manipulations bring about these various combinations. The writer has found it best to embody these details in the form of a table, which is handy for ready reference. This table is given on page 272.

It will thus be seen from this list that the receiver well and truly meets its title of "Universal," and can in a measure claim to represent a certain measure of finality from the point of view of rectification, regeneration, L.F. amplification and "switchification." The table only represents the main combination which can be obtained, and actually the writer has worked out 155 permutations and combinations which can be obtained, and he would be glad to hear from any reader who can elucidate further possible combinations. No prize, however, is offered.

There is yet another small point which needs consideration. Supposing it is desired to use a loud-speaker at a certain volume which was louder than that given by two valves going at full strength, but yet not so loud as would

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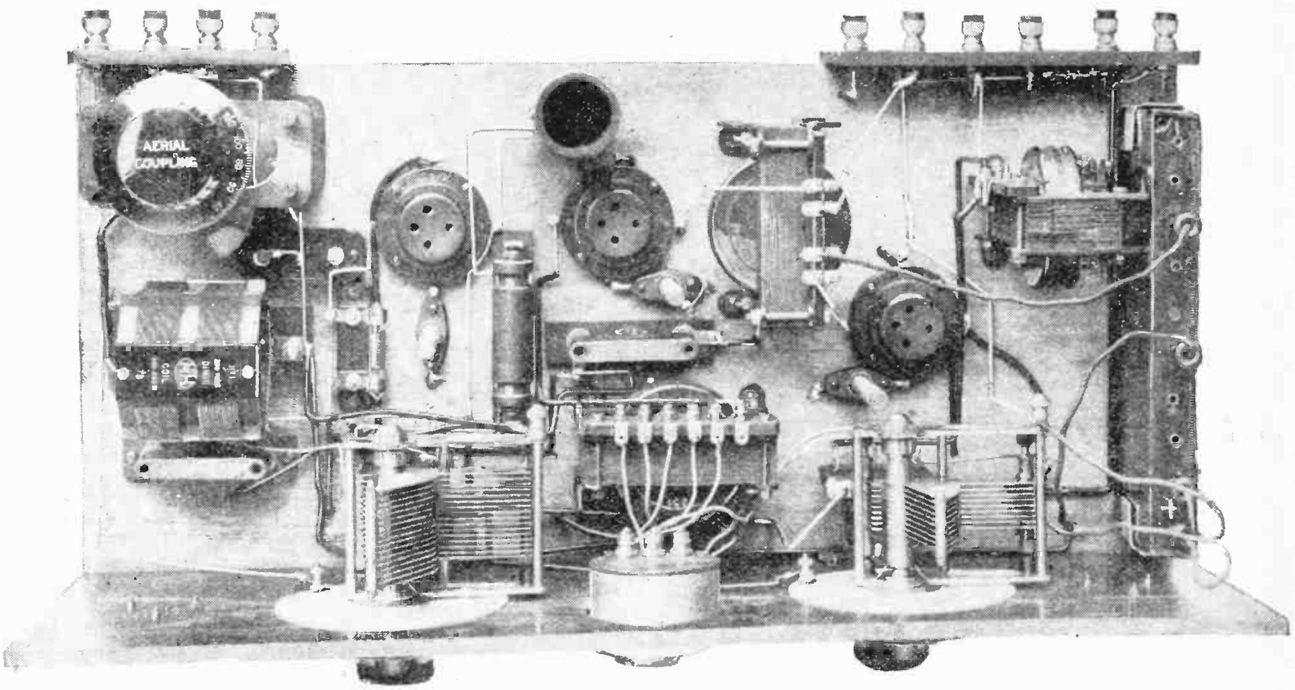
be given by three valves. This could easily be arranged for, of course, by using the loud-speaker after three valves and operating the volume control. Now supposing it was desired to use telephones after the first valve, it would probably be too loud for telephones, and, of course, our volume control as at present arranged does not affect the telephones.

But even if volume were not loud enough on telephones from the first valve owing to distance from the broadcasting station, we could not just plug in telephones after the first L.F. and work the volume control, for we should cut down our volume from the loud-speaker too much.

high-frequency energy corresponding to wavelengths below this value. As the wavelength increases beyond this, however, the corresponding frequency naturally decreases, and accordingly a larger value of by-passing condenser is necessary if the wavelength being dealt with exceeds about 4,000 metres, such as would be the case if the whole receiver were being used for reception of the big C.W. stations working in the neighbourhood of 10,000 metres, or if the amplifier portion were being used after a superheterodyne employing this value of intermediate wavelength.

Above this wavelength of 4,000 metres also we must increase the value of our fixed feed-back condenser,



Plan view of the baseboard layout. Note the tapped transformer.

It will be seen, therefore, that in any case we want independent volume control for the telephones. This could easily be provided for by shunting the telephones with a good 0-500,000 ohms variable resistance. Fortunately a telephone plug is now obtainable which embodies such a variable volume control which is adjusted by a small knob on the "handle" of the plug, which is of somewhat different shape to the ordinary cylindrical type. This instrument may be obtained from the firm mentioned in the list of components used in constructing this receiver, and on test functioned exceedingly well for the purpose just described.

Do not forget that it is necessary that the fixed condenser across the primary of the first transformer be of the plug-in interchangeable type if it is intended to make the receiver fairly universal in the sense that the amplifier portion of it can be applied to the output of *any* receiver. The customary value of 0.001 mfd. is perfectly suitable up to about 4,000 metres, since it will adequately fulfil its function of by-passing the

therefore this component is also of the plug-in type. Since, also, it is advisable when working on very long wavelengths to experiment with other than the customary values of grid leak and condenser, these components are also of the plug-in type, and are placed in such a position that they are easily accessible. The "Cosmos" H.F. choke has only sufficient inductance to carry us a little beyond the 4,000 metre wavelength, and we must remove it (it is also of the interchangeable type) in favour of a home-made type consisting of a *plain* (not slotted) bobbin of similar dimensions filled with No. 47 D.S.C. wire. We need not use a slotted former since self-capacity will not trouble us on these very long wavelengths.

Constructional Details.

We can now pass on to the constructional work. Since the receiver was intended to be a "final" household set for use as a source of musical entertainment as well as an instrument for the experimenter, it was decided to

LIST OF COMPONENTS.

1 "Ebonart" panel, 21in. × 8in. × ¼in. (Redferns Rubber Works, Ltd., 75, Newman Street, W.1).
1 Baseboard, 21in. × 9½in. × ⅜in.
2 Ebonite terminal strips, 7in. × 1½in. × ¼in. and 4in. × 1½in. × ¼in.
1 Ebonite former, 3in. × 1in.
1 "Dimic" coil base with appropriate coils.
2 0·0005 mfd. S.L.F. condensers without verniers (Ormond).
1 0·0005 mfd. S.L.F. condenser (Success).
1 Double-range voltmeter (The Sifam Electrical Instrument Co., 95, Queen Victoria Street, E.C.4).
1 Semi-automatic crystal detector (Harlie Bros., 36, Wilton Road, Dalston, E.8).
1 Stud switch with five studs and two stops (A. Munday, Ltd., 59, Watling Street, E.C.4).
1 "Utility" four-pole double-throw switch (Wilkins and Wright).
1 "Utility" D.P.D.T. Switch (Wilkins and Wright).
2 "Vermo-mahoganite" vernier dials (Detex Distributors, Ltd., 110, Victoria Street, S.W.1).
2 Valve windows ("Deckorem," A. F. Bulgin, Ltd.).
3 "Anti-phonic" valve holders (Burndept).
3 Fixed resistor holders and appropriate resistors (Burndept).
1 Tapped secondary 2·5 : 1 L.F. transformer (W. G. Pye, Ltd., Granta Works, Cambridge).
1 L.F. transformer: ratio 4 : 1 (Pye).
1 32-henry choke (Pye).
1 0·0003 mfd. fixed condenser (Peto Scott).
1 "Dumetohm" 2 megohm leak and holder (Dubilier).
1 0·001 mfd. plug-in fixed condenser with holder (Peto Scott).
1 0·00005 mfd. plug-in fixed condenser with holder (Peto Scott).
1 "Cosmos" H.F. choke (Metro-Vick Supplies, Ltd.).
6 1 mfd. fixed condensers (T.C.C.).
2 Double circuit filament control jacks (Edison Bell).
2 Single circuit filament control jacks (Edison Bell).
1 Telephone plug (Bowyer Lowe).
1 special volume control telephone plug (Rothermel).
1 15-volt grid battery (Hellesen).
1 Grid battery holder ("Deckorem," A. F. Bulgin, Ltd.).
10 Indicating terminals: A_1, A_2, E, P, H.T.+, H.T.$+_2$, H.T.$+_3$, H.T.—, L.T.—, L.T.+ (Belling Lee).
4 Wander plugs.
Quantity of No. 36 D.S.C. wire.
Length of red and black flex.

Approximate total cost - £12 10 0

make the appearance of the front panel as attractive and as well balanced as possible. Undoubtedly a polished "Mahoganite" panel excels all others from the point of view of appearance, and the necessity of going to America for this material was avoided by using a sheet of which not only were vernier dials of a type singularly free from backlash, but made also in "Mahoganite" with metal parts gold-plated. Unfortunately, however, the dial markings were in white, which gave it a very grotesque appearance. This was remedied, however, by

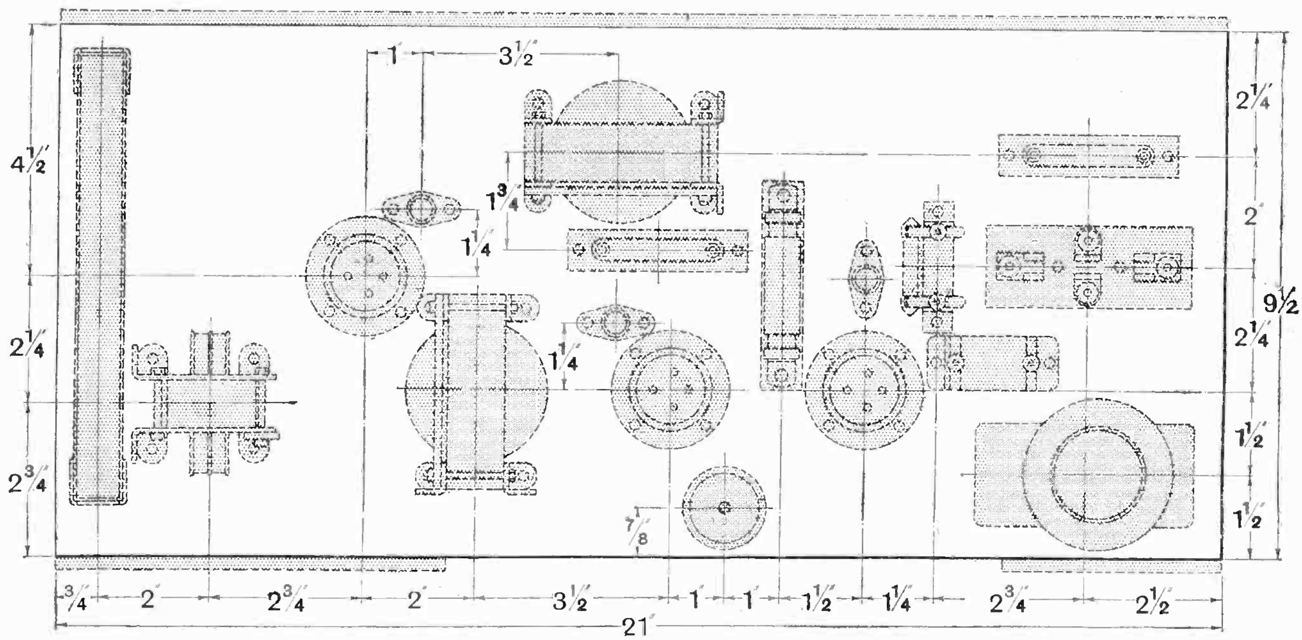


Fig. 6.—Details of the baseboard layout.

"Ebonart," which is British and is finished in an exceedingly attractive manner. After deciding on this type of panel, it was essential that all dials and knobs be also of "Mahoganite" finish, all metal parts gold-plated, and all dial markings, etc., filled in with gold, for nothing appears so incongruous as black dials with white markings and nickel-plated or black-finished metal work on a "Mahoganite" panel. Fortunately, dials were found despatching the dials, together with the panel, to Messrs. Regent Radio Supply Co., 45, Fleet Street, E.C.4, where the dial markings were filled in with gold, and the panel was engraved with the markings as shown in the title picture, and filled in with gold. The voltmeter, the jack heads and washers, the stud switch, and the crystal detector, which were purchased nickel-plated, and the "Utility" switches, which were obtained in black

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finish, were despatched together with the brass wood screws holding the panel to the baseboard, to the Plating Co., Ltd., 10, Kirby Street, Hatton Garden, E.C.1, who returned them in 48 hours beautifully gold-plated at a cost of only a few shillings. It should be mentioned that, if desired, the "Ebonart" panel already drilled and engraved for this receiver, and the two dials with panying this article owing to the absence of colour photography.

After receiving the panel and panel fittings all ready prepared, we can proceed to mount the components on it. The only logical condenser to use for tuning is an S.L.F. condenser, as already explained by the writer in this journal.[1] It is immaterial what type of condenser is used for reaction or aerial coupling, but an S.L.F. type

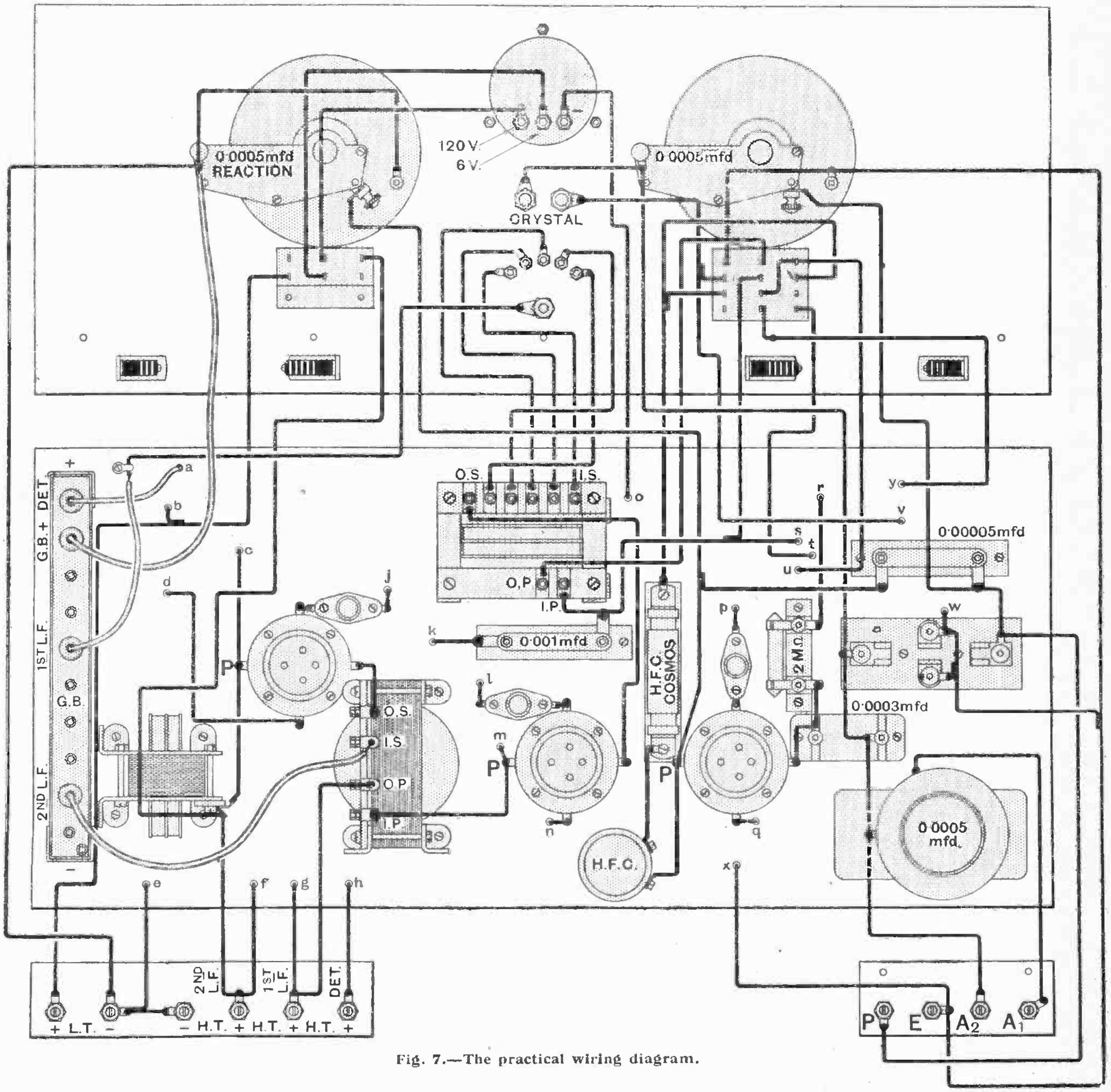


Fig. 7.—The practical wiring diagram.

markings already filled in with gold, may be obtained direct from the Regent Supply Co. instead of getting them from their makers. The result of this is that the panel presents an exceedingly pleasing appearance to which little justice is done in the illustrations accom- is preferable in the former position owing to its low minimum, which is very necessary. As will be seen from the theoretical diagram in Fig. 2, one plate of this con-

[1] *The Wireless World*, August 4th, 1926, page 149.

Combinations Possible.	Switching Necessary.	Remarks.
1. Crystal only.	Telephones in Jack No. 1.	The crystal becomes connected as in Fig. 1. No valves light up.
2. Crystal plus reaction valve.	Same as in No. 1, but with a dummy telephone plug in Jack No. 2.	The dummy plug in Jack No. 2 causes the 1st valve to light up.
3. No. 1 or No. 2, plus one or two L.F.	Loud-speaker plug in Jack No. 3 or No. 4 Four-pole switch to "Crystal." Dummy plug in Jack No. 1.	Insertion of loud-speaker plug in Jack No. 3 or No. 4 causes requisite valves to light up, except detector valve whose filament circuit is broken when moving the four-pole switch to "Crystal." Movement of this switch brings transformer primary to output of crystal, and joins the H.F. choke to H.T.+. Insertion of Dummy plug in Jack No. 1 lights up reaction valve.
4. Valve only with alternative grid or anode rectification.	Telephones in Jack No. 2 and grid bias wander plug of detector valve adjusted as explained in the text.	The telephones in No. 2 Jack light up valve. Adjustment of wander plug gives a positive or negative bias to grid of detector valve for providing alternative grid or anode rectification as required.
5. No. 4 plus one or two L.F.	Same as in No. 4, but loud-speaker plug in Jack No. 3 or No. 4.	Same as No. 4, but the plug in No. 3 or No. 4 Jack lights up the requisite number of L.F. valves.
6. One pair of phones from crystal detector and one from valve detector, using grid or anode rectification.	One telephone plug in No. 1 Jack, and another telephone plug in No. 2 Jack. Grid bias wander plug adjusted according to the type of valve rectification required.	The insertion of a pair of telephones in No. 1 Jack gives the same effect as in No. 1 and the insertion of a telephone plug in No. 2 Jack gives the same effect as in No. 4.
7. Same as No. 6, but with a loud-speaker after 3rd valve and/or after 4th valve; the valve detector feeding the loud-speaker or speakers.	Same as in No. 6, but with a loud-speaker plugged in Jack No. 3 and/or Jack No. 4. Four-pole switch to "Valve."	The loud-speaker plugs in Jack No. 3 and/or No. 4 lights the requisite valves. The four-pole switch places the transformer primary over to the detector valve.
8. Same as No. 7, but using the crystal detector for feeding the loud-speakers.	Same as in No. 7, but with the four-pole switch to "Crystal."	Same as in No. 7, but the moving of the four-pole switch changes transformer primary from valve to crystal detector. This would extinguish the detector valve filament but for the telephone plug in Jack No. 1.
9. Any of the foregoing on a small indoor aerial.	Same as in No. 1 to No. 8, but aerial should be connected to A_2 instead of A_1.	The connecting of the aerial to A_2 cuts out the aerial coupling condenser which is unnecessary when using a small indoor aerial.
10. Any of the foregoing on a frame aerial.	Same as No. 1 to No. 9, but the "Dimic" coil should be removed in favour of a frame aerial.	The necessary connections for a frame aerial are clearly shown in Figs 2 and 3.
11. Any of the foregoing after a neutrodyne H.F. amplifier.	Same as in No. 10, but secondary of the output H.F. transformer takes the place of the frame. This secondary must have a centre tapping.	The necessary connections are clearly shown in Fig. 3, and, of course, by manipulating the four-pole switch and the detector valve wander plug, alternative methods of rectification may be used, and also reaction is optional.
12. Any of the foregoing after an "ordinary" H.F. amplifier.	Do *not* remove "Dimic" coil, but turn to Fig. 2, page 754, Wireless World, June 2nd, 1926 issue, and connect output of the amplifier there shown across the A_2 and E terminals of this set.	This type of amplifier is the conventional type with an H.F. choke in the anode circuit of the H.F. valve followed by tuned grid circuit, and is frequently used for placing in front of any existing Detector and L.F. or crystal receiver.
13. Input of L.F. amplifier to output of a separate receiver.	First remove earth connection from "Universal" set and unplug the crystal detector or the "Dimic" coil, then connect a telephone plug to the telephone terminals of the existing receiver, and insert plug in No. 1 Jack. In case of superhet., change value of plug in fixed condenser across transformer primary as explained in text.	The putting of the four-pole switch to crystal and the insertion of the plug coming from output of separate set puts primary of transformer across the output of this set. If earth connection is not removed first, however, the H.T.+ of separate set will become earthed through transformer primary. If either crystal or "Dimic" coil is not inplugged, the output of separate set will become short-circuited by "Dimic" coil and crystal detector in series.
14. Operating the double-range voltmeter.	To read L.T. voltage put the two-pole switch to the right. To read H.T. voltage put it to the left. Placing it in the centre disconnects meter. Before a reading can be taken a plug must be inserted in either Jack No. 2, 3 or 4.	The meter when not in use can be left switched off or left over to the L.T. side as explained in the text. The meter is not operative unless a plug is inserted into one of the three valve Jacks.
15. Using the meter to read the voltage of a separate battery.	To read separate L.T. battery take a connection from L.T.— and L.T.+ to the separate L.T. battery and put double pole switch over to right. To read separate H.T. battery take a connection from L.T.— and H.T.+ tapping of final valve to the separate H.T. battery and put switch over to the left.	This enables a separate H.T. and L.T. battery associated with another set to be applied to the meter for a voltage test.

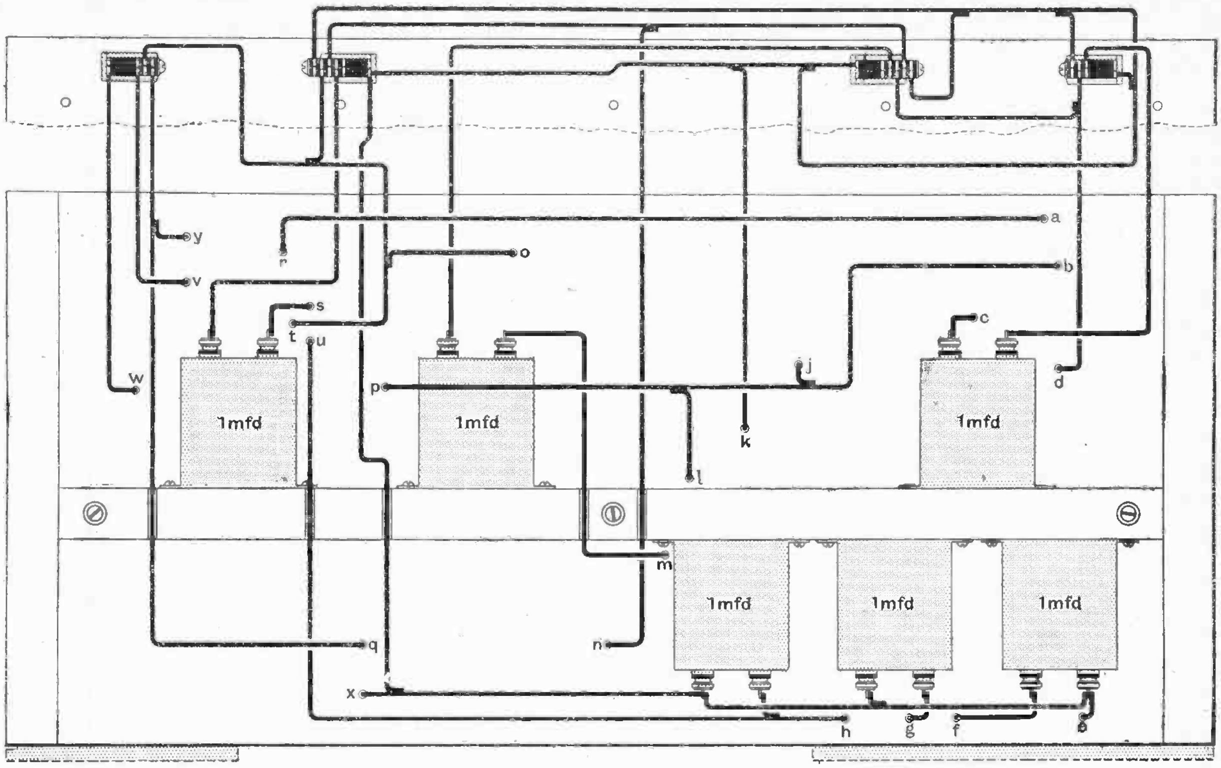
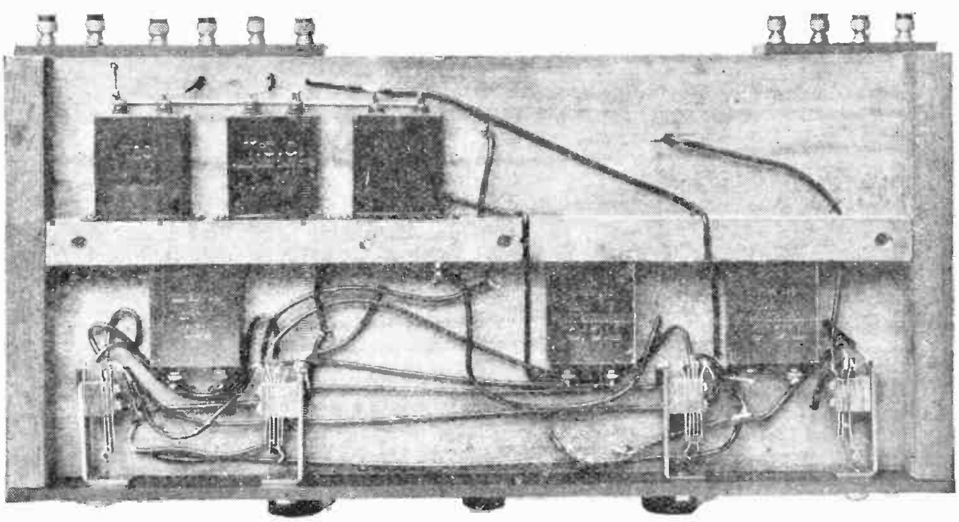


Fig. 8.—Particulars of the wiring of the underside of the baseboard.

denser is definitely at earth potential, and if the rotor is earthed no trouble will be experienced from hand capacity effects. Both plates of the tuning condenser are at high oscillating potential, however, and in order to avoid these evil effects it would ordinarily be necessary to use a condenser, in which neither set of vanes was attached to the operating shaft, such as the "Newey," or to set the condenser well back from the panel and use an ebonite extension shaft as was done by the writer in the Hartley receiver described by him in the July 21st issue. Messrs. Ormond's, however, now supply an S.L.F. condenser specially for the purpose in which a separate capacity shield (which should be earthed by the terminal provided) is used, and this was found perfectly satisfactory.

Components on the Panel.

The valve windows and retaining rings are obtainable already gold-plated, and since these are merely for the purpose of panel ornamentation, it is sufficient just to mount them on the panel, and it is not absolutely necessary to drill observation holes in the panel, since in any case no light would be visible from the modern dull emitter even if mounted close up against the window. The particular crystal detector used, which is of the semi-automatic type, was chosen for its constancy, ease of adjustment, and foolproofness. It plugs into two "valve" sockets on the panel, these sockets being sold with the detector. The writer has a large number of detectors, including the ordinary catwhisker type (Burndept) to which he has fitted legs so that he can instantly plug any type of detector he desires into the panel sockets.



View of the underside of the baseboard, showing the wiring to the jacks.

(To be concluded.)

CALIBRATION WAVES FROM THE N.P.L.

Transmissions of Wireless Waves of Standard Frequencies from the National Physical Laboratory (Station Call-sign 5HW).

DURING the last three years waves of accurately known frequency have been transmitted on the recommendation of the Radio Research Board of the Department from the wireless station at the National Physical Laboratory to provide a means of checking the calibration of wavemetres and other apparatus.

This transmission has consisted of eight waves covering a range 360 to 60 kilocycles per second (833 to 5,000 metres wavelength). It is transmitted between the hours of 1500 and 1600 G.M.T. on alternate Tuesday afternoons.

In order to increase the usefulness of this service, arrangements have been completed, after consultation with the Post Office and others interested, for the present transmissions to be greatly extended. The new transmissions will include sixteen waves. These will be transmitted in two sections, each section being transmitted once each calendar month. One part will be transmitted on the first Tuesday in the month between 1500 and 1600 G.M.T., while the other part will be transmitted on the third Tuesday in the month between the same hours.

The system of the transmissions will be, provisionally, as follows :—

(1) An announcement will be made in Morse on plain C.W. on a wavelength of 1,500 metres that a transmission of standard waves is about to take place. This announcement will be made at 1455 G.M.T.

(2) Each standard wave will be transmitted as follows :—

(a) *Short-wave Programme on the first Tuesday in each month.* The letter N followed by a number identifying the wave. This will be repeated three times, and will then be followed by a dash lasting 40 seconds.

Four such dashes will be thus transmitted, each preceded by the identifying letter and number.

As far as possible the dash will begin at 20 seconds past the appropriate minute, and will continue to the end of minute.

An interval of 4 minutes will elapse, when the next wave of the series will be transmitted in exactly the same way.

(b) *Long-wave Programme on the third Tuesday in each month.*—This will be transmitted in exactly the same way as the short-wave programme, but the identifying letter will be M. The actual programme is set out in detail below.

SHORT-WAVE PROGRAMME.

G.M.T.	Signal Transmitted.	Frequency, Kilocycles per sec.
1455—1500	Announcement in Morse	200
1500—1504	N1, N1, N1—40 sec. dash—transmitted 4 times.	960
1504—1508	Silence.	
1508—1512	N2, N2, N2—40 sec. dash—transmitted 4 times.	840
1512—1516	Silence.	
1516—1520	N3, etc., as above	700
1524—1528	N4, „ „	580
1532—1536	N5, „ „	500
1540—1544	N6, „ „	360
1548—1552	N7, „ „	300
1556—1600	N8, „ „	260

LONG-WAVE PROGRAMME.

G.M.T.	Signal Transmitted.	Frequency, Kilocycles per sec.
1455—1500	Announcement	200
1500—1504	M1, M1, M1—40 sec. dash—transmitted 4 times	200
1504—1508	Silence.	
1508—1512	M2, etc., as above	160
1516—1520	M3, „ „	115
1524—1528	M4, „ „	86
1532—1536	M5, „ „	66
1540—1544	M6, „ „	50
1548—1552	M7, „ „	40
1556—1600	M8, „ „	30

During the pauses dashes may be heard whilst the settings and adjustments of the circuits to the next wave of the series are being made. These dashes must not be taken as part of the programme.

The announcement will consist of the general call-sign CQ de 5HW repeated a few times, and followed by the words "Short (or long) standard wave frequency transmissions, stand by."

The frequencies transmitted will be highly accurate, so that it will be unnecessary to transmit any corrections. The transmission of the actual frequency will, therefore, not take place, since the identifying letter and number serve this purpose.

The aerial current will be recorded, but will not be transmitted. Information regarding the value of the current on any particular occasion will be given on request. The address of the Department of Scientific and Industrial Research is 16, Old Queen Street, Westminster, S.W.1.

A few notes relative to the reception of these waves are appended.

Reception of Standard Waves.

It is presumed that the instrument under calibration by means of the waves is a self-generating valve oscillator of smoothly variable frequency. It is further essential that a tunable receiving set with detecting arrangements and headphones should be used in conjunction with the heterodyne source. The most accurate means of calibration is to set the heterodyne source until the beat tone heard between it and the incoming standard wave has a pitch equal to that of a small tuning-fork of known pitch. This will be unnecessary in the higher frequency waves, but in the case of the longer waves the belt of frequency within which no beat tone is heard will represent more than one part in a thousand, whereas by using a definite beat tone of, say, 1,000 cycles per second the sensitivity of the receiving set will be high, and the accuracy of setting will be much greater than can be read on the heterodyne unless it is of exceptional construction.

The frequency of the beat tone must, of course, be added to or subtracted from that of the standard wave frequency according to which side the heterodyne source has been set. It is convenient to set the heterodyne first higher and then lower than the incoming wave, using the tuning fork to obtain equality of pitch on the two sides. The frequency of the tuning fork need not then be known. The mean of the two readings on the heterodyne condenser corresponds exactly to the transmitted frequency.[1]

An examination of the frequencies included in the transmissions will reveal the fact that, except for a few frequencies far apart, they are not exact multiples of one another.

On this account it is possible to obtain calibrating frequencies intermediate between those actually transmitted. Thus on the long wave programme the heterodyne could be set at a frequency of 33 k.c. per sec. when the standard wave of 66 k.c. per second was under transmission. The 2nd harmonic of the heterodyne at 66 k.c. per sec. will give a well-defined beat with the standard wave of 66 k.c. per sec.

The following intermediate frequencies can all be obtained in this manner without difficulty :—

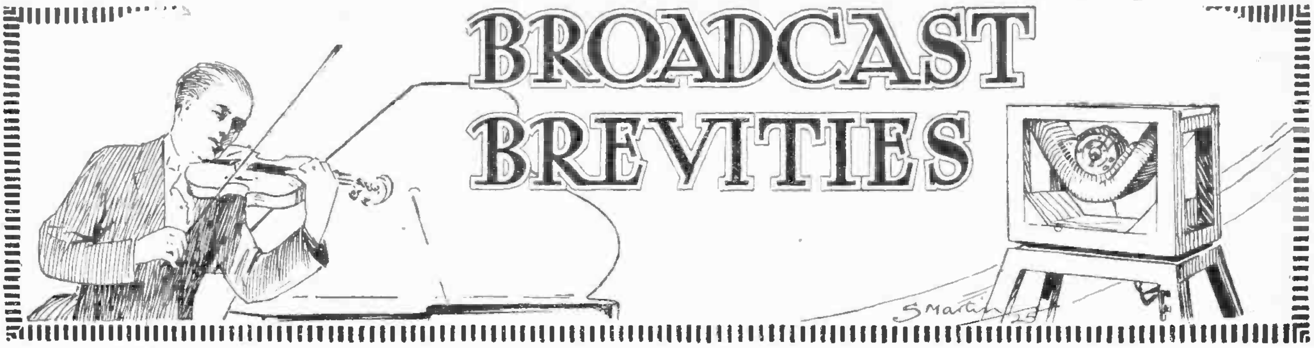
2nd Harmonics :—33, 43, 57.5, 80, 100, 130, 150, 180, 250, 290, 350, 420, 480.

3rd Harmonics :—$38\frac{1}{3}$, $53\frac{1}{3}$, $66\frac{2}{3}$, $86\frac{2}{3}$, 100, 120, $166\frac{2}{3}$, $233\frac{1}{3}$, 280, 320.

Shorter wave heterodyne oscillators can, of course, be calibrated by the harmonics of an intermediate wave oscillator itself calibrated from the short standard waves.

The transmissions here announced will commence on Sept. 7th with the short-wave programme, and will thereafter follow the sequence given.

[1] This assumes that over the range of condenser used there is a linear relation between capacity and frequency. If any other relation holds a small correction will be necessary to obtain the highest accuracy.



NEWS FROM ALL QUARTERS.

By OUR SPECIAL CORRESPONDENT.

Oscillation on the Decline.

The campaign against oscillation at last appears to be meeting with some success. From Savoy Hill I learn that during the last few weeks the number of complaints received has dropped by 30 per cent. A month or two ago woeful letters were arriving at the rate of 60 per week.

oooo

Interference on the New Wavelengths.

Before the new wavelength allocation scheme is put into force, efforts are to be made to trace interference which is at present upsetting the Daventry transmissions. For instance, a C.W. station in the neighbourhood of Blackpool is causing trouble on the 1,600-metre wavelength. From observations made it appears that an arc transmitter is being used, the mush being abnormal.

A good deal will have to be done in the next two or three weeks to clear the ether if the new scheme is to make an effective start. At the moment there is an epidemic of heterodyning by foreign stations.

oooo

B.B.C. Engineers on "Transmitter Fatigue."

A flutter has been caused in the Birmingham dovecote by the correspondence which recently appeared in *The Wireless World* anent the fading of new transmitters after being in operation a few weeks.

Readers may remember that Mr. James B. Walker, of Bishop Auckland, whose letter was printed in the issue of August 11th, remarked that the most striking case of fading in his experience was Birmingham. "The old American transmitter," he wrote, "at first gave really excellent signals; then, after five weeks, fading started, and signals fell right off until it was very problematical whether we would raise him at all." The same phenomenon was noticed by this correspondent when the station was removed to another site.

oooo

Sceptical.

The B.B.C. engineers are frankly sceptical regarding the suggestion that fading might be due to increased resistance in the earthing system. The aerial amps. remain constant (it is stated), and the tendency would be for the aerial current to fall if the earth were affected by electrolytic action. If there is any diminution in the strength of transmission after a well defined period of five weeks after the opening of the new station one would have to take into account meteorological conditions (the effect of which is very little known in many respects), but this would not be a constant factor.

oooo

A Psychological Cause?

"After all," state the engineers, "the strength of 5IT or of any other broadcasting station in this country has been proved to remain fairly constant, and we are inclined to regard the fading phenomenon as psychological rather than physical."

So that's that.

oooo

All the Hours.

On an ordinary weekday a listener in England, if he has the time and inclination, can receive B.B.C. programmes for eight or nine hours. The Continental listener, as a rule, can regale himself for seven or eight hours.

They would smile at such programme poverty in Australia. 2FC, the well-known broadcasting station at Sydney, provides a daily fare totalling fourteen hours! Transmission begins at seven o'clock in the morning, and continues, with a few silent periods, until midnight.

oooo

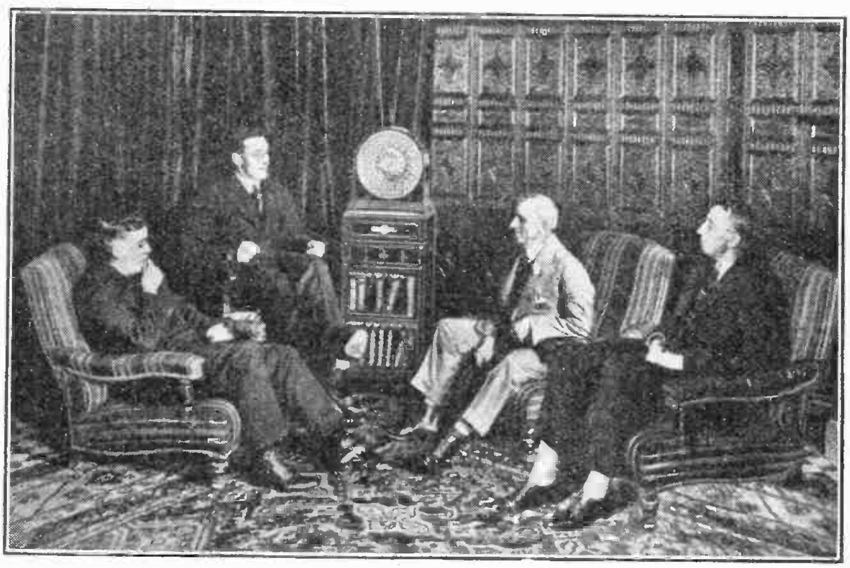
No Rush.

There is no great competition, I understand, for the job of programme director at Sydney.

oooo

Novels Before the Microphone.

Mr. A. E. W. Mason's novel, "At the Villa Rose," which was read before the microphone a few weeks ago, met with a good response. A new serial story, similarly prepared for broadcasting, is to be heard at the end of the month, this time from Daventry but not London.



AN ECHO OF THE TEST MATCH. Members of the Australian team listening to a broadcast programme in their private lounge at the Hotel Cecil. (Left to right) W. H. Ponsford, A. J. Richardson, Sydney Smith (Manager) and J. Ryder.

An Operatic Idea.

Another programme proposal under consideration is a sort of "Operatic Pot Pourri," the idea being to broadcast excerpts from famous operas, intermixed with brief accounts of each so as to give a complete picture of each opera.

oooo

Then and Now.

It is gratifying to know that the broadcast receiver manufacturers exhibiting at the National Radio Exhibition, Olympia, are hitching their wagon to a star in the matter of instrument design and appearance. Gone are the days when a broadcast receiver resembled anything from a coffin to a Noah's Ark, when everything, so to speak, was hanging on by the eyebrows, and a cough from a visitor wrecked the exposed valves or sent the grid leak flying into the bottomless depths.

oooo

Broadcast Receivers and Wireless Sets.

The examples we shall see at Olympia will, I imagine, go to demonstrate the world of difference which can exist between a broadcast receiver and a mere wireless set. The latter can still consist of any old junk capable of responding to a "sig.," but a broadcast receiver must at least be an instrument.

The arrival of the all-enclosed broadcast receiver, in a handsome cabinet, is probably welcomed most of all by the feminine listener, and by all those whose thankless task it is to keep rooms tidy.

oooo

Filling Up the Blanks.

Many little stunts have been devised for indicating to listeners that the broadcasting station is still alive during intervals in the programme. In London we have the clever improvisations on the pianoforte by Mr. Hely Hutchinson; on the Continent they are rather fond of a sonorous gong. The Berlin station officials, however, have adopted a new method, viz., clock ticks, which can be heard very clearly throughout one of those long pauses to which our Continental friends are so addicted.

It is suggested that the system be adopted over here; but I fancy that a good many people in this country already listen "on tick."

oooo

Broadcasting and the Gramophone.

In the early days of broadcasting fears were expressed in certain quarters that the new form of entertainment would oust the gramophone from the homes of the million. Experience has now shown that broadcasting and the gramophone are close allies, the frequent transmission of gramophone records proving a useful guide to those who like to choose their records with care.

The Sheffield station has, I see, issued an invitation to listeners to send in requests for the broadcasting of special records of any make. The gramophone transmissions take place on Monday, Wednesday and Friday mornings.

FUTURE FEATURES.

Sunday, August 29th.

LONDON.—Prize Band of Metropolitan Police Festival.
BIRMINGHAM.—Symphony Concert.
GLASGOW.—Band of H.M. Grenadier Guards.
MANCHESTER.—Chester Cathedral Quartet.
NEWCASTLE.—Astra Desmond, contralto.

Monday, August 30th.

LONDON.—Camille Couturier in a Musical Divertissement.
ABERDEEN.—"Dido and Aeneas," an Opera by Purcell.
BOURNEMOUTH. — Popular Overtures, relayed from Winter Gardens.
BELFAST.—Variety Programme.

Tuesday, August 31st.

LONDON.—The Kutcher Quartet.
BIRMINGHAM.—Scenes from Popular Operas.
BELFAST.—Arnold Trowell, 'cello.
CARDIFF.—"Gwen," a Play by M. Tydfil Richards.
MANCHESTER.—Symphony Concert.
NEWCASTLE.—Parry Jones, tenor.

Wednesday, September 1st.

LONDON.—Musical Comedy Programme.
ABERDEEN.—"Radiance," a Gleam by J. Vaughan Emmett.
GLASGOW.—Besses o' th' Barn Band.
LEEDS-BRADFORD.—Russian Programme.
MANCHESTER. — Buxton Gardens Night.

Thursday, September 2nd.

LONDON.—"Nerves," a Comedy in one act.
ABERDEEN.—Music Humour by the Station Orchestra.
BIRMINGHAM.—The Spirit of Carnival.
BELFAST.—"The Land of Heart's Desire," by W. B. Yeats.
NEWCASTLE.—"The Idol of Jade," Dramatic Sketch by John Wright.

Friday, September 3rd.

LONDON.—Symphony Concert conducted by Sir Hamilton Harty.
BIRMINGHAM.—"What He Won," by W. H. Williamson.

Saturday, September 4th.

LONDON.—Wireless Orchestra relayed from Olympia.
BOURNEMOUTH.—Louis Hertel, Entertainer.
CARDIFF.—Besses o' th' Barn Band.
GLASGOW.—Irish Programme.
MANCHESTER.—Variety Programme.

Three Choirs' Festival.

The B.B.C. will be able to broadcast the Three Choirs' Festival at Worcester for one day only this year, viz., Wednesday, September 8th. The soloists will be Miss Dorothy Silk and Mr. Robert Radford.

Sir Edward Elgar will himself conduct his "Variations for Orchestra," Opus 26, while a new work by W. H. Reed, conducted by that composer, will also be heard.

oooo

A Plymouth Programme.

Bernard Ross, the leading bass of the Carl Rosa Opera Company, is to broadcast from the Plymouth station this evening (Wednesday). Other artists include Renee Sweetland, solo pianoforte, from the Royal Academy of Music, and the Fulbrook Trio, who are very popular with West of England listeners.

oooo

Novel and Queer.

Something new in broadcasting will be tried on Friday, when an unusual transmission will be made from the Prince of Wales' Playhouse, Lewisham. It is hoped that the cinema audience will join with orchestra and vocalists in well-known songs, the words and music appearing on the screen.

Several popular pieces will be broadcast including that celebrated work, "Three Blind Mice."

oooo

Film Play by Wireless.

Another experiment, fixed for Monday, August 30th, will be the transmission from Manchester of a play founded on the film "The Greater Glory," adapted from Edith O'Shaughnessy's novel, "Viennese Medley." The experiment will be conducted by arrangement with First National Pictures, Ltd.

The description of the story-teller will take the place of sub-titles. Dialogue and sound effects will supply the "scenes," and a background of orchestral music, similar to that arranged for the film, will lend suitable emotional atmosphere. By this experiment the B.B.C. hopes to establish a method whereby listeners may visualise a film through the medium of sound.

oooo

Who Wouldn't be an Author?

Incidentally, if the experiment is successful, another avenue of wealth will be opened up to the successful author, who already reaps a harvest from book rights, film rights, American rights, serial rights, and if I am not mistaken, several other rights.

oooo

More Carillon Music.

Carillon recitals will be given by Mr. W. A. Jordan from the War Memorial Tower, Loughborough, on September 19 and 26. The two transmissions will be put out from Birmingham and the latter from 2LO and 5XX in addition. The approximate length of land line from the War Memorial Tower to the Birmingham Studio is 45 miles.

LOUD-SPEAKER EFFICIENCY.

Sources of Energy Loss and their Relative Importance.

By C. M. R. BALBI, A.M.I.E.E., A.C.G.I.

IT is perhaps not generally realised that only about one per cent. of the power that is put into a present-day loud-speaker, in the form of electrical energy, is converted into sound.

If we consider the effect that would be obtained by raising the efficiency to, say, 80 per cent., which is not an uncommon figure for electric motors and transformers, we should find that there would be ample volume when a loud-speaker was worked direct from a crystal set. The advantage of this is too manifest to require comment; therefore, it may well be asked why the efficiency of the modern loud-speaker should be so low, and what it is that is preventing it from being raised.

The answer to the question is not an easy one, as the contributory causes are many; however, we at least know what they are and can examine them one by one.

Losses Classified.

The first is *resistance*. Any circuit provided for the passage of an electric current has a resistance, which, when a current is passed through it, causes some of the energy to be converted into heat. By using copper for the conductor, which is one of the best metals for this purpose, we are able to reduce this loss to a minimum.

The second is *hysteresis*. When any particle of iron is undergoing a variation of flux it offers a resistance to this change; so, as in the case of a loud-speaker, where there is a rapid and continual variation of flux in both the diaphragm and the pole pieces, there is much loss which cannot be avoided.

The third is *eddy currents*. A fluctuating current induces a current in any adjacent circuit. Such circuits are formed by the pole pieces on which the windings are mounted, and the diaphragm, so that currents are sent circulating in these members which are finally dissipated in the form of heat.

Some attempt is generally made to avoid excessive loss in this direction by laminating the pole pieces.

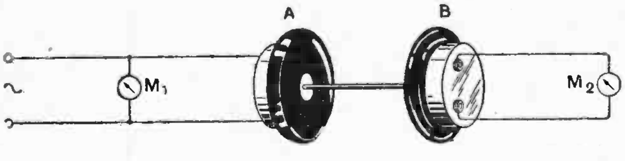


Fig. 1.—Illustrating a method of investigating the efficiency of loud-speaker movements.

The fourth is the *mechanical loss in the diaphragm*. If a perfectly elastic body could be found it would be possible to bend or deform it without any loss of energy, but as there is no material which approaches this state, mechanical energy is lost every time the diaphragm is moved.

The fifth is *the acoustic loss in the receiver*. The movement of air within the case gives rise to a certain amount of friction between the air and the sides of the chamber resulting in a loss; also the movement of air gives rise to a movement in the case in unison with it; therefore, some of the sound produced is converted into mechanical energy, which is dissipated as in the case of the diaphragm.

The sixth is *the acoustic loss in the horn*. This loss is analogous to that which takes place in the case and consists of a mechanical and frictional loss, which is dissipated as heat. To make a complete survey of the subject it is not sufficient to make a qualitative analysis of the losses as in the preceding manner, but we must go on to obtain quantitative results if possible.

This part of the problem is an exceptionally difficult one, as measurements have to be made where only very small amounts of power are available, and where the frequencies are of a relatively high order; therefore, any experiment that will dissect the losses into two or more components, which then can be analysed separately, is of considerable value.

Such an experiment has been devised to differentiate the electrical and mechanical losses from the acoustic.

Two identical loud-speakers of a well-known make were coupled together by means of a short rod, as shown in Fig. 1. The diaphragm has been taken out and a bar put across the poles, which had been provided for the units so that they could be used to operate a hornless loud-speaker if required.

The loud-speaker unit A was connected to a powerful wireless set which was capable of giving an output of about $\frac{1}{10}$ of a watt. Across the set was connected a wattmeter M_1, while the unit B was connected to a wattmeter M_2. Now, if an impulse is given to the cross bar in unit A by a current through the windings, the movement will cause the rod to move in sympathy and cause the other cross bar in unit B to move also. This impulse will cause an electromagnetic variation to take place, and induce a current in the winding of B which can be read on the meter.

The readings of M_1 represent the output from the wireless set, and the energy that will reach the loud-speaking unit A will be equal to this amount, but here a loss of energy will take place, and the amount it will deliver to unit B *via* the rod will be equivalent to the reading M_1 times the efficiency, which we will call X. As we have already seen, the mechanical energy produced will be transformed electromagnetically in unit B, but again a loss of energy will take place, and if the efficiency of unit B is the same as that of unit A, which it should be, as they are of identical construction, the energy that will reach the meter M_2 will be $(M_1 \times X)\ X$, which is equal to M_1X^2.

Now, in an experiment it was found that when the meter M_1 read 90 milliwatts, the meter M_2 read 5 mW., and from these figures we may deduce the mechanical

Loud-speaker Efficiency.—
and electrical efficiency (X) of the separate units from the formula

$$M_1X^2 = M_2.$$

Substituting, $90\,X^2 = 5$

$$\therefore X = \sqrt{\frac{5}{90}} = \sqrt{\frac{1}{18}} = 0.24.$$

Therefore, efficiency = 24 per cent.

From this we see that the mechanical and electrical loss must be 76 per cent. Now, as has been previously stated, the overall efficiency of a loud-speaker is about 1 per cent. This figure has been established by Dr. A. E. Kennelly and other well-known experimenters, so as the process by which the conclusion is reached is very complicated, we will take it as being so.

We know that if the mechanical and electrical loss is 76 per cent., and the overall efficiency is 1 per cent., then the acoustic loss must be 23 per cent.

We have now enough data to give a preliminary analysis in the form of Fig. 2; here the output (1 per cent.) in the form of sound is compared with the acoustic loss (23 per cent.) and the mechanical and electrical loss (76 per cent.). Tabulating, we get :—

1 per cent. = overall efficiency.

76 per cent. = resistance, eddy currents, hysteresis, and mechanical loss.

23 per cent. = acoustic loss in base and acoustic loss in horn

Can these figures be subdivided further to show us the other losses? Yes, they can, but in many cases these are very difficult to measure or calculate. The first we will take is a very easy one: it is resistance.

The ohmic resistance of the loud-speaker on test was 2,000 ohms. When the input was 90 milliwarts, as before, the current (R.M.S. value) was 4 milliamps.

The loss, therefore, is C^2R, which is equal to

$$0.004 \times 0.004 \times 2{,}000 \times 1{,}000 \text{ milliwatts}$$
$$= 32 \text{ milliwatts.}$$

Therefore, the percentage of loss attributable to the resistance is

$$\frac{32 \times 100}{90} = 36 \text{ per cent.}$$

By substracting 36 from 76 (the combined mechanical and electrical losses) we are left with the eddy current, hysteresis, and mechanical loss.

Attempts were made to measure the mechanical loss by measuring the decrement of the amplitude of a vibration—with the diaphragm *in vacuo*, but it proved too difficult; therefore, the combined hysteresis and eddy current loss was calculated, many assumptions having to be made.

The calculations involved a rather heavy mathematical treatment and were therefore omitted. The results they gave were—

Hysteresis loss = 20 per cent.
Eddy Current loss = 8 per cent.

From which, by substraction, the mechanical loss is 12 per cent.

We now arrive at the point where the acoustic loss has to be dissociated. Fortunately, it is possible to do this by an experiment on the lines of the one previously described and shown in Fig. 2.

Instead of the two units A and B having cross-bars connected together by a short rod, the bars were removed and replaced by diaphragms.

The units were secured together by a short rubber tube, and therefore the coupling between the two diaphragms was an acoustic one instead of a mechanical one; that is to say, a movement of the diaphragm in unit A was communicated to the diaphragm of unit B by the compressions and rarefactions that took place in the intervening air passages.

Measurements taken in a similar way showed that for an input of 90 milliwatts the corresponding output from unit B was 1 milliwatt; therefore, the efficiency with this arrangement given by the same formula is found to be

$$M_1y^2 = M_2,$$

where y is the efficiency of either unit with the new arrangement.

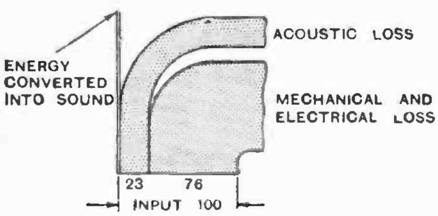


Fig. 2.

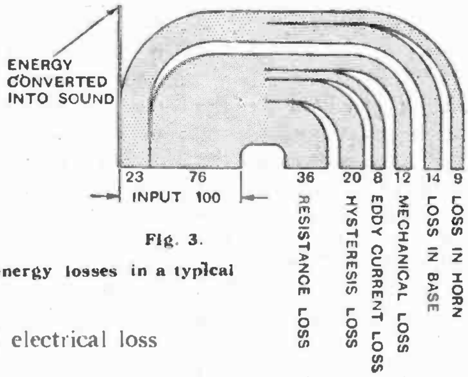


Fig. 3.

Graphical illustrations of the distribution of energy losses in a typical loud-speaker.

Equating we get

$$90y^2 = 1$$

$$y = \sqrt{\frac{1}{90}} = \sqrt{0.011}$$
$$= 0.105$$
$$= 10 \text{ per cent.};$$

therefore the acoustic loss in the base must be

$$100 - 10 - 76 = 14 \text{ per cent.},$$

and therefore the acoustic loss in the horn must be

$$10 - 1 = 9 \text{ per cent.},$$

hence we get the following tabulated results :—

	Per cent.
Overall efficiency	1
Resistance loss	36
Hysteresis loss	20
Eddy current loss	8
Mechanical loss	12
Acoustic loss in base	14
,, ,, ,, horn	9

If we express these graphically, as in Fig. 3, we see the extent of the losses better.

It must be understood that the results obtained are based on comparatively few tests, and as such may differ from what might have been obtained if extensive tests and more elaborate precautions had been taken, but figures at least serve to indicate what we may expect.

Very little can be done to reduce these losses with the

Loud-speaker Efficiency.—

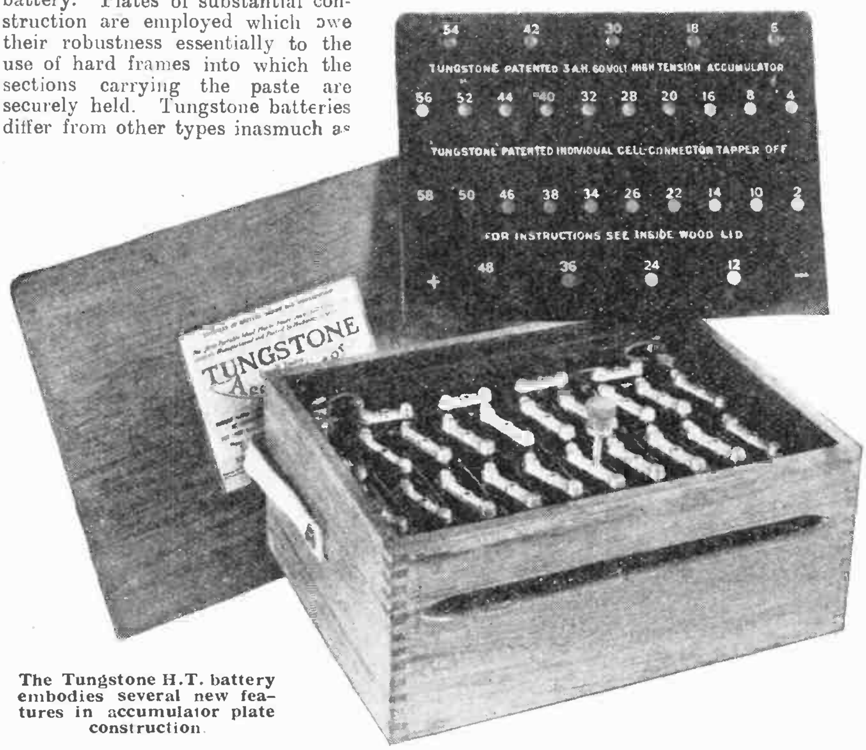
present form of design, but the time may come when some radical improvement will eliminate most of the losses shown. So little is known of the characteristics of any but the most conventional forms of loud-speaker, that it is very difficult to decide what principle is best adapted to give more efficient results, but it might be interesting to point out that a membrane controlled electrostatically would not have a resistance loss or an eddy current loss or hysteresis loss. However, the results given have so far proved very weak, so that it must not be imagined that better efficiency may be had for the asking.

NEW APPARATUS.

A Review of the Latest Products of the Manufacturers.

THE TUNGSTONE ACCUMULATOR.

The avoidance of separators such as wood, ebonite, or celluloid is one of the principal features in the construction of the cells of the Tungstone high-tension battery. Plates of substantial construction are employed which owe their robustness essentially to the use of hard frames into which the sections carrying the paste are securely held. Tungstone batteries differ from other types inasmuch as a frame form of construction is employed for making the plates.



The Tungstone H.T. battery embodies several new features in accumulator plate construction.

It would seem desirable from a mechanical standpoint that the plates of an accumulator should be made from pure lead, though insufficient mechanical strength is obtainable by so doing, and antimony is usually alloyed with the lead to stiffen the plates. In order that the active material may be carried by metal sections of pure lead, a hard antimonial alloy frame is used into which the paste-carrying sections are firmly clamped.

The plates are die-cast and the manufacturers claim that a new process is employed by which holes and spongy portions in the lead are eliminated. A longer life should be obtainable from plates constructed in this manner, as they possess a stiffness and rigidity that will effectively prevent buckling and expanding, while the paste probably adheres better to the pure lead frames than to grids of antimonial alloy. The cells of this battery give a capacity of 3 ampere hours, though, owing to the specialised construction of the plates, they are somewhat smaller in size than those used in many other cells of similar capacity. Each cell carries a pair of plates; the boxes are of glass with indiarubber external separators between the cells and stand upon an indiarubber mat.

Many H.T. accumulator batteries owing to the design of the cover plates and vents, are particularly messy. The Tungstone battery has been found to remain clean in use, and spacing between the cells eliminates corrosion to a big extent. An additional cover is provided, indicating the potentials obtainable by plugging in on to the connecting bars at any part of the battery.

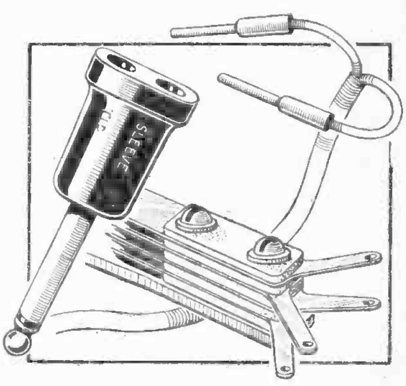
A teak box, with carrying strap, inspection window, and ebonite shrouded terminals are other features of the battery. It is supplied with a partial charge so that the process of a careful first charge is avoided, and, when filled with acid, will, with ordinary use, give a service of about a month, whilst, after a full charge, it is estimated that nearly six months' service is obtainable.

NEW ASHLEY PLUG AND JACK.

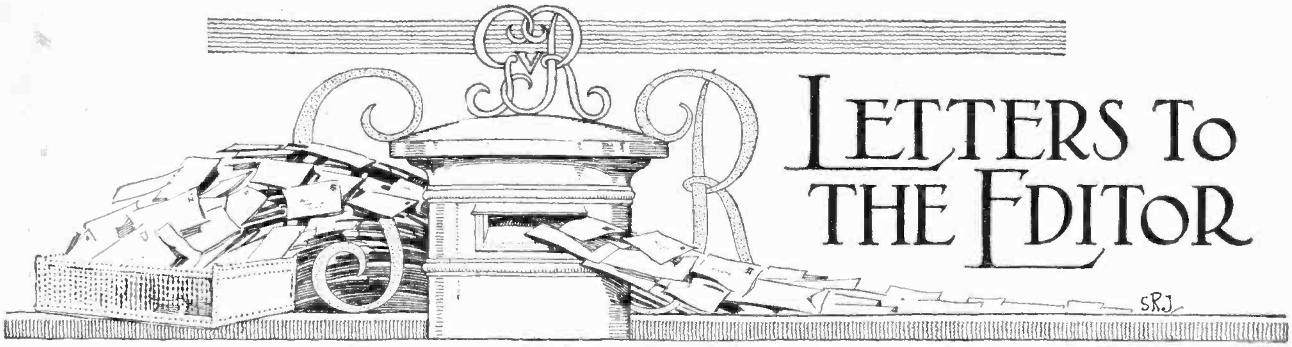
Several new features have been introduced into the range of jacks now manufactured by the Ashley Wireless Telephone Co. (1925), Ltd., Finch Place, Liverpool.

It is usually by no means easy to make the soldered connections to the tags of a multi-contact jack, and this difficulty is overcome by spreading out the tags in various directions so that they are well spaced. The jacks are made of brass, heavily nickel-plated, and the insulating pieces are of genuine Bakelite. The contacts are of nickel silver and silver, and the assembly of the jack is particularly rigid. A spacing washer is supplied to permit of the use of the jack with panels of various thickness and they can, in fact, be secured to panels varying from $\frac{1}{8}$in. to $\frac{3}{8}$in.

The new type plug is extremely neat and will take the pin tags of either loud-speaker or telephone cords, which are attached merely by pressing between spring contacts. The body of the plug is of Bakelite; no screws are used in its construction, and attachment is made to it without the aid of a screwdriver.



Spread-out connecting tags on the new Ashley jacks greatly facilitate the making of soldered connections.



The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

THE NEW B.B.C. WAVELENGTHS.

Sir,—From the table of proposed wavelengths for B.B.C. stations, it appears that Aberdeen and Birmingham are to work on 491.8 and 491.6 metres respectively, and if these figures are correct it would appear that the policy of catering exclusively for the crystal user is still being pursued.

For persons situated, as I am, midway between these two stations, it means that neither can be received, which is absurd.

I have more than a suspicion that at the present time some of the stations are a long way off their advertised wavelengths.

S. A. HUGHES.

Ballymoney, Co. Antrim.

COMMUNICATION ON LOW POWER.

Sir,—I read with interest the letters of Messrs. Exeter and Townend, and think that the idea as outlined by them for a series of tests by low power users is an exceptionally good one.

Mr. Allen (G6YW) has suggested the same thing in this month's issue of the "T. and R. Bulletin," and in view of the fact that increasing use is being made of very low powers, such tests, if made, would probably yield some very interesting data as regards the reliable ranges of such powers.

It is very difficult when using powers in the neighbourhood of three watts to establish contact with a distant station while so many comparatively high-powered transmitters with anything but sharp tuning are at work. The Continental transmitters, most of them unlicensed, seem to delight in making a very loud noise and calling CQ for long periods.

No difficulty should be experienced in obtaining a good number of low-power men to participate, but one naturally has doubts about some of the aforementioned Continental men being persuaded to shut down for a period, and here it may be mentioned, just two or three alternating current notes can play havoc with quite a number of pure C.W. stations of minute power, especially on a waveband of 2 metres, i.e., 44-46, even though the frequency band is comparatively wide.

May I suggest that, if arrangements can be made, that your excellent journal prints the schedule of the tests, and so reach a vast number of short-wave listeners both at home and abroad, who, judging from the numbers of reports I get on my own low-power transmissions, are real enthusiasts. Incidentally, reports are always acknowledged, whatever distance they are sent from.

W. HARTLEY (G6YR).

Follifoot, nr. Harrogate.

Sir,—I read with great interest the letters re low power tests. I am in entire agreement with your correspondents, and to that end have been testing for a considerable period with very low power. The results of my tests may be of interest to other low-power amateur transmitters.

These results are only given to show that the "low-power man" can get a "look-in"; records are not claimed. It may be said that only two-way working tests are given. Although a 500 v. generator was available, it was decided not to use it, as, human nature being what it is, it would be easy to "turn up the wick" if signals were reported QRZ, so two 60-volt batteries were commissioned for H.T.

Tests were commenced in April, 1926, on 45 metres, with a power of 2 watts input, and in every case this power was used for establishing and maintaining communication, and up to the present month 98 stations have been worked, the greatest distance being 1,800 miles. Contact could always be established at first call over a distance of 350-500 miles, and it was found that signals reported R6-7 at this distance were always reported only just readable at 100 miles.

Curiously enough, on nights when it was thought that signals would be very strong no stations were worked, although the post would bring some QSL cards a few days after the test. I had eleven blank nights during May, June and July. On those nights signals from other stations were received very strongly, and not much fading was observed. However, many interesting data were obtained *re* weather conditions, etc.

Writing of QSL cards brings me to my "moan" (and perhaps I do not moan alone). I am not a QSL hunter, but one likes to have a confirmation of a test, even if only to show that the other fellow's call sign was not "poached." I have acknowledged the 90 odd stations I have worked on 45 metres, but have only received 50 per cent. in return; perhaps some have gone astray—anyway, I like to think so. The QSL cards sent by receiving station are acknowledged if they contain some information, but I really cannot afford to answer cards of this type:—"Ur sigs rcd OK OM pse QSL bi crd."

Just one other "moan." I have received lots of cards with only a halfpenny for postage, and I have had to pay excess postage in each case.

CLIFFORD W. TITHERINGTON (G5MU).

Moigne Combe, nr. Dorchester.

JAZZ v. THE CLASSICS.

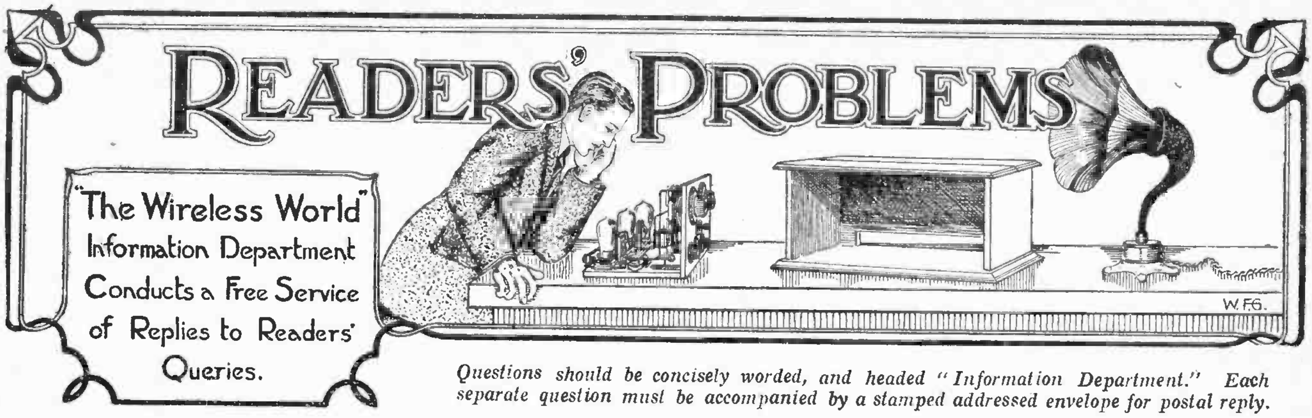
Sir,—I should be glad if you would allow me to correct an unfair and misleading statement issued recently by the British Broadcasting Co., following the broadcast debate "Classics *versus* Jazz," between Sir Landon Ronald and myself.

According to the B.B.C. the "actual voting (by letter) was, for classical 568, for jazz 172, indefinite 88. Consequently classical music is much more favoured than jazz."

Now, aside from the inconclusiveness of a poll of a few hundred out of a possible poll of some hundreds of thousands, the B.B.C.'s figures did not take into consideration the 623 letters which I personally received. Of these 545 were definitely in favour of so-called popular music, and 78 were either incoherently indefinite or violently abusive of me. Allowing, therefore, the 78 violently minded people who presumably prefer the gentler classics to what they wrongly call jazz to be counted with the "opposition," the amended poll is 717 for popular music and 646 for the "classics."

JACK HYLTON.

London; W.C.2.



Questions should be concisely worded, and headed "Information Department." Each separate question must be accompanied by a stamped addressed envelope for postal reply.

The Original Schnell Short-wave Receiver.

Can you give me the original Schnell short-wave receiver, which I understand has been adopted officially by the American navy? T. E. R.

The circuit to which you are referring is undoubtedly the one used by Mr. F. H. Schnell, President of the A.R.R.L., when he accompanied the American Fleet during the Pacific Manœuvres for the purpose of demonstrating the practicability of short wavelengths for reliable communication. The original receiver was intended to function chiefly on wavelengths below 100 metres, but Mr. F. H. Schnell has since given particulars of the values of coils necessary for tuning up to 400 metres, these being just published in the American magazine *Popular Radio*.

We reproduce the circuit diagram in Fig. 1. It will be noticed that a capacitatively coupled aerial circuit is used, whilst the variable condenser tuning the grid coil has a very low maximum value. The values of L_1 and L_2 to cover the wavelength are given below, and since these values were derived from a considerable amount of experimental work, they should be adhered to. The values are as follow:—

Wavelength Range.	L_1	L_2
Below 15 metres	1 turn	2 turns
15 to 26 ,,	3 ,,	3 ,,
23 to 45 ,,	6 ,,	4 ,,
35 to 70 ,,	10 ,,	5 ,,
58 to 113 ,,	19 ,,	6 ,,
110 to 220 ,,	38 ,,	10 ,,
200 to 400 ,,	75 ,,	20 ,,

The coils are wound in basket-weave formation, using a circle of 13 pegs and tied with thread, no other support being used. Ordinary bell wire was used for winding both coils, which are in fixed relationship to each other, the separate distance being 1in. Reaction control is, of course, provided by the 0.00025 mfd. variable condenser. It will be noticed that the values of grid condenser and leak are unusual.

It is most important that the correct value of H.T. be used on the detector valve if satisfaction is to be obtained from this receiver. The grid of the detector valve returns to L.T.+ *via* the grid leak in the normal manner. The L.F. portion of this receiver is, of course, perfectly conventional, but it is important to note that no fixed condenser must be put across the primary of the first transformer, or the receiver will be inoperative. This definitely rules out the possibility of using certain makes of L.F. transformer which have a fixed condenser in this position, built into the transformer.

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Using a Double-range Voltmeter.

I have mounted on the panel of my 4-valve receiver a double-range moving coil voltmeter for the purpose of taking the plate and filament voltage readings of each valve in my receiver in accordance with the diagram published in the "Hints and Tips" section of your journal for August 11th. When not actually taking a reading, must I leave the double-pole switch in the central position, thus disconnecting the meter, or can I leave it permanently across the H.T. or L.T. battery during the time the receiver is in use? S. E. C.

The current taken by a moderately-priced moving coil voltmeter is about 16 milliamperes for full-pole deflection. Now, if the meter is left connected to the L.T. side, this current will be drawn continuously from the accumulator, in addition to the current for lighting the valves. But even if all your four valves are of the 0.06 amp. type, the current taken by them continuously from the accumulator will be 240 milliamperes, and the extra 16 milliamperes will therefore be "lost" in the comparatively large filament current, and will not, therefore, necessitate more frequent recharging. The meter may, therefore, be left permanently over to the L.T. side without damage to either meter or accumulator. If left permanently over to the H.T. side, however, the 16 milliamperes would represent a very appreciable load on the H.T. battery, in addition to the normal load imposed by the plate current of the valves, and the battery would speedily be run down.

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Tins or Toroids?

I notice that in America a very large number of receivers embodying H.F. stages make use of the so-called "fieldless" or closed magnetic circuit coils in order to avoid direct pick-up from the local station. Is not this a more efficient way of tackling the problem than the use of screening boxes which appear to be prevalent in this country? T. G. B.

The use of "fieldless" coils undoubtedly gives a satisfactory solution to the problem of direct pick-up, and from this point of view they are fully equal to, if not better than, screening boxes. Unfortunately, however, the peculiar shape in which it is necessary to wind these coils in order to prevent them having any appreciable external magnetic field results in a very considerable increase in their H.F. resistance, consequently one often finds

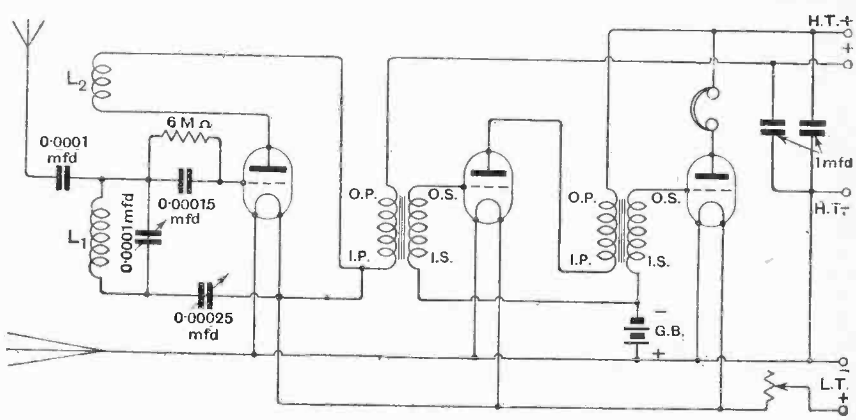

Fig. 1.—The original Schnell short-wave receiver.

that a receiver with two H.F. stages using this type of coil or transformer gives less actual amplification than a receiver employing only one H.F. stage in which a more conventional type of coil is used.

Of course, if the screening of coils is carried out improperly without regard to technical considerations, the result will be a great increase in the H.F. resistance of even the best-designed coil or transformer. In the first place, the screen must not be placed too near the windings, or a considerable damping effect and a great change in the natural wavelength of the coil will be experienced. The screening boxes should be constructed of the highest grade copper sheet in order to avoid losses due to the heating up of the metal box by eddy currents which would occur if the boxes were constructed of unsuitable metal. Needless to say, also, the boxes should be made in such a manner that there are no chinks or crevices through which direct pick-up can operate.

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Frequency and Wavelength.

I have read with great interest the article published in your August 4th issue, on "Frequency and Wavelength," and should be glad if you could give me a list of all the B.B.C. stations and also Radio Paris, with their wavelengths and corresponding frequencies, as I find these details rather tedious to work out from the formula published in your original article. P. L. H.

We publish herewith a list of these stations, with the particulars you require. Should you desire to have these particulars for any other foreign station, they may be readily ascertained by using the following formulæ in an intelligent manner. To ascertain the frequency when the wavelength is known use the following formula :—

$$\text{Frequency in kilocycles} = \frac{300{,}000}{\text{Wavelength in metres.}}$$

To ascertain wavelength when the frequency is known, the formula becomes :—

$$\text{Wavelength in metres} = \frac{300{,}000}{\text{Frequency in kilocycles.}}$$

Station.	Call Sign.	Wavelength in Metres.	Frequency in Kilocycles.
London	2LO	365	821.9
Daventry ..	5XX	1600	187.5
Bournemouth ..	6BM	386	772.0
Birmingham ..	5IT	479	626.3
Manchester ..	2ZY	378	476.1
Newcastle ..	5NO	404	742.5
Cardiff	5WA	353	849.8
Glasgow	5SC	422	710.9
Aberdeen ..	6BD	495	606.0
Belfast	2BE	440	681.8
Sheffield	6FL	306	980.3
Leeds	2LS	321	934.3
Bradford ..	2LS	310	967.7
Hull	6KH	335	895.5
Nottingham ..	5NG	326	920.2
Swansea	5SX	482	622.3
Plymouth ..	5PY	338	887.5
Stoke	6ST	301	996.6
Liverpool ..	6LV	331	966.7
Dundee	2DE	315	952.3
Edinburgh ..	2EH	328	914.6
Dublin	2RN	397	755.6
Radio Paris ..	CFR	1750	171.4

The Question of Grid Bias.

When a negative grid bias of, say, 6 volts is applied to the grid of an L.F. amplifying valve through the transformer secondary, I can well understand that if I apply 6 volts to the "I.S." terminal of the transformer secondary I get practically the full 6 volts on the grid, which is connected to the "O.S." terminal, because there will be only a very small potential drop across the transformer secondary, owing to its moderately low D.C. resistance. When applying the bias through a 1-megohm grid leak, however, as in the case of a resistance- or choke-coupled amplifier, surely there must be a big voltage drop across this large resistance, so that, in order to get 6 volts on the grid, a very big voltage indeed would have to be applied to the other end of the leak? S. B.

You are quite wrong in your assumption, and there is no voltage drop at all across the grid leak, nor is there the slightest voltage drop across the transformer secondary. A little thought will at once make this clear. We know that if we bias the grid negatively, no grid current will flow, and so no current will flow through the grid leak or transformer secondary. Now, Ohm's Law tells us that the voltage drop across any resistance is equal to the product of the resistance and the current flowing through it, the actual formula being $E = C \times R$, where E is expressed in volts, C in amperes, and R in ohms. By substitution we get $E = 0 \times 1{,}000{,}000$, for, of course, in order to apply the formula, the value of the 1-megohm leak must be expressed in ohms, and we know that the current flow is nil, by virtue of the fact that we have biased the grid negatively. Therefore, $E = 0$, and it is obvious that, no matter what the resistance of the grid leak or the transformer secondary, as the case may be, the voltage drop across it is nil. Since no volts are dropped across the resistance, therefore, it follows that, whatever voltage we apply to the bottom end of the grid leak or transformer secondary winding, will successfully reach the grid without loss.

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Correct Value of Shunting Condensers.

I am building a two-stage transformer coupled L.F. amplifier which I intend to be used after any type of receiver, including from an ordinary single valve reaction receiver up to a superheterodyne receiver, the receivers themselves possessing no L.F. stages. Can you tell me what should be the correct value of the condenser shunting the primary of the first transformer? P. M. S.

The purpose of this condenser is to bypass H.F. component of the current present in the anode circuit of the detector valve, since, of course, when coupled to a receiver the transformer primary will be connected in the plate circuit of the detector valve of that set. The condenser must be sufficiently large to offer a low impedance path of escape to this H.F. current. Since the impedance of a condenser is inversely proportioned to the frequency, or, in other words, the higher wavelength, the greater will the capacity of this condenser have to be. On the broadcasting wavelengths a capacity of 0.0005 mfd. is ample. Since most receivers have to cater also for the wavelength of Daventry and the long wave Continental stations, however, a value of 0.001 mfd. is usually advocated in order to embrace all these wavelengths.

In the case of a superheterodyne, the intermediate wavelength may be anything between 2,000 and 10,000 metres, and since we have got to make frequency for shunting away the comparatively low frequency corresponding to this wavelength, it follows that our shunting condenser must be considerably larger than 0.001 mfd., and the value usually lies between 0.002 mfd. and 0.003 mfd., according to the intermediate wavelength used. It would be incorrect, however, for you to put in a permanent condenser of this later value, since, of course, such a big value does have the effect of shunting away a certain proportion of the higher musical frequencies, which is a prolific cause of distortion in many superheterodynes employing a very long intermediate wavelength. In order to avoid distortion, the value of this condenser should be as small as possible compatible with the band of wavelengths being received.

The capacity in parallel with the inductance of the primary winding forms a closed oscillatory circuit. The possibility of resonance in the primary cirsuit should, therefore, be taken into account in fixing the value of the shunting condenser.

Since your amplifier is intended to be suitable for attaching to all types of receivers, you are therefore advised to make use of a plug-in type of fixed condenser in this position, such as is sold by Messrs. Peto Scott, Ltd., Messrs. L. McMichael, Ltd., and many other firms. You can then plug in the appropriate value of condenser according to the wavelength being dealt with.