The Design of H.F. Amplifiers—By W. James (See Page 273)

MODERN WIRELESS

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Edited by
NORMAN EDWARDS
M.I.R.E., M.R.S.L., F.R.G.S.

Vol. VIII. No. 9. SEPTEMBER, 1927.

The "LONG-RANGE" FIVE

CONTENTS

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The Reduction in Valve Prices—American S.W. Transmissions—B.B.C. Pronunciation.
By the EDITOR.

MR. J. Y. FLETCHER, who is the chairman of the British Radio Manufacturers' Association, recently explained the reasons for the reduction in the price of valves lately announced.

In future 8s. bright-emitter valves will cost 5s., 14s. dull-emitter valves 10s. 6d., and 18s. 6d. dull-emitter valves 12s. 6d. The reasons for this reduction, Mr. Fletcher stated, were threefold. In the first place, the cost of manufacture had fallen to a small, but not very material, extent; secondly, British manufacturers had to contend with valves made in countries where the cost of production and wages were less than in this country; and, lastly, it was to encourage the million crystal-set owners in Britain to use valves, which would give them far better results.

Still Too Dear

It is estimated that the total annual market for valves here is about 4,000,000, of which at least 1,500,000 are imported. "We hope," said Mr. Fletcher, "that the reductions will induce listeners to give some preference to English-made valves, incidentally finding employment for British labour."

Mr. Fletcher pointed out that the valve manufacturers of Great Britain spent a great deal of time, money, and effort on research work and experiment, testing and rejection, with the result that perhaps only 75 per cent. of their actual output was put on the market. As a consequence, however, he believed that British valves, both for receiving and of the water-cooled transmission type, were the best in the world. The lives of British valves were very much longer than those of similar cheap foreign types. One such foreign valve with a filament voltage of 3·7 volts had a useful life, on test, of 220 hours, whereas a British valve of the same type was going strong after 1,000 hours.

"Personally I would agree that valves are still too dear," added Mr. Fletcher. "As the cost of production goes down and the number of valves in use increases, it will be the policy of the association, persistently and consistently, to bring prices within range of everybody's pocket. Mass production in the true sense of the term has not yet been attained in the valve industry. Continual improvements and changes in design are being effected, and the product cannot be said yet to be standardised. We are, however, all working for standardisation, aiming eventually at mass production and consequently still lower prices."

On the Short Waves

THE American stations 2 X A D on 22·02 metres and 2 X A F on 32·77 metres are usually so well received in London that correspondents say they can tune them in without earth or aerial on two-valve sets. 2 X A D is usually to be heard on Mondays, Wednesdays, and Fridays from 11 p.m. (British summer time). 2 X A F is working on other nights and on Sunday mornings from 12.40. At the latter transmissions the times of short-wave transmissions are given out. The station with the lower wave-length is the more constant of the two. 2 X A F is usually well received when it is dark in both countries at 3 o'clock in the morning, but fades rather badly when it is daylight at either the receiving or transmitting end. When this happens 2 X A D can generally be tuned in quite well.

K D K A can be heard on 64 metres. This is, however, rather a difficult station to hear these days. K D K A is best received when there is little light between the transmitter and the receiver.

"English As She Is Spoken"

THE B.B.C continues to "tell the world" how to pronounce certain English words. Whatever the value of the recommendations made, they do at least serve as a means of creating controversy. "English as she is spoken" always puzzles a foreigner, and some of the following examples will, no doubt, puzzle Englishmen.

A word which seems to have given the B.B.C. Advisory Committee more trouble than any other is "golf" What is to be done about "goff" for "golf"? asks Mr. James, but he fails to answer that vital question! Some of the recommendations of the committee are:

Aerial.—First syllable of noun to be pronounced "air," the adjective to be "aieerial." Aeroplane.—First syllable to be pronounced "air." The use of the term "airplane" advised. Amateur.—Ammaterr. Aspirant.—Accent on second syllable, which rhymes with spire. Bedizen.—Second syllable to rhyme with horizon. Caoutchouc.—Cowchook. Celtic.—First letter pronounced as "s." The "k" pronunciation is recommended for Wales. Dail.—To rhyme with "oil." Falcon.—Fawk(on). Fauteuil.—Fotil. February.—First "r" is often omitted. The committee recommend it should be pronounced. Lute.—Lewt. Pianoforte.—Final "e" should always be pronounced. Soviet.—Accent on first syllable, long "o." Valet.—"t" to be pronounced.

FACTS ABOUT SHORT WAVE TRANSMISSIONS

Some reliable information concerning some of the more popular American short-wave broadcasters.

By R. W. HALLOWS, M.A.

IF you ask the next half-dozen short-wave enthusiasts that you meet to tell you exactly what K D K A's wave-length is, it is quite likely that you will receive as many different replies; each of them may, in fact, "prove" the truth of the figure that he gives by showing it to you in print in some publication or other. Within the last few days I have actually seen it stated variously as 58·79 metres, 62 metres, 63 metres, 63·6 metres, and 65 metres. 2 X A F's wave-length, again, has been given lately in different papers as 32·02 metres, 32·77 metres and 32·79 metres, whilst W L W's ranges in various tables from 50 metres to 53·03 metres.

Station.	Place.	W/L Metres.	Sunday.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.
K D K A (1)	E.Pittsburg U.S.A.	62·00	— 5 a.m.	11 p.m.– 5 a.m.	11 p.m.– 5 a.m.	11 p.m. 5 a.m.	11 p.m.– 5 a.m.	11 p.m.– 5 a.m.	11 p.m.– 5 a.m.
W L W (2)	Cincinnati, U.S.A.	52·02	9 p.m.– 3 a.m.	9 p.m.– 3 a.m.	9 p.m.– 3 a.m.	9 p.m.– 5.30 a.m.	9 p.m.– 5.30 a.m.	—	11.55p.m.– 3 a.m.
2 X A F (3)	Schenectady,U.S.A.	32·77	—	—	11 p.m.– 3 a.m.	—	11 p.m.– 3 a.m.	—	11.45p.m.– 3 a.m.
P C J J	Eindhoven, Holland	30·02	—	—	6 p.m.– 9 p.m.	—	6 p.m.– 9 p.m.	—	Often works during evening
2 X A D (3)	Schenectady,U.S.A.	22·02	Midnight– 2 a.m.	11 p.m.– 12.30 a.m.	10 p.m.– 11 p.m.	11 p.m.– 3 a.m.		11 p.m.– 3 p.m.	
K D K A (4)	E.Pittsburg U.S.A.	14·00	—	11 p.m.– 5 a.m.	11 p.m.– 5 a.m.	11 p.m.– 5 a.m.	11 p.m.– 5 a.m.	11 p.m.– 5 a.m.	11 p.m.– 5 a.m.

All Times British Summer Time.

(1) Often closes down 2–3 a.m. Power varies a good deal.
(2) Usually best after midnight, but sometimes strong early in evening.
(3) Sometimes begins before advertised hour.
(4) Transmissions on 14 metres take place during practically all K D K A's regular programmes. May sometimes be heard much earlier.

Official Details

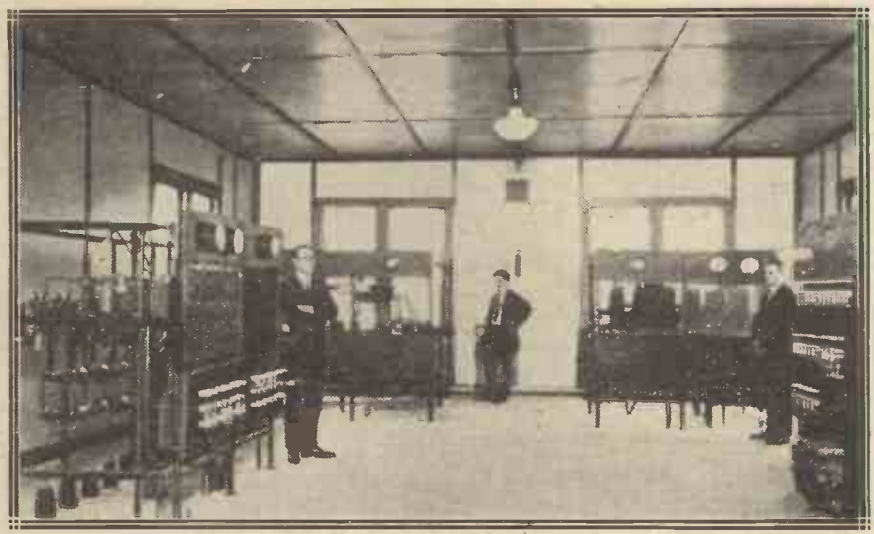
In view of these conflicting figures, the soundest method seemed to be to write to each short-wave station which conducts regular broadcasts, asking its director to give the official figures. The results of these inquiries are embodied in the table given above, which also shows the times during which the short-wave relaying is conducted from the various stations.

It is interesting to note that when K D K A is not coming in strongly on 62 metres the transmission may often be heard quite well on its third harmonic, that is upon 20·6 metres. During July, when the 62-metre transmission was very difficult to receive on most nights, and suffered from extraordinarily bad fading effects, the harmonic was nearly always receivable at good strength, and with much less fading. This harmonic has been heard by enthusiasts in many parts of the country. Many have formed the idea that the 20·6 metres transmission is a deliberate relay of K D K A, but the station itself states that no such transmission is made and verifies the fact that the harmonic is widely heard. Though K D K A states that the 14-metre transmitter is used during practically all the station's regular programmes, it did not appear to be in operation during the month of July, for I did not hear it on one single occasion, and others who tried for it with their short-wave sets had the same experience.

Other Stations

In addition to the stations already mentioned there are several others which conduct frequent though not

(*Continued on page* 312)



The transmitting room at K D K A, one of the pioneer, and still one of the most popular, American short-wave broadcasting stations.

The LONG-RANGE FIVE

Designed and described by W. JAMES.

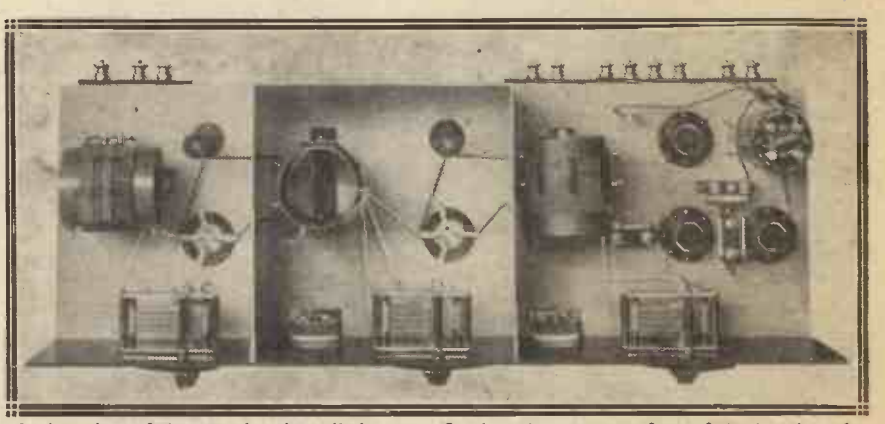
Full constructional details of a magnificent receiver which works excellently with 2-volt valves, and has an extraordinarily wide loud-speaker range, even in broad daylight.

UNTIL quite recently it used to be thought wellnigh impossible to construct a receiver which would be easy to tune and yet unfailingly bring in the distant stations.

Straightforward Design

Sets designed for long-distance work in the past all too frequently were found hard to make and difficult to tune. Upkeep costs were rather heavy, and quite often certain desirable features were sacrificed in order to provide the necessary sensitivity. But nowadays, thanks to the vast amount of research work which has been carried out, it is possible for the average man to build a set capable of receiving most of the European stations with an ease which a year or two ago would have been thought little short of marvellous. Naturally, the different designers have tackled the various problems encountered in different ways, and it may be as well to indicate briefly what to me appear to be the most important features.

First of all I place ease of construction. To my mind, it is of vital importance so to design the receiver that the average man can build it and obtain results with it of the same high standard as the designer does with the original. In other words, the design must be so prepared that there is nothing of a freaky nature about it. The results must be obtained by a skilful balancing of the parts used,



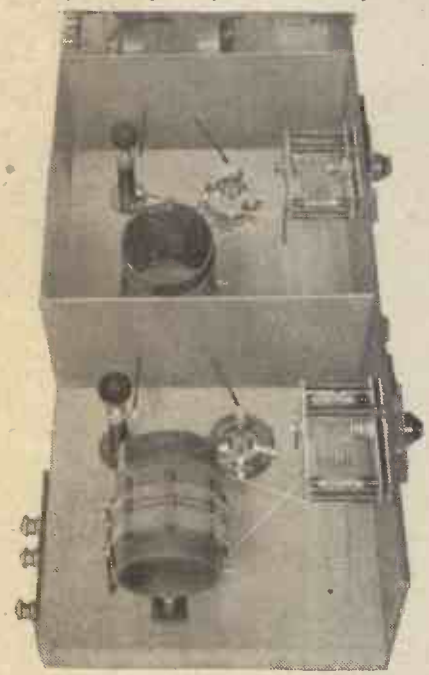
A plan view of the set, showing all the parts fixed to the upper surface of the baseboard.

STATIONS RECEIVED IN ONE TEST—ALL AT FULL LOUD-SPEAKER STRENGTH

Station.	W/L	1	2	3
Vienna	517·2	8·8	88·5	89
Brussels	508·5	8·7	87·5	88·5
Aberdeen	500	86	87	78
Bournemouth	491·8	85	86	86
Langenberg	468·8	82	83	83
Barcelona	462	81	82	82
Stockholm	454·5	80	81	81
Rome	450	79	80	81
Bilbao	434·8	77	77	78
Frankfurt	428·6	75	77	77
Bern	411·0	72	74	74
Glasgow	405·4	71	73	73
Plymouth	400	70	72·5	73
Hamburg	396	69	71	72
Toulouse	392	68	70	72
Manchester	384·9	67·5	68·5	70
Stuttgart	379·7	67·5	67·5	69
Madrid	375	67	67·5	68
Oslo (Bergen)	370·4	64	67	67·5
Leipzig	365·8	62	65·5	67
London	361·4	61	65	66
Prague	348·9	60	62	63 5
Barcelona	344·8	59	60	62
Naples	333·3	57·5	58	59
Birmingham	326·1	55	55·5	57
Breslau	315·8	52	53	54
Newcastle	312·5	51	52	53
Belfast	306·1	49	51	52
Nuremberg	303	49	50	52
Relays	297	47	48	49
Lyons	291·3	44	45	47
Dortmund	283	42	42	44
Nottingham	275·2	39	41	42
Dantzig	272·7	39	40	42
Toulouse	258	34	34·5	35·5
Bradford	252·1	30·5	32	35
Gleitwitz	250	29	30	35
Munster	241·9	26	28	31
Belgrade	225·6	20	23	28
Toulouse (Harmonic)	195	0	7	15

and there must be nothing in the set which demands an element of good fortune, either in its construction or in operation.

Next to ease of construction I place simplicity of operation, and in this connection I have no use whatever for anything which requires tricky tuning. My aim is always to



A close-up of the aerial-grid H.F. Transformer and its circuit, and the complete high-frequency stage.

produce a set having controls of such a simple nature that it is necessary merely to turn them to certain positions for definite stations to be heard if they are working.

The receiver illustrated here, for instance, has three tuning condensers; two of them tune fairly sharply, while the third one tunes broadly. Thus tuning is a relatively simple matter. No self-oscillations are produced, and the set does not squeal or howl at any point over the whole tuning range. Adjustable reaction is not used at all, and the set's very high sensitivity is entirely due to the design of the parts used.

The third important feature, to my mind, is the provision of an adequate volume control—a control which will cut down the strength of the local station without distortion to pleasing loud-speaker volume. This last point is all the more important because most sets, even those expressly designed for long-distance reception, are used for listening to the local station for the greater part of the time.

IMPORTANT NOTE.

The Long-Range Five has been specially designed for the lower broadcasting band of wavelengths and cannot be used for the reception of 5 XX, etc.

The receiver should, therefore, be one which gives the finest quality on the local station.

Following my usual practice I do not provide a low-frequency volume control—but so design the low-frequency amplifier that it gives the required loud-speaker reproduction with a certain input to the detector, and so arrange the high-frequency amplifier that incoming signals are brought up to this strength.

Reference to the schematic diagram, Fig. 1, will make clear the essentials of the receiver. There are two high-frequency stages, V_1, V_2, followed by a valve detector, V_3, and two low-frequency stages, V_4 and V_5. Transformer high-frequency couplings are employed with transformers, T_1, T_2 and T_3. These are tuned by condensers C_1, C_2, and C_3.

The first transformer, T_1, has a primary with connections at A_1 and

COMPONENTS REQUIRED.

As this receiver has two stages of balanced H.F. amplification it is essential to adhere to the specification.

- **1 Radion panel, 30 in. × 7 in.**
- **1 baseboard, 30 in. × 10 in. × ½ in.**
- **3 ·0005-mfd. S.L.F. tuning condensers. (Eureka.)**
- **3 slow-motion dials. (Ormond Engineering Co.)**
- **1 ·0002-mfd. T.C.C. fixed condenser with grid-leak clips.**
- **1 ·0001-mfd. T.C.C. fixed condenser with two pairs of grid leak clips.**
- **1 ·001-mfd. T.C.C. series-parallel type with grid-leak clips.**
- **4 1-mfd. condensers, 300-volt type. (T.C.C. Lissen, Dubilier, etc.)**
- **1 2-mfd. condenser, 300-volt type. (T.C.C. Lissen, Dubilier, etc.)**
- **2 ·5-megohm grid leaks. (Ediswan.)**
- **1 1·0 megohm. (Ediswan.)**
- **1 3·0 megohm. (Ediswan.)**
- **1 50-ohm filament resistance. } Igranic-Pacent, Lissen, etc.**
- **1 5-ohm filament resistance. } Igranic-Pacent, Lissen, etc.**
- **2 valve holders. (Bowyer-Lowe.)**
- **3 valve holders. (Anti-Pong, Sterling Electric Co.)**
- **2 balancing condensers. (McMichael.)**
- **3 special H.F. transformers with bases. (Messrs. Wright & Weaire, Ltd., 740, High Road, Tottenham.)**
- **1 Concert Grand L.F. transformer. (Eureka.)**
- **1 dry cell, T type. (Siemens.)**
- **1 16·5-volt tapped battery. (Siemens.)**

Metal for screen.

- **1 special cabinet with battery compartment; this is provided with a recessed back for the screen. (Unica Cabinet Co., 73, Campden Street, N.W.1.)**
- **1 set of valves as specified.**
- **1 set of terminals as specified. (Igranic Electric Co.)**
- **3 grid-battery plugs. (Lisenin Co.)**

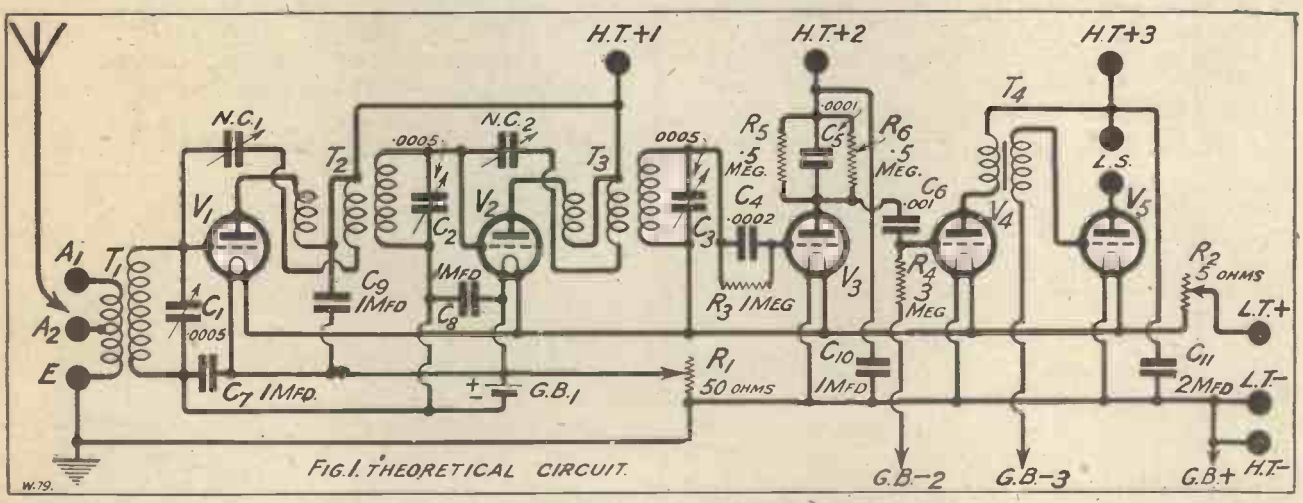


FIG. 1. THEORETICAL CIRCUIT.

Theoretical connections of the Long-Range Five. The following parts are used:—
T_1, T_2, T_3, Special High Frequency Transformers; T_4, Eureka Concert Grand L.F. Transformer; C_1, C_2, C_3, ·0005 mfd. S.L.F. Tuning Condensers; C_4, ·0002 mfd., C_5, ·0001 mfd., fitted with two pairs of grid-leak clips; C_6, ·001 mfd., series-parallel type, fitted with grid-leak clips; NC_1 and NC_2, balancing condensers; C_7, C_8, C_9, C_{10}, 1-mfd. Condensers; C_{11}, 2-mfd. Condenser; R_1, 50-ohm variable resistance; R_2, 5-ohm variable resistance; R_3, 1-megohm grid leak; R_4, 3-megohm grid leak; R_5 and R_6, 0·5 megohm grid leaks; GB_1, single dry cell; GB_2 and GB_3, 16·5-volt grid battery.

A_2 for the aerial; E is for the earth. The secondary of this is connected to the grid of V_1 and to the filament through a grid-bias battery, GB, of negative 1·5 volts. Condenser C_7 shunts the battery and the resistance R_1. Connected to the anode of V_1 is the primary winding of the double-wound transformer T_2, the second primary being connected to the balancing condenser, NC_1. Its secondary is joined to the grid of V_2 and the grid-bias battery GB_1, by-pass condenser C_8 being provided. Transformer T_3 is connected between valve V_2 and the detector in the usual way.

Efficient H.F. Amplification

The three transformers used are of the type specially developed by the writer for high-frequency amplifiers covering the wave-length range of 200 to 600 metres. They have secondary windings of 27/42 Litzendraht cable and are some of the finest transformers ever constructed for this purpose. The set relies for its very high efficiency upon these transformers, which have secondary resistances at 400 metres of only 2 ohms, giving a high-frequency amplification of about 35 per stage.

This compares with the more usual amplification of 8 to 12 given by high-frequency transformers wound with solid wire, measured at the same wave-length. Thus the high-frequency transformers used in this receiver are highly efficient and provide an extremely economical means of securing a high amplification. But to secure this high amplification it is necessary to take certain precautions—not only must the transformers be properly made, having primaries of No. 40 gauge wire, but really low-loss tuning condensers and valve holders must be used. It is also imperative to bias the high-frequency valves *negatively*. As regards selectivity, they are far more selective than solid wire transformers, and to apply reaction to them would immediately result in distortion. The resistance of the coils is so low, because of the careful design, that reaction is not required, and to use reaction would only add another adjustment without giving any corresponding advantage.

To prevent instability balancing windings are provided on the high-frequency transformers, and a metal screen is placed between them. Thus the high-frequency stages are more or less completely isolated, being divided into three parts, each with its transformer, tuning condenser, and valve. Further measures taken to ensure stability include the provision of by-pass condensers, C_7, C_8 and C_9, of one microfarad each, to carry high-frequency currents direct to the filaments of the valves, and it will be noticed that the three high-frequency transformers are placed in the same straight line, while the fields of the coils are mutually at right angles.

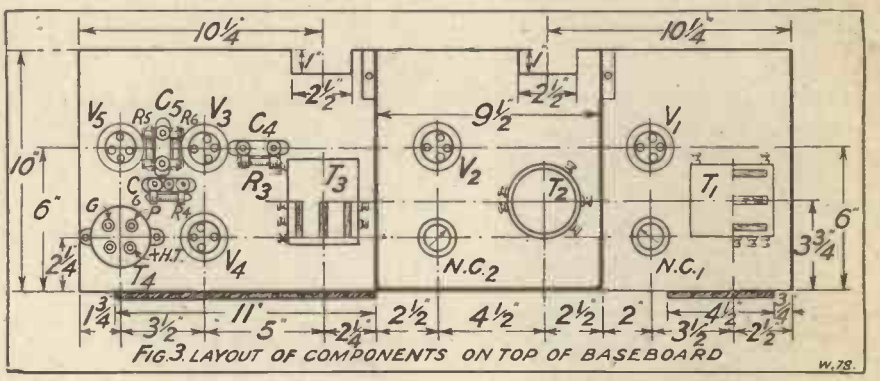


FIG. 3. LAYOUT OF COMPONENTS ON TOP OF BASEBOARD

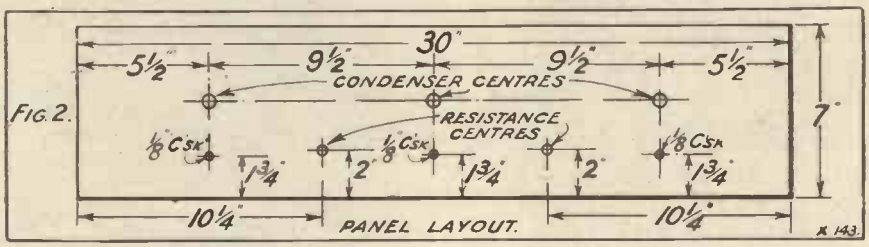
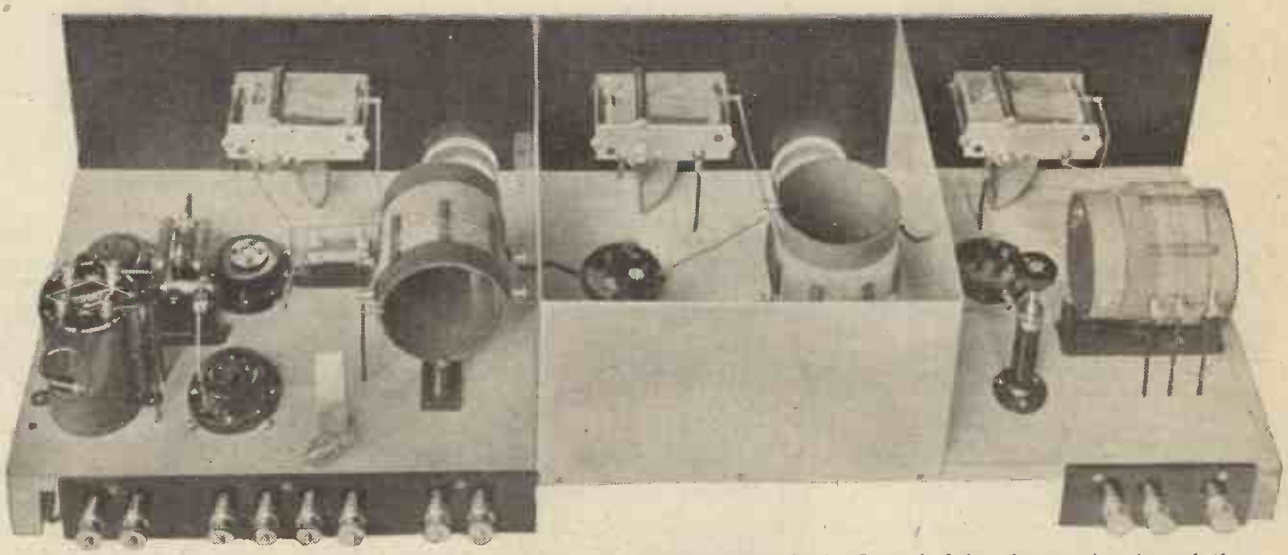


FIG. 2.

Perfectly Stable

This last point is, of course, most important, for if the coils are not properly arranged the stages will be magnetically coupled and instability will result.

The set as described is perfectly stable with 120 volts H.T. applied



Notice how the screen is arranged and fixed by screws to the back of the baseboard. Several of the wires passing through the baseboard can be seen in this view.

to the two high-frequency stages, provided, of course, that the balancing condensers NC_1 and NC_2 are properly set—and it is easy enough to do this.

Complete screening was not used in this receiver on account of its com-

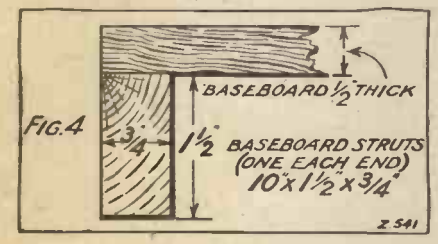


FIG. 4

plexity and cost, although the writer has described elsewhere a completely shielded five-valve set. The present five-valve receiver was made stable by carefully proportioning the coils and arranging them in the receiver, and it is quite essential to use the metal screen shown in the illustrations.

Operation of the Circuit

The high-frequency amplification is controlled by means of rheostat R_1 connected to the filaments of valves V_1 and V_2. As this is increased in value the filament current of the two valves is reduced; this has the effect of increasing the anode A.C. resistances of the two valves. The amplification therefore falls, because

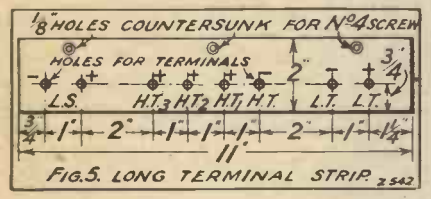


FIG. 5. LONG TERMINAL STRIP.

the amplification per stage for a given high-frequency transformer, and a valve of a fixed voltage factor, depends entirely on the valve's A.C. resistance. As this is increased, so the amplification given by the valve and transformer is reduced. This control is further assisted by connecting R_1 to the negative side of the filaments, so that the negative grid bias of the valves increases as the filaments are dimmed.

Referring now to the detector V_3, it will be noticed that grid-leak rectification is used. The values of the parts used are such that distortion is negligible; this is achieved by employing a relatively small condenser C_4 of ·0002 mfd. and a low value of grid-leak resistance R_3 of one megohm.

In the anode circuit two grid leaks, R_5 and R_6, of 0·5 megohm each are employed in parallel, giving a combined value of 0·25 megohm, and the by-pass condenser C_5 is of ·0001 mfd.

It should be noted that anode rectification can be used merely by disconnecting the end of the grid return from the positive side of the filament where it is joined at present, and connecting it to the grid-bias battery in order to give the grid a negative bias of 1½ or 3 volts. The grid condenser and leak may be short-circuited, although this is not strictly necessary.

The L.F. valve, being resistance coupled to the detector stage, has a mica coupling condenser C_6 of 0·001 mfd. and a grid leak R_4 of 3 megohms; this passes 70 per cent of the full amplification at 50 cycles, which experience shows is ample, because of the effect of the H.F. circuits in reducing the higher audio frequencies.

Valve V_4 is transformer coupled to the power stage by means of a transformer T_4 having a nice flat curve when used with the valves specified, and

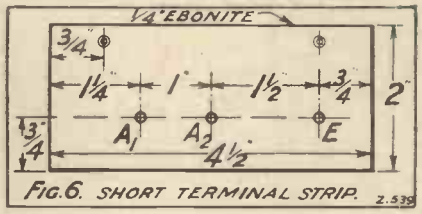


FIG. 6. SHORT TERMINAL STRIP. Z 539

negative grid bias is arranged in the usual way at GB_2 and GB_3.

To turn the set "on" and "off," a rheostat R_2 of low resistance is used. Thus the receiver has three tuning condensers mounted on the front panel, an "on" and "off" rheostat,


Note that the high-frequency circuits are well spaced and screened.

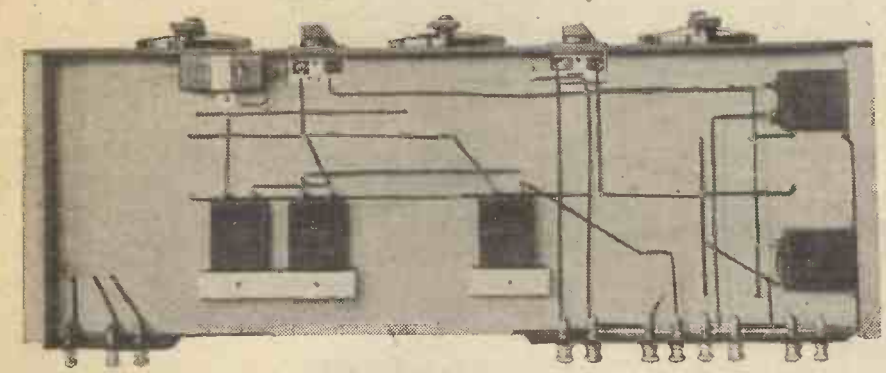
and a filament control rheostat. The selectivity can be varied by means of aerial taps A_1 and A_2, tap A_2 giving the better selectivity.

The construction is rather unique in that the transformers, valves, and tuning condensers are mounted on the upper side of the baseboard, while the by-pass condensers and terminals are mounted below the baseboard. This method of construction tends to simplicity and efficiency, and has been used by the writer on many occasions.

Constructional Details

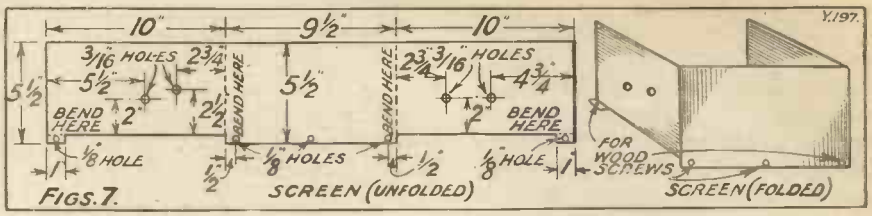
The views of the receiver showing the wiring serve to indicate its neat appearance. Actually all battery wires are below the baseboard, which leaves the important high-frequency wires and the low-frequency wires going to grid and anode plenty of clear space. The construction is therefore remarkably easy.

A front panel of Radion, measuring 30 in. by 7 in., is used, and on it are mounted the three tuning condensers and two rheostats; the rheostat on the right is R_2, of 5 ohms, while R_1, of 50 ohms, is on the left. The positions of these parts are shown in Figure 2. It may be necessary to drill further holes for vernier dials, but as this will


This illustration shows the by-pass condensers and the dry cell mounted on the underside of the baseboard, while the wiring is clearly seen.

depend upon the particular dials used, none are indicated.

Next, a baseboard of wood measuring 30 in. by 10 in. by ½ in. is prepared, and at each end a batten of wood 10 in. by 1½ in. by ¾ in. is screwed (Figure 4). On the back edge of the board two terminal strips of good ebonite are fixed; one of these strips, Figure 5, measures 11 in. by 2 in. by ¼ in., and has eight terminals, while the second strip, measuring 4½ in. by 2 in. by ¼ in. has three terminals. These terminal strips are illustrated in Figures 5 and 6.



FIGS. 7.

The illustrations show that the low-frequency part of the set is quite compact, but yet there is ample room for the parts. A Eureka Concert Grand transformer was put in the set after thorough tests were made with this component; it operates very well indeed.

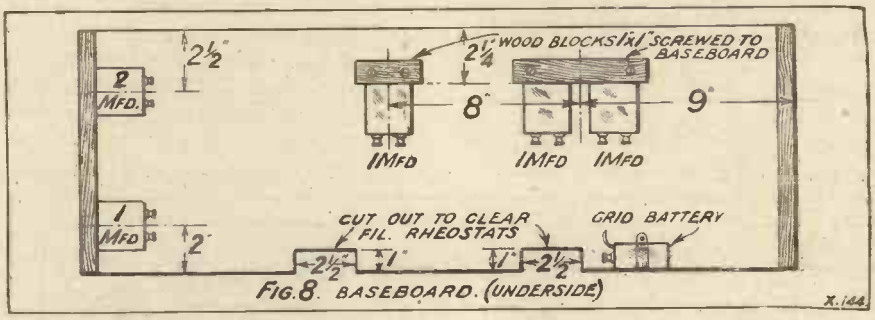


FIG. 8. BASEBOARD. (UNDERSIDE)

We now come to the metal screen. This is very easily made up from a piece of copper or aluminium measuring 29½ in. by 5½ in.; aluminium of gauge No. 20 is easily worked. Shape it as shown in Fig. 7 by marking with a scriber, when it will be found quite easy to break off the edges along the lines. Holes should be drilled for fixing screws and for the connecting wires, and then the sheet can be bent to the shape shown in Fig. 7. Reference to the photograph will make the matter clear.

All that remains to be done to finish

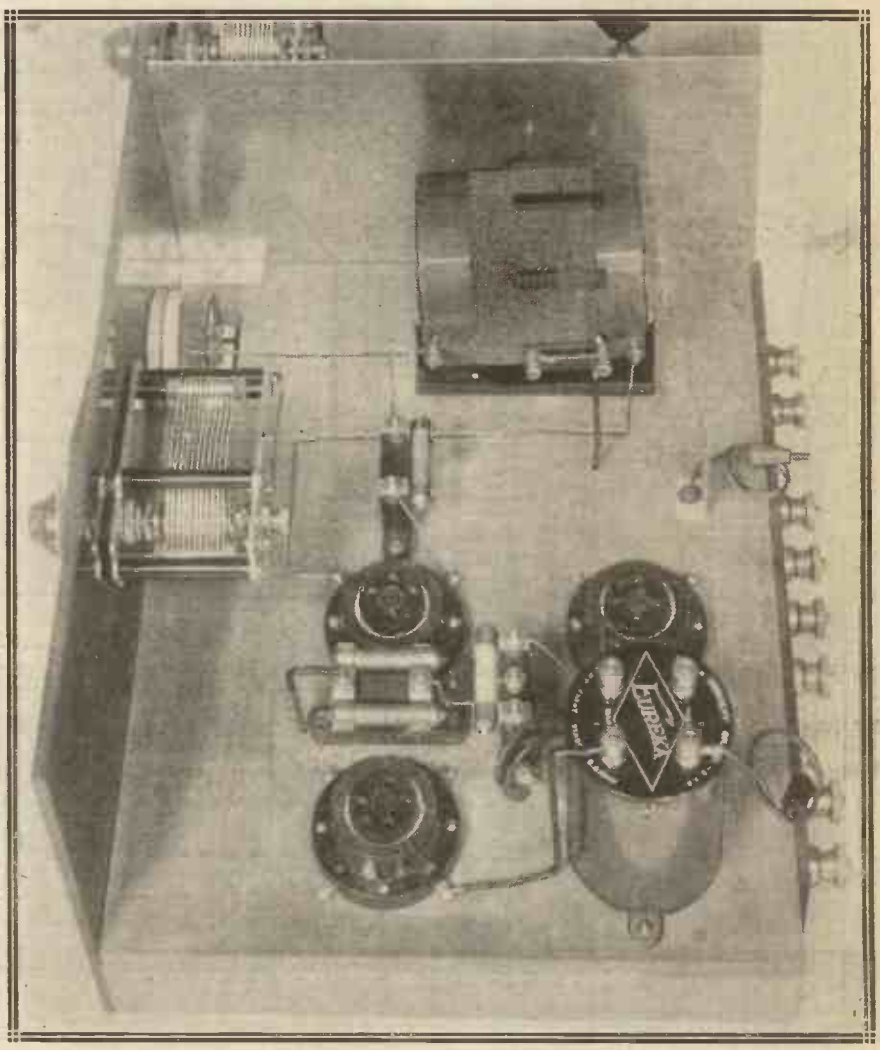
It is now necessary to fix the by-pass condensers to the under side of the baseboard. These condensers can be fixed, as shown in Figure 8, by screwing two additional short lengths of wood to the baseboard and fixing the 1-mfd. condensers to them; and a 1-mfd. and a 2-mfd. condenser are screwed to the end batten. It will also be noticed that a single dry cell is fixed to this side of the baseboard by means of a metal clip. This cell is a Siemen's, Type T.

The next step in the construction should be to cut out the two pieces in the front edge of the baseboard to clear the two rheostats. Having done this, we may turn the board over and screw down the valve holders. It should be noted that the two holders used for the H.F. valves are of Bowyer-Lowe make, for the reason that they have low losses, whilst the other three are of the cushioned type, these being desirable for the detector and L.F. valves.

Completing the Mounting

Also fix the two balancing condensers, the grid condenser and leak (one unit), the anode by-pass condenser (which is fitted with two pairs of clips to carry the two anode resistances in parallel) and the coupling condenser of 0·001 mfd., which is of the series-parallel type and carries grid-leak clips.

These condensers are all of T.C.C. manufacture, and the method of using them eliminates the cost of special grid-leak holders, saves wiring and space, and increases the efficiency.



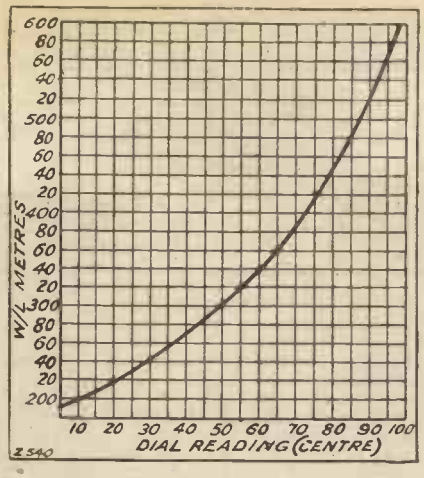
This view shows the low-frequency end of the set, with the detector and third H.F. transformer.

the assembly is to fix the three high-frequency transformers. These components were very carefully designed by the writer, and thousands of them are in use giving really good results; in fact, so much interest was aroused when first they were described, over twelve months ago, that the writer's original designs were extensively adopted by manufacturers, so much so that several manufacturers now market complete receivers with these transformers, the sets being built to the writer's published designs.

Special Coils

The making of them naturally calls for careful attention and the use of the best Litzendraht wire.

Special coils for this set are being made by Messrs, Wright & Weaire, Ltd., 740, High Road, Tottenham, N.17.



When the coils and their bases are obtained, mount them on the baseboard in the positions marked. As the three coils are of different construction no difficulty will be experienced in mounting them in their proper places. That on the left, looking over the front of the set, is the aerial coil; the one in the screen is T_2, which couples the first and second valves, while the last one is T_3, which couples V_2 to the detector.

With the parts assembled on the baseboard and panel, we can consider the wiring. First of all, it will be necessary to drill a number of holes through the baseboard to take connecting wires; the position of these

(Continued on page 312.)

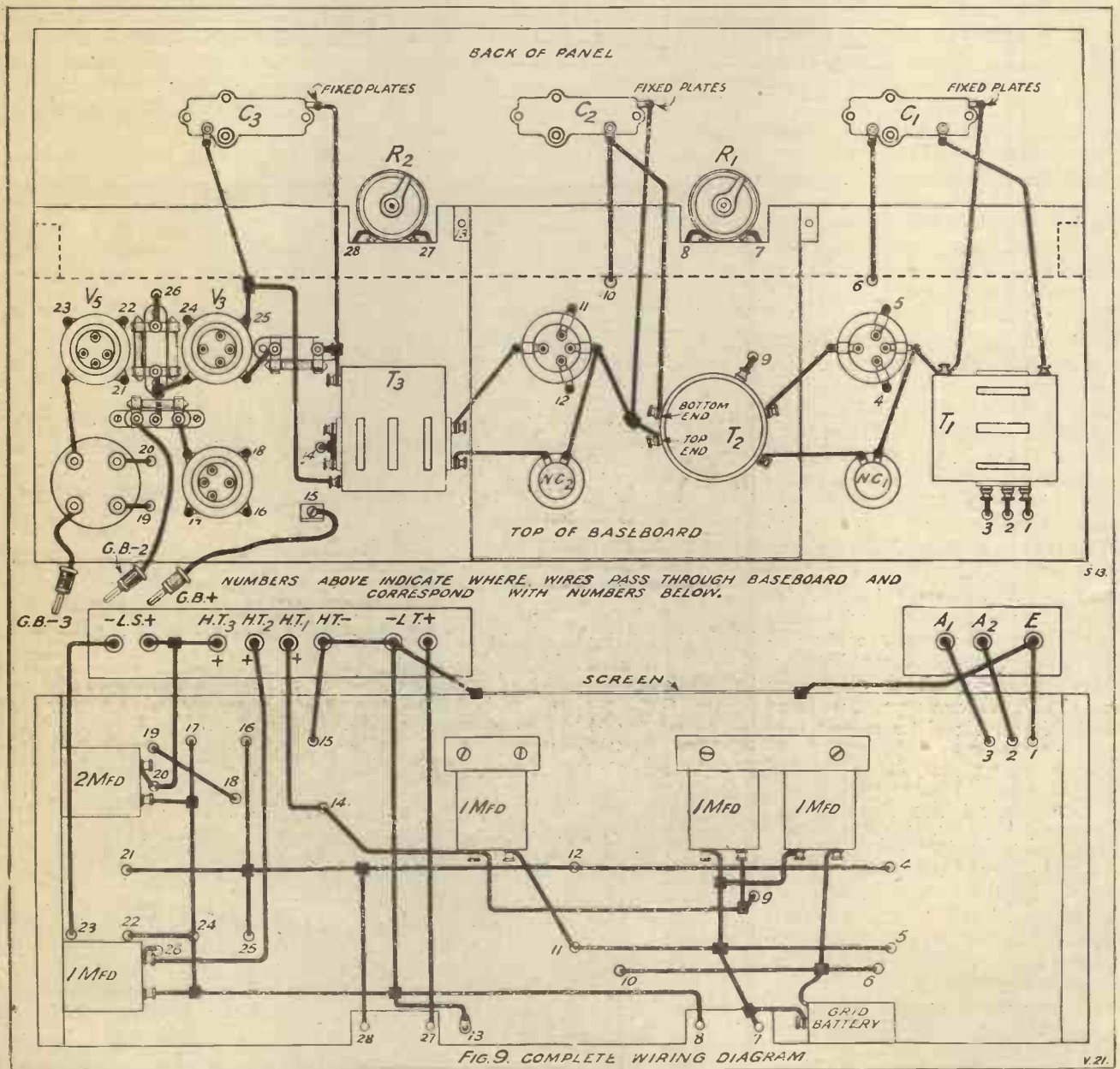


FIG. 9. COMPLETE WIRING DIAGRAM

The back of panel is shown in the upper portion; the centre shows the upper side of the baseboard, while the lower section shows the under side of the baseboard. (Wires which pass through holes are numbered.)

Some Interesting R.C. Experiments

An article of value to every experimenter. By ALLEN CARTER.

I RECENTLY carried out some experiments on resistance-capacity coupling in a small set consisting of a detector and two stages of L.F. The set was so arranged that either leaky-grid rectification or anode-bend rectification might be used, as desired, while the resistances both in the anode and grid circuits were all interchangeable, though it was chiefly intended for use with high resistances.

One or two rather curious results were obtained in the course of these experiments, and I felt that it would be of interest to other experimenters to give some details on this subject.

The circuit employed is shown in Fig. 1, and the experiments carried out were prompted by the fact that I was experiencing considerable trouble with distortion in this receiver when using resistances of values higher than those generally employed. In order to check up everything carefully, microammeters were inserted in the grid leads and milliammeters in the plate leads, as shown in Fig. 1.

The Valves Employed

The following types of valve were used, and for simplicity I have given each one a letter for reference. "A" was a valve with an impedance in the neighbourhood of 75,000 ohms and an amplification factor of about 40. "B" was a valve with an impedance of about 20,000 ohms and an amplification factor of about 20. "C" was a valve with an impedance of about 16,000 ohms and an amplification factor of about 13. "D" was a valve with an impedance of about 6,000 ohms and an amplification factor of about 7, and "E" was a valve with an impedance of about 4,000 ohms and an amplification factor of about 3·3. The H.T. voltage used on the L.F. valves was 120, and different values of grid bias were employed, according to the valves being used.

The experiments were carried out at a very short distance from 2 L O, using a very small, low aerial, actually under conditions far from ideal. It was, nevertheless, found that the H.F. signal voltage applied to the grid of the detector valve was in the neighbourhood of 5 or 6 volts.

In the first experiment two valves of high impedance were employed for V_1 and V_2, ordinary values of anode resistances being employed. The object of this experiment was to determine how much of the distortion might be due to overloading of the last valve. The first valve to be tried in the last position was of the usual small power type, namely type "D," and with this valve it was found that a swing of over 20 microamps was obtained in the grid circuit, while the milliammeter in the plate circuit showed a very large variation, kicking badly on high and loud notes.

A valve of type "E" was substituted for the one in use, and the maximum swing in the grid circuit was reduced to 6 or 7 microamps when using grid bias of 18 volts negative. With the value of R_3 equal to ·25 megohms a satisfactory degree of volume was obtained, while the purity, considering that a small amount of grid current was present, was of quite a high order.

Effect of More Bias

In view of the fact that the grid current might be due to grid choking on the last valve owing to R_5 having too high a value, the substitution of a lower value leak was tried. This almost entirely eliminated grid current, but it was found that the volume obtained from the receiver had dropped considerably, while the use of the lower value of leak had a definite effect in spoiling the quality

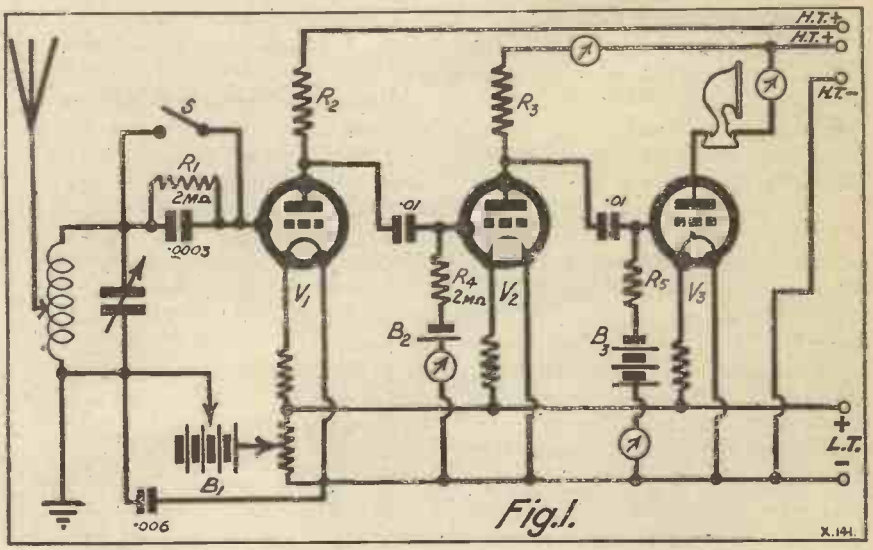


Fig. 1.

of the output. The low frequencies were specially affected and the quality of speech and music became thin and distorted.

Replacing the higher value of grid leak and increasing the value of grid bias was found to reduce the grid current obtained. With 24 to 27 volts negative on the grid of the last valve it was found that practically no grid current was obtained at all.

Under these circumstances, of course, the plate current on the last valve was considerably reduced, and it was found that a slight movement of the milliammeter needle was obtained, showing that lower-bend rectification was resulting.

Anode Bend v. Leaky Grid

When tested aurally, however, the quality obtained was exceedingly good.

The effect was then tried of removing the grid leak R_3 altogether, and under these circumstances extraordinarily good quality and volume were obtained. Notwithstanding the fact that the milliammeter needle was by no means steady no audible distortion was present, and it would appear that some automatic form of compensation came into play when the grid of the last L.F. valve was left entirely free.

Having made sure that the last valve in the receiver was working under the correct condition, I now turned my attention to the other end of the receiver and tried the effect of comparing leaky-grid condenser rectification as against anode bend. It did not take long to find out that leaky-grid condenser rectification was entirely unsuitable for use with this circuit, the drop in signal strength being extremely marked.

Contradictory Results

Several different valves were tried for the detector, but in every case the same results were obtained. It was actually found possible to obtain satisfactory results when using leaky-grid condenser rectification, but only when extra negative bias of 6 to 7½ volts was applied, by means of the grid battery, B_1. In view of the fact that this was the value required in order to obtain maximum signal strength when using anode-bend rectification, it would appear that the grid condenser and leak were not functioning in their usual manner.

The greatest signal strength was obtained when a valve of type "A" was employed as the detector, but when comparing this against one of type "B" some contradictory results were obtained.

We have often been told that when a high impedance is used in the plate circuit low frequencies will be amplified to a much greater degree than when a low impedance is used. It would therefore appear that when high resistances are used low tones will be amplified better than when low resistances are used.

Alteration in Pitch

In the case of the valve "A" this was actually found to be the case. With an anode resistance R_2 of 80,000 ohms the pitch of the output was decidedly higher than when a ·25-megohm resistance was employed, and this again was higher than when a 2-megohm resistance was used.

The best results were definitely obtained when R_2 was of 2 megohms and not 250,000 ohms, as recommended by the makers of the valve. When, however, the valve "A" was taken out and valve "C" inserted it was found that the pitch of

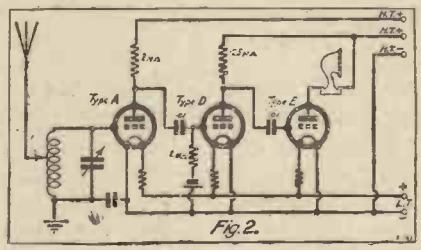


Fig. 2.

tone went up. Now, in changing these valves we have increased the ratio of the anode resistance to valve impedance and we would therefore expect the pitch of the output to be lower. Indeed, it was definitely proved that when using the valve "A" the pitch of the output was altered in conformation with this rule. Yet here was a case where the opposite was occurring, and this was confirmed definitely by repeated trials.

Raising Resistance Values

When using anode-bend rectification it was found that there was a definite upper limit to the value of the anode resistance R_2 according to the valve which was being employed. In the case of the valve "D," for instance, it was found that no improvement was to be obtained by raising the value of this resistance above ·25 of a megohm, and when comparing this value against 2 megohms no difference at all was noticed. In the case of the valve "A," however, the increasing of the anode resistance from ·25 to 2 megohms was accompanied by a marked increase in signal strength, while little difference was experienced when comparing a 2-megohm against a 5-megohm resistance in the anode circuit.

The next valve to be experimented with was V_2, the L.F. valve, and here again rather interesting results were obtained. Using a resistance of ·25 megohms for R_3, no difference in volume or pitch of the output was noticed when comparing a valve of the "B" type against one of the "D" type. When you compare the figures for these two types of valves it is hardly to be credited that no difference was noted in the performance between the two, for in the one case we have a valve with an amplification factor of 20 and the other one with an amplification factor of only 7.

On turning my back to the receiver and getting someone to put in these two valves alternately, I voted for the valve of the "D" type as first L.F. amplifier.

For Tone and Volume

When the valve "D" was compared against the valve "A" in this position very little difference was noted between the two, although the valve "A" certainly gave somewhat stronger signals. At the same time, however, this valve was much more easily overloaded than the other one, while it was found that 1½ volts grid bias was too much. Of course, with the other valve it was possible to use a far larger value of grid bias, and it was possible to apply a much larger grid swing without overloading the valve.

Fig. 2 shows a circuit which gave very excellent results, both as regards purity of tone and volume. A control has been eliminated and several components cut out, so that it presents certain advantages from the point of view of the initial outlay, while, working under the correct conditions with the right valves, very excellent quality is to be obtained from a receiver using this circuit.

I found that despite the fact that a lesser degree of amplification is obtained by the use of ordinary resistance-capacity valves (i.e. not the very high-mu type) and resistances in the neighbourhood of 100,000 ohms, the valves were, nevertheless, far less easily overloaded and distortion much less difficult to get rid of. With the high-mu valves and high anode resistances it was very difficult to get the needle of a milliammeter in the plate circuit to remain steady.

A Loud-speaker for Music Lovers

Pure reproduction and good volume characterise the loud speaker described in this article.

By A. E. GARLAND, M.B.E., F.I.C.

A PLEATED-PAPER loud speaker of the usual type, made from a Brown "A" headphone, employs a flat paper diaphragm, 12 in. in diameter, with ½-in. pleats, and has a centre of cork fixed with seccotine. Even under the best

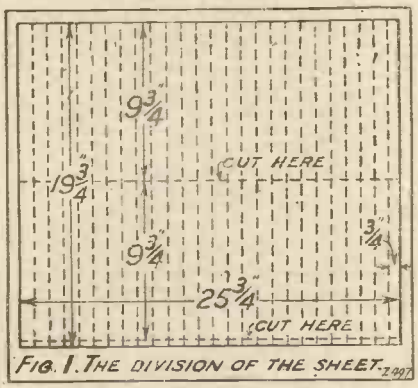


FIG. 1. THE DIVISION OF THE SHEET.

conditions, the results obtained with such loud speakers are no better than those which can be obtained from trade loud speakers. Owing to the relatively small size of the diaphragm the tone given by music is muffled. Moreover, a rigid centre-piece of this description does not allow for expansion of the paper, with the result that continual adjustment of the phone-magnets is required in a room of varying temperature.

Pure Reproduction

The writer, after spending much spare time last winter in making numerous experimental shapes and fittings of paper loud speakers, has produced a design which, for musical tone and volume, is superior to any other loud speaker heard by him. Speaking as one who has a keen appreciation of good music, he is confident that any reader who has sufficient patience and keenness for music to follow out the directions given below will be amply repaid, and will possess a loud speaker which will please a really critical musical taste. Possibly certain recent and expensive loud speakers, where the diaphragm is actuated by a coil instead of a reed, may or may not be equally good or better, but the important fact is that the results described in this paper can be obtained by anyone possessing a Brown "A" phone.

The loud speaker to be described, which is illustrated in Figs. 2 and 3, has a paper diaphragm of the usual flat form, nearly 20 in. in diameter, folded fan-wise into 1-in. pleats, and mounted very simply on a child's wooden hoop. Similar loud speakers with smaller diaphragms (say 16 in. in diameter) are found, in the experience of the writer and his friends, to give a distinctly poorer tone.

"Parchment" Paper

The pleasing resonance and well-damped overtones of transmitted piano music, as heard on loud speakers with the described 20-in. diaphragm, give the illusion that one is listening to a real piano; the rendering of orchestral music makes the listener feel as if he were sitting in the front row of the balcony at a symphony concert. Transmitted singing is fairly satisfactory, a baritone voice especially being heard to great advantage.

Transmitted speech has the effect, common to most speakers, of having been spoken down a tube, but it is quite clear and sufficiently natural for ordinary purposes. In the writer's experience, the best reproduction of speech from home-made paper loud speakers is given by conical forms, but reproduction of music has been found to be unsatisfactory. Finally, the adjustment of the phone magnets, when using the loud speaker under consideration, in a room of varying temperature, is infrequently required.

The paper diaphragm is made from a variety of paper called "imitation parchment," which can be bought at shops selling artists' materials, or those which specially advertise materials to be used for loud-speaker purposes. It is a variety of hardened paper, which has the toughness and stiffness required for efficient reproduction of sound.

Ordinary cartridge paper, owing to its soft texture, is relatively unsuitable. The paper is sold in sheets $25\frac{3}{4}$ in. by $19\frac{3}{4}$ in. A little more than one sheet is required to make a diaphragm, and this introduces some difficulty, as the paper has been found to vary in thickness. It is very necessary to see that both the sheets used for making the diaphragm are of similar thickness, since results will be entirely spoilt if portions of sheets differing markedly in thickness are used for the same job.

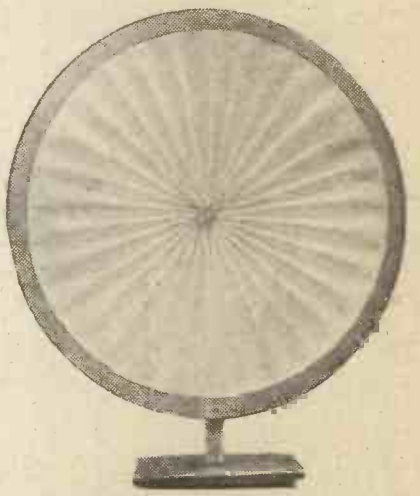


Fig. 2. The complete loud speaker, as built by the author of this article.

Dividing the Sheets

Comparing one diaphragm with another, it has been found that thicker sheets give a slightly greater volume of sound in the finished loud speaker, but are more difficult to manipulate in the making.

For making the diaphragm a hollow cylinder of paper is required, 60 in. in circumference, $9\frac{3}{4}$ in. high,

and 19¾ in. in diameter, i.e. a cylinder formed by joining together the ends of a strip of paper a little over 60 in. long and 9¾ in. wide.

It is obvious that this strip can be made conveniently by dividing one sheet of the paper lengthways into two portions, joining these together and adding a short length from the other sheet. Before cutting the sheets of paper, however, attention must be given to the following considerations. For guidance in making the 1-in. pleats the strip must be divided off uniformly by vertical pencil marks into divisions 1 in. in width.

Three Lengths Required

Suitable overlapping, i.e. ½ in., will be required at each join. It follows, therefore, that each strip must be divided in such a manner that the pencil divisions at both ends are ¾ in. in width, and the remainder are 1 in. in width.

For convenience, the whole sheet is ruled off in one operation. The plan followed is, first, to place the sheet lengthways on the table and to divide it off by vertical pencil lines at 1-in. intervals into 25 divisions of

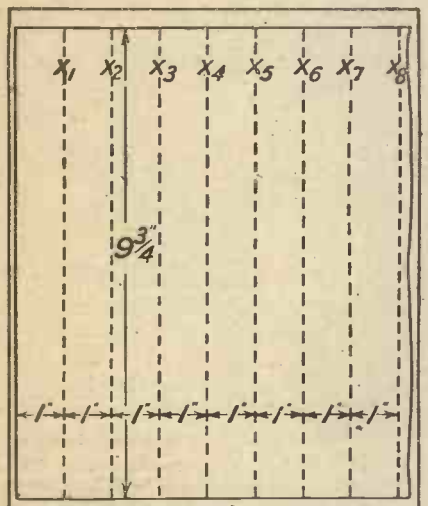


FIG. 4. THE MARKING OF THE STRIP.

1 in. in width, and one division, at the end, ¾ in. in width. Next, two pencil lines are drawn horizontally, parallel to the top edge of the paper, at distances 9¾ in. and 19½ in. respectively from the top.

These divide the paper into three divisions, two 25¾ in. by 9¾ in., and one narrow strip 25¾ in. by ¼ in. (Fig. 1). The paper is cut along the horizontal pencil lines so as to provide strips of these dimensions. The narrow strip is discarded.

The two strips are now placed together with the ¾-in. divisions overlapping, and are joined with seccotine to produce one strip 51 in. long. In making all joins, a minimum quantity of seccotine should be employed, smearing out evenly with a matchstick, since, by taking these precautions, the joins will dry quickly and without troublesome cockling.

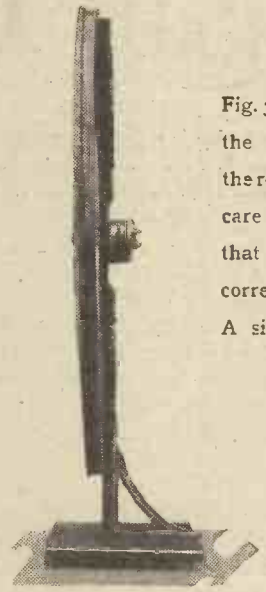


Fig. 3. When fixing the diaphragm to the reproducing unit care must be taken that everything is correctly centred. A side view of the speaker.

Another strip of paper, 12 in. by 9¾ in., is now cut from the second unused sheet of paper, and is divided off in the same way by vertical pencil lines into twelve divisions, 1 in. in width. It will be noted that both the prepared strips of paper are unsuitable to be joined together as regards the position of the vertical divisions and the amount of overlapping. To render them suitable, pieces of ¼ in. in width are removed from both ends of both sheets.

The Creasing Operation

The strips are then joined together to form one length 61 in. long, and it will be seen that this length is divided off uniformly into vertical pencilled divisions 1 in. in width, excepting the first and last, which are afterwards to be overlapped. For convenience, the pencil lines are now marked X_1, X_2, X_3, X_4, etc., at the top of the strip, and commencing from one end (Fig. 4).

This facilitates creasing, and is an identification mark for that edge of the sheet which it is intended shall form the centre of the diaphragm and which, as will be seen later, requires different treatment from that given to the paper near the opposite edge forming the periphery.

The next operation is the creasing of the paper along the lines X_1, X_2, X_3, X_4, etc., to form the pleats. It is most important that this should be carried out with a minimum of pressure and without any cracking of the paper except what is absolutely necessary at the extreme ends of the "concertina-ed" pleats which are to form the precise centre of the diaphragm.

The paper must not be pinched severely or sufficiently to cause cracking at a distance greater than ⅛ in. from the centre of the diaphragm. Cracking the paper destroys the resonant properties of the diaphragm. But it is obvious that pinching of the pleats at the central position is absolutely necessary in order that they may fit closely together into a hard, compact centre.

Alternate Folds

The operation of folding will prove a failure if it is attempted in a warm, dry room. The conditions recommended as suitable are those given by a room in which the atmosphere is kept moist by steam issuing from a kettle of boiling water. Also, before the folding of each pleat, the paper should be held for an instant in the steam from the kettle and passed through the steam along the line at which folding is to take place.

For ease in manipulation and in order to avoid pencil marks on the

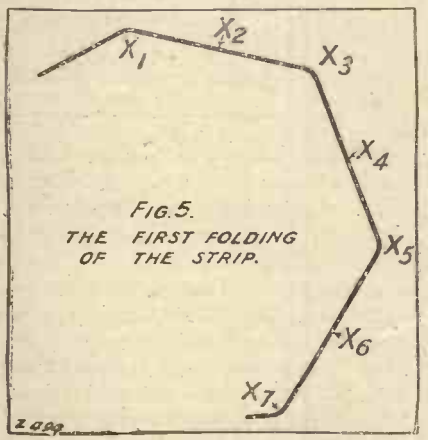


FIG. 5. THE FIRST FOLDING OF THE STRIP.

front face of the diaphragm, it will be found convenient to follow the method of creasing outlined below. It will be noted that, in using this method, creasing is carried out first at the positions of alternate lines, viz. X_1, X_3, X_5, X_7, etc. (Fig. 5). Creasing at all these positions is carried out similarly in the same direction, namely, by folding the paper in the direction towards the operator, who carefully observes the pencil lines which remain visible on the external edge of the fold.

The remaining X_2, X_4, X_6, X_8, etc. (Fig. 6), obviously must be made by folding in the opposite direction to that used for X_1, X_3, X_5,

etc., in order to form the pleats, and this is effected by reversing the position of the paper and folding in the same direction as for X_1, X_3, X_5, etc. No reference to pencil lines is made for the creasing at X_2, X_4, X_6, etc., as the method employed, which is very accurate, renders this unnecessary.

To carry out the folding, the strip of paper is held in a vertical position with the pencil-marked side facing the kettle, and the edge marked X_1, X_2 and X_3, etc., on the left-hand side.

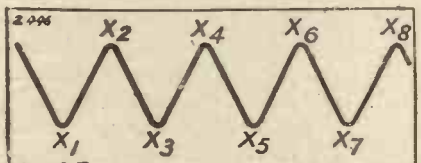


FIG. 6. THE FINAL FOLDING OF THE STRIP.

The remote surface of the strip is then held against the jet of steam along the line X.

The action of the steam softens the paper and assists folding by making the paper curl in the desired direction of folding, namely towards the operator. As indicated previously, creasing must be definitely and accurately made to the pencil marks on the extreme left-hand side, but must be made so gently that cracking is avoided.

Completion of the Cylinder

On the extreme right-hand, folding can with advantage amount to no more than a slight bending, just sufficient to assist the vanes in this (the outer) section of the finished diaphragm to assume a uniform position. The paper is creased in the same manner at alternative pencil lines, X_3, X_5, X_7, etc., using the jet of steam in each instance, until the whole strip has been so treated.

In order to complete the creases for the pleats, thirty foldings remain to be carried out at lines X_2, X_4, X_6, etc., in an opposite direction to the foldings at X_1, X_2, X_3, etc. This is conveniently effected by reversing the paper so that the marked side faces the operator, but the edge marked X_1, X_2, X_3, etc., is still on the left-hand side.

Pairs of adjacent creases at X_1, X_3; X_3, X_5; X_5, X_7, etc., are brought together in turn between the fingers and holding each pair, in turn, exactly over each other, the creases at X_2, X_4, X_6, etc., are pressed out symmetrically. Folding is assisted, as before, by steam playing on the side of the paper remote from the operator, and similar care is necessary as regards folding accurately, and varying the degree of folding from left to right.

The ends of the strip are now joined together, with the pencilled side inwards, so as to form a cylinder, and the flat diaphragm is made in the usual manner. For the benefit of those who have not made a paper diaphragm previously, it may be mentioned that the method consists in placing the paper cylinder in an upright position upon a smooth table, gathering together the upper ends of the pleats between the fingers, and pressing downwards.

Forming the Diaphragm

The pleats held in the fingers come together to form the centre of a disc, of which the periphery is formed by the unfolding of the lower ends of the same pleats. In making such a large diaphragm as one of 20-in. diameter the operator requires to use extreme care. He must take steps to ensure that the diaphragm produced has a tiny circular orifice at the centre, not more than $\frac{1}{4}$ in. in diameter (and preferably $\frac{3}{16}$ in. or less), that the edges of the pleats at the centre of the diaphragm are perfectly level on both sides and free from cracking except at the extreme centre, and that the periphery is free from splits.

The operation, in fact, must be carried out by a process of coaxing, pressing the paper downwards towards the table in a series of gentle pushes, watching to see that the vanes come together in a uniform manner, and pinching the pleats at the extreme centre. If the paper is of suitable thickness for the dimensions taken, and the operation has been carried out carefully, the final push downwards will cause the diaphragm to complete itself by springing into position.

Avoiding Distortion

It is then in a condition of tension that will cause it to spring upwards on being disturbed and released. If the strip has been formed of two different thicknesses of paper it will be found impossible to form the diaphragm without distortion, and if this distortion has produced an orifice at the centre greater than $\frac{1}{4}$ in. in diameter the diaphragm should be discarded.

On the other hand, when using thick paper it will be found that it is impossible to press out a diaphragm of the given dimensions without splitting. If a position, therefore, is reached during the pressing out where further coaxing obviously would be ineffective and might result in distortion or splitting, the situation is relieved by slightly reducing the width of the strip, i.e. taking off one or more narrow pieces (say 0·05 in. in width) from its inner edge.

The Wooden Frame

This naturally reduces the diameter of the disc and relieves the strain. If this process is accidentally overdone the resulting diaphragm will not be quite flat, but will show little puckers at the periphery. This fault does not appear to matter very much when using thick paper. The effect on a thin paper diaphragm, however, is not known. As stated previously, the important points are (1) a small central orifice, (2) edges of pleats even at centre, (3) folds uncracked.

The diaphragm must now be fixed by means of seccotine to a circular wooden frame which is slightly smaller in internal diameter than the diaphragm, i.e. for a diaphragm of $19\frac{3}{4}$ in. diameter $19\frac{1}{4}$ in. is employed. For this purpose a child's wooden hoop can be used successfully, and the most suitable hoop which can be purchased is about 22 in. in diameter.

Such hoops are made from strips of wood nailed together, and when cutting and rejoining to reduce to the correct size, one strip should be allowed to overlap the other by several inches at the join, and should be secured by two small screws. Hoops, after this treatment, are seldom circular, and a shape sufficiently approximating to circularity must be produced by fixing two small screws in the outer surface of the hoop at selected positions and stretching a piece of string across from one to the other under adjusted tension.


Fig. 7. The Brown "A" mechanism which is employed as the driving unit for the loud speaker. An extension piece is screwed into the reed portion of the unit.

A further drawback to the use of hoops for this purpose is that they

seldom lie exactly in one plane. Some are better than others in this respect, and discrimination should be used in purchasing. In order to avoid the trouble of adjusting a hoop to exact dimensions, a circular wooden sector about 1 in. wide can be used which is cut from a piece of perfectly flat three-ply wood.

Ensuring Rigidity

It will be found necessary, however, after mounting the diaphragm on the sector, to increase the rigidity of the latter in some way. This can be effected conveniently by screwing at the back a wooden hoop which, for this purpose, does not require to be absolutely circular.

In seccotining the diaphragm to the wooden frame care must be taken to avoid any strain that will produce distortion. The seccotined join has afterwards to take no particular strain, and it is only necessary, therefore, to rest the diaphragm in a natural position so that its edge overlaps the frame about $\frac{1}{8}$ in., and to apply seccotine to this portion of the diaphragm or hoop. If a plain hoop is used for mounting, the operation can be effected quite simply by allowing the hoop (which is approximately $\frac{1}{2}$ in. in width) to lie on the table with a little seccotine round its inner edge, pressing out the diaphragm upon the table (marked side downwards) and transferring it quickly so that its edge rests on the hoop.

This operation can be carried out best by using two pairs of hands, as it is difficult to manage singly. If the diaphragm is to be mounted on a braced wooden sector it must be so arranged that the centre of the diaphragm is supported in a natural position $\frac{1}{2}$ in. below the level of its seccotined edge. It is necessary to place small weights on the centre and outer edge of the diaphragm until the seccotine has dried.

The Brown A earphone is attached to the wooden frame by means of a wooden lath 1 in. by $\frac{1}{4}$ in., and 25 in. long. A circular hole is bored in the lath about $\frac{3}{8}$ in. in diameter, 10 in. from one end. The ebonite earpiece is attached to the lath by small screws driven through the holes in the earpiece so that the central hole of the earpiece is opposite the centre of the orifice in the lath.

The Reed Connection

The central hole of the earpiece is slightly enlarged to about $\frac{3}{16}$ in. diameter. The lath is strengthened by additional laths screwed on to the same side as that on which the earphone is fixed.

The connection of the earphone to the diaphragm is made by means of a piece of threaded 6 B.A. brass rod $2\frac{1}{2}$ in. long. The end of the brass rod which is to pass through the orifice in the earpiece is filed down symmetrically to about 10 B.A. size so as to avoid any possibility of its touching the earpiece. To this is soldered either the head of the small screw, which was removed from the 'phone with the aluminium diaphragm, or a piece of threaded 12 B.A. rod.

The total length of screw or 12 B.A. thread and filed rod should be about $\frac{3}{8}$ in. Contact with the diaphragm is made by means of two nuts and thin brass washers. The inner surfaces of the brass washers which rest against the paper diaphragm are each provided with a thin layer of rubber cut from a piece of cycle inner-tubing and fixed to the brass washers with Chatterton's compound.

This thin lining of rubber assists contact with the diaphragm and has also been found to improve greatly the tone produced by the loud speaker. Fig. 7 shows how the brass rod with nuts and washers is screwed into a 'phone which has been removed from its earpiece.

The final fitting of the earphone to the wooden frame carrying the diaphragm is made in the following manner. First, the 'phone is screwed firmly into the earpiece and the brass rod carrying the back nut and washer is passed through the orifice in the lath and screwed gently but firmly into the reed of the 'phone.

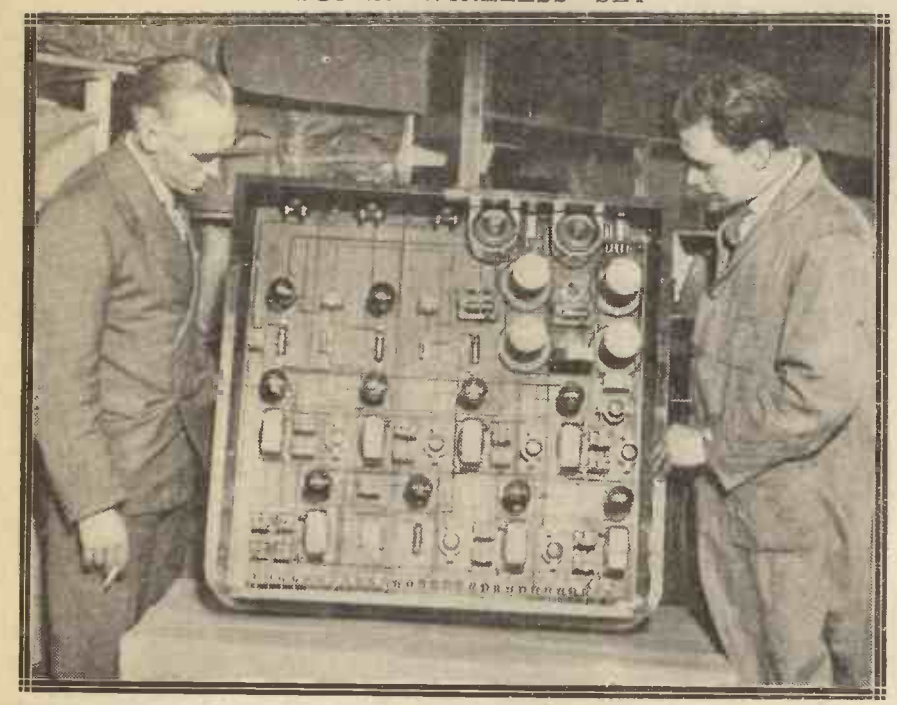
Finishing Off

The brass rod should project symmetrically from the earphone. Next, the lath carrying the earphone is placed carefully against the back of the wooden frame so that the brass rod passes symmetrically through the centre of the diaphragm without touching the paper edges, The lath is then firmly fixed to the wooden frame by means of screws which have been previously screwed into the lath at the correct positions, and the front nut and washer are placed on the projecting portion of the brass rod in front of the diaphragm. The lath carrying the diaphragm can now be fitted to a wooden stand by a strong angle iron, and the wooden stand provided with suitable rubber pads on its under surface.

The loud speaker, so completed, can be made quite attractive in appearance by giving the front of the wooden sector a coating of gold paint and by staining the stand, etc., with walnut water stain. If preferred, coloured "imitation parchment" paper can be obtained for making the diaphragm, but, in the writer's opinion, the effect would not be so tasteful

(*Continued on page* 310.)

A SUPER WIRELESS SET



A huge wireless receiver made for St. Giles Hospital, Camberwell. It is designed to operate 550 pairs of 'phones and 42 loud speakers. The set is believed to be the largest in the country.

A great deal has been said about 2-volt valves, and constructors will find this article of great interest and value.

USING 2-VOLT VALVES

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

I PROPOSE in this article to take a typical valve of a modern 2-volt type and see how much magnification can really be obtained at high frequency.

By the way, I noticed that a correspondent in MODERN WIRELESS was worried about the term "valve impedance," and questioning whether

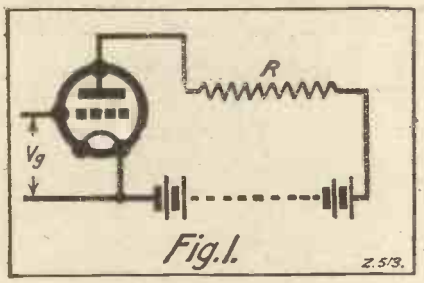


Fig. 1. Z.513.

it varied with frequency. I do not quite know how valve impedance as a term came about, except that impedance is now commonly used for any mixture of resistance, capacity, and inductance effect, and if capacity and inductance are missing the term is still used, although resistance would be the only remaining factor and, of course, there is no frequency effect with a resistance.

Valve Impedance

A valve impedance as given by the maker is its resistance, and any alteration of that impedance is due to valve capacity which, being small, is only liable to enter at fairly high frequencies. The maker takes no account of this capacity when giving his figures. The user will have to do that if he is desirous of obtaining accurate results. This valve capacity enters to some extent into the amplification question on the higher speech frequencies, but fortunately it is completely absorbed into the tuning capacity on high-frequency work and only becomes of very great importance if we want to obtain resistance amplification on very high frequencies.

A short explanation of how the value of valve amplification is obtained may be useful here. The current flowing in a triode is produced by the electrons flowing from filament to plate. These electrons are pulled away from the neighbourhood of the filament by the voltages applied to the grid and the plate. The voltage on the grid Vg acts directly on the electrons, but the voltage of the plate Va has to work through the grid mesh, which reduced its effect by a factor M, which might be called the screening factor. The plate voltage Va is equal in action to $\frac{Va}{M}$ grid volts.

The Screening Factor

This screening factor depends upon the make of the grid, being obviously high if the mesh is close and low if the grid wires are very far apart.

Current flow in any conductor is represented quantitatively by Ohm's law, where we say that

$$I = \frac{V}{R} \text{ or } KV$$

where I is the current, V the voltage, and R the resistance, or K its reciprocal, the conductivity. This law was established when only ordinary conductors were known, and Ohm would have missed fame if the valve had been the chief conductor of his time, for, unfortunately, in a valve to get this equation we have to be assuming

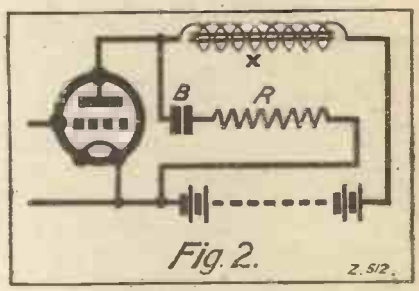


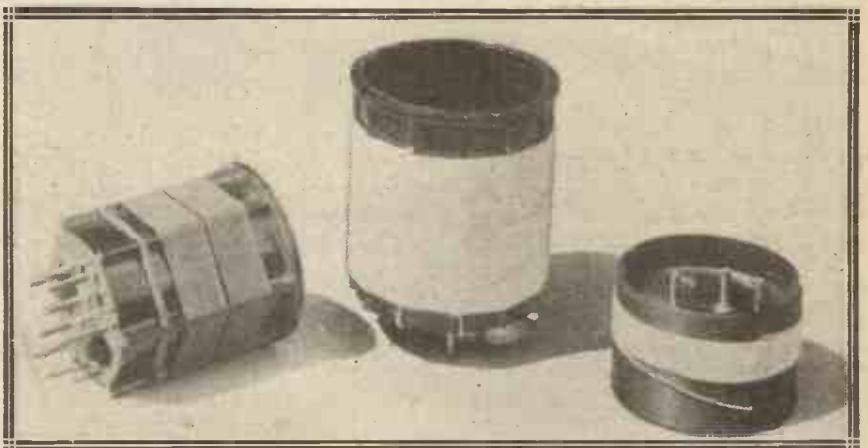
Fig. 2. Z.512.

at every voltage a different value of R because the valve does not behave like a copper wire.

The mathematician gets over this difficulty by saying that if he considers only a little change of current dI, then for this little change the resistance can be considered constant, so that

$$dI = \frac{dV}{R} \text{ or } KdV,$$

and as in a valve the voltage is made



In adjusting the impedance of H.F. couplings to suit a given valve interchangeable primaries are sometimes used.

up of Vg and Va, we get a modified Ohm's law for the triode

$$dI = \frac{dVg + \frac{dVa}{M}}{R} \text{ or } K\left[dVg + \frac{dVa}{M}\right]$$

This K is called the mutual conductivity for obvious reasons, and is the slope of the usual characteristic published by the manufacturers. But note that K will vary with varying values of I, and that is where the characteristics come in. They tell us the K value at any setting of the current.

We need the value of K and M to calculate the magnification the valve will give in any particular case. Thus in Fig. 1 the magnification of voltage, that is the ratio between the voltage across R and that on the grid, is

$$\frac{MR}{R+Ra}$$

which it is sometimes convenient to write

$$\frac{Km}{Kr+Ka}$$

where Km, Kr, and Ka are the respective mutual, external, and plate conductances.

Mutual Resistance

It is rather a pity that this term, "mutual conductance," has been introduced at this date. Mutual resistance would have been more useful for circuit calculations of resistances and impedances, especially as there is no real unit for conductance. Perhaps it is the result of some mathematician hating to do a division sum.

If, as in Figure 2, we shunt the resistance with a very large choke X of low resistance and high inductance it will ensure that the battery voltage is always fully on the valve, and it will not affect the magnification if the impedance of the choke is much higher than the resistance, and if necessary we can put in a blocking condenser of very large value B.

This modified circuit acts just the same as before, but we can now change R as much as we like without shifting the position on the valve curve, and with the same valve Km will remain constant.

Question of Voltage Loss

Thus, if R is made very large its reciprocal Kr becomes negligible and the voltage magnification from the previous formula is $\frac{Km}{Ka}$ or M, which is the maximum magnification obtainable with a valve without transformation ratios.

A circuit LCR (Fig. 3) is the basis of all high-frequency work. L is the inductance, C the capacity, and r the resistance, which latter term is usually taken to include all the losses. For calculation purposes r can be replaced by a shunt resistance R across L, the value of R which gives the same loss as r being obtained by the formula $\frac{r}{L} = \frac{\frac{1}{R}}{C}$ or $R = \frac{L}{Cr}$.

Take a simple case where L = 300 ohms, C = ·0001 mfd., and r = 10 ohms. Then

$$\frac{10}{300} = \frac{\frac{1}{R}}{\cdot 001} \text{ or } R = 300{,}000 \text{ ohms.}$$

Thus, the resistance of 300,000 ohms across the coil will give the same loss effect as 10 ohms in series.

Note that if r is increased R has to be decreased to give an equivalent, and if r is zero then R is infinite.

If we take our Figure 2 and, as in Fig. 3, put an L and C across the resistance R, and if L and C have no loss, then when we are considering a frequency in tune with LC the impedance of L and C in parallel is infinite, and the circuit for magnification is just as though R only was there.

We can consequently consider LCR is our circuit, where R represents the losses and in tune the magnification can be calculated as though only R was there.

The process of calculation is thus. Determine LCr of the plate circuit. Convert r into a shunt R and then

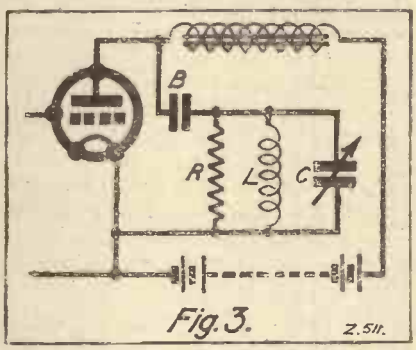


Fig. 3. Z.511.

calculate as though we had a resistance amplifier.

Just one more point. R across L gives a certain energy loss measured as $\frac{V_2}{R}$ where V is the voltage across L. If we put $\frac{R}{4}$ across half the coil where the voltage is half, the energy loss is the same, and $\frac{R}{9}$ across one-third of the coil, and $\frac{R}{16}$ across a quarter of the coil are all equivalent to R across the whole coil. So that tapping down the plate coil, or using a ratio transformer, is equivalent to lowering the plate resistance.

A Typical Case

As a practical example of all this I have taken a 2-volt D.E. valve of modern type, drawn its characteristics, and determined its mutual conductance Km at different mutual voltages. From this curve I have obtained a table giving various M values, and the mutual conductance, and the plate conductances (Fig. 4). The meaning of this is that if the maker kept all the dimensions of his 2-volt valves the same, but altered the grid mesh to give the various M values in the table, then the mutual conductances and plate conductances would be as in the second and third columns. From this table we can determine the magnification and, as an example, I have taken a coil and condenser circuit which normally has an equivalent shunt R and drawn curves of magnification with valves

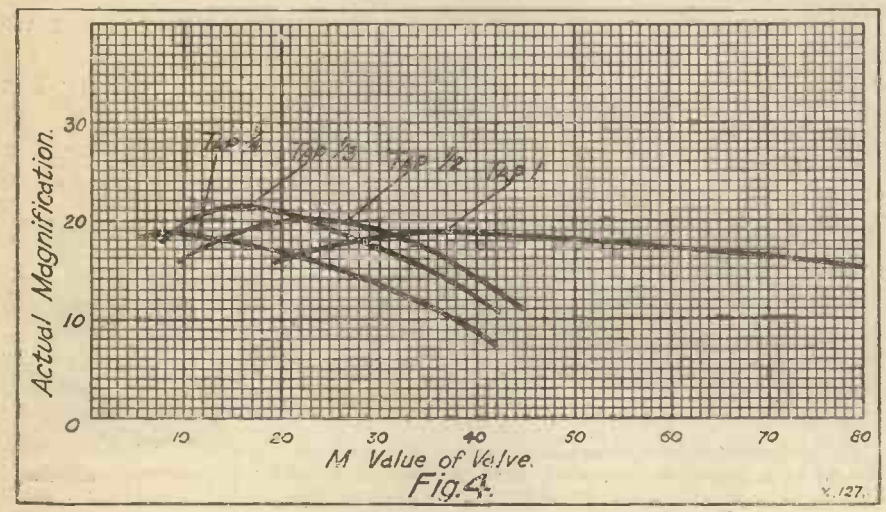


Fig. 4. X.127.

of different M and with Km and Kp obtained from the above table and at different tap positions on the coils. The resistance R I have assumed at 240,000 ohms (Fig. 4).

All the magnifications, it will be seen, hover round 20 maximum, but it certainly looks as though a tap of one-third down with a valve of M value from 15 to 20 is about right for best effects, and I think this is about the average result obtained by all using neutralised tuned-anode circuits.

In considering this amplification one must also consider what is happening with the tuning. At any particular tap, as the M value is raised so the damping applied by the valve to the coil is reduced, so that the tendency would be to use an M value a little above the optimum rather than below or, what is a somewhat similar equivalent, the tap position should be a little lower with any particular valve than that which gives the optimum with that particular value of M.

A Speculation

I am going to finish up with a speculation which, although with triodes it is not practical except by excessively raising the plate voltage, with the tetrode it is quite easy. Instead of Km decreasing rapidly with increase of M, suppose Km were constant and M could be raised to as high a value as we like.

Let us take a valve with a value of Km as $\frac{\cdot 5}{1000}$ and maintain this constant as we change M, then with the shunt resistance R of 240,000 ohms the magnification curve will be as shown in Fig. 5.

The maximum magnification when M is infinite will be KmR, or, in this case, $\frac{\cdot 5}{1000} \times 240{,}000 = 120$, a very different story from the triode case. A little consideration will show that in this case there is no advantage in tapping down the coil.

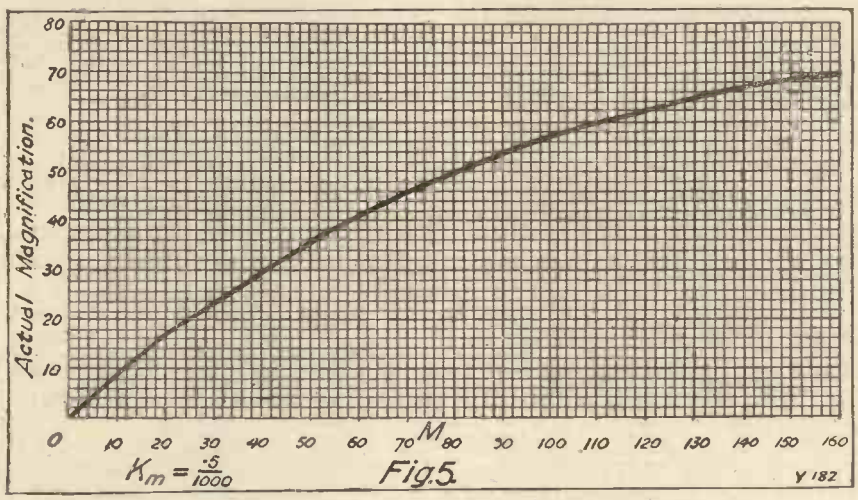


Fig. 5.

DISTORTION

By A SUFFERER

FOR two years I have been living in a house where at times even a crystal set distorts. Moreover, it distorts not merely on the local station but on Daventry as well. When a valve set is substituted for the crystal, the blight is often found to extend over quite a wide band of wave-lengths, even though a selective set is used.

I have seen my nearest neighbour's set. If I didn't know him for a fairly truthful man I should judge it to be of last century's workmanship. I am satisfied that it is responsible for more than a little of the trouble. I have tried educative talk, but it is no good. The man is a Scot, and when he learned that he would need an additional valve if he gave up tight-coupling, he turned the conversation to vegetable marrows.

So, as our aerials are parallel and not very far apart, there is not much that can be done about it, except with a gun—and my wife hates noise.

Four other neighbours sport aerials. I have seen the set that is attached to one of them. That is certainly responsible for a bit more of the distortion that infests the neighbourhood, and I know that at least one other set is a "plonker" too. Anyhow, the fact remains that on three or four evenings a week either the local station or Daventry, or both, are not worth listening to.

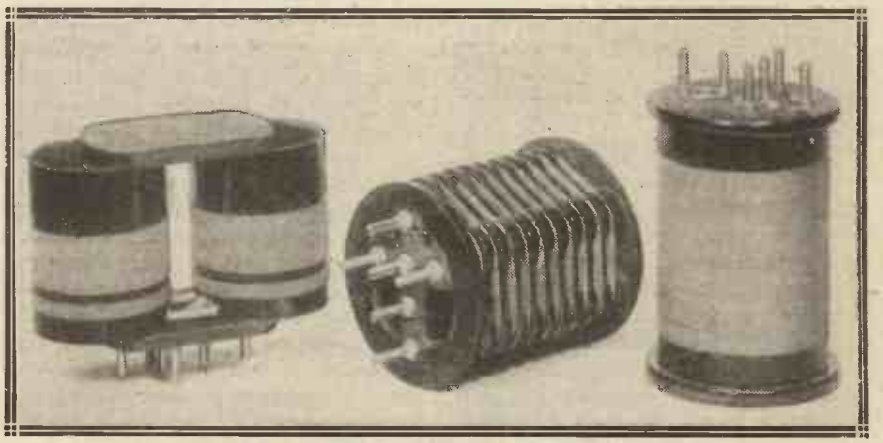
A Remedy

Just now and again everything is beautiful, but that state of things does not last long.

But there is a palliative that similar sufferers may find worth trying. It is very simple. Disconnect your aerial and work on a makeshift.

Of course, if you are at present pushing a small set to the limit of its power, this advice is not of much use. It means adding another valve. And in such a case it is more than probable that you yourself are responsible for your distortion. But if you are getting fair results with your reaction condenser at O, or your coils well apart, it is quite likely that you will get equal results by increasing your reaction, with an absurdly poor aerial.

The kind of thing I mean is a piece of D.C.C. led from the set along picture rails up to the height of the first-floor landing. Alternatively, a connection may be made from the aerial terminal to a gas pipe, the earth lead being disconnected, or used as usual, according to results. It may be possible to dispense with an aerial entirely, merely connecting the earth lead to the aerial terminal.



A group of typical H.F. couplings. The one on the left is an experimental "binocular" coil.

THE "M.W. FIVE" IN OPERATION

Some interesting notes concerning the handling of this efficient multi-valve set.

By G. P. KENDALL, B.Sc.

I HAVE received so many inquiries as to just what the "M.W. Five" can do that I had, perhaps, better commence these notes on the details of operation by giving the promised test report. The set has been in regular use for some considerable time, and tests have been carried out in a sufficient variety of situations and under a sufficiently wide range of atmospheric conditions to permit a true idea to be given of its capabilities, and the first fact which emerges is that its sensitivity is high enough to permit it to be used upon an indoor aerial and yet give quite a long list of distant stations on the loud speaker after dark. This can be done, moreover, without making undue use of reaction or otherwise forcing the set, but with a reasonable margin of safety so long as the indoor aerial is not unduly small or low.

Now, with a set of such sensitivity as this it is quite easy to pick a fairly good night, attach the receiver to a good outside aerial, and then proceed, with a wave-meter for purposes of quick identification, to compile an almost incredibly long list of stations heard upon the loud speaker. To do this, however, is to run the risk of misleading the less experienced reader, who may imagine that he will be able to repeat these results in full, forgetting that variations in atmospheric conditions alone may easily cut the list down by half on many nights, particularly in the summer. Moreover, probably something like a third of the stations on the list owed their places there to the skill of the operator, a good aerial, and a ready means of quick identification.

Promising Results

I prefer, then, to give an idea of the behaviour of the set under adverse conditions, and the first tests carried out were designed to show this. The element of skill on the part of the operator I could not eliminate, of course, but I endeavoured to offset this to some extent by making only moderate use of reaction, and not logging stations which required critical reaction adjustment.

The first test was on a very poor outdoor aerial consisting of a single wire 80 feet long and only 10 feet above the ground, very imperfectly insulated and shut in by houses at varying distances on all sides. Instead of a direct earth a counterpoise was used consisting of an indoor aerial.

A Severe Test

Under these conditions fourteen distant stations were tuned in on the loud speaker after dark, although the set had not then been calibrated. Of the fourteen, seven were British, four German, two French, and one Spanish. These were tuned in during a single run round the dials, and no attempt was made to bring out any station which required a great deal of reaction.

These results were so promising that it was decided to make an extended test on an indoor aerial. This aerial consisted of a 100-feet length of covered wire carried round the picture-rail, out of the door and upstairs, through a trap into the loft, and there festooned round the rafters, and probably was not very efficient. On this aerial the set was tested every night for a week, and it was found that on an average night the following stations would come in on the loud speaker. Brussels, Aberdeen, Bournemouth, Langenberg, Rome, Frankfurt, Gothenburg, Glasgow, Hamburg, Toulouse, Manchester, Madrid, Leipzig, Barcelona, Königsberg, Birmingham, Breslau, Newcastle, Belfast, San Sebastian, Hanover, Dortmund, Danzig, Muenster, Stettin. It is not to be understood that these stations could be heard in a single run round the dials at any moment, but they—or, at least, an equal number of others on different occasions—would all be logged in an hour or so's listening on an average evening. For these tests the H.F. transformers used were Lewcos split primaries, and the valves were as follows. H.F., two D.E.8 H.F. type, detector, D.E.H.612. First L.F., S.T. 61. Last valve, Stentor Six, D.E.5A., and L.S.5 A. on different occasions.

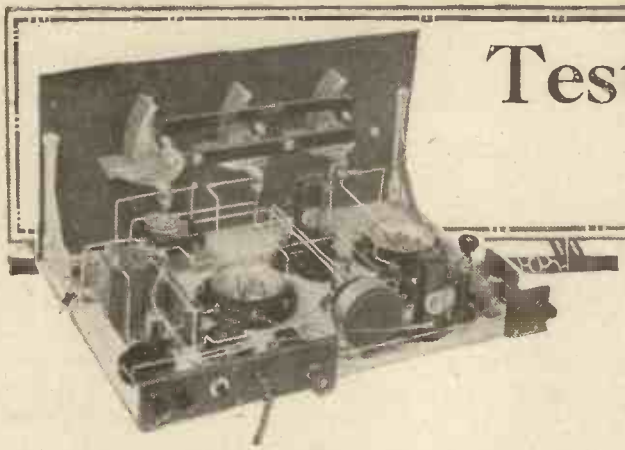
This is the "M.W. Five"
Full constructional details were given in last month's "Modern Wireless."

Another test was made on a fair outside aerial on a moderately good night, and the list of stations reproduced herewith shows what can be done when conditions are favourable. I give this list chiefly for comparison with those given for other highly sensitive receivers.

The Valves to Use

Turning now to operating details, the first question to be settled is that of valves. A considerable variety has been tested in the set, and for the H.F. stages a valve of impedance from 13,000 to 25,000 ohms seems desirable, with an amplification factor

(*Continued on page* 305.)



Testing With a Neon Lamp

Full details of an easily-made fault-finder and trouble-tracker.

By H. J. BARTON CHAPPLE, Wh. Sch., B.Sc. (Hons.), A.C.G.I., D.I.C., A.M.I.E.E.

THE average home constructor is usually called upon to undertake a fair amount of testing work and fault tracing in connection with wireless receivers, both for himself and friends, and to accomplish this it is necessary to have within easy reach some simple apparatus in order to carry out the work in a reliable and expedient manner. There are many devices available, a pair of telephones and a dry battery being a useful adjunct for many of the tasks.

During the course of my own work, however, I have often taken advantage of the interesting properties of the neon lamp, which in one of its most familiar types is the "Osglim" made by the G. E. C. For example, when connected up correctly, the lamp is capable of converting a direct-current supply into a regular pulsating current.

Audible in 'Phones

These pulses of current are either countable as flashes or can be heard as clicks in a pair of telephones when the lamp is shunted by a condenser C and connected to a D.C. source through a high resistance R, the period T of these current pulses being proportional to the product of R and C. I have made up a special unit for conducting tests of this nature, the theoretical diagram of connections being shown in Fig. 1, and details of this were furnished some time ago in MODERN WIRELESS (May, 1926).

Quite apart from this, however, I use the lamp for continuity tests, in preference to the telephones and battery. Those constructors who have an electric supply in their houses can duplicate exactly the arrangement to be described, and in those cases where such a source of voltage is not available, ordinary dry batteries with a total voltage of about 180 will suffice. Fig. 2 is the simple circuit arrangement, the Osglim lamp being held in a batten lamp holder mounted on a small wooden base, which can be obtained complete with a length of flex and an electric-light plug from Messrs. J. J. Eastick's. One of the accompanying photographs illustrates very clearly the apparatus, and to the pair of terminals on the wooden block should be joined a length of flex terminating in a pair of testing handles. These can be made up very cheaply, and Fig. 3 shows the details and necessary dimensions for the brass and ebonite.

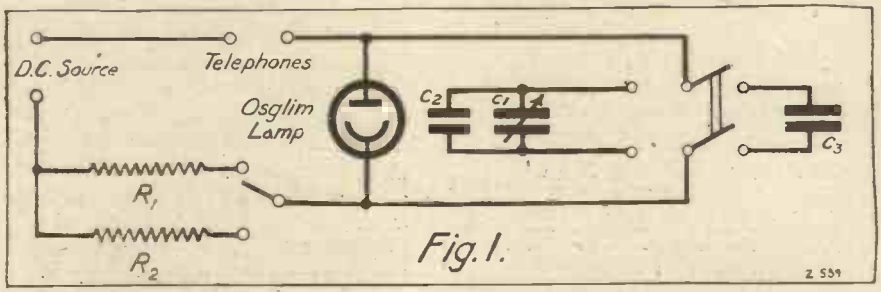


Fig. 1.

This photograph shows the neon lamp mounted upon its base, and the two testing spikes which are used for pricking through insulation, when testing coils, etc. Note also that the unit is plugged into the mains in the usual manner.

The Contact Pointers

The thick ebonite tube should be screwed internally for about 1⅛ in., and the brass rod screwed externally for the same length, so that the brass screws into the ebonite and is held rigidly. Bare the insulation from one end of a length of flex and pass the ebonite tube over the end. Thread the wire end through the ⅛-in. hole in the brass rod, soldering it in place in the small channel shown at A. The ebonite tube can now be screwed over the rod and the handle is complete. This process must, of course, be duplicated for the other handle, then the pair of free flex ends should be bared of insulation and placed under the terminals of the lamp block. As will be seen, the construction is particularly simple, and the constructor will now have in his possession a piece of test apparatus

which will find application in nearly all his testing work.

In actual use the electric-light plug must be placed in an ordinary lamp holder, and the insulated portion of

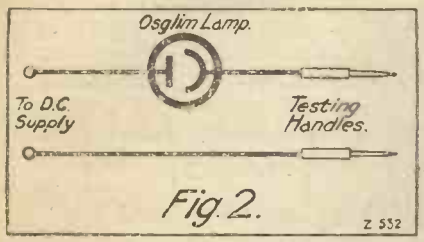


Fig. 2.

the handles held one in each hand. Continuity in a circuit will be evidenced by the glowing of the neon lamp—a visual signal which will be quite definite when the metal points of the handles make contact. Only about three to four milliamps of current flow through the lamp when alight, hence the current consumption is negligible.

Extremely Useful

The handles prove very useful for getting at the internal wiring of a wireless set when making sure that all connections are intact, and in one of the photographs an actual test of this nature is indicated. Coils, condensers, resistances, etc., can be treated similarly, while in the case of condensers, especially fixed ones, a test of this character is very searching. If the condenser insulation is imperfect, and the test handles are left under the condenser terminals for, say, a couple of minutes, a flicker of light will be noticed in the lamp. With the progress of another few minutes the frequency of the flashes will gradually increase, until ultimately there is practically a continuous light, this proving that the insulation has broken down and needs replacement. A test of this character is better than one with a megger, and I have on several occasions found insulating material, which on the megger seemed quite satisfactory, gradually cause the neon lamp to flicker after a time, whereas if it were perfect no lighting up of the lamp would take place.

By means of the neon lamp tester it is a simple matter to trace such leakage as in the insulation of a valve holder, between grid and filament. This leakage may not be apparent in the ordinary way, but may still be enough to cause poor results.

The outcome of a considerable amount of use with this tester has demonstrated its value to me, and I can recommend it to the earnest consideration of all readers.

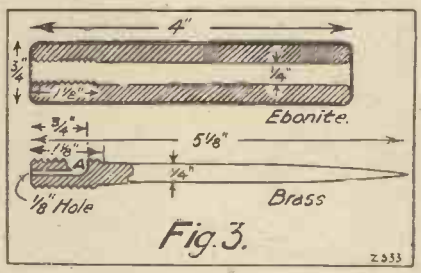


Fig. 3.


The neon lamp tester in use. In the instance shown the testing spikes are placed across the two sets of vanes, and the variable condenser is adjusted to see if shorting or bad insulation occurs in any position of the dial.

FINISHING FLEX LEADS

THERE is to-day a growing tendency to fit all flexible leads with some form of terminal at either end, and this tendency is fostered by the very low price at which these stampings are retailed. Types of stamped terminal to meet every requirement are now obtainable at any and every radio dealer's, and the cost of an assorted packet sufficient to fit all the leads, from the aerial and earth leads onwards, costs less than twenty cigarettes.

Frayed Insulation

They are usually made with small claws which are intended to be pressed over the wire by means of a pair of pliers, but some heavier types are intended for soldering only. In any case, the fitting of the terminal to the flex is not by any means difficult. After the terminals have been fitted is another matter, as sooner or later the cotton covering of the flex is bound to fray, and will in the end destroy the work expended in the fitting of the terminals.

Bind the Joint

However tightly the tags are fitted in the first place, the occasional disconnection of the leads is sufficient, in time, to break the strands of the flex, and the only way to prevent this is to bind the joint securely.

Strong thread, of the type used for stitching buttons, is the best, and a reel of this will not cost more than threepence, while judicious search will probably discover some already in the house. The joint should be bound from the base of the terminal for about half an inch along the flex. Bind tightly and evenly, finishing as neatly as possible. A little melted beeswax rubbed over the binding will protect the joint still further.

A "Valve" Tip

Another method consists of cutting a short piece of cycle valve rubber sufficient to cover the base of the terminal and the half-inch of flex already referred to, sliding along the flex before soldering the tag and rolling back again afterwards. It will hold quite tight, and is not as tricky an operation as the binding described above. If desired, however, the rubber may be slipped over the binding as an additional protection.

C. A. J.

THE "BETTER BALANCE" CRYSTAL SET

Designed and built in the "M.W." Research Department.

To secure that the maximum voltage shall be developed across a tuned circuit by incoming signals it is desirable that, among other things, the ratio of inductance to capacity shall be high, and in receiving circuits designed to tune over a fairly wide wave range this condition is not very easy to fulfil. For example, it is not generally considered permissible to change coils in tuning over the 250–550-metre band, and the entire range is covered by variation of the tuning condenser.

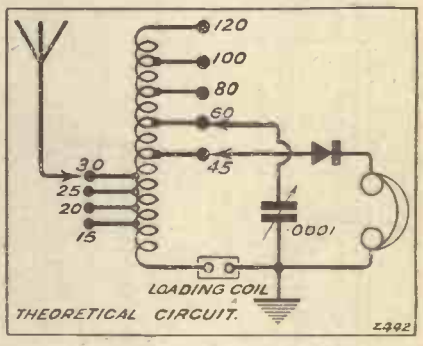
COMPONENTS.

1 ebonite panel, 8 in. × 7 in. × ¼ in.
1 upright-type cabinet to fit, with base-board 7 in. deep (V.C. Bond, Camco, etc).
1 ·0001 mfd. "Midget" condenser (Peto-Scott, or similar type).
1 board-mounting single-coil socket and shorting link.
1 crystal detector ("Lion").
4 engraved terminals (Belling & Lee).
3 tapping clips (Burndept).
1 piece Pirtoid or Paxolin tubing, 3 in. × 6 in.
¼ lb. No. 22 D.C.C. wire.
"Junit" wire, flex, pieces of wood, screws, etc.

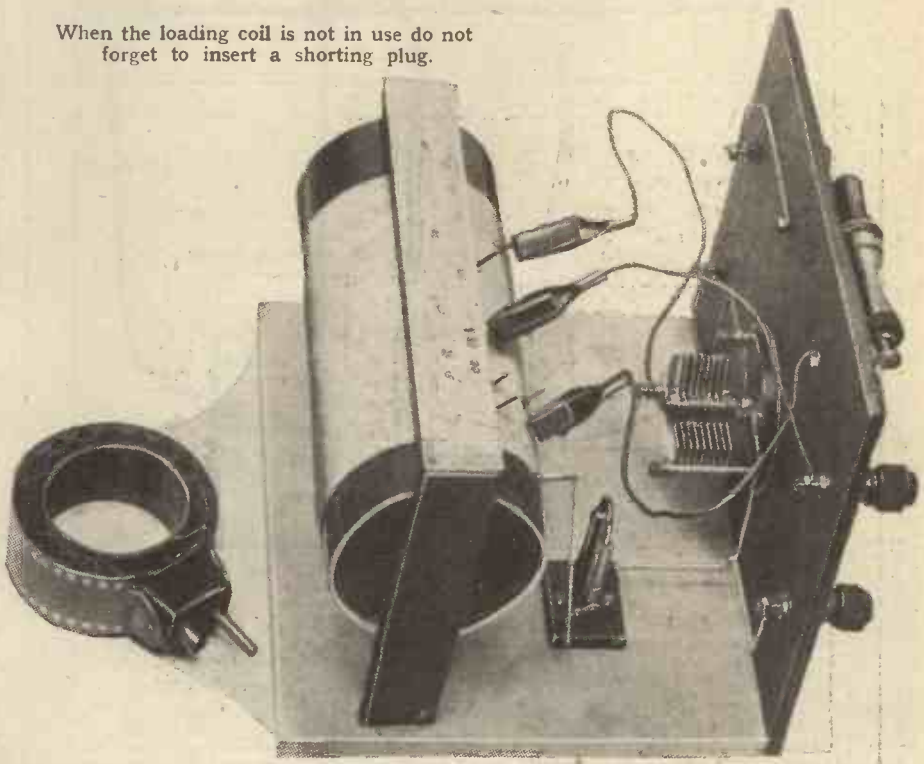
Higher Efficiency

In a receiver intended to work from a number of stations distributed over this range such an arrangement is probably necessary from the point of view of convenience, but it is not a highly efficient scheme, since it means that on the higher waves the coil will be shunted by a considerable capacity, i.e. that the ratio of inductance to capacity is no longer very favourable. Now, where a set is intended to work from one or at the most two stations, it is possible to use a tapped coil and so secure a high inductance to capacity ratio by suitable adjustment for any given wave-length within the tuning range, and the crystal receiver about to be described is an example of such a design.

The circuit used is a perfectly standard one of a type giving a good degree of selectivity, so that there need be no fear of the set becoming useless when alternative programmes are transmitted by a high-power station on the short wave-band. A diagram of the circuit will be found on these pages, and it will be seen that there is a tuned circuit consisting of a tapped coil, shunted by a *small* variable condenser, this last being of



When the loading coil is not in use do not forget to insert a shorting plug.



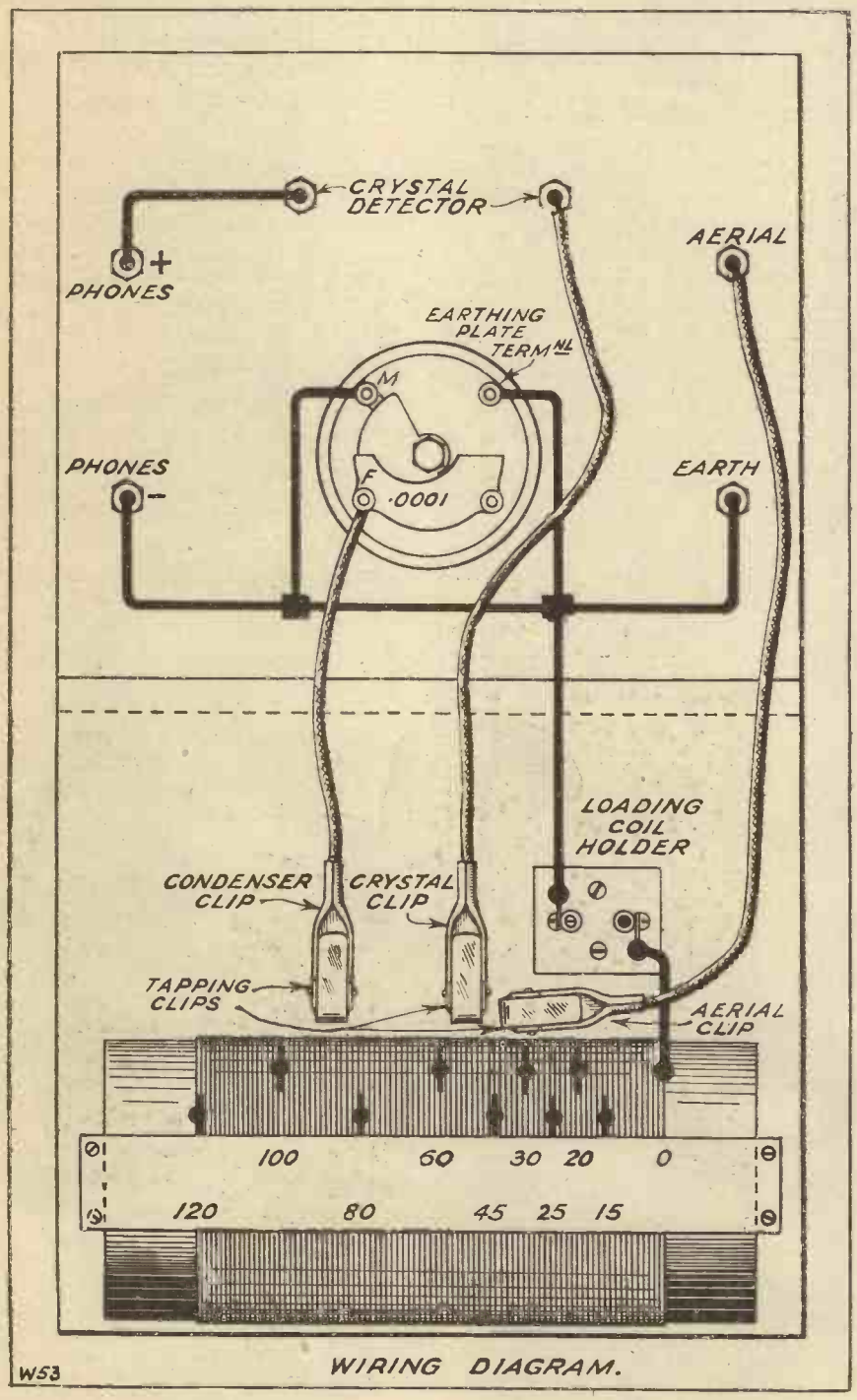
The tapping-points on the coil should be "staggered" to prevent the clips from touching each other when in use.

only ·0001 mfd. maximum and intended simply to cover the intervals between the tappings.

The earth is connected to the lower end of this circuit, and the aerial connected across a part only of the coil, so giving the useful scheme known as auto-coupling, with its well-known advantages of higher selectivity and improved results with inefficient aerials. Several tapping points are provided for the aerial, in order to allow of adjustment to suit different aerials and wave-lengths.

A further tapping arrangement is provided to enable the crystal and 'phones to be connected across varying portions of the tuned circuit, most readers being no doubt familiar with the fact that if the crystal is tapped across only part of the circuit a definite increase in selectivity follows, together with a slight improvement in signal strength, the correct point being found quite easily by trial and error, as we shall see later.

A third tapping scheme enables the variable condenser to be placed across varying portions of the coil to permit the circuit to be tuned to any desired wave on the broadcast band. This, of course, simply means that the amount of inductance included in the tuned circuit can be varied in steps. In each of these three schemes the tapping device is a Burndept clip on the end of a short flex lead, as may be seen in the photographs and wiring diagram.



WIRING DIAGRAM.

Winding the Coil

The general layout and method of assembling the set is simple, and should be readily followed from the diagrams and photographs, and we can now proceed to the details of construction, commencing with the coil. This is wound upon a piece of "Pirtoid" or "Paxolin" tubing, three inches in diameter and six inches long, and consists of 120 turns of No. 22 D.C.C. wire in a single close layer. In the course of winding tappings are made at the 15th, 20th, 25th, 30th, 45th, 60th, 80th, and 100th turns, by any convenient method with which the constructor may be familiar. For example, at each point a small loop can be twisted up as winding proceeds, and subsequently scraped bare so that the tapping clips may make good contact.

A neater method is to cut the wire as each point is arrived at, and secure the end by passing it through two small holes in the tube. The end from the bobbin is then secured by passing it through two more holes close to and in line with the previous ones, and winding continued. If the two projecting ends are soldered together the desired tapping is very neatly provided. Whatever method is adopted the tapping points should be staggered a little to separate them and prevent the clips from fouling one another when placed on adjacent tappings.

Assembly

The coil is mounted in a horizontal position, and for this purpose two strips of wood or ebonite can be used fixed to the baseboard vertically by passing screws upwards into them from below. In these strips saw cuts are made to receive the edges of the tube in a manner which will suggest itself from an inspection of the photographs. To the upper ends of these uprights a horizontal stiffening piece of three-ply or other thin wood is attached with small screws, so that it lies about half an inch above the coil. Upon this strip is pasted a slip of paper upon which the turn numbers at the various tapping points are

marked in ink for reference purposes when manipulating the clips.

When the coil has been mounted and the various other components secured in place, and the panel screwed to the baseboard, the wiring-up process should be carried out, and those who are at all doubtful of their abilities in soldering will be well advised to use the same wire as that employed for test purposes in the original set, this being the specially prepared material known as "Junit."

Assuming now that the set is finished, let us see how it may be tested and adjusted to give the best

An ordinary condenser dial has been fitted to the midget condenser for convenience in tuning.

results from any particular station on any aerial. First, connect aerial and earth to terminals A and E, and a pair of 'phones to the appropriate points. Place the crystal tapping clip on turn No. 60, and the aerial clip on either turn No. 20 or turn No. 30, according to whether the wave-length of your local station is below or above 400 metres.

Preliminary Adjustments

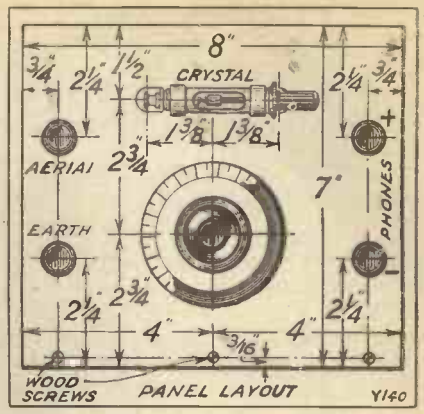
Now take the tuning clip (the one from the variable condenser) and try it on each tapping in turn, starting with 130 turns (this is the end of the coil) and working back along the tapping points. At each point tune with the variable condenser, and you will presently pick up the local station, whereupon the crystal detector should be carefully set to give the best results. Then proceed once more with the tuning operations. You will probably find that the station can be heard upon several tappings, provided that the variable condenser is adjusted correspondingly, and you should choose that tapping which enables it to be heard with the condenser about half in, for this preliminary adjustment.

Now turn to the adjustment of the aerial coupling turns, and try the appropriate clip on a variety of the tapping points, carefully retuning on the condenser each time. You will find that the higher the number of turns the aerial is tapped across the louder the signals up to a certain point, beyond which tuning becomes very flat and strength falls off slightly. The smaller the number of turns, on the other hand, the sharper the tuning, and a compromise to suit the particular conditions must be effected. In any case, trial and error is the only method available of determining the best number of turns.

The Crystal Tap

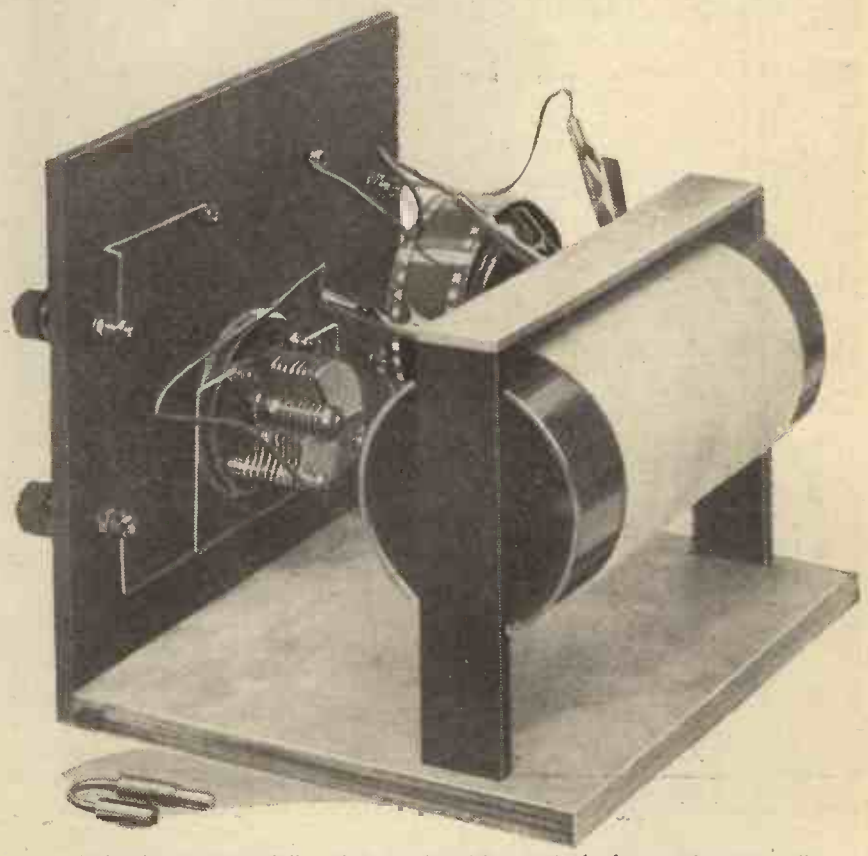
Having obtained a satisfactory adjustment of the aerial tap, proceed to the adjustment of the crystal tap, which will be found a simple operation. Simply try the clip on each tapping point in turn between those occupied by the other two clips, or even going a little below the number of turns tapped into the aerial circuit. At each point retune slightly, and you will probably find that signals are best and tuning sharpest when the crystal is tapped across perhaps only a third of the coil.

Now return to the tuning clip (the one from the variable condenser) and try moving it up to the next higher tapping point on the coil, where it may be found that louder signals are

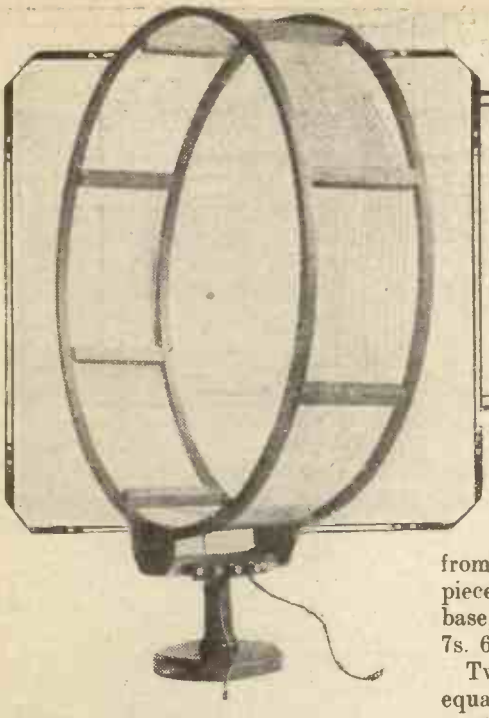


now obtained. If this should be so, leave it there and readjust the crystal tap once more. When this has been done you may assume that the set is now correctly adjusted to suit your conditions, and the strength of signals (assuming that your crystal is a good one) will probably be found quite a surprise.

Provision has been made to enable Daventry to be received by means of a loading coil, size 150 or 200 according to the dimensions of the aerial. When this is placed in the socket it will probably be necessary to manipulate the tuning clip, as well as the variable condenser, before the correct adjustment for Daventry is found. The other two clips can remain as they were for the shorter waves.



This view was specially taken to show the method of mounting the coil.



An Adaptable FRAME AERIAL

By G. C. P. BROWN.

THE building of frame aerials for a specific receiver, such as a "super-het," has become a matter of routine to the experienced constructor. For general experimental work, however, some foresight is necessary in the design in order to keep pace with modern circuit development.

To begin with, it should be made possible to tap on to the winding at every turn throughout its length. Again, it should be arranged that any number of turns may be short-circuited from either end. The winding must be of sufficiently large size to give new circuits a fair trial, without becoming unwieldy in the small space usually allotted by the Lady of the House. A straightforward solution is to wind the frame with bare wire so that tappings can

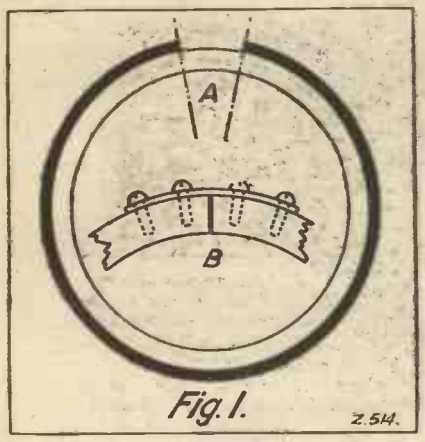


Fig. 1. Z.514.

be easily made by means of flexible leads and clips.

The frame illustrated was made from two children's hoops, a small piece of oak, and a turned wooden base, at a cost of something under 7s. 6d.

Two hoops are procured as nearly equal as possible in size. They must, of course, be made exactly equal, and the procedure is as follows. Pass a piece of strong tape or wire round the circumference of the


When putting on the wire make sure it is drawn taut over each cross member of the frame.

smaller hoop, and cut so that the ends meet exactly.

Winding on the Wire

Transfer the tape to the larger hoop. The gap between the ends of the tape (see Fig. 1A) is cut away with the saw. The ends of the hoop are pulled together by a piece of sheet metal and four screws, as shown at Fig. 1B. There is no noticeable loss of circular shape in a hoop contracted in this way within reasonable limits. Now carefully measure the tape. In this case it was exactly 70 in. The next step is to divide the

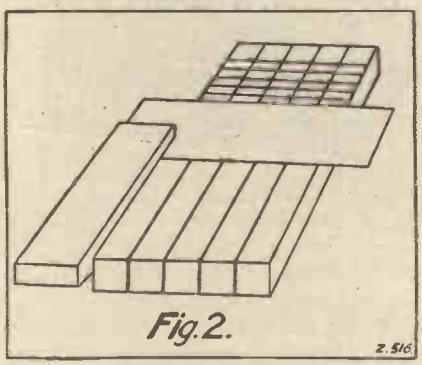


Fig. 2. Z.516.

circumference of the hoops into eight equal parts. In our example we divide 70 in. by 8 and get $8\frac{3}{4}$ in. A piece of tape is therefore cut to this length and used to mark out the divisions round the hoops. A transverse screw-hole is now drilled at each of these markings.

The eight spokes are cut from $\frac{3}{4}$-in. square-section oak, and are 5 in. long. This allows for seventeen sawcuts $\frac{1}{4}$ in. apart, leaving $\frac{1}{2}$ in. at each end.

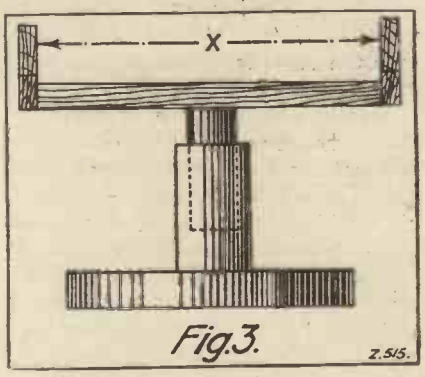


Fig. 3. Z.515.

The eight spokes are clamped together and marked out simultaneously in the manner shown in

(*Continued on page* 310.)

A MODERN AMPLIFIER

Employing one valve with a volume control and filter output circuit.

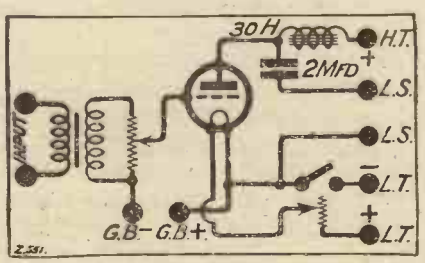
This easily made L.F. unit, which will meet the requirements of all who need "another L.F. valve," can be attached to any type of receiver.

By K. D. ROGERS.

WITH the advent of Daventry Junior a great number of listeners have been brought into range of alternative programmes, and many have found that even with simple receiving apparatus they have a choice of at least three stations: the local, 5 X X, and Daventry Junior. Many of those owning one-valve or two-valve sets are able to pick up the two high-power stations, if not their local transmission as well, at full loud-speaker strength if they add one note magnifier, while not a few owners of the humble crystal set will have a chance of working a loud speaker if they add an amplifier.

Smooth Tone Control

It is with a view to satisfying the needs of listeners in the circumstances outlined above that the one-valve amplifier described in these pages was



designed, and at the same time the various requirements of different home constructors were borne in mind, and the unit was therefore made as universal as possible.

As will be seen from the theoretical diagram the amplifier consists of one valve, whose input is coupled by means of an L.F. transformer, and at the same time controlled by means of a high-resistance potentiometer placed across the secondary of the transformer. This enables a variable input voltage to be obtained, so that signal strength can be controlled to a nicety without introducing distortion into the receiver. The output is choke and condenser coupled to the plate of the valve, so that there is no need for accurate matching of the valve in any particular type of loud speaker that is to be used. For instance, the amplifier should operate an ordinary horn loud speaker of the 2,000-ohms type as well as it would a cone loud speaker, without the necessity of the valve being changed in order that its impedance should be suitable for use with either loud speaker. But we will discuss the valve question further on.

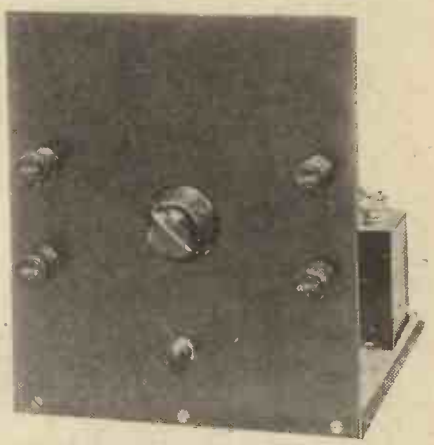
COMPONENTS REQUIRED.

1 panel, 8 in. × 7 in. × ¼ in.
1 baseboard, 7 in. deep.
Cabinet to fit.
1 L.F. transformer of good make.
1 L.F. choke of good make.
1 baseboard-mounting rheostat.
1 Centralab modulator, 500,000 ohms.
1 L.T. on-and-off switch.
4 terminals.
1 condenser, 2 mfd., Lissen, T.C.C., etc.
1 anti-microphonic valve holder.

H.T. Connections

An on-and-off switch has been fitted, while a variable baseboard-mounting resistor is also included. It will be noticed that no H.T. – has been provided for, and this is for a very definite reason!

As this amplifier has been designed with a view to being suitable for addition to any type of set requiring a transformer-coupled amplifier, it had therefore to be so arranged that its addition might be as simple as possible. Now, in many sets the L.T. + wiring is connected internally to the H.T. – terminals, while in other receivers the L.T. – is taken to H.T. –. In a crystal set, of course, no battery leads are required. Now, if the amplifier were to have its H.T. – connected to L.T. –, and it was connected to a receiver having L.T. + taken to H.T. –, there would be a danger, if certain alterations were not made, of the L.T. battery being short-circuited via the internal wiring of the amplifier and receiver. Similarly, if the amplifier had L.T. + taken to H.T. – and were connected to a set having L.T. – and H.T. – connected together the same possibility would occur.



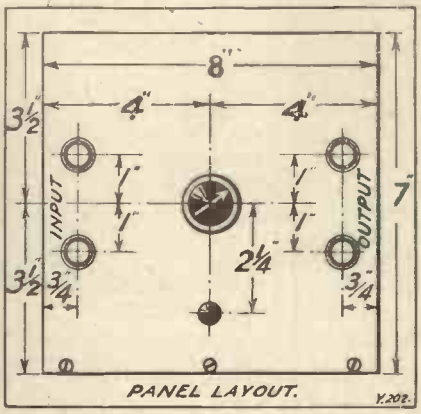
The panel layout is made as simple as possible and is arranged to match the "Better Balance" crystal set.

It is obvious that if one H.T. – connection is available—and that is to be found in the receiver—no further connection is required, so that it has been left out altogether in the amplifier, which can therefore be connected to any type of set without fear of short-circuiting occurring. In the case of a crystal set, an external connection between the L.T. battery and H.T. – is required in order to complete the battery connections of the amplifier.

The L.F. Transformer

As regards actual construction of the amplifier there is very little to be said, as the diagrams and photographs speak for themselves. The mounting of the components and the drilling of the panel are extremely simple operations, the dimensions and layout being shown in the panel drilling diagram and the wiring diagram. The exact dimensions of the set were chosen so that constructors of the "Better Balance" crystal set, (described by Mr. G. P. Kendall in this issue): who require an L.F. amplifier may be able to make one to match their set, the dimensions of the panel, baseboard, and of the cabinet being identical with those of the crystal set, while those who require the unit for other purposes will find its size is a very convenient one.

In the actual amplifier unit photograph the low-frequency transformer has a ratio of 2·7 to 1, and in the opinion of the writer it is perhaps the most useful ratio for the general-purpose amplifier. Such a transformer—as a matter of fact any ratio from 2·7 - 3½ to 1 will be satisfactory—will enable the unit to be employed successfully in either first- or second-stage low-frequency positions following a valve set or to follow a crystal set.

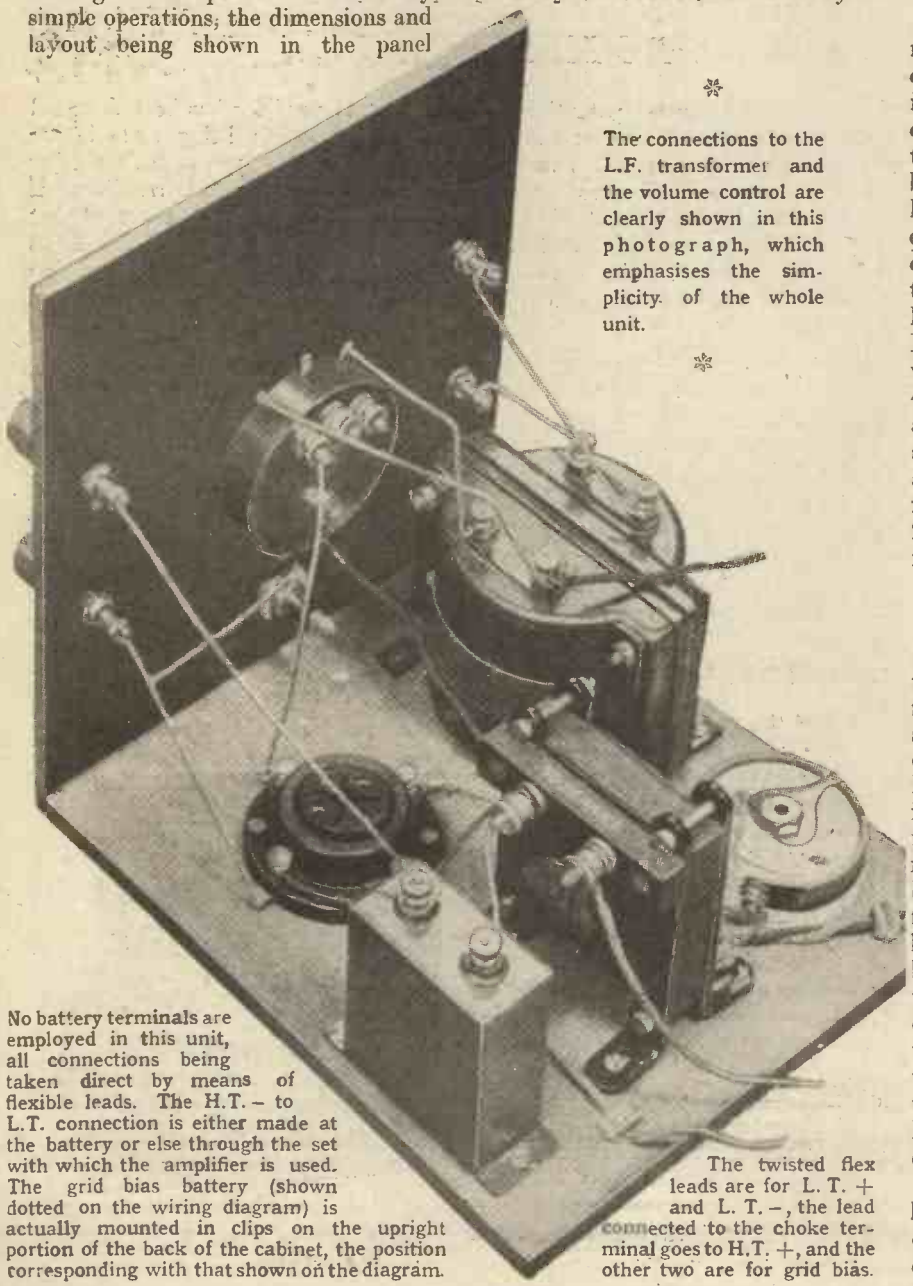


It might be argued that better results could be obtained by specially choosing a transformer whose primary impedance would suit the output circuit to which it is to be coupled, and to a certain extent that is quite true, but if one were to employ a transformer having a 6 to 1 ratio, which would be excellent if it were to be used specifically with a crystal set, one would find that the amplifier would be of very little use in any other capacity. So I would advise constructors to keep within the limit of 2·7 and 3½ or 4 to 1, unless they want to construct an amplifier to be used with some specific receiver. In such an event a 4 to 1 transformer would be better for a second-stage amplifier, while the 2·7 is to be preferred when employed in the first low-frequency position.

Choosing a Valve

As regards the valve to be used, this must be chosen according to the filament voltage desired by the constructor and according to the amount of power it is to be called upon to handle. For instance, if the amplifier is following a one-valve set or a crystal receiver it can have a valve with a fairly high magnification factor—say, between 10 and 17—but if the amplifier is to take its position in a second low-frequency stage a valve with a lower impedance and lower amplification factor will be required. In this event the amplifier should be looked upon as part and parcel of the set with which it is to be used, and the valve chosen so that it will adequately handle the power supplied to it without any danger of overloading.

Such valves as the Cossor L.F.610, P.M.6, B.4, P.V.5, S.S.610P, D.E.L.610, etc., are useful valves from which to choose provided tremendous volume



The connections to the L.F. transformer and the volume control are clearly shown in this photograph, which emphasises the simplicity of the whole unit.

No battery terminals are employed in this unit, all connections being taken direct by means of flexible leads. The H.T. – to L.T. connection is either made at the battery or else through the set with which the amplifier is used. The grid bias battery (shown dotted on the wiring diagram) is actually mounted in clips on the upright portion of the back of the cabinet, the position corresponding with that shown on the diagram.

The twisted flex leads are for L. T. + and L. T. –, the lead connected to the choke terminal goes to H.T. +, and the other two are for grid bias.

is not to be required—these, of course, are 6-volt valves, but 2-volt or 4-volt types with corresponding characteristics can be employed if desired. If a really large volume is required—and in this case the amplifier will, of course, be used as a second or third stage of magnification—it will be necessary to employ a super-power valve having a long straight portion to its characteristic curve. And herein lies the only snag which the constructor may encounter.

The L.F. Choke

The connections to the amplifier are obvious, though a change over of input connections may make a difference in some instances where valve sets are used. In the case of a crystal set the earth terminal of the crystal set should be connected to the L.T. – terminal of the L.T. battery, or alternatively a connection between I P and O S of the amplifier (internally) might be beneficial. No condenser is included across the input terminals, as it is assumed this will be present across the output terminals of the valve or crystal set.

It will be noticed that a low-frequency choke is employed in the output circuit of the amplifier. Unfortunately there are few chokes on the market which will pass sufficient current to the plate of a super-power valve without becoming saturated and thus causing distortion. With an ordinary valve requiring less than 10 milliamps practically any well-made choke will operate satisfactorily, but if a super-power valve is to be employed the constructor will be well advised to ascertain from the makers of the choke he proposes to use its D.C. resistance and its saturation-point.

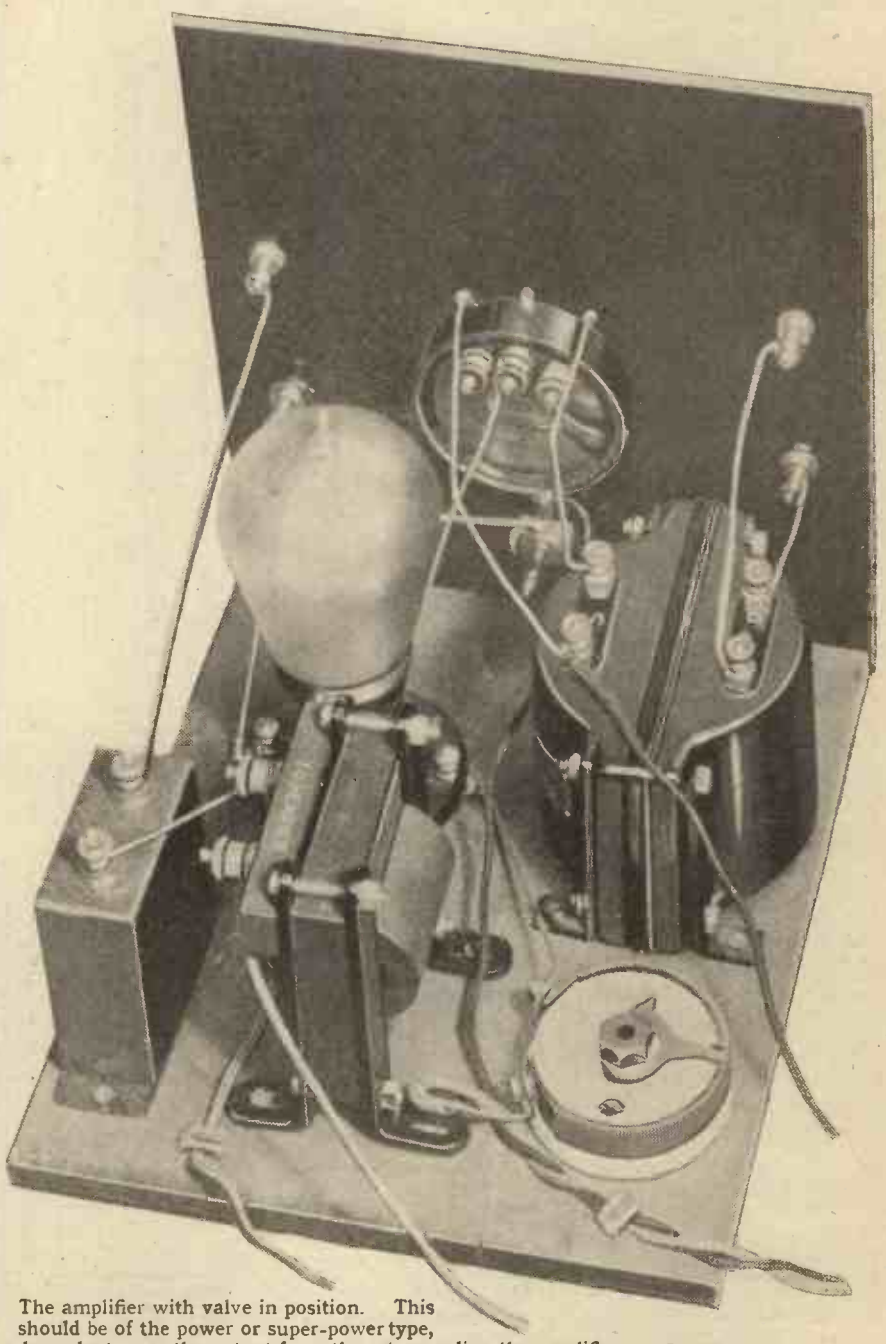
Important Points

Both of these are important. The former should be as low as possible, so that when a fairly large current is passing through the choke the voltage drop will be no larger than is absolutely necessary, while the choke must not saturate at any current value likely to be required by the anode circuit of the valve to be used in the amplifier. All reliable makers will provide information as to their chokes without hesitation, and if the constructor is likely to require the amplifier to give a large output he should go into this question carefully and make sure that he has a choke that will behave itself properly in whatever circumstances the amplifier may be employed.

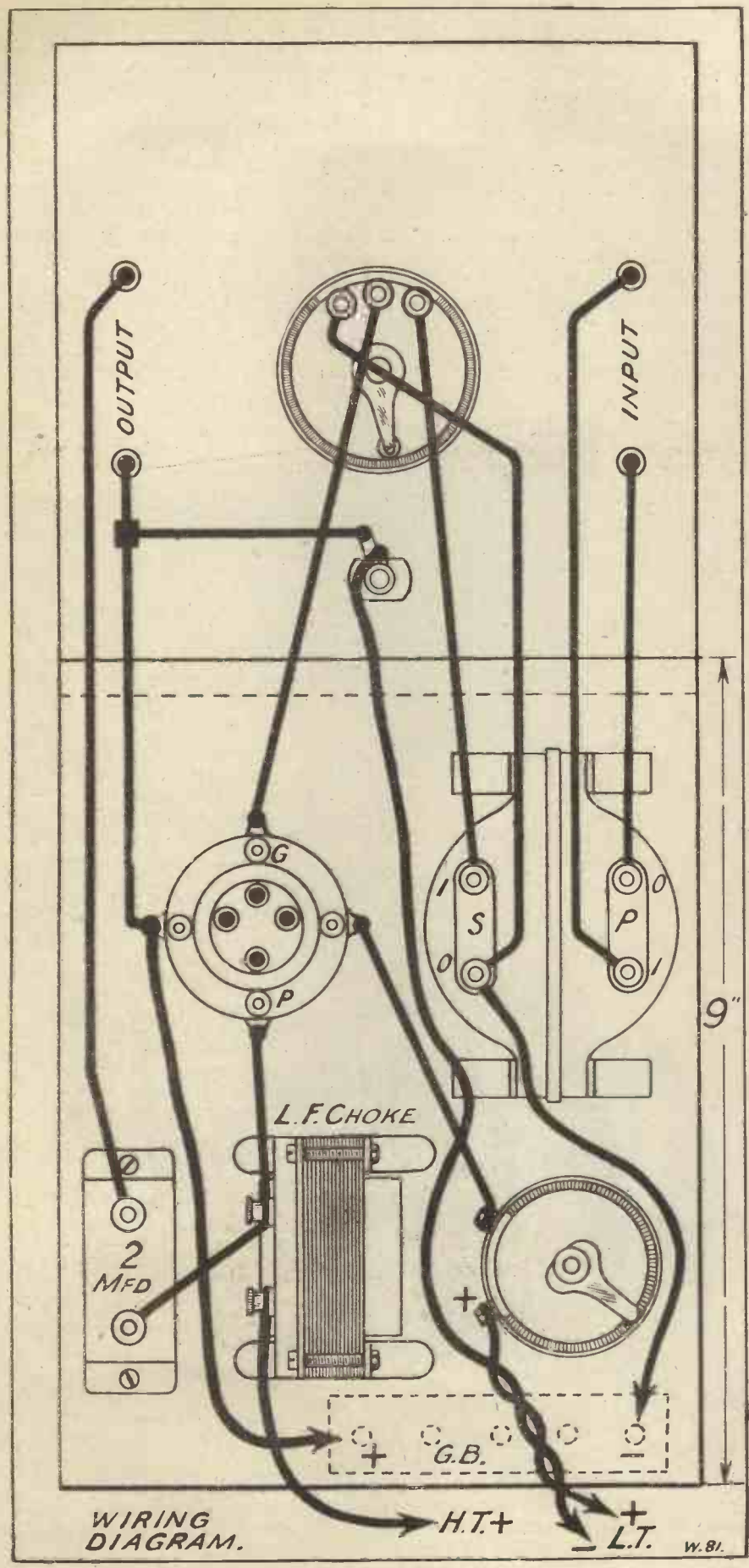
A "snag" was mentioned earlier in this page when the subject of super-power valves was being discussed, and this concerns the case of 2-volt valves rather than those taking a higher L.T. voltage. It must be remembered that up to the time of writing there are no 2-volt *super*-power valves, so that should 2-volt valves be used in the set to which the amplifier is to be attached, the constructor will have carefully to consider the question of the output valve.

There are some excellent 2-volt power valves, capable of handling quite a good grid swing, but they cannot as yet compare with the 6-volter for real "beef," and if loud loud-speaker results are required then a 6-volt valve is almost a *sine qua non*. Two-volt valves are excellent, but they cannot be expected to give the same "punch" as their more expensive and more extravagant brothers.

Extravagant not only in filament wattage but in H.T. consumption, and this is a point the user of the amplifier must watch. The super-power valve, even when properly biased, has a hearty appetite and can easily swallow 16–20 milliamps. from the H.T. battery if given over 100 volts. If provided with less than 100 volts it is really wasted and an



The amplifier with valve in position. This should be of the power or super-power type, dependent upon the output from the set preceding the amplifier.



WIRING DIAGRAM.

ordinary power valve would be almost as good a proposition.

So if the set with which the amplifier is to be used has an ordinary H.T. battery, and it is necessary to use a super-power valve to deal with the output of the set, then a separate H.T. battery for the amplifier would be an advantage. This battery should be of the triple-capacity type and capable of providing 120–150 volts. It is best not to drop below the former figure if purity of reproduction is desired and a super-power valve is being used. The H.T. battery in this case would have its negative joined to the L.T. battery in the same way as in the case of the battery in the set, or it can be taken to the H.T. — on the set (which amounts to the same thing).

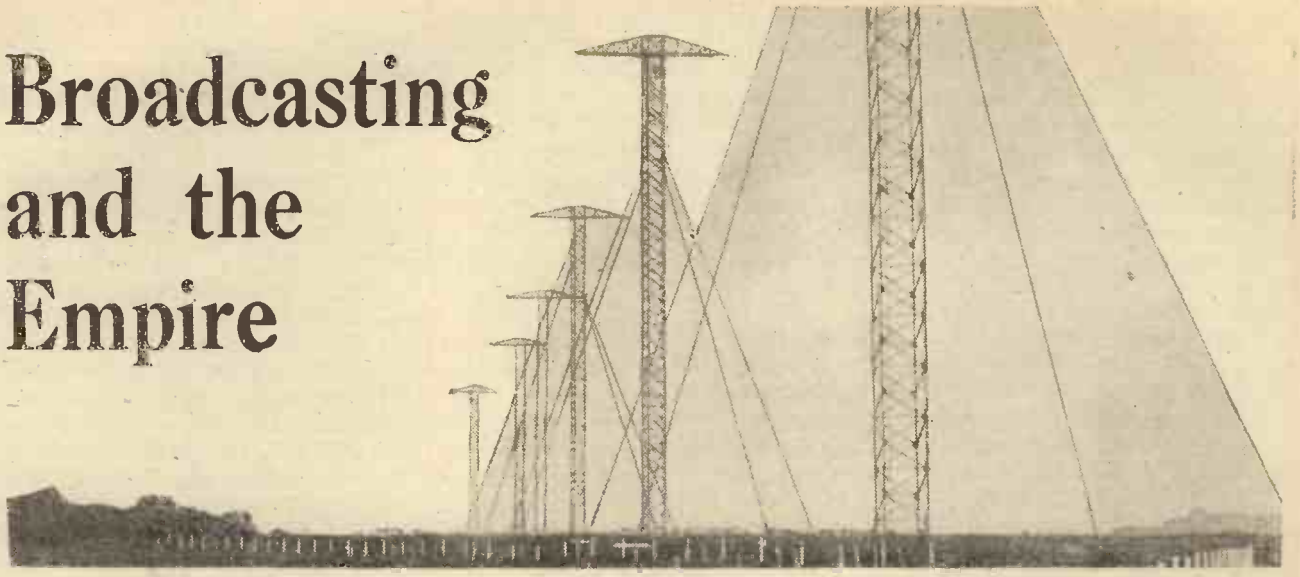
Watch that Valve

In the case of 2-volt power valves I have found the D.E.P.215 an excellent super-power substitute, as also is the S.P.18/R.R. These two can carry a remarkable amount of input, but even these will overload if they are expected to carry too much. Don't make the mistake of supposing, because you have an "extra L.F. valve," you will get tremendous volume without distortion. You *can* do so, but not unless you use suitable valves, and you will not find these unless you use super-power valves. *Good* volume is obtainable with ordinary power valves, 2-, 4-, or 6-volt types being O.K., but really big volume requires the 6-volt super-power.

I am not running down the 2- and 4-volt classes. They contain excellent valves, but I have come across so many receivers that are giving distorted results simply because the owners are using the wrong valves in the last stages. "Oh! I'm using a power valve," they say. So they may be, but it is not enough if one is trying to handle "big stuff," and I *don't* want constructors of this amplifier to get the impression that any power valve will do for *any* volume. Treat your set properly and you will get good results, but don't spoil the ship for a "ha'porth of tar." If you want "big stuff," you can have it—by using the proper valve; don't expect it to be added unto you just because you have built an amplifier, no matter what valve you employ.

Get a suitable valve, bias it properly, and use H.T. over 120 volts, and you will be all right. Use too small a valve, wrong bias or H.T., and the good apparatus put into the amplifier will be wasted.

Broadcasting and the Empire



A Reply to Captain P. P. Eckersley.

By the Editor.

FEW radio things have caused so much argument as the suggested Empire Broadcasting scheme. The success of P C J J, to say nothing of various American short-wave stations, in transmitting programmes to the most distant parts of the world, has had the not unusual effect of making the British public sit up and take notice, and to ask, in no uncertain voice, why it is that the B.B.C. has made no real attempt—as far as the public knows—to emulate P C J J, and to relay for the benefit of the Dominions occasional programmes from 2 L O.

Non-technical people, on the whole, quite appreciate the fact that a short-wave Empire service would be spasmodic—that success could not be guaranteed—and that, at the most, transmissions would only be heard with clarity for, perhaps, half an hour (in, for example, India), at rare intervals.

The disadvantages and the drawbacks to such a service have been pointed out time after time—not only by the B.B.C. but by those very critics who have urged the B.B.C. to inaugurate an experimental service at the earliest possible moment.

But in spite of the disadvantages, in spite of the fact that reception problems prevent the possibility of a guaranteed service, the view was, and still is, widely held and expressed that some sort of service, however experimental, should be started by the B.B.C. without delay.

Some months ago, in response to pressure of public opinion, the B.B.C. stated its intention of organising such a service without delay; but months passed, and when pressed again the B.B.C. hedged and showed unmistakable signs of apathy with regard to the whole question.

Mr. Gerald Marcuse's offer to run a series of experimental broadcasts for the Dominions, "off his own bat," so to speak, and at his own expense, again focussed public attention on the subject, and again strong representations were made to the B.B.C.—so strong, indeed, that it had to state its position without equivocation.

The gist of the reply made by the B.B.C. is that "We intend to play our rightful part in the development of Empire broadcasting."

So far as it goes that is satisfactory—but so far no adequate interpretation of "rightful part" has been given by the B.B.C. "Rightful part" may mean anything; what the public wishes to know is *when* the B.B.C. expect to make a definite attempt at short-wave broadcasting.

Mr. Marcuse, and the directors of P C J J, K D K A, etc., have wasted little time in talking and telling the public about "technical difficulties"—which the public is fully aware of. They have got on with the job; not with full success, but with enough to show that the attempts have been well worth while and that the psychological effect has been extremely beneficial to broadcasting in general.

Not so our own B.B.C. Long explanations for the delay, and equally long explanations for the rejection of proposals made to them with regard to a more or less immediate experimental service, have been issued from 2, Savoy Hill; the latest, as these words are written, in the form of a letter to the "Times," and signed by no less a person than Captain P. P. Eckersley.

The research station at Ditton Park.

That letter has already been dealt with in some detail in our weekly contemporary, "Popular Wireless," and there is no need to repeat the operation here. But, in brief, it may be said that Captain Eckersley gives "unsound and premature" as the reason for the rejection of the proposals for a short-wave broadcasting service made in these and other columns.

These proposals—which are doubtless familiar to our readers, and which have been relegated to the limbo of the B.B.C.'s rejected ideas—have met their fate

(according to Captain Eckersley) for several reasons, the chief of which seems to be that if they were put into practice they would be "damaging to the cause of Empire broadcasting," create much disappointment because of uncertainty of success and of technical imperfections, and would, in short, serve only to whet the appetite of a public which could not be properly fed with an adequate short-wave Empire service at this juncture.

We give it as our considered opinion that the reasons advanced by Captain Eckersley are mainly irrelevant and, to a considerable extent, are applied to the problem of Empire broadcasting in such a way as to make them specious in the extreme.

Thousands Hear P C J J

The fundamental objection to Captain Eckersley's case is exemplified by P C J J. Thousands and thousands of ordinary listeners, unskilled in radio technique, have reported reception of P C J J from many distant parts of the earth, and on numerous occasions also.

The Phillips Lamp Co., of Holland, have authentic records of the reception of P C J J in S. Africa, S. America, India, China, and many other distant parts—and the reports indicate that although reception is not regular, and although clarity and quality are not of the first class, the programmes are recognisable, and that the effect on those exiled as they are, is ample justification for P C J J's transmissions.

These are proved facts; and if P C J J can obtain such a satisfactory measure of success, and if ordinary two- and three-valve "straight" circuit receivers, in the hands of the unskilled, can produce such results, then Captain Eckersley's argument that only the skilled amateur can enjoy short-wave broadcasts is proved not only fallacious but quite beside the point.

As for "damaging to the cause of Empire broadcasting"—the word "bunkum" is, if rather colloquial, the only adequate reply.

The Marcuse Experiment

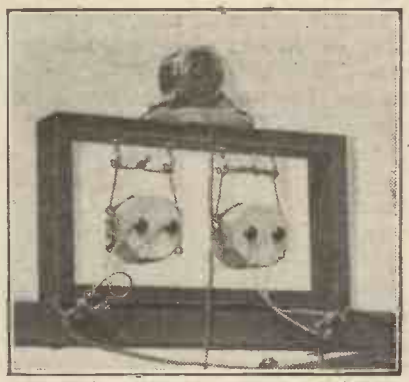
The very fact of the B.B.C. *trying* to do some Empire broadcasts would stimulate eager interest in the Dominions, and if Captain Eckersley will study the S. African, Australian, and Indian press, as the writer has done, he will appreciate this point.

But there is still hope. Mr. Gerald Marcuse, unselfishly organising a service on his own, has now received the P.M.G.'s permission to begin his short-wave Empire radio experiments.

He, unlike the B.B.C., does not set himself a fantastically high standard, which might be reached after years of effort, and which, on the other hand, might not—but intends to get on with the job and do his best to improve his service, and to experiment with a view to overcoming technical problems, as he goes along.

B.B.C. Apathy

Thus, listeners will be able to notice for themselves, by comparision, the improvements made in his service, and at the same time interest will be stimulated and kept fresh in the Dominions, and the success which he will, undoubtedly, partially obtain will but serve to stiffen his determination to continue his undertaking with optimism, imagination, and a complete disregard for the apathy and lack of initiative set him as an example by the B.B.C.



The microphones used to broadcast the Menin Gate ceremony—an event for which an "Empire" station was badly needed.

THE ALL-ENCLOSED SET

By C. A. J.

THE all-enclosed set, having its batteries, coils, and in many cases even its loud speaker inside the cabinet, is still enjoying a large measure of popularity, and will, in all probability, continue to do so; the point that is receiving a great deal of attention at present is the most compact design which it is possible to evolve, while retaining the original features which made this type of set so desirable.

This trend of design, unfortunately, is responsible for a tendency to crowd the accessories rather close to the set itself, and this is a practice which cannot be too strongly discouraged. A compact set is in itself an achievement, but to go to the extreme certainly detracts from its value.

Avoiding Overcrowding

Consider, first of all, the inconvenience caused by lack of space when endeavouring to adjust H.T. and grid-bias batteries, or the loud speaker, when the batteries must, perforce, be removed from the cabinet to adjust the tappings or to reach the adjusting knob of the loud speaker. In many cases it happens that only one size of H.T. battery can be accommodated, and this renders the use of a power valve, with the additional H.T. supply which it necessitates, a matter of impossibility.

A point which cannot be sufficiently stressed is that it is imperative that there should be a screen of some sort between the batteries and the set; a case was brought to light recently of a receiver which was built early this year, and which after a few months began to give a lot of trouble in the form of crackles, intermittent contacts, and general unreliability.

Finally, signals ceased altogether, and when the set was taken from its cabinet it was found that all the wiring was corroded and nearly every joint came apart at the slightest touch. The fine wire of an H.T. transformer was completely ruined in parts, and other damage of a similar nature had taken place in other components.

Accumulator Fumes

This was all due to the accumulator standing right under the set, which was of the sloping-panel type, built into a cabinet having two doors in front, and space for the batteries reached through a flap at the rear.

The accumulator could only just be inserted, and it was not possible to see the back of the panel when the flap was lifted, unless a flash-lamp was used; the cabinet was as tight as a drum, and there was absolutely no means of escape for the fumes from the accumulator, which attacked the wiring and components in the manner described above.

MAKING FIXED RESISTORS

An article of practical value to the constructor of valve receivers.

By H. BRAMFORD.

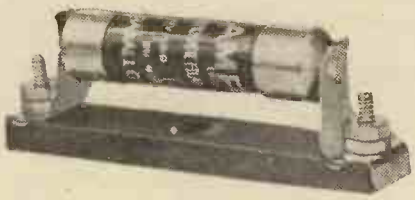
FIXED resistors are easily made, and a few suggestions are given in this article on more or less simple lines. The only essential factor to understand clearly before we commence is what wire to use and what ohmic resistance to employ for the particular valves which we intend the resistors to control.

Yet, again, we may require one resistance to control each valve, or, alternatively, we may wish one resistor to control two or more valves. Before dealing with construction, therefore, I will give brief formulæ embracing these points, so that the reader may easily work out for himself how much wire he should use, and of what gauge such wire should be, for any valve or valves of which the voltage and amperage are known, together with the voltage to be applied to the valve via the resistor from the L.T. accumulator.

Calculations

In the first place we will work with Eureka resistance wire in all cases.

For one valve the resistance in ohms required in each case



The "Amperite" is a special form of resistor and is more correctly described as a "barreter."

$$= \frac{\text{Voltage of battery} - \text{Voltage of valve}}{\text{Normal current taken by valve}}$$

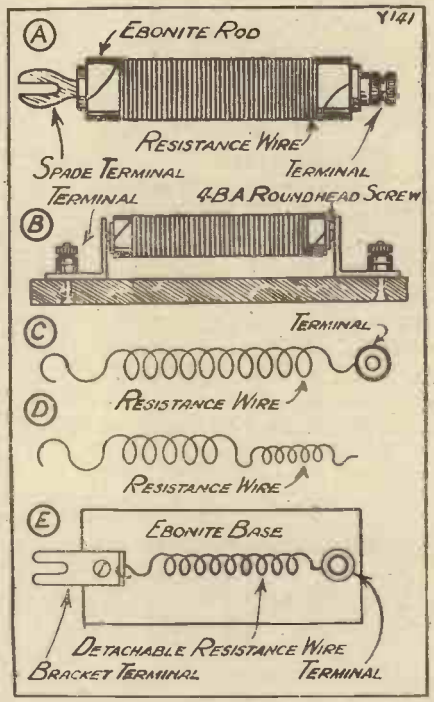
Ex.: 6-volt battery, 3·5 volt, ·06 amp. valve

$$= \frac{6 - 3{\cdot}5}{{\cdot}06} = \frac{2{\cdot}5}{{\cdot}06} = 41 \text{ ohms.}$$

Ex.: 4-volt battery, 3·5 volt, ·06 amp. valve

$$= \frac{4 - 3{\cdot}5}{{\cdot}06} = \frac{{\cdot}5}{{\cdot}06} = 8 \text{ ohms.}$$

For more than one valve, using only



one resistor, the ohmic resistance

$$= \frac{\text{Voltage of battery} - \text{Voltage of one valve}}{\text{Normal current taken by all valves used}}$$

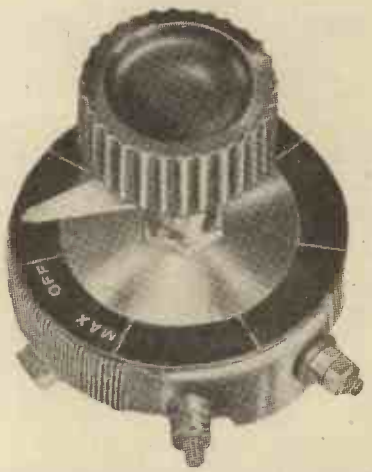
Ex.: 4-volt battery, two 3·5 volt, ·06 amp. valves; one 3·5 volt, ·1 valve

$$= \frac{4 - 3{\cdot}5}{{\cdot}22} = \frac{{\cdot}5}{{\cdot}22} = 2 \text{ ohms.}$$

With this data it is easy to calculate what resistance should be used to control one or more of any type of valve by means of one or more fixed resistors. When this factor is known it is only necessary to choose a gauge of Eureka wire which will safely carry the total current to be passed through it. This may be seen at a glance from the table given.

S.W.G.	Resistance Per yd. (ohms)	Safe Current (Amps.)
14	0·134	9·5
16	0·209	6·0
18	0·372	4·3
20	0·661	3·0
22	1·093	2·2
24	1·77	1·5
26	2·645	1·0
28	3·914	·76
30	5·575	·59
32	7·35	·47
34	10·128	·37
36	14·84	·28
38	23·808	·19
40	37·184	·15
43	66·136	·11
47	214·284	·05

Supposing one resistor is to be used for controlling two 3·5 volt, ·06 amp. valves and one 3·5, ·1 amp.

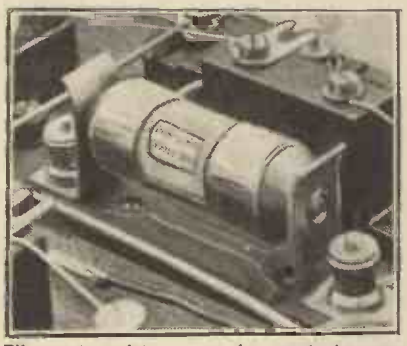


The variable filament rheostat is tending to become obsolete in the construction of a modern receiver.

valve in parallel, using a 4-volt battery. Our last example shows that a resistance of 2 ohms would be required. The current which it would have to carry would be ·22 amp., being the total amperage of the three valves. From the table we note that No. 36 wire carries safely ·28 amp., which is on the right side.

Short Length Required

We may go above this, but not below. One yard of this wire represents 14 ohms approximately, therefore one-seventh of a yard, that is 14 ÷ 7 (resistance required), suits our need, or roughly 5 in. In these figures I have not gone into decimals as regards the answers. This, however, is hardly necessary, provided the safe side is adhered to—that is to say, the resistance should be over the specified figure and the gauge of wire larger than that specified to carry a given current, but in no case should the figures drop below. In this way the constructor may easily make his own resistors to be used in any manner desired for any valves, to be worked from any accumulator. Now I will give a few simple but efficient suggestions for their construction.



Filament resistors can be made in neat forms for mounting on baseboards similarly to grid leaks, etc.

Several examples of types of resistors are shown in the drawing. A represents one which is suitable for connecting at the spade end directly to the filament terminal of the valve holder, a terminal being provided at the other end for connection to the L.T. battery. The material required merely consists of a piece of ebonite rod, a spade terminal with screwed shank, and an ordinary terminal. The wire, if bare, should be space wound.

Further Types

C is even simpler, consisting of wire only. One end is looped to attach to the terminal of the valve holder, the other end is equipped with a terminal.

B is a type suitable for baseboard mounting. The resistor clips into brackets to make interchangeability easy. Construction is much the same as for A, but round-headed B.A. screws are provided at each end, which adjust themselves to holes drilled in the brackets when clipped into position.

D is the simplest type it is possible to make, being constructed from a suitable length of resistance wire only. One end attaches to the terminal of the valve holder, while the other end is wound spirally to hold on to No. 16 bare wire used for connection to the L.T. battery terminal.

E is again suitable for baseboard mounting, but somewhat simpler than C. The bracket terminal adjusts itself directly to the terminal of the valve holder, while the terminal is for making connection to the battery. The resistance wire is cut to a suitable length, wound spirally, and looped each end and sprung between the bracket and the terminal.

IMPROVISED LOUD SPEAKERS

ONE often desires to be able to enjoy the broadcast programme after turning in, and yet does not wish to be bothered with the business of disconnecting the loud speaker, trotting upstairs with it and connecting it to the extension. The suggestion which the subconscious mind instinctively makes on behalf of a new speaker is just as instinctively vetoed. A second thought immediately insinuates itself, to the effect that it need not be a large one; but this receives the same treatment.

Utilising Old 'Phones

However, there is probably an old pair of 'phones lying about somewhere, and if you really want to enjoy the aforementioned programmes at the time specified you can doubtless find the necessary energy which will assist in the transformation of one (or both) of the 'phones into a small loud speaker. (Small but efficient loud-speaker attachments can be purchased cheaply, and the pleasure derived certainly justifies the expenditure.)

There are a hundred and one different ways in which these little instruments are easily camouflaged, and here are one or two suggestions. You may be fortunate enough to have in your bedroom an alabaster bowl as an electric-light shade, and this will prove an excellent diffuser of sound, as well as of light.

The reproducer, whether 'phone or gramophone attachment, is easily adaptable to a wire framework which will allow it to point towards the base of the bowl. Square tinned copper wire, as used for wiring up the set, is strong enough; but bicycle spokes are much better, provided that the constructor is fairly good with the soldering iron.

As they are of steel, they are rather more tricky than tinned copper; but, on the other hand, they are generally well-plated and should not be too difficult to handle. The leads to the reproducer are best taken up to the ceiling in the same manner as the electric-light wiring, and afterwards disguised as well as possible.

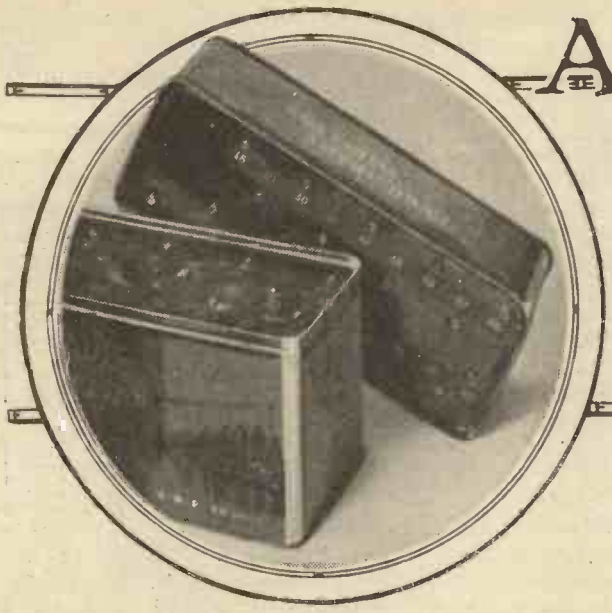
The concave copper bowl of a reflector-type electric heater will be found eminently successful, and the reproducer fitting, if carried out as described above, may be detachable. On no account should the reproducer be left in position while the heater element is in use, as disastrous effects will ensue.

Large sea-shells are really wonderful—natural loud speakers, nothing more or less.

Many Different Methods

If a pair is obtainable, the two earpieces from a set of 'phones may be employed with gratifying success. The fitting of the 'phones to the shells is the only snag. This is accomplished by removing the ends from the shells, leaving an orifice a little larger than that in the cap of the 'phone. The latter must then be drilled out to take the end of the shell, which may then be fitted to it with the aid of Chatterton's Compound. Leave them to set for some time before attempting to use them, as the compound must set hard. A point to watch is that the shell does not touch the reproducer diaphragm, but is just flush with the inside edge of the 'phone cap.

Doubtless other constructors will be able to devise various ways of adapting these suggestions to suit objects which they already possess. Vases, bowls—anything of that kind lends itself to the purpose, and with a little ingenuity will be transformed into an ornamental loud speaker.



ALL ABOUT DRY BATTERIES

The construction of a dry battery is a highly specialised task, and our contributor fully describes the processes that have to be gone through during the manufacture of even the simplest of dry batteries.

By C. W. PEARSON

IN conversation with quite a number of people upon the subject of dry cells, I have been struck with the ignorance of the average amateur as to the construction and functioning of the dry cell, although their knowledge of wireless technique has exceeded expectations. It is not the fact that interest is lacking as much as that no reliable data is procurable. True, various textbooks have endeavoured to explain the mystery. But, as the good battery is a trade secret, not all the textbooks obtainable will be able to explain the details which differentiate between a good and bad battery, as they are very jealously guarded.

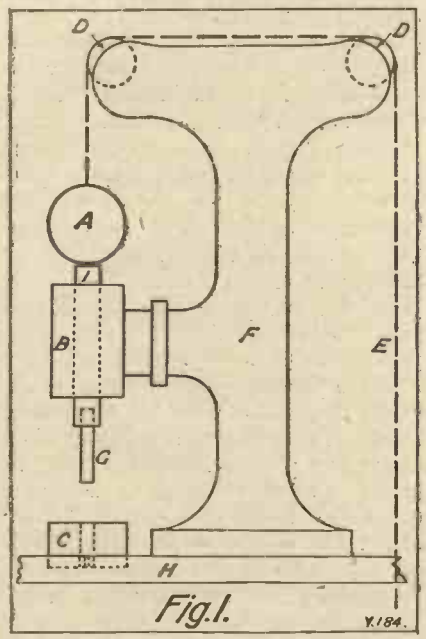


Fig. I. V.184.

In the early war years, viz., 1914–15, quite a number of companies were floated, but many of these have faded into thin air, mainly because they lacked the special knowledge required to produce the reliable article. The dry cell of quality is definitely a trade secret and the result of expensive chemical research, so that a brief outline of the methods and construction should prove interesting to all.

Although we may obtain accumulators and reliable apparatus to use the mains, conditions are such that the dry cell, or, to be more elastic, the primary cell, will never leave the market, as quite a number of us are not so fortunate as to have mains current at our disposal. Or, again, we may live a considerable distance from a reliable charging station. Thus, the only alternative is to use a dry cell, but let it be a first-class article, made by a firm who cannot afford to lose a good name.

The Simple Cell

The primary cell is purely a means of exchanging chemical for electrical energy. A simple cell consists of a plate of zinc and a plate of copper immersed in dilute sulphuric acid and connected together with a wire outside the acid. Positive electricity is carried from the zinc to the copper by the "ions" of hydrogen. In this case the electrical energy is derived from the chemical energy in the combination of the zinc and sulphuric acid.

This simple cell may be used to illustrate clearly the action of a Leclanche cell; which, in turn, is the foundation of the so-called dry cell. The term is misplaced, as the cell will not function if perfectly dry, but would be known commercially as an "inert cell." In the ordinary dry cell, water-attracting materials are added, in order that evaporation losses are minimised.

Raw Materials

The selection of the raw material calls for a wide chemical and electrical knowledge. There are no "might do" materials, as everything must be selected so that the theoretical 100 per cent efficiency is obtainable in the finished article. It is the work of a skilful chemical analyst, and only the manufacturer with a large business or a large capital reserve can afford to pay such a man. Upon the result of his selection depends whether you get a three-month or one-month service from your cell. Materials for an average good-quality dry cell are tabulated under:

Manganese peroxide.
Plumbago or black lead, or graphite.


Right, an old cell; centre, the carbon element; left, the carbon in position inside the sac.

Carbon pencils.
Butter muslin.
Maize flour.
Zinc chloride.
Ammonium chloride or sal-ammoniac.
Mercury perchloride or corrosive sublimate.
Zinc.
Pitch.
Resin.
Bitumen.

A brief outline of commercial selection and the various pitfalls is given below.

Manganese Peroxide. — Occurs evenly distributed all over the world, and the varieties available run into hundreds, but of these very few are of any use for battery manufacture. Little can be said here of the undesirable qualities, as the extensive chemical description required would appear pedantic and out of place in a wireless journal. One of the best samples used by the author emanates from the Caucasus in Russia, and on analysis showed 87 per cent manganese peroxide, and only traces of iron, arsenic, copper, and phosphorus, the balance being harmless residuals, i.e. alkalies. water, and silica.

Ground to Grist

Suffice it to say that so long as the oxide content is as above, and a minimum percentage of iron, arsenic, copper, and phosphorus, this may be taken as a good commercial specimen suitable for our purpose. Any reasonable manganese will give a result of a kind, but reliability will be lacking.

Three further stages in the construction of dry cells.

Naturally manganese occurs in nodules as big as a pinhead, and in pieces weighing hundreds of tons.

Before being used for batteries, the product is ground to a grist known as "Cyclone," or wind carried. This is extremely fine and is almost immeasurable. Too much care cannot be bestowed upon its selection, and many an otherwise good battery owed its failure to bad and unsuitable manganese, whilst many a factory has had to close its doors owing to ignorance in the choice of it.

Plumbago.—Known as black lead and "graphite." Occurs naturally, distributed all over the world in patches. Here, again, the manufacturer can easily fall, as the value is governed by its carbon content. This varies from 60 per cent to 98 per cent. Very few of the natural graphites are of any use to us, owing to iron, copper, and phosphorus impurities.

Points to Watch

One of the finest graphites that the writer has used is an artificial product, made in electric furnaces near the Niagara Falls, and known to the trade as "Aitcheson." It is a dull grey-black powder, but containing a very high carbon content, i.e., 98–99 per cent, the remainder silica, which is a harmless, inert substance (electrically). It is made at the Falls owing to the fact that a very heavy electric current is required at the furnaces, and current is remarkably cheap, there, owing to water power.

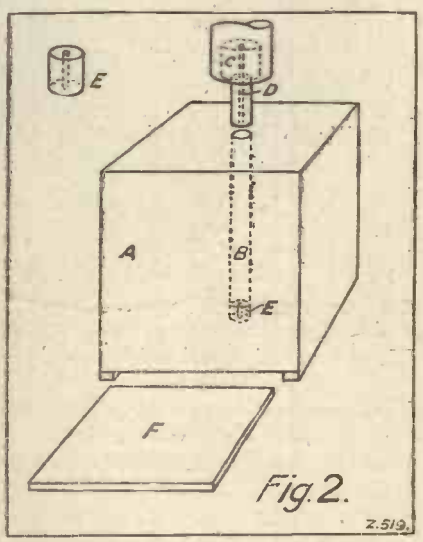
Butter Muslin. This is an open material, sold by all drapers, but not being a textile expert I cannot say more.

Maize Flour. This is the residual starchy material obtained as a by-product from the extraction of the oil from maize. It is identical in its action (electrically) with ordinary starch.

Zinc Chloride. This material should be familiar to all amateurs as "*Killed Spirits of Salts*" (a material which you should not use as a flux when building a set.) It is used in a battery on account of its hygroscopic or water-attracting properties. A cask of this material, weighing two hundredweight will quickly pass into a syrup through water absorbed from the atmosphere.

Ammonium Chloride. This material is that known more commonly as sal-ammoniac, and as appears quite clear from the name is a "salt of ammonia." Briefly, in the manufacture of coal gas, a liquid distils over which is called ammoniacal liquid. After extracting various valuable by-products, the liquid left is treated with an alkali such as soda, and again distilled, when ammonia gas comes off. This gas is dissolved in water, if ordinary ammonia is required, or passed into an acid if the salt of ammonia is wanted. Thus, if ammonium sulphate is wanted, the gas is dissolved in sulphuric acid, or in the case of ammonium chloride, hydrochloric acid.

The solution obtained is evaporated to dryness, and the horny residue heated, when the purest form of sal-ammoniac is passed over as white fumes which on cooling give a pure white powder. Its quality can



usually be judged from its colour, as one of the most likely impurities to be looked for is iron. This, if present, would colour the material a faint yellow or pink. It is usually bought in fine granules for electrical purposes.

Mercury Perchloride. Also sold as corrosive sublimate. This is a very strong irritant poison, and if purchased the buyer is usually asked to sign the poison book. Too much care cannot be bestowed on it, as a very minute portion is a fatal dose, resulting in a painful death. A solution in water is decomposed by metallic zinc, giving up a portion of its mercury in exchange for some zinc, which is attacked by the chlorine left over from the decomposition and results in a solution of zinc chloride. Later, we will see how this valuable exchange is utilised.

A Rough Test

Zinc. We are all more or less conversant with this commodity, as rolls are nearly always displayed by builder's merchants and ironmongers. In the selection of this the analyst can supply some very interesting data. Commercial samples usually contain iron, lead, cadmium, arsenic, antimony, copper, silver, sulphur, and a few rare metals. It is the actual zinc content of the sample that determines its value electrically, the

others being unwanted and in some cases deleterious to the battery.

Some samples of American spelter, as this sheet zinc is often called, only contain 75–80 per cent metallic zinc. These are useless. A very pure sheet zinc comes from the Liege area in Belgium, and the writer has analysed samples that have shown as much as 97–98 per cent pure zinc. This is the material that should be sought. Of recent years Australia and Canada have prominently figured in the zinc markets, and some of the better varieties are of very high quality.

A rough indication of quality in this metal is indicated by its uniform colour, its ability to withstand bending at sharp angles without fracture, and absence of crystalline surface structure.

Pitch, Resin, and Bitumen. These three are purely subsidiary substances, and do not require such care in selection, as their only use is to seal the cells and supply an outward finish.

Manufacturing Methods

The cell may be divided into three distinct headings, viz., the "dolly," the container, and finishing off, and each process will be dealt with in sequence.

The "Dolly." The composition of the black material is varied by different manufacturers, but in an average good battery has a composition of:

Manganese dioxide, 3 parts - - - - } by weight.
Plumbago, 1 part - - }

These two are mixed intimately in revolving mixers, constructed from wood, and simply may consist of an ordinary 40-gallon barrel mounted on an axis, with an aperture in the top, which may be closed by a small trap-door to allow adding raw material and removal of mixed product. Small solid rubber balls are sometimes placed in the barrel, so that when it revolves their movement will accelerate the process of mixing.

The mixed material is removed from the apparatus and placed on a wooden floor, and damped with a solution of sal-ammoniac in water, about 1 part of sal-ammoniac to 20 parts of water. No great accuracy is required for this solution, as its presence is only required to prevent dilution of sal-ammoniac in the electrolyte. As stated previously, the sal-ammoniac forms the excitant of the cell, consequently we cannot afford to lose any, otherwise the battery would not deliver the life for which it was primarily designed.

On the other hand, too much ammonium chloride will cause "creeping" of the salt, which, as we all know, soon puts a battery out of action by eating away the copper connecting wires. The mixture from the barrel is thoroughly damped with the sal-ammoniac solution, taking care that it is not made too wet, as otherwise the finished "dolly" lacks uniformity and is a great trouble to remove from the mould, besides taking a long while to dry before it can be handled.

The Carbon Core

A carbon rod forms a core for the "dolly," and is capped at the top with a small brass cap. The carbon used for an average battery is 6 mm. diameter by 54 mm. long, and must be dead straight and of very low porosity. If the rod is porous the electrolyte is carried by capillary attraction to the small brass terminal cap at the top, and gradually eats the cap away, resulting in a broken connection.

It is possible to prevent this creeping by steeping the top of the carbon in hot paraffin wax, but to be effective the rod must remain in the wax so as thoroughly to permeate the carbon. From the body of the "dolly" to the top of the rod is a space, left for a porous material so that any gases formed may percolate and escape.

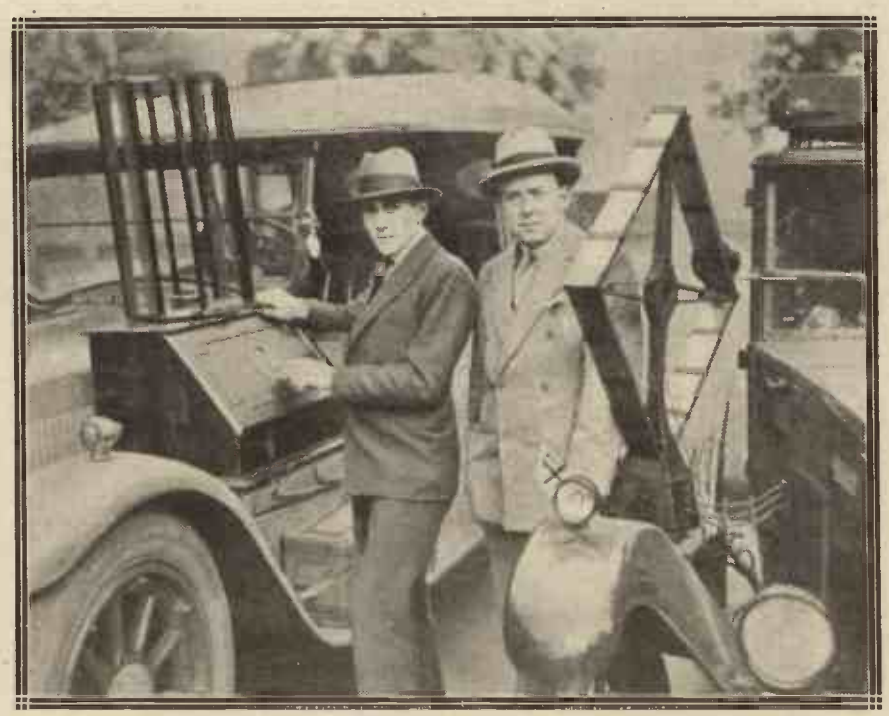
In forming the "dolly," a mould of slate is used. This may consist of a square about 2¼ inches thick with a hole bored true and smoothly to the outer diameter of the "dolly." A round collar of wood is turned on the outside, so as just to fit in the slate mould. This collar is made to agree with the space between the top of the "dolly" and the top of the carbon pencil, and also holds the carbon pencil upright in the mould, as well as dead central.

By resting the mould on two pieces of wood about ¼ in. thick by ½ in. wide, we have a space so as to insert a piece of steel plate covering the central hole and forming a stop so that the carbon rod and collar will not fall through. Figs. I. and II. illustrate the assembly.

Some of the damped powder is now placed in the mould and rammed well down by the plunger. A light blow of a mallet on the plunger will compress the powder and bind it. After the hole is filled with powder and compressed the plate at the bottom is removed, and a few blows of the mallet on the plunger will remove the "dolly" from the mould. By carefully holding the "dolly" the collar may be removed by twisting it and gently withdrawing.

Drying the "Dolly"

The finished "dolly" is now placed to dry at about blood heat, and after two or three days will be found to be quite hard. This antique and lengthy process is still used in small factories in England and on the Continent; but the larger shops use multiple moulds and hydraulic presses, capable



Captain L. F. Plugge, who, with Mr. Horace Connell, is undertaking a tour of Europe. The two cars will travel 500 miles apart and will endeavour to keep in touch by means of portable transmitters and receivers.

of an output around 800 per hour. After practice it is surprising how few bad "dollies" are produced, but a new operator requires two or three days of very low production to become accustomed to the work.

After hardening, the "dolly" is ready for wrapping, a task which requires nimble fingers. Girls used to sweet-wrapping very quickly fall into this work and give a large daily production. A small square of butter muslin, sufficient to cover the "dolly," is used, wrapped round with ordinary cotton, leaving the top of the carbon projecting. The wrapper must be kept away from the metal cap, or otherwise corrosion will take place, as it forms an easy path for the creeping of the electrolyte.

Preventing Local Action

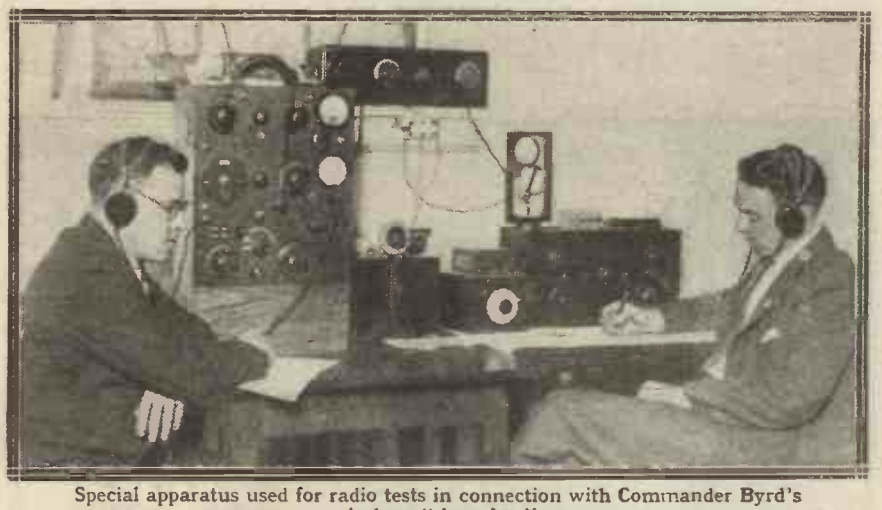
Little can be said about the zinc container, as this is simply a cylinder, soldered at the seam, with a bottom soldered into place to form an open-topped watertight container.

Having a cylinder complete and a wrapped "dolly," we are now ready for the electrolyte. A good electrolyte may consist of a semi-saturated solution of sal-ammoniac in water, i.e. a hot saturated solution of sal-ammoniac is taken and the volume doubled by adding cold water. To every gallon of this solution is added three fluid ounces of cold saturated solution of mercury perchloride, which amalgamates the inside of the zinc container. This amalgamation is very important, as it prevents wasting of the zinc by the process known as "local action." In the zinc are minute impurities of copper, iron, and arsenic, which set up minute currents in their immediate neighbourhood. As the current is set up at the expense of the zinc, it is perfectly logical that in a short while the whole of the container would waste away without doing any useful work. By adding the mercury perchloride, combination of the zinc and mercury takes place, coating the inside of the container with an amalgam of these two metals.

Self-Supplying Zinc

Chemical action will only take place between the sal-ammoniac and the amalgam when the circuit of the cell is completed, consequently the zinc will only be used as wanted. As the zinc is used from the amalgam more pure zinc is dissolved from the container, thus always exposing a pure surface to the action of the electrolyte. The importance of this cannot be too strongly recommended, but it is possible to add too much of the mercury salt. If this is done the container will almost fall to pieces in about two or three days.

To the solution of ammonium chloride is added some syrupy solution of zinc chloride, about a gill to a gallon of sal-ammoniac. The quantity is not critical, as it is electrically inert and merely added in order that the cell will not dry up. Too much is not required, as it is formed during the electrical decomposition of the zinc. All these ingredients are well stirred in an earthenware vessel with a stirrer of wood, so as to avoid any contamination from iron, which the sal-ammoniac readily attacks.



Special apparatus used for radio tests in connection with Commander Byrd's airplane "America."

Filling and Finishing

We have now ready for use the electrolyte, "dolly," and zinc container. A cardboard disc of a diameter so as to fit into the container is placed in melted paraffin wax, and after draining is pushed into the zinc shell, so as to rest on the bottom. This serves to insulate the "dolly" from the shell, but there is a chance when the centre is placed into position that the sides will touch the cell. Two small rubber rings are slipped over the muslin wrapper of the "dolly," one at the top and one at the bottom, thus insulating it effectively at all points.

We are now ready to pour in the electrolyte. The liquid is usually placed in a glazed china receptacle such as a small jug or teapot, the lip or spout serving to pour a thin continuous stream. Sufficient flour or starch is added to give the solution the appearance of milk, and poured into the assembled cell, so as just to cover the shoulder of the "dolly," taking care that none falls upon the exposed part of the carbon rod or the sides of the zinc shell. This prevents creeping of the salts.

The Final Corrections

The cell before sealing is set aside for a day or two, so that the loss of the electrolyte, caused by absorption in the "dolly" may be made up. The next operation is sealing the cell, but a "gassing" space must be left over the electrolyte. This is provided by either sawdust or seed husks, a thin layer of about $\frac{1}{16}$ in being placed over the electrolyte. The sealing compound may consist of approximately 10 parts pitch, and 1 part resin, the latter causing the pitch to hold the surface better.

The cell is now complete, and we have for poles the side of the zinc shell and the brass cap of the carbon pencil. The cell should now show a voltage of 1·6 if the above directions have been carefully followed, but in making a battery there is a drop over connections, etc., which gives an effective voltage of 1·5. As these cells are the foundation of all dry batteries used in wireless and pocket lamps, it is a simple matter to work out how many cells are wanted for any voltage. For example, a 60-volt H.T. battery will require 40 cells, and a 9-volt battery 6 cells, connected in series by a tinned copper wire of about 26 gauge.

All that now remains to complete the battery is to place the cells in a cardboard container, connect them together in series, and seal off with pitch. The brass tapping sockets in an H.T. battery are merely small brass tubes soldered at definite intervals to the connecting wires and held in position by the pitch.

Recent Valve Developments

The coming "season" will be of great interest to all constructors, for it will show some considerable changes in valve design.

By KEITH D. ROGERS.

BRITISH valves have come down in price once more, in order—so we are told—to compete with the foreign valves now on the British market. In order to do this the British manufacturers have reduced the price of all valves, so that the "home" made valve shall have more chance against those imported from other countries.

It is doubtful, in my opinion, if the reduction that has taken place will have any effect, for the prices still keep British valves at a higher figure than the foreign ones. Against this it might be argued that the British tube is far superior to the foreign one, but I am afraid few people take that into consideration if they are at all tempted to buy the imported article.

Will Sales Go Up?

But, in defence of the British valve, I must say that it *is* worth its price when considered side by side with the foreigner. Whether or not the British valve could be still further cheapened is another matter—I have my own opinion about that—but as it has not been reduced further than it has, there is no use in talking over the "might-have-beens."

Now, readers will agree with me that although many foreign valves can be found to give good results, comparatively few of them have any lasting power and rarely live as long as a British-made valve. Besides this, there is not the choice to be found on the foreign market that can be met with among our own products.

On a recent test of a foreign and British valve, used for the same purpose (L.F. amplification), the foreigner lost its "punch" long before the Britisher gave the slightest symptom of growing old; and the matching of valve and components was a difficult one when the French valve had to be used. As a matter of fact, I never got the imported valve to give quite the tonal purity I could obtain with the English article.

High Standard

A further great point in favour of British valves is the high standard of constancy that has been achieved, and in most cases, at any rate, we know that if we burn out a valve we can replace it with another having reasonably near, if not the same, characteristics.

Another reason for the price reduction is that the lower price is meant to be an incentive to the crystal man to either scrap his crystal set and go in for valves, or else to add amplifiers to his present receiver. In either case he would get better results, but would have to pay more for them. With dull emitters down to 10s. 6d. there *should* be not a few crystal-set owners, and many people who have hesitated about getting a set at all, who will now take the plunge and launch out further into the etheric sea. I wonder if they will?

However, no matter what the price of the valve, there is no doubt that we all have a tremendously wide selection. There are over 400 valves on our market, the large majority being of British manufacture, and this 400 comprises all kinds and classes, sufficient to suit all purposes. Furthermore, new valves are constantly being placed on the market, and recent developments have shown that we, as valve designers, are by no means behind in the radio world.

An Outstanding Advance

The most outstanding advance is the new S.625 valve, which will probably be available to readers by the time this appears on the bookstalls. This valve is quite unlike

The new S.625 valve has a novel appearance. The three pins at one end are for grid and filaments, while at the other are two well-spaced pins connected to the anode and the shielding "grid." Circuits employing this valve have to be heavily screened.

anything that has yet been seen on the English market, and is designed especially for H.F. amplification. Indeed, it bids fair to revolutionise H.F. practice, for it certainly gives results far and away above those obtainable with ordinary valves.

The valve in question has four electrodes, having a specially "earthed" shield inside to shield the grid from the plate, and thus to prevent any possibility of feed-back. The photographs show the construction in a clearer way than I can describe.

This shield is taken to about 80 volts positive on the H.T. battery, while the plate is taken to a still higher voltage. The main or control grid should have a negative bias, so that it is always operating below zero grid volts, and the peculiar thing about the valve is that it operates best at about saturation-point.

On test certainly the valve showed itself to be a wonderful amplifier, and a magnification of 40 per stage is obtainable on the ordinary broadcast band. Up to 150 or more can be obtained on Daventry's wavelength, while the construction of the valve is such that no neutralisation is required. Instead, the circuits must be very carefully screened so that no feed-back is possible, and then, with a high-impedance anode circuit—such as the tuned-anode system—a full measure of amplification is obtained.

Further Types

At present the only type of valve of this kind on the market is the S.625, taking ·25 amp. at 6 volts: but I understand that 2-volt ·1 and 4-volt valves are shortly to be released. The valve photographed is a Marconi valve, but Osram valves of the same type are also available.

The main characteristics of the valve are given as

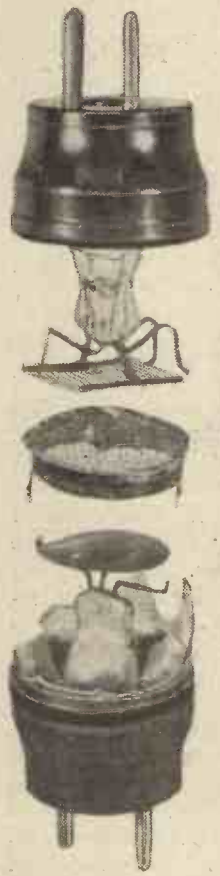
Fil. volts 6·0
Fil. amps. 0·25
Under average conditions
Impedance 175,000
Mag. factor 110
Anode volts 120
Screen volts 80

Under working conditions the valve takes only 3 milliamp. or so, with the screen taking ·5 milliamp. at 80 volts.

Another interesting valve is the Robinson two-plate valve, which is self-neutralising. In appearance the models I have seen are similar to the P.M. type of valve, except that, mounted directly above the ordinary filament-grid-plate, assembly is an exactly similar grid-plate assembly, without a filament. Thus the second assembly is shielded from the *filament* (the source of the electron stream) by the lower plate (inside which is the filament), and, therefore, the second plate is *dead*; it collects no electrons.

Self-Neutralising

The second grid is connected to the first grid, but the second plate is connected to a flex lead on the base of the valve, the lead being taken to the end of a neutralising winding. Thus we have the "dead" plate-grid capacity equal to the first or "live" grid-plate capacity, the former capacity acting as a neutralising condenser in the conventional neutralised circuit (split-primary type), and, therefore, the valve is, as far as its own *internal* capacities are concerned, self-neutralising. External wiring has to be carefully arranged, however, in order not to defeat the object of the valve by introducing outside unneutralised capacities.



The elements of the S.625 (shielded) valve. At the top of the photograph we have the grid and filament unit, then comes the shield which fits over the plate. The shield requires a positive potential of about 80 volts and the anode or plate requires 120 volts. The valve is, preferably, mounted in a horizontal position when used, as owing to the high amplification obtained careful screening has to be adopted.

* * *

It has been rumoured from a fairly reliable source that a well-known valve firm is shortly going to do wonderful things with a new super-power valve for A.C. mains. Up to the present, although super-power valves have been good, they have had fairly low mutual conductances, and thus have been capable of handling great volume but of amplifying very little. This new valve is said to have a low impedance, 2,500 ohms or thereabouts, with a mutual conductance of 4; or, in other words, an amplification factor of 10. This sounds really good if the valve can handle a good voltage swing. Its H.T. voltage is given as 200 volts, and I for one am looking forward to the valve's debut.

Talking about valves for last-stage L.F. amplification reminds me of the new D.E.H., D.E.L., D.E.P.610 types recently brought out by the Marconi and Osram people. In this case I must say I was very disappointed with the power valve, though the others are exceedingly good. But let us take them in order. The D.E.H.610 is a valve designed for resistance-capacity coupling, and as such is extremely efficient. It has an impedance of 70,000, with an amplification factor of 40, and takes ·10 amp. at 6 volts. In use it is extremely efficient, and should be very popular for first-stage resistance-capacity coupling.

Poor "Power" Valve

The D.E.L.610 is, in my opinion, the "plum" of the group, and I have no hesitation in recommending it to all readers. For H.F. neutralised circuits, detector acting on either grid leak and condenser or anode-bend principle, R.C. coupling, transformer, or even choke, the valve is extremely good. It will not overload under normal conditions and is wonderfully efficient. Having an amplification factor of 15, with an impedance of 13,000, the valve makes a very useful "general-purpose" valve, though I do not usually like to use that term.

Unfortunately, on test, the D.E.P. 610 fell short of my expectations of its behaviour—until I saw the characteristic curve. It has, as its makers state, a "steep slope"; it has wonderful amplifying properties (mutual conductance=1·55), its impedance is not high—4,500 ohms, but it will not stand much more than 100 volts H.T., and it certainly will not carry anything like a decent grid-voltage swing. To rate a valve as a "power" valve and to eulogise upon its clear reproduction would be all very well if the valve would carry a fair grid swing, but it overloads at the slightest excuse, and I am afraid will not be popular with the man who wants good loud-speaker strength with purity. Used as a first-stage L.F. valve (taking rather

(*Continued on page 306.*)

THE "HALE" ONE-VALVER

" I doubt whether any other single-valve and crystal arrangement has combined such volume and purity . . ."

Designed and described by
PERCY W. HARRIS, M.I.R.E.

THE Hale circuit, which I had the pleasure of introducing to the home constructor in " Popular Wireless " last winter, is adding to its hosts of friends every day. I doubt whether any other single-valve and crystal arrangement has combined such volume and purity from the local station with the remarkable distance-getting qualities of this circuit, and certainly it forms the most efficient way to use a single valve. Apart from its simplicity and efficiency it possesses many interesting features, and for this reason alone a compact single-valve Hale receiver may perhaps be acceptable to readers of MODERN WIRELESS.

Smooth Reaction

Although generally called a " reflex " circuit the Hale arrangement is essentially different from the ordinary reflex circuit which uses the valve first of all as a high-frequency amplifier, the output being then rectified by the crystal and passed back, to be magnified again at low frequency. Practically all ordinary reflex circuits show a marked propensity to " howl," due to the fact that the low-frequency transformer couples plate and grid circuit in such a way as to invite low-frequency reaction. Furthermore, most reflex circuits of a normal kind do not lend themselves to smooth reaction build-up, and thus the amplification of weak signals generally presents difficulties with them.

One of the most pleasing features of the Hale circuit (whether used with magnetic reaction of the swinging-coil type or with the popular condenser-controlled arrangement commonly known as " Reinartz ") is the delightfully smooth reaction control. This not only makes operation simple, but gives remarkable sensitivity. For example, with the single-valve Hale set about to be described Langenberg can be received at Wimbledon in broad daylight at sufficient strength to be heard on a loud speaker. The strength, of course, is not what is generally termed " loud-speaker strength," but the volume is sufficient for one to be able to follow any announcements made four or five feet from the speaker in a quiet room. Expressed in terms of headphone

A semi-permanent type of crystal detector is utilised, and is so mounted that it cannot be accidentally knocked off its adjustment. The knob for adjustment is clearly seen in this photograph.

reception, this means that the Langenberg signals in daylight are really loud and clear. Bournemouth, Brussels, Hilversum, Radio-Paris, and one or two others are also received at clear headphone strength in daylight; while Daventry and London, of course, operate a loud speaker, the 2 LO giving very full volume.

Pure Reproduction

At the same time, it is foolish to imagine that this or any other single-valve circuit is a suitable equipment for a man who wishes to spend most of his time in hunting for distant stations. The achievements recorded above are given rather as an indication of the "safety factor" possessed by this set. Provided one is not living in the shadow of a powerful station there is no difficulty whatever in logging fifteen or twenty stations on this single-valve set (including those in the Daventry range), but this will only be done with very careful use of reaction, and is not recommended save to those who have a little experience in handling reaction sets.

If, however, you want pure loud-speaker reproduction from your local station up to fifteen or twenty miles,

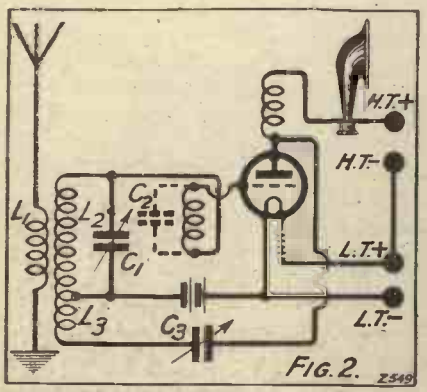


FIG. 2. Z549

then this single-valve Hale circuit will give it to you, providing you have a reasonably good aerial of average dimensions.

Concerning the Circuit

Fig. 1 shows the circuit, the most remarkable feature of which is the peculiar position of the low-frequency transformer and its connections. The aerial is coupled to the grid circuit by means of a standard six-pin Reinartz coil, the tuning capacity being ·0005 mfd. maximum and the reaction condenser of similar value. A standard low-frequency transformer is used and a crystal detector of the permanent mineral type. Incidentally this type has been found to be superior in the Hale circuit to those in which a cat's-whisker is used with a crystal of the galena type. The plate circuit offers no novelty, and the usual radio-frequency choke will be seen. This,

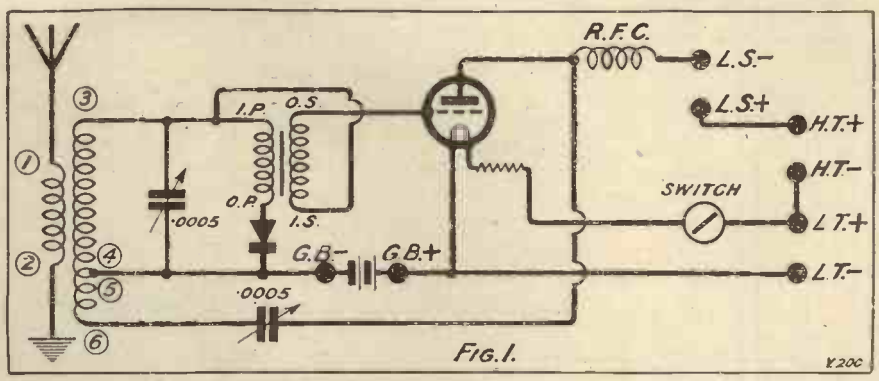


FIG. 1. V.200

of course, is to enable the particular form of reaction to be used.

The crystal, it will be noticed, is joined in series with the primary of the transformer, but at the opposite

COMPONENTS REQUIRED.

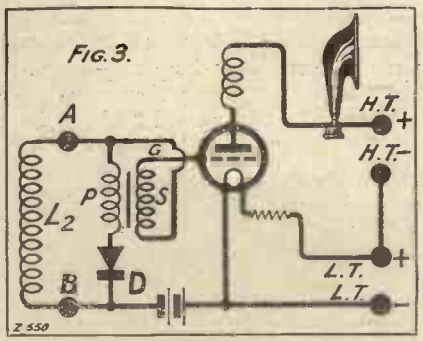
1 panel 10 in. × 7 in.
Baseboard 7 in. deep.
1 ·0005 mfd. variable condenser, S.L.F. or S.L.W., according to taste.
1 ·0005 mfd. variable condenser, S.L.W. (There is no point in using a straight-line frequency condenser for reaction. It is better to use a straight-line wavelength.) The condensers shown are Gecophone and have the advantage of occupying a comparatively small space on the panel.
1 crystal detector of the double-crystal type. (R.I.-Varley Ltd.)
1 good intervalve transformer. The Pye 6 : 1 ratio is used in the set illustrated, but practically any good make will do with the exception of the types including a condenser across the primary.
1 base for six-pin coil. Lewcos or other makes occupying small space.
1 standard Reinartz-type transformer. 250 to 500 metres.
1 standard Reinartz-type transformer, 1,000 to 2,000 metres.
1 anti-phonic valve socket. (Lotus, Lissen, Benjamin, Burndept.)
1 good radio-frequency choke. (McMichael, R.I.-Varley, C.E. Precision, Lissen, Ormond, etc.)
1 fixed resistor to suit valve chosen. Magnum, Lissen, Burndept, Tempryte, Amperite, Igranic, etc., are available as alternatives.
1 on-and-off switch. Igranic is shown. Others available are Lotus, Lissen, etc.
Terminal strip 10 in. long with ten terminals for—
Aerial, Earth, L.T.+, L.T.−, H.T.+, H.T.−, G.B.−, G.B.+, Loud Speaker −, Loud Speaker + respectively.

end to normal. O.S. of the transformer is joined to grid in the conventional manner, but I.S. instead of going to filament or grid bias is connected to I.P. The grid of the valve is given a negative bias by means of the grid-bias battery indicated. The adjustment of this is important, as will be explained later.

The functioning of the circuit will be best understood by analysing its action on the high-frequency and the low-frequency sides respectively. Fig. 2 shows what happens to the high-frequency component. Here the oscillations in the aerial are made to induce similar oscillations in the grid circuit, consisting of L_2—C_1, the high-potential side of the tuning condenser being connected, as will be seen, to I.S. of the transformer. The secondary winding offers considerable impedance to high-frequency currents, but there is sufficient capacity in the winding to enable the high-frequency component to reach the grid. The equivalent capacity C_2 is shown dotted in the illustration.

The L.F. Transformer

Critics who have not tried the circuit have sometimes suggested that it would only work with an inferior transformer having high self-capacity in the secondary winding. As a matter of fact, those transformers which are



Z 550

specially designed to have a very low self-capacity work excellently with the circuit. The Marconi "Ideal," Pye, and R.I.-Varley, to mention but three in which the self-capacity of the secondary is exceedingly low, all function excellently, and superior

results are not obtained by the cheap transformers with high self-capacity windings.

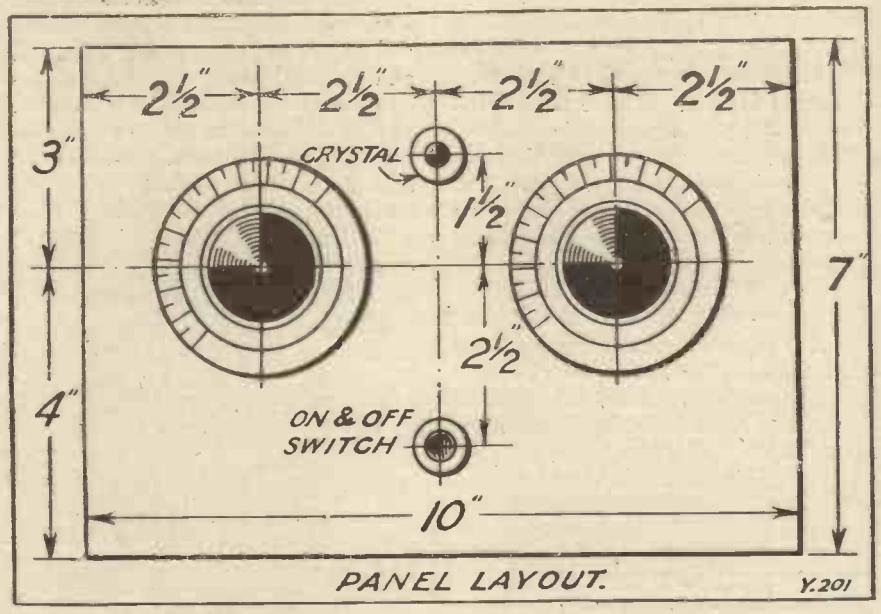
It should be mentioned, however, that the Ferranti, an excellent transformer of very high grade and very low self-capacity in its windings, does not function satisfactorily in the Hale circuit, not because of its low self-capacity but due to the fact that there is built inside the casing a fixed condenser across the primary winding. The presence of this condenser is detrimental to the working of this particular circuit, although in a normal circuit the presence of this condenser is in no way detrimental. It is, as a matter of fact, part of the fundamental design of the instrument.

Still considering the high-frequency component, we see that the valve acts quite normally as a high-frequency valve, reaction being obtained by the winding L_3 and the condenser C_3. The effect of this reaction, of course, is to reduce the losses in the grid circuit to a negligible figure, and if too much reaction is used the set will oscillate in the normal way.

Operation of the Circuit

Let us now consider Fig. 3, which shows the low-frequency portion of the circuit. L_2 is the tuning inductance, and high-frequency potentials are present across A–B. Rectified current passes through the primary winding P of the transformer and low-frequency differences of potential appear in the normal way in the winding S. One end of this, it will be observed, is connected to the grid, while the other reaches the filament through the winding L_2 which, for the low-frequency current, is practically a short circuit, the effect being precisely the same as if the secondary return were taken directly to the point B.

The valve is now acting in quite a normal fashion as a low-frequency valve.



The grid-bias battery serves to keep the working-point on the correct part of the characteristic curve, and prevents the valve rectifying (save with very strong signals).

A particular virtue of the Hale arrangement is that no part of the transformer is in the plate circuit, and thus the usual trouble with low-frequency reaction and howling is avoided. The excessive use of reaction will, however, set up an audio-frequency howl, but as this does not occur until reaction has been advanced beyond the point of oscillation it is not detrimental to work, and, in fact, is a helpful and very audible indication that excessive reaction is in use.

With a good setting of the crystal the reaction build-up is very smooth, but any alteration of crystal adjustment will alter the reaction setting. However, it is a simple matter to find the best adjustment of the crystal when little or no reaction is being used, and once this has been found it need not be touched again until the good point is lost.

Suitable Valves

Accessories needed are one good low-frequency or small power valve. With the particular crystal detector and low-frequency transformer used in this set and with the Reinartz six-pin coil I have found the most satisfactory results to be obtained with what are generally termed the small power valves. In the 6-volt class typical valves I have found suitable are P.M.6, Cossor 610L.F., Marconi or Osram D.E.5, B.T.H. B.4, and Ediswan P.V.5, Electron S.S.610P and S.T.62. Six-volt valves are more efficient than the 4-volt, and the 4-volt more efficient than

The left-hand condenser is used for tuning, while the other controls the reaction. An on-off switch is provided for control of the L.T. supply.

the 2-volt, but this circuit will work quite well on 4-volt or 2-volt valves provided types are chosen which suit low-frequency amplification.

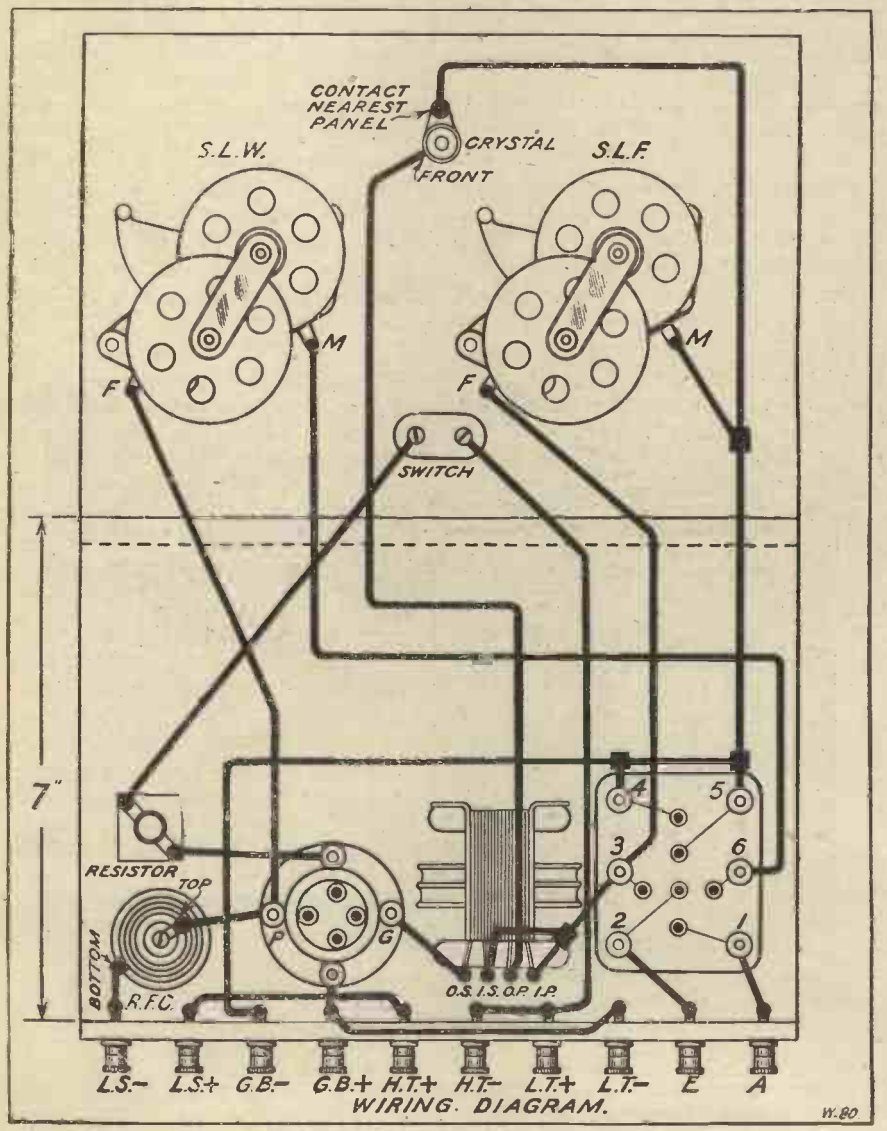
Constructional Details

For example, in the 2-volt series I have worked successfully with the Cossor 210 L.F., Mullard P.M.1 L.F., and B.T.H. B22. Marconi or Osram D.E.L.210 is another excellent valve for this purpose, and the P.V.2 of Ediswan. So far as the 2-volt series is concerned, it should be remarked that if the set is to be mainly for the local-station working, and the local station is not more than ten or fifteen miles away, it may be found an improvement to use one of the 2-volt power types of valves such as the B.T.H. B.23, Cossor Stentor 2, etc. These will handle more volume without distortion but the amplification will be slightly lower than with those previously mentioned.

Constructional work is quite normal in this set. The only point to bear in mind is that if different components from those illustrated are used, care must be taken to see that they fit into the available space, as pains have been taken to make the set as compact as possible. The crystal detector, by the way, is mounted on the panel in rather an unusual fashion. I have found that by drilling a single hole, several different makes of crystal detector can be interchanged with ease. It is then only necessary to unscrew one terminal from the cartridge type of detector and insert the shank of the screw and secure the terminal on the front of the panel. In the R.I.-Varley type this places the adjusting knob behind the panel, but this is no disadvantage, as this should not be touched more frequently than is necessary.

Try and follow as closely as possible the actual layout of the wiring used, as this has been carefully designed in view of the importance of the high-frequency path.

Aerial and earth are joined up in the usual way, as are the H.T. and L.T. batteries. Grid bias, however, requires a little manipulation, for if too much is used the set will not give a proper reaction control, and if too little you may get undesirable rectification and distortion. The best way is to use as much grid bias as you can while retaining the ability to bring the set up to the oscillation-point at any reading of the tuning dial.



Preliminary Adjustment

The preliminary adjustment of the receiver is very easy if you follow the sequence about to be described.

First of all, set the reaction condenser at zero and tune in your nearest station on the tuning dial. Without altering the reaction condenser setting find the best position on the adjusting knob of the crystal, grid bias being set, meanwhile, at about one and a half volts if you are using a 60-volt battery, or four and a half if you are using a 120-volt battery.

If your nearest station is within ten or fifteen miles then the 120-volt battery is decidedly the best, as it will give you good, undistorted volume and excellent loud-speaker reproduction.

Having found the best position for the crystal setting, set the tuning condenser somewhere near maximum, and slowly turn the reaction dial. If the set is going smoothly into oscillation before the maximum reaction condenser setting, use a little more grid bias and repeat the process, until the set will just oscillate at the top of the tuning scale before the reaction condenser reaches its maximum.

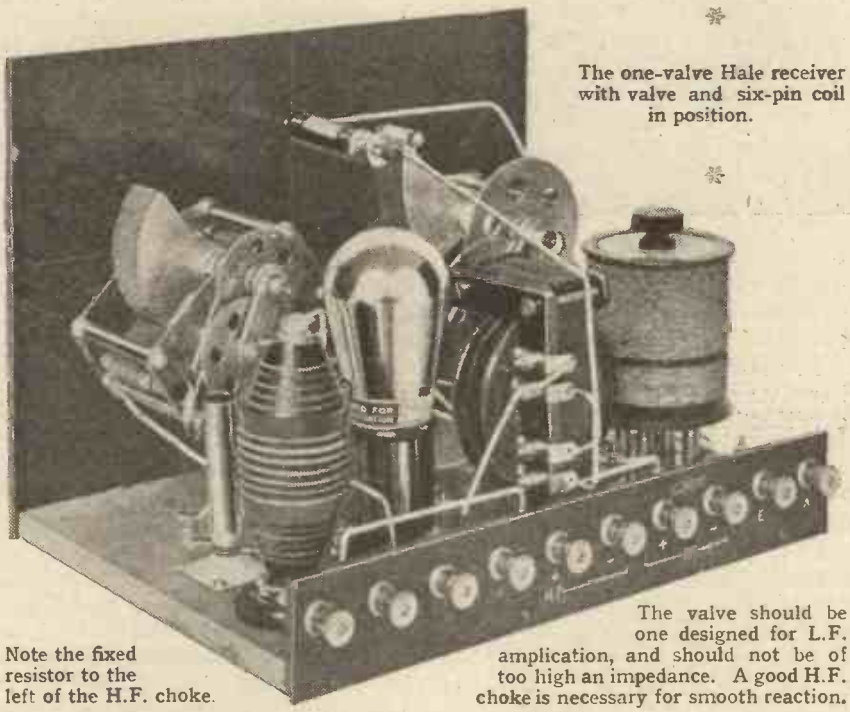
The Oscillation Control

Now, leaving the grid bias as adjusted, try the oscillation control at various positions of the tuning dial. You will, of course, use less reaction as you lower the tuning condenser reading.

With some types of crystal detector it may be necessary to try several different adjustments of the crystal before you find one which will give you a smooth reaction control with a reasonable amount of grid bias, and at the same time preserving sensitivity. An hour's practice with the set, however, will be ample in the case of most experimenters, and once

the best setting has been found the manipulation of the set is a sheer delight.

Be careful not to advance your reaction condenser too far, otherwise you will get a "squawk." As previously mentioned this "squawk" does not occur until the set has gone into oscillation and therefore cannot be considered a practical disadvantage.



The one-valve Hale receiver with valve and six-pin coil in position.

Note the fixed resistor to the left of the H.F. choke.

The valve should be one designed for L.F. amplication, and should not be of too high an impedance. A good H.F. choke is necessary for smooth reaction.

Results Obtained

With the particular low-frequency transformer used, the set was found to work excellently on the 1,600 m. range as well as on the lower band. Using a ·0005 mfd. S.L.F. type of condenser the following tuning positions were found. The coil used was a standard Lewcos 6-pin Reinartz-type of transformer. Stations close to the London wave were tuned in after London had closed down for the night. In every case the stations were picked up on the speaker without using telephones:

Name of Station	Dial Reading
Langenberg	123
London	78
Bournemouth	134
Brussels	139
Birmingham	53
Stuttgart	88
Hamburg	96
Bilbao	112
Barcelona	122
Madrid	86
San Sebastian	40
Bratislava	24

Straight-line frequency calibration will be found to be quite accurate from the top of the condenser scale down to about 30°, but below this point the curve will flatten out somewhat. On the 1,000- to 2,000-metre Reinartz coil, Daventry came in at 128, Radio-Paris at 148. If the selectivity of the set is not high enough for your particular locality, it will be considerably improved, with a very slight reduction in signal strength, by the insertion of a ·0002 mfd. condenser in the aerial lead.

A SOLDERING TIP

By C. A. J.

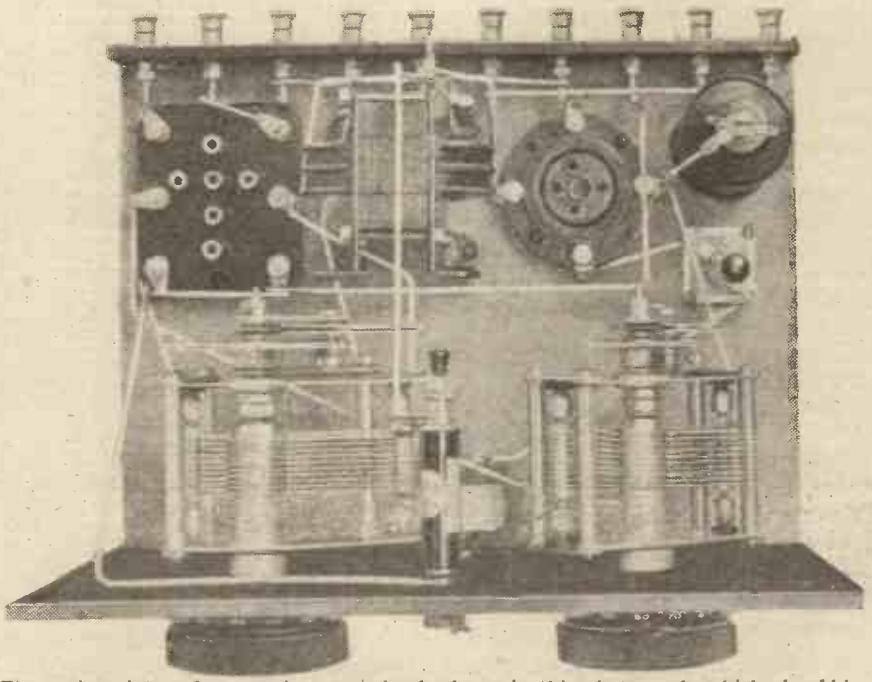
THE greatest bugbear in soldering is the dirty condition into which the copper bit gets every time it is heated.

The remedy to which most constructors fly, namely, liquid flux, is equally bad, as it corrodes the iron with terrible rapidity, and the formation of scale on the iron is sometimes worse than that caused by paste flux.

A piece of block sal-ammoniac, with a small hollow scooped out and filled with solder, will be found to be the best cleanser that one could wish for. It keeps the iron thoroughly clean and coated with solder, and has the additional advantage that when it becomes slightly charred the solder is easily removable from its bed, which a moment's work with a knife will restore to a fine whiteness.

This will not, unfortunately, prevent the formation of the ugly black scale which is bound to appear on the iron before it is in use very long. A piece of old file, which has been softened and screwed to the bench, is very useful for removing scale, as a light rub along the rough surface will take off the hardest deposit.

To soften the file, heat it to a cherry red and allow it to cool: when cold, it may be sawn, drilled, and filed just as an ordinary piece of metal.



The various internal connections are clearly shown in this photograph, which should be studied in conjunction with the diagram on the previous page.

Long-Wave Troubles

G. L. (Maidstone).—"I have a receiver employing two screened H.F. stages, followed by an anode rectifier and a couple of resistance-capacity L.F. amplifiers. On the ordinary B.B.C. band the set is perfectly stable and neutralises quite easily.

"On wave-lengths about 1,000 metres, however, it is impossible to stop the receiver from oscillating, although each H.F. valve apparently neutralises in the normal manner, and since the H.F. side is completely screened there is little possibility of interaction.

"Can you give me any idea of where the trouble is likely to be?"

Some receivers behave in a very curious manner on the longer wave-lengths. Although an efficient H.F. choke is incorporated in the plate circuit of the detector valve, H.F. currents sometimes appear to get through into the L.F. stages, especially when R.C. coupling is employed.

The trouble seems to be confined to sets utilising one or more H.F. valves, and is intensified when an attempt is made to obtain high magnification. The general layout of the set is important, and where space permits it is a good plan to arrange the stages in a straight line, starting with the aerial and earth terminals on the left, and the loud-speaker terminals on the right. This, unfortunately, is not always possible, owing to the long and unwieldy cabinet required in the case of a multi-valve receiver.

The remedy in most cases is to insert a small carbon resistance directly in the grid lead of *each* L.F. valve, i.e. between the coupling condenser and its grid resistance and the grid of the valve. A value of about ·25 megohm is suitable.

Valve to Use

P. R. (Colchester).—"I have just constructed a single-valve Reinartz receiver. What type of valve is most suitable, bearing in mind that the set will be used for the reception of distant stations when conditions are favourable?"

In most cases a valve having an impedance of 20–30,000 ohms, and an amplification factor of 20 or more, gives the best all-round results.

An H.T. value of about 80 volts seems to be about right. Valves of the R.C. type do not usually give such good results, but sometimes a fairly low impedance valve of the L.F. type gives very satisfactory reaction control.

Noisy Background

C. M. (Bath).—"Why should my three-valver, which has previously been giving excellent results, suddenly develop a noisy background? I have tried a new H.T. battery, tested the insulation of the various components, cleaned all contacts, and examined the wiring for defective joints.

"Still this background of rustling noises continues. Removing aerial and earth has no effect."

You have evidently tested everything except the valves themselves. Even in these days of careful works testing it is sometimes possible to find that the D.C. insulation of a valve is not up to standard. The symptoms are similar to those which indicate a faulty H.T. battery, i.e. rustling and crackling noises. Obtain a valve known to be perfectly silent, and substitute it for each valve in your set, noting whether this has any effect upon the background noises mentioned. Very frequently troubles of this nature have been traced to a faulty valve.

Fixed Resistors

F. U. (Cranbrook).—"How can I determine the values for the fixed resistors in my four-valve receiver? Three of the valves are rated at 5·5–6 volts ·1 amp., and two at 5–6 volts ·25 amp."

By Ohm's law, and neglecting all external resistances, the voltage to drop across the fixed resistor is equal to the current in amperes multiplied by the resistance in ohms. By substitution we find that the resistance required equals the voltage to be dropped in the resistor divided by the current. In the case of your first three valves, in order to reduce the voltage across the valve filament to 5·5 it is necessary to drop half a volt across the resistor. Dividing ·5 volt by ·1 amp., which is the current, gives an answer of 5.

This is the value, in ohms, required for each of the ·1 amp. valves. In the same way it will be seen that the resistors used in conjunction with the ·25 amp. valves should have a value of 4 ohms each.

Actually, in practice, it is not essential to employ resistors provided the valves are used with a suitable L.T. battery. For instance, 6-volt valves can be run straight off a 6-volt accumulator. The same thing applies to the 2- or 4-volt types when used with 2- or 4-volt accumulators.

In addition, there is frequently a small voltage drop in the leads from the battery to the set and from the terminals on the set to the valve. With certain "on-off" switches, having a "point" or "line" contact, there may easily be a further drop, especially in the case of multi-valve sets. The sum of these small losses in bad cases may amount to a volt, or perhaps more, and the receiver may only give a portion of its maximum efficiency.

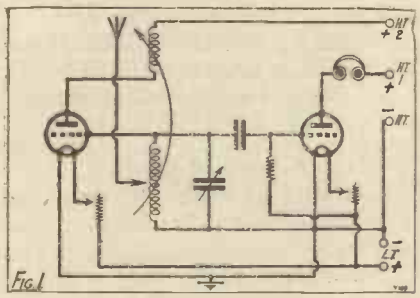
The SEPARATE REACTOR VALVE

"To-day . . . the tendency is more and more towards using one valve for one purpose."

An article of interest to all valve users.

By J. ENGLISH.

SOME three years ago, when reflex circuits were all the rage, experimenters were obsessed with the idea of getting the last ounce out of every valve used in their

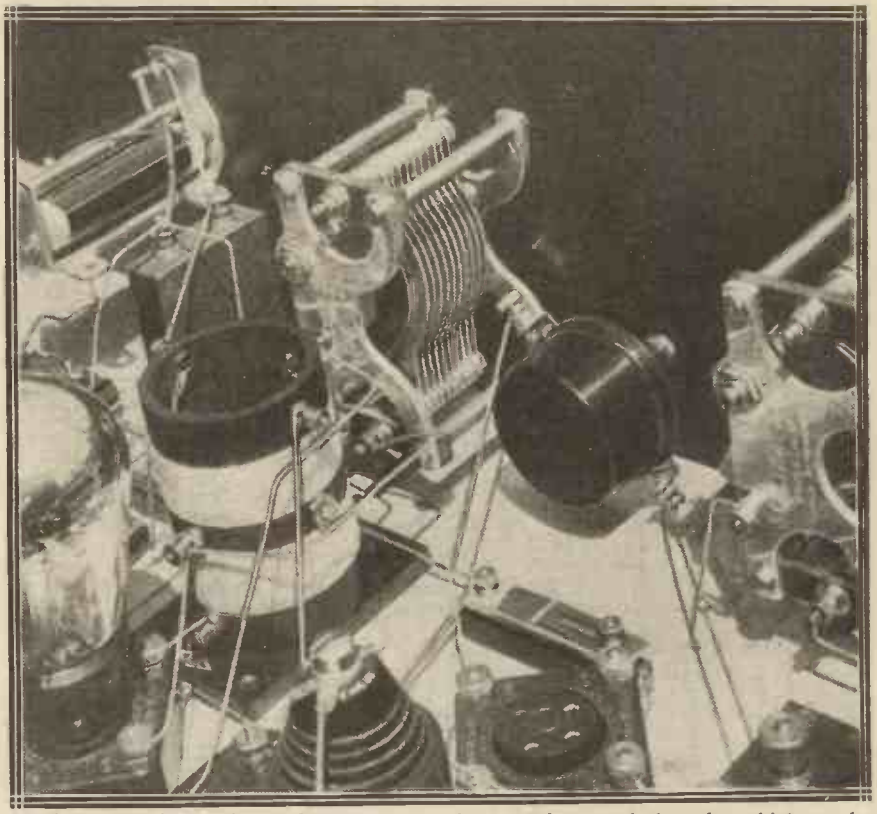


receivers. It is possible they would even have welcomed a circuit wherein the detector valve amplified at high or low frequency simultaneously. This craze for imposing several jobs on one valve undoubtedly originated in a striving after economy. In those days, as many will remember, an additional valve imposed a greater drain on one's pocket and L.T. accumulator than it does to-day.

Better Rectification

With the advent of cheaper valves, requiring much less filament current, the influence of reflex and dual receivers began to wane. To-day hardly anyone uses such circuits, and the tendency is more and more towards using one valve for one purpose only. There still remains, however, one valve in the majority of our receivers that performs two functions simultaneously. This is the detector valve with reaction, wherein the two purposes of rectifying and providing reaction are simultaneously carried out, whatever the particular form of reaction circuit used.

From past experience with reflex circuits we know that it is wellnigh impossible for a valve to perform two functions simultaneously with the maximum efficiency in each. Similarly, the detector valve cannot give the best results when called upon to supply reaction feed-back at the same time. If we take away this second task and use a separate valve for reaction only, there is no doubt that greater rectification efficiency is obtained from the detector, while many pronounced advantages accrue from the use of the separate reactor valve. Although the idea of a separate reactor is not new, experimenters



This is the "oscillator" end of a super-heterodyne receiver, and the valve which can be seen is, as in most super-hets, operating purely as a "reactor." Combining the duties of the "oscillator" and first detector is not usually attended with real success, and this is another point in favour of "separate reactor valves."

seem to have overlooked its manifest attractions. It is no longer extravagance to use another valve, because many of the cheaper dull-emitter and general-purpose valves can be used here. Such valves nowadays are not so useful for specialised jobs, so that a ready use can now be found for them.

Easily Employed

A separate reactor valve can be used in a very simple manner, without occasioning extra controls, as shown in Fig. 1. Both valves have a common grid circuit, and by coupling the reaction coil of the reactor valve to the common grid coil all the advantages of reaction are obtained in the same manner as if the detector itself supplied the reaction effect.

Now, however, both valves can be chosen in order to give the maximum efficiency for each purpose. It is well known that high-impedance valves are among the best detectors, some of the new R.C. valves being remarkably good in this respect. But such valves are often poor oscillators, and a low impedance valve, itself a poor detector, must be used where smooth and even reaction control is desired. This well illustrates the impossibility of obtaining maximum efficiency when using one valve for both detector and reactor. There are useful circuits where anything but a separate reactor is highly disadvantageous. By using a separate reactor, however, we can use one of the new R.C. valves as detector.

Having outlined some of the advantages that accrue from the use of a separate reactor valve, let me suggest some concrete examples from which the necessary practical points can be gleaned. While less necessary in a receiver with H.F. stages, there are still vast numbers of receivers where separate reactors could be added with advantage and little expense. Especially is this the case with short-wave receivers.

We have seen the principle of the method from Fig. 1. Now let us reconstruct the circuit, using all the modern devices for smooth reaction control and the utmost rectification efficiency. We then arrive at the circuit of Fig. 2. This uses an anode-bend detector with the latest in R.C. coupled amplifiers, a separate reactor with capacity control, and an inductively coupled aerial circuit for selectivity.

Simple Arrangements

The reaction arrangements with the new method are quite simple. Instead of connecting one side of the reaction condenser to the anode of the detector, as we should do if the latter were to supply the reaction effect, the condenser is connected to the anode of the reactor valve in the anode circuit of which is an H.F. choke as normally required with capacity controlled reaction.

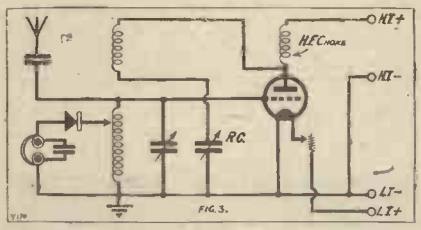


FIG. 3.

The reactor valve requires but a small anode voltage, usually about 50, so that its drain upon the H.T. battery is very small. More important still, the adjustments of anode and filament voltages for smooth reaction are not so critical as with the reactive detector valve. In the latter, the adjustments of these voltages, grid bias, and the size of the reaction coil for both smooth reaction and efficient detection are somewhat critical and antagonistic.

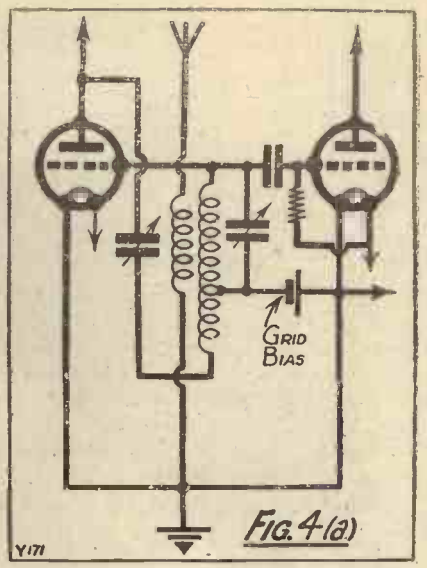


FIG. 4 (B)

The effect known as backlash is then a prominent cause of trouble. With the separate reactor, however, these adjustments are not at all critical, the low anode voltage and small reaction coil required making reaction control particularly smooth. In fact, with this method a more even and stable control is obtainable than with any form of regenerative detector, especially on short wave-lengths.

R.C. Coupling

You will notice that R.C. coupling is used between the detector and amplifier. This is important, as in this way full advantage can be taken of the great efficiency of the high-impedance valve as a detector, while obtaining a high degree of distortionless amplification. Because of the valve's high impedance, transformer coupling would not give the same freedom from distortion. In spite of arguments to the contrary, I still hold that there is no superior L.F. coupling for this form of high-efficiency detector than the R.C. method. However, personal opinions on such a debatable point are hardly pertinent in this article.

There is one further point about the circuit of Fig. 2, in which "anode-bend" rectification is used. With "high-mu" valves no extra grid bias is often required for anode-bend detection other than connecting the grid-circuit return lead to filament negative.

There is an additional reason for using a separate reactor valve with a high-mu detector. If a high anode resistance of 1 or 2 megohms is used with the latter, ordinary reaction

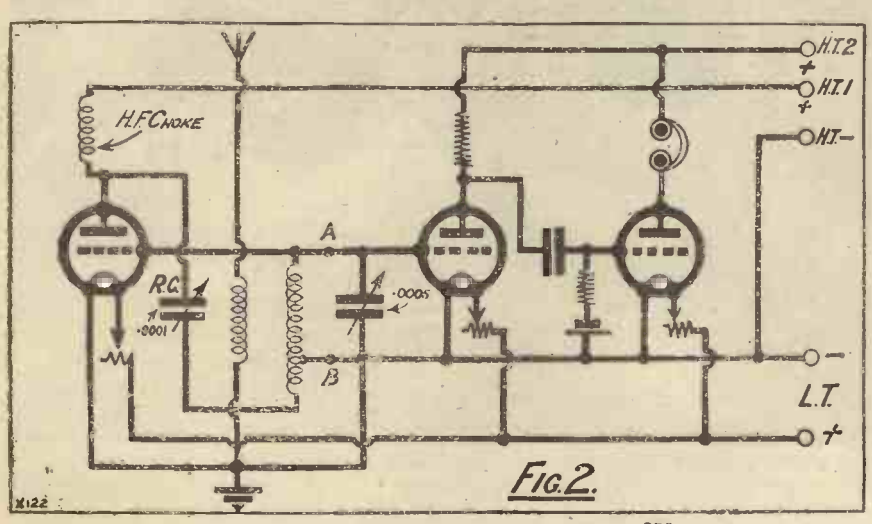


FIG. 2.

effects from the same valve are somewhat difficult to obtain unless the anode resistance is shunted with a small capacity. This, of course, weakens the amplification on high notes, so that in the interests of pure music the separate reactor is strongly advised here.

The circuit of Fig. 2 is certainly a valuable one both for long and short-distance reception. The comparative

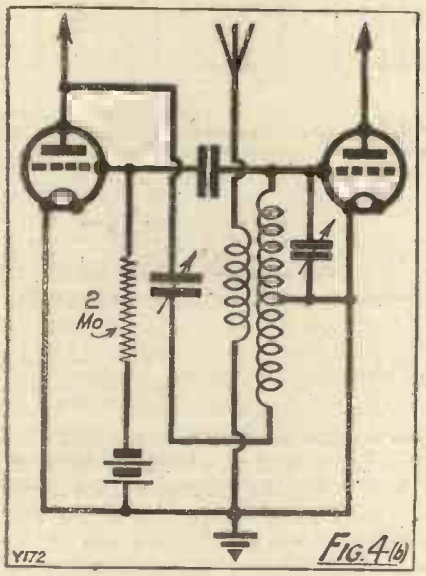


FIG. 4(b)

simplicity of the tuning arrangements makes it possible to construct without difficulty plug-in inductances combining the various coils for different wave-lengths. With a little modification such a receiver could be used as an "All-wave" set. Results on the ordinary wave-length are almost as good as those obtainable with a powerful three-valve set.

Some Special Features

A valuable feature of the separate reactor valve is that it can be used with great advantage with a crystal detector. Used in this way, the separate reactor is probably as effective as an ordinary tuned anode H.F. amplifier, as the efficiency of the latter is never at a maximum with a crystal detector. Moreover, the man who is graduating from the crystal set to valve receivers will find this combination just the thing, as it is far easier to work and simpler to make up than an H.F. stage.

A representative circuit is shown in Fig. 3. Either swinging-coil or capacity reaction can be used, the latter being preferable for its smoothness of control. It will be seen that the addition of an L.F. stage is quite a simple matter. Notice that the crystal is tapped off a part of the grid coil. This, when correctly located, causes no drop in signal strength, while ensuring better selectivity. Interesting experiments can be carried out by trying the effect of a resistance of a few thousand ohms across the crystal. Such a resistance tends to stabilise the circuit by making the degree of reaction required less dependent upon the crystal setting.

Where a greater refinement of selectivity and sensitivity is required when using a valve detector, there is a further aspect of the separate reactor valve which should be taken into account. If the grid of the latter becomes positive at any time the flow of grid current will cause additional damping and flat tuning of the grid circuit. This may happen with a strong signal, so that it is advisable to bring the working-point of the reactor valve on to the correct part of its characteristic by using a suitable value of negative grid bias. This can be done as shown in Figs. 4a and 4b, for a grid-leak and anode-bend detector respectively, the essential parts only of the circuit being shown. The damping effect can also be reduced without upsetting the reaction arrangements by tapping across part of the grid coil as in Fig. 5.

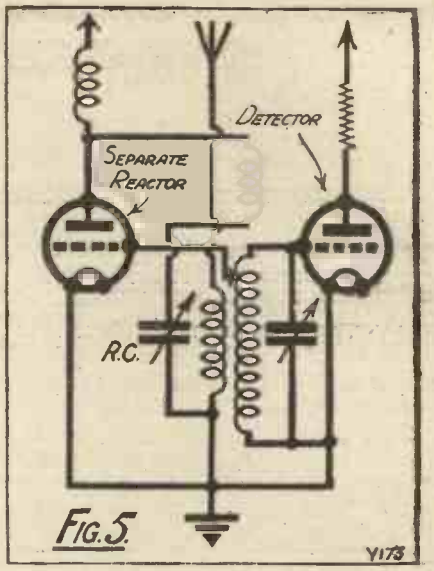
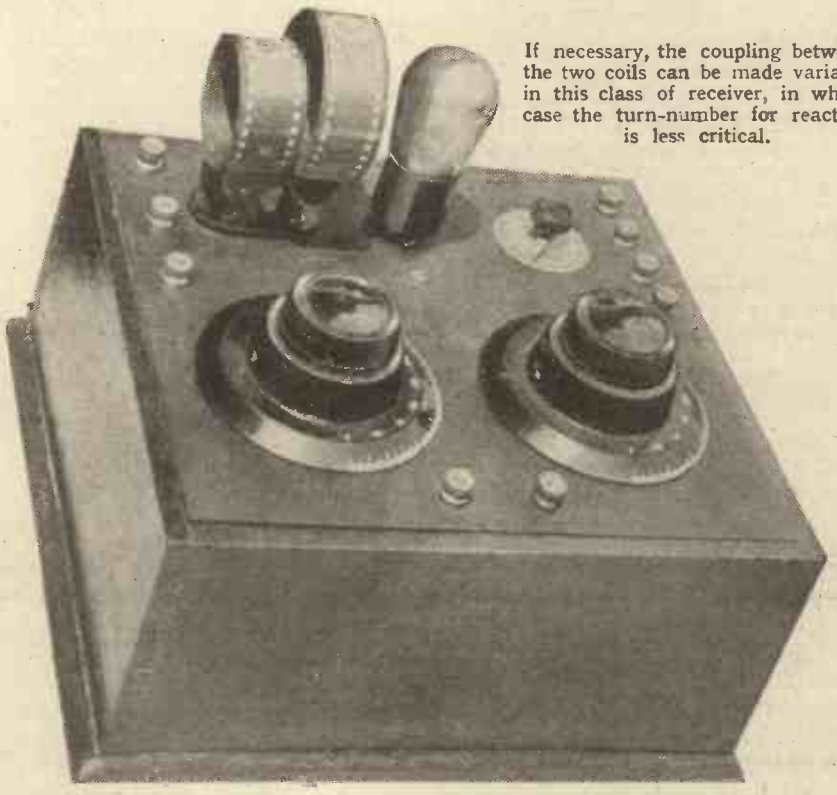


FIG. 5.

In view of the points considered above there can be little doubt that the addition of a separate reactor valve is well worth while. The utmost efficiency with the least distortion can only be obtained from modern types of valve rectifiers by employing this separate reactor. Therefore, apart from receivers with H.F. stages requiring no direct reaction, this system undoubtedly deserves more attention from progressive experimenters.



If necessary, the coupling between the two coils can be made variable in this class of receiver, in which case the turn-number for reaction is less critical.

A standard one-valve receiver embodying the so-called Reinartz form of reaction. Mr. English advocates the use of an additional valve for "reaction," leaving the detector free to carry out the task of rectification.

A USEFUL VALVE RACK

From a Correspondent.

OF late we have had several demonstrations of the durability and relative robustness of valves, but naturally the constructor or experimenter, while appreciating these facts and at times marvelling at them, does not desire to test out the ability of his own valve stock to withstand rough treatment.

In spite of repeated reduction in price the valve is still an expensive

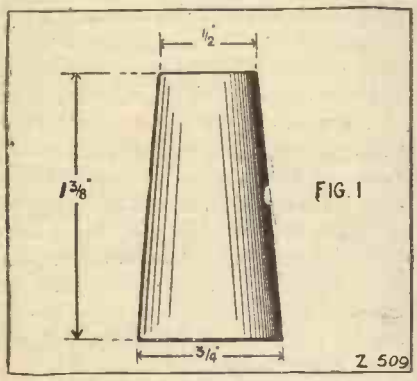


FIG. 1

item in the "kit" of essential accessories which must be purchased for use with receivers other than crystal sets, and consequently it must be handled carefully and stored properly if the replacements bill is to be kept within a narrow margin.

A Familiar Dodge

When the construction of a receiver is completed the constructor is naturally anxious to make his initial aerial test and prove the efficacy or otherwise of his handiwork. The designers, as a rule, recommend various valves which work satisfactorily in the respective high-frequency, detector, and low-frequency stages, but, where one's stock of valves is of sufficient magnitude, it is advisable to try out all possible combinations to find the one which is capable of giving the best results from the dual standpoint of quality and quantity.

Naturally, one's valves must be to hand, but they are prone to roll about on the table or bench if knocked, or a hasty movement to reach out and adjust the H.T. battery voltage may precipitate one or more upon the floor, the subsequent breakage damping one's previous enthusiasm at hearing the first signals come through on the new set.

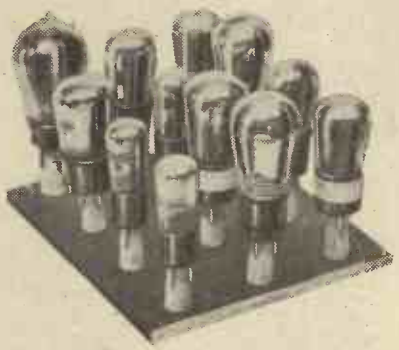
To avoid such possibilities it is advisable always to keep the spare valves stored in a place of safety, and a rack is admirably suited for this purpose. Many devices, simple and elaborate, are open to the choice of the individual. For example, a series of holes drilled in a thick wooden board and spaced correctly by means of a valve-pin base template is one familiar dodge, the four valve pins being inserted in the holes in the same way as for a valve holder.

Very Small Outlay

A recent addition to my own stock of valves caused me to look round for another rack, and by chance I discovered that the four pins of any valve just fitted tightly over a certain-sized cork. The dimensions of the cork were approximately as given in the sketch of Fig. 1, and I procured a dozen of these from the chemist for the small outlay of 2d. A spare piece of wood 9 in. by 7½ in. by ⅜ in. was next found on the junk heap, and the positions for twelve holes marked out as shown in Fig. 2.

Holes were drilled at the positions indicated and countersunk on the underside so that a 1-in. wood-screw could just pass through with the head flush with the surface of the board. The twelve corks were then fixed to the baseboard by the screws so that the smaller diameter was at the top end.

This completed the simple construction, and, as the photograph



One advantage of the valve rack is that all the valves are readily accessible.

indicates, twelve valves can be housed with their pins pushed over the corks. They are held quite firmly in place, and the rack was found to constitute a useful and remarkably cheap addition to my "wireless kit," and can be recommended to readers with every confidence.

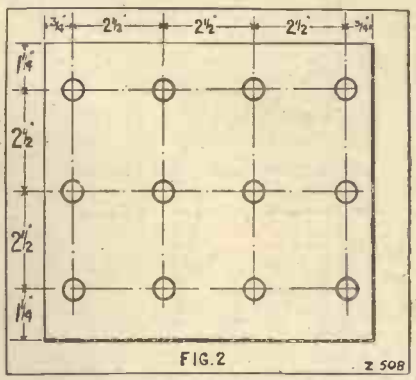


FIG. 2

RENOVATING BASEBOARDS

THE constructor who undertakes a lot of set building and frequently dismantles old sets in order to effect improvements or make replacements will no doubt find that he has several wooden baseboards on hand. Their appearance is no doubt spoilt by the screw holes on the surface, and the purchase of new boards is resorted to. While not expensive, the securing of the correct size is often inconvenient, and any means whereby the old baseboard can be renovated will be welcomed.

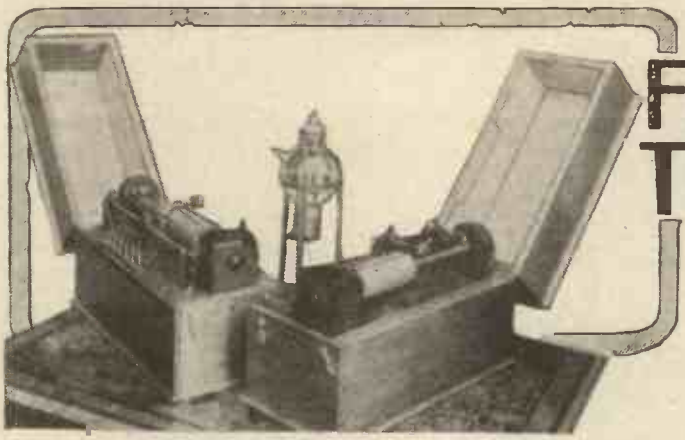
A Good Finish

A mixture of glue and sawdust is one expedient for filling up the holes, but I find it preferable to use Necol plastic wood for the work. A tin can be purchased cheaply at any ironmonger's, and after the material, which somewhat resembles putty, has been pressed firmly into any of the holes, it will harden quite rapidly. The judicious use of a file and a little sandpaper will give the whole surface a good finished appearance.

FILLING HOLES IN A PANEL

HERE is a tip for filling up unsightly holes in ebonite panels. At a toyshop procure a penny stick of black "Glitterwax"—which is a compound sold for children's modelling—and warm a little of this by working it between the fingers. Press a little into the hole and cut flush with a sharp knife, finally polishing lightly with a cloth. The repair is almost invisible.

B. R. P.



FACSIMILE TRANSMISSION

Recently commercialised methods of transmission, which will cheapen and quicken the sending of long messages.

By Lt.-Col. CHETWODE CRAWLEY, M.I.E.E.

WE are now becoming accustomed to have every year at least one outstanding advance in the commercial application of radio signalling. In 1925 it was the use of short waves for long ranges, in 1926 it was the opening of the first transatlantic telephone service and the first transatlantic short-wave beam service, and in 1927 it is the world-wide extension of beam services and the advent of facsimile transmission. Films and television are now visible above the horizon of possibility, and the transmission of power has just entered the far-off field of prophecy. But these are not yet in sight of commercial practice, and in this short article we will confine ourselves to the new commercial recruit—facsimile transmission.

Many Advantages

The advantages of facsimile transmission are, firstly, that for the transmission of messages it saves time, as long messages can be sent in facsimile much quicker than by spelling out each word in the usual method; secondly, simple pictures and the like can be sent telegraphically, which is, of course, impossible by the usual method of signalling, and, thirdly, what is received is a facsimile of what is sent.

Whether the receiver will always be pleased to have a message in the handwriting of the sender, apart from that on cheques and other welcome documents, is a moot point, but it is obvious that the speedier transmission of long messages must lead to lower rates, and that there are almost unlimited possibilities in the facsimile transmission of pictorial and printed matter. But this new method of signalling is still in its infancy, and we must not expect in 1927 more than a bare introduction to its commercial possibilities.

As a matter of fact, the first commercial facsimile service by wireless was opened in the summer of last year, between the Marconi Company's offices in London and the headquarters of the Radio Corporation in New York. But the landlines were far ahead of this, as the almost forgotten telautograph was used over landlines many years ago, and a long-distance facsimile service was opened by the French Telegraph Administration between Paris, Strasbourg, and Lyons in January, 1924, and has since been extended to Bordeaux, Nice, and Marseilles.

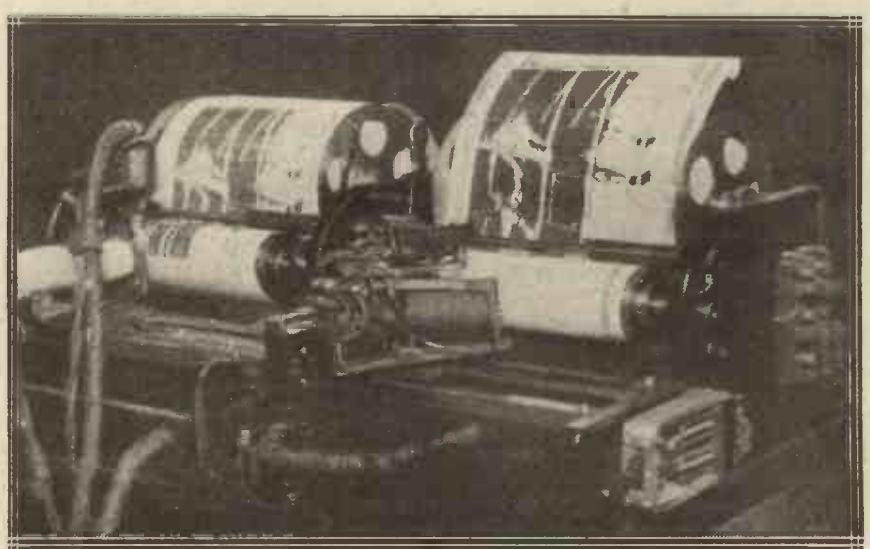
In this system, invented by M. Belin, the sender writes the message with special ink which is slow drying and contains an adhesive substance. Powdered shellac is shaken over the message and adheres to the ink. The whole is then electrically heated to melt the shellac, and, on cooling, the writing, in the form of hard shellac, stands out in slight relief. The form is then placed on a revolving cylinder, and a light lever, with its end touching the cylinder, traverses the surface.

Every portion of the message passes under the lever, and the raised parts, by lifting the lever, close contacts which allow currents to pass along the wire. At the receiving end these currents, by deflecting a mirror, vary the intensity of the light falling on a sensitive photographic surface mounted on a cylinder, which is rotated in synchronism with the sending cylinder, and the writing is reproduced as dark lines on the photographic surface.

An American Method

The charges for messages in this service are based on the area to be transmitted, and if this area is filled up with writing the cost of sending the message is considerably less than by the ordinary telegraph system.

There is also a commercial facsimile service in operation over certain telephone lines of the American Telephone and Telegraph Company in the United States. The message is prepared as a cylindrical film transparency. The cylinder is rotated, and a beam of light which is made to traverse the message passes through the cylinder to a photo-electric cell,



Receiving American news photographs by means of wireless. Part of the apparatus used at Radio House, London.

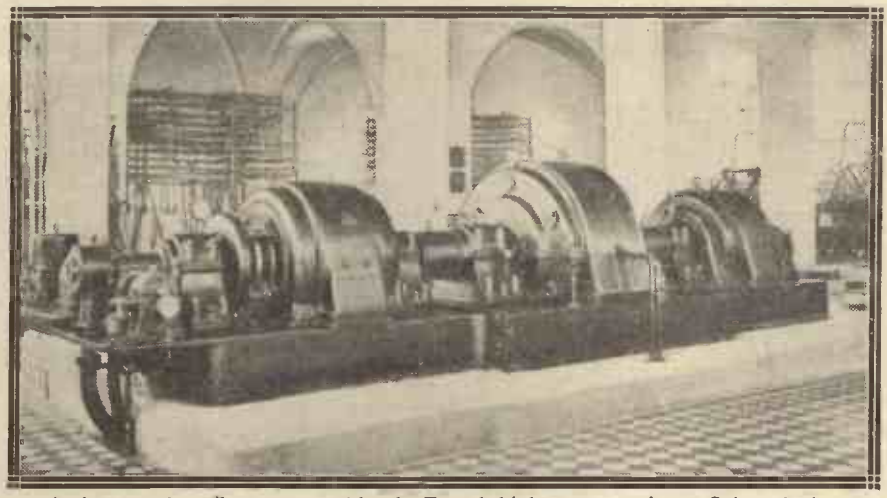
which converts the variations in the density of the film into corresponding variations of current which modulate the carrier current in the line.

At the receiving end these currents vary the intensity of a beam of light which falls on a cylinder of photographically sensitive film rotated in synchronism with the sending cylinder, and so reproduces the message or picture transmitted. The signalling time for a picture, 5 in. by 7 in., is about seven minutes, but the other operations involved bring the total time up to about three quarters of an hour. The charges made for the transmission of a picture vary from 15 dollars between Boston and New York to 50 dollars between Boston and San Francisco.

A Successful System

The commercial long-wave wireless service between this country and America is on a system invented by Captain Ranger of the Radio Corporation of America, and is used principally for the transmission of pictorial matter. Good reproductions of pictures received have appeared from time to time in the Press, and it seems that for really good results clean whites and dark blacks are essential, so that too much must not be expected from the fine shades of half-tone pictures.

In this sytem the picture is prepared on a film transparency which is wrapped round a glass cylinder. The cylinder is rotated and a beam of light is directed by lenses and prisms so that every part of the transparency is brought into its path. This beam falls on a photo-electric cell with an intensity which varies according to the density of the portion of the film through which it has passed, thus varying the current through the cell, which in turn varies the frequency and length of transmitted dots. At the receiving end, in one of the methods used, the dots are reproduced on paper carried on a rotating cylinder by means of a pen filled with melting wax. The charge for the transmission of a quarter-plate picture is £10, and for a half plate £20.



A giant 500-kw. alternator used by the French high-power station at Sainte-Assise.

Beam Transmission

A million-dollar cheque was recently paid on a facsimile sent by this service to America, and it has been frequently used for similar interesting purposes, and even for the transmission of thumbprints for use in criminal proceedings.

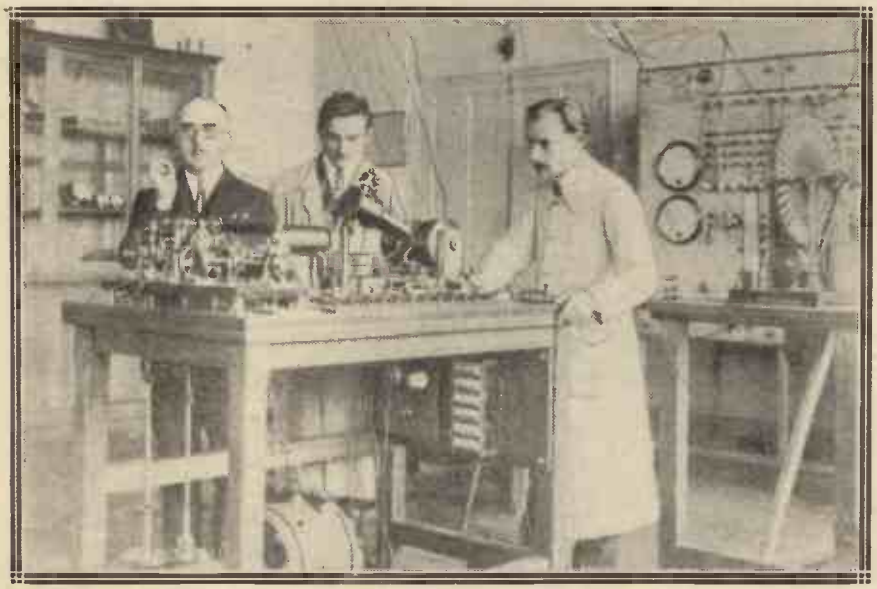
The Marconi Company have now in hand a new arrangement of facsimile transmission suitable for their beam services. This system is said to be a distinct step in advance both as regards simplicity and speed of operation. In March last a page of the "Times" was sent successfully in half an hour, and with some improvements in apparatus could be sent, it was said, in about five minutes.

An interesting broadcasting service for the facsimile transmission by wireless of simple weather charts to ships has been in experimental operation from Germany and the United States for more than a year past. It is known in Germany as the Dieckmann System and is specially adapted for the transmission of simple charts showing the isobars and necessary figures. It is much less complicated than the other systems, and instructions for the construction of suitable receiving sets have recently been published in Germany for the use of amateur experimenters. An area of about fifteen square inches can be sent in less than five minutes.

High-Speed Service

Another system of high-speed facsimile transmission by wireless has recently been developed by the Telefunken Company of Berlin and the Austrian Radio Company of Vienna. This system, which uses short waves, is about to be put into commercial operation and has already been used experimentally between Germany, Italy and the Argentine, where transmitters are now being installed.

In Japan a great interest is being taken in facsimile transmission, and the same will happen in China when they can spare the time from more exciting pursuits.



M. Edouard Belin (left), who recently gave a successful demonstration of his television scheme.

The Die-Hard

THERE are times when, encompassing me with the clammy crawling movement of treacle, I am possessed by a feeling that the world is too much for me. At these times the fret and hustle of the flying days irk me like the pinch of new boots; the adjuncts of civilised life seem to be only so many nails in the jolly old coffin. It is then I crave for the sleepy Middle Ages when men had time to think and trees to grow, when the now lost art of digestion was freely permitted and practised, and

"With cocktail saloon, complete with jazz band and vamps."

if a fellow was asked to have his block chopped off to oblige the king he need not hurry, but could park in the Tower for ten years or so till he got used to the notion.

Of course, we all have these fits. Generally, they drive us to seek peace and forgetfulness by jolting a hundred miles along the earth in the wake of another fool's exhaust and putting up in some quiet little place of 30,000 population, at some quaint old inn with fifty beds, dance-hall, and cocktail-saloon complete with jazz-band and vamps.

When All Seems Wrong

You have worked, let us say, six months at the prettiest little deal you ever propounded to a world full of suckers, an absolutely one hundred and fifty per cent proposition whichever way it goes. And then, when you go to collect, some yapping terrier, a newspaper, or maybe a financier fresh from "jug," has scared the bunnies deep into their suburban boltholes.

Or perhaps you have spent many nights amidst the ebonite, glue, and exaggerated hopes of the "home-constructor," making the fifth and last edition of the world-shaking "Neverdyne 12." And then some indefatigable expert announces that he has improved the design so much that he can scarcely recognise it. It's then you look at the cut in your thumb, and the holes you bored in the table, and wish you were leading a simple life as a foreman haymaker in some village which was overlooked by the Domesday Book.

Well, under the influence of some such "back to the land" urge I went in August to old Peter Stone's place at Haycocks, Sussex, there to gather balm and escape from inductance, capacity, wave-length, and Bach.

At Peter's Place

I had no scruples about plunging into Peter's place, because my father took an aged cow off his father as settlement of a debt. Hence, I have always felt that I had a sort of claim on the Stone crowd.

Pete has a fine little house in the lap of a valley, surrounded by an orchard. This is peculiar in a man who has means enough to live in Brighton and keep a car. But there is more. Pete is a throw-back to about 1800 and refuses to come on. He has a set of oil lamps which take him on an average fifteen minutes each per day to light, and when they are lit they are storm centres of plain stinkdom. He has large cavities in the walls, called fireplaces, and in these smoulder damp logs. Fires! He winds his water from a well which smells like a recently-opened family vault, though the water seems pretty good, after being filtered and boiled. He gives his guests warming-pans instead of whisky on cold nights.

The nearest that Pete had ever been to a wireless receiver was twelve miles. That was because the nearest was at Lewes, twelve miles from Haycocks; it had a loud speaker, but even its creator, Bert Brown, one of the most imaginative "fans" that ever had "the 'phones on the table and heard it all over the house," would not have claimed a twelve-mile range for his home-made cone.

Down on the Farm

It was certainly not with any intention of converting Pete to the sweet uses of radio that after my first week there I asked his permission to send for and install my own set for the rest of my visit. I had had a beautiful week, watching the wasps get drunken on his plums, improving my knowledge of pigs, and soaking in the peace and content of the Haycocks Arms. Henery, a toothless mummy of eighty-five years, had five times told me how, in 1850, he went to Lewes and saw the Mayor; a wonderful story, somewhat mixed with an account of a pig called Trixie belonging to his ninth

"The peace and content of the Haycocks Arms."

son, Henery John. And after a two-hours' stalk I had blown a young rabbit into powder with Pete's blunderbuss—and included a beeskep and a marrow-frame in the slaughter, with the same shot.

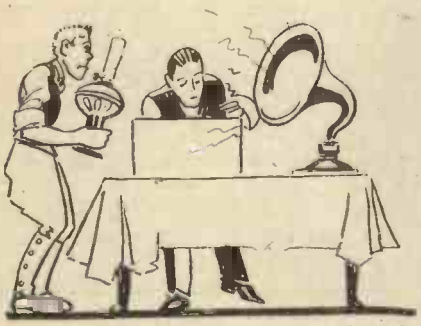
But the 2 L O programmes for the next week had a few bright spots, and I had some vague idea of a demonstration in the Haycocks Arms, chiefly because I wanted to see old Henery sit up and suck his gums rhythmically.

I thought it might take his mind off Trixie. So I asked Pete what about it. As I had just been telling him about that scandalous cow his father swung off on mine I suppose he felt a little sore in the conscience; or else he thought I was referring to a set of dominoes. Anyhow, he consented, with the proviso that I must not expect him to join in, and so I slipped in a wire to the man who shares my rooms, and began to put up an aerial.

A Five-Valver Arrives

A few days later, the packing-case having been dumped by the village carter at Pete's door, upside down, I returned from a walk to find Pete extracting my five-valver, he having opened the case because he thought it contained some 1860 port which he had ordered. He shied a little when I rescued my receiver from the chicken-food bin into which he hurriedly dropped it, and said he supposed it was a "Tantalus."

The local rooks took possession of the aerial from the first—though the starlings were strong competitors—and they used to line up on it in the afternoons and talk things over, dropping rude remarks about Pete and me whenever we showed ourselves. I tried the effect of dropping one end of the wire when they were deep in debate, but although the result was enough to make one limp with mirth, the language those birds put up was such that the vicar said he *fee-ahd* it might corrupt the *dee-ah* village children.



"Hard on this speech came Pete himself, lamp in hand."

"Only too apt, Mr.—ah—Jones; only *tu apt* to memorise the coarser adjectives, I fee-ah," he repeated.

So I put a little weak gum on the wire, and a few hours afterwards was able to call Pete's attention to the fact that the rooks were flying about in snowshoes. Hay sticks beautifully. Pete wrote ten pages to "Country Life" about it, enclosing one rook's shoe as evidence.

Pete was cleaning the oil lamps in the pantry when I first switched on. I heard him jump as a voice cried:

"There will be rain generally in Southern England."

"Nay, lad," he called out, "you've been reading some of these new-fangled weather-charts! My corns say it'll be fair and warmer!"

Then I turned on some music. It was a cornet solo.

"Hey!" came from the pantry. "Is that the old coach-horn? I've tried to get a toot out of her many a time, but since sexton blew his false teeth down the tube she's never been quite the same."

Hard on this speech came Pete himself, a lamp in each hand, just as some station burst into the overture "1812." He side-stepped briskly, dropped the lamps—lucky they were made by an ironfounder in 1790—and dashed to the door to find the missing German band. It was not until I had jammed his head down the loud speaker that he would be deterred from donning his second-best hat and going down to the Philharmonic Society with his bassoon.

A Radio Fan's Nightmare

But when Pete learned that it was only my vile contraption, he put on his fine old country squire air and went out to the gun-room, and made a lot of unnecessary jangling with the old mare's harness. After that there was nothing for me to do but to keep out the entire population of Haycocks with a broom, while the loud speaker rattled on and the crows cursed over the scene, shoving each other up and down the slopes of the sagging aerial. A radio fan's nightmare!

The next evening Pete was engaged on some mysterious job connected with the noble open fireplace, in which he stood with his upper half hidden from sight up the flue. Bricks occasionally came clattering down, together with soot and other concomitants of a fine old English chimney. I turned on a few choice radio excerpts from here, there, and elsewhere; but Pete only said it was a poor occupation for a man, and that the ferrets required cleaning out, if I was so minded. I replied that I was not in the vein; that my mind did not often run on ferrets, and that all my complexes were identified with rabbits, which I loved. As I spoke, I tuned idly into the 600-metres band and let loose an inferno of Morse.

I think Pete got the impression that I had blown up, or that I was trying the fine old English harmonium which stood in the corner by the warming-pans. Anyhow, he emerged at once, looking like the president of the Cannibal Islands.

"I never saw a better means of scaring birds off my fruit."

"Why this sudden interest in my vile contraption?" I asked, attempting heavy sarcasm.

"Did that thing do that?" he asked.

"Yes, surely," I replied; "and if you like it, here's some more."

And I made the vases rattle with Rugby.

"That's fine," he said, as it were to himself; and drew nearer, peering with interest at the valves and cocking his ears at the loud speaker.

"Well, Pete," I said, "I give you up. But if this Bedlam excites your sense of beauty, why not go in for a set?"

"I'll think it over," he answered, and went up the chimney again.

The end of it was that I left the receiver with him, complete with aerial and rooks, at a price—a fair price—and returned to London, rejoicing in the conversion of the most pig-headed Victorian fossil outside the War Office.

Note my disillusionment! A week after my escape he wrote asking me to send him six more loud speakers.

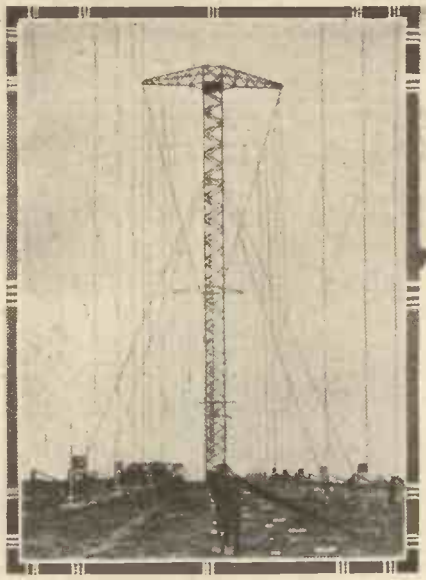
"Ha!" thought I. "Community listening!"

Bucolic Radio

I sent the goods and wrote for news. I imagined old Henery and the rest sitting amazed beside their grandfather clocks, checking up on Greenwich Observatory, and telling tales of how, in 1860, the clock of St. Barnabas' struck thirteen at midnight on Bartlemass Eve.

But no! Pete replied as follows:

"Dear Jones,—Your infernal machine is a great success. I have joined up the trumpet things and stood them about the garden. *I never saw a better means of scaring the birds off my fruit.*"



The Wireless Beam Service

A description of the completed Imperial scheme for linking Britain and the Dominions.

From A Special Correspondent.

THE opening of the new short-wave Beam service to India marks the completion of the Imperial scheme for linking the Mother Country to the Dominions by a network of highly directional wireless channels.

The first Imperial Beam service to come into operation was the one to Canada, which was inaugurated towards the end of last year. This was quickly followed by the opening of the South African and Australian services, the Indian link being the last of the quartet.

The transmitting aerials for the outgoing Canadian and South African messages are both located at Bodmin, in Cornwall, the layout of the parallel oscillators and reflectors which generate the "beam" of wireless waves being respectively arranged precisely at right angles to the Great Circle bearings of the distant receiving stations with which they are designed to work.

Alternate Wave-lengths

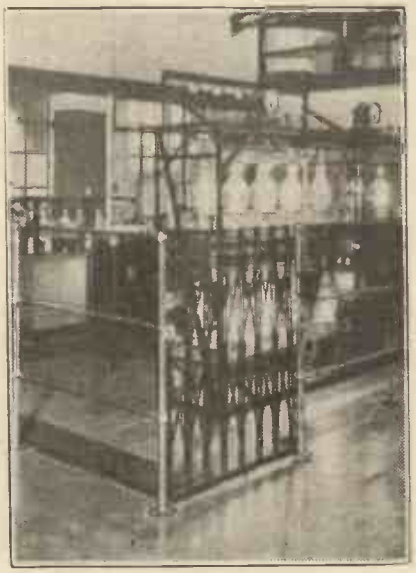
The corresponding beam antennæ for receiving the incoming messages from these two Dominions are also located close to each other at Bridgwater, in Somerset.

Outgoing messages for Australia are radiated from Grimsby; whilst incoming messages from the Antipodes are received at Winthorpe, close to Skegness. It is interesting to note that the Australian Beam aerial is designed so as to transmit waves in either direction along the Great Circle bearing, according to the sunlight conditions to be encountered en route.

For instance, when it is morning in this country the path of the waves may be directed westwards so as to cross the Atlantic and Pacific Oceans. Evening here corresponds to morning in Australia, and the beam is then directed in the opposite direction, i.e. eastwards over Europe and Asia.

In the case of the South African service the different conditions of daylight are counteracted by using two different wave-lengths, one of 16 metres, which is found to travel better when sunlight predominates, and a longer wave of 33 metres, used when the path of the waves is mainly through darkness.

In the case of the Indian Beam, the transmitting and receiving aerials are located close to those used for the Australian service, transmission taking place from Grimsby and reception at Winthorpe, near Skegness.



Some of the "Beam" apparatus at Grimsby.

Parabolic Beams

The modern beam aerial is a development of the arrangement employed in the original Inchkeith reflector, and in similar small-powered radio "lighthouses" designed to assist navigators at sea during foggy weather. In this type of installation a single short rod, or Hertzian oscillator, is located at the focal point of a parabolic series of reflecting wires, the whole system being mounted to revolve around a central axis so as to send out a wireless "beam" capable of sweeping around the horizon like the rays from a revolving lighthouse lamp.

Horizontal Beams

The principle of such directional transmitters is based upon a well-known optical law, according to which all the rays from a source of light (or a transmitting aerial) placed at the focus of a parabolic mirror (or screen of reflectors) are reflected back parallel to each other, no matter at what angle they strike against the surface of the mirror. For reception the converse holds, namely, all rays (or received signal waves) travelling parallel to the principal axis of a parabolic surface are reflected so as to pass through the principal focus (where the receiving aerial is located).

Instead of using a parabolic reflecting surface, and a single oscillator at the focus, the high-powered beam aerial, as used for long-distance transmission, consists of a horizontal "array" of vertical oscillators (or energised aerials) backed by a parallel row of non-energised rods or reflectors.

The general outlay of a typical beam aerial is shown diagrammatically in Fig. 1. It consists of two horizontal rows of vertical rod oscillators A, A_1, placed one above the other, the whole being suspended from a pair of masts M.

The rods are spaced a fraction of a wave-length apart in a plane which is at right angles to the desired direction of working. They are connected together at the top and bottom by horizontal wires L, L_1, L_2, L_3, and each rod, together with the connecting wires, is tuned to the working wave-length.

Small condensers C may be inserted between the wires L_1, L_2, in order to couple the upper and lower series of oscillators together, though in practice the inherent capacity existing between the wires L_1, L_2, is found sufficient to serve this purpose.

It is desirable that no oscillations should be set up along the horizontal wires, as this would represent a loss of energy. Accordingly, resistances marked R are inserted at intervals to damp out any horizontal oscillations that may tend to occur.

Reflectors

Such a system would, of course, be bi-directional. That is to say, the radiated energy would be propagated at maximum strength in a direction at right angles to the plane of the aerial system both front and rear.

In order to convert it into a non-directional system, a bank of reflectors of similar shape and size is mounted parallel to the first and a quarter of a wave-length behind it.

The action of the primary oscillators upon the reflectors is purely inductive, since true radiation does not take place inside a quarter wave-length distance from an energised aerial.

When the field from any given aerial cuts across the reflector wire it induces in the latter an E.M.F. which is 90° out of phase with that in the primary oscillator owing to the distance $\frac{\lambda}{4}$ between them. The corresponding current in the reflector wire lags 90° behind the induced voltage owing to the inductance of the reflector and its low resistance.

Cutting Off "Back" Radiation

Accordingly, the current in the reflector wire is exactly 180° out of phase with that in the primary oscillator. As the horizontal spacing of both the aerials and reflectors corresponds to half a wave-length, the additional effect of each pair on either side of any selected wire will practically cancel out.

One is therefore able to consider the effect of the current induced in any particular reflector wire as being due entirely to the individual aerial immediately in front of it. As we have seen, the current in the reflector is exactly 180° out of phase with the aerial current.

Under these conditions it has been shown by Professor Fleming that "back radiation" is entirely neutralised, i.e. no waves are emitted to the rear of the reflecting network. On the other hand, the "forward" radiation is practically doubled by the action of the reflecting system.

Increasing the "Forward" Radiation

In other words, if the strength of the field radiated by, say, a row of thirty oscillators alone is N, then the effect of adding a row of thirty reflectors at the back of the oscillators is to increase the forward radiation to 2 N.

The polar diagram showing the directional concentration of the energy radiated by a beam aerial is very sharply defined. At a distance of 3,000 miles the "spread" is only 100 miles, corresponding to 2° of arc. Therefore reception is only possible inside an isosceles triangle having

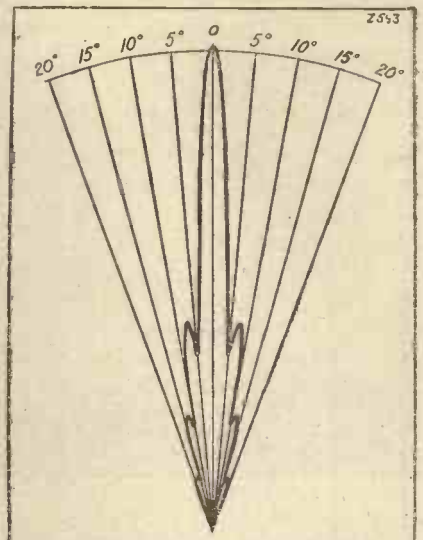


Fig. 2. Polar Diagram of Beam Transmission shewing lateral "offshoots."

sides of 3,000 miles and a baseline 100 miles long. Outside this area the field of the radiated signals falls practically to zero, although it is interesting to observe that offshoots of energy of comparatively limited range occur with some intensity over an arc of 10° and to a lesser extent over a wider arc, as indicated in Fig. 2. These may be compared with the interference bands due to optical diffraction, and provide an interesting reminder of the close analogy that exists between light and the shorter "radio" waves.

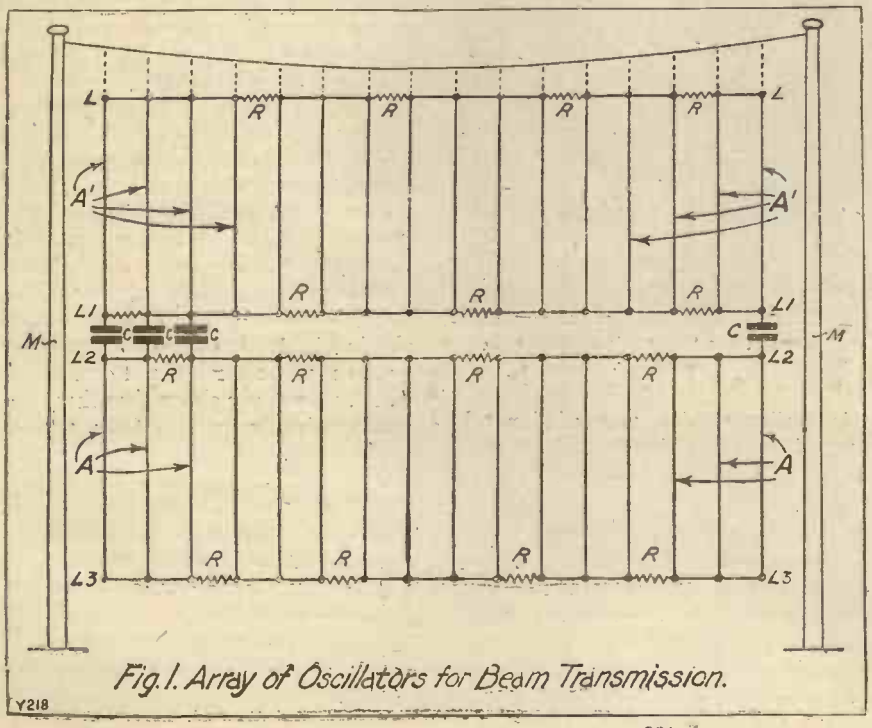


Fig. 1. Array of Oscillators for Beam Transmission.

Hertzian Oscillators

As regards the directive action of each individual aerial it can be shown that when a plain Hertzian oscillator is energised electrostatically from one end, a "standing wave" is produced which has a maximum current value of the middle, as indicated in Fig. 3A. Such an aerial radiates best at right angles to the direction of the wire, the directional or polar diagram being a figure of eight, as shown in dotted lines.

If the oscillator is energised at such a frequency that the length of the wire is one and a half times that of the emitted wave, the "standing wave" distribution is as shown in Fig. 3B. Here it will be seen that the current in the upper and lower sections of the wire is opposite in phase to that in the middle section.

The "Franklin" Oscillator

If now the centre portion of the wire is doubled back on itself, as shown in Fig. 3C, so that the radiation from this

portion is practically annulled, the current distribution again becomes predominant in a direction at right angles to the aerial, giving a much sharper directional or polar diagram than before, as shown in dotted lines.

This method of increasing the concentration of radiated energy in a

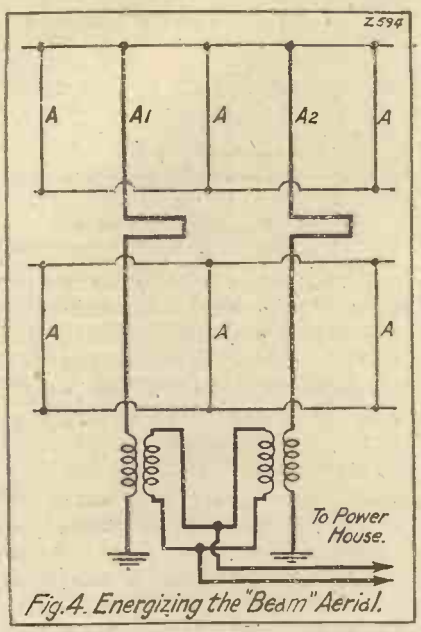


Fig.4. Energizing the "Beam" Aerial.

definite direction has been applied by C. S. Franklin, of the Marconi Company, to improve the working efficiency of the beam aerial.

Feeding the Oscillators

Generally speaking, the smaller the spacing between the aerials, and the larger the number employed, the nearer does the radiation approach the ideal of a "current sheet" travelling outwards at right angles to the bank of oscillators.

When the aerials are spaced apart by only half a wave-length the oscillation voltage induced into any one aerial by the radiation from the two adjacent aerials on either hand is in correct phase and assists the current impressed upon the first aerial by the feeder coupled to it. Actually, each aerial tends automatically to maintain the correct current phase in every adjacent aerial.

From this it follows that in practice it is not really necessary to couple each individual aerial directly to the high-frequency supply. In order to

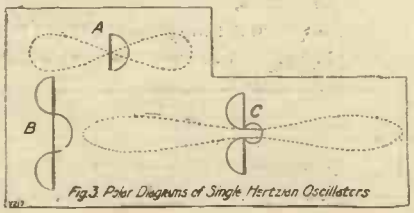


Fig.3 Polar Diagrams of Single Hertzian Oscillators

simplify matters the scheme illustrated in Fig. 4 is adopted. Here a portion of a bank of Hertzian oscillators is shown, the oscillators being arranged in two columns one above the other. Those marked A are insulated from each other and are not energised directly, but only by induction from the aerials marked A_1, A_2.

The latter are both earthed as shown and are coupled to the feed cables from the power-house. It will be noticed that each of the energised aerials, A_1, A_2, etc., is of the Franklin type, the centre part being doubled back so as to increase the directional effect in the manner previously explained.

As regards operation, both the transmitting and receiving aerials are connected by landlines to the central Radio Office, the whole process of transmitting and receiving Beam messages being carried out through automatic relays controlled directly from the General Post Office in London.

A USEFUL GADGET

By C. A. J. MEADOWS

THE need sometimes arises for a tool which will cut a clean hole of an inch or more in diameter through ebonite, or into wood, and this is one of the little snags which are apparently insurmountable when one is only provided with the tools generally employed for all wireless purposes. The mounting of a voltmeter, ammeter, or milliammeter will necessitate the cutting of a disc at least 1½ in. in diameter, and a similar operation is necessary to accommodate a well-type valve holder.

To cut a true disc of such a size with ordinary tools is next to impossible, and should never be attempted, as the most determined and painstaking effort is foredoomed to failure. The only sure method of accomplishing this operation is with the aid of a disc cutter, which consists of a small-diameter Morse drill having a block formed on the shank, with an adjustable right-angled cutter running through the block.

The diameter of a disc cut with this type of tool at the limit of its capacity is over three inches, which is more than sufficient for any requirement it would be called upon to fill in the hands of the constructor.

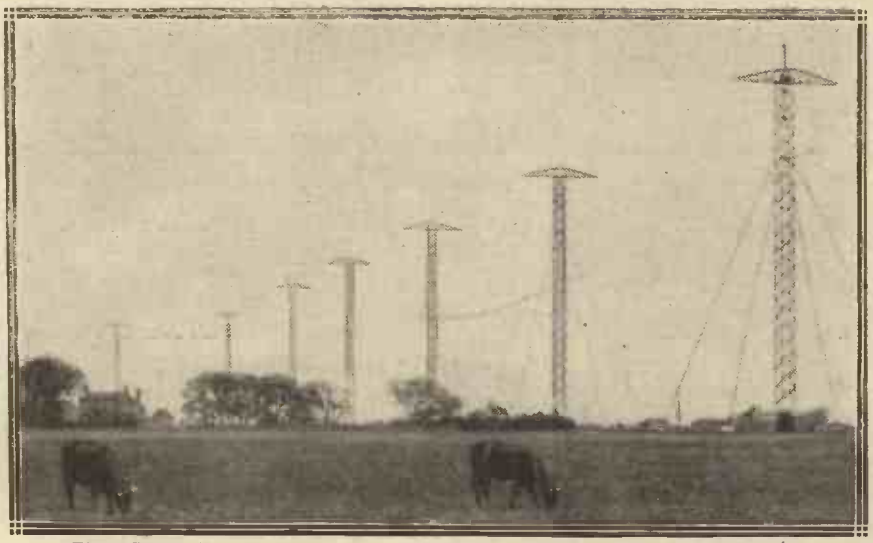
THE "WORLD'S WORST BLIND SPOT"

SIR,—I have been a regular reader of your MODERN WIRELESS for the last three years, and feel that I must congratulate you on producing such an excellent and interesting paper.

In your May issue, I was reading an article written by "Sparks" about the east of Ceylon being the World's Worst Blind Spot. I must agree with "Sparks" there, as I have always experienced extreme difficulty in receiving signals from the Colombo Station anywhere near that vicinity.

I am now contemplating constructing the two-valve Short-Wave Receiver, described by Mr. Simmonds in your February issue, and shall be looking forward to hearing some amateurs from home.

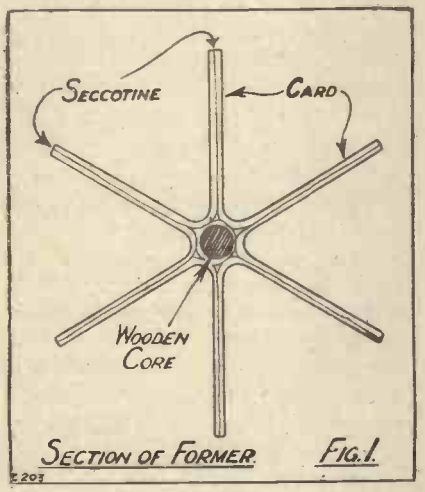
Yours faithfully,
"Another Sparks."
S.S. "Knut Hamsun."


The "Beam" masts at Skegness, showing the typical cross-bar construction.

An H.F. Choke For Short Waves

By HUMPHREY PURCELL.

IN a short-wave receiver it is essential that losses should be kept at a minimum at every point, and the H.F. choke demands



SECTION OF FORMER. FIG. 1.

as much attention as any other component. If this is unsuitable, it will offer insufficient resistance to the H.F. impulses, and reaction control will be difficult or even impossible.

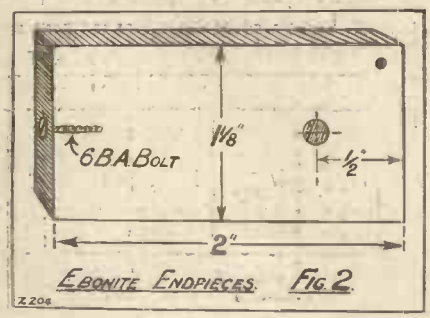
Easy to Make

The accompanying photograph shows a low-loss choke which is simple to construct and which costs only a few pence for materials. Six pieces of fairly stout cardboard, measuring $2\frac{5}{8}$ in. by $1\frac{3}{4}$ in., or thereabouts, are folded lengthways. They thus become V-shaped troughs. The outer sides are then smeared liberally with seccotine, and the six pieces placed together so that their sectional view is as shown in Fig. 1. While the seccotine is still wet, a wooden skewer, or similar length of wood, is thrust down the centre where the points of the V-shaped cards meet. The former is dried thoroughly, then painted with shellac varnish, and dried again.

Two pieces of ebonite measuring approximately 2 in. by $1\frac{1}{8}$ in. by $\frac{1}{4}$ in. (or $\frac{1}{8}$th) are required as end pieces. These are mounted on a wooden base $3\frac{3}{4}$ in. by 1 in. by $\frac{1}{4}$ in., by means of


A photograph of the completed choke.

6 B.A. bolts passed upwards through the wood into holes drilled and tapped to take them in the ends of the ebonite pieces (see Fig. 2). Suitable holes, $\frac{1}{4}$ in. diameter or smaller, are drilled in the ebonite pieces to take



EBONITE ENDPIECES. FIG. 2.

the ends of the wooden skewer as a tight fit, the wood afterwards being cut off flush with the ebonite. A small hole is also drilled near one top corner of each piece of ebonite for a bolt and nut to hold a soldering tag.

Winding the Choke

The winding consists of sixty turns of No. 30 D.S.C. wire, the turns being slightly spaced. Winding is rather trying to the eyes, but is not difficult if taken slowly. The beginning and end of the wire are passed through small holes drilled in the cardboard, either by means of a fretwork drill or by pushing a large needle through the card. The ends may, if desired, be soldered to the tags mounted on the ebonite uprights, but it is a better plan to use those tags merely as supports for connecting wires, and to solder the ends of the choke winding direct to the connecting wires themselves.

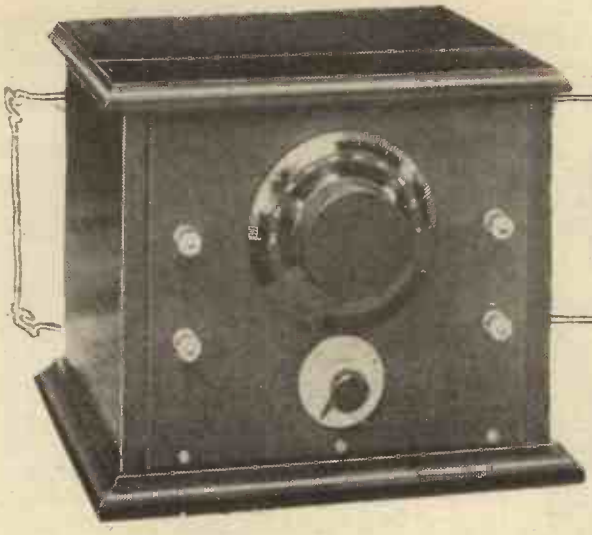
RUBBER-COVERED CLIPS.

THERE are many types of spring clips available at the present time, and they form very useful accessories when making tests on wireless apparatus. A number of flex leads terminating in these spring clips generally should be found amongst the aids to testing, for they allow temporary alterations in wiring to be effected very rapidly when ascertaining the best component arrangement, etc., prior to soldering on the final leads. With the good spring and toothed jaws the clips ensure that the connections, although temporary, are electrically efficient and prove very useful. There is one drawback in nearly all the types, however, for when being placed inside a set amongst components and wiring already executed and often "alive," that is, with the H.T. and L.T. battery leads joined up, the metal portion of the clip is liable to cause short circuits if brought into contact with certain wires, etc.

In addition, they may slip from the fingers and drop across, say, the filament and battery leads inside the set, which, if bare, will cause serious damage.

A Safeguard

I have been the unfortunate victim on some occasions, and my carelessness has left me repenting the loss of several valves. In consequence, I resorted to the expedient of purchasing some rubber "fingerettes" (the rubber thimbles used by typists and clerks to facilitate the turning of ledger pages, etc.) for covering the clips. A small hole is made in the top, and the flexible lead joined to the clip passed through this hole, so that the fingerette covered the clip and left the end exposed for clipping in place. Failing this, short lengths of rubber tubing can be pressed into service, these being of sufficient diameter to house the clip, while if either of these are not to hand, loosely bind over the clip a little black adhesive tape, and this will also prove very effective. The cost is negligible, but since accidental short circuits then become a rarity the outlay amounts to a low premium insurance for protection.



A Midget Loud-speaker Set

This compact receiver embodies one of the new Loewe multiple valves. The set designed, constructed, and described by A. S. CLARK.

THIS set incorporates an arrangement which is more or less new to the amateur constructor, and it should therefore be met with interest by all readers. Although, as will be seen from the photographs, only two valves are used, the set is in reality a four-valve receiver, and is capable, in spite of its midget size, of giving full loud-speaker results.

Its chief attraction lies in its simplicity and the small amount of constructional work involved. Therefore it will appeal greatly to the constructor who, while feeling capable of making a simple single-valve set, does not like to tackle an ordinary loud-speaker receiver. If, therefore, you want a set which will work a large loud-speaker, be compact, and also easy to make, you should construct the set described in the following pages.

COMPONENTS REQUIRED.

- Ebonite panel, 8 in. × 7 in. × ¼ in. (Ebonart.)
- Cabinet for same, with baseboard 7 in. deep.
- Terminal strip, 8 in. × 2 in. × ¼ in.
- 11 terminals.
- 1 on-and-off switch. (Lissen, Lotus, etc.)
- 1 ·0005 variable condenser. (Cyldon.)
- 1 coil mount.
- 1 30-ohm rheostat. (Lissen, Precision, etc.)
- 1 anti-shock valve holder. (Lotus, Etherplus, Benjamin, etc.)
- 1 ordinary valve holder.
- 1 aperiodic H.F. transformer, 300 to 600 metres. (Magnum.)
- 1 ditto for 5 X X band. (Magnum.)
- 1 Loewe valve and holder. Type 3NF.
- Glazite wire and wood-screws.

Local Receiver

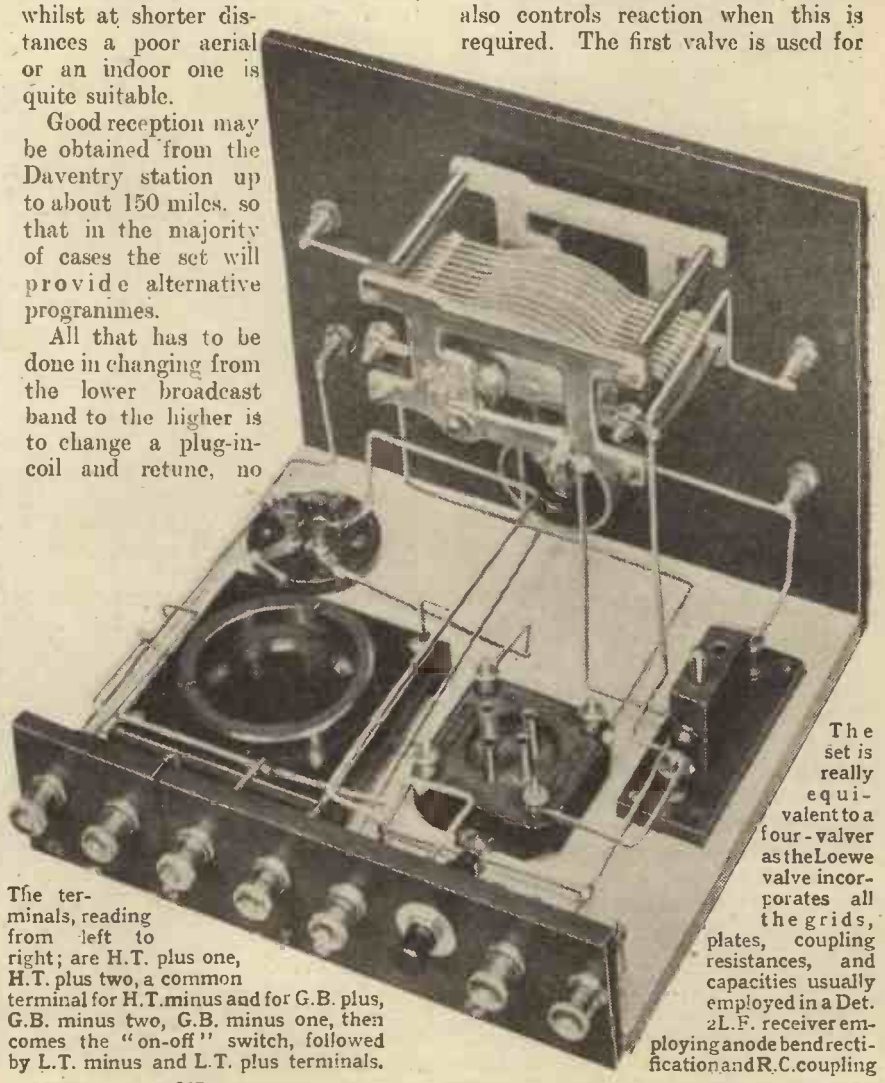
The set is entirely a local-station receiver, but unlike many such does not require a good outdoor aerial. So much is this so that at eight miles from 2 L O full loud speaking can easily be obtained on a frame aerial with two-foot sides.

It will be gathered from this that the set is sensitive, and will therefore give good results up to at least 20 to 25 miles from a main station, whilst at shorter distances a poor aerial or an indoor one is quite suitable.

Good reception may be obtained from the Daventry station up to about 150 miles, so that in the majority of cases the set will provide alternative programmes.

All that has to be done in changing from the lower broadcast band to the higher is to change a plug-in-coil and retune, no other adjustments whatever being necessary.

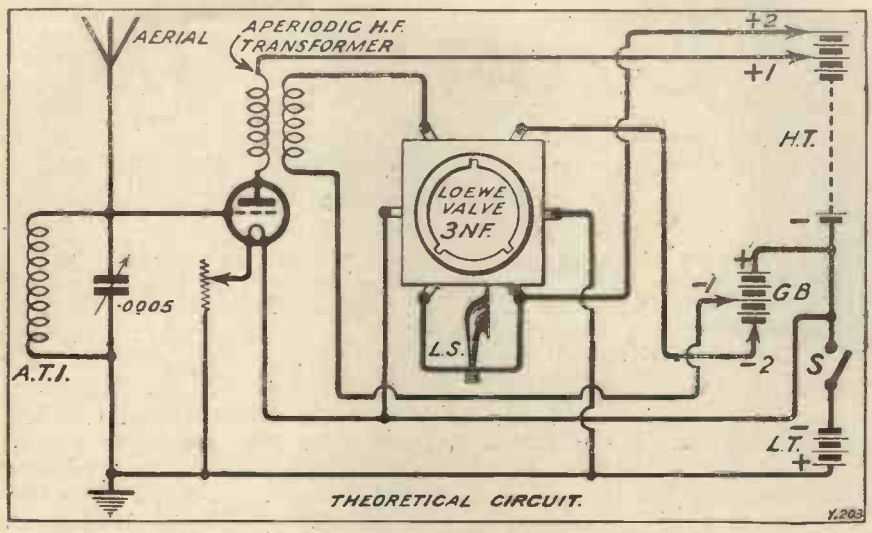
The theoretical circuit is given in Fig. 1 and is not such as to frighten even the veriest beginner. Only two variables are employed, the variable condenser for tuning and the filament resistance for the first valve, which also controls reaction when this is required. The first valve is used for



The terminals, reading from left to right; are H.T. plus one, H.T. plus two, a common terminal for H.T. minus and for G.B. plus, G.B. minus two, G.B. minus one, then comes the "on-off" switch, followed by L.T. minus and L.T. plus terminals.

The set is really equivalent to a four-valver as the Loewe valve incorporates all the grids, plates, coupling resistances, and capacities usually employed in a Det. 2L.F. receiver employing anode bend rectification and R.C. coupling

H.F. amplification, and may be any low impedance H.F. or small power valve. The aerial circuit is directly coupled, consisting of a plug-in coil tuned by the variable condenser. In the plate circuit of the H.F. valve is the primary of an aperiodic H.F. transformer, the secondary of which is connected to the following special valve.



This special valve is known as the Loewe valve, and is the invention of a German scientist from whom it obtains its name. It is in reality three valves in one, and consists of an anode-bend rectifier followed by two stages of resistance-capacity-coupled note magnification. The resistances and all the necessary coupling condensers, etc., are inside the valve. It will therefore be appreciated that the values of the components are particularly suited to the valves. This is definitely a great advantage, since failure to obtain the correct values and right valves is often the reason for poor results with resistance-capacity-coupled note magnifiers.

The L.T. Supply

No fixed resistor or rheostat is required for this valve, since the filaments are arranged to work direct off four volts, and for this reason it is necessary to use a 4-volt valve for the first one. The first two filaments of the Loewe valve are connected in series and the third filament, that of the last valve which has to handle most power, is connected across the first two and takes as much current as the first two together. The total filament consumption of the valve is 0·34 ampere. The valve is rated at 90 to 150 volts H.T., and while it is desirable to use at least 90, fair results have been obtained with less. In order to make the circuit diagram straightforward, the holder of the valve has been shown, looking at it from above.

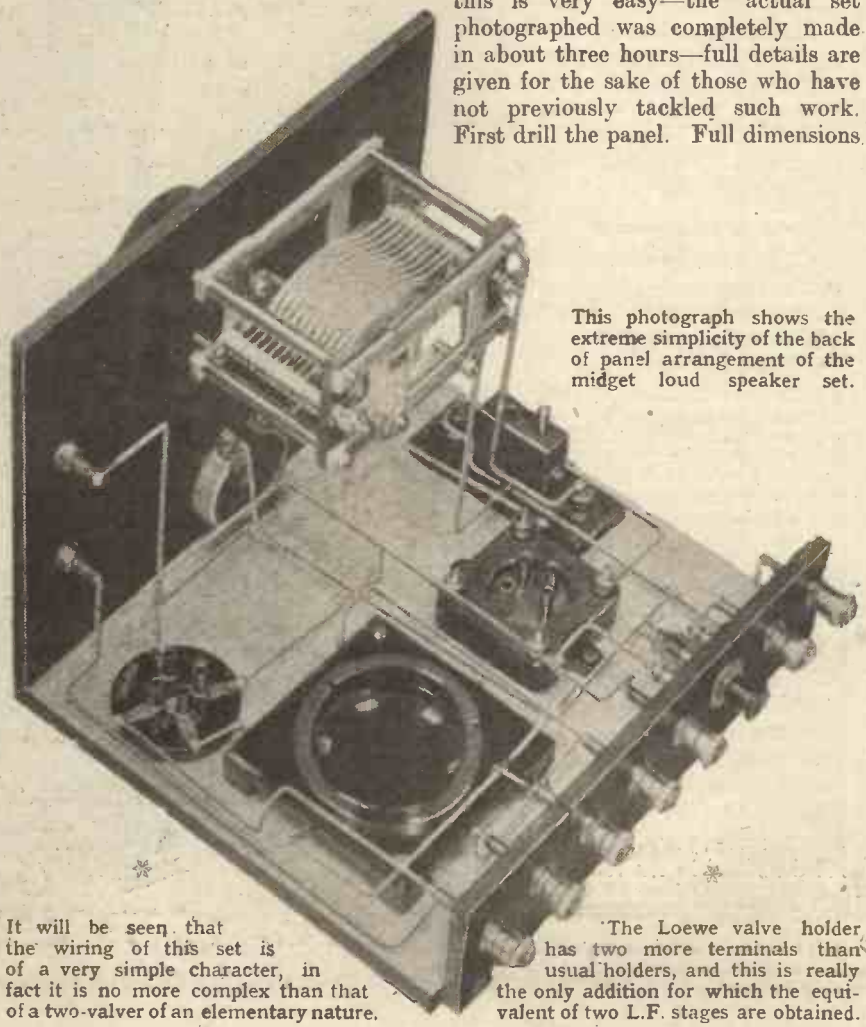
All the components required are given in a list in another part of the article. Any other makes of components than those specified may be employed, apart, of course, from the Loewe valve. Different makes of aperiodic H.F. transformers vary greatly, however, and in some cases difficulty may be experienced in getting the first valve to oscillate. This can generally be overcome, however, by increasing either the filament current or H.T. voltage. Several types of Loewe valves are made, and care must be taken to specify the right one, since others would be entirely unsuitable for this set.

Whatever type of valve is to be used in the first position it is advisable to obtain a 30-ohm rheostat, otherwise difficulty may be experienced in controlling reaction.

A vertical panel is employed, with a cabinet with a hinged lid for inserting valves and the coil. All the battery terminals and the on-and-off switch are carried on an ebonite strip at the back of the set. The two terminals on the left of the panel are for aerial and earth and the two on the right for the loud speaker.

Drilling

When the components are all collected together the constructional work may be commenced. Although this is very easy—the actual set photographed was completely made in about three hours—full details are given for the sake of those who have not previously tackled such work. First drill the panel. Full dimensions



This photograph shows the extreme simplicity of the back of panel arrangement of the midget loud speaker set.

It will be seen that the wiring of this set is of a very simple character, in fact it is no more complex than that of a two-valver of an elementary nature.

The Loewe valve holder has two more terminals than usual holders, and this is really the only addition for which the equivalent of two L.F. stages are obtained.

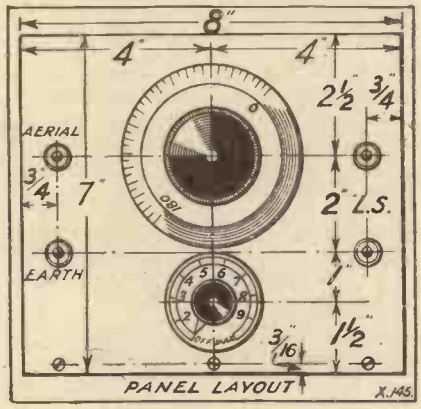
for this are given in the drilling diagram. The positions for the holes should be marked out on the back of the panel with a scriber or other sharp instrument. Centre-punch all points to be drilled before doing so, in order to prevent the drills wandering. If a condenser similar to the one specified is used, a drilling template will be found enclosed in the box. Eight holes must be drilled in the terminal strip, the third one from the right-hand end being made large to take the filament switch. Holes for securing to the panel must also be drilled.

All the components must now be mounted, including the terminals on the terminal strip. As soon as this is done, all terminal shanks, soldering tags, terminals, etc., to which soldered connection is to be made should be heavily tinned. This will make the work of wiring up very much simpler than would otherwise be the case. When this is done slip the baseboard, panel, and terminal strip into position in the cabinet, and screw the panel and strip in position. Now mount the remaining components on the baseboard. The positions indicated in the wiring diagram should be followed as nearly as possible. After these components have been tinned where necessary the set is ready for wiring.

Glazite was used for this in the original set. It is, however, not necessary to use this. Square wire or ordinary tinned copper wire, with or without systoflex, may be employed with equally good results. It is, however, just as well for those who are not expert at wiring to use covered wire, since it avoids trouble should two wires touch. Keep the various wires well spaced, making use of the photographs of the back of the set in order to follow the original wiring as nearly as possible.

H.T. Voltages

As has already been stated, the valve used for H.F. is more or less immaterial. Good results have been obtained with 06 types of valves and also with small power valves and valves designed for H.F. amplification. Probably the constructor will have a valve by him already; if, however, he has not, it is advisable to purchase a special H.F. valve. The set needs H.T. batteries which are in good condition, and it is preferable to have those of high capacity, or, better still, H.T. accumulators. If you are doubtful of your batteries, shunt them with some fixed condensers of 2 to 4 mfds. total capacity. This is, as a matter of fact, advisable in any case. Any value from 90 volts to 150 is suitable. A grid-bias battery tapped at every 1½ volts and with a maximum of about 18 volts should be purchased, although more may be required with very high H.T. voltages.



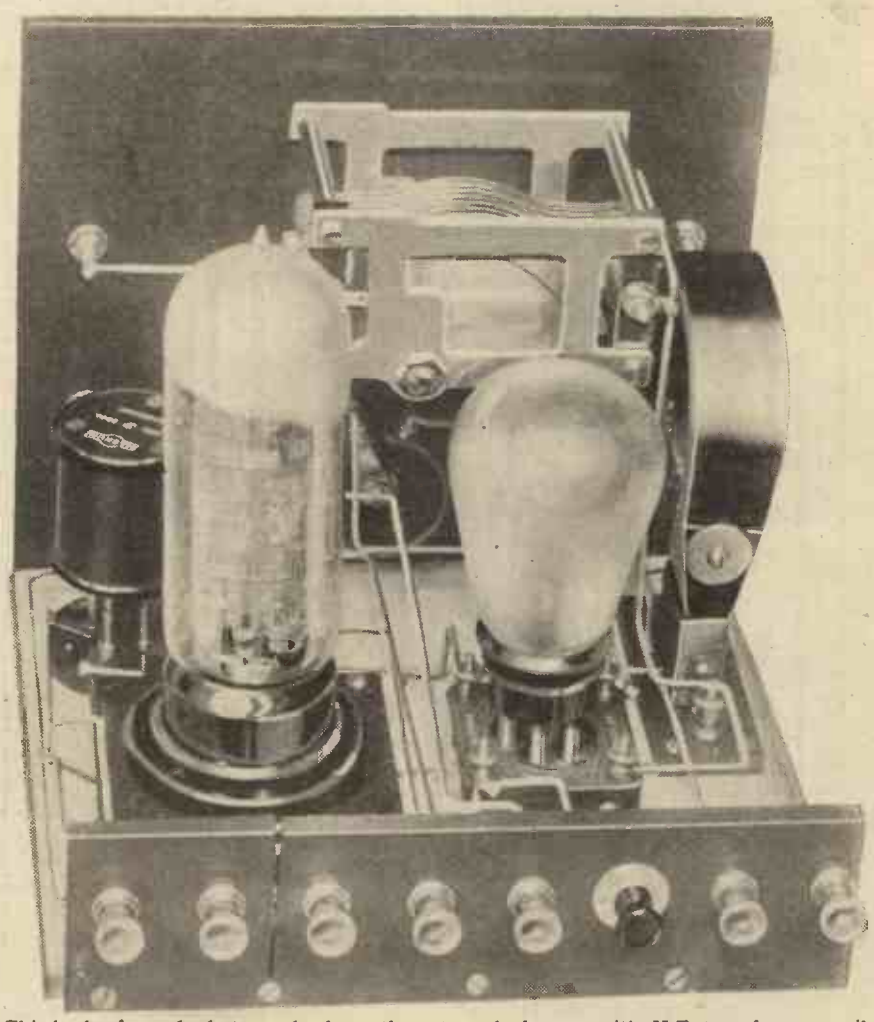
A small accumulator will be required for the filaments, and any good plug-in coils are suitable.

No terminal is provided for grid-bias positive, which should be connected to either L.T. negative or H.T. negative. Connect 1½ volts on G.B. minus 1 and about 9 on G.B. minus 2. Use about 100 volts on H.T. positive 2. The voltage to be put on H.T. positive 1 will vary with the H.F. valve, but should be high enough to cause this valve to oscillate with the filament not quite full on.

Easy to Operate

The receiver is as easy to operate as it is to construct. When using a good aerial the H.F. valve will not be required. It should be turned right out by means of the filament resistance, and the station tuned in on the variable condenser. If the set is worked on a poor aerial or at some distance from a station, the filament of the first valve must be turned up until the strength is sufficient, but never have it high enough to keep the set oscillating, or very bad quality will result. An adjustment of reaction will probably call for an adjustment of the tuning condenser.

The greater the volume desired, the greater must be the H.T., and

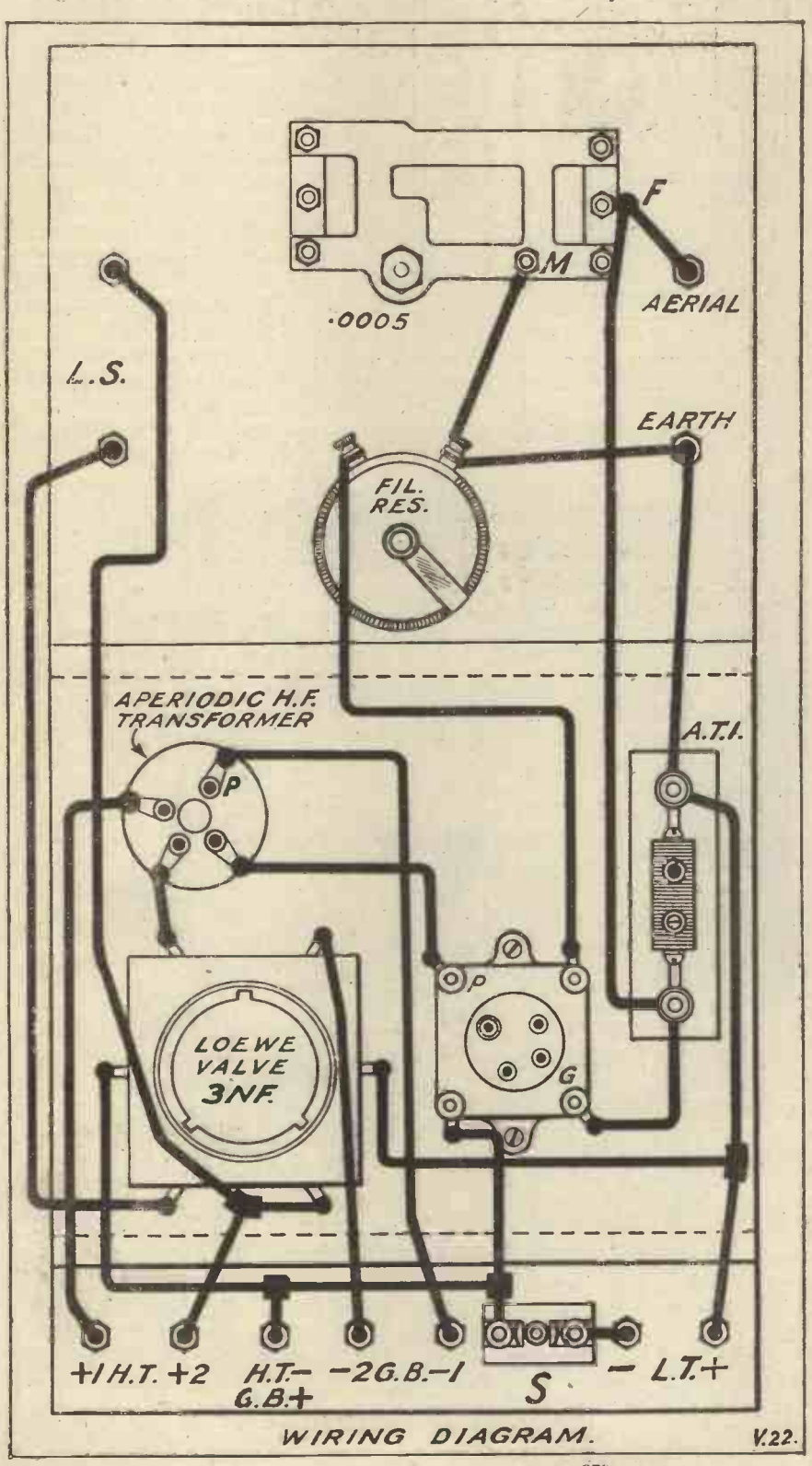


This back-of-panel photograph shows the set ready for use with H.F. transformer, coil, and valves in position.

consequently the grid bias. It must not be considered, however, that the volume may be indefinitely increased, because if it is increased too much the valve will be overloaded and distortion will result. When in use, the H.F. valve resistance makes an excellent volume control, and when not in use, volume can be adjusted by detuning the aerial circuit.

If a very high pitched whistle is heard when the set is not oscillating, and which can be cured by reducing the H.T., it indicates that either not enough grid bias is being used, or the H.T. batteries are in a bad state, in which case they should be shunted, as indicated in the earlier part of the article, by large fixed condensers.

It is also necessary for the accumulator to be fully charged, otherwise poor quality and general insensitiveness and thin tone will result.



WIRING DIAGRAM. V.22.

Good Results

Many experiments were made on the aerial, and, apart from the frame-aerial results already described, full loud speaking could be obtained on almost any arrangement—nine feet of wire across a room, for instance, or one end of the frame connected to the aerial terminal and an earth connection made to the earth terminal. Even a piece of wire laid along the floor was suitable. It will therefore be gathered that if desired the arrangement is ideal for use as a portable set for districts around a broadcasting station. On Daventry (70 miles away) it was found necessary to use an outside aerial to obtain good loud-speaking.

FREAK AERIALS

By C. A. J.

THERE are times when one is in need of an emergency aerial to receive some special item which is to be broadcast, and either the usual aerial has broken down, or something has happened to render some other type of aerial a necessity.

The spring mattress is so well known for its efficiency in this direction that little need to be said about it, but there are not a great number of people who are aware that a birdcage will function very well if fairly close to a broadcasting station, or that a piano frame may be used with complete success under similar conditions.

On a recent "field-day" with a portable set a snag cropped up. There were no trees within half a mile, and all that could be seen for some distance was a line of posts supporting a double wire fence. The aerial which had been arranged was of the sling-up type, consisting of sixty feet or so of heavy rubber-covered flex. Someone suggested that the two fence wires should be utilised, and proceeded to connect both wires together, running a lead to the aerial terminal of the set. London and Daventry were received at really good strength, and in the evening several Continental stations came in well, including Langenberg and Radio-Paris.

The chief point which helped to make the fence such an efficient aerial was that it was very dry, and had been so for days; the wooden posts supporting the wires were, therefore, good insulators, and to that fact was due the good reception that was fortunately obtained.

Electrolytic H.T. Battery Eliminators

By E. H. TURLE, M.I.E.E. M.I.R.E.

A WIDESPREAD desire for better reproduction by wireless receivers is slowly evolving from a proper appreciation by the public of what can now be attained with modern apparatus. The public demonstration of the B.B.C. some months ago, and the subsequent publicity given to the circuits and valves used by them, have done much to foster this desire for improved reproduction, and have led to a greater readiness to face the facts and the necessity of providing for an expenditure of 5 watts or more in a final power output stage if full volume of really good quality is to be attained.

While there is neither difficulty nor much expense in the provision of such a final power stage itself, many are led to hesitate at the cost of maintenance and of running. Dry batteries for such outputs would be so bulky, costly, and unreliable as to be quite unsuitable, hopelessly uneconomical, and wholly out of the question. High-tension accumulators of suitably high voltage and large capacity involve a considerable initial expense, careful maintenance, and regular recharging under proper supervision.

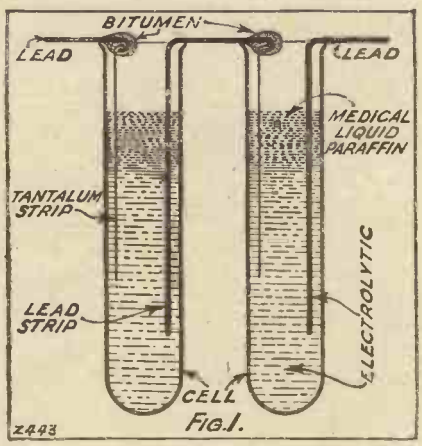
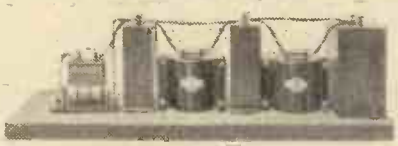


FIG. 1.

Where alternating-current supply mains are available, the first thought is towards a full-wave valve rectifier or battery eliminator, but reference to a list comprising twenty-one of


A practical form of smoothing circuit, connected up in the method shown in Fig. 2 (overleaf).

varying sizes and makes shows but two of sufficient output at a suitable voltage. Further, their cost equals or exceeds that of suitable accumulators, there is the occasional renewal of expensive valves, the difficulty or expense of eliminating any noise arising from ripple voltage, and the question of A.C. hum, all of which particularly arise on these large sizes.

A Way Out

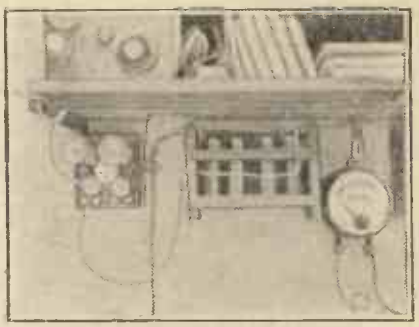
A still greater difficulty arises from the fact that a wireless receiver is usually installed in the most suitable position for it, and, further, often operated by remote control from the various rooms, so that there is consequently the greater complication of also switching on and off the rectifier itself; or the alternative of leaving the latter permanently on, increasing not only the current consumption by some 150 units per year due to the filament current, but also the frequency of renewal of the somewhat expensive valves.

The provision of a simple electrolytic rectifier or H.T. battery eliminator permits of the above difficulties being largely overcome or reduced to matters of small moment. In the design and arrangement of an electrolytic rectifier for this duty, regard must be paid not only to the highest anode voltage required, but also to the maximum current output, the former governing the number of cells and the latter their capacity.

Table I. gives data in respect of A.C. supply voltages usually met with, and D.C. output voltages usually required, while Table II. gives the requisite data for representative sizes. In deciding upon the size to install an ample margin of capacity should be allowed, as there is always a tendency to increase the demand from time to time; and provision should be made for the temporary connection of a high-resistance voltmeter as required to check the output voltage, without overloading the rectifier.

The Containers

The effect of varying the size of bridging condenser (C_1, Fig. 2) given in Table II. is such that any increase within moderate limits increases the output voltage by lowering the impedance of the circuit, but at the same time the open circuit losses are


The handiest place for the outfit is tucked away below a shelf, as shown above.

increased for the same reason. Hence the sizes given are selected for economical reasons.

To form the cells of the rectifier, 6 in. by 1½ in. diameter hard glass test tubes (" boiling tubes ") are suitable up to 30 m.a. capacity; and above that, wide-mouthed conical flasks of resistance glass (Erlenmeyer's form) may be used of a size to hold the volume of electrolyte set out in the table without reaching within 2 in. of the top. The cells should be spaced apart in two rows and be suitably supported in an open framework to expose ample cooling surface to the air.

Sizes of Electrodes

Each cell requires two electrodes, the anode a strip of tantalum foil (0·2 mm. thick) cut ⅛ in. wide, of suitable length to give the depth of immersion given in Table II.; and the cathode a strip of sheet lead (12 gauge), cut ½ in. wide, of suitable length to reach slightly below the bottom of the tantalum strip and long enough to bend over to and reach and form a lap joint with the tantalum strip in the adjoining cell.

Making the Joints

The connection between the tantalum and the lead strip should be carefully made (the end of the lead being scraped bright and not afterwards touched by the fingers), the tantalum freed from grease, maintained for five minutes at a dull red heat in a Bunsen flame to expel occluded gases; when cool it is polished with fine emery, wiped, and then ⅛ in. of the clean end of the lead is folded over one end of the tantalum strip and hammered tight.

The whole of the area surrounding this join should be immersed in electrical-grade medium hard bitumen, previously carefully and slowly heated to a moderately thin liquid. On removal the now bitumen-coated joint is allowed to set in cool air. Care must be exercised not to crack the bitumen in any subsequent bending of the electrodes to fit the cells, as shown in the sketch (Fig. 1).

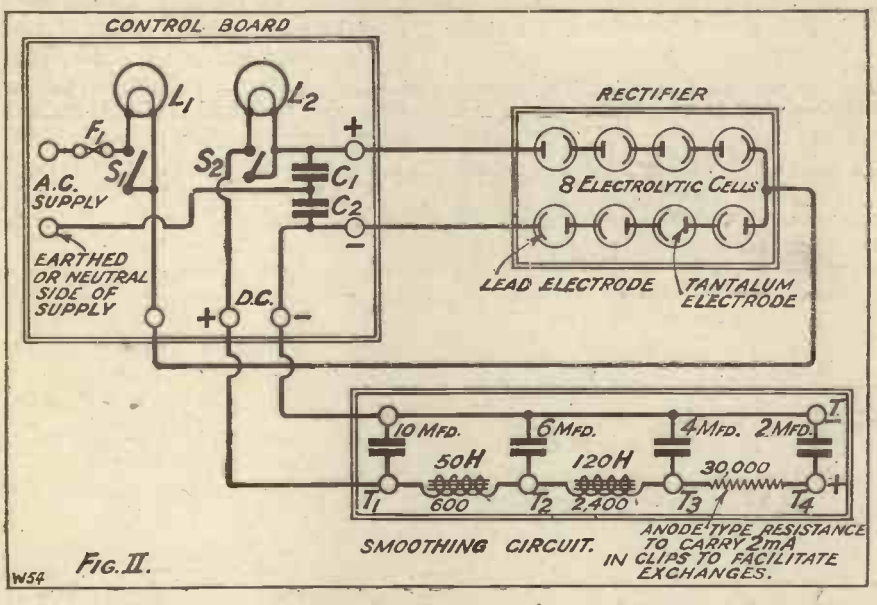
The electrolyte used comprises dilute pure (brimstone) sulphuric acid of 1·220 specific gravity, preferably purchased at one of the accumulator makers' official recharging stations. To this is added 5 per cent in volume of a saturated solution of pure ferrous sulphate previously dissolved in tepid (not even warm) distilled water, and finally a layer ½ in. deep of medicinal liquid paraffin should be floated on the top of the electrolyte in each cell to eliminate sparking at the point of immersion of the electrodes, and also to reduce the spraying of this corrosive acid by the evolution of gas. The whole of the bitumen surrounding the joint must be kept 1 in. above the surface of the paraffin as bitumen is miscible with it in all proportions.

TABLE I.

A.C. supply. Voltage.	Series resistance lamp. Voltage and watts.	D.C. output available. Volts.	Number of electrolytic cells.
	240/20	120	6
	200/20	140	8
	200/30	150	8
200	200/40	200	10
	200/60	250	10
	100/20	230	10
	100/30	240	10
225	200/30	175	8
225	100/30	250	10
250	200/30	190	8
260	200/30	200	10
260	100/30	270	12

NOTE.—The D.C. voltages given in this table are the maximum available for the final power stage of a receiver, and the readings are based on outputs of 35–65 m.a.

The number of cells given is the *minimum* advisable in each case.



The Input Circuit

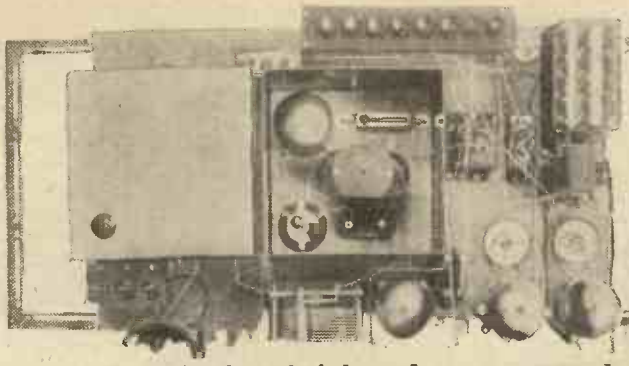
A special circuit is necessary in applying the A.C. supply to the rectifier, which circuit is set out in Fig. 2, and should be carefully adhered to, and on the output side it is further necessary to incorporate a filter of the " low-pass " type also shown, to effect a smoothing action and reduce below the audible limit any ripple voltage; but this is less difficult than with valve rectifiers with their transformers. The first (power) choke can be omitted if particularly desired,

(*Continued on page* 304.)

TABLE II.

Maximum output of rectifier. m.a.	Size of each condenser. mfd.	Electrode length immersed. * Inches. Ta.	Pb.	Quantity of dilute H_2SO_4* Fluid ozs.	D.C. check resistance lamp. Voltage and watts.	
30	2	1·0	1·2	2	100	10
40	3	1·2	1·4	3	50	10
50	4	1·5	1·7	3·5	50	10
60	4	2·0	2·2	4	50	10
80	5	2·2	2·5	4·5	50	10
100	6	2·5	2·7	5	25	10

* In each cell.



The DESIGN of H.F. AMPLIFIERS

A thoughtful and interesting discussion on modern H.F. practice.

By W. JAMES.

EXPERIMENTERS are slowly but surely beginning to realise the enormous value of tuned high-frequency amplifiers. Gone for ever are the days when such an amplifier was regarded as the plaything of the advanced experimenter. In the past, reaction was all too frequently relied upon to provide the sensitivity and selectivity which are essential for the reception of distant broadcast stations, but at last the efforts of various experimenters are being rewarded, and high-frequency amplification is coming into its own. Much has been written and said in favour of sets relying on reaction for their effectiveness, but it has to be admitted that although reaction is a good servant it is a very bad master.

Regarded With Suspicion

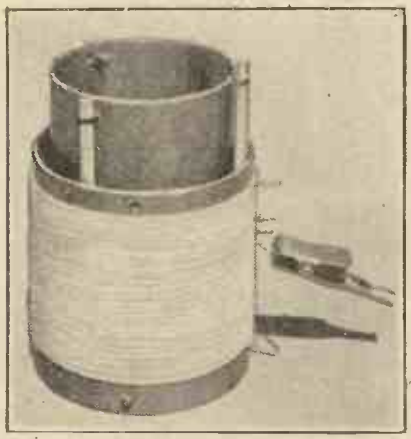
High-frequency amplification has for too long a time been regarded with suspicion. Many experimenters still consider that it gives more trouble than it is worth. It is generally associated with instability and low amplification, and it is the purpose of this article to discuss the question of instability. The difficulty with high-frequency amplifiers has been to obtain a reasonable amount of amplification with stability. It was found that such an amplifier had a natural tendency to produce violent oscillations unless certain precautions were taken. The precautions usually taken consisted in damping the circuits to such an extent that the amplification given per stage was reduced to such a small amount that instability could not occur. Obviously, such an amplifier was of little value.

Three Forms of Interaction

The tendency of high-frequency amplifiers to burst into oscillation is due to a single factor, namely to coupling between the output and input circuits. It therefore follows that to obtain successful high-frequency amplification it is necessary to remove or to neutralise all stray couplings.

There are three distinct forms which have to be considered :

1. Conductive couplings.
2. Magnetic couplings.
3. Capacitative couplings.



An H.F. transformer with a tapped primary winding and an adjustable coupled secondary.

These may act to promote stability or instability, and they may behave in such a manner that their effects cancel out in part. Steps should always be taken to minimise them, but it is usually not necessary to endeavour completely to eliminate them unless several stages of amplification are to be used, when it is quite essential to track them down and ruthlessly remove them.

This is sometimes a tiresome job, for it often happens that the removal of one coupling will increase the instability of the amplifier owing to the fact that the particular coupling which has been removed acted to offset the effects of another form of coupling in the amplifier. Thus, the removal of one of them has the effect of allowing the other one free play, but provided the amplifier is dealt with systematically all couplings can be removed or neutralised, although it has to be admitted that the complete suppression of couplings is apt to be rather a difficult and sometimes an expensive matter.

Conductive Coupling

We will discuss this form of stray coupling first of all, not because it is the easiest to dispose of, but because it is the most easily overlooked. Conductive couplings are due to such things as lengthy connecting wires and high-resistance batteries. The impedance offered by a common anode battery or even by a grid-bias battery is often sufficient to cause instability.

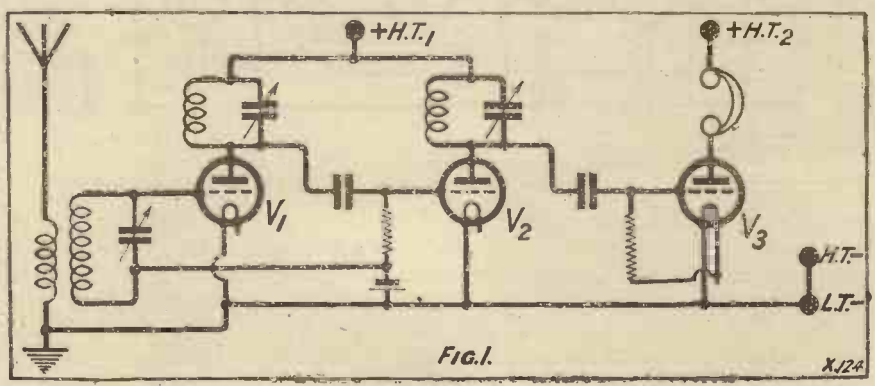


FIG. I.

The high-frequency currents which return to the filament circuit through the anode battery, having a high impedance, set up tiny voltages across the impedance, which are communicated to all the valves connected to the battery. Thus, in Fig. 1, the anode circuits of the two high-frequency amplifying valves V_1 and V_2 are connected to the anode battery at H.T.+1. As the two anode circuits are connected together any voltage variation across the anode battery is communicated to both valves, with the result that a reaction effect is produced.

By-Pass Condensers

This form of coupling is generally quite easily removed by means of by-pass condensers connected between the positive H.T. end of the tuned circuits and the filaments of the valves by the shortest possible connecting wires. These condensers are marked " C " in Fig. 2. The position of these by-pass condensers in the receiver, and the length of the connecting wires, are important, particularly when the amplifier has two or more stages. The wires should always be made as short as possible, and the by-pass condensers themselves have a capacity of about 1 mfd. if of the Mansbridge type. A common grid-bias battery often causes difficulties. Instability may be promoted by the length and position of the various connecting wires from the circuit to the grid battery, and it is almost invariably necessary to provide grid-battery shunting condensers connected as shown in the figure at C_1.

Rarely is it necessary to take extreme precautions such as the provision of choking coils and damping resistances, but when two or three stages of high-frequency amplification are being used with considerable magnification it may be necessary to take all of these precautions. Chokes connected in the anode-battery feed-wires in conjunction with by-pass condensers will practically prevent the passage of high-frequency currents through the anode battery.

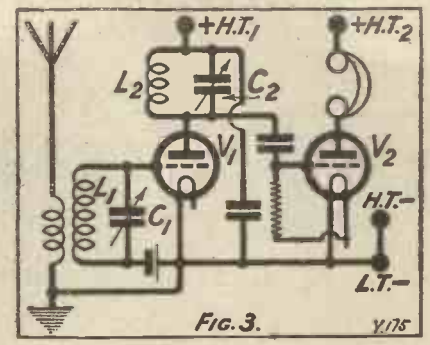


FIG. 3. X.175

Similar chokes or resistances may also have to be joined in the grid circuits, but fortunately it is seldom necessary to do this. In some instances, though, it has been found advisable to connect 1-mfd. condensers across the filaments of the amplifying valves.

Magnetic Couplings

Stray magnetic couplings are often the cause of instability. Thus, if the field associated with a coil connected to one circuit links with a coil connected in another circuit, a reaction effect is bound to be produced. It may so happen that the coupling is of such a nature that it tends to stabilise the circuit, but, on the other hand, this coupling may, and usually does, contribute to instability. It depends on the way the coils are connected. It is further necessary to consider very carefully the position of wires carrying high-frequency currents.

Stray magnetic couplings can be eliminated by shielding, but to be complete each circuit, comprising the valve, tuning coil, tuning condenser, and other apparatus, will have to be enclosed in a metal box connected to earth. Fortunately, it is not necessary in many instances to employ complete shielding; it is often found that partial shielding with a suitable arrangement of coils and connecting wires will suffice. Undoubtedly, the easiest way of obtaining high amplification is to shield each stage completely, but this has in the past been rather expensive, and such a receiver is more difficult to construct than one making use of partial shielding.

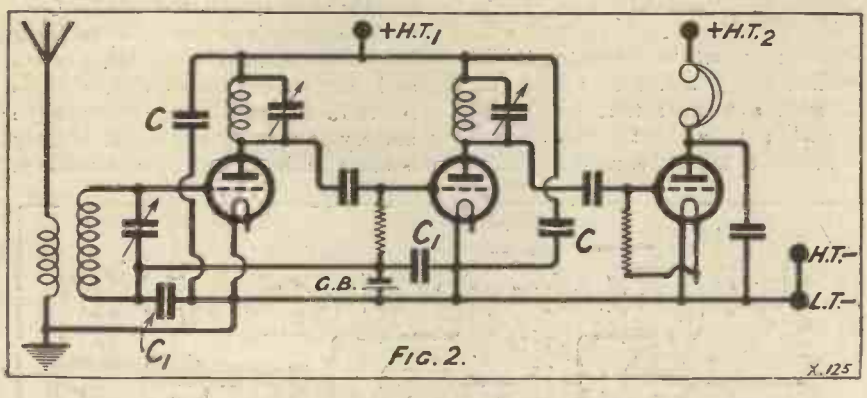


FIG. 2. X.125

Shielded Sets

The writer has constructed totally shielded sets and found it possible to obtain enormous magnification with complete stability, but he has also found that a partially shielded receiver, which is much more easily and cheaply constructed, will give almost as good results, provided the components are correctly proportioned.

It is true that a partially shielded receiver is liable to be a little more bulky than a completely shielded set, but it has certain advantages. Experience shows that the majority of the separately shielded coils at present on the market are not very satisfactory, the shielding being of such a nature that the coils tune broadly and give poor amplification. Shielding has to be very carefully designed if it is to be effective and not to introduce serious losses.

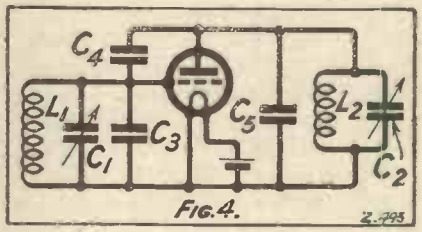


FIG. 4. Z.795

We now pass to the third and probably the most common cause of instability in amplifiers, namely, the stray capacitative couplings. This coupling may be due to the proximity of coils and tuning condensers connected to grid and anode circuits, or to the capacity of the valve itself. Capacitative couplings external to the valve may easily be eliminated by careful screening, but that due to the valve is not so easily disposed of.

Capacity Troubles

The problem will be more easily understood if we consider a simple circuit such as that of Fig. 3. Here we have two valves, one a high-frequency amplifier, and the other a detector. Connected to the grid of the high-frequency amplifying valve, V_1, is a tuned circuit, L_1 C_1, and to the anode of this valve a similar circuit L_2 C_2. This arrangement will usually oscillate most violently, even

when all couplings except that due to the valve have been eliminated—that is to say, when there is no magnetic coupling between coils L_1 and L_2, no capacitative coupling between

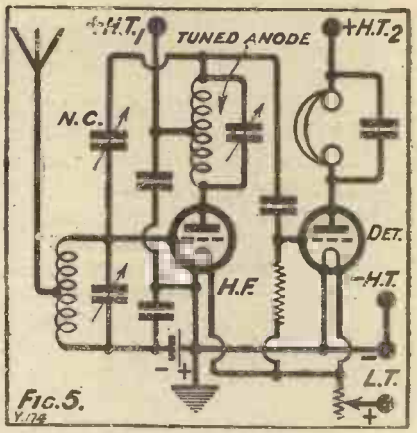


FIG. 5.

circuits $L_1 C_1$ and $L_2 C_2$, and no common impedance, the circuit when tuned will produce most violent oscillations. We are therefore left with the stray coupling provided by the capacity of the valve.

In Fig. 4 we show the three capacities of the valve as condensers C_3, C_4, and C_5. These condensers are made up of the elements of the valve and valve holder, and have as a dielectric the glass pinch of the valve, the bakelite shell which carries the valve pins, and the insulating material of the holder. Condenser C_3 will obviously not have a great effect, as it is in parallel with the tuning condenser C_1, but there is this to be remembered, that if it happens to be a bad one it will have the effect of reducing the voltage applied to the grid.

Inter-Electrode Capacity

Some valve holders have very bad dielectric properties, with the result that condenser C_3 is an absorbing one. In fact, C_3 can be represented as a perfect condenser shunted by a resistance, or as a perfect condenser in series with a resistance, and as it is connected across the whole of the tuned input circuit $L_1 C_1$, the effective resistance of this circuit is increased. The result is that signal strength and selectivity are impaired by an amount depending upon the nature of the insulating material used. Sometimes this is a very serious matter, but provided the valve holder used is chosen carefully not much harm is done.

Condenser C_5, representing the anode-filament capacity of the valve, is across the tuned circuit joined to the anode. The quality of this condenser will, therefore, to some extent determine the damping of the anode circuit, but as this is already damped by the following valve, the effect is not likely to matter appreciably.

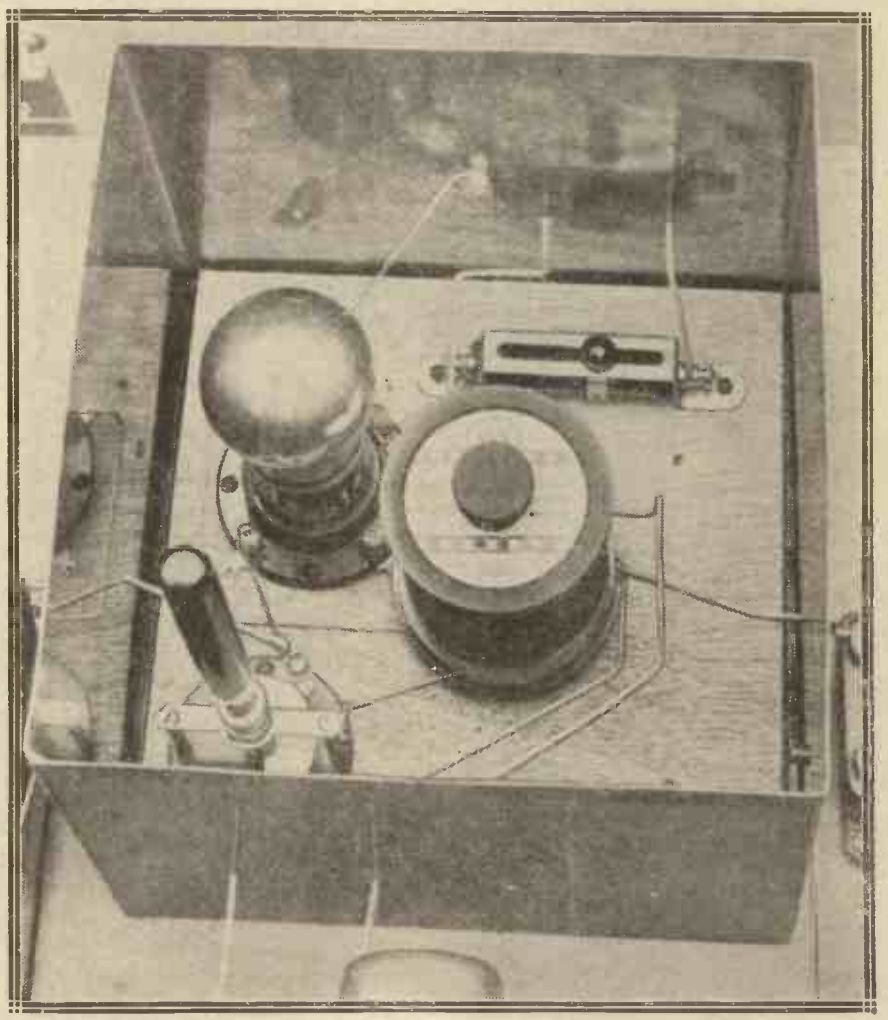
Anode-Grid "Condenser"

Finally, we come to condenser C_4, which represents the anode-grid capacity of the valve and that of the connecting wires joined to the anode and grid. The effect of this condenser will be better understood if we consider the action of the valve as an amplifier. We know that high-frequency voltages induced in the grid circuit produce by normal valve action magnified voltages across the tuned anode circuit. We therefore have a difference of potential between the anode and filament circuits which is greater than that between the grid and filament, and as these are out of phase the difference of potential between the anode and grid will usually exceed that between the anode and filament.

A current therefore flows through the anode-grid condenser, its magnitude depending, of course, on the capacity of the condenser and the potential difference. Thus there is a transfer of energy from the anode to the grid circuit. It is this condenser which causes most of the trouble in H.F. amplifiers, for when the amount of current passed by it exceeds a certain amount the circuits will oscillate, provided the phase of the current is right, as it usually is.

Tuned Anode Effects

The effects produced by tuning the anode circuit are rather complicated, but briefly we may say this, that the effect of the anode circuit on the grid circuit depends entirely on whether they are in resonance or whether the anode circuit has a capacitative reactance or an inductive reactance. Thus, suppose the grid circuit is tuned to resonance with an incoming signal and that the anode circuit is tuned to a longer wave-length. At this setting of the anode circuit there is too much capacity for resonance, and



A typical example of the scientific application of screening to a complete H.F. stage; one of the new standard "Modern Wireless" screening boxes wired in a receiver, but with its lid removed to show the components.

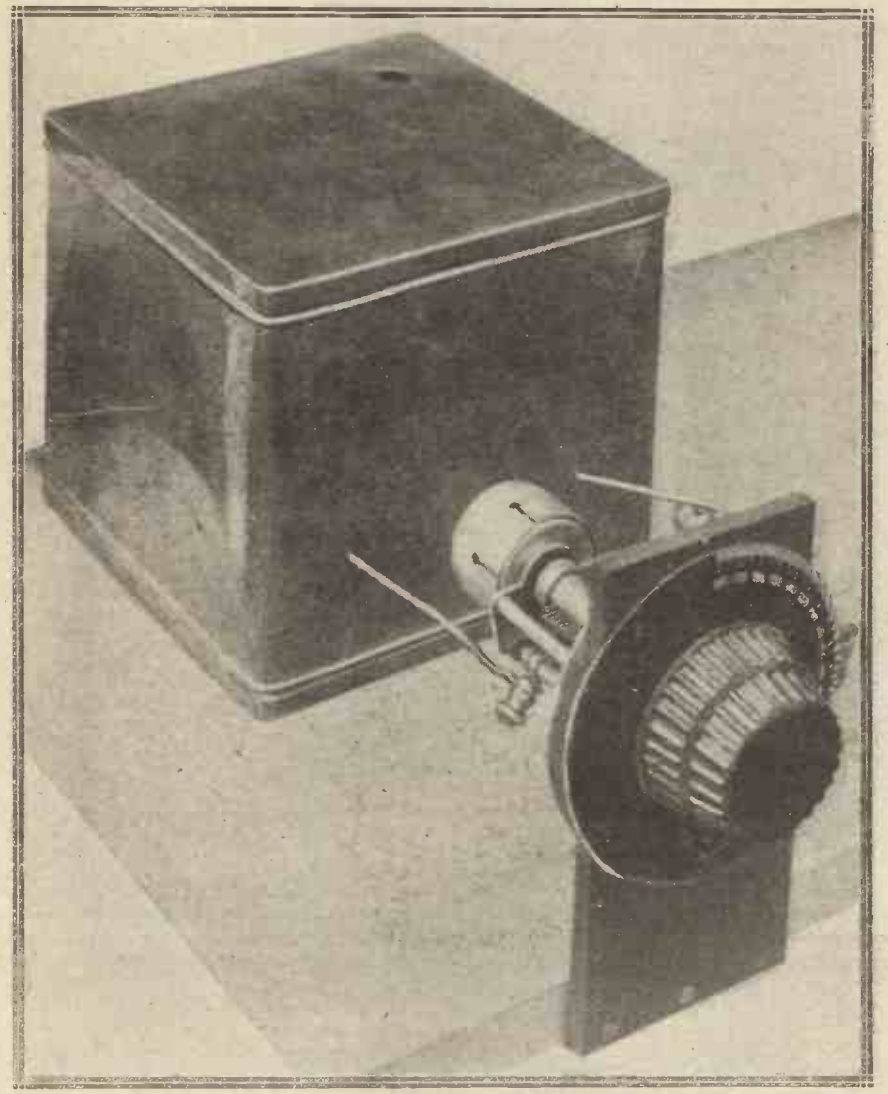
therefore the anode circuit behaves as though it were a condenser, having capacitative reactance. Currents are therefore passed back to the grid circuit through the anode-grid capacity in such a way that the tendency is for the incoming signals to be reduced in strength. In other words, the effect is one of anti-reaction, and the input circuit is damped by an amount depending upon the properties of the whole circuit under the conditions being considered.

Resonance Conditions

When now the anode circuit is tuned so as to be exactly in resonance with the grid circuit and the incoming signal, the phase angle of the anode circuit is zero, and it behaves as though it were a pure resistance having no capacity and no inductance. Under these conditions the phase of the current fed back to the grid circuit is still such that the voltages applied to the grid are reduced. We still have anti-reaction, but not to the same extent as before.

Why Oscillation Occurs

Suppose now we further reduce the value of the anode tuning condenser so that there is not sufficient capacity in the anode circuit to tune it to resonance. The anode circuit then behaves as though it were an inductance, and the effect now is that the currents passed back to the grid circuit through the anode-grid capacity are of such phase that the incoming signals are strengthened. The effect is one of positive reaction, and the circuit tends to oscillate. It will oscillate if the amount of energy fed back to the grid circuit is sufficient to overcome its losses. This will depend upon the electrical constants of the grid circuit and the anode circuit, and on the type of valve, and the voltages applied to it.



A standard "Modern Wireless" screening box experimentally wired up. A complete tuned H.F stage is represented by this and the variable condenser. When the lid is properly in position the control handle of the neutralising condenser passes through the hole that can be seen.

If the coils and condensers are good ones and the valve is used with a normal anode voltage, the circuit will invariably oscillate most violently. The user of a receiver having a tuned-anode stage therefore has the means for producing oscillations, and, in view of the explanation given, it may be asked why the circuit should invariably oscillate when tuned to an incoming signal in spite of what we have said about the anode circuit producing an anti-regenerative effect when it is in resonance with the incoming signal.

The truth is, of course, that the user has no means of telling when the anode circuit is in resonance, but tunes for maximum signal strength, which will always be obtained when the anode circuit is slightly inductive, i.e. when the tuning condenser is tuned to a value a little below that required for resonance. In this position of the tuning condenser the regenerative effect strengthens the incoming signals, and the values of the parts used in practice are such that the circuit will invariably oscillate when the anode condenser is moved by only a very small amount from the tune position.

Preventing Instability

It should be quite clear that one method of preventing instability is to reduce the amplification to such a low value that the amount of energy fed back to the grid circuit is insufficient to start oscillations. In the past it has been usual to prevent the circuit oscillating by this method. Many schemes have been used. One consisted in applying a small positive bias to the grid of the amplifying valves in order to set up grid current. This results in the grid circuit being damped, and voltages applied to the grid circuit are therefore reduced in value. This scheme impairs the selectivity.

The circuit can, of course, be damped in other ways. Thus, it was not at all unusual for the coils to be wound with a relatively fine wire in order to give them a fairly high resistance. This reduces the amplification, and therefore tends to promote stability. An alternative scheme sometimes adopted was to use small tuning coils and a large tuning condenser; this again resulted in a low amplification.

This type of circuit can only be made stable with ordinary valves by reducing the amplification in one way or another, and is therefore inherently a bad one, as it tends to oscillate violently and to give only a little amplification. Selectivity is

(*Continued on page* 306.)

SHORT-WAVE RECEPTION

A page for the novice on this fascinating branch of radio.

FROM A CORRESPONDENT.

MANY new amateurs who have been attracted by the fascination of short-wave work appear to imagine that a very sensitive multi-valve receiver is necessary for the reception of signals from distant short-wave stations like 2 X A F, 2 X A D, and K D K A.

In practice, however, it will be found that excellent short-wave reception can be obtained with a two-valve set—one detector and one L.F. amplifier.

H.F. amplification on the short waves is usually unsuccessful; in fact, in nine cases out of ten an H.F. stage in a short-wave receiver is more of a hindrance than a help.

It is general, therefore, to rely upon an extremely sensitive detector valve, followed by one stage of L.F. amplification.

Such a set is cheap and easy to construct, and, with a little practice, quite easy to handle.

In short-wave receivers of this nature it must be remembered that adjustments are far more critical than in receivers covering the ordinary broadcasting wave-band, and that greater care has to be taken to prevent leakage losses—losses which on the longer waves would not affect reception so vitally as on the short waves.

The use of the old "flip-flop" reaction method on a short-wave set is practically impossible, as with this method it is extremely difficult to obtain the necessary vernier control and, furthermore results in the alteration of the tuning every time the position of the reaction coil is altered in relation to the aerial coil. In short-wave sets the best plan is to control reaction by means of a condenser, as in the well-known Schnell circuit.

Obviating Capacity Effects

The tyro may imagine that two valves are hardly enough to use for the reception of signals from a station perhaps 3,000 miles away, but the writer has found that, given suitable conditions, loud-speaker signals can be received at good strength from 2 X A F, and other stations, using only two valves, i.e. one detector and one L.F. valve.

The use of a third valve (i.e. a second L.F. amplifier) does not appear to help matters much. In fact, beyond a consequent amplification of static, the additional L.F. valve is not likely to improve results!

The question of coupling the valves in a short-wave circuit is of considerable importance, and perhaps a method most suitable for the novice is by means of a transformer. It will be found that the proper layout of the components and special attention to earthing will obviate "body" capacity.

A filter circuit in the plate circuit of the L.F. valve, consisting of an H.F. choke and a ·001 mfd. fixed condenser, will be found efficacious—the choke being placed in series with the plate of the valve and the 'phones, the ·001 condenser being used between the plate and L.T. –, thus passing any H.F. impulses to earth.

The new constructor of a short-wave set will find the ordinary broadcast receiver choke unsuitable. For the short waves a choke of 50 turns of No. 32 D.C.C. wire (single-layer wound) on an ebonite rod makes a suitable component.

For the tuning condenser a value of ·00025 mfd. is suitable, and a good vernier action is very desirable. The reaction condenser should have a value of about ·0002 mfd., while for the grid condenser a value of ·0001 mfd. will be found sufficient.

The aerial coupling should not be direct. Aperiodic coupling is the alternative—or capacity coupling.

With such a set it will be found that special low-capacity valves are not essential, while a 4-megohm grid leak will prove most satisfactory.

Good Consistent Reception

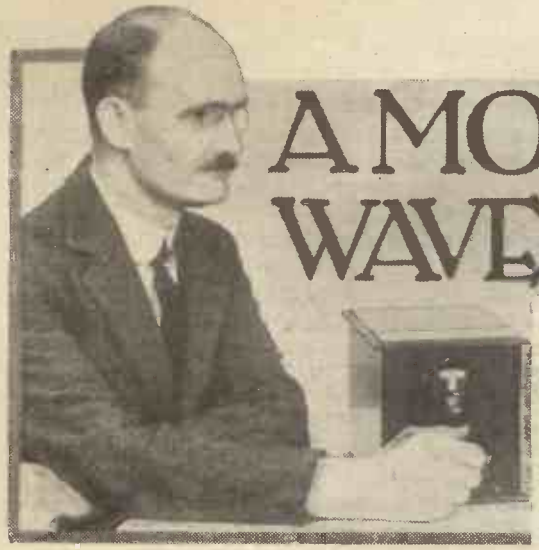
A short-wave set, if carefully constructed, and handled with patience and care, will provide endless pleasure and interest. Surprising results may be obtained. Using a set as outlined above the writer has received 2 X A D. on 22·02 metres with consistent ease at full 'phone strength.

Amateurs who have sets capable of bringing in both 2 X A D and 2 X A F (which operates on 32·77 metres) will be able to experience for themselves the fascination of short-wave reception. 2 X A D transmits on Mondays, Wednesdays, and Fridays from 11 p.m. onwards; 2 X A F on Tuesdays and Thursdays from 11 p.m. and on Sunday mornings from 12.40 a.m. In the Eastern States the time is five hours behind our own, so that 11 p.m. British Summer Time is 6 p.m. "Daylight Saving Time" in Schenectady.

It is thus dark in Great Britain but broad daylight at the transmitting station. In such circumstances 2 X A D, the station with the shorter wave-length, is nearly always good from the moment when the transmission begins but as time goes on it grows darker on the far side of the Atlantic and fading is usually more pronounced. At 3 o'clock in the morning, when it is dark, or very nearly so, in both countries, the transmission may be at its worst, but an improvement sets in as daylight begins to appear at the receiving station. 2 X A F behaves in almost exactly the opposite manner. This station is generally at its best when it is dark in both countries and fades most markedly when it is daylight in one or the other. 2 X A D thus tends as a rule to become less good as time goes on, while 2 X A F improves steadily until dawn.

A WELL LAID OUT STUDIO

The main studio of the Nashville (Tennessee) Broadcasting Station, W L A C.



A MODERN WAVEMETER

Some practical calibrating notes and details of the instrument described last month.

By G. P. KENDALL, B.Sc.

BEFORE dealing with the actual calibration of the wave-meter which was described in the last issue one or two practical points concerning its use call for consideration. The filament supply for the valve, for example, requires attention if the best service is to be obtained from the instrument.

The actual current used will be extremely small, since the meter will only be in operation for a few seconds at a time; and, moreover, the consumption of both valve and buzzer is low. There is consequently a considerable risk of the accumulator suffering from too little use and too infrequent charging.

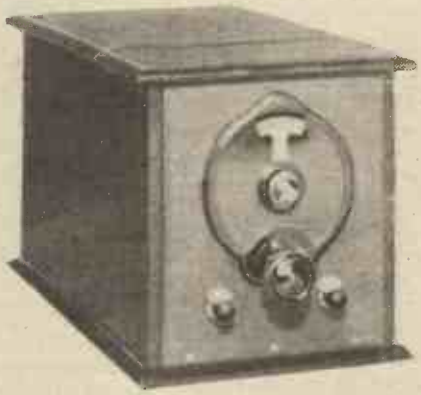
Lengthening the Valve's Life

It is as well, therefore, to make a point of seeing that it gets a short refreshing charge at regular intervals —say, once a month—since it is important in the interests of constancy that the battery should be kept in a normal healthy condition. After each charge it is as well to switch on the valve and leave it running for a quarter of an hour or so, for the voltage of the battery to settle down to its normal value before the meter is used Whether this precaution is strictly necessary or not will depend upon the valve.

The filament current will require adjustment to a suitable value before the calibration is done, and the aim is to find the lowest current which will still permit the valve to oscillate strongly at both top and bottom of the tuning scale.

A simple test with a receiving set will settle this point. The object, of course, is to lengthen the life of the valve, and this is rather important, since when the valve dies the meter has to be recalibrated with a new one. With reasonable care, however, the valve should last a very long time.

Another point which must not be forgotten is that the large grid-bias battery used for H.T. supply will not last for ever, although the demands upon it are very low indeed, and a time will come when its voltage will fall sufficiently to upset the calibration. This should not



This wave-meter was constructionally described in the August issue of "M.W."

happen for many months, but it is as well to look out for it. If you possess a good high-resistance voltmeter the matter is simple, periodic readings of the battery voltage being taken, and a new one obtained when the voltage is found to be below the danger-point at which the calibration begins to be seriously upset.

The Danger-Point

This point can be determined quite easily when the battery is new, by bringing the H.T. plug down a socket at a time and noting where the heterodyne note of a station begins to change seriously.

It may be as well at this point to give details of a coil for the Daventry wave-band, for the benefit of those who wish to include this range in the final calibration. The former to be used is one of the special Daventry type made by Messrs. Collinson, and is provided with a series of slots to take the windings. The reaction coil consists of 120 turns of No. 38 S.S.C., all of which can be got into a single slot (the one farthest from the pins). The grid coil is composed of 297 turns of No. 32 S.S.C., equally distributed between the other slots.

Turning now to the process of calibration, there are two principal methods available, and of these the simplest is to borrow a wave-meter which is known to be reasonably accurate and calibrate one against the other. Only a limited number of readers will be able to do this, but I will give the method for the benefit of those who can obtain the loan of a suitable instrument.

How to Calibrate

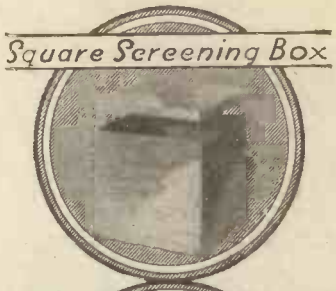
The procedure will depend upon whether the borrowed meter is a heterodyne or buzzer type, and we will first assume the former. A set with some sort of reaction control will be needed, connected to a very small aerial for preference. Set the meter to 550 metres, and search for it with the set in a state of oscillation. When the meter radiation has been found tune it in as though it were a carrier wave, taking the set just off the oscillation-point. Now set the newly-made wave-meter working, and turn its dial until you hear a chirp cross the "carrier" which is being received from the other meter. Adjust the new instrument so that this chirp comes down to the silent point, and then record this dial reading, which, of course, is that for 550 metres on the meter under calibration. Repeat this process for 525 metres, 500 metres, 475 metres, and so on down the scale until a complete calibration has been obtained.

A graph can then be drawn, plotting dial readings horizontally and wave-length in metres vertically. The result, with a good square-law condenser, should be practically a straight line, and if any points fall noticeably to one side they should be checked up again carefully. Having such a graph, of course, one can read off any wave-length along it in a moment when the dial reading

(*Continued on page* 309)

NEW COMPONENTS for 1928

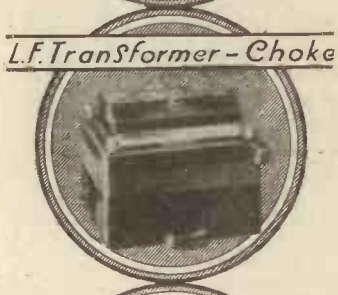
These new 1928 Bowyer-Lowe components represent the latest phase in component design and performance. It is only after exhaustive tests and trials in the Bowyer-Lowe laboratories and works, when absolute accuracy and the highest standard of performance are assured, that they are offered to the public.



SQUARE SCREENING BOX

Matt finished aluminium, supplied with baseboard and fixing screws. Packed flat and can be assembled in a few minutes.

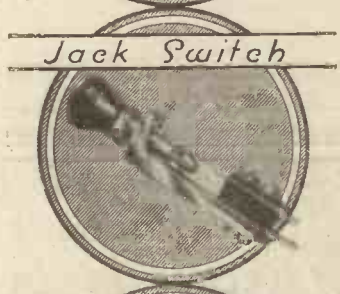
List No. 283. 6/-



LOW FREQUENCY TRANSFORMERS AND CHOKE

Bowyer-Lowe Low Frequency Transformers made two years ago are still giving excellent service, but the large amount of copper and iron necessary for the construction of an efficient transformer made them expensive. Owing to recent developments we can now supply this transformer at an economic price and for those who want the best possible reproduction there is no other choice. Supplied in two ratios for first and second stage.

List No. 284. Ratio 3-1 22/6
List No. 285. Ratio 6-1 25/-
Also in Multi ratio giving 1.8, 3, 3.66, 4.5, and 6 to 1.
List No. 286 27/6
Also Low Frequency Choke.
List No. 287 20/-



JACK SWITCH

Fills the need for a simple and positive On and Off switch, is similar to our jacks in construction, and fits the panel in the same manner.

List No. 281. 3/-

VARIABLE RESISTOR

Better than the panel rheostat and an advance on the fixed resistor, for use on the baseboard of the receiver and graduated so that settings may be repeated. Wound under tension on a non-shrinking former and providing maximum air cooling. Base is of Bakelite, made in two resistances.

List No. 289. 5 ohms 3/-
List No. 290. 30 ohms 3/-

SIX SOCKET BASE

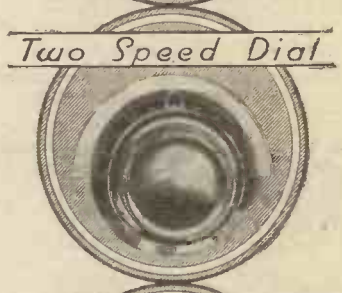
Has sockets to the standard "Southern Cross" arrangement, and is for use in the Square Screening Box or when the six pin coils and transformers are to be used without a screen. Provided with six terminals correctly numbered. Made of Bakelite.

List No. 291 3/6

MARK II WAVEMETER

Covers all wave-lengths between 150/2000 metre. Fitted with a buzzer, self-contained battery, and a lamp to indicate resonance for transmitting and other uses where more convenient. Tuning is very sharp. Two coils with calibration charts are contained in case. A high class instrument which every serious experimenter should possess.

List No. 226—
In oak case .. £6 0 0
In walnut case .. £6 10 0



TWO SPEED DIAL

Manufactured under Burndept Patent 243,218.

This dial is of polished Bakelite 3½" diam. concealing a double reduction friction epicyclic gear, giving a reduction of 18 to 1 or a direct drive. Entirely free of backlash or noise — all the moving parts being floating and self compensating for wear. The Station recorder is provided with renewable scales and is readily detachable.

Fits 3/16" or ¼" spindles.
List No. 253. Complete with Station recorder 9/-

UNIVERSAL H.F. CHOKE

The ideal component wherever a H.F. Choke is indicated. By virtue of its special sectional winding not only is the distributed capacity kept at a minimum but it will efficiently operate over a very wide range of wave lengths from the shortest to the longest.

List No. 288 Price 9/-

A great advance over all previous types of springy valve holder. Inter-electrode capacity is at a minimum and always constant, making it ideal for the Super-Het and short-wave receivers. Initial amplitude of vibration under shock is large, yet damping is quick and gentle. Made of Bakelite, supplied with marked terminals, soldering tags and fixing screws. Base 1½ in. square overall with projection adjacent to plate leg of valve "Whiteline" for safety.

List No. 282 2/3

WRITE TODAY FOR A NEW COMPLETE LIST OF PRODUCTIONS

A NEW SUPER HETERODYNE RECEIVER for amateur construction covering all wavelengths from 35 to 2,000 metres, also the latest in SHORT WAVE RECEIVERS will be shown on our Olympia Stand.

TESTED RADIO Bowyer-Lowe APPARATUS

BOWYER LOWE CO LTD LETCHWORTH

NATIONAL RADIO EXHIBITION OLYMPIA STAND NO 124

505

My Broadcasting Diary

Under this heading, month by month, our Broadcasting Correspondent will record the news of the progress of the British Broadcasting Corporation, and will comment on the policies in force at B.B.C. headquarters.

Alternatives: Action at Last

With 5 G B started on August 21st, the B.B.C. at long last is actually doing something about alternative programmes. Savoy Hill has talked about alternatives for two years; in fact, there has been so much "yapping" that, however good they may turn out to be, they are almost bound to be condemned. Still, that is by the way. The important present fact is that the B.B.C. is trying to give a real contrast to London in the service areas of 5 X X and 2 L O. In order to find a channel for 5 G B there is a reshuffle of wave-lengths. The new station is to work on 491·8 m. (610 kc.), which is Bournemouth's old channel. The latter is to be given 326·1 m. (920 kc.), Birmingham's channel. Thus there will be no transmitting from Birmingham after August 21st.

This does not mean the disappearance of the Birmingham Station. On the contrary, Percy Edgar's popular aggregation, which is probably the most efficient staff in the country, will be maintained at full strength to provide most of the programmes for 5 G B. In the faithful execution of this plan lies the best hope of real success in attaining satisfactory contrast programmes as between London and 5 G B. If 5 G B were to be handled entirely as part of headquarters then it would inevitably become a kind of convenient dumping-ground and its original purpose would be soon obscured.

Then again, to get genuine contrast it is desirable that the dominating personalities should be basically different and distinctive. The contrast between the personalities of the London and Birmingham Station Directors is just what is required. Mr. B. E. Nicolls, who was promoted from Manchester to take over London some eighteen months ago, is an Oxford man with a marked academic bent. His extensive travels have broadened his outlook, but it is in the realm of the classical that he is a specialist.

Mr. Percy Edgar, of Birmingham, on the other hand, is the most versatile and successful B.B.C. producer of popular programmes of the lighter sort. He is himself possessed of considerable histrionic ability and experience. With this contrast in personality there is strong probability of real contrast in the programme products.

Sweet Reasonableness at the Post Office

I have it on excellent authority that the attitude of Post Office officials to the B.B.C. has recently undergone a great and advantageous change. There is no longer the tendency to place all conceivable obstacles in the way of progress. This more enlightened view is not due to a change of heart, but rather to the direct inspiration of the Treasury, which is urging that Broadcasting be developed as quickly as possible so that there may be more profitable State raids on its revenues.

There are indications, therefore, that the B.B.C. Regional Scheme will be expedited rather than hindered by the Post Office pundits. Savoy Hill is naturally cautious about plans, but it is understood that after the lessons of 5 G B are digested—that is about November—work will begin on the new twin stations at Manchester, Cardiff, and Glasgow simultaneously.

Captain Eckersley as Ambassador

Captain Eckersley will attend the Washington Conference in October. He will go as the representative of the Union of European Broadcasters, and of the B.B.C.

A photograph of the machine-room at 5 G B (Daventry Junior), showing the giant generators.

Unfortunately he is not included in the British Government delegation. Therefore he will not have official status at the Conference, but will be in the position of an observer in attendance at a few of the discussions. It is, of course, an egregious blunder that the British Government has entirely ignored Broadcasting in constituting its delegation.

In view of this direct snub it might have been as well for the B.B.C. to have withdrawn its delegate, and explained why. But the European Union was anxious to be represented, so Captain Eckersley is to go over in a dual unofficial capacity.

Even although he will be excluded from the important meetings of the Government delegates, Captain Eckersley will make his presence felt with the press and the general public of America.

If the British representatives do anything foolish the popular Chief Engineer of the B.B.C. will transfix them with that devastating ridicule of which he is a master. I should not be surprised to see him emerge as the dominant personality at a Conference that had offered him no status. His position will be in many respects comparable with that of Lord Riddell at the Washington Conference of 1922.

Mr. Filson Young's Future

Keen observers of B.B.C. developments have been discussing the future of Mr. Filson Young in relation to Broadcasting. He has been at Savoy Hill in a programme advisory capacity for more than a year. His influence has been considerable, and there is no doubt that it has been consistently to the advantage of programmes, particularly on the dramatic and specialist sides.

Those who know Mr. Young's active ambitious nature realised that a subordinate advisory capacity of this order would not suit him for long. He has taken great personal interest in the problems presented by B.B.C. work, and is now ready to assume more responsible tasks. No announcement has been made as to Mr. Young's new post; but it is felt that he will be associated more closely with the actual direction of programme work. There seems no doubt that this will result in a general broadening and enrichment of the programmes.

Timidity with the Promenades

There has been some dulling of the glory attaching to the B.B.C. for its Proms policy. When the Proms were saved everyone was pleased, and music-lovers of London were enthusiastic. But when the details of the works to be given and the artists engaged were made known, there was keen disappointment. Apparently the B.B.C. thought that merely keeping the Proms in being would be enough. Therefore, when it had made the deal with Mr. Boosey, and engaged Sir Henry Wood, it closed down on expenditure, with the result that the fare this year will be unusually meagre both in new works and in eminent talent.

Sir Henry Wood remains silent, but he is probably very "sick" about the whole thing. It is hoped that even at this late hour the B.B.C. will lay out a little extra money to brighten the last part of the season. The cancellation of the next dozen "dud" alleged humorous programmes would yield the funds, and would be hailed with a sigh of genuine relief by all listeners.

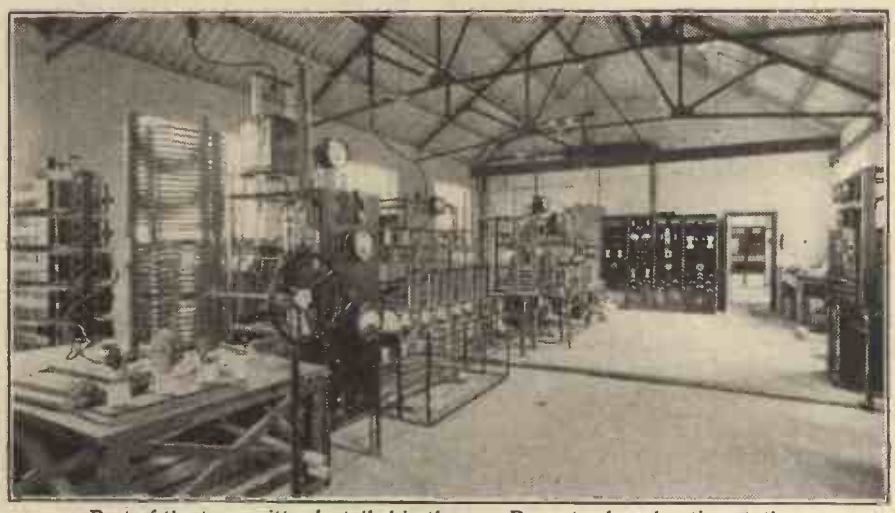
The B.B.C. and the Trade

I hear in the trade that relations with the B.B.C. are acutely strained. There have been interminable discussions about B.B.C. interference with reception and manufacture problems. These discussions have led to an *impasse*, and there is, in consequence, great and growing ill-feeling.

The difficulty began with attacks on programmes by the trade, which rightly or wrongly have put down all their recent and present troubles to the failure of the B.B.C. to provide the kind of fare the public wants.

Then the B.B.C., sensing the danger of a general slump, discovered that there was a tremendous amount of unsatisfactory reception, and that a contributory factor was bad apparatus.

So the trade went hammer and tongs for the B.B.C. programmes; and the B.B.C. went equally violently for rotten receiving apparatus. The B.B.C. succeeded in clearing itself of most of the charges against the programmes; but there was no progress on the counter-claim.



Part of the transmitter installed in the new Daventry broadcasting station.

Then the crisis was rendered still more acute when the B.B.C. threatened to advertise foreign goods, and to abandon its all-British policy. Negotiations have been broken off, and it is understood that Captain Eckersley and his colleagues are engaged on getting out model circuits and specifications in order to force the hands of the trade, through the buying public. Simultaneously, the trade, or a section of it, is considering the application of a permanent boycott against advertising in B.B.C. publications.

If this boycott is applied, then it is probable that the B.B.C. will throw open its columns to advertisements of foreign goods, and will definitely encourage imported radio apparatus.

It would be a great pity if the hostilities were carried to that stage. Surely the cooler heads on both sides can get together even at this late stage, and discover some reasonable way out of the present *impasse*.

Advertisements

As far as possible all advertisements appearing in "M.W." are subjected to careful scrutiny before publication, but should any reader experience delay or difficulty in getting orders fulfilled, or should the goods supplied not be as advertised, information should be sent to the Advertisement Manager,

"Modern Wireless," 4, Ludgate Circus, London, E.C.4.

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LOUDSPEAKER ACOUSTICS

An article that emphasises the importance of correctly placing the "speaker."

By G. V. DOWDING, Grad.I.E.E., (Technical Editor.)

THE "Search for Quality" does not end with the construction of an efficient receiver and the choice of its accessories. A set could be delivering 100 per cent. energy to a 100 per cent. loud speaker and yet fail to provide music of "natural" quality and quantity. The acoustics of the room in which the loud speaker is operated must be studied and understood before complete success can be achieved. This

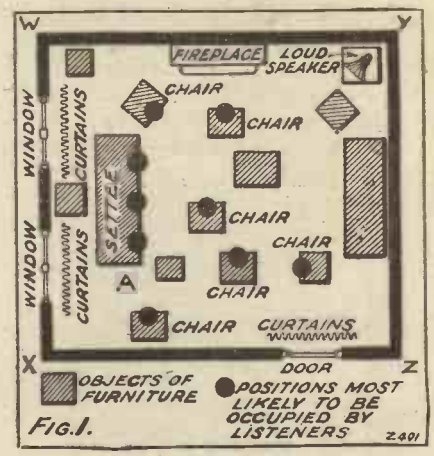

FIG. 1.

is no mere theoretical conception: the subject is of really vital practical importance.

More Than a Refinement

Hitherto, it has been dealt with somewhat sketchily; the placing of a loud speaker has been treated as a refinement and not as an essential operation. But up to a year or so ago the average loud-speaker outfit itself distorted so badly that, in the majority of cases, faulty projection passed unnoticed. Nowadays it is possible, with our more scientifically designed components and accessories, to approach very closely to the ideal of perfect reproduction.

During the past month or two I have been conducting a series of experiments in the placing of loud speakers, and the results of these were most illuminating, and they have proved that loud-speaker acoustics are worthy of scientific investigation. In this short article, however, I intend to deal with the subject from a purely practical point of view.

In the first place, let me make it plain that we are now concerned with the sound after it has left the speaker, and that I am not going to say anything about the merits or limitations of the various types and makes of loud speakers. Whatever the instrument you possess, your object should be to see that it operates to its best advantage.

An Absorption Effect

Now, have you ever noticed that on one or more occasions when you have demonstrated your set to a number of friends it did not seem to be quite up to its usual standard? Perhaps it did not appear to be delivering as great a volume, or slight distortion crept in. At these times you may have put such failings down to a more than usually critical attitude on your part, but it is more than probable that the shortcomings were real and not merely imaginary.

It is a well-known fact that the presence of a number of people in a room can play havoc with its acoustic properties, and my observations tend to show that the effects are intensified when the sound is being projected in a directional manner. The human body will absorb, reflect, and refract sound waves, so that if your speaker has a horn do not direct the flare of this towards a group of people in a room. Those nearest the speaker may hear the set at its best, but the others will probably receive a false impression.

The absorption effect is, perhaps, the most important. You will require a greater initial volume when a number of people are in the room in order to counteract this, and you must not judge the effect from a point directly in line and close to the speaker or from behind it. The best position for a horn-type loud speaker is, in most instances, in a corner of a room, but it is not necessarily better to have it pointing obliquely away from the walls, although this might at first sight seem to be the case.

A Practical Example

Let me take a specific instance and then you will obtain some sort of an idea of the general considerations involved. One of the photographs accompanying this article illustrates the corner of quite a normal sort of drawing-room. In this corner a loud speaker of the horn type was to be

Showing the actual loud speaker and a corner of the room illustrated in Fig. 1.

situated. Fig. 1 is a rough plan of the room and its furniture.

Now it would appear, superficially examining the problem, that the speaker should give best results when its flare was pointed directly towards corner X

at a level of three feet six inches. But I found that with six people disposed more or less as shown in the diagram, the results were very far from being perfect.

A greater intensity of sound was actually measured at point " A " when the speaker was pointed towards the ceiling and the sound reflected downwards at sharp angles. The aim is to fill the room with evenly distributed sound, but if this be accomplished only at the expense of introducing a number of irregular reflections, distortion may arise.

Two Problems Solved

With the flare directly pointed towards corner X there was first of all absorption caused by the people, and to a considerable and no doubt greater extent by the heavy curtains. Added to this there was irregular reflection and refraction caused by the irregularly disposed furniture that intervened.

Results were worse still when the flare was pointed at either the W or Z corner, and this was no doubt due to the irregular reflecting surfaces (mantelpiece, etc.). Directing the speaker at point Y resulted in an improvement, but I did not consider the results passable.

The loud speaker placed in the corner of the room as in Fig. 2. As will be seen the the instrument is of the "non-directional" type, as the sounds are projected from a vertical copper column.

The best possible results were obtained when the speaker was directed upwards into the corner of the room directly above it, the line from the centre of the flare striking the junction between the two walls and the ceiling. The volume had to be increased slightly, but the sounds could be heard with equal purity and strength at any point in the room by any of the half dozen or so people in it.

Such problems as the one discussed above apply equally to both large and small rooms, and to both scantily furnished and to crowded rooms. I will give you a case which in many ways furnishes a contrast to the above-mentioned drawing-room. A loud speaker was to be used in a small dining-room, a plan of which is given in Fig. 2. Here again, direct projection with a horned instrument right across to corner X failed to prove completely satisfactory; best results

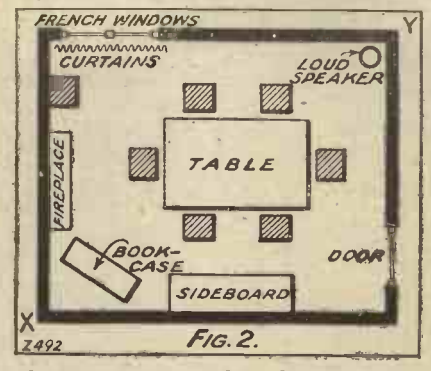

FIG. 2.

of any were given when the projection followed the same line but struck the ceiling-walls corner at X.

But owing, no doubt, to the height of the ceiling (13 ft. 6 in.) and to the sparse furniture and curtainings, distortion crept in through echo effects. Resort was then made to the use of a non-directional type of speaker of an ornamental pattern, and when this was placed in corner Y on a fairly high pedestal, there was no room for criticism. The walls behind the speaker made perfect reflecting surfaces, and it was significant that there was an actual improvement when there were several people in the room to contribute a modicum of " damping " to that already supplied by the curtains.

Resonant Effects

It was desired to fill the hall of the same house as contained this dining-room with broadcast music, but it was some time before this could be accomplished to the satisfaction of the writer. The available speaker was one of the " rose-bowl " variety. To cut a long story short it was found that the best position for this loud speaker was not in the hall itself, but at the top of a flight of stairs and standing on a rather high pedestal. The sounds were reflected down into the hall, and were distributed with beautiful evenness.

Close investigation will often lead to the discovery of resonant effects in the most innocent-looking objects. These effects may not be blatantly evinced and may, in cases, be put down to slight imperfections in the receiving outfit itself. I conducted a most interesting series of experiments with the object of tracking down resonating pieces of furniture and what not in the previously mentioned drawing-room. For the purpose I constructed a microphone-earpiece " electric stethoscope."

An assistant ran through a wide band of audio-frequencies with a " hummer " while I carefully " listened " to every conceivable cause of resonance in the room. The results were most interesting. A pane of glass in the china cabinet simply " boomed " at a frequency of 160, while a vase on the mantelpiece sang away merrily at 2,000 or thereabouts. Other " lively " objects were a small metal picture frame, a metal bracket on an inkstand, the fireirons in the fireplace, and a portion of the electric light fitment. Needless to say, the china cabinet held a multitude of resonators!

Sustained Vibrations

In the normal course of events, quite a number of the above items would not cause trouble, but knowing at what frequencies the various objects resonated, I turned on the loud speaker and during a band item very carefully listened for them. The vase and the fireirons produced noticeable discordances, inasmuch as their notes were sustained. When they were totally removed from the room another step towards perfection was taken.

The vibrations from both of these objects could actually be felt, although I must admit that I have abnormally sensitive fingers. But I would have defied anyone to have tracked down these culprits by ear alone.

(*Continued on page* 308.)

The rose-bowl loud speaker (on the stand) mentioned in the article.

Invaluable to every Amateur and Constructor

The "POPULAR WIRELESS" BLUE PRINTS

of Tested Circuits

The following is a *complete* list of the "P.W." 6d. Blue Prints for Constructors, showing the different circuits available.

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5. H.F. (Tuned Anode) AND CRYSTAL, WITH REACTION.
6. H.F. AND CRYSTAL (Transformer Coupled, without Reaction).
7. 1-VALVE REFLEX WITH CRYSTAL DETECTOR (Tuned Anode).
8. 1-VALVE REFLEX AND CRYSTAL DETECTOR (Employing H.F. Transformer, without Reaction).
9. H.F. AND DETECTOR (Tuned Anode Coupling, with Reaction on Anode).
10. H.F. AND DETECTOR (Transformer Coupled, with Reaction).
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12. DETECTOR AND L.F. UNIDYNE (With Switch to Cut Out L.F. Valve).
13. 2-VALVE REFLEX (Employing Valve Detector).
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17. CRYSTAL DETECTOR WITH TWO L.F. AMPLIFIERS (With Switching).
18. 1-VALVE REFLEX AND CRYSTAL DETECTOR, with 1-VALVE L.F. AMPLIFIER, Controlled by Switch.
19. H.F. DETECTOR AND L.F. (With Switch to Cut Out the Last Valve).
20. DETECTOR AND 2 L.F. AMPLIFIERS (With Switches for 1, 2, or 3 Valves).
21. THE 2-VALVE LODGE "N."
22. "THE GUARANTEED REFLEX."
23. THE 1-VALVE "CHITOS."
24. THE "SPANSPACE THREE." Three-Valve Receiver employing 1 Neutralised H.F. Valve, Detector with Non-Radiating Reaction Control, and 1 L.F. Valve.
25. 2-VALVE REINARTZ (Det. and L.F.).
26. A "STRAIGHT" 4-VALVER (H.F., Det., and 2 L.F. with Switching).
27. A "MODERN WIRELESS" 4-VALVER (2 H.F., Det., and L.F.).
28. A "MODERN WIRELESS" 5-VALVER (H.F., Det., and 3 L.F.).

ALL "POPULAR WIRELESS" BLUE PRINTS 6d. EACH

All orders for these Blue Prints should be sent direct to the "Popular Wireless" Queries Department, Fleetway House, Farringdon Street, London, E.C.4, enclosing a stamped addressed envelope and a postal order for 6d. for each Blue Print ordered.

WHAT READERS THINK

The "Combine Five"

SIR,—I am sending you a letter which I think might be helpful to readers of MODERN WIRELESS who have built the "Combine Five."

I have no doubt a number of your readers will have built the "Combine Five" with the same object as I did—to own a set that would cut out their local station, and be able to get with ease and at any time, at loud-speaker strength, good quality reception from foreign stations in order to have a choice of programme that one could enjoy.

At first I did not get the success I had hoped for—but after making alterations suggested by Mr. Harris in the August number I can now get excellent results. If any of your readers are unable to get good results from their sets I suggest they do as I have done.

Build the set exactly as described, except alter the coils as Mr. Harris recommends, change over the connections to the Ormond condensers—viz., that connecting to the moving plates be changed to the fixed plates and vice-versa—and you will have no difficulty in getting a good number of stations any night you try.

I give below the valves and voltages used and stations obtained.

H.F.: Cossor Point One Red Band.

Det.: Scott Taggart 61A, with 1½ v. G.B.

1st L.F.: Osram D.E.5, with 12 v. G.B.

2nd L.F.: Osram D.E.5A, with 16½ v. G.B.

Voltages.—H.T.+1=80. H.T.+2=105. H.T.+3=112. H.T.+4=120.

I used an Amplion L.S., Type A.R.19, with an Igranic 1 to 1 transformer, instead of the "Pye" specified—which, of course, should be used if a cone type of L.S. is employed.

The following is a list of stations I have obtained at good L.S. strength, most of which can always be obtained any evening I want them—but those marked * do not come in so well as the others these summer evenings, but will no doubt be better on winter nights.

	Aerial Con.	1	2
Radio-Paris	170	173	162
Daventry	165	166	156
Stockholm (Motala)	144	146	128
Berlin (Kghn.)	140	140	122
Copenhagen (Soro)	129	130	110
Warsaw*	125	126	108
Hilversum	120	121	98
Vienna	169	173	166
Brussels	165	170	165
Bournemouth	162	166	160
Langenberg	158	162	154
Paris (Ecole S.)	154	159	152
Rome	152	157	150
Frankfort	149	152	145
Glasgow	146	147	140
Berne*	147	148	142
Hamburg	143	145	136
Toulouse*	139	142	134
Madrid	136	136	131
London	134	134	127
Leipzig*	135	135	128
Paris P.P.*	128	128	115
Marseilles*	108	112	94

Trusting the foregoing will be of interest.

Yours sincerely,
G. J. JACKSON.

Cobham.

High "Mu" Valves

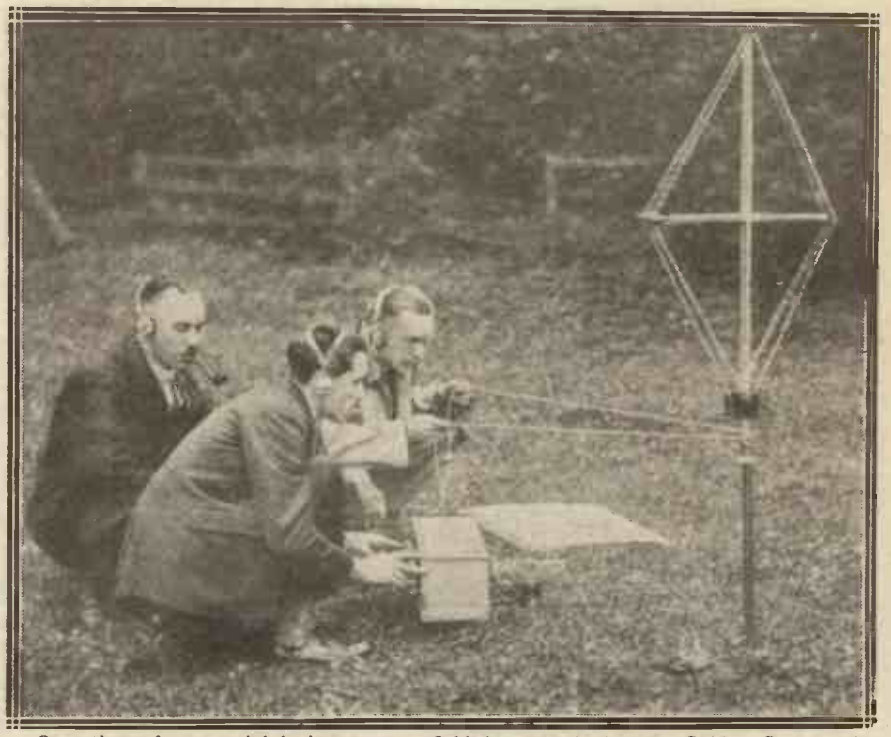
SIR,—In your issue of May, in the article entitled "Choosing Your Valves," by Keith D. Rogers, he refers to high-magnification valves and also states his dislike of high (2 or 3 megohm) anode resistances.

This prompts me to send you particulars of a four-valve set which I have now had in use for some months, and which gives results which are really excellent—big volume and purity of reproduction.

The set is crowded (carefully) into a small cabinet with baseboard 17 in. by 9 in. The choke filter circuit is, however, outside the cabinet.

The aerial coil is wound on a 3-in. paxolin former fitted with a 5-pin base to fit a standard 6-pin base, the primary being carried on ebonite strips over the secondary of Litz wire.

The anode and grid-leak resistances are provided by an Ediswan unit, but with a ·0005 condenser fitted in parallel with the ·0001 condenser in that unit.



Operating a frame aerial during a recent field-day organised by the Golders Green and Hendon Radio Society.

The rectifier valve operates without grid bias.

Reaction is beautifully smooth, but only necessary for the weaker foreign stations.

The ·0003 condenser between the anode side of the anode resistance and L.T.— does not appear to reduce signal strength, but undoubtedly reduces "mush."

Undoubtedly the results are largely due to high anode voltage, but I do not know the actual value of this, not having a suitable voltmeter, but I run off 250 v. A.C. mains from a unit of my own construction.

Valves. These are all 2-volt Cosmos: 1, blue spot, 2, blue spot, 3, green spot, 4, red spot (undoubtedly an R R spot would be better.)

About 60 stations come in at loud-speaker strength.

Yours truly,
W. H. LOWE.

Discrimination Required.

With regard to the above letter, which has been passed on to me for my attention.

The main trouble with high-magnification valves is encountered when two or more of these valves are used on the *L.F.* side; that is, as detector and as 1 L.F., and so on. To use one as H.F. and another as det. as Mr. Lowe does should not cause overloading, seeing that he uses a "Green Spot" in the first L.F. stage. Another fault of high-mu valves and high anode resistances is the falling off of the amplification curve of the stage at the higher frequencies, which to my mind is one good reason why these valves should be used with discrimination and a due regard to the results likely to ensue.

Yours truly,
KEITH D. ROGERS.

Those Bass Notes

SIR,—I was very interested in your article in the current number of MODERN WIRELESS, as I have myself been "in search of those bass notes" for some time, so I think possibly some of my ideas and conclusions may interest you.

I decided very early on that it was useless to try to estimate how the bass notes were coming out from ordinary broadcast music, so I have fixed up an audio-frequency generator on the lines of that described in "Experimental Wireless" some months ago, and which I have calibrated by comparison with the piano.

I also have chosen the Lissenola to experiment with (and a jolly good instrument it is, too!), and one of the first essentials for the production of the low notes is a really low resistance valve to feed it; the difference between a 4,000 ohms and a 2,000 ohms valve is astonishing. I have not tried anything less than 2,000 ohms, as theory suggests that as the Lissenola's resistance is 2,000 ohms, that is the best resistance for the valve (though a rough measurement of the *impedance* of one of my Lissenolas at a very low frequency gave 1,850 ohms as the value; the question has got to be investigated further).

Needless to say, the amplifier has to be specially designed to amplify the very low frequencies.

As to "diaphragms," I am working on the idea that it is not fair to expect any one diaphragm to work efficiently at all frequencies. I have found nothing to equal the horn type of L.S. for the very high frequencies, and I use one of these with quite a small condenser in series (·001 or ·002 mfd.); in this way the L.F. "juice" is not wasted on a speaker which can't make good use of it.

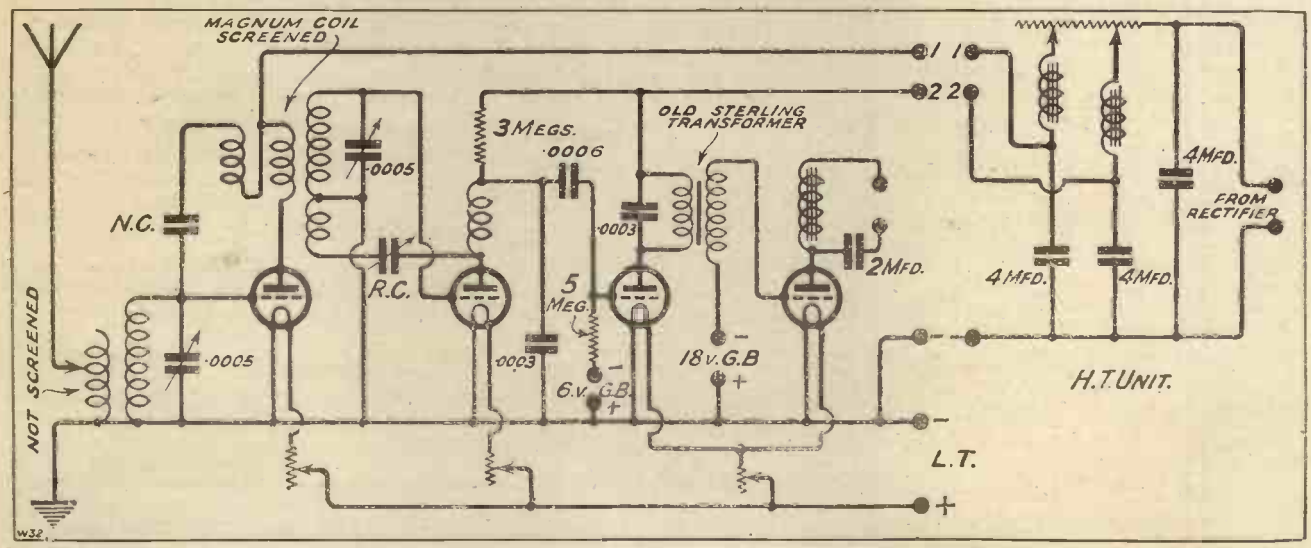
A pleated paper diaphragm with fixed edge is good down to about 100, but utterly useless below that, and is inclined to resonate here and there. The paper diaphragm with free edge (12 in. diameter) will go right down to the lower frequencies, but very weakly, not because it does not vibrate—it does, vigorously—but simply because it is not large enough. It is also very weak on the middle frequencies, owing to the presence of a node at some intermediate diameter, and the consequent cancelling out of the vibrations due to the centre and outer portions of the diaphragm.

A Novel "Diaphragm"

A cone should be much better in this respect, but I have not yet tried one. It is most important to have a screen round the diaphragm, preferably completely enclosing the back, to prevent the sound-waves from, so to speak, slipping round to the back. I have myself verified this effect, as well as reading about it.

The best "diaphragm" I have found yet for the bass notes, and one which offers scope for heaps of experiment, is an old tea-box made of $\frac{3}{16}$-in. three-ply wood, size about 24 in. by 18 in. by 18 in. Using one side of this, just as it stands, it will sound any note, down to the very lowest, but rather weakly and with considerable resonance, due probably to its rather battered state.

Yours faithfully,
A. K. GORDON, M.A.
Blundellsands, Lancashire.



The four-valve circuit employed by Mr. W. H. Lowe. About 60 stations have been received at loud-speaker strength.

Cosmic Rays

THE Cosmic ray has been the subject of further experiments and investigations by Dr. R. A. Millikan, who has just recently returned from Bolivia where he has been carrying out his experiments. These tests were made in lakes in the Andes several thousand feet above sea level. Dr. Millikan, who is a scientist with a world-wide reputation, recently created a minor revolution amongst scientific men by announcing his discovery of the Cosmic ray, which is the shortest and most penetrating electro-magnetic wave so far discovered. The wave-length of the Cosmic ray is only a very small fraction of the wave-length of the gamma ray from radium, which hitherto was the shortest known radiation. It is believed that these Cosmic rays emanate from the fixed stars. The rays have a remarkable power of passing through matter which is ordinarily opaque, and will pass readily through a thickness of as much as six feet of metallic lead. Results from the tests in the Andes are being tabulated for analysis and for the preparation of scientific reports.

New Territory

Talking about Bolivia, the Government of Bolivia has lately opened up for settlement a vast area of unpopulated territory, and the party who have secured the concession expect to settle 4,000 to 5,000 European families there within the next two or three years. The advance party of about a dozen is taking a 500-watt C.W. and telephone transmitter with which to keep in touch with civilisation. It will operate from Gaiba, the first settlement, to Corumba the nearest railhead about 100 miles away.

India

One of the most promising fields for broadcasting is India, with its population of over 300,000,000 people. There are only a few stations at present, and these are mostly of low power. The Indian Broadcasting Company, erecting two 12-kw. transmitters in Bengal and Bombay districts, points out the possibilities when a chain of powerful stations shall make possible crystal reception throughout the densely peopled areas. A listening license in India costs 10 rupees (about 15s.).

Broadcasting the Organ

The church organ is one of the most difficult instruments to broadcast. The Crosley Station at Cincinnati, Ohio, however, makes certain

(*Continued on page* 296.)

They make the music clearer!

Their unique construction enables "Cosmos" Short-Path Valves to reproduce the entire gamut of musical sounds with clarity and fidelity. Users of "Cosmos" Valves agree that they provide a Short-Path to better reception.

Note the NEW PRICES

It is hoped that these very favourable prices will enable *all* valve-set users to enjoy the remarkable reproduction of Broadcast music which has been so highly commented upon by musicians and critics.

NEW PRICES of COSMOS VALVES

	OLD PRICE	NEW PRICE
For 2-volt accumulator:		
S.P.16/R 0·09 Amp. ..	14/-	10/6
S.P.18/G 0·3 Amp. ..	14/-	10/6
S.P.18/B 0·09 Amp. .. (Resistance Capacity)	14/-	10/6
S.P.18/RR 0·3 Amp. .. (Power)	18/6	12/6
For 6-volt accumulator:		
D.E.50 0·09 Amp. ..	14/-	10/6
S.P.50/B 0·09 Amp. .. (Resistance Capacity)	14/-	10/6
S.P.55/R 0·25 Amp. .. (Power)	22/6	20/-
A.45 0·65 Amp. .. (Bright Filament)	8/-	5/-
For series running in Multi-Valve sets:		
D.E.11 0·25 Amp. .. (1·1 volt)	14/-	10/6

NATIONAL RADIO EXHIBITION
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Cosmos
VALVES

RADIO ABROAD

—continued from page 294

of the perfect transmission from the organ at its station W L W by having the organ specially constructed and connected with an audio amplifier. Many prominent U.S. artists have played on this organ and remarked upon its wonderful tonal quality, the same opinions having been endorsed by thousands of listeners who have written to record their appreciation.

Longest on the Air

The distinction of being on the air longer than any other station in the world (fourteen hours a day), is claimed by Station 2 F C, Sydney, Australia. This station begins at 7 a.m. with the previous day's cricket scores and continues with short transmissions until midnight. A recent broadcast from this station was from the bottom of a mine-shaft 2,000 feet below the sea.

Langenberg

The giant German station at Langenberg, with an output of 24 kilowatts, has its studios at Elberfeld, Dusseldorf, Köln, Dortmund, and Münster, although it may be connected by landlines with any other German stations. Its output as stated is 24 kilowatts, input 60 kilowatts, and wave-length 468·8 metres.

The transmitter operates in three stages, the first a 400-watt tube with two 50-watt modulators; the second has two 1½-kilowatt tubes; and the third employs 20-kilowatt tubes. On the plates of the intermediate valves 4,000-volts are used, and on the final amplifiers 10,000 volts.

Three huge rectifier tubes are used to convert the 5,000-volt alternating current received over long-distance power-lines: this current supplies the valves except the filaments of the smaller ones, for which a D.C. generator is provided.

A special cooling plant is included for cooling the anodes: this consumes about 1,300 gallons of water per hour, the water being first passed through a water-softening plant so that scale may not be deposited in the water jackets around the tubes. The aerial is a "T" of five wires, and suspended between two steel towers 328 ft. high and 820 ft. apart.

Elaborate Earth

The excellent reception of this station (which has been reported up to over 800 miles on a crystal set) is attributed to the elaborate earthing system, which consists of a radial net of copper wire buried about 3 ft. deep, eight miles of wire being used in this way.

Powerful as the Langenberg station is, a "dead" area for its reception has been found south of Cologne, and a relay station is proposed for the benefit of the residents in that district.

New Rectifiers

Dry rectifiers are now being largely adopted, more particularly in the United States, the country of their origin and development.

There are two principal types of these rectifiers, the first being known as the Raytheon "A" tube, and the second as the Kuprox.

The first consists of a copper-plated steel tube (about the size of the little zinc container of the unit of a flash-lamp battery) within which is a cathode of a special alloy, this being surrounded by a paste of concentrated sulphuric acid and silver. This rectifier will pass 2½ amperes of direct current and has an extremely low internal resistance, about 1 ohm. About 8 or 9 volts of alternating current applied to the rectifier, when

(Continued on page 304.)

In Our Test Room

An Efficient Power Transformer

WE have recently had a Gecophone power transformer on test. It is a production of the General Electric Co., Ltd., and is for use with their K.L.1 valves. These, it will be remembered, have indirectly heated filaments and heating elements which can be operated on the raw A.C. derived from such a transformer as this Gecophone component.

This has a secondary winding split up into four sections, each giving a constant output of 3·5 volts, in order

This new Marconiphone D.C. mains unit supplies H.T., L.T., and grid bias.

to distribute the load when more than one valve is in use. It is of an eminently sound design throughout, and embodies several other valuable features. For instance, its core is secured in such a manner that vibration is practically impossible, and the windings have air spaces through which heat is conveniently dissipated.

Up to 20 amperes could be extracted from the transformer for lengthy periods without it showing any signs of distress, and this is more than double the current needed when four K.L.1's are in use.

We particularly like the arrangement of terminals. These are provided with a removable cover so that when the transformer is installed in a set protection is afforded against both shocks and shorts of an accidental nature.

It has in every respect ample margins of safety, and is in our opinion a thoroughly reliable and satisfactory transformer. The price of this "Gecophone" product is £1 17s. 6d., and it is suitable for use with any voltage A.C. mains of any periods.

For Sulphated Accumulators

Nearly all accumulators tend to sulphate after a few months of use, and unless they are very carefully maintained they rapidly deteriorate for this reason. Severe sulphation renders an accumulator practically useless, so that any real cure for this must be of extreme value. We recently had a quantity of D.A.R. forwarded to us for test. D.A.R. is claimed to be a preventive and a cure for sulphation. It is a colourless fluid and has to be mixed with the acid solution, and thus is operative during the charging of a battery.

On test we found the substance most efficacious, and were able to restore some badly attacked cells with it. Whether or not these will retain their rejuvenated conditions remains to be seen. If they do, then D.A.R. is more of an event in the radio world than an innovation!

The "Oriel" Loud Speaker

The London Radio Manufacturing Co., Ltd., of Station Road, Merton Abbey, S.W.19, recently sent us one of their "Oriel" cabinette-type loud speakers. It has a rectangular case of polished oak, the front of which is cut away in an ornamental fashion to show the fabric covering which conceals the inner structure. Inside is a conventional type of unit, and the terminals of this project through the side of the case and the adjusting knob passes through the bottom. The case is supported on three small rubber feet.

The speaker is not of the cone or disc type, but has a horn bent round in such a manner that a fair length is obtained. The flair opens out widely immediately behind the fabric material. This latter is of a quiet hue and, indeed, the whole speaker is "neutral" in design and would easily fall in line with practically any style of furnishing.

On test the "Oriel" gave quite good results. Despite its enclosed nature it has an excellent projection and is well up to the average in point of sensitivity. Its tone, too, is good, and we think that few amateurs would have much fault to find with it

A Receiver Cabinet

We recently had the opportunity of examining a pedestal cabinet constructed by Messrs. G. F. Ambatielo and Co., Ltd., of Farringdon Road, London, E.C.1. It is a handsome affair built up on Jacobean lines from stout oak. It has two compartments, one for the set itself and one for batteries and spare parts. The former is provided with two well-fitting doors,

The cabinet described in the accompanying paragraph fitted with a set and its batteries.

while the front of the latter, which is situated at a lower level, falls forward and is retained in a horizontal position. The upper part of the back is hinged to provide access to this part of the cabinet and, to render accessibility complete, the top of the cabinet is hinged.

The whole is supported on four nicely cut twist-pattern legs. It forms a handsome piece of furniture, and when closed does nothing to reveal the electrical nature of its contents. The whole assembly is substantial, and there does not appear to be any camouflaging of second-class material in out-of-sight corners. It retails at £5, and strikes us as being in every way a sound and attractive proposition.

New Ediswan L.F. Transformer

With the serious attention that is being paid to L.F. transformer design these days R.C. coupling may yet receive a considerable setback. Four or five years ago the idea appeared to be current, even among manufacturers of repute, that as long as a transformer had an iron core and a fair amount of wire nothing else mattered. As a matter of fact, the majority of the L.F. transformers used in sets of those days were survivals in design of the time when there was no wireless telephony. And in the amplification of Morse signals it was even helpful for everything to have a curve like an inverted "V" with the peak around about four or five thousand cycles, for if these peaks (the 'phones included) coincided so much the better. But, in the case of telephony, the flatter the curve the better, and the lower down and the higher up the "drop-offs" the more closely do we approach the ideal in reproduction.

Messrs. Ediswan's new L.F. transformer appears to us to be an excellent example of modern design. It is shielded and is very heavy. It has an iron core of ample capacity, while the inductance of its primary winding is as high as 50 henries at 100 cycles. It has the useful ratio of 1 : 3·5, and is thus suitable for either first- or second-stage work. We have had this new Ediswan transformer in use in a four-valve set (H.F., Det., R.C., Trans.), and it has proved perfectly satisfactory. It does not appear to "saturate" with upwards of five milliamps. passing through its primary, and personally we can detect little difference, except perhaps in volume, when this transformer and its connections are replaced in favour of a properly arranged R.C. stage.

Messrs. Ediswan are producing some excellent components of late, and this L.F. transformer is of similarly high standard. Its retail price is 25s.

The "Ala" Hydrometer

We recently received an "Ala B" hydrometer from Messrs. A. H. Hunt, Ltd., of Croydon. A hydrometer is a most useful device, and everyone who uses accumulators should have one in his possession. But it would be as well for us to point out that a hydrometer does not fully replace a voltmeter. The two instruments should always be used in conjunction with one another. It is all very well to mark a hydrometer with such indications as "Fully Charged," "Half Charged," "Dead," and so on, but such terms can be somewhat misleading. For instance, during our tests with the "Ala" we came across an accumulator cell which, according to this hydrometer, was something a trifle less potent than "Dead." The uninitiated would naturally have been lead to believe that this poor cell would register "No Volts" on a voltmeter. Actually it was able to shift a needle to a full two, and hold this on discharge at two amperes for two hours without a quiver!

However, the electrolyte of that cell wanted seeing to, so that, in a sense, the hydrometer's danger-reading was justified. But it is a fact that accumulators cannot be adequately tested by either a voltmeter or a hydrometer alone, and many such batteries would enjoy longer lives if this fact were more widely appreciated.

The "Ala" hydrometer sells at 2s. and is thus quite cheap, but we found it to be absolutely accurate. It is calibrated with S.G. readings as well as with the usual indications, and it is designed on generous lines so that its markings are readily visible and close S.G. readings can be taken.

Novel Variable Condenser

We recently had the opportunity of examining Messrs. Ripault's improved lateral action variable condenser. It appears to be an excellent production. The action is both novel and efficient. The two sets of plates, which are formed of hard brass, are mounted so that they interleave in a lateral manner, the movement being transmitted through a smooth-working cam arrangement. The plates each measure approximately 2½ in. by 1¼ in. The one set is rigidly fixed to the main framework, while the other slides *en bloc* along two guides. Compactness is thus achieved without sacrificing either electrical or mechanical efficiency. The one set of plates is easily removable.

The cam itself is easily removable. Three differently-shaped cams are available and, according to which one of these is fitted to the condenser, so will it operate on either the straight-line-frequency or straight-line-wavelength scheme, or, with the third cam, on the "Exponential" principle.

The condenser operates very easily and there is no harshness or looseness at any one point. It is, in fact, a very commendable piece of work, and is both robust and neat in appearance. Each one is sold complete with a slow-motion dial of sound design, the price of the ·0005 mfd. being 18s. 6d. and the ·00025 mfd. 16s. 6d.

The Amplion Symphony Orchestra of Toronto, which is, we are informed, a popular feature of Canadian broadcast programmes.

RADIO NOTES AND NEWS OF THE MONTH

A feature in which our Contributor brings to your notice some of the more interesting and important Radio news items of the month.

Conducted by P. R. BIRD.

The Wireless Exhibition

WHAT makes the forthcoming National Wireless Exhibition quite an exciting event for every listener in the land is the fact that not until it commences is Britain's 1927-8 radio programme published. New designs—hitherto secret—are first blazoned abroad at Olympia. On September 24th the year's crop of newer ideas, better goods, and lower costs will be on view at last.

A Peep Behind the Scenes

At last year's show visitors to Olympia looked through thick glass into a studio, from which 2 L O's broadcasting was being carried out. This year a different peep behind the scenes has been arranged by the B.B.C. Replicas of the control- and transmission-rooms have been erected at the Exhibition, and the public will see the methods of controlling, regulating, and perfecting the programmes as they pass on their way from microphone to aerial.

New French Station

Readers who have been puzzled by picking up an unfamiliar French programme, just below 300 metres, have probably been eavesdropping upon the new Lille station.

This was opened only at the end of July, and is the first of the French stations established under the new system of Government control. The wave-length is 285 metres.

Warm Invitation from Chile

In a cheery epistle from Valparaiso, M. Gustavo Vierling informs me that he has been allotted the call-signs S C-2 B L and S C-N A D. Readers who pick up these calls are invited to send reports to P.O. Box 1,653, Valparaiso, Chile.

Evidently, schedules could be arranged, for the letter concludes:

"I am interested in having Q R O's with English Hams stations (short waves specially), and to know the exact time this gentleman works in Radio."

A Record Broken?

When the Bombay broadcasting station was opened, the Secretary of State for India was unable to attend in person. So an opening speech was delivered in London, specially recorded there by the H.M.V. Co., and then a special messenger took the gramophone record out to Bombay to be broadcast.

All went well, but one can't help wondering what would have happened if the poor chap had dropped His Master's Voice!

Sir Oliver Lodge

The announcement that Sir Oliver Lodge will start a series of broadcasts on September 29th has been widely welcomed by listeners. The spacious subject chosen—"Pioneers of Astronomy"—is just the kind that Sir Oliver himself enjoys; and the miracle is that he will make us understand and enjoy it, too!

(*Continued on page* 302.)

RADIO NOTES AND NEWS OF THE MONTH

—continued from page 300

Short-Wave Telephony

Short-wave receivers, delving down on 15 metres and thereabouts, are always picking up something of interest. Their latest haul—reported recently from listeners in all parts of the country—is 2 X G, Rocky Point, New York. This short-wave station has a Boy-Scout-like habit of helping the transatlantic telephone service. It repeats numbers, gives missing words, and back-answers, etc., and generally makes itself pertly indispensable to all parties concerned. To hear 2 X G crisply repeating the remarks of the New York "Hello-girlies" is a highly diverting wonder of the short waves.

Wellington Calling

New zeal and vigour have been given to New Zealand radio by the opening of 2 Y A. This is the call-sign allotted to the powerful broadcasting station which was opened recently at Wellington.

Designed with a daylight range covering the whole of New Zealand, this station claims to be second only to Daventry within the British Empire.

Peru's Troubles

Behind a dry-as-dust statement that the Peruvian Government is going to try wireless instead of land-lines for telegraphic communication, lies an amusing story of nature in Peru. It appears that the ants out there are so voracious that wooden telegraph poles are useless—the ants just bite through them *en passant!* But that's not all!

The Overland Route

Even if the poles "stay put," large families of monkeys climb them and go in hundreds by hand and tail along the overland route afforded by the wires! And finally there are the spiders—"of huge dimensions and incredible aspect," as Mr. Mitchell Hedges would say—spinning webs like doormats that short the circuit and bring down the wires and insulators. No wonder they are going to try communication by wireless!

R.A.F. Wireless

It is announced that the R.A.F. people have hundreds of vacancies for aircraft apprentices aged between 15 and 17. Wireless operator-mechanics are drawn from this class, so any embryo Cobham who would like to listen-in from a great height, whilst watching the clouds roll by, should apply for particulars. The address is The Royal Air Force, Gwydyr House, Whitehall, London, S.W.1.

Those German Stations

Have you noticed that no matter what comes along, whether it be summer-time, eclipse of the sun, X's, jamming, Tooting, Clapham, or Dwyer—nothing whatever seems to make any difference to those German stations? Rain or shine, day or night, they are to be found on all wave-lengths "Achtung" about for all they're worth!

Their programmes, by the way, seem much more entertaining than they used to be, some of the orchestral concerts being particularly fine.

Are Long Waves Obsolete?

Several readers have raised the interesting point as to whether long waves are now worth catering for. "Now that we shall have alternative low-wave programmes," says one letter, "will the extra big coils be worth their cost? Won't the tendency be to concentrate all broadcasting below 1,000 metres?"

I don't think so. There are now in Europe more than thirty stations broadcasting on wave-lengths between 1,000 and 4,000 metres. And, personally, I find that these long-wave programmes want a lot of beating, both for quality of transmission and reliability of reception.

Bound Volumes of "Modern Wireless"

As several readers who like to have their volumes of MODERN WIRELESS bound have raised the question, I recently inquired how future volumes would be numbered, and how many numbers each would contain.

I understand that the intention is to commence a new volume every six numbers, but to number the issues consecutively, and not to revert to Number 1 again every time a new volume is commenced.

The Epilogue

The agitation for the abolition from the programmes of the Sunday evening Epilogue does not seem to be meeting with much support from the public. It appears that a very large body of listeners really like these Epilogues as arranged by the B.B.C. And those who do not happen to like them are generally quite content to switch off when the Epilogue is

(*Continued on page 304.*)

"MODERN WIRELESS"
SPECIAL EXHIBITION NUMBER

On Sale September 23rd

THE next issue of "Modern Wireless" will be on sale a week earlier than usual—i.e. Sept. 23rd, and will contain, besides many important technical articles in connection with the official opening of the wireless season, a review of the Radio Exhibition at Olympia.

BE sure and order next month's issue well in advance, for without this invaluable guide to the Exhibition you will not be *au fait* with this year's latest radio developments.

WHEN YOU VISIT OLYMPIA, TAKE A COPY OF

"MODERN WIRELESS"

with you or buy a copy at our stand, where you will be heartily welcome.

VISIT US AT STANDS 74 & 75

ELECTROLYTIC H.T. BATTERY ELIMINATORS

—continued from page 272

and the arrangement further cheapened by substituting smaller condensers than those of the values shown, but it should be realised that an increase in condenser capacity is of more value than an increase in inductance of a choke, as the latter lowers the voltage available, by reason of the drop in volts due to the increased resistance, while the former reduces the A.C. impedance of the output circuit, and the larger the condenser the smaller is the ripple voltage.

The rectifier is usually wisely accommodated under a shelf where it is safe from accidental spillage and least exposed to dust. The alternating current should be switched on for a few minutes before the load is applied on the D.C. side, and afterwards the output voltage can be varied by changing the size of the series lamp, as indicated in Table 1. The level of the electrolyte must be maintained by the addition of distilled water only, from time to time, to make good any losses.

Low Running Costs

The normal consumption of electrical energy at 200 volts for an output of 50 m.a. at 150 volts is of the order of 20 watts, and while this can be materially reduced by using a step-down transformer in lieu of the series resistance lamp, such saving is not proportional owing to the transformer losses, while A.C. hum is ntroduced and the ripple voltage augmented. As to remote control the author's practice is to leave the rectifier permanently connected to the A.C. power supply (at 1¼d. per unit) when, the open circuit losses being less than 12 watts, the annual loss thus resulting is only of the order of 6s. per annum, and the total consumption about 150 units per annum, or about 16s. per year.

Prevention of Sparking

The electrodes last indefinitely provided sparking is kept down by employing an adequate number of cells such that any momentary sparking across one will not, by reason of throwing the whole voltage across the remaining number, result in the peak voltage thus suddenly imposed on any cell approaching the breakdown value.

RADIO NOTES AND NEWS OF THE MONTH

—continued from page 302

announced. That, I think, is one of radio's biggest blessings—you can either take it or leave it, as per the passing fancy.

New Wireless Discovery

A story of an entirely novel system of wireless comes from Bologna, Italy, the home of several famous wireless inventions. A professor of Physics at the University there claims to have evolved a system of wireless telephony in which invisible ultra-violet rays are employed. Conversations have already been carried out at distances exceeding ten miles, and it is thought that the new system may have some important advantages over present methods, especially as regards secrecy of working.

RADIO ABROAD

—continued from page 296

this is in series with a 6-volt battery, is sufficient to pass over 2 amperes of rectified current.

Kuprox

The Kuprox rectifier consists of an arrangement of metal discs between which copper oxide is introduced. Each set of plates has a comparatively low reverse or breakdown voltage, and therefore a number of the units have to be connected together in series in order to provide for the charging of a 6-volt battery. This rectifier also has a very low internal resistance, and is entirely without liquids or anything else to go wrong.

Chemical Earth

A new so-called chemical earth has been developed by Messrs Ungar & Watson, of Los Angeles, California, and consists of a copper-sheet cylindrical container about 12 in. long and 4 in. in diameter, which is entirely sealed except for two small holes at the bottom. This container is filled with a compound of copper salts, and when buried about 2 or 3 ft. in the ground it soon forms, and afterwards maintains, a reliable electrical connection with the earth, owing to the absorption of moisture by the salts within. It is claimed that this earth is effective even in comparatively dry ground.

(*Continued on page* 306.)

THE "M.W. FIVE" IN OPERATION

—*continued from page* 228

of at least 12, and preferably a good deal higher, say 15 to 20. In the 6-volt range—to be preferred for use with the standard split-primary transformers—a few examples are these: D.E.L.610, S.T.61, P.M.5X., Cossor 610H.F., D.E.5b., etc.

For the detector a valve of the R.C. type is good, but the impedance should not be too high (maximum about 60,000 ohms) or difficulty will be experienced with the reaction control. In the first L.F. stage a valve of similar type to those in the H.F. sockets is suitable (remembering the characteristics of the Ferranti L.F. transformer,) while in the last stage a super-power valve is very desirable.

Balancing the Gang

The balancing of the gang condenser is a very simple matter in the "M.W. Five" if a good make of matched coil is used, such as the Lewcos. Simply set the two halves exactly in line, then tune in a distant station, and proceed to give one half a very slight lag or lead until the exact setting is found for loudest signals. Keep the set well off oscillation-point while this is being done.

Before you can pick up a distant station for balancing purposes, however, a rough neutralising adjustment must be obtained, and the following procedure is recommended. Set the two halves of the gang exactly in line. Set the neutrodyne condensers and the reaction condenser at minimum. Turn the Kurz Kasch dials of the tuning condensers and note whether the set oscillates. It probably will at certain points, and you should then increase the neutralising condensers a little at a time until the set is stable over the whole tuning range. You can now proceed to use a little reaction, search for a distant station, and adjust the gang exactly.

Neutralising

Next you can get the set exactly neutralised, and here there is a choice of methods. If you have a local station the following procedure is advised. After carrying out the previous steps, tune in the local station, turn off the filament current of the first valve, and retune until you hear the signals again as loudly as possible. Now turn the first neutrodyne condenser until you find a setting at which the local station is suddenly

(*Continued on page* 308.)

RADIO ABROAD

—continued from page 304

Rotating Loud Speaker

A remarkable and revolutionary design in loud speakers has been made by F. E. Miller, a well-known United States engineer, and is known as the Miller Rotating Loud Speaker. The loud speaker has the usual conical trumpet, and inside this are two conical spirals made of metal ribbon. One of these is of a smaller angle or taper than the other, the smaller one being positioned inside the larger one, and both being similarly positioned inside the conical trumpet. The two conical spirals are maintained in rotation about the common axis, which is the axis of the trumpet, and in opposite directions, and it is reported that the volume of production may be augmented to a degree "almost painful," whilst at the same time retaining perfection of quality.

RECENT VALVE DEVELOPMENTS

—continued from page 248

high plate current for the position), the valve works well, but I have found it of little use anywhere else in the set. I like more than a grid swing of 3½ volts either way for my power valve.

After the success of the K.L.1 (indirectly heated cathode A.C. valve), the makers have decided to place a valve of similar design but higher impedance and magnification on the market. This takes the form of the K.H.1, having an impedance of 30,000 and an amplification factor of 40. Fil. volts 3·5, current 2·0 amp., H.T. 150 max., are its further characteristics, while on the brief tests I have given it it has behaved itself wonderfully well. It is a good H.F. valve and good detector, while I expect to get good results on resistance-capacity coupling after further experiment. The makers are to be congratulated on this series of valve.

New Nomenclature

I must mention the series of Six-Sixty valves I have just received. These are all good valves, and can be recommended for readers' consideration. By the way, the Electron Co. have altered the designation of these valves, and they have now come into line with other makers in their nomenclature. The complete list is as follows: S.S.210H.F., 210L.F., 210R.C., 215P., 2 volters; S.S.410 H.F., 410R.C., 410P., 425 Super Power, 4 volters; and the list of 6-volt valves contains S.S.610 H.F., 610R.C., 610P., 625 Super Power among the ordinary valves, and S.S.610H.F.T., S.S.210H.F.T., 210 R.C.T., 410H.F.T., 410R.C.T., 610 R.C.T. are special non-microphonic valves in the 6, 4, and 2-volt classes.

THE DESIGN OF H.F. AMPLIFIERS

—continued from page 276

invariably poor because of the stabilising devices employed.

The effect of the anode-grid capacity, it should be noted, is to damp the input circuit so that even if a cell is included in the grid circuit, to give the grid of the valve a negative bias, the valve behaves as though it had a resistance connected across the grid and filament terminals in addition to a condenser. The value of the effective shunt resistance depends upon the anode-grid capacity of the valve, and varies with the construction of the anode circuit.

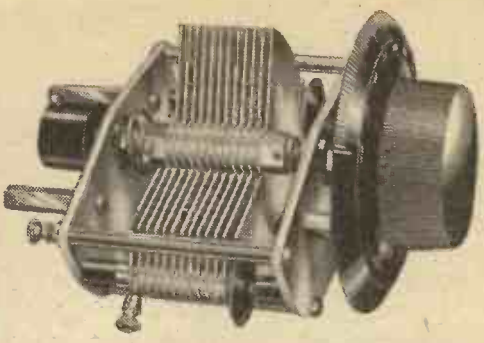
Effect of Neutralising

This has the effect, of course, of lowering the amplification and broadening the tuning.

In view of these remarks it is small wonder that many people have doubted the value of high-frequency amplification, and it had to be admitted that the simple circuit illustrated was a very unsatisfactory one. But to-day these circuits are not used. Instead of leaving the anode-grid capacity to do its worst, circuits are used which neutralise this capacity and so enable us to obtain very considerable amplification with complete stability.

Naturally, there are good and bad neutralised circuits, and many of them fail when an attempt is made to obtain a high amplification per stage. By taking suitable precautions, however, circuits can be so arranged that they give high amplification and extremely good selectivity. This naturally follows from the fact that when the anode-grid capacity is neutralised the input impedance of the valve is very materially increased. The effect of the arrangement used is practically to eliminate the grid-filament shunting resistance referred to above, and it follows that for this reason alone better amplification and selectivity are bound to be obtained from a neutralised high-frequency stage.

Here is the latest Condenser development

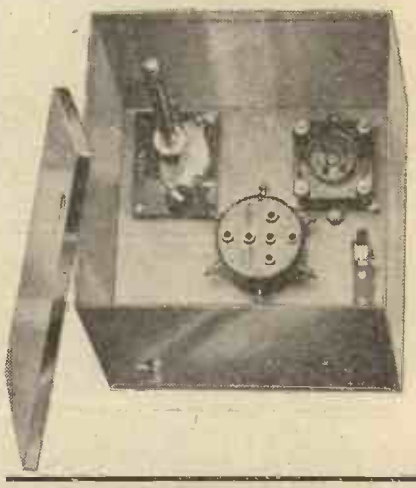


—the Keystone Universal Logarithmic

HERE is a Condenser which has several unique features that you have been wanting. It is adaptable to different circuits—a great advantage. Two or three single condensers can be ganged together to form a double or triple gang, in a few moments, with the aid of only a spanner. Both fixed and moving plates are insulated from the frame—another unique feature! A patented vernier adjustment is provided, enabling the capacity to be varied to fine limits. Rigidly constructed from finest materials. British made.

PRICES :

Single, ·0005 mfd. less dial	**13/6**	Twin-Gang, ·0005 mfd. less dial	**27/6**
Single, ·0003 mfd. less dial	**12/6**	Triple Gang, ·0005 mfd. less dial	**42/-**



CŌPEX H.F. SCREENING UNIT

(as used in the "Modern Wireless" Five).

Copex Standard H.F. Screening Unit, as illustrated, assembled and wired ready for use **25/-**

Standard baseboard (with components comprising Keystone Neutralising Condenser with special long handle, Copex 6-pin base, vibratory valve-holder, and Keystone Fixed Resistor), assembled and wired **13/-**

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6,840 miles on the Loud Speaker with this Peto-Scott Five-Fifty-One

(5 valves-50 stations-1 Dial)

Receiver

This is the Receiver of 1927. No set has such a remarkable achievement to its credit. With a similar model to that illustrated here, and on a trip from England to Australasia and back, 244 stations were definitely received and identified. W.B.B.M. Station, Chicago, was actually received on the Loud Speaker regularly every evening, in Dunedin, New Zealand—6,840 miles. Surely a record! Hear this fine Set for yourself. We will demonstrate it anywhere, without obligation. Write and ask us.

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Suitable for neutralising the electrode capacities of all types of valves. Low minimum capacity. Wide spacing of vanes renders accidental "shorting" impossible. Board mounting (as shown) **5/-**

Panel mounting, **6/3**

Keystone "Midget" Reaction Condenser

Ideal for the many positions where a small-capacity condenser is required. Aluminium shield prevents hand-capacity effects. Special taper bearing giving smooth movement. Capacity ·0001 mfd. Price **5/6**

See these Sets and Components—and more—at

STAND 163

National Radio Exhibition, Olympia

P.S. 9572

THE "M.W. FIVE" IN OPERATION

—continued from page 305.

very much reduced in volume, or even disappears altogether, and on either side of which it reappears.

Make sure you have really found the correct point by trying a little re-tuning again, then turn on the valve once more and carry out the same process on the second H.F. valve.

Now proceed to tune in a weak distant station, and bring up the reaction until the set is on the verge of oscillation. Try varying the first neutrodyne condenser. If it is correctly set the receiver should go into oscillation when it is moved either way. Make sure such a point has been found, and then turn to the second neutrodyne condenser.

The object is to find such a setting for each that the greatest possible reading of the reaction condenser is required to make the set oscillate. In other words, such a setting that when the receiver is brought to the edge of oscillation by means of added reaction the slightest variation either way will send it into oscillation.

Such a setting can be found without the preliminary adjustment on the local station, and this method should be adopted by those who have no local signal available. Proceed exactly as before up to the point of getting the gang correctly set. Then tune in a distant station, and bring the set to the very edge of oscillation with the reaction condenser. Next increase the first N.C. slightly, and retune for loudest signals.

The set will now be further off the oscillation-point and more reaction can be introduced. Again increase the first N.C. a little, and proceed in this way until you find you are beginning to overshoot the mark, and further increases of the neutralising condenser no longer stabilise the set, but cause it to oscillate. You will easily locate the exact setting, and can turn to the second H.F. valve and repeat the process here.

A final point. It is advised that some spare aerial formers be obtained, and extra coils wound with 15 turns (tap at 10) and 10 turns (tap at 6), to suit various requirements of selectivity, etc.

LOG OF STATIONS RECEIVED.

All at full loud-speaker strength in one hour and a half.

STATION.	DIAL READING. (*Gang condenser.*)	STATION.	DIAL READING. (*Gang condenser.*)	STATION.	DIAL READING. (*Gang condenser.*)
Munich	85·5	Berne	63	Newcastle	39
Vienna	82·5	Glasgow	62	Madrid (EAJ 12)	38
Brussels	81·5	Cork	61	Belfast	37
Aberdeen	79·5	Hamburg	60	Hanover	35·3
Bournemouth	78	Radio-Toulouse	59	Stoke-on-Trent	34·5
Berlin	77	Manchester	57·3	Radio-Lyon	31
Lyon-la-Doua	76·5	Madrid (EAJ7)	55·5	Dortmund	29·5
Langenburg	74·5	Leipzig	53·5	Nottingham	27·5
Oslo	72·8	Cardiff	49	Danzig	27·4
Rome	71·5	Barcelona	47·2	Sheffield	26
Brunn	69·5	Konigsberg	44	Toulouse	21·5
Bilbao	69	Birmingham	43	Kiel	18·5
Fredrikstad	68·5	Dublin	41	Bradford	18
Frankfurt	67	Breslau	40·2	Muenster	14
Gothenburg	65	Spanish (? station)	39·8	Stettin	11·5

LOUD-SPEAKER ACOUSTICS

—continued from page 288

There are many other things in connection with loud-speaker acoustics that must be considered before absolute perfection of distribution can be attained—the very bricks with which a house is built, the thickness and nature of the plaster which covers the walls, the wallpaper itself, these will all play their parts as well as the contents of a room; but I think I have said enough to indicate the complexity of the subject.

You may not care to spend the time on the disposing of your speaker or speakers in an absolutely scientific manner, but I urge you to carry out a few experiments before you finally decide upon their positions. I am sure that if you take careful note of the varying results you will consider that it can be decidedly worth while.

A MODERN WAVE-METER.

—continued from page 280

is given. It is important, however, to note that this graph should be drawn to a really large scale—say, one-tenth of an inch per metre and one-fifth per degree.

A very similar method can be adopted if the borrowed instrument is of the buzzer type, except that the receiving set must be kept just gently oscillating all the time. Place the buzzer wave-meter so far from the set that you can only just hear it when it is tuned to some wave, switch it off, and turn the dial of the new wave-meter until the usual chirp is heard, and then proceed as before.

Getting a Graph

Most people, of course, will not be able to borrow a meter for calibration purposes, and in their case the procedure is to pick up a series of stations of known wave-length, find the reading for each on the wave-meter, and with the data so obtained plot a graph as before.

This method, of course, requires that the wave of each station used shall be accurately known, and hence the stations should be chosen with care.

Most of the German stations are adhering closely to their published waves at the present time, and a useful calibration can be obtained by using Frankfurt and Langenberg, in addition to Belfast, Newcastle, Birmingham, Cardiff, London, Manchester, Bournemouth, and Aberdeen.

This series will give a graph from about 300-500 metres, and it can be taken a little higher and lower by continuing by eye, carrying on the general form of the "curve" (nearly a straight line, of course).

For the Short Waves

For the lower range, below 300 metres, a considerable number of stations must be received and identified, because the graph becomes less straight in this region. Most of the Germans will be found fairly close to their published waves, but if any fall appreciably out of line they should be disregarded as being probably off their waves. To make sure of this part of the curve, and so finish the calibration, it is necessary to receive a considerable number of the shorter-wave stations and draw a line which averages them out as well as possible. A useful guide is to be found in Muenster, which is generally very close indeed to its rated wave.

A LOUD SPEAKER FOR MUSIC LOVERS

—continued from page 224

and, moreover, he has had no experience with coloured paper.

The nuts and washers should be adjusted to a very light contact with the diaphragm. This can be done with great accuracy, if desired, by listening to a transmission of very faint sound. It will be found that the volume of sound from the loud speaker and the sharpness of adjustment of the magnets can be regulated by altering the position of the nuts relative to the earphone. It is generally found that a loud speaker gives best results when the nuts are so adjusted that the diaphragm exercises a slight pressure towards the earpiece.

Good Volume

Brass rods of various weights and washers of various substances have been tried. A great volume of sound is given by the use of 10 B.A. threaded rod with thin cardboard or celluloid washers, but the musical tone is not so good as that given by the combination which has been described. The subject, however, merits further experiment.

With regard to both volume of sound and tone, there is a vast difference given by 'phones of 2,000 ohms resistance and those of 60 ohms resistance used with a telephone transformer. The latter, as far as the writer's experience has indicated, are enormously superior for this purpose and give a wonderful volume of sound for a comparatively small input from the set.

Using a one-valve crystal reflex set provided with an efficient valve and working from a good aerial, 10 miles from 2 L O, the writer is able to reproduce a musical transmission of good quality from two loud speakers which is distinctly audible all over a small house. Transmitted speech, where purity of tone is not so essential, can be obtained with deafening loudness in the rooms where the loud speakers are situated.

Concerning the Set

In a loud speaker which is so sensitive, purity of tone is markedly affected, as it is to some extent in all loud speakers, by the nature of the set employed, the accuracy with which the set is tuned, the quality of the transmission, and the operation of neighbours' valve sets. One hears of loud speakers with paper diaphragms jarring on one particular note, making a sound like that produced with a tooth-comb and paper, or on occasion misbehaving in various unaccountable ways. If such happenings are found to occur when using a loud speaker which has been made as described above, the constructor can rest assured that the fault does not lie with the loud speaker, and that the remedy must be sought elsewhere.

AN ADAPTABLE FRAME AERIAL

—continued from page 234

Fig. 2. The sawcuts need be little more than scratches in order to hold the wire.

No. 20 tinned wire is used for the winding. The end is passed in and out of two holes in a piece of scrap ebonite. The ebonite is used to grip and stretch the wire during winding, the feed being regulated by the thumb (see photo). Keep pushing the frame away from you, spoke by spoke, during the winding, and keep the "feed" as tight and even as possible. The ends of the winding are looped once round the last spoke.

Supporting the Frame

The method of supporting the frame shown in the photo and Fig. 3 is merely a suggestion and may be varied to suit materials in stock. It is essential, however, that the frame should rotate quite independently of the base. Three terminals are necessary, two for the ends of the winding and one "free" terminal. This arrangement will allow of the various Reinartz variations being tried out. No. 20 wire can be gripped firmly in the central slot of a coil plug or wander plug, either of these forming excellent clips.

Above all, when working with hoops for scientific apparatus, base your measurements on the circumference and never on the diameter. Friend "π" is sure to let you down badly if you do.

The constructional articles which appear from time to time in this journal are the outcome of research and experimental work carried out with a view to improving the technique of wireless receivers. As much of the information given in the columns of this paper concerns the most recent developments in the Radio world, some of the arrangements and specialities described may be the subject of Letters Patent, and the amateur and the trader would be well advised to obtain permission of the patentees to use the patents before doing so.

OVERSEAS RADIO NOTES

A Belgian Base

A new radio station at Ruysselde, Belgium, which was tested out last month, is intended to link that country with the Congo and the Americas. The receiving station of the system is at Liedekerke. Underground cables for long-distance work have been laid down in Belgium and provide several hundred trunk-lines to its frontiers. It is stated that Belgium is seeking to attract the central European radio organisation at Geneva, under the auspices of the League of Nations, to the view that central broadcasting, as well as aviation, can be more effectively carried on from the plains of the Low Countries than from the Alps.

The Russian Way

The Soviet authorities in Russia seem to have carried out their well-known principles in radio administration as elsewhere. It has been decided that musicians, authors, and artists are to receive no remuneration for broadcasting, nor are they to have any royalties for the performance of their works. The argument appears to be that the mere placing of a microphone upon the stage does not throw any extra burden upon the performer, and that, so far as the composer is concerned, he should, instead of expecting payment, be very grateful for the advertisement which he receives from the medium of the broadcast!

Crystals in Germany

According to a report from Herr Zawadski, of Munich, the crystal and single-valve sets still predominate in Germany, notwithstanding the improvements in radio apparatus which are repeatedly being made. The reasons for the lack of multi-valve sets is apparently the freedom from interference which means that there is no great need for selectivity. Considerable progress has been made in Bavaria and elsewhere in Germany in the development of valves. In Bavaria alone on January 31st, 1927, there were practically 100,000 radio listeners.

Wireless in Shanghai

At a recent exhibition in Shanghai a considerable amount of wireless apparatus was shown, the receiving sets covering everything from a simple crystal set up to a ten-valve super.

THE LONG-RANGE FIVE

—*continued from page 218*

holes can be seen by referring to the wiring diagram of Fig. 9.

A pair of tags should be put under the screws holding the screen at the back of the baseboard, and another should be put at the point marked 13. The holes which are numbered should be large enough to take No. 18 tinned copper connecting wire with a covering of Sistoflex.

Wire first of all the filament circuits and then the by-pass condensers. Having done this, wire the low-frequency side, paying particular attention to the wiring of the coupling resistance and condensers. The connections of the primary of the low-frequency transformers, it should be noted, are reversed, and three flexible wires are provided for the grid-bias battery.

Final Wiring

Finally, wire the high-frequency transformers. Starting with the aerial coil, connect the wires to the aerial and earth terminals, and then join the grid wire to the tuning condenser, the grid of the valve, and one side of the balancing condenser, NC_1. The filament side of the secondary is connected to a tag held on the end plate of the tuning condenser by a small screw put in a spare hole, which will be seen, while another wire is run from the tag joined to the pigtail of the condenser to the single-cell grid battery. These wires can be seen in the illustrations.

From the anode of the first valve a covered wire is taken through the screen to the middle (primary) terminal of the coil; another one is taken from the balancing condenser NC_1 to the bottom (primary) terminal, while the positive H.T. wire is connected to the two primary terminals on the coil which are joined together. The secondary winding of the second high-frequency transformer has its top terminal connected to the grid of the valve and one side of the tuning condenser, while the bottom terminal is connected to the tuning condenser, and by a wire passing through the baseboard to the single-cell grid battery.

The third high-frequency transformer is easily connected. Reference to the photographs will make the wiring quite an easy matter.

(*In the next issue will appear a full description of how to operate the receiver, and further notes on its design.*)

FACTS ABOUT SHORT-WAVE TRANSMISSIONS

—*continued from page 212*

regular relays on the short waves. An interesting newcomer is W R N Y, the station operated by the American "Radio News" whose main wave-length is 309 metres. This station has just installed a short-wave transmitter with a wave-length of 30·91 metres, with which it is intended to relay some at any rate of the main programmes. The most likely to be heard by listeners in this country are those between 11 p.m. on Fridays and 4 o'clock the following morning. W A B C at Asheville, South Carolina, has also acquired a short-wave transmitter, to which a wave-length of 64 metres has been allotted. In Europe the short-wave transmissions other than those conducted by amateurs are unfortunately few and far between. Koenigswusterhausen works at intervals on 58 metres, and Nauen is sometimes heard on 40·2 metres.

Useful "Test" Stations

Besides the short-wave stations conducting telephonic transmissions there are many Morse transmissions on the short waves which are exceedingly useful for calibration purposes. Of these the Eiffel Tower is one of the most useful, for even those who cannot read Morse will have little difficulty in memorising and recognising the call-sign FL. This in Morse is . . — . — . . —, which may be learnt rapidly by fitting to it the words "Did it *hurt* you? Oh *yes* it did." The Eiffel Tower is to be heard on 32 metres at 8.55 a.m., 8.55 p.m., and 10.50 p.m. On 75 metres its transmissions take place at 5.30 a.m., 9.40 a.m., 5 p.m., and 11.50 p.m., all times being British Summer Time. On 20 metres Toulon, with the call-sign O C T N (— — — — · — · — — —·), transmits daily from 4.30 to 4.40 p.m. On 33 metres the same station is to be heard from 4.45 to 4.55 p.m., and on 57 metres from 5 to 5.10 p.m. B.S.T.

Other useful checks for short-wave calibration charts are provided by the harmonics of B.B.C. main stations. Those living near such stations will often find that there is a very powerful harmonic on exactly a quarter of the normal wave-length.

INDEX TO ADVERTISERS

Electrify your Gramophone!

GRAMOPHONE results never before obtainable are now made possible by the **Brown** Electrical Pick-up. 'Wonderful reproduction' was the description given by the "Wireless Constructor" last month. No need now to buy a new gramophone to appreciate fully the new standard of reproduction set by the electrical record. Just electrify your present gramophone by fitting a **Brown** Electrical Pick-up in place of the sound box and connecting to an amplifier and loud speaker. The result will be an entirely new pitch of tone perfection that will command instant admiration. Reproduction will be infinitely purer; the lower notes with equal fidelity to the high notes.

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Will fit any model—no alteration necessary.

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Puts Life into your Gramophone

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