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EDITORIAL COMMENT.

What is a Kit Set?

The Need for a Definition.

WHEN we buy a kit set what do we expect to get? It may sound absurd to ask such a question when wireless kit sets have been with us long enough for the name to have become almost a household expression. But when we try to find an answer to our question it is not so easy to decide just what would be a proper definition; certainly manufacturers who sell kit sets have quite divergent views as to what they should comprise, with the result that purchasers are often surprised, when the kit set of their choice is delivered to them, to find that often there are quite a lot of additional things to buy, the cost of which may amount to more than the kit set originally.

The trouble arises solely from the absence of any accepted understanding in the trade and amongst the public as to when the kit set is complete. Some kit sets comprise merely the components without cabinet or panel, without valves, and even without wire for connecting up, and the price may be correspondingly low. Some other manufacturer may also describe as a kit set an outfit which includes components, cabinet, baseboard, valves, wire, screws, and every item required down to the last detail for building a set; and even when all this is provided there are still other manufacturers who will not regard a kit as complete unless it incorporates the loud speaker in the cabinet as well.

Now we think it is very desirable that some sort of agreement should be reached on this score, and we would suggest that, before a collection of components for building a set can properly be described as a kit set, it should include every detail required, except batteries and loud speaker, to complete the installation. We would make one reservation: it is possible that valves might be regarded as additional to the kit, provided it is clearly indicated when they are not included. A cabinet can be regarded as an extra provided that the receiver is self-supporting when assembled.

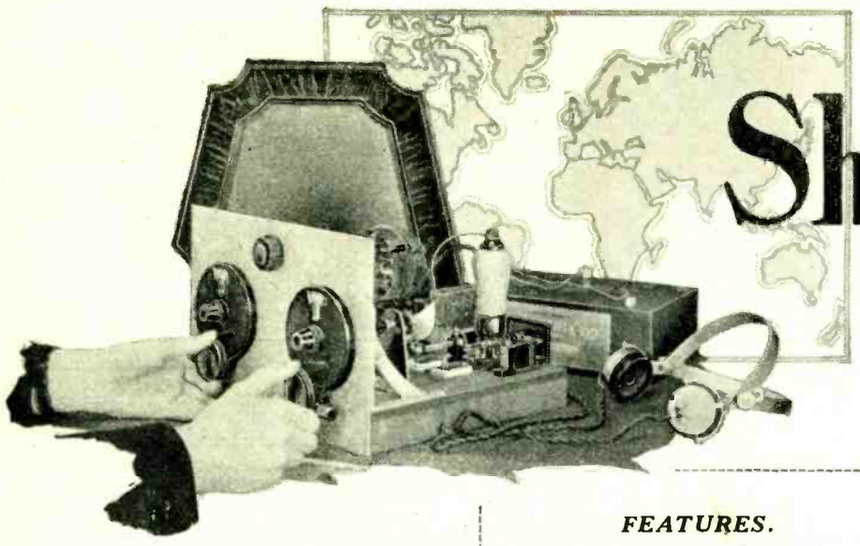
What is a Chassis?

Another term we would like to see defined, and the definition generally accepted, is chassis. Opinions vary as to what constitutes a chassis between merely the metal base on which a set is to be built, and the complete equipment of a receiver in working order but without a cabinet. We believe we are correct in stating that in the motor industry a chassis is accepted to mean a car without a body (the equivalent of a cabinet) in a condition in which it can be driven on the road. We should like to have readers' views as to the best forms that these definitions could take, and especially should we welcome the views of those marketing such apparatus.

Valve Data.

Next Week's Special Issue.

A SHORT while back we commented on the fact that there were too many obsolete types of valves still listed by manufacturers which tended to confuse the user in his choice. Next week, in a special valve number, a Valve Data Supplement is to be included giving details of makes and characteristics of more than 400 valves on the British market, this total still remaining after we have set an example by omitting all those valves which we recommended should no longer be listed.



2 Short-Wave

By H. B. DENT.

Constructional Details of a 15 to 80 Metre Two-valve Receiver.

FEATURES.

General.—*Two-valve short-wave receiver for battery operation. Wave range approximately from 15 to 80 metres covered by five plug-in coils.*

Circuit.—*Screen-grid detector with reaction, coupled by parallel-fed L.F. transformer unit to pentode output valve.*

Controls.—*(1) Tuning control. (2) Reaction. (3) Aerial coupling. (4) Battery switch.*

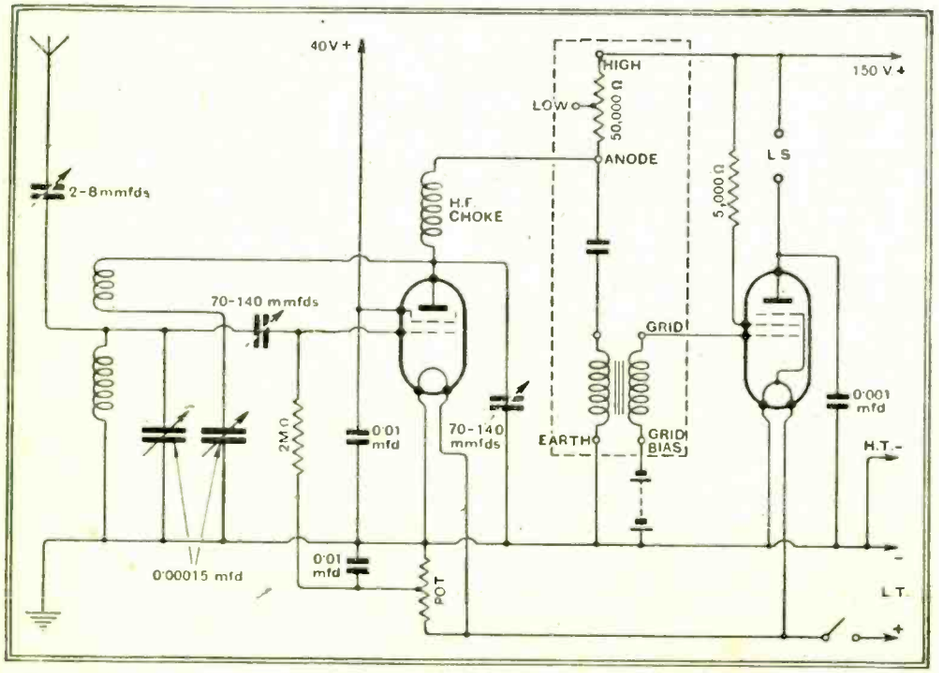
Batteries.—*L.T. 2 volts 0.4 amps.; H.T. 150 volts 6/8 mA.; G.B. 9 volts.*

IN view of the fact that experimental transmissions in connection with the new Empire broadcasting service may commence within the next few weeks, more than usual interest now attaches to the subject of short-wave reception. Below 50 metres receiving conditions differ very widely from those obtaining on the normal broadcast wavebands; indeed, so marked is this difference that the particular types of receiver developed for the latter purpose are not necessarily the most suitable for use on the very short waves.

In the first case, the selectivity problem is virtually non-existent as between 15 and 50 metres; for example, there are approximately 1,555 transmitting channels available which are shared by some ninety short-wave broadcasting stations, in addition to Service and commercial stations, also amateur experimenters. Even so, there is ample ether space to accommodate all, whereas on the medium broadcast waveband there are but 100 channels available between 200 and 500 metres, and these are shared by no fewer than 130 European broadcast stations.

Such interference as may be encountered on rare occasions is not troublesome as a rule, for it takes the form of an intermittent heterodyne due to a service or commercial station transmitting Morse messages. Very rarely indeed are signals entirely blotted out or rendered unintelligible by interference other than atmospheric disturbances. Consequently, a single-tuned circuit suffices to provide adequate selectivity on these very short wavelengths.

It is equally true, also, that very high sensitivity is not of paramount importance in a short-wave receiver, for messages can be exchanged over vast distances with quite low power transmitting apparatus and simple receiving equipment. Simplicity in this respect must not be confused with poor design and careless workmanship, as, owing to the very high frequencies employed, unnecessary capacity can introduce serious losses, and, of course, the performance suffers.



Theoretical circuit diagram of the receiver. The components enclosed by the dotted line are contained in the special L.F. coupling unit.

Smooth Reaction.

The sensitivity of a Det.-L.F. arrangement, for example, depends largely on the use of reaction, at least so far as short-wave reception is concerned. As a consequence, this should be given careful attention when planning the design of a set of this nature. The detector circuit should glide gently into oscillation, be under perfect control at all times, and be entirely free from electrical backlash. If these conditions can be achieved the sensitivity possible with the ubiquitous regenerative Det.-L.F. arrangement is surprisingly high and quite adequate to meet all the requirements of short-wave reception, no matter how distant the transmitting station may be.

The type of components employed for the receiver and the manner in which they are assembled have a profound effect on the results obtained. It is by careful attention to detail, by the use of suitable components, and by good workmanship that the performance of one particular receiver may show such a marked superiority over others embodying the same basic circuit. If the hand falls close to a tuning condenser when operating the set, signals will disappear when the hand is removed

Short-wave Two.—

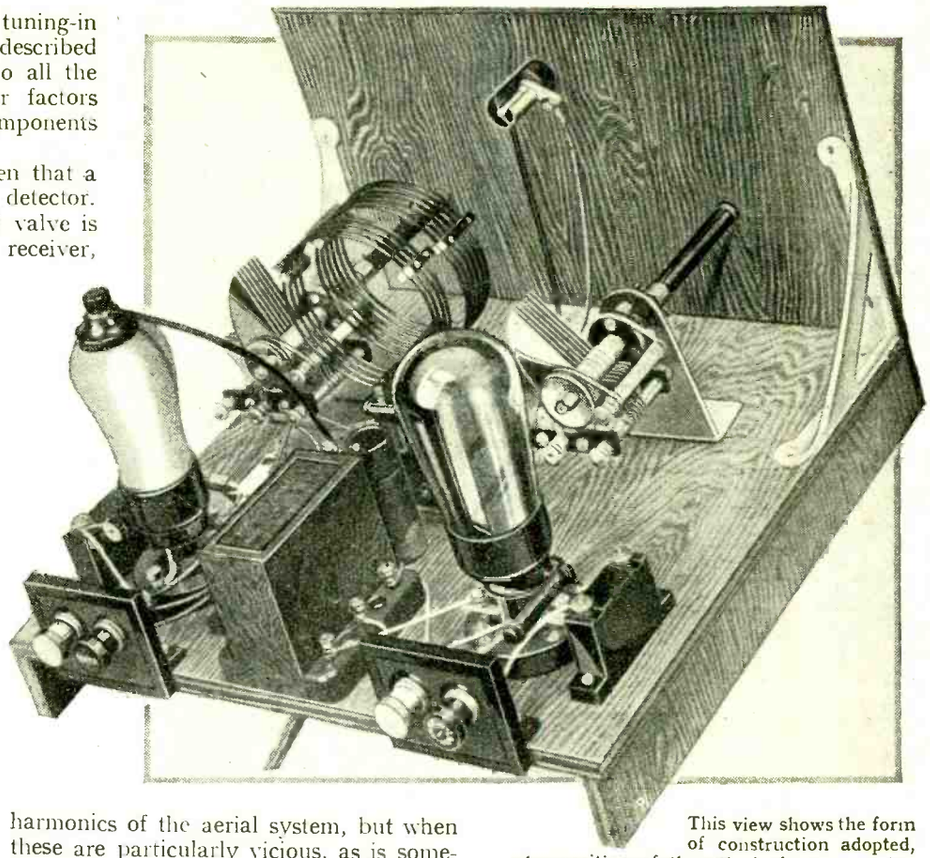
from the control knob, and the process of tuning-in becomes very laborious. In the receiver described here particular attention has been given to all the points mentioned above, while such other factors that have influenced the choice of the components will be dealt with as they arise.

From the theoretical circuit it will be seen that a screen-grid valve is employed as the detector. Experiments have shown that this type of valve is an excellent detector for a short-wave receiver, reaction can be made perfectly smooth without undue difficulty, and, in addition, it affords an appreciable amplification. Following this is a parallel-fed L.F. transformer-coupling unit, and, finally, a pentode output valve. This combination provides a high order of amplification without unduly straining the capabilities of the high-tension battery, for the total consumption can be kept down to less than 8 mA. at 150 volts.

Hand Capacity.

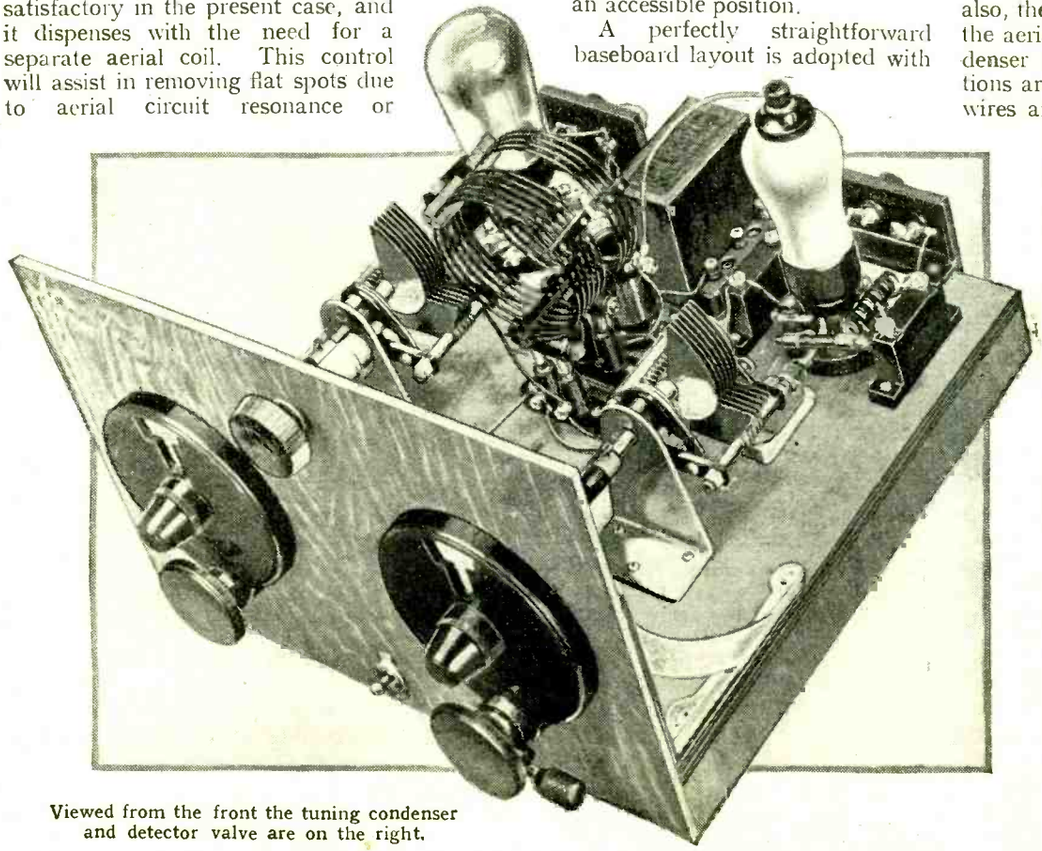
Hand-capacity effects have been avoided by mounting the two variable condensers well back from the panel and fitting long ebonite extension rods. The condensers used are special short-wave models designed to be electrically silent in operation, the main bearing consisting of a metal journal working in an insulated bush. The coils used are the air-spaced two-pin plug-in type, and five coils suffice to give continuous tuning from approximately 15 metres to 80 metres.

The aerial is joined to the high-potential end of the grid coil *via* the medium of a very small-capacity variable condenser, this arrangement having been found very satisfactory in the present case, and it dispenses with the need for a separate aerial coil. This control will assist in removing flat spots due to aerial circuit resonance or harmonics of the aerial system, but when these are particularly vicious, as is sometimes the case with certain aerials, the addition of a small coil in series with the aerial lead will overcome the trouble. A number 40 or 60 plug-in coil will prove efficacious in the majority of cases. Since the condenser just referred to serves to vary the aerial coupling, it is mounted in an accessible position.



This view shows the form of construction adopted, also position of the principal components.

A perfectly straightforward baseboard layout is adopted with all the components but three mounted on the top. The exceptions are the aerial coupling condenser referred to above, the L.T. switch and the small grid-bias battery, the latter being accommodated in the shallow underdeck well, in which is run, also, the filament wiring and the lead from the aerial terminal to the small series condenser on the panel. All other connections are made above the baseboard, and wires are kept as short as possible. The three leads joined to the grid coil-holder must be of sufficient length to allow free movement of the small slide on which it is mounted between the two limits required.



Viewed from the front the tuning condenser and detector valve are on the right.

The adoption of this mounting arrangement is to enable the various sized grid coils to be fixed so that the coupling between them and their respective reaction, or anode, coils is always as tight as possible.

Despite the relatively small maximum capacity of the tuning condenser—a 0.00015 mfd. size is employed—a slow motion drive with a big reduction ratio is essential, since the tuning is very critical, especially on the shorter wavelengths. The special Igranic dial is particularly well suited for this purpose as it provides a fast drive of 10 to 1, also a micrometer control giving a reduction of 500 : 1 for fine adjustment. The reaction control is less critical and a drive with a reduction of 10 : 1 will suffice.

There is one small detail in the

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assembly that does not appear clearly in the drawings. The two Cyldon semi-variable condensers, one of which serves as the grid condenser while the other as the anode by-pass condenser, have their adjusting screws located in the porcelain base. Consequently, two holes—about ⅜ in. in diameter—must be drilled in the baseboard so that the blade of a screw-driver can be inserted from the underside, for the initial adjustments.

A variable grid condenser was found to be very effective in obtaining smooth reaction over the whole range. When the set is first tested this condenser is set to its maximum capacity while the anode by-pass is adjusted to a shade less than maximum. If reaction is at all fierce, that is to say, the circuit does not glide gently into oscillation, particularly on wavelengths of the order of 50 metres, the capacity of the grid condenser should be decreased slowly until smooth regeneration is achieved over the whole range. An excess of positive bias on the grid of the detector will prove inimical to smooth reaction so that it is essential to connect the small fixed potentiometer in the correct manner. The two ends of the former are coloured yellow and blue respectively; the wire lead adjacent to the blue spot should be joined to the L.T. positive terminal on the valve holder.

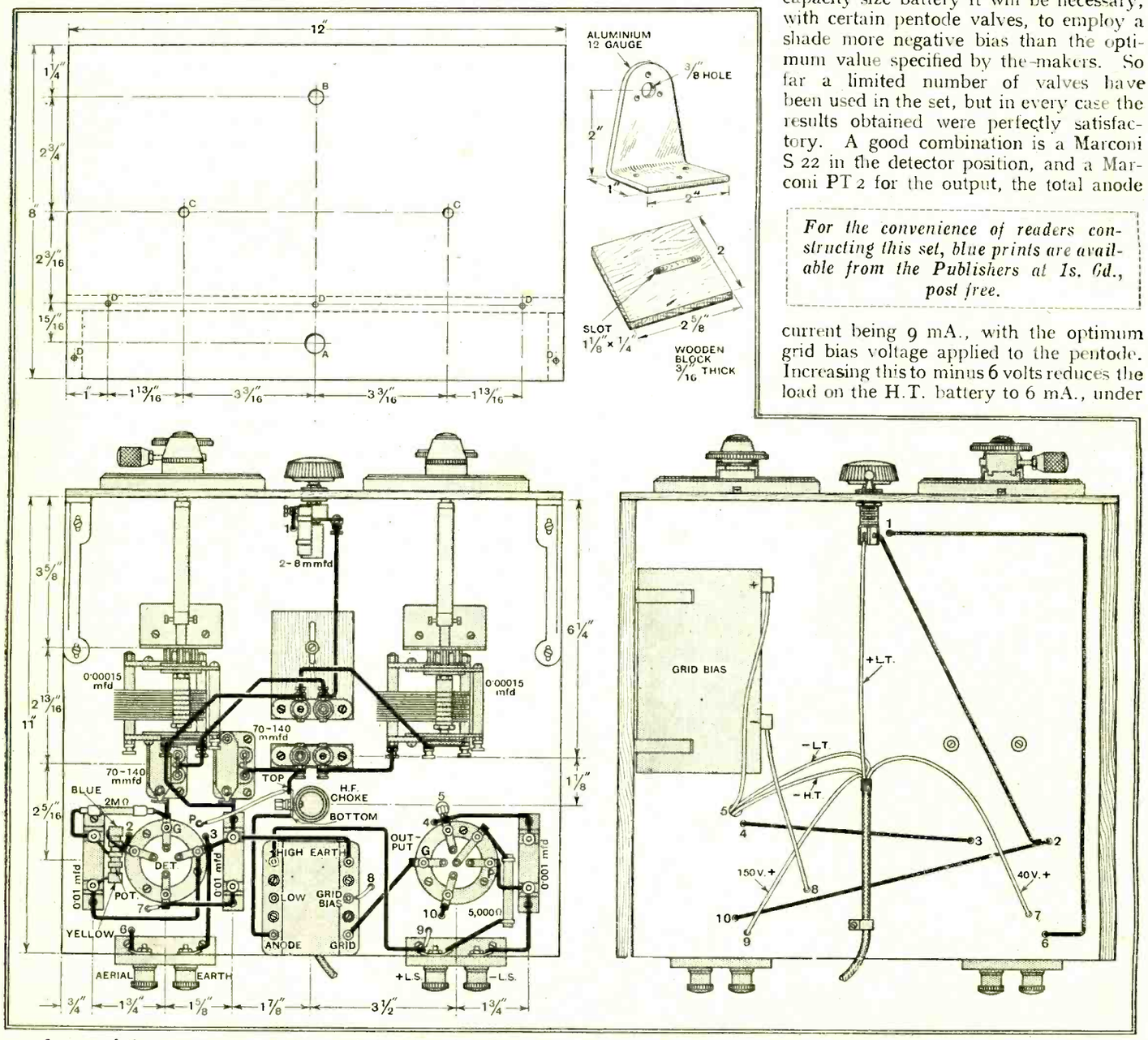
Five coils will suffice to cover a wave band of 15.4 to 80.8 metres, their respective type numbers and the wave range of each pair in the Eddystone series being given in the next column.

The wave ranges are covered with the aerial series condenser set to its minimum position.

The performance of the receiver does not vary to any marked extent with valves of different make, so that the choice in the present case is largely a matter of personal preference. If the H.T. consumption is to be kept within the economical discharge rate of the standard capacity size battery it will be necessary, with certain pentode valves, to employ a shade more negative bias than the optimum value specified by the makers. So far a limited number of valves have been used in the set, but in every case the results obtained were perfectly satisfactory. A good combination is a Marconi S 22 in the detector position, and a Marconi PT 2 for the output, the total anode current being 9 mA., with the optimum grid bias voltage applied to the pentode. Increasing this to minus 6 volts reduces the load on the H.T. battery to 6 mA., under which condition signals of reasonable volume do not appear to be adversely affected in quality, although slight distortion becomes apparent when the volume rises above a certain level. Normal broadcast quality of reproduction is rarely maintained for any appreciable time on the short waves owing to the

Coils.	Grid Coil.	Reaction Coil.	Minimum wavelength (metres).	Maximum wavelength (metres).
Eddystone.	No. 3	No. 3	15.4	30.3
	No. 6	No. 4	23.7	49.7
	No. 12	No. 6	38.8	80.8

For the convenience of readers constructing this set, blue prints are available from the Publishers at 1s. 6d., post free.



Layout of the components and the practical wiring plan, also dimensional details of condenser brackets and grid coil holder mounting. Panel drilling: A = 7/16 in. dia.; B = ⅜ in. dia.; C = ¼ in. dia; D = ⅛ in. dia.

Short-wave Two.—

PRINCIPAL SHORT-WAVE STATIONS.

(N.B.—Times of Transmission, given in parentheses, are approximate only, and represent G.M.T.

Metres.	Kc.	Call Sign.	Station.	Tuning Position.
80.0	3,750	2RO	Rome	
70.2	4,273	RW15	Khabarovsk (Russia). (*Daily* 09.00–12.00)	
62.56	4,795	VE9BY	London, Ont. (Canada). (*Sun.* 06.00)	
62.5	4,800	W2XV	Long Island, N.Y. (U.S.A.). (*Fri.* 24.00)	
58.3	5,146	PMY	Bandoeng (Java). (*Daily* 12.20 *and* 07.00.)	
58.0	5,172	OKIMPT	Prague (Czechoslavakia). (*Tues. and Fri.* 19.30)	
54.52	5,502	W2XBH	Brooklyn, N.Y. (U.S.A.). (*Relays WCGU*)	
52.7	5,690	FIUI	Tananarive, P.T.T. (Madagascar)	
52.5	5,714	HCJB	Quito (Ecuador). (*Daily* 12.30)	
51.22	5.857	XDA	Chapultepec (Mexico)	
50.6	5,930	HKO	Medellin (Colombia)	
50.26	5,970	HVJ	Vatican State, Rome. (*Daily* 19.00)	
50.0	6,000	ZL3ZC	Christchurch (New Zealand). (*Wed.* 03.00, *Sat.* 07.30)	
50.0	6,000	—	Bucharest (Roumania)	
50.0	6,000	RW59	Moscow	
50.0	6,000	EAR25	Barcelona, Radio Club (Spain). (*Sat.* 20.00)	
49.96	6,005	VE9DR	Drummondville (Canada). (*Relays CFCF*, 01.00–05.00)	
49.96	6,005	HRB	Tegucigalpa (Honduras). (*Daily ex. Sun.* 00.00–05.00)	
49.83	6,020	W9XF	Chicago, Ill. (U.S.A.). (*Relays WENR*)	
49.8	6,023	XEW	Mexico City (Mexico). (*Daily* 01.00)	
49.67	6,042	W2XAL	Coytesville, N.J. (U.S.A.). (*Relays WRNY*)	
49.59	6,050	VE9HX	Halifax (Nova Scotia). (*Relays CHNS*)	
49.58	6,050	—	Reserved for Empire Broadcasting, Zone 5...	
49.5	6,060	VQ7LO	Nairobi (Kenya Colony). (*Daily* 16.30)	
49.5	6,060	W8XAL	Mason, Ohio (U.S.A.). (*Relays WLW*)	
49.5	6,060	W3XAU	Philadelphia, Pa. (U.S.A.). (*Relays WCAU*)	
49.43	6,069	VE9CS	Vancouver, B.C. (Canada)	
49.4	6,072	UOR2	Vienna (*Tues.* 13.00, *Thurs.* 15.00, *Sat.* 23.00)	
49.34	6,080	W2XCX	Kearny, N.J. (U.S.A.). (*Relays WOR*)	
49.34	6,080	W9XAA	Chicago, Ill. (U.S.A.). (*Relays WCFL*)	
49.22	6,095	VE9GW	Bowmanville, Ont. (Canada). (*Daily* 21.00)	
49.2	6,098	ZTJ	Johannesburg (S. Africa). (*Daily* 15.30)	
49.18	6,100	W3XAL	Bound Brook, N.Y. (*Relays WJZ*)	
49.1	6,110	VUC	Calcutta, India. (*Daily* 13.00)	
49.02	6,120	W2XE	Long Island, N.Y. (U.S.A.). (*Relays WABC*)	
48.86	6,140	W8XK	East Pittsburg, Pa. (U.S.A.). (*Relays KDKA*)	
48.8	6,147	VE9CL	Winnipeg (Canada). (*Daily ex. Sun.* 00.30)	
48.65	6,167	XIF	Mexico City (Mexico)	
48.35	6,205	HKC	Bogota (Columbia). (*Daily* 15.00)	
48.2	6,220	2RO	Rome (Italy)	
48.05	6,243	HKD	Barranquilla (Colombia). *Weekdays* 23.45	
48.0	6,250	CN8MC	Casablanca (Morocco). (*Relays Rabat*)	
47.0	6,382	HC1DR	Quito, Ecuador. (*Daily* 01.00)	
46.69	6,425	W3XL	Bound Brook, N.J. (U.S.A.). (*Relays WJZ irregular*)	
46.67	6,426	VE9BY	London, Ont. (Canada). (*Sat.* 01.00, *Sun.* 02.00)	
45.38	6,611	REN	Moscow (*Relays Trade Union Stn.*)	
45.0	6,667	FM8KR	Constantine (Algeria). (*Mon. and Fri.* 23.00)	
45.0	6,667	TGW	Guatemala City (Central America). (*Daily* 03.00)	
43.75	6,860	—	Radio Vitus, Paris. (*Daily* 20.30)	
43.0	6,976	EAR110	Madrid. (*Tues. and Sat.* 22.30)	
41.7	7,195	VS1AB	Singapore (Malay States). (*Sun. and Wed.* 15.30)	
41.6	7,211	EAR58	Teneriffe (Radio Club) (Canary Islands)	
41.5	7,230	HB9D	Zurich (Radio Club) (Switzerland). (*1st and 3rd Sun.*)	
41.0	7,320	HSP2	Bangkok (Siam). (*Mon.* 14.00)	
40.3	7,443	—	Radio Nations, Prangins (Switzerland), (*Sun.* 22.00–22.45)... ...	
39.7	7,556	HKF	Bogota (Colombia). (*Westinghouse Labs.*)	
39.4	7,612	X26A	Nuevo Laredo (Mexico). (*Thurs.* 16.00)	
38.7	7,797	—	Radio Nations, Prangins (Switzerland), (*Sun.* 22.00–22.45)... ...	
36.92	8,125	PLW	Bandoeng (Java). (*Daily* 10.00–14.00)	
34.68	8,650	W2XV	Long Island, N.Y. (U.S.A.). (*Fri.* 23.00)	
34.68	8,650	VE9BY	London, Ont. (Canada). (*Mon.* 21.00)	
33.50	8,928	TGX	Guatemala City (S. America)	
32.26	9,300	—	Rabat (Morocco). (*Sun.* 20.00)	
31.58	9,500	PRAA	Rio de Janeiro (Brazil). (*Daily* 21.30)	
31.55	9,510	VK3ME	Melbourne (Australia). (*Wed. and Sat.* 10.00)	
31.54	9,510	—	Reserved for Empire Broadcasting	
31.51	9,520	OXY	Skamlebaek (Denmark). (*Relays Copenhagen*)	
31.48	9,530	W2XAF	Schenectady, N.Y. (U.S.A.). (*Relays WGY*)	
31.38	9,560	DJA	Zeesen (Germany). (*Daily* 13.00)	
31.35	9,570	SR1	Posen (Poland). (*Tues. and Thurs.* 17.30)	
31.35	9,570	W1XAZ	East Springfield, Mass. (U.S.A.). (*Relays WBZ*)	
31.3	9,582	W3XAU	Philadelphia, Pa. (U.S.A.). (*Daily ex Thurs. and Fri.* 21.00) ...	
31.3	9,580	—	Radio Nations, Prangins (Switzerland). (*Sun.* 22.00–22.45) ...	
31.29	9,585	—	Reserved for Empire Broadcasting	
31.28	9,590	VK2ME	Sydney (Australia). (*Sun.* 05.00, 09.30, 19.00)	
31.25	9,598	CT1AA	Lisbon (Portugal). (*Tues. and Fri.* 22.00–24.00)	
31.10	9,640	HS2PJ	Bangkok (Siam). (*Mon.* 02.00–05.00)	
30.4	9,869	EAQ	Aranjuez (Spain). (*Daily* 23.30, *Sat.* 18.00)...	
30.0	10,000	—	Belgrade (Yugoslavia). (*Mon.* 19.00)	
29.3	10,238	T14NRH	Heredia (Costa Rica). (*Daily* 22.00 *and* 02.00)	
28.98	10,350	LSX	Buenos Aires (Argentina). (*Daily* 20.30)	
28.2	10,365	PLR	Bandoeng (Java). (*Daily* 11.00–15.00)	
26.83	11,180	CT3AQ	Funchal (Madeira). (*Tues. and Thurs.* 10.30–12.30)	
25.63	11,700	FYA	Pontoise (France). (*Colonial Stn. E-W. daily*, 20.00)	
25.6	11,720	VE9JR	Winnipeg (Canada). (*Daily ex. Sat. and Sun.* 17.45)	
25.53	11,750	G5SW	Chelmsford. (*Relays Daventry National daily, ex. Sun.*)	
25.5	11,760	XDA	Chapultepec (Mexico). (*Daily* 20.00)	
25.4	11,810	VE9GW	Bowmanville (Canada). (*Daily* 18.00)	
25.4	11,810	2RO	Prato Smeraldo, Rome. (16.00 *and* 19.30)	
25.34	11,840	W9XAA	Chicago, Ill. (U.S.A.). (*Relays WCFL*)	
25.28	11,865	—	Reserved for Empire Broadcasting, Zone 2....	
25.25	11,880	W8XK	East Pittsburg, Pa. (U.S.A.). (*Relays KDKA*)	
25.2	11,905	FYA	Pontoise (France). (*Colonial Stn. N-S*)	
23.38	12,820	—	Rabat (Morocco). (*Sun.* 11.30)	
20.5	14,630	XDA	Chapultepec (Mexico). (*Daily* 19.30)	
19.9	15,075	T14NRH	Heredia (Costa Rica). (*Sat., Sun., Mon.* 16.00 *and* 21.00)	
19.84	15,120	HVJ	Vatican State, Rome. (*Daily* 10.00)	
19.81	15,140	—	Reserved for Empire Broadcasting	
19.73	15,200	DJB	Zeesen (Germany). (*Daily* 13.00–17.00)	
19.72	15,210	W8XK	East Pittsburg, Pa. (U.S.A.). (*Relays KDKA*)	
19.68	15,244	FYA	Pontoise (France). (*Colonial Stn. E-W*)	
19.56	15,340	W2XAD	South Schenectady, N.Y. (U.S.A.). (*Daily* 21.00)	
16.9	17,750	HSP	Bangkok (Siam). (*Sun. and Tues.* 21.00)	
16.88	17,770	—	Reserved for Empire Broadcasting, Zone 2....	
16.57	18,105	W9XAA	Chicago Ill. (U.S.A.). (*Relays WCFL*)	
14.47	20,730	LSY	Buenos Aires (Argentina). (*Sun.* 21.00)	
13.97	21,470	—	Reserved for Empire Broadcasting, Zone 3 (*Daylight working*)	
13.92	21,540	W8XK	East Pittsburg. (*Relays KDKA*)	

effects of fading. Taking this into consideration there need be no hesitation in slightly over-biasing the output valve in the interests of economy, for provided discretion is used good intelligibility can be assured.

Alternative Valves.

The corresponding valves in the Osram series gave identical results, while the Lissen combination, consisting of the SG 215 and PT 225 proved quite satisfactory. The total consumption with the pentode biased minus 6 volts is 10.2 mA. Increasing the bias to minus 7½ volts brings down the anode consumption to a shade over 8 mA.

This is by no means the full range of valves that can be employed in the receiver. Further tests are being arranged, and it is hoped to treat the subject in greater detail at a later date. The valves mentioned serve as an indication of the types that have so far proved satisfactory, and these can be used as a guide when choosing valves of other make.

LIST OF PARTS REQUIRED.

After the particular make of component used in the original model, suitable alternative products are given in some instances.

2 Short-wave variable condensers, 0.00015 mfd. **(J.B. S.W. Special)**

1 Short-wave valve holder, 4-pin **(Eddystone)**

1 Short-wave valve holder, 5-pin **(Eddystone)**

1 Midget variable condenser **(Eddystone)**

1 Fixed potentiometer (S-W model) **(Eddystone)**

5 Two-pin plug-in short-wave coils (two No. 3, one No. 4, one No. 6, one No. 12) **(Eddystone)**
Equivalent values in Atlas and Igranic.

1 Short-wave H.F. choke **(Igranic)**
Bulgin H.F.3, Goltone Wearite H.F.3.

1 Indigraph Vernier Dial, fitted with micrometer adjustment **(Igranic)**
Burndept, Utility.

1 Indigraph Vernier Dial, fitted with large knob **(Igranic)**
Burndept, Utility.

1 Transcoupler L.F. Unit **(Bulgin)**
Benjamin, Formo, R.I.

2 Intermediate tuning condensers, semi-variable, 70-140 m-mfd. **(Cyldon S.T.140)**
Colvern Pre-set 0.0001 mfd., J.B. 0.0001 mfd. trimmer.

2 Single coil holders **(Lotus)**
Igranic.

2 Fixed condensers, 0.01 mfd., mica **(Dubilier Type 620)**
Graham Farish, T.C.C. Type 34, Telsen.

1 Fixed condenser, 0.001 mfd., mica **(Dubilier Type 620)**
Graham Farish, T.C.C. Type 34, Telsen.

1 Grid leak, 2 megohms **(Loewe Type F.Z.128/36)**
Dubilier, Erie, Igranic, Claude Lyons.

1 Fixed resistor, 5,000 ohms, 1 watt **(Erie)**
Dubilier, Claude Lyons

2 Terminal mounts **(Junit)**
Belling-Lee, Goltone.

4 Terminals, A, E, L.S.+, L.S.– **(Burton)**
Belling-Lee, Igranic.

1 On-off toggle switch **(Claude Lyons, B.A.T. No. 728)**
British Radiophone, Bulgin, Igranic, Utility, Wearite.

1 Pair panel brackets, 4in.×4in. **(Magnum)**
Bulgin.

2 Condenser extension rods, 4in. long **(Bulgin E.H.10)**
Red Diamond.

1 Grid battery, 9-volt **(Grosvenor)**
Ever Ready, Oldham, Pertrix, Ripaults, Siemens.

1 Battery cable, 5-way **(Goltone)**
Belling-Lee, Bulgin, Concord, Harbros, Lewcos.

1 Pair grid battery clips **(Bulgin No. 5)**

Wood, 1 oz. No. 22 tinned copper wire, screws, systoflex, 2 wander plugs, etc.

Approximate cost of parts, excluding valves, £4 12s. 0d.

This receiver is available for inspection at the Editorial Offices, 116-117, Fleet Street, London, E.C.4.

UNBIASED

By FREE GRID.

More pleasing than the original.

A Courageous Dictum.

THE sayings of great men frequently get woefully distorted from their original form. A classic instance of this is a remark said to have been made by C. J. Caesar to the reporter of the Gallic Gazette in the cocktail bar of the "Maid of Kent."

Caesar, having first looked it up in a Latin dictionary, actually said *Veni, Vidi, Fugi,** but the ever-tactful reporter, knowing that he, if not his newspaper, was likely to be suspended by the senate on the slightest provocation, altered the last word to "Vici."

I think a similar thing must have happened in the case of the organiser of the Olympia and Manchester radio exhibitions. Moody by name, but evidently not by nature, he gave forth to the world, according to one of our most famous national "dailies," the remarkable dictum: "When reproduction is not exact it is frequently more pleasing than the original."

There is only one explanation of this notable statement other than the obvious one that his remarks have been twisted out of their true meaning, and that is that Mr. Moody really means what he says. If this latter explanation be the true one? I remove headgear to him for saying something which I have always longed to say but have been afraid to.

It is insufficiently realised, I think, what an enormous amount of suffering we are saved during the broadcasting of "hot jazz" by the fact that we are spared the more strident shriekings and blarings of the circular saw and similar instruments which go to make up the modern dance band, simply because deliberate dips have been introduced by certain loud speaker manufacturers into the performance curves of their wares. Hats off, therefore, to friend Moody and the more enlightened manufacturers who have dared to come out into the open and boldly propagate the great truth which the more lily-livered of us, including myself, have long thought but never dared to put into words. Let the B.B.C. blazon forth Mr. Moody's words in letters of fire through every microphone, and let every radio manufacturer hang them as a motto over every work bench.

* I fled.

An Old Dodge.

WE are coming to a pretty pass when the radio correspondent of a well-known journal hailing from the north of England has the effrontery to try to palm off as a new idea the use of a yard or so of flex, one wire of which is connected to the aerial and t'other to the aerial terminal of the set in order to improve selectivity.

I do not doubt the good gentleman's statement that it works (it certainly did work all right when I tried it some years ago), but I do venture to question his statement that "all the aerial energy is transferred to the set by induction in this manner." There is no "all" about it; as a matter of fact the amount of inductive coupling is relatively negligible, and the arrangement is nothing more or less than a rather inefficient series-aerial condenser of small capacity. The somewhat more costly small semi-fixed condenser would be found to be a better investment than the tuppence squandered in buying a yard or so of flex.

Liquidity in Music.

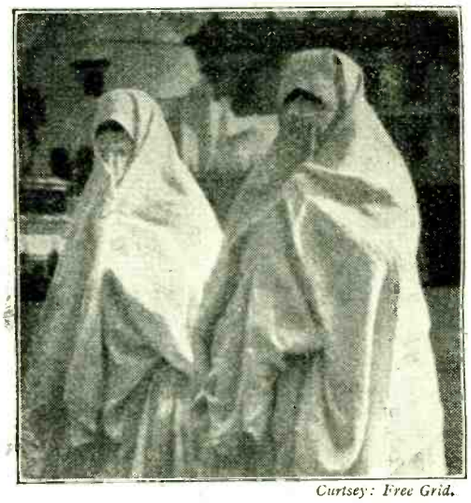
CAN any enlightened musician explain to me what the word "liquid" means as applied to his art? I want to know because a certain technical reviewer of a loud speaker in which I am interested, but which I have as yet not heard, describes the tone of the instrument as "liquid." Whether or no the word is

Liquid tones.

intended to have an alcoholic significance or not I do not know, and it is just this point on which I desire enlightenment. If the word *is* intended in the sense I have named, then, of course, the description is a singularly vivid and graphic one, and at once conveys the principal characteristics of the instrument to me, and I may say that I know at least half a dozen moving-coil loud speakers to which this highly descriptive word might well be applied.

Killing the Germs.

SINCE the Olympia Show I have attended a good many exhibitions, both on the Continent and in various parts of the British Isles. I have recently taken a busman's holiday in the form of a visit to the Motor Show, and I found the same unhygienic conditions prevailing



Curtsey: Free Grid.

Yashmaks.

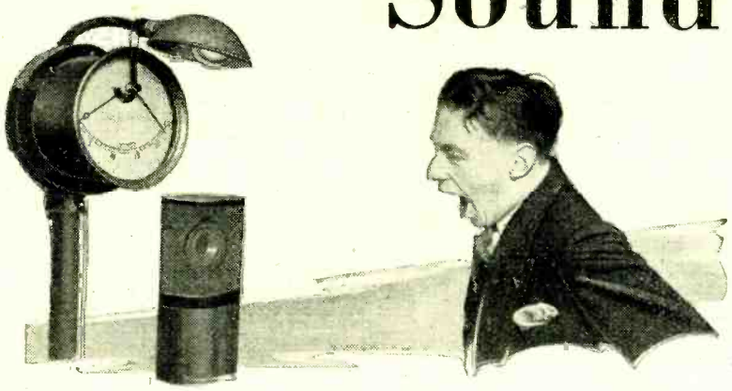
there as at stands in certain of the radio shows. In those rare instances where the exhibiting firm provided a competent person to deal with technical questions he was perched precariously behind a sort of shelf over which the seekers after knowledge lounged in various attitudes of studied negligence.

Among the many who besieged these all too rare stands many were obviously suffering from coughs, colds and other maladies mentioned in patent medicine advertisements, and I could not help thinking that the presiding Solomon was exposed to great risk of infection. I think that the least that could be done would be to supply him with a Yashmak liberally soused with disinfectant.

A better idea, however, would be to give him a modified disinfectant sprayer such as is used in cinemas and similar places. I would suggest that a piece of thin piping be mounted over the place where questioners are accustomed to lounge, connection being made to a reservoir containing disinfectant, which could be placed in any convenient position on the stand. The usual rubber bulb could be placed on the floor near to the technical expert's foot, and when any individual came along who was obviously suffering from a cold he could then depress it.

Sound Intensities.

Volume Level and the Loud Speaker.



WHILE the majority of us have loud speakers which fall short of perfection, reasonably faithful reproduction can be secured by careful attention to the question of resonances. Too many speakers, in emphasising the bass register, mask the upper notes and cause the low-frequency sounds to persist too long. This latter condition is responsible for much of the blurred reproduction so common to-day.

IN a recent article[1] in *The Wireless World* dealing with the "Loudness of Sound," we saw that the response of the human ear to sound depends upon (1) the intensity or acoustic air pressure, (2) the pitch or frequency. When the variation in air pressure corresponding to the sound is too small, no sound is heard, and it is said to be below the threshold of audibility. On the other hand, if the sound exceeds a certain loudness it is beyond the threshold of feeling. To refresh the reader's memory the threshold curves are reproduced in Fig. 1. The space enclosed by the curves is the auditory sensation area. If we choose any point within the area the sound intensity is, say, I dynes per square centimetre, and the frequency 1,000 cycles per second. A note of this intensity and frequency sounded by a loud speaker in a dead or completely damped room—of the type used for acoustic measurements—should be audible to any person with normal hearing.

We also indicated in the previous article that when the loudness remained steady, the air pressure variation was much greater at low than at high frequencies—up to, say, 5,000 cycles. Beyond this frequency the sensitivity of the ear decreases and the air pressure variation causing the sound

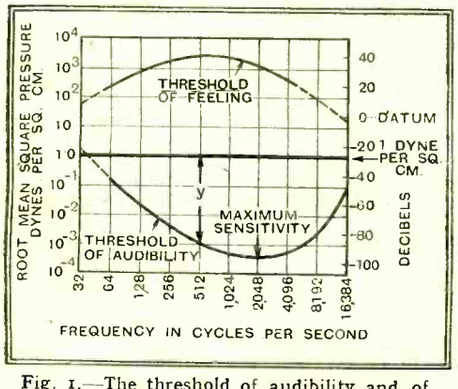


Fig. 1.—The threshold of audibility and of feeling for normal ears at various frequencies are shown in this diagram.

has to be increased accordingly to preserve equal loudness. Another point we observed was that although with a certain air pressure variation a note of 1,000 cycles appeared quite loud, one of 64 cycles was inaudible. But as the pressure was raised the 64-cycle note became audible and increased in loudness much more rapidly than the 1,000-cycle note. After this brief *résumé* of this important subject we shall now endeavour to explain the results obtained from loud speakers in their relationship to the above properties of the aural organs.

Let us begin with an ideal combination where the response of the loud speaker is the same at all frequencies, and it is operated in an absolutely dead room where reflection and standing waves cannot conspire to introduce false results. Suppose a series of notes starting at 64 cycles are sounded at intervals of an octave up to 8,192 cycles. The loudness will, of course, depend upon the intensity or air pressure variation measured in dynes per square centimetre. For the purpose of our test we will make the air pressure variation equal for all the notes. Referring to Fig. 2 and taking an intensity corresponding to −70 decibels below the zero or datum level, what happens at 64 cycles? So far as our ears are concerned there is no result, because the sound is well below the threshold of audibility. At 128 cycles nothing happens either, but at 256 cycles, which corresponds to middle C on the piano, the sound is faintly audible. At 2,048 cycles, which is two octaves above middle C, the note is quite comfortably audible, having a loudness level of 25 decibels above the threshold. Above this frequency the loudness steadily dwindles, and at 8,192 cycles, *i.e.*, an octave beyond the highest note of the pianoforte, the loudness is only 10 decibels above the threshold of audibility.

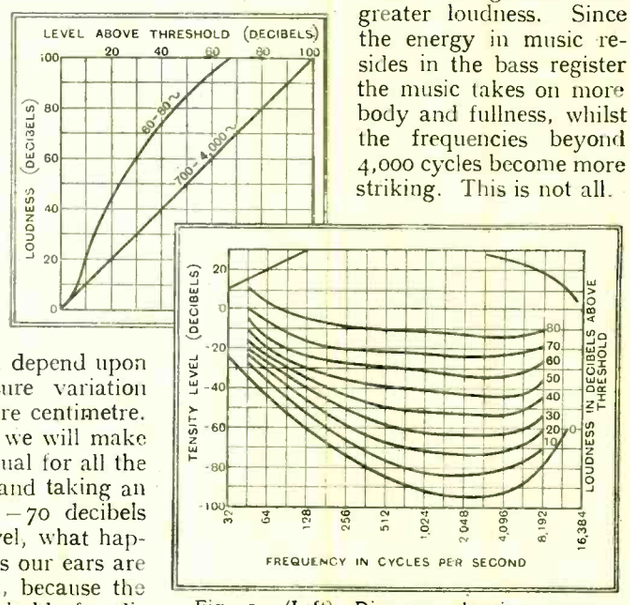


Fig. 2.—(Left) Diagram showing curves where the loudness is the same at all frequencies. (Right) Curves showing that the loudness in the lower register increases much more quickly than that in the upper register for equal increments above the threshold of audibility.

Lost Bass.

Now let us imagine that a large orchestra is reproduced with this ideal arrangement. Remembering that the loudness is quite small over the range 64 to 700 cycles, we realise at once that the low frequencies will be weak and actually inaudible below about 256 cycles. Consequently, instruments like the double bass, violoncello and bass drums will be robbed of their character, only the higher over-tones being audible. For all practical purposes the musical effect will be almost akin to that produced if these low-toned instruments were not there at all. If the intensity level is gradually raised the character of the music steadily becomes louder. Beyond a certain point it progressively undergoes a transformation, the lower frequencies being heard at greater and greater loudness. Since the energy in music resides in the bass register the music takes on more body and fullness, whilst the frequencies beyond 4,000 cycles become more striking. This is not all.

It has been known for many years that if two tones are sounded simultaneously, say 200 cycles and 2,048 cycles, at an in-

[1] See article entitled "The Loudness of Sound" in issue dated July 29th, 1932.

Sound Intensities.—tensity level of 60 decibels, the loudness of the higher frequency as perceived by the ear is reduced a good deal. The effect depends upon the intensity level, but in general the loudness of a pure tone is reduced when one or more additional tones are sounded. Perhaps this particular point will be understood more clearly by another example. We have all experienced the pangs of oscillating receivers—usually some other fellow a few doors away. Now imagine we are listening to a Promenade Concert at the Queen's Hall

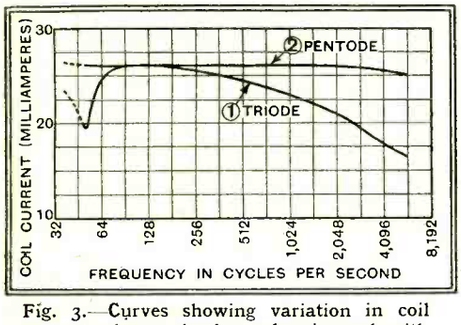


Fig. 3.—Curves showing variation in coil current when a loud speaker is used with one LS5A valve or one pentode. It is clear that there is no appreciable current variation with the pentode, which proves that the coil impedance is relatively negligible.

when in the middle of a Bach concerto someone sets a nearby receiver in oscillation. This is radiated and picked up by our own receiver. After rectification at the detector we get a beat note mixed up with the concerto. When this note has a very high pitch its effect is chiefly one of annoyance and distraction, since the music is not seriously influenced. But as the pitch of the note becomes lower, the musical balance is upset.

The Effect of Masking.

One can experiment to an extent with the hum note of the mains (if loud enough). In this case the relative strength of the note and the music can be regulated by merely operating the volume control. When the intensity of the music is below a certain level the hum—apart from being very annoying—alters the character of the music and makes it difficult to follow. This effect might be called "acoustic jamming," but actually it is described by the more polite scientific term "masking." I think, however, there are definite instances, such as talking against tube noises and against the indescribable hubbub of a modern city, which should definitely come under the category of "jamming." In the near future the various municipal authorities will have to get busy with noise-measuring apparatus in order to make the large cities habitable to any but the brainless.

Reverting to our ideal conditions test at increasing intensity level, we see that owing to the interaction of various tones—which constitute the complex sounds of music—in the aural organs, the curves of Fig. 1 do not tell us precisely and exactly what happens as the level rises. In general, the loudness of the low-toned instruments increases very rapidly once it becomes of adequate degree. By virtue of the masking effect caused by loud low tones, the middle and the upper frequencies appear to be subdued to a greater extent than the curves indicate. If the intensity level were raised perceptibly beyond that at which we might ordinarily listen in a concert hall, the general pitch level will appear to fall, since the masking effect of the low frequencies reduces the audibility of the high frequencies considerably.

The majority of us have loud speakers which are undoubtedly imperfect. All hornless moving-coil loud speakers depend upon resonances, which in good designs are reduced to a relatively small amount. To get a good bass register there must be resonance of some description. A common method is for the diaphragm to resonate upon the annular surround or upon a centering device.

L.F. Resonance.

Let us consider the case of a loud speaker with a prominent low-frequency resonance and try to gain some idea of the effect of reproducing speech and music with it. We shall consider the upper register to be fairly normal.

At very low output intensities the bass register will be inaudible as in the ideal case so that nothing striking will happen. As the intensity is raised the bass will become audible earlier than before, and the musical balance will be quite different from the ideal case. In fact, if the resonance is not very accentuated, such a condition at moderate intensities is not entirely unpleasant for average domestic conditions when reproducing music. For high intensities the results are decidedly distasteful for two reasons: (*a*) the bass register is much too powerful, which upsets the musical balance and masks the upper register, (*b*) the low-frequency sounds from the loud speaker persist after they have ceased at the studio, owing to the resonance not being adequately damped. Condition (*b*) introduces blurring and indefiniteness, and on the whole the music loses its sense or interpretational qualities.

Where the reproduction of speech is concerned matters are even worse. Taking the voice at its natural intensity level, the resonance introduces boom and indistinctness, not to mention unpleasantness. At high intensity level we have the feeling that a super-giant fifteen feet tall with special low-frequency vocal organs stands before the microphone. The boom is then particularly pernicious. It is worth while noticing the quality of a speaker's voice in the open air when standing in front of him. The low tones are not particularly striking. If one goes immediately indoors the voice takes on a different character due to room reflections and the consequent increase in the low-frequency vibrations. Even so, the strong boom, which is the characteristic of a badly designed loud speaker with a powerful low-frequency resonance, is absent. Such effects can be mitigated by the use of a low-resistance power valve and an intense magnetic field. Failing this, the constraint of the surround should be reduced, *i.e.*, made less taut. The influence of using a low-resistance triode is shown in Fig. 3, where the current at resonance is reduced considerably. The lower the resistance of the triode (up to a practical point) the smaller the current at resonance. If the current at resonance is reduced to half its normal value the output is only one-quarter of that with a pentode where the current is substantially constant. Although this is only about 6 decibels it is better than no reduction at all.

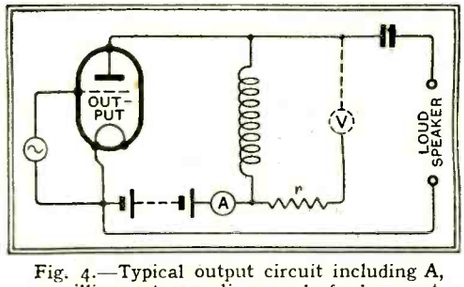


Fig. 4.—Typical output circuit including A, a milliammeter reading anode feed current, and V, a voltmeter in series with r, which is a measure of the anode feed current fluctuation. Distortion caused by anode rectification is not so unpleasant as that caused by grid current.

The points which have been enumerated above by way of illustration can readily be corroborated with the aid of a volume control to alter the intensity level. If in addition the reader has constant frequency records, which are usually marked off in decibels, he will be able to substantiate some of the remarks made in relation to loudness effects with pure tones. In this respect it is advisable to issue a warning, particularly in connection with low frequencies. The pick-up and its tone arm must not chatter, and the amplifier must not be overloaded either as regards grid current or anode blasting. Absence of the latter is detected in the usual way by aid of a feedmeter in the anode circuit. Failing this, a low-reading voltmeter of high resistance or with a high resistance in series to avoid a shorting effect can be placed across the anode feed choke, as shown in Fig. 4. It is quite easy to be deceived regarding the purity or impurity of a tone, since the addition of a few harmonics does not alter the pitch. The ear, however, as we have shown, is particularly sensitive from about 700 to 4,000 cycles, and any harmonics in this region may sound louder than the fundamental.

Practical HINTS AND TIPS.

AIDS TO BETTER RECEPTION.

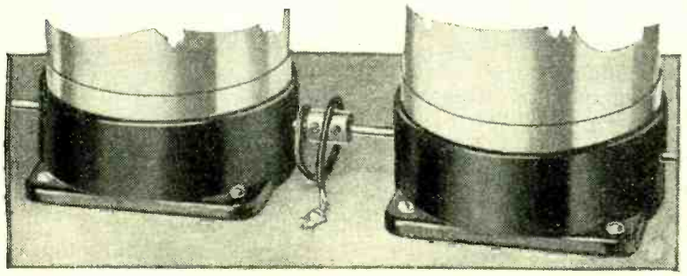
BATTERY users are now paying greater attention to the efficiency of their receivers, and particularly to quality of reproduction. But there is one point that seems to be generally neglected: it is not always realised that there will be a gradual falling-off in the voltage of a dry-cell H.T. battery. The purpose of this note is to stress the desirability of buying a battery of rather higher initial voltage than is needed, or, alternatively, of obtaining a "booster" battery after the main battery has been in use for a few weeks.

A Supplementary H.T. Battery.

The latter plan is perhaps the best and most economical, as the auxiliary cells, which will eventually be used as a supplementary source of voltage, may deteriorate slightly before occasion arises to put them into service. A 50-volt battery will be suitable in most cases, and it is not essential that it should have quite as high a capacity as that of the main battery. Perhaps this question of capacity is not of great importance, but a fairly good case can be made out for the use of the next smaller size of cell.

All battery valves are now rated to work at 150 volts, and so those who are desirous of obtaining the maximum sensitivity and volume will normally start with a 100-cell battery, which gives approximately that initial voltage. After fifty or sixty working hours the voltage of such a battery will probably fall to 1.25 volt per cell, or a total of 125 volts; at this juncture 25 volts from the "booster" battery may be added in series. As the modern H.T. cell maintains its voltage at roughly 1.25 volts for a considerable period, it is unlikely that any further addition will be necessary for some considerable time. After, perhaps, a total of 150 working hours it may be necessary to add the remaining 25 volts of the auxiliary battery in order to restore pressure to the original value of 150 volts.

This method of boosting would have been condemned at one time, as a falling-off in battery voltage is always accompanied by an increase in internal resistance. But nowadays, thanks to the general use of decoupling, a fairly high internal resistance may be tolerated.



An improvised earthing connection for a switch rod.

INSTABILITY in an H.F. amplifier is made evident by the fact that the valve (or valves) tend to oscillate uncontrollably when the various circuits are brought into tune with each other. This state of affairs should never be tolerated, even though, with the modern method of volume control by means of a grid potentiometer, it may be possible to attain stability by applying a suitable value of negative bias. But, when stabilised in this way, the sensitivity of the amplifier, even when operated close to the point of self-oscillation, will not often be so great as that obtainable when it is in a state of complete stability.

Unwanted Couplings.

Instability is almost always due to spurious couplings, and much space has been devoted in these columns to the nature of these couplings, as well as to the appropriate steps to be taken for their removal. It is sometimes forgotten that a metallic rod, when used as a mechanical link between the various switches of a ganged wave-change system, will often act as a medium for the transference of energy between grid and plate circuits. Most manufacturers who produce matched coil assemblies nowadays take precautions against this trouble either by breaking electrical continuity in the rod by the insertion of insulating pieces between the various coils, or by making provision to earth the rod at corresponding points. A low-resistance earth connection between each section will almost always prove efficacious, and is often arranged by fitting a light metal spring in such a way that it acts as a brush, making continuous contact with the rod as it is rotated. Another method of earthing, which may be more convenient to the amateur who has traced the cause of instability to this source, is illustrated in the accompanying photograph; instead of a spring, a "pigtail" of flexible wire is used to tie down the rod electrically, either to a metal chassis, or to the earth line of the receiver.

Unshielded wires in grid circuits are well-known causes of instability and care should consequently be taken both with regard to their position and to reduce their length. The fact that many ganged tuning condensers are fitted with duplicated terminals or soldering tags for each stator section often enables us to reduce the unshielded length of such leads.

It is a common practice to mount the valve on one side of the condenser and the coil on the other, and it is a good plan in such cases to make use of both connection points in the manner suggested in Fig. 1, where the wires in question, which bear corresponding lettering, are shown both diagrammatically and pictorially.

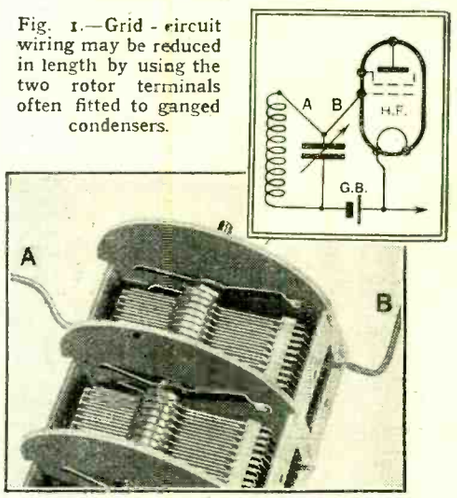


Fig. 1.—Grid-circuit wiring may be reduced in length by using the two rotor terminals often fitted to ganged condensers.

WHEN several H.F. chokes are available it is wise to choose the best and most efficient specimen for insertion in the anode circuit of an H.F. valve which precedes a parallel-fed tuned inter-valve coupling. An ineffective choke, used in this position, will appreciably reduce the amount of H.F. amplification, and if it has a very high self-capacity will also tend to restrict the wave-range of the circuit.

H.F. Choke Efficiency.

A choke of poor design will often serve well enough as a deflector of H.F. energy in a detector anode circuit. This choke, of course, is used in connection with reaction control, and even if it be hopelessly ineffective the basic qualities of the receiver will not be impaired, and in any case there will be a clear indication of what is wrong. Inefficiencies in the H.F. coupling, on the other hand, are more insidious, and it may be difficult to discover the cause of a poor performance.

NEWS of the WEEK.

Mussolini and Broadcasting.

SIGNOR MUSSOLINI, during his recent visit to Turin, showed great interest in the local broadcasting station, carefully examining the apparatus and also paying much attention to an exhibition of photo-electric cells.

The Duce is a firm supporter of broadcasting.

How They Laughed.

TO enable a Hollywood film producer to judge the length of the laughs for the film of Ivor Novello's play "Party," the public performance of the stage production was recorded by "His Master's Voice" at Golders Green Hippodrome on October 22nd. Thirty records were required, which will cost the film producer £10 each.

Idea for the B.B.C.?

LISTENERS to the French Foreign Legion broadcasting station at Tunis are complaining that the station operates only at unannounced times and that, consequently, no one knows when to stay at home to listen or seek the more certain delights of hiking. Apparently the station occasionally relays music from a Tunis café orchestra directed by a seventy-year-old woman pianist. The relay takes place if the subaltern in charge "feels like it."

Toulouse on 60 Kilowatts!

HERE is a pretty problem for listeners whose loud speakers are inclined to buckle under too great an output. Radio Toulouse, which for some years has outpointed many higher-powered European stations, using itself a modest 7 kW, is about to employ a 60-kW transmitter!

The transmitter has been installed in the old Chateau D'Agnan, some twenty miles from the town. The officials have now applied for the necessary Post Office permit to use the new transmitter.

Honours for M. Branly.

IT is not generally known that M. Branly, the French "Father of Wireless" and inventor of the Coherer, is a physician. Steps are now being taken to organise the celebration of his jubilee in the medical profession. M. Branly has already received the honour, rare in the case of a living man, of having a street named after him. Branly Avenue was inaugurated at Cannes last year.

It is hoped that he will shortly receive the supreme decoration—the Grand Cross of the Legion of Honour.

No Dancing?

IF listeners hear less German dance music on the air nowadays, it is owing to the new "war" which has developed between the Funkstunde and the dance band directors. In view of the financial crisis, the broadcasting authorities recently ruled that the fee of 80 marks per transmission previously paid to the dance bands should go to the Berlin Winter Relief Fund, it being considered that the orchestras and café owners obtain excellent advertisements from broadcasting. But the dance bands demur and trouble is brewing.

Current Events in Brief Review.

Leipzig and Frankfurt.

BY the time these lines are read, Germany's most powerful station at Leipzig will have started a regular service, using a wavelength of 389.6 metres. Frankfurt-am-Main station, which reverts to Leipzig's original wavelength of 259.3 metres, has increased its power from 1.5 to 17 kilowatts.

R.S.G.B. and Television Society.

THE Radio Society of Great Britain will hold a joint meeting with the Television Society at the Institution of Electrical Engineers on November 25th at 6.15 p.m., when a lecture will be delivered by Mr. T. M. Lance, of the General Electric Research Laboratories.

A MIDNIGHT TEST. In response to appeals by local radio dealers, Post Office engineers recently journeyed to Kennington at midnight to test the tramway conduit system as a possible source of interference. Typical portable sets, as seen in the picture, proved that in this case the tramways were not the offenders.

Anti-Static Congress.

THE second French Anti-Static Congress is to be held in the Maison de France, Avenue des Champs-Elysées, on November 25th, 26th, and 27th. The same building is housing the first French Exhibition of Anti-Interference Apparatus and the show will run until the end of the month.

Loud Speakers at the Shoot.

LOUD speakers are being used by French sportsmen in pursuit of game. When the marksmen have taken up their position in the shooting butts, a commentator with microphone watches the entire zone swept by the beaters from his perch on a tree. When the birds rise he announces the fact on loud speakers, and this presumably helps the men with the guns. On the other hand, it may help the birds!

Frequency Tests for Listeners.

DURING the broadcast discussion entitled "The Ordinary Listener and his Set" to take place to-morrow evening (Saturday) between Mr. R. A. Watson Watt and Mr. O. F. Brown, the carrier waves of the stations taking the National programme will be modulated with tones from about 50 to 6,000 cycles. This scale will be run through several times, at least once continuously in each direction and at least once with pauses at reference frequencies. Mr. Brown will report to Mr. Watson Watt what he observes when using an obsolete set which gives a non-uniform response.

It is hoped that many listeners will be able to use the modulated scale for testing their own receivers.

R.A.F. Non-stop Flight.

WEATHER permitting, the non-stop flight of the R.A.F. long-distance monoplane from Cranwell to Cape Town will commence between November 9th and 15th next. The plane, starting at 6 a.m., will transmit every two hours at even hours, using the following call: CQ CQ CQ V GEZAA GEZAA GEZAA, followed by the position. The wavelength will be 33.17 metres.

Short-wave amateurs may have a good opportunity to follow the flight, which will pursue a route *via* Berre, Tunis, Duala, Boma, St. Paul de Loanda, and Walfish Bay.

If a distress call should be received the listener is requested to notify the Air Ministry by telephone immediately (Holborn 3434, Extension 383 or 370), or otherwise communicate with the Air Ministry, Kingsway, London, W.C.2, by the quickest means available.

No Time for Talk.

A CLAIMANT to the title of Champion Radio Amateur lives at Limoges. A watchmaker by profession, he dons his headphones when starting work at 7 a.m. They remain on his head throughout his working hours and even during meal times; his one regret is that he cannot listen while asleep, as the European stations are then silent.

We learn, however, that he is putting finishing touches to a short-wave set which will enable him to listen all night to the American stations.

R.A.F. Wireless School.

THE annual reunion dinner of officers of the Electrical and Wireless School, R.A.F., will be held at the Royal Air Force Club, 128, Piccadilly, London, W.1, on Saturday, November 26th, at 7 for 7.30 p.m.

Particulars and tickets can be obtained from the hon. secretary, J. F. Herd, Ditton Corner, Datchet, Windsor.

Negro Broadcasting.

"TO help solve the economic problems of the negro race" is the object of a scheme to erect a ½ kW. broadcasting station in New Jersey. The station would devote itself to the service of the big negro population which is not at present catered for by such powerful local stations as WNJ, Newark, and WKBO, Jersey City.

BROADCAST BREVITIES

By Our Special Correspondent.

Henry Hall.

WHILE it is fairly certain that the recent changes in the B.B.C. Dance Band are only the prelude to bigger upheavals, I think a word should be said in defence of Henry Hall. Much of the criticism levelled at his head concerns the alleged monotony of the "sweet" type of dance music, of which he is the leading exponent to-day. But is it generally realised that Henry Hall has to spend a large part of his so-called leisure in making his own orchestrations?

Shortage of Funds.

Other famous dance-band leaders do not hesitate to enlist the services of eminent musicians for the orchestration of quite commonplace melodies, and as often as not it is the orchestration which really makes the hit.

But eminent musicians do not work for love, and herein lies Henry Hall's major obstacle when competing with dance bands not under the control of the B.B.C. Henry Hall lacks the money for spectacular experiments involving financial outlay.

Hotter and Sweeter.

While the B.B.C. is quite right in sparing no money to make its Symphony Orchestra one of the finest in the world, it should not lose sight of the Dance Band, which, if the truth were known, probably appeals to an even bigger audience than the Symphony Orchestra.

Let Henry Hall still be given a chance to show that, with equal resources, he can outplay the hottest and sweetest of his competitors.

That Non-stop Variety.

The B.B.C. Dance Band excelled itself during the first night of "Non-stop Variety." It quite caught the spirit of this new effort to raise vaudeville out of the rut.

By the way, Lance Sieveking's name is not being mentioned in connection with "Non-stop Variety," but I hand him the credit, here and now.

The next "Non-stop" night is on Monday, November 7th.

A Better 5XX.

THE new aerial now being used at the Daventry long-wave station was first exclusively illustrated in *The Wireless World* of October 14th last in the picture showing the short-wave aerial on the same site.

The engineers state that the aerial, which has a floating high potential point, is of greater capacity than its predecessor, and that it should deal more kindly with the higher audio-frequencies. Have you noticed this?

Hissless Microphones.

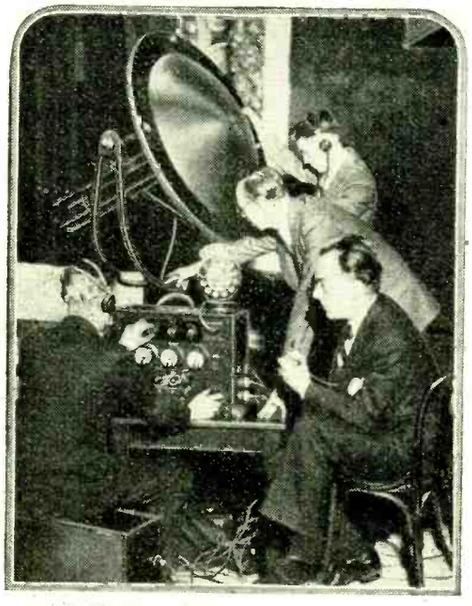
IN the old days many people thought they could hear the rushing of the sea during every broadcast, even when the signals had originated in Oxford Street and were being picked up in places like Sidcup.

The new modified Reiss should dispel the last illusion, for it is guaranteed to be hissless. It is already in standard use at Broadcasting House, and is slowly replacing the earlier models at the provincial stations.

Moving-coil Types at the Queen's Hall.

The Western Electric moving-coil mike is also being tested. Two or three of these are being used at the Queen's Hall. To my ear these moving-coil microphones seem able to handle larger masses of sound without blasting. Last week they stood up quite bravely to the crashings and bangings of Frank Bridge's orchestral rhapsody, "Enter Spring."

This was a good test.



"FOCUSING" THE MICROPHONE.—Engineers of the American National Broadcasting Co. using a parabolic reflector microphone for an opera broadcast. The microphone is highly directional and can be turned towards any particular speaker, in the manner of a stage spot light.

Broadcast By French Ex-President.

IF only because ex-President Doumergue has long been famous as a genuine "wireless fan," I shall seek an opportunity to hear his speech at the Annual Dinner of the Association of Great Britain and France at Claridge's on December 1st.

The speech is to be broadcast from the National transmitter.

A Long-Distance Listener.

During his term of office, which expired in the spring of 1931, when the late President Doumer took the reins of office, President Doumergue spent many evenings at the Elysée in tuning-in foreign stations. He was an enthusiastic visitor to the Paris radio shows.

Poppy Day Appeal.

THE appeal on Sunday next, November 6th, will be given by Major-General Sir Frederick Maurice, President of the British Legion, and one of Earl Haig's original helpers. This appeal is called Earl Haig's British Legion (Poppy Day) Appeal. It has been broadcast regularly for the past eleven years, and is made on behalf of those who served in the war and are now in distressed circumstances.

On Armistice Day.

The Festival of Remembrance in the Royal Albert Hall on Armistice Day (November 11th), which will be broadcast, forms a fitting culmination to the nation's observance of Remembrance Day. It is a means of reunion with old comrades for those who are able to attend, and broadcasting extends the range of that reunion with ex-Service men and others in distant parts of the Empire and all over the country.

Bernard Shaw's Tercentenary.

THE first performance of a new short play by E. M. Barling is to be broadcast from the Birmingham Repertory Theatre Studio on November 15th. It is entitled "Back to G.B.S.," and is highly fantastic in conception. The scene takes place on a terrace adjoining the Memorial Talkiedrome at Malvern in the year A.D. 2156, when the Shaw Tercentenary Celebrations are in progress. Although this will be the first performance of the play, it was published in book form in time for the recent Malvern Festival. In the cast are many names well known to lovers of the Repertory Theatre.

Higher Mathematics at the Post Office.

IT is interesting to note that the Post Office officials were correct in their calculation that the five-millionth licence would be taken out on Saturday last, October 29th. I happen to know that this date was fixed upon some fourteen days beforehand, being based upon a nice balance between the law of averages and the probable reaction of human frailty to the Anti-Pirate campaign.

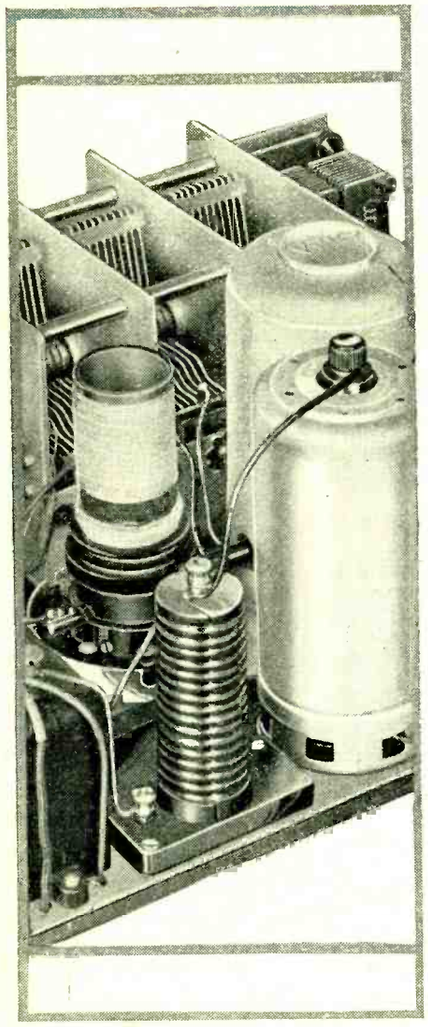
Set Confiscation.

Surprise has been expressed over a recent pirate prosecution in which the set was confiscated. But this step is permitted to the authorities by the Wireless Act of 1904, which, incidentally, allows of a maximum penalty of £100 on indictment, or alternatively, a term of imprisonment with or without hard labour.

A crumb of comfort: on summary conviction the maximum penalty is a fine of £10. Even so, the fun scarcely seems worth it. For half this figure one could stop a train.

The Signal Through the Receiver.

Part V.—The H.F. Intervalve Coupling.



The principal components of an H.F. stage in a typical ganged receiver.

THE previous part of this series ended with the conclusion that the degree of amplification obtained from a screen-grid valve depends upon the slope of the valve and the impedance in its anode circuit. If we want high gain—and who does not?—we must therefore choose a valve of high slope and make the impedance in its anode circuit as high as possible.

It would appear, at first sight, that the impedance of the coupling following the valve could be made as high as we like without difficulty. We might, for example, use a one-megohm resistance, relying on the text-book statement that a suitably constructed resistance has much the same value for high-frequency as for direct currents. We should then get the circuit of Fig. 22 (a). Or we might use a choke in place of the resistance, the advantage of this being that although it could be wound to have an impedance of a megohm or so to the signals its resistance to the direct current drawn from the H.T. battery need only be a few thousand ohms. This circuit is shown in Fig. 22 (b).

It is an unfortunate fact that a trial of either of these circuits will reveal at once that the amplification yielded falls most ludicrously short of the theoretical figure obtained by multiplying the slope of the valve by the resistance of R or the impedance of L. This discrepancy between theory and practice arises because we had forgotten to take into account the stray capacities between the anode of the screen-grid valve and earth—"earth" in this connection, meaning any point on which high-frequency potentials do not appear, irrespective of whether that point is at earth-potential from the point of view of direct current. The most obvious of these capacities is that between the anode of V_1 and its screening-grid; in addition there is the grid-filament capacity of V_2 and the capacity across the terminals of R or L.

Stray Capacities.

It is found in practice that these capacities amount to at least 30 micromicrofarads under working conditions[1]; although this capacity sounds small its impedance at 1,500 kc. (200 metres) is only about 3,500 ohms. This explains matters: however high the impedance of L or R may be made there is always this parallel path of comparatively low resistance, and we cannot by any possibility make the total impedance in the anode circuit of the valve higher than the few thousand ohms which it presents.

Clearly something must be done about this stray capacity before we can get any high degree of amplification from our valve. Some scheme must be evolved by which the effect of the capacity can be nullified. Now since inductance and capacity have exactly opposite properties, it is always possible to neutralise the effects of one by adding a suitable dose of the other. Our particular predicament is that we have a capacity carrying a current the flow of which we want to stop; this can be done by putting in parallel with it an inductance to draw an exactly equal and opposite current. The bare bones of the solution to the problem are shown in Fig. 23, where C represents the capacity we require to neutralise and L the coil with which we neutralise it. As symbolised by the two pairs of arrows, the current through L travels down while that through C travels up, and vice versa. The result is that the two currents neutralise one another, and the net current is reduced to zero. This takes place when the inductance and the capacity both offer the same impedance to the particular current flowing.

But the impedance of a condenser rises, and that of an inductance falls, with decreasing frequency (rising wavelength), so that the balance will have to be re-established every time we pass from one station to another. This could be done by using a variable inductance (variometer) for L of Fig. 23, but as it does not really matter whether it is C or L that is made variable so long as they are always correctly adjusted to one another for the particular wavelength wanted, L is usually fixed while C is an ordinary variable condenser.

We have now developed the circuit of Fig. 24 as a suitable one for a high-frequency amplifying stage. If we imagine a signal applied to the grid of V_1 from the band-pass filter of our set, telephones connected in the anode circuit of the detector-valve V_2 will give no sound if C is wrongly set. Adjusting C we shall find a point, its exact position depending on wavelength, where the capacity exactly balances the inductance of L, so that C and L taken

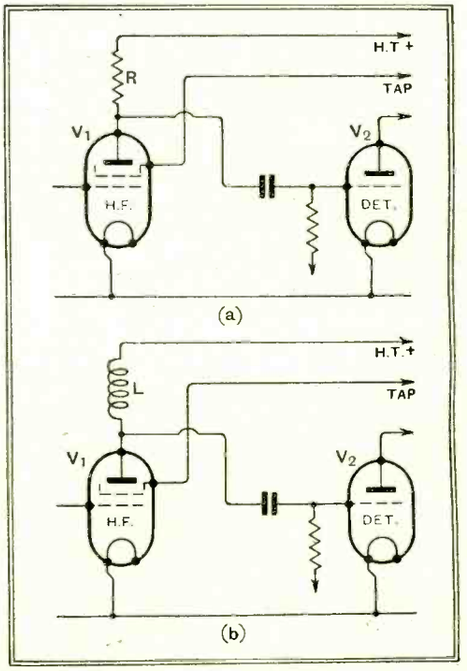


Fig. 22.—Resistance-coupled and choke-coupled H.F. stages, which at first sight appear to fulfil all the conditions necessary for high gain.

[1] "Aperiodic H.F. Amplification," *The Wireless World*, July 2, 1930, p.5.

The Signal Through the Receiver.—

together offer a high impedance to the signal. At this setting, and this setting only, V_1 will give effective amplification, and the signal will be heard.

We have come back, by another route, to the tuned circuit and the need for tuning it, but this time our approach has been such as to show that it offers, when tuned, a high impedance to currents trying to pass through it from valve anode to H.T. positive. We have spoken as though this impedance were infinitely high at the point of tune; it would be, if the coil and condenser had no properties other than those of inductance and capacity. In a practical case both have resistance. The characteristic feature of resistance is that it absorbs power; it cannot therefore be balanced out by anything save a source of power. If this is lacking the two currents can never *exactly* balance, and the greater the resistance present in the arms of the circuit the more marked the resulting unbalance becomes. As a direct consequence of this unbalance, the impedance of the tuned circuit as a whole drops down from the infinitely high value it would have in the absence of resistance, and the final impedance reached is called the dynamic resistance[2]. It is upon the dynamic resistance of the tuned circuit of Fig. 24, combined with the slope of the preceding valve V_1, that amplification depends.

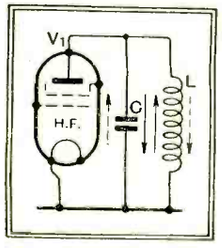


Fig. 23.—To nullify the stray capacities C which prevent Fig. 22 from giving high gain, an inductance L is added. The current through this must exactly neutralise that through C.

In the receiver of Fig. 9 the anode circuit of V_1 is rather more complicated than that shown in Fig. 24, but can nevertheless be derived from it quite simply. It will be remembered that last week the signals were left as an electron current passing from filament of V_1 to anode. The rest of their path back to filament is indicated by arrows in Fig. 25, in which the essential circuit of this part of the set is repeated from Fig. 9.

Dynamic Resistance

The choke L_6 has an inductance high enough to offer an enormous impedance to the signals, so that it serves in effect merely as a route for the direct current drawn from the battery. The feed-condenser C_5 will in most cases have a capacity of 0.0001 mfd.; this seems low, but since its impedance is in series with the A.C. resistance of the valve it will offer no appreciable barrier, in comparison with this, to the passage of the signals. The signal-currents next pass through part of the coil L_7, and so back to filament. It is, of course, in this last section of their path that they do useful work.

[2] For sample figures of dynamic resistance see *The Wireless World*, Sept. 30 and Oct. 14, 1932.

We have seen that the tuned circuit L_7C_7 has a dynamic resistance depending upon its construction. If C_5 were connected directly to the top end of L_7 it is evident that the whole of this dynamic resistance would be included in the signal-path. Such an arrangement is quite usual—it is known as the "tuned-grid circuit"—but it has the drawback that the selectivity obtained is not very high. By moving the connection from C_5 lower down the coil selectivity rises, but amplification drops. The particular compromise between these two that the diagram is intended to represent is that obtained when the feed-condenser C_5 is connected to the centre-point of the coil. At this point the dynamic resistance actually included in the anode circuit of V_1 is only one-quarter that of the whole circuit, but we can set off against this the fact that the coil now acts as a two-to-one transformer, the secondary being the whole coil and the primary the lower half. Assuming that the dynamic resistance of the tuned circuit is unaffected by the movement of the tapping-point, we are left with half the possible amplification of the stage, the other half having been sacrificed in the interests of selectivity. Other tapping points, it will be clear, will give other compromises, so that the position of the tap may be adjusted to taste.

TO those who have only lately joined the ranks of home constructors, the mechanism of the tuned circuit often appears complex. In this article, which forms the fifth of the series, the underlying principles of resonance are described in simple terms. The signal has now been traced through the H.F. stage and in next week's instalment the detector circuit will be discussed.

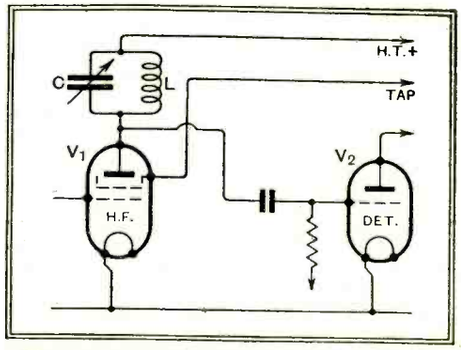


Fig. 24.—The practical form of Fig. 23 as it would be developed for use in a set. This is the tuned anode circuit.

It will have been noticed, perhaps, that stray capacities have been neglected in this discussion. But in the circuit of Fig. 25, which is also that of the set, there is an intentional capacity C_7. The stray capacities now have no other effect than to make a station tune in at a lower setting of C_7 than would have been required in their absence. They therefore do no more than restrict the tuning range, and this matter has already been discussed in connection with the filter.

We have already seen that the dynamic resistance of the tuned circuit C_7L_7 is determined by the resistance of its component coil and condenser, and that this resistance can only be neutralised by a source of power. Such a source is to hand in the detector valve V_2 which, although not specifically intended to do so, will amplify to some extent the high-frequency currents applied to its grid. In the complete circuit of Fig. 9 will be seen the coil L_8 connected, through the reaction condenser C_6, between the anode of this valve and earth, with the result that a certain proportion of the amplified high-frequency currents will flow to earth through this coil. The exact proportion so flowing is controllable by adjustment of C_6, which acts as a variable impedance in the path.

The Detector.

L_8 is coupled to L_7, so that the amplified currents passing through the former induce a voltage in the latter. This means that in effect L_8 behaves towards L_7 as a source of power, the magnitude of which can be adjusted (by C_6) so that the resistance in the tuned circuit can be at least partially nullified. The dynamic resistance of the tuned circuit thus rises as reaction is increased, and with it rises the amplification given by the preceding valve, in whose anode circuit L_7C_7 is effectively connected. In addition, the neutralisation of losses enhances selectivity, which, as we have already seen, is greater the less the losses of the circuit.

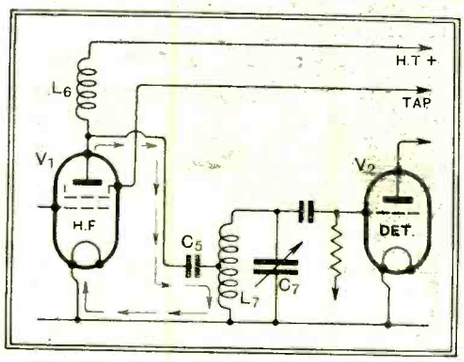


Fig. 25.—A portion of the circuit of the receiver of Fig. 9, the path of the signals round the anode circuit of V_1 being marked out by arrows.

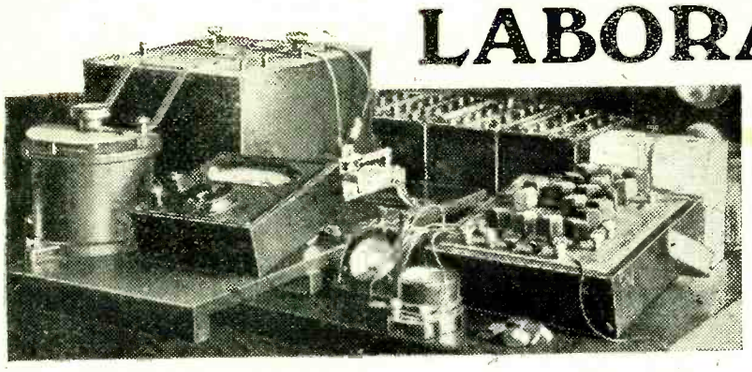
The voltage developed across the tuned circuit is applied, as Fig. 9 shows, between grid and filament of the detector valve V_2. The manner in which this valve deals with the signal will be discussed next week.

Amateur Call Book

The new issue of the list of the Call Signs and addresses of amateur transmitters throughout the world is now published and may be obtained from Mr. F. T. Carter, Flat A, Gleneagle Mansions, Streatham, for 5s. 6d. post free.

The increase in the number of these stations is shown by the fact that this section of the list now occupies 177¾ closely printed pages, as against 140¼ for the corresponding issue last year. The book also contains a useful list of short-wave commercial stations, and those transmitting Press News, Weather and Time Signals.

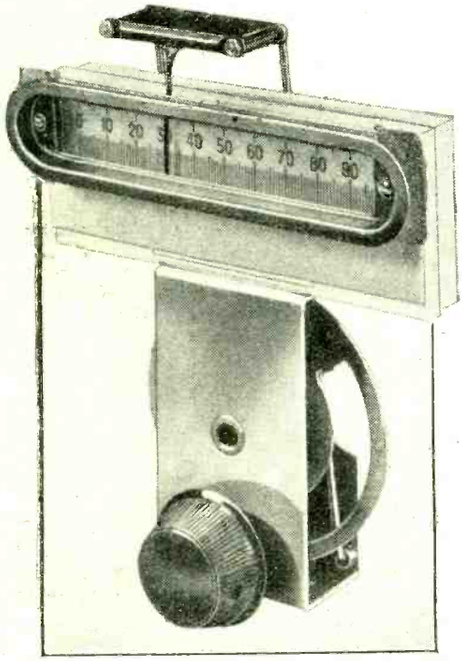
LABORATORY TESTS



NEW RADIO PRODUCTS REVIEWED.

UTILITY HORIZONTAL SCALE.

A NEW tuning scale, described as a Straight Line Full Aperture Dial, is one of the recent additions to the Utility range of components made by Wilkins and Wright, Ltd., Utility Works, Holyhead Road, Birmingham. It consists of a horizontal scale illuminated from the back and traversed by a pointer, which is operated through a $7\frac{1}{2}$ to 1 reduction drive, an eccentric cam-action being employed to maintain the pointer vertical throughout its movement. In the case of the specimen examined, the engraved scale is $4\frac{1}{8}$in. long, but the aperture in the panel should be $5\frac{1}{8} \times \frac{7}{8}$in. to accommodate the special escutcheon plate. This is a very neat affair, fitting flush with the panel, and provided with a glass window, held in position by two end clips, which serve also as the fixing for escutcheon.

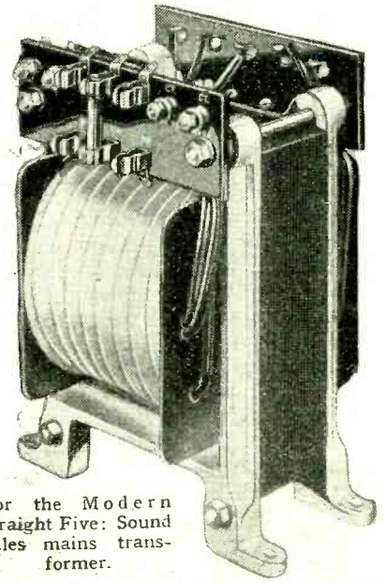


Utility straight line full aperture dial: provision is made for illuminating the scale.

The dial is of robust construction, and will drive a four-gang condenser without slip or backlash, and the price is 7s. 6d.

SOUND SALES SS/VM5 MAINS TRANSFORMER.

A TRANSFORMER for the Modern Straight Five receiver has been sent in for test by Sound Sales, Ltd., of Tremlett Grove, Junction Road, London, N.19. It has secondaries rated for 400-0-400 volts at 120 mA. and 4 volts C.T. at 3.5 amperes to suit a class C rectifier valve used with a thermal delay switch requiring 1 ampere heater current. Windings are also provided with outputs of 4 volts C.T. at 2 amperes for the output stage, and 4 volts C.T. at 6 amperes for a number of indirectly heated



For the Modern Straight Five: Sound Sales mains transformer.

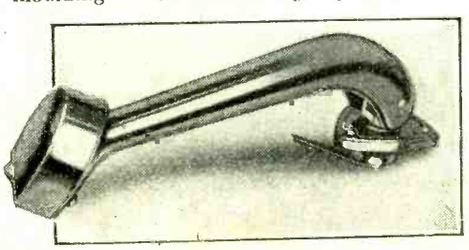
valves. The core is of exceptionally large dimensions, and the primary is electrostatically screened from the secondaries in order to avoid modulation hum.

The primary is tapped for 200, 220, and 240 volts mains, but instead of the usual terminals the desired tapping is selected by inserting a fuse into one of the three sets of clips mounted on the terminal board. This arrangement not only provides a ready means of changing the connections to suit different supplies, but it protects the transformer against an overload.

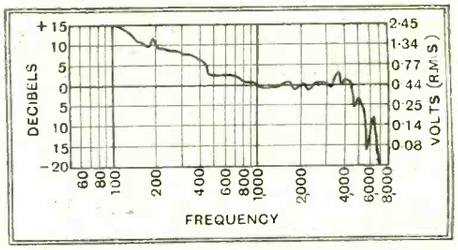
The application of the transformer is, of course, not confined to the Modern Straight Five, for it is suitable for any receiver in which the voltage and current requirements are similar.

BRITISH RADIOPHONE PICK-UP.

THE pick-up head and tone arm in this model are produced as an integral moulding which ensures rigidity and freedom from tone-arm rattles. The head is off-set at the correct angle for accurate needle track alignment, and the arm as a whole hinges vertically to facilitate the needle replacement. The output is substantially level between 500 and 4,500 cycles with a very slight armature resonance



British Radiophone type 351 pick-up and tone arm.



Open-circuit output characteristic of the British Radiophone type 351 pick-up with H.M.V. loud needle.

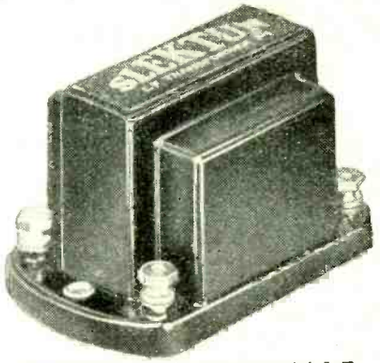
at about 3,600 cycles. Below 500 cycles there is a steady rise of output down to 100 cycles below which accurate readings could be obtained with the special constant frequency records without applying additional pressure to the tone arm.

The unit is made by the British Radiophone, Ltd., Aldwych House, Aldwych, London, W.C.2, and the price is 22s. 6d.

SLEKTUN SUPER TRANSFORMER.

MADE by Slektun Products, Ltd., 21, Douglas Street, Vauxhall Bridge Road, London, S.W.1, the super model L.F. transformer is available in four different ratios, viz., 1:2. 1:3, 1:4 and 1:5 respectively. This component is particularly well made, and is housed in a neat moulded bakelite case with the terminals placed in the most accessible position for wiring.

Tests made with the 1:3 specimen revealed the very satisfactory primary inductance of 52.5 henrys without D.C. flowing, while

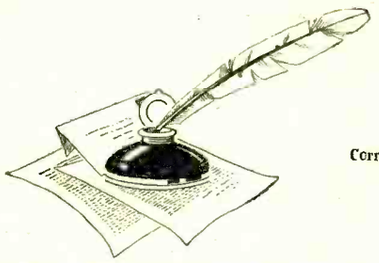


Slektun 1:3 ratio super model L.F. transformer.

some 42.5 henrys were recorded with 1.5 mA of D.C. passing through the primary windings.

When connected in the anode circuit of a valve passing this order of anode current the amplification afforded by the stage using a valve of approximately 10,000 ohms A.C. resistance was sensibly constant from 300 cycles up to 8,000 cycles, the average value being approximately 45 times. At 100 cycles the voltage amplification falls to half this value, but since this represents a reduction of about 6 decibels it will not affect materially the reproduction of the bass.

The performance of this transformer is exceptionally good and well above the average for its class, and the price is 8s. 6d.



Letters to the Editor.

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

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

The "Ether Wave" Organ.

NO doubt many of your readers are interested in thermionic musical devices but how many realise that *Poste Parisien* gives one an opportunity nearly every Sunday night of hearing a recital on the Givelet-Couplex "ether wave" organ, illustrated in "*W.W.*" some months back? I listened to a César Franck and Bach recital on this interesting organ on Sunday last (October 23rd), and was satisfied that it is indeed a musical instrument.

May I express my appreciation of the clear manner in which you display the foreign programmes? The "ether wave" recital is only one of the happy "discoveries" I have made since touring Europe under the guidance of *The Wireless World*.

E. WESTON FURNIVAL.

Watford, Herts.

American Reception.

I WAS interested in Mr. Monkhouse's paragraph in your Correspondence column of the October 21st issue of *The Wireless World*. I hardly think he runs any risk of having epithets, such as he suggests, hurled at him for stating that he is able to receive U.S.A. on a Monodial Super receiving set.

I have a "Wireless World" D.C.3 in an equally unfavourable area, and can receive WABC and WPG any night after 12.30 when the static level is not too high. This is a standard circuit, built on one chassis, using components as specified with the exception of the smoothing condenser, which is electrolytic, and the smoothing choke and L.F. transformer, which are both Thordarson, the fixed resistances and volume control are Centralab Carbon type. I have found that wire-wound resistances give rise to noises which are often taken to be static or mains noises.

Your technical department deserves congratulating on the development of such an efficient three-valve set. I was taking its performance as a matter of course until I read Mr. Monkhouse's letter.

JOHN CRAWLEY.

Westbourne Grove, W.11.

Sparks from Records.

RECENTLY I bought a set of four new gramophone records (H.M.V.), being a symphony of Beethoven, and, whilst playing them through, observed that, on turning each record over, distinct clicks and crackles with sparks flew to my fingers.

Obviously the record was becoming statically charged, but how? I have often rubbed hard and long at gramophone records in the hope of being able to charge up the surface, so tried again on these with a silk cloth and a piece of fur, but could not induce a charge.

I thereupon placed the record on the playing table again, the pick-up in position, and heard a side through again, lifting the record carefully clear at the end. The record was charged heavily, *but* on the *opposite* side to the pick-up.

I now tried the ancient Electrophorus experiment by inverting a tray of metal insulated from the table by a large glass, placed the charged record on top of the tray, touched the under side of the tray to earth it, removed the record, and then applied my finger to the edge of the tray, when a considerable spark jumped across.

Can anyone inform me how the record is becoming charged? The pick-up needle is earthed so that any charge it induces should be immediately earthed. The playing table is earthed, and there was no slip between the record and the velvet on the playing table to give a charge.

Sheffield. J. E. WOOD.

"His Master's Voice" Research Laboratories, to whom the above letter was passed, have kindly communicated the following notes:—

The phenomenon has been well known to us for many years, but we have never examined the matter very seriously. Visible and audible sparks are readily obtained after the playing of a new record on an ordinary gramophone or radiogram.

It seems that a charge is induced on the surface of the record by means of "frictional electricity," "friction" or "intimate contact" by pressure and attrition taking place between the needle tip and the walls of the record groove. It should be remembered that the pressure between needle tip and record groove is of the order of 2 tons per sq. in. after the needle had played one record, so that the necessary "intimate contact" between steel and shellac in order to produce an electric field is easily realised.

The question of exactly why a charge is induced when two different substances are pressed together is one which we believe has never been explained satisfactorily by any physicist, and is rather outside the scope of this letter.

We have found that no obvious charge will accumulate on the record surface if the needle be held in a solid ebonite "sound-box," whereas we have obtained quite lively sparks from a record that has been charged from a needle which has been deliberately earthed. In order to produce a charge on the record it is necessary to have the needle earthed, although the earth connection may be a very poor one, such as conduction across a wooden motor board.

We have noticed that the largest sparks are obtained after the first playing of a record, and the amount of induced charge falls away with subsequent playings. It may be that a minute trail of conducting steel is left upon the groove walls and the induced charge is immediately dissipated.

The Electrophorus experiment described in the fourth paragraph of Mr. Wood's letter makes a very interesting demonstration for a Christmas party, and very large sparks can be produced if the record be rubbed steadily with a piece of fur.

Summer Time—Confusion at Home and Abroad.

SUMMER time ended on October 2nd, and this country reverted to Greenwich time. In this connection a review of the situation may therefore be of interest.

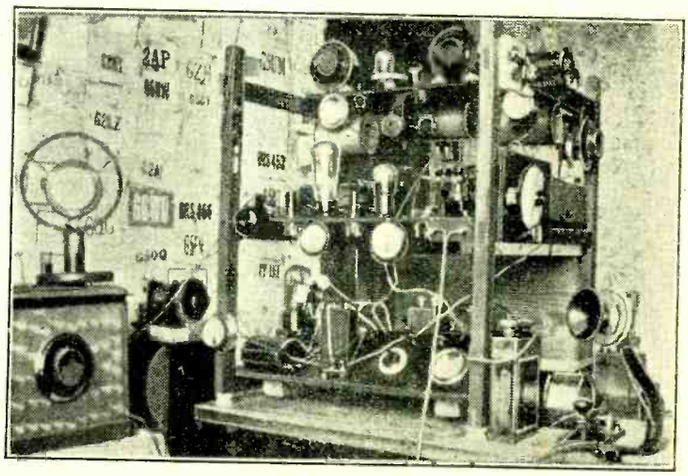
In Europe summer time is in force in Belgium, Finland, France, Greece, Holland, The Irish Free State, Portugal, and Roumania. In France, however, there are great stretches of territory, especially in the Centre, where the clocks remain unchanged, and life is carried on according to the same time-table as in winter. In Albania, Austria, Bulgaria, Czechoslovakia, Denmark, Esthonia, Germany, Hungary, Italy, Latvia, Lithuania, Norway, Poland, Russia, Spain, Sweden, Switzerland, Turkey, Yugoslavia, etc., clock-time is constant throughout the year; in other words, these countries have no "summer time."

With regard to the Western Hemisphere, the chief cities in Eastern Canada adopt daylight saving time, but most towns and rural communities throughout the Dominion observe normal time. The U.S.A. Federal "Summer Time" Law has been repealed; some States have daylight saving time, but its observance is not uniform.

In view of this evident lack of unanimity respecting daylight saving and the apathy displayed by other countries, it may be asked whether it would not be advisable for this country to revert to pre-War time conditions.

G. M. T.

Sydenham, S.E.26.

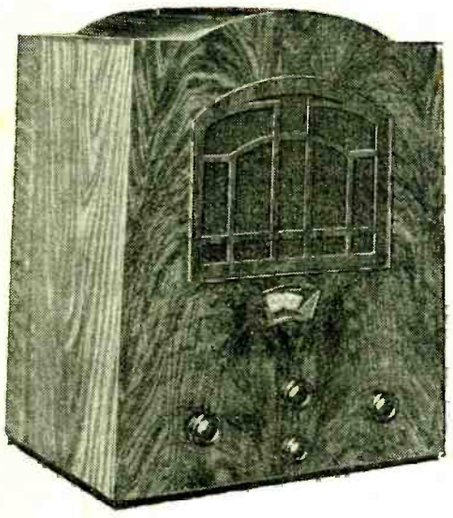


Experimental Transmitter G2YI constructed by Mr. R. C. Horsnell, at The Rosary, Nevendon Road, Wickford, Essex. It is A.C. operated and crystal controlled. The lower stage contains the power supply, while above this is shown the crystal oscillator, power Amplifier with two speech amplifiers and the modulator. The set works on 1859.5, 1907 and 3551 Kc/s. Mr. Horsnell welcomes reports from distant stations, especially on the 1859.5 transmissions.

Dominion Receiver

TYPE S.G.P.3.

A Well-finished Three-valve Set for A.C. Mains.



OF the numerous features commending this receiver to the potential buyer, not the least is the cabinet, which is attractively finished in figured walnut.

A glance at the photograph reproduced above shows that the controls are placed conveniently to the hand, while the illuminated dial, calibrated in wavelengths, is easy to read without being obtrusive. The set as a whole is compact and well-proportioned and is less weighty than the majority of 3-valve A.C. mains receivers of similar specification.

The circuit follows the popular arrangement of a screen-grid H.F. stage followed by a grid detector and a power pentode output valve. The H.T. supply is derived from a full-wave valve rectifier, and the field winding of the moving coil loud speaker is included in the smoothing circuit. All the anode feed and automatic bias circuits are adequately decoupled, and the output from the pentode is compensated to avoid undue shrillness in the quality of reproduction.

An Efficient H.F. Stage.

Single dial tuning has been adopted and the two-gang condenser tunes simultaneously the input and output circuits of the H.F. stage. The ganging is accurate and the complication of a trimming control has consequently been eliminated. The tuned circuits do not include a band-pass filter, but selectivity is achieved by conserving the efficiency of the H.F. coupling circuits. Both the coils and their screening cans are larger than the average and the loading of the detector is reduced by tapping down the tuned secondary of the H.F. transformer. The damping due to the H.F. valve can also be reduced by the volume control which reduces the screen-grid voltage and so increases the valve resistance. Reaction is provided so that the user by intelligent manipulation of the volume and reaction controls can vary the selectivity of the set to suit different conditions. Thus, to increase selectivity, the volume is first reduced by the volume control and then restored by reaction.

The combined selectivity and volume control is placed immediately below the main tuning control in the middle of the panel, the reaction control is on the right and the wave-range switch on the left.

The first impression on switching on the set was one of general liveliness and "punch." In handling some receivers there is always a subconscious effort to squeeze the last ounce of power from the circuit, but in the Dominion set the tendency is rather to tone it down. Far more volume is available than can be used in the average room, and under normal working conditions it will be found that the quality is bright without shrillness and full-bodied without a preponderance of bass. The reproduction of the soprano voice, regarded by many as a crucial test of quality, was unusually good.

The sensitivity and range indicate that the H.F. stage is giving full measure and there is no appreciable difference in this respect between the performance on long and medium waves. In London, upwards of 15 stations on medium waves and 6 or 7 on long waves may be relied upon to give enjoyable programmes. The employment of critical reaction is not essential to the efficient reception of these stations, and normally the only controls used will be the wave-range switch and the main tuning knob.

Selectivity.

Having regard to the fact that band-pass tuning is not employed, the selectivity is remarkably good. On long waves Königswusterhausen can be received in Central London quite clear of Radio Paris and with only the slightest background from Daventry National. With the aerial connected to the most selective tapping (A_3), the London National programme can be confined to a band 20 metres wide and the Regional to 45 metres and four or five distant stations can be received between the wavelengths of local stations without background interference. There was slight breaking through of the local stations at the bottom of the long-wave range, but the interference was confined to only a few degrees and did not prevent the reception of any worth-while station.

The set is well above the average from the point of view of residual mains hum, which is inaudible unless the head is placed immediately in front of the loud-speaker grille.

A feature is made of the fact that the chassis is of all-steel construction, while the components used are all of tried design and good quality.

Sockets are provided at the back of the set for an external loud speaker and also for a gramophone pick-up. The wave-range switch has not been complicated by the addition of contacts for gramophone reproduction, so that the pick-up leads must be detached when not in use. It will be seen from the circuit diagram that the detector valve is biased negatively from the same source as the screen grid valve during the playing of records. Breaking through of broadcasting is avoided by turning the screen grid volume control to the left, and it is worthy of note that this control gives a very good minimum even when the set is used within sight of the Brookmans Park aerials.

H.T. Supply.

Adjustment of the mains transformer primary to the supply voltage is effected by a wander plug fitting into sockets conveniently situated in a small panel between the pentode and power rectifier valves. The range of adjustment is as follows: 200/210, 220/230 and 240/250 volts.

In view of the fact that a class "B" rectifier is included in the specification, there is no fear that any of the valves will be starved of H.T. current. The whole of the current from the rectifier is available for the receiving valves since the loud speaker field winding is in series and not shunt across the rectifier output. Incidentally, the field winding is in the positive H.T. lead, and grid bias for the screen-grid and pentode valves is taken from a common resistance in the negative H.T. lead.

All the valve holders are readily accessible and a special single unit carton has been designed to ensure the safety of the valves in transit.

There can be no doubt that the purchaser of a Dominion S.G.P.3 receiver will get very good value for money from the point of view both of performance and appearance.

FEATURES.

General.—*A three-valve self-contained receiver for A.C. mains Built-in energised moving-coil loud speaker. Ganged single-dial tuning. Provision for gramophone pick-up and external loud speaker.*

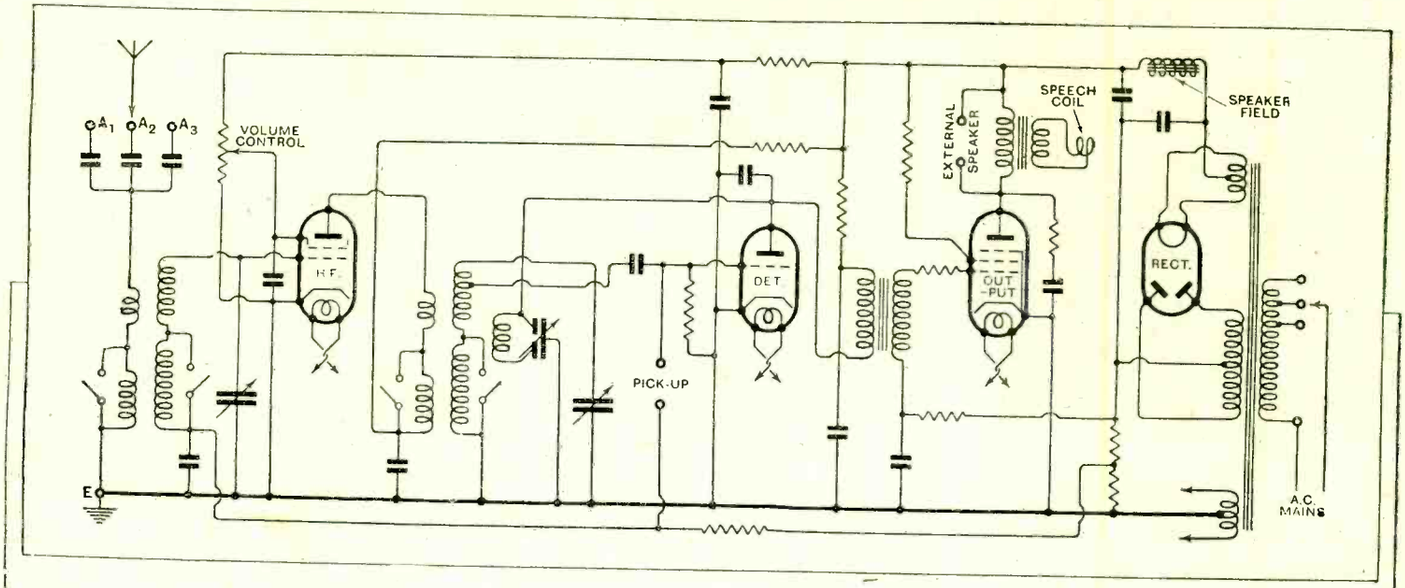
Circuit.—*Screen-grid H.F. stage with tuned transformer coupling and screen-potential volume control. Grid detector with reaction, transformer coupled to compensated power pentode output valve. Full-wave valve rectifier.*

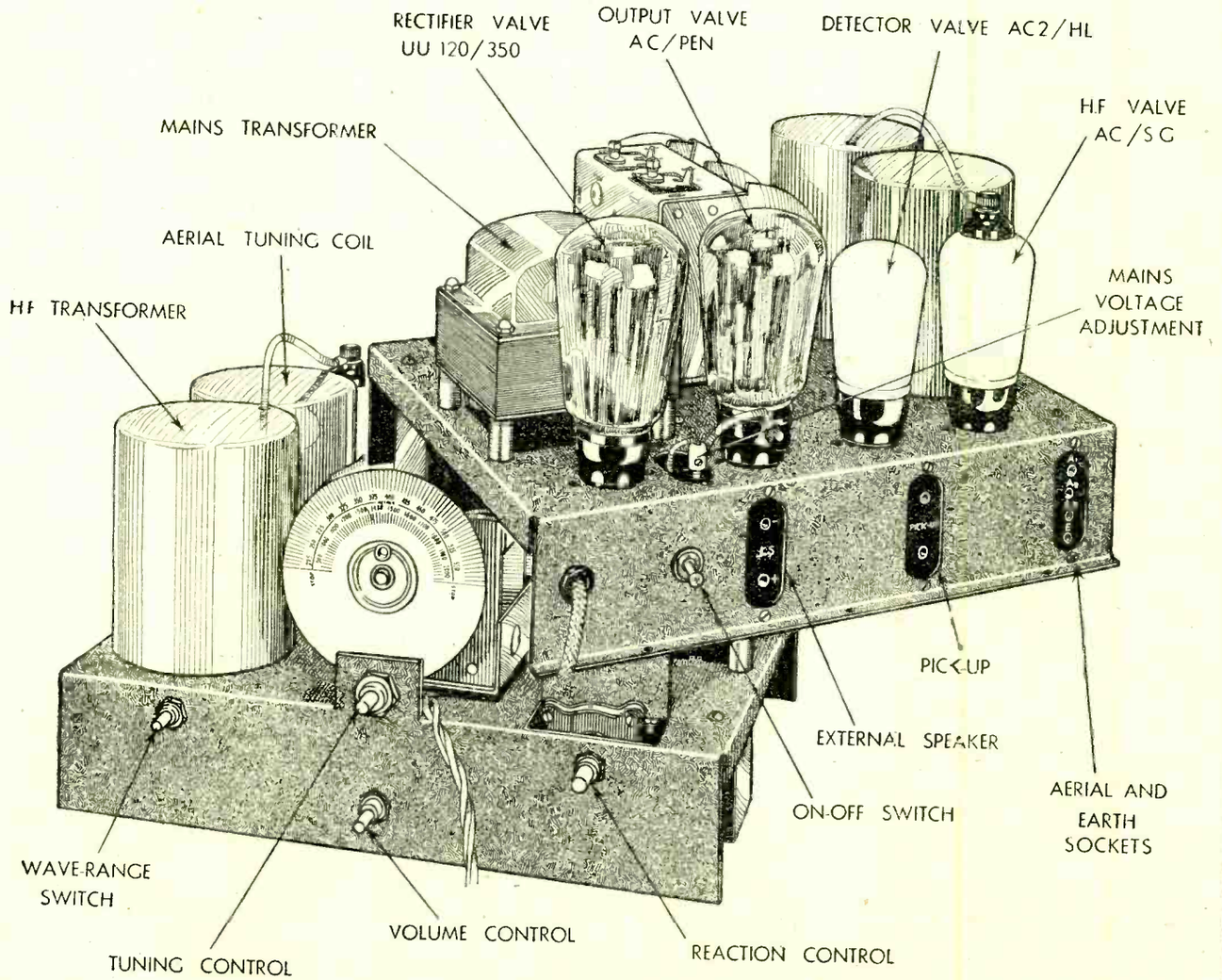
Controls.—*(1) Main tuning (ganged) with illuminated scale calibrated in wavelengths. (2) Volume (and selectivity) control. (3) Reaction. (4) Wave-range switch. (5) Mains on-off switch at back of cabinet.*

Price.—*15 guineas.*

Makers.—*Brownie Wireless Co. (G.B.), Ltd., Nelson Street Works, London, N.W.1.*

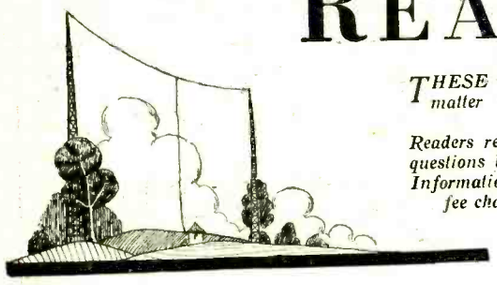
THREE-VALVE SET OF SOUND DESIGN AND CONSTRUCTION.





Circuit diagram and two views showing constructional details of the chassis in the Dominion S.G.P.3. mains receiver.

READERS' PROBLEMS.



THESE columns are reserved for the publication of matter of general interest arising out of problems submitted by our readers.

Readers requiring an individual reply to their technical questions by post are referred to "The Wireless World" Information Bureau, of which brief particulars, with the fee charged, are to be found at the foot of this page.

Tuning Effects Made Visible.

THE widely adopted plan of inserting a current-indicating instrument in series with the detector anode is almost impracticable when diode rectification is employed. As the current flowing in the output circuit of the valve amounts merely to microamperes, an extremely sensitive, and consequently a very expensive, meter would be necessary.

Fortunately for those who like to have some visual indication of what is happening in the preceding tuned circuits and in the detector itself there is a simple and quite permissible little trick which enables us to overcome this disability. As has already been pointed out in these pages, a milliammeter of ordinary sensitivity may be joined in series with the anode of the L.F. valve which immediately succeeds the diode, and the readings of this instrument will serve as a useful index to the functioning of the entire tuning system and of the detector.

A reader who is aware of this plan has applied it to the "Diode Quality Four" (*The Wireless World*, September 30th), and is surprised to find that the meter needle moves in a downward direction when a strong signal is tuned in.

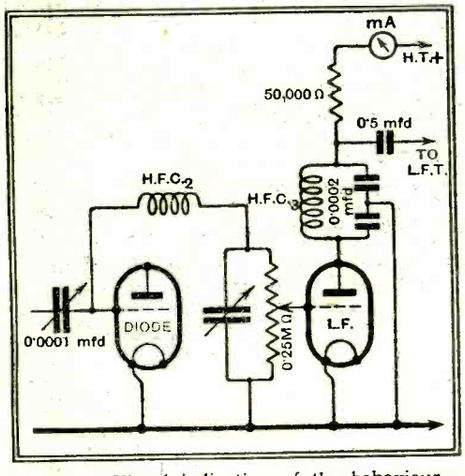


Fig. 1.—Visual indication of the behaviour of both tuning system and detector; a milliammeter added to the "Diode Quality Four."

But surely this is exactly what one would expect it to do. The rectified current from the diode builds up a voltage across the load resistance which is in parallel with the L.F. valve grid circuit, and this voltage is of such polarity that the grid of the valve is made more negative. As a consequence, anode current is reduced. If this were not so, we could not depend on the rectified carrier wave to provide negative bias automatically.

It will now be appreciated that maximum downward deflection of the meter needle is an indication of maximum output from the detector. Thus the instrument will serve as a visual guide to the trimming of the tuned circuits, and generally to the effectiveness of adjustments made to the H.F. section of the receiver.

The appropriate position for the meter is indicated in Fig. 1. As the L.F. valve is unlikely to consume more than 2 milliamperes, a fairly sensitive instrument—say 0 to 5 milliamps—will be most satisfactory.

High-note Response.

IN every receiver a compromise is effected between the requirements of its selectivity and high-note response. Even in an ambitious set like the "Monodial A.C. Super" some such compromise has been necessary, and both constructors and prospective constructors of this set have evinced an interest in the extent to which high notes have been sacrificed in order to attain the exceptionally high standard of selectivity of which this set is capable.

In answer to these queries it may be stated that there is no appreciable attenuation to frequencies up to about 5,000 cycles in the receiver circuits. Even at the high frequency of 6,000 cycles there is still an appreciable response.

This applies when initial adjustments have been done in the manner suggested. One of the attractive features of the set is that, without any great difficulty, it may be adjusted to embrace a wider, or even a narrower, band of modulation frequencies. Adjustments of this nature are mainly effected by choosing an appropriate coupling between the elements of the various band-pass filters, and it is a relatively easy matter to satisfy individual tastes, as well as the requirements of those working under exceptional receiving conditions.

An Impending Apology.

EVER since the broadcasting station at Newcastle-on-Tyne reduced its wavelength to 211.3 metres we have had queries from that part of the world regarding the alteration of existing sets, many of which are incapable of being tuned to so short a wavelength. Another result of the change-over now emerges from our correspondence. A reader who is suffering from the activities of a local oscillator asks us whether it is not a fact that a set which cannot properly be tuned to the wavelength of the local station is more likely to cause interference than one which covers the wave-range adequately. Our correspondent is apparently doing a little amateur detective work, and, knowing that one of his neighbours has a set which cannot be tuned below about 220 metres, thinks it probable that this is the offender.

We are afraid that our querist must abandon this clue. It is quite impossible for a receiver which will not tune below 220 metres to cause heterodyne whistle interference with another set tuned to 211.3 metres. The lowest possible beat frequency would be far beyond the limits of audibility.

Free Bias Simplified.

A CIRCUIT diagram sent by a reader for criticism would seem to indicate that he has not quite grasped the principles of free grid bias. For his benefit, and that of others, a brief explanation of the "cathode lead resistance" system may be given.

This method is applicable only to indirectly heated valves, and in essentials could hardly be simpler. In order to obtain a given bias voltage for a valve, a resistance of suitable ohmic value is inserted in the

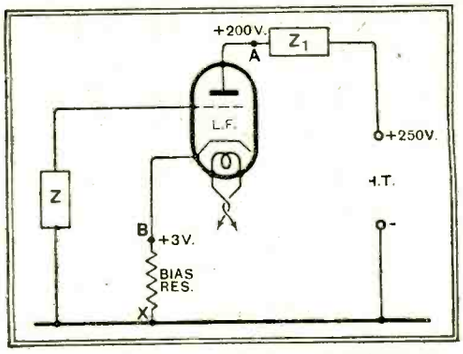


Fig. 2.—Typical distribution of voltage in the anode-cathode circuit of a valve with self-bias. The grid is connected to a point more negative than the cathode, and thus the bias voltage is of correct polarity.

cathode lead of that valve. The current which gives rise to the bias voltage is the anode current of the valve concerned.

This method is represented diagrammatically in Fig. 2. In order to trace the distribution of voltages throughout the valve anode circuit, which comprises the source of H.T. supply, the bias resistor, the valve, and the anode impedance Z_1, a start may be made at the point X, which, being connected to H.T.−, is the most negative point of the valve circuit.

It is assumed that the input H.T. voltage is 250 volts; of this total, 50 volts is dissipated in the anode load (which will probably be an L.F. coupling), 197 volts in the valve, and 3 volts in the bias resistor. The valve cathode is thus 3 volts positive with respect to point X and the earth line, to which the grid, through an impedance Z, is connected. In other words, grid and earth line are at the same potential. As the cathode is positive with respect to the grid, it follows automatically that the grid will be negative with respect to the cathode, which is the desired state of affairs.

The Wireless World

INFORMATION BUREAU.

THE service is intended primarily for readers meeting with difficulties in the construction, adjustment, operation, or maintenance of wireless receivers described in *The Wireless World*, or those of commercial design which from time to time are reviewed in the pages of *The Wireless World*. Every endeavour will be made to deal with queries on all wireless matters, provided that they are of such a nature that they can be dealt with satisfactorily in a letter.

Communications should be addressed to *The Wireless World* Information Bureau, Dorset House, Tudor Street, E.C.4, and must be accompanied by a remittance of 5s. to cover the cost of the service. The enquirer's name and address should be written in block letters at the top of all communications.

The Wireless World

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EDITORIAL COMMENT.

Wavelength Allocations.

Is there an Alternative Scheme?

A CONTRIBUTOR to our correspondence columns in this issue, in discussing the question of quality and station separation, puts forward proposals which, although they may have come up for discussion at international broadcasting conferences, we cannot recollect have been generally discussed. Although, as our correspondent suggests, there are difficulties in the way of the proposals he puts forward, it would seem that they might form a basis when considering a rearrangement of wavelength allocations in Europe should the present difficulties prove insuperable and a new plan become essential. Our correspondent's proposals are that, instead of the various countries of Europe having scattered waves allotted them for individual stations, each country should be given a contiguous band equivalent in kilocycles to the sum of their present wavelength allocations.

There are many advantages which might accrue from such an arrangement, although a reduction in the total of stations might become necessary. Each country would be left to decide for itself how close its stations would be set, and any wandering off the station's wavelength would interfere not with a transmission of a neighbouring country, but with one of their own. If possible, a band of a few kilocycles width might separate each national wavelength allocation so as to guard still further against "international interference."

The attempt has hitherto been made to separate stations of high power as far as possible geographically in the general arrangement, and to divide the best waves fairly. Now, however, that the stations in Europe are so powerful, these considerations of choice of wavelengths and location no longer have the same significance.

Valves.

The Importance of Data.

IT has been the practice of *The Wireless World* for many years past to issue some time during the autumn a special Supplement giving data on current valves of all types. In this issue we again include this feature as a special supplement, but this year in the form of a booklet in place of the folding sheet to which our readers have been accustomed in the past. The booklet is introduced for the reason that it is likely to be found more convenient for reference purposes than the folding sheet. As we have already announced, we have this time decided to omit from the information included in this supplement all valves of obsolete type, including four- and six-volt battery valves, in order to be the first to set an example in the endeavour to reduce the unnecessarily large total from which the user has to choose. We hope that our example will be followed and that valve manufacturers will discontinue listing obsolete valves in their catalogues for general distribution, retaining such valves on the market only for the purpose of replacements to existing sets.

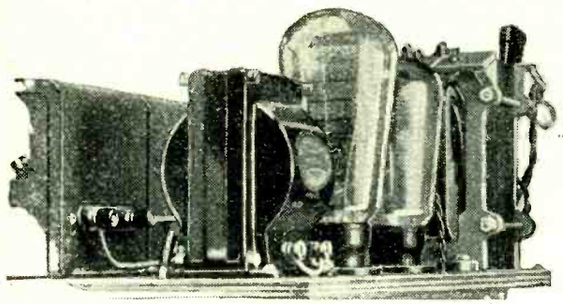
In addition to supplying all the essential data regarding valves necessary to the reader who wishes to choose his types intelligently, a good deal of explanatory matter is included in the supplementary booklet and in the pages in this issue.

We cannot impress too strongly upon readers who may be limited in their technical knowledge the importance of understanding the valve, for, after all, it is the principal component in the modern receiver.

The OUTPUT STAGE.

Choosing the Right Valve.

By A. L. M. SOWERBY, M.Sc.



Mains supply and output stage of "The Modern Straight Five" receiver giving 5 watts speech energy.

FROM the multiplicity of output valves now available, it becomes a matter of some difficulty to make the right choice to suit any particular set of conditions. This article, which discusses the considerations governing the choice of the last valve in a receiver, also gives valuable hints on the matching of pentode and loud speaker—a process which, if not carried out properly, generally leads to distortion and loss of output.

THERE are all sorts of reasons for choosing one particular type of output valve rather than another, but in most cases it will be found that the choice is chiefly governed by the considerations of anode-current supply. A 25-watt valve would be an extremely expensive luxury for the user of dry batteries, while the listener who derives his anode current from the mains would be throwing away his opportunities if he contented himself with an output valve taken from a portable set.

The last sentence suggests that cost is to some extent the ruling factor, so that it becomes interesting to compare the price paid for electricity derived from dry batteries with that paid for current taken from the public supply mains. If direct-current mains are used to supply the anode circuits of the set there is no wastage other than any that may be made necessary by having to reduce the voltage at the actual anodes by the insertion of series resistances. One pays, perhaps, sixpence for each unit of one kilowatt-hour, and even if some of this has to be uselessly dissipated in the way suggested the bill for anode current actually drawn by the set can hardly exceed a shilling per unit.

In using alternating-current mains losses in transformers and rectifying valves have to be faced, but to set against these extra losses we have the fact that we can provide rectified current at the right voltage without needing to make adjustments by inserting series resistances. The power actually drawn by the set may perhaps, in an unfavourable case, cost as much as 1s. 6d. per unit.

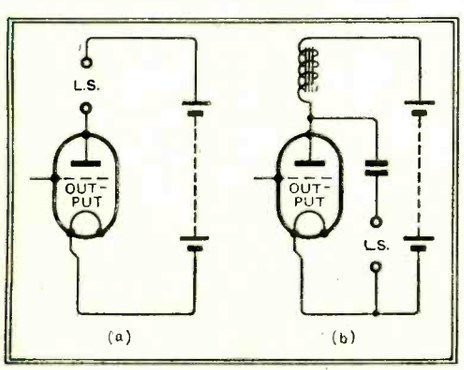


Fig. 1.—For Triodes only.—In both these circuits the loud speaker is effectively connected directly in the anode circuit. (*a*) Is suitable for battery receivers, but (*b*) is safer in mains sets since speech-currents go direct to filament or cathode.

Compare these figures with those for dry batteries. A battery of "standard" size, rated to deliver some 10 milliamps., costs from 10s. to 12s. in the 120-volt size, and may deliver perhaps 150 watt-hours (0.15 of a unit) before its voltage has dropped enough to qualify it for superannuation. The cost per unit in such a case is about £3 10s. Larger batteries, of higher first cost, are naturally more economical—but there is still a very long way to go before the price of mains H.T. is reached.

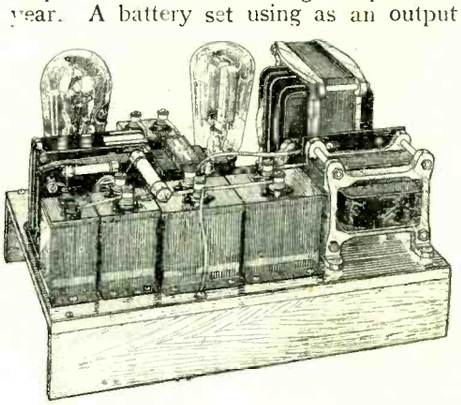
Battery Economy.

For those who do not possess mains, the only alternative to dry batteries is H.T. accumulators. Unless the current to be taken is quite small, these are considerably more economical than dry batteries, but the higher first cost and the need for careful and skilled attention if their life is to be reasonably long has robbed them of much of their former popularity.

Where dry batteries are to be used, the need for economy in current generally limits the listener to a small output valve, drawing perhaps 5 to 10 milliamps. and delivering from 150 to 300 milliwatts of undistorted speech or music to the loud speaker. This amount of power is not adequate for the reproduction of bass notes in their true proportion, so that the highest standard of reproduction is not available. To make the most of such bass as is present in the output, it is often profitable to choose a loud speaker which has a fairly pronounced resonance somewhere in the lower register, bearing in mind, of course, that it is accentuation of bass that is wanted, and not merely an omission of treble. As another suggestion, it might be worth while considering the point of view that with so small an output from the valve the most important point of all is that the speaker should be as sensitive as possible, and that it should be chosen with this primarily in mind.

The largest size of output valve intended for battery, as distinct for mains, operation is really too greedy in anode current for its use in conjunction with dry batteries to be an economical proposition. Such a valve will take, perhaps, 18 to 25 milliamps. at an anode voltage of 150, bringing the total consumption of the set up into the neighbourhood of 30 milliamps. or even more.

The selection of a valve of this class will generally be made when high-tension accumulators, or an eliminator, provide the anode current. If either of these is available there is no advantage whatever in choosing a valve of smaller available output, for accumulators have to be charged every month or so whether they are run down or not. The extra current demanded by the larger valve is, therefore, in practice, no extra expense. Using mains, the extra current does inevitably add to the bill, but to the rather microscopic extent of about eighteenpence a year. A battery set using as an output valve the most powerful that is made with a two-volt filament, and taking anode current from an eliminator offers an extremely good, simple, and economical equipment for use in conjunction with direct-current mains.



Power supply and output valve (250 volts) for the Monodial Super.

With an output valve of this type some care has to be expended in the choice of a speaker, for at the volume represented by the available output falsities in the reproduction are likely to be rather too obtrusive. If D.C. mains are in use the ideal is a big moving-coil speaker with a really generous field-magnet wound for the mains voltage; this will provide a sensitivity so much higher than a less-ambitious speaker that the volume avail-

The Output Stage.—

able becomes equivalent to that given by a more powerful output valve still used in conjunction with a speaker of more modest type. Where H.T. accumulators provide the anode current a permanent magnet moving-coil speaker is suggested as the best, remembering in choosing it that, though higher sensitivity in the speaker costs money, it is cheaper than arranging for more milliwatts from the last valve. When first cost is an important consideration a smaller speaker of either

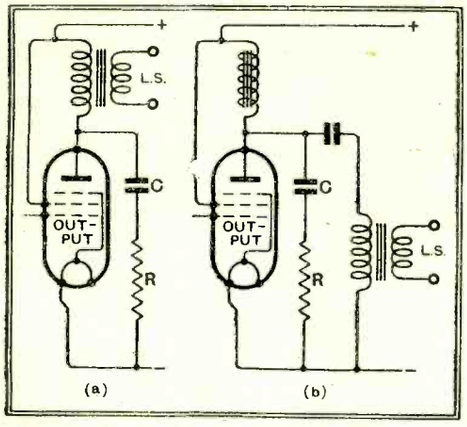


Fig. 2.—Pentode output circuits using step-down transformers, of ratio about 2½ to 1 for average speakers. C may be 0.002 to 0.01 mfd., and R, 10,000 to 50,000 ohms. Circuit (*b*) provides against motor-boating, and relieves the transformer primary of steady current.

kind is to be preferred to one of moving-iron type, though an inductor speaker, which may be regarded as lying between the moving coil and the ordinary moving iron, is sometimes an acceptable compromise.

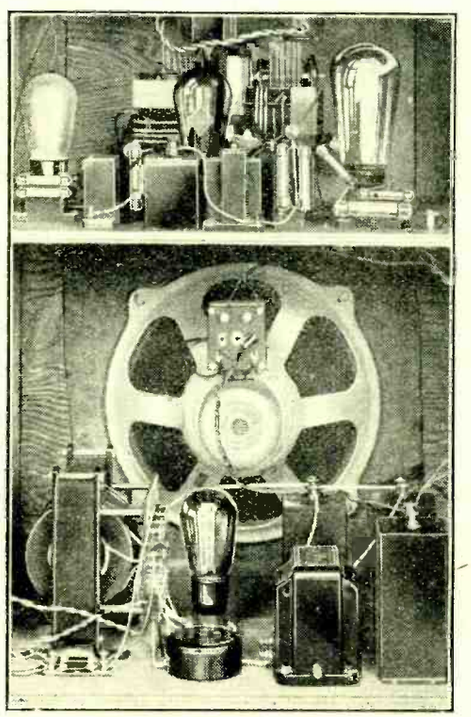
It should not be overlooked that when more than 500 milliwatts are available the lack of free movement in the average cone-type speaker begins to make itself manifest by restricting the bass response, while it must be remembered that a bass resonance can only be accepted as a substitute for true bass when reproduction is on so small a scale that the difference between the two can pass unnoticed.

Triode versus Pentode.

A still more powerful output valve, operating at 200 volts and consuming some 25 to 40 milliamps., is likely to be the smallest that will be accepted by the user of an all-mains set, where the heavy filament current of such a valve, as well as the anode current, comes from the mains. The output is now not likely to fall much below 1,500 milliwatts, which is comfortably sufficient for realistic reproduction in a small room; the average volume-level will be about that of a good mechanical gramophone. A moving-coil speaker is the only type likely to give lasting satisfaction with such an output, and it is suggested that since the mains are already in use an energised speaker is to be preferred as being both more sensitive and, for a given standard of excellence, lower in first cost than one of permanent magnet type. The field may be used either for smoothing or as an output choke, thereby saving a component in the set, and still further reducing first cost.

Those who have a large room in which to listen, or who have intercommunicating rooms so arranged that it is convenient to have the speaker in one room and listen, through an open door, in the next, will be best served by removing the speaker to as great a distance as possible and feeding it with power on the scale associated with public-address equipment. A pair of 400-volt valves, taking some 60 milliamps. each, can be comfortably supplied by a single C-type rectifier which, since there are some volts to spare, may feed the speaker-field as well, this being used either as smoothing or as output choke. If the speaker is very carefully chosen, and is placed at some distance from the listener's ear, the standard of realism attained will be found to surpass that of an ordinary mains set by at least as big a margin as that by which the mains set surpasses a battery-driven receiver. But those who live in quiet districts should remember that an output of 10,000 or more milliwatts will make noise enough to be audible a quarter of a mile away on a calm summer evening, even though it only sounds loud enough to be realistic at the other end of a big room.

So far our discussion has turned largely upon the volume to be expected from output valves of different sizes, and upon the suitability of each for installations of different types. We have left in abeyance the question as to whether the valve chosen should be a triode or a pentode, for the very good reason that there are both triodes and pentodes to be found within the limits of each of the four main



Showing the principal components of *The Wireless World* "Power Radio-Gram," the output stage of which is capable of a high volume level giving realistic reproduction.

classes of output valve we have considered.

The pentode, besides offering slightly greater magnification, has the advantage that in many cases it is capable of delivering more power to the loud speaker than can a triode drawing the same anode current. With mains sets this advantage is not of much account, but for battery sets the high-efficiency pentode, which has nearly double the efficiency of a corresponding triode, is a very attractive valve. It offers some 500 milliwatts of

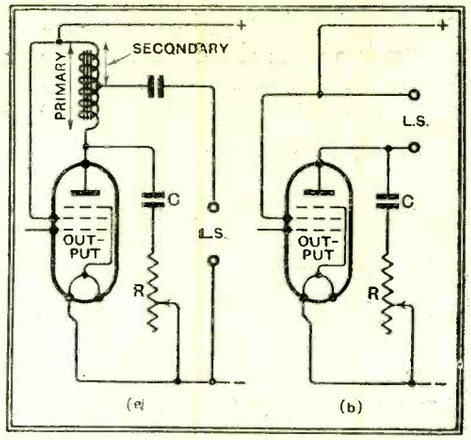


Fig. 3.—Pentode output circuits. (*a*) A centre-tapped choke will do duty as a 2 : 1 step-down transformer. R is here shown variable to act as tone-control. (*b*) For speakers containing a transformer tapped for pentode this is connected to the L.S. terminals shown. CR may or may not still be needed.

output power in return for the modest consumption of 7 milliamps. at 150 volts, or, in a larger valve, 1,000 milliwatts for 19 milliamps. at the same voltage.

As always, there is a fly in the ointment. In this particular case it is due to the fact that it is not always easy to persuade a pentode to pass on its full rated output to the loud speaker, and this difficulty is most marked in the case of the smaller of the two valves mentioned. The difficulty is primarily one of matching; the triode is not at all fussy on this point, but will deliver practically full power without distortion into a load which is half or double that which is strictly correct. With the pentode, on the other hand, the power falls off very rapidly as soon as the correct speaker impedance is departed from. Alternatively, the power remains, but distortion becomes very evident.

With a triode either of the circuits of Fig. 1 will be found perfectly satisfactory, the difference between them being merely that in *a* the steady anode current passes through the speaker and the speech currents through the battery, while at *b* the direct current traverses the choke and the speech currents are returned directly to filament or cathode. The choke-filter circuit will, therefore, be adopted in mains sets, the circuit *a* being reserved for the less ambitious of battery receivers. In either case there is no attempt at special matching, reliance being placed on the makers of the speaker to adjust its impedance to some value that is within

The Output Stage.—
the wide limits permissible with a triode output valve.

With a pentode this casual treatment of the problem is definitely not good enough. Apart from one or two speakers specifically designed to follow a pentode, this simple circuit will lead to a tremendous over-emphasis of treble, combined either with distortion or a disappointingly low output. Correct matching is far more vital with a pentode than with a triode, and, in addition, the impedance of the average speaker is far too low to suit a pentode, which requires a load of 10,000 ohms at least, and, in the case of the low-consumption battery valve, double this figure. The solution to the difficulty lies in the introduction of a transformer between pentode and speaker, as suggested in Figs. 2 and 3, combined with the "impedance-limiting" circuit C R which is effective on the higher notes, where the impedance of the speaker tends to run up to very high values. A little experiment with the ratio of the transformer, and with resistance and capacity values in the impedance limiter, will establish the most satisfactory combination for any individual case. Those who do not wish to go to this trouble, or who do not feel inclined to purchase the extra components, will be well advised to stick to the more easily handled triode.

The modern moving-coil speaker generally has a transformer fitted to it when purchased; the primary terminals of this may be treated as the speaker terminals in the circuits we have mentioned. Where special primary taps are provided for connecting a pentode the step-down transformer suggested as necessary may be omitted, the extra ratio being provided in the speaker's own transformer, but the impedance-limiting circuit will still be useful if reproduction appears shrill.

Correspondence.

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

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

Morse Interference.

WHILST fully in agreement with "G. G.," in that morse on the broadcast band is a nuisance, I would ask him to look back at even 1928, when I feel that he will realise what a colossal improvement has taken place in this respect.

Whereas it is, of course, true that many stations are using obsolete apparatus, everything is being done to minimise interference, and in a short time I am confident that interference from morse will be far more rare than that from several high-power broadcast stations wandering off their allotted frequency!

That much-abused body, the G.P.O., should be praised, not blamed, for its efforts in this direction.

With regard to the radio societies, let "G. G." attempt to form one, and perhaps then he will understand that societies which cannot govern themselves can never hope to advise the G.P.O. on its duties!

RICHARD K. SHEARGOLD.
Radio G6RS.

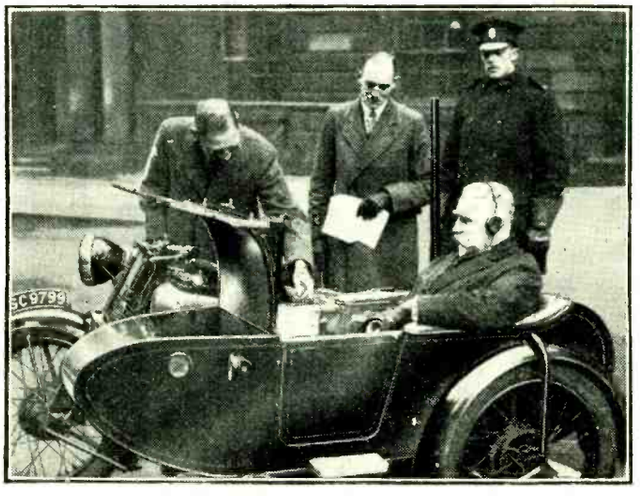
MAY I heartily support the plea put forward by "G. G." that you shall take up the matter of morse interference on the broadcast bands. Having built the "Monodial Super," I am now acquainted with at least a couple of dozen fresh morse transmitters whose existence I had hitherto been ignorant of, while our old friends on the long waves and from 200 to 300 and 450 to 600 are louder than ever. The fine range, quality, and selectivity of this receiver are quite powerless to deal with this nuisance, which, so far from decreasing, seems definitely to be growing.

These are not ship transmissions. For instance, one particularly infuriating source whose point of greatest virulence coincides with the wavelength of Budapest but which charitably embraces at least 100 kCs on either side, has been radiating for the past three years to my own knowledge. If this be a ship, how is it invariably at the same strength, and never apparently in dock except occasionally on Sunday?

In effect, one is compelled to suspect that these transmitters are in the service of the Press itself, or else of interests so powerful as to render them immune from attack. As I write Milan is being accompanied by two distinct morse transmissions plus a peculiar gurgling noise which may be the famous nightingale refreshing itself in an adjoining studio for all I know. Last night I was driven off the Strauss concert from Budapest by the first-mentioned pest, which screeched at intervals so loudly that it might easily have been next door.

If the undeniable influence of *The Wireless World* can stimulate public opinion to move in the matter it will put listeners and the radio industry perpetually in its debt.

Hampstead, London. G. E. B.



FOR SCOTTISH "SPEED COPS."—Chief Constable Ross, of Edinburgh, testing the new motor cycle radio-telephony equipment which Standard Telephones and Cables, Ltd., have constructed for the Edinburgh Traffic Police.

Reception Quality and International Wave-band.

HAVING been a constant reader almost since the inception of your paper, and much interested in the "Quality" discussion of some while back, I should like to bring forward the following, which, as far as I can remember, or find out from present files of the "W. W.," has so far not been mentioned.

One side of the argument demands wider frequency bands, and the other points out the limits due to interference, both sides have reasonable arguments, and both are interdependent to a large extent, despite tone control, etc. Again, the trader points out the demand of the public for the "mellow 'cello" brand of loud speaker output. This can be altered by education, and the education would be quickest if the B.B.C. broadcast notes extending over the whole limit of the frequency spectrum, on the audio side, for if Mr. X suddenly discovered he was missing something, and he'd find that out from the announcement, if made properly, he would very soon go into the matter, as the average man hates to miss anything, especially when he has paid for it, as he does for B.B.C. quality, which he rarely uses or realises is there for his benefit.

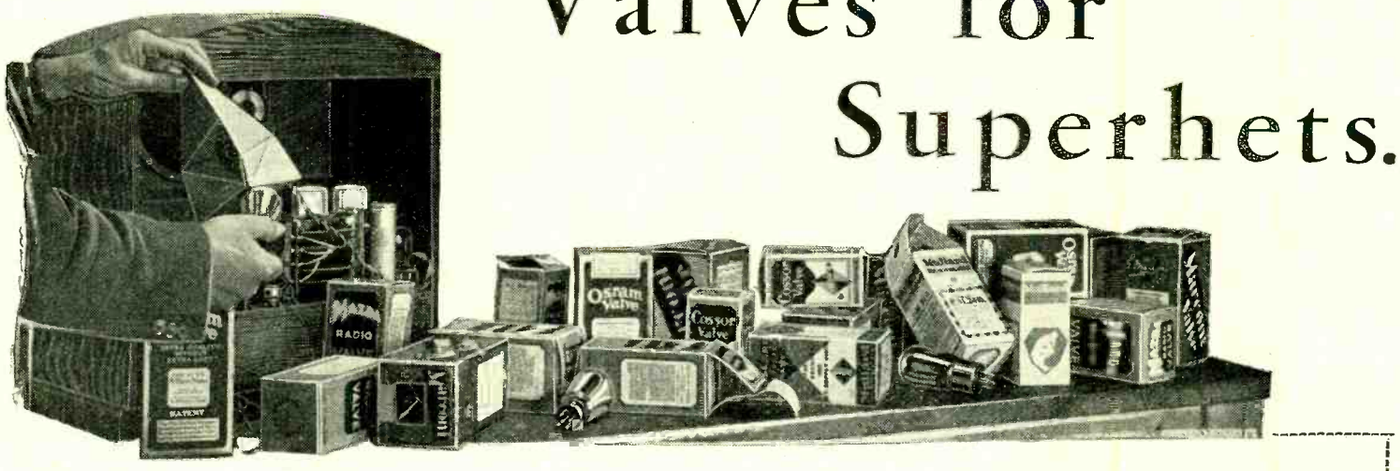
Now the best idea, as I see it, is for each country to be allocated a frequency band of the same width as at present allowed, *but* contiguous. Instead of having one station say, at 1,000 kCs, another at 850 kCs, etc., as at present, each country would be allocated its own complete band, say, of 100 kCs, or, if necessary, more or less as is found possible and desirable. Within those limits each country would then be free to do just as it desires without interfering with another, and as the tendency is for higher power, just a few high-power stations with a 15 kC separation could be operated. Naturally, many sets would suffer by virtue of their selectivity, but that could be easily remedied with no great cost. Again, the listener would be better able to tune in foreign programmes, knowing exactly within what limits he might expect to hear any country's stations, etc., and it is almost certain that each country would take care its quality was as good as possible. Furthermore, many relay stations could be closed down and the resulting frequency bands re-allocated or used to provide a very definite blank space. Many other things will naturally occur to your readers, but I fancy the scheme is not at all impracticable, nor would it necessitate any great change in station equipment, of modern stations, at any rate. British and foreign listeners would, I believe, gain immeasurably from such a change, even if it only resulted in freedom from interference apart from quality considerations.

The objections are fairly obvious, but certainly not insuperable if "all hands" got down to it.

"15 kCs."

At Sea.

Valves for Superhets.



How to Effect a Compromise Between Sensitivity and Stability.

By W. T. COCKING.

THE considerations governing the choice of valves for a straight set are well known. In the case of the superheterodyne, however, so many functions are allotted to the valve that it is a matter of some difficulty to make the right selection. The author, who is well known as the designer of a number of "Wireless World" superheterodynes with many original features, here discusses, among other points, how the different requirements of frequency changing and intermediate frequency amplification can be fulfilled.

THE task of selecting the types of valve for the various stages of a superheterodyne is considerably more difficult than in the case of a straight set, if only because there are a greater number of different functions to be performed. In the straight set one is concerned merely with the straightforward processes of H.F. and L.F. amplification and detection, whereas in the superheterodyne there may be, in addition, the first detector, oscillator, and I.F. amplifier to consider.

The requirements as regards the detector and low-frequency stages are little different from those of any ordinary receiver, and, in fact, those variations which are sometimes found in practice are usually due more to the use of tone correction than to the employment of the superheterodyne principle. It is chiefly the H.F. and I.F. amplifiers, the first detector, and the oscillator with which we are here concerned.

The function of the oscillator is simple; it has merely to provide a high-frequency current of the requisite amplitude and as free as possible from harmonics. A commonly employed frequency-changer circuit is shown in Fig. 1, and many types of valve will perform satisfactorily as the oscillator. In general, however, it is desirable to choose a specimen having an anode A.C. resistance of between 3,000 ohms and 10,000 ohms in the case of indirectly heated valves, and between 6,000 and 20,000 ohms in the case of battery-type valves. The difference is brought about by the lower mutual conductance of the latter type, which renders it inadvisable to employ a very low resistance valve on account of its low amplification factor.

Types represented by the 164v., the M.H.L.4, and the AC/HL, or their D.C. counterparts, are suitable in the mains-operated class; while the P.M.2DX and the HL2 represent the best category of battery valves. The anode potential should normally be moderate and lie between 60 volts and 100 volts, while the negative grid bias should have the value which would be applied if the valve were acting as an amplifier. The anode current, however, will be greater than the rated value for the valve under those operating conditions by an amount depending upon the circuit constants and the D.C. resistance of the anode circuit.

The higher the D.C. circuit resistance, the smaller will be the increase in current due to oscillation, so that it is usually desirable to feed the anode circuit through a high resistance R of Fig. 1. A valve which normally passes an anode current of 5 mA. may easily take 30 mA. when oscillating if the circuit resistance be low, as in the case where the H.T. is taken directly from a tapping on a battery. The insertion of a feed resistance may allow of satisfactory results being obtained with a current of no more than 7 mA.

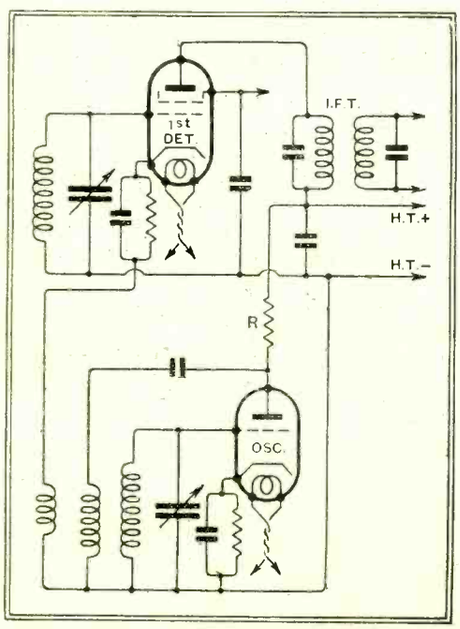


Fig. 1.—The circuit of a typical modern frequency changer showing the oscillator and first detector with mains-type valves.

The first detector acts as an anode-bend rectifier in practically every modern superheterodyne, but its action is not necessarily identical with that of the more familiar type sometimes used to feed the L.F. circuits. Its action is modified by the presence of the local oscillator, and it is linear when correctly operated. A high mutual conductance is desirable for the sake of efficiency, while a high internal A.C. resistance is necessary to avoid damping the tuned I.F. coupling connected in its anode circuit; moreover, the internal grid-anode valve capacity must be low in order to avoid the signal frequency input tuned circuit being heavily damped by anti-phase feed-back. A screen-grid valve is thus obviously necessary.

The First Detector.

When biased to the optimum rectification point, however, the valve must be capable of handling, without any flow of grid current, the maximum input which it is ever likely to receive; grid current might introduce distortion, and would certainly reduce the selectivity of the input circuit. The signal input will often be larger than one might at first expect. Not only will there be potentials due to the local oscillator and to the wanted signal, but when receiving a station on a wavelength close to that of the local there may be several volts due to that local station.

The sum of these various potentials will often be about 5 or 6 volts, and, in

Valves for Superhets.—

consequence, the bias should not be less than this figure. In certain special cases the input voltage may be considerably greater, and the bias must then be correspondingly increased. The valve selected, therefore, must have such characteristics that, with the maximum rated values of anode and screen voltage, it requires a bias of at least 5 volts for optimum rectification efficiency. This limits the choice to fairly low mutual-conductance types, and the M.S.4 and D.S. represent one of the most suitable classes among mains valves. A wider range is available among battery types, and the S.21, S.22, P.M.12, 215S.G., and S.G.215 should all be satisfactory. The use of variable-mu valves is not ruled out, and the possibility of applying a high value of grid bias, although at reduced mutual conductance, is a property which may prove increasingly valuable in the future.

Single-valve frequency changers offer far less scope for individuality in the choice of a valve, and, in the case of the bi-grid type, there is little possibility of variation. The case of the self-neutralised pentode circuit of Fig. 2 is somewhat different, however, but the requirements are rather stringent. The valve must oscillate freely with the appropriate circuits connected between its anode and space charge grid,

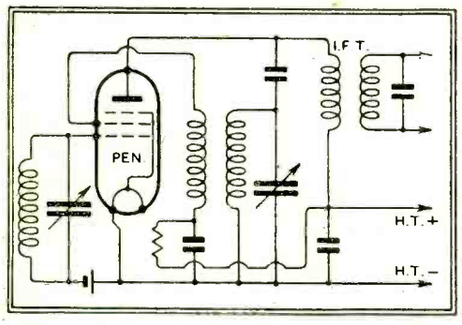


Fig. 2.—The connections of the self-neutralised pentode single-valve frequency changer used in *The Wireless World* Baby Superhets.

it must have approximately equal control grid—anode and space charge grid—anode inter-electrode capacities, it must have a high internal A.C. resistance with the optimum operating potentials, it must function with a sufficiently high negative bias on the control grid to avoid grid current, and it must be silent in operation.

Pentode Frequency Changer.

The majority of these requirements cannot be determined from the usual valve characteristic curves, and at present it is often necessary to rely upon trial and error. Most pentodes are satisfactory as regards their internal resistance, since this becomes high at the low screen potential at which optimum oscillation is secured. The grid bias required is appreciably less than with the usual frequency changer of Fig. 1, because the oscillator voltages are not applied to the control grid, and we have to cater only for the signal potentials. Although all the pentodes available have not been tried with this circuit, a large number have been tested, and only the AC/Pen., the M.P.T.4, and the Pen.220A have been found satisfactory on all counts.

We next come to the question of the H.F. valve, if such be included. The greater the amount of stable amplification which can be secured, the less important is background hiss likely to be, but the greater the risk of overloading the first detector when the set is tuned near the local station. A variable-mu type is essential, otherwise cross-modulation will make the stage worse than useless; in most cases it is better to dispense with it altogether than to use an ordinary screen-grid valve.

Variable-mu valves vary among themselves, however, and those with a low mutual conductance have usually the nearest approach to the desired characteristics. Although rather less amplification may be achieved, therefore, this type is usually desirable in order to obtain the maximum immunity from the evil effects of cross-modulation and modulation rise.

In the I.F. amplifier there is usually no necessity, as regards cross-modulation, for the use of variable-mu valves, but they should normally be employed in order to secure a simple, effective, and distortionless volume control. In this connection it should be pointed out, however, that although the variable-mu valve gives a control of amplification which is greatly superior to that afforded by any screen-grid type, it is not necessarily perfect. It is, in fact, quite possible for there to be serious distortion when it is used with a high bias voltage for reception of the local station. The matter depends largely upon the total amplification of the set, the manner in which this is obtained, and the way in which the bias voltages are graded in the different stages. It is quite possible to obtain a distortionless volume control in almost any set, but the indiscriminate use of the variable-mu valve is not in itself a guarantee of this.

Where two I.F. stages are employed, the valves should definitely have low mutual conductances, otherwise stability may be difficult to achieve. Even with a single stage it is often advisable only to use a high-mutual-conductance type in cases where no preliminary H.F. amplification is fitted. The greater the amount of amplification following the first detector, the more serious is background hiss likely to be, and this places a definite limit to the amount of useful I.F. amplification which can be secured.

The second detector differs in no way from the detector of an ordinary straight set, save that the damping on the input circuit due to anti-phase feed-back is likely to be greater. This is due to the fact that the by-pass condenser C, in Fig. 3, cannot have a higher capacity in a superheterodyne than in a straight set, on account of the necessity for preserving the higher audible frequencies. As a result, the detector load impedance at the intermediate frequency may be fairly high, and, in spite of the high reactance of the valve inter-electrode capacity, a considerable amount of feed-back may occur. The valve chosen, therefore, should have as low a capacity as possible, but, as the effect is only of secondary importance, the valve should be selected chiefly for its other characteristics.

The L.F. and output stages are in no way different from the straight set as regards the choice of valve, and the usual

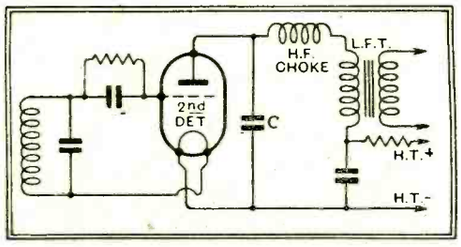


Fig. 3.—Anti-phase feed-back in the second detector is likely to be greater in a superheterodyne than in a straight set on account of the higher reactance of the by-pass condenser C.

considerations fully apply. Where the very best quality is desired, therefore, triodes will be selected for the output stage, and will be used in conjunction with an intermediate L.F. stage designed to give a low gain with a moderate degree of tone correction for any sideband cutting in the I.F. amplifier.

Tone Correction.

In cases where economy is of importance, however, the possibility of using an uncompensated pentode output valve to provide automatic tone correction should not be overlooked. Such a valve may be fed directly, and, with a fully efficient coupling from the detector, and will provide, in most cases, as great a degree of tone correction as many of the special circuit arrangements. The use of a pentode in preference to a triode in a superheterodyne, therefore, leads to a considerable saving, not merely because of the greater sensitivity, but because tone correction can be secured without additional apparatus. A pentode may thus be a true economy, and its substitution for a triode will often give increased brilliance to the reproduction.

The disadvantage of a pentode, of course, is that it is more liable to introduce amplitude distortion than a triode when the circuit conditions are not exactly correct, and careful matching of the valve and loud speaker are essential. The output choke or transformer must have a higher inductance if distortion is to be avoided, and so these components will be of greater cost. Furthermore, the output of a pentode working under even the best conditions is likely to contain a greater percentage of harmonics than that of a triode.

The output stage is always rather a controversial question, but we may fairly say that where the best quality is desired it is advisable to choose triodes. Where the maximum of efficiency or economy is needed, while still retaining high-quality reproduction, a pentode should be used.

Practical HINTS AND TIPS.

AIDS TO BETTER RECEPTION.

WITH the help of the Valve Data booklet which accompanies this issue of *The Wireless World* it is possible to find out all that one is likely to want to know with regard to the D.C. voltage delivered by standard rectifying valves.

Rectifier Output Shown Graphically.

As is well known, this voltage is dependent on the current drawn from the rectifier by the various valves, and it is a matter of some importance that the amateur designer should be able to form a reasonably accurate estimate of the extent to which voltage will rise on light loads, in order that an absorbing resistance of suitable value may be used to cope with it.

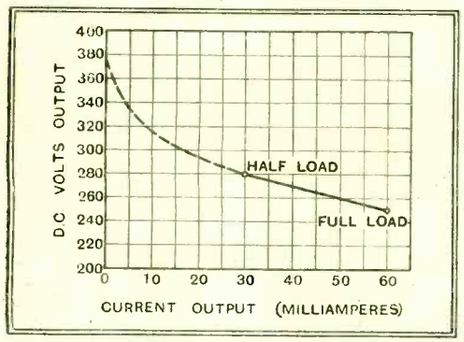


Fig. 1.—Regulation curve of a rectifying valve, prepared from the Valve Data Supplement.

With this object in view data is given concerning the voltage delivered on full load and half load. For intermediate outputs, and for those of less than half the rating, the easiest way of ascertaining the exact voltage that will exist is to prepare a graph; that given in Fig. 1, which represents the behaviour of an imaginary, but nevertheless typical, "A" class rectifier will serve as a guide to those who are unaccustomed to the preparation of curves.

This curve is prepared by plotting the published "full load" and "half load" currents against their corresponding voltages, and joining together these points with a straight line. For outputs of appreciably less than half the rating the curve will no longer be straight, but will follow roughly the form indicated in the diagram by dotted lines.

There is another point with regard to the Valve Data Supplement that may puzzle the beginner; this is the omission, so far as battery heated valves are concerned, of the column which gives the appropriate value of resistor to be employed in self-bias circuits. It should be remembered that this data applies to true self-bias schemes where negative grid voltage is developed only by the flow of anode current of the valve concerned.

The cathodes of indirectly heated valves, and also of certain types of directly heated valves when supplied with L.T. current from separate transformer windings, are entirely isolated from each other, and so this plan becomes possible. But the cathodes of battery-heated valves cannot economically be isolated in this manner, and accordingly a bias resistance must almost inevitably be inserted in such a position that the anode current of all valves, and not merely of the valve to be biased, will pass through it.

IT is a fortunate circumstance that a tuned circuit—in other words, a simple combination of a coil and a condenser—has the property of absorbing energy from another similar circuit in which oscillatory currents are flowing. The necessary condition for absorption is that both circuits be tuned to exactly the same frequency or wavelength; of course, they must be linked or coupled together electrically in a suitable manner.

The Absorption Wavemeter.

It is not too much to say that this absorption principle has become a veritable fairy godmother to the amateur experimenter; applied with care and a little commonsense, it enables him to carry out operations that would otherwise be impossible outside a properly equipped radio laboratory. With its help, for example, the relative efficiency of tuning coils may be estimated, sources of H.F. loss traced and localised, and inductance values matched. Even though true quantitative measurements may not be possible, the results obtained are at least informative and useful.

But if the absorption principle generally can be likened to a fairy godmother, the type of wavemeter which makes use of this principle is certainly the Cinderella of the piece. For some reason absorption wavemeters are generally regarded as of little account and of strictly limited application. Actually, they may be calibrated with sufficient accuracy for most amateur needs, are simpler and cheaper than any other type, and can be used in quite a number of different ways.

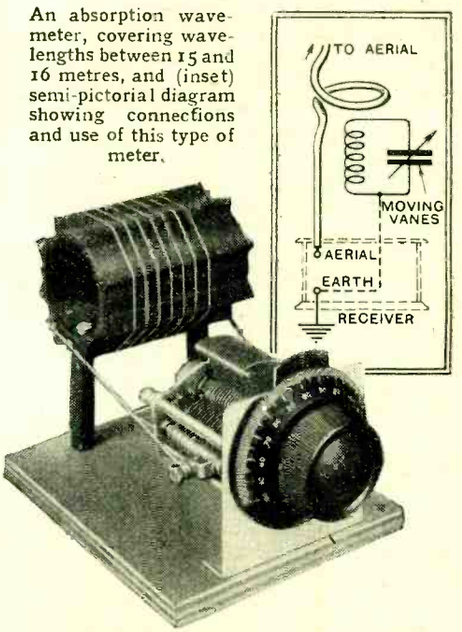
How Wavelength is Measured.

It is often thought that an absorption wavemeter is only usable when it can be placed in direct inductive relationship with one of the coils in the receiver; if this were so, it would certainly be ruled out for use with modern sets fitted with "potted" coils. Another fallacy is that it can only be used to measure the wavelength of valve circuits in a state of self-oscillation, the point of resonance then being indicated by a cessation of the oscillations which takes place as the absorbing circuit is brought into tune.

In actual fact, a clear and well-defined reading may generally be taken when the wavemeter is very loosely coupled to the set, and as a rule sufficient indication of resonance is obtained when the coil of the instrument is placed in proximity to a single-turn loop formed in the aerial lead-in wire of the receiver; this indication takes the form of a decided and definite reduction in signal strength, which occurs when the meter is brought into tune with the wavelength of the incoming oscillations. When dealing with a sensitive set, readings may be taken in the complete absence of signals; in this case an indication of resonance is afforded by a reduction in the intensity of background noises, which are seldom entirely absent.

The operation of calibrating the meter may be carried out with the help of transmissions from stations which are known to adhere strictly to their allotted wavelengths, the corresponding readings of the wavemeter condenser being plotted on squared paper in the usual manner.

A point to be borne in mind is that absorption effects will be most clearly defined when an efficient, and consequently a large, tuning coil is employed in the meter. Again, in order to avoid the disturbing influence of hand-capacity effects, it may be desirable to earth the rotor of the tuning condenser, as indicated by dotted lines in the diagram. When dealing with a battery set the meter will sometimes function satisfactorily when its coil is coupled to a loop formed in the earth lead. In a mains set this lead may be more or less "dead" from the "H.F." point of view, as there will be an alternative path to earth through the supply wires.



An absorption wavemeter, covering wavelengths between 15 and 16 metres, and (inset) semi-pictorial diagram showing connections and use of this type of meter.

The Valve Curve.

A Simple Explanation.

IN discussing the valve curves reproduced in the accompanying figure the best starting-point will be a mental picture of the processes going on within the valve. These start at the filament, which, when heated by the passage through it of the filament current, emits a stream of particles of negative electricity. These are known as electrons, and are distinguished by the property of being attracted towards any positively electrified object and repelled by any that is negatively electrified.

The flight of the electrons after they are ejected from the filament is controlled by the potentials applied to the other electrodes—grid and anode—contained within the valve. The anode is positively electrified by being connected, through the anode-circuit components, with H.T. *plus*, while H.T. *minus* is connected to the filament. The grid, on the other hand, is usually made negative to the extent of a few volts, a small battery or its equivalent being interposed between it and filament for this purpose.

Being negatively charged, the grid will tend to repel electrons back into the filament, even in spite of the fact that the plate is positive. The latter, owing to its greater distance away and to the fact that it has to exert its pull through the meshes of the grid, has much less effect on the movements of the electrons just after they have left the filament than has the grid.

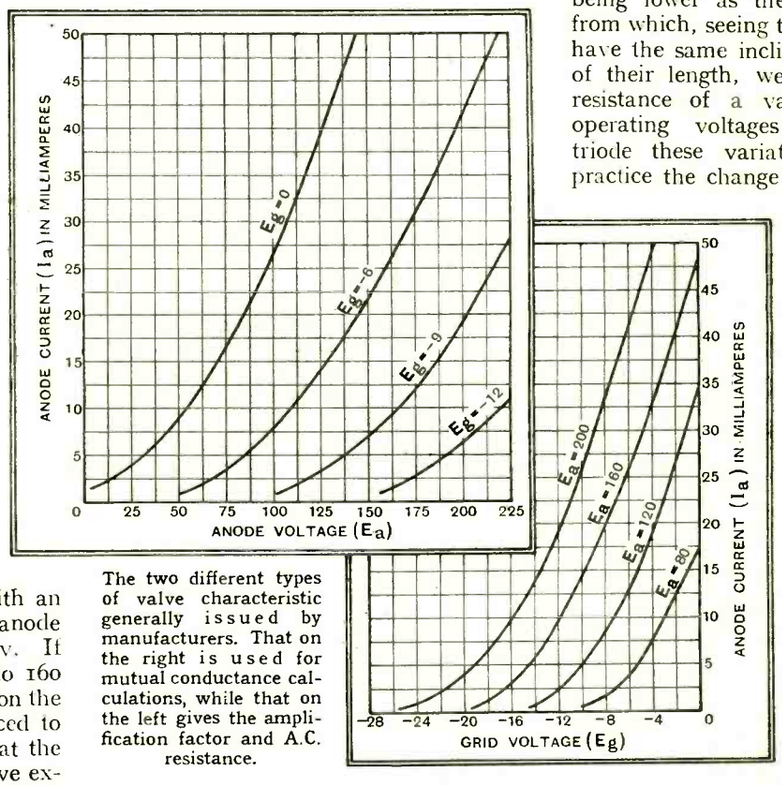
If we compare the curves connecting grid voltage E_g with anode current I_a the greater effect of the grid can be seen quite clearly. With an anode voltage E_a of 200 I_a (the anode current) is 26 mA. when $E_g = -10$ v. If now the anode voltage is reduced to 160 volts, taking us on to the next curve on the diagram, the anode current is reduced to $14\frac{1}{2}$ mA. The reduction in voltage at the anode has reduced, as one might have expected, the number of electrons reaching it in any given time. By making the grid more positive it will repel less firmly the electrons in the space between it and the filament, so that more will pass through its meshes and reach the plate. The anode current can therefore be restored to the original value of $26\frac{1}{2}$ mA. by decreasing the grid bias. Running the eye along the curve for $E_a = 160$ leads to the discovery that the grid voltage corresponding to the anode current we want is -6 volts.

Amplification Factor.

For the particular valve to which these curves refer it is therefore clear that a decrease of 40 volts on the anode can be compensated by making the grid 4 volts less negative. It follows that grid and anode are so constructed and so positioned that a change of 1 volt on the grid has the same effect on the anode current as a change of 10 volts on the anode itself. This ratio, namely 10, is known as the *amplification factor* of the valve, and is usually represented by the Greek letter μ.

How this ratio defines amplification can best be seen by considering the anode-voltage/anode-current curves, each of which refers to the fixed value of E_g marked against it, and gives for that bias the variation of anode current with changing anode voltage.

Suppose, now, we were to insert in series with the anode of the valve some device (e.g., a choke) that would hold the anode current constant, and then swing the grid voltage rapidly up and down—say from 0 to -12 volts. If we began by setting the valve at $E_g = -6$ and $E_a = 150$, the anode current would be 22 mA., as the curve shows. On rapidly swinging the grid voltage between the limits mentioned, the anode voltage would have to change according to the curves if the current could not alter; the whole process would be expressed by a horizontal line at the height 22 mA. in the diagram, and stretching from the curve for $E_g = 0$ to the curve for $E_g = -12$. The anode voltage would therefore swing between the limits 85 and 205 volts, a range of 120 volts. This represents 10 volts per one-volt swing on the grid, so that the experiment has resulted in amplifying the voltage supplied to the grid 10 times—amplifying it, that is, by the figure we have already found for μ.



The two different types of valve characteristic generally issued by manufacturers. That on the right is used for mutual conductance calculations, while that on the left gives the amplification factor and A.C. resistance.

Another important property of the valve can be directly deduced from the anode - current/anode - voltage (I_a/E_a) curves we have been discussing. On the curve for $E_g = -6$, the anode current corresponding to $E_a = 150$ v. is $21\frac{1}{2}$ mA., while that corresponding to 200 v. is $41\frac{1}{2}$ mA. An increase of anode voltage of 50 volts drives an extra 20 milliamps. through the valve. By Ohm's Law its resistance in thousands of ohms must therefore be 50/20, which comes out at 2,500 ohms. This is the *A.C. resistance*, or *impedance*, of the valve, and specifies the resistance the valve offers to a small alternating voltage superimposed on the steady voltage of the H.T. battery. Clearly the numerical value depends on the inclination of the curves, being lower as the curve gets steeper; from which, seeing that none of the curves have the same inclination over the whole of their length, we infer that the A.C. resistance of a valve depends on the operating voltages applied. With a triode these variations are trifling, in practice the change in resistance is small over the regions used in practice, but with other valves, notably screen-grid valves, the variations are much greater.

The third characteristic of the valve, *mutual conductance* or *slope*, symbolised by *g*, is derived from those already discussed. It is shown best by the E_g/I_a curves, from which the term "slope" is derived. Over the straight portions of these a change in grid voltage of one volt induces a change in anode current of about 4 milliamps. (On curve for $E_a = 200$, $I_a = 49\frac{1}{4}$ at $E_g = -4$, and $33\frac{1}{4}$ at $E_g = -8$. Change 16 mA. for 4 v., or 4 mA. per grid volt.)

The mutual conductance can also be found by dividing the amplification factor by the A.C. resistance; in the present case $\mu/R_a = 10/2{,}500$, which is 0.004 amps., or 4 milliamps. per grid volt. This will be seen by remembering that, by Ohm's Law, one volt change on the anode will alter the anode voltage by 1/2,500 amps., or 0.4 milliamps. Since, by the definition of amplification factor, one volt on the grid is equivalent to μ volts on the anode, the change in anode current provoked by altering grid bias by 1 volt is μ times that due to a one-volt change on the anode.

NEWS of the WEEK.

Write First !

THE fifty-one Park Bylaws just revised by the London County Council include the rule that without the consent of the Council in writing, one must not tune in a radio set in a London park.

Royal Visit to Pye.

WE understand that H.R.H. Prince George will pay the first royal visit ever made to a radio factory when, to-morrow afternoon (Saturday), he inspects the works of the Pye Radio Co., Ltd., at Cambridge. The factory employs 1,500 people, and turns out 4,000 complete wireless receivers weekly.

"Compounding a Felony."

THE *Brighton Evening Argus* looks from a new angle at the Post Office policy of giving an unlicensed listener a chance to atone for his offence by buying a licence immediately he is detected. "If this is not compounding a felony," remarks our contemporary, "it must be something very like it."

Amateurs and Presidential Election.

THE distribution of the Presidential election results on Tuesday last, November 8th, gave American radio amateurs a great opportunity. The American Radio Relay League transmitted election returns from its headquarters Station W1MK. Listening watches were organised at the majority of America's 35,000 amateur stations, and it is probable that through the medium of these stations vast numbers of people got the news many hours sooner than would have been possible through the ordinary channels.

TESTING SUPERHETS BY CATHODE RAY. A photograph taken in the Ferranti Works at Hollinwood, Lancs, showing how the intermediate band-pass stage is tested by means of a special cathode ray equipment. An image of the tuning curve seen by the operative enables her to adjust the receiver accordingly.

Current Events in Brief Review.

GS. . . . . .

EIGHT call signs are to be used at the British Empire broadcasting station, Daventry. They will be as follows:—GSA (49.58 metres); GSB (31.54 metres); GSC (31.29 metres); GSD (25.53 metres); GSE (25.28 metres); GSF (19.81 metres); GSG (16.88 metres); GSH (13.97 metres).

Without Comment.

FROM the Correspondence column of a daily newspaper:—

"These gentlemen (the B.B.C. announcers) with their precious accents and undergraduate-man-about-town drawls are, I am sure, responsible for much of the current wave of crime."

Obsolete Sets for Hospitals ?

SHOULD manufacturers send unsold and obsolete sets to the hospitals? This question is being raised in France following an appeal to listeners not to throw away their old sets on purchasing new ones. It is now being hinted that certain manufacturers have destroyed thousands of old-fashioned sets which would have been received with joy by sick listeners.

Competitive Amateurs.

WHAT is perhaps the most ambitious series of amateur transmitting tests organised in Europe has just been commenced by the Radio Society of Great Britain. The first of the series comprised the official tests on the 1,750 k.c. band, which, held on the first two week-ends of this month (November), attracted a wide entry. Then follow the 10-metre contest during the first two week ends of December, and the low power competition for a week in the middle of January. In the latter a maximum plate supply of 100 volts is being specified. After the 80-metre tests in April there will be a National Field Day in June which will be run on distinctly enterprising lines.

All these contests are being run on a definitely scientific basis, while presenting a strong competitive element.

A Difficult Test.

LEADING European amateur transmitters have just participated in an entirely novel form of radio competition.

They were invited to relay among themselves messages of a personal nature—such as station descriptions and so on—in the language of the country in which they originated. Thus a message transmitted by an enthusiast in Madrid could not be changed from its original Spanish, irrespective of the fact that it might be handled by amateurs in Wigan, Brno or Ljubljana. Moreover, the slightest mistake in copying the most jaw-cracking names cost the participant valuable points!

Not for years has there been so much searching among amateur literature for the correct morse characters for Scandinavian A, (Å), the Spanish Ñ, and the French acute accent!

LEIPZIG'S VALVES. Germany's highest-powered broadcasting station uses an interesting assortment of Lorenz valves. Left to right: First stage valve with 3 watts output; 250-watt, 1 kW. and 800-watt valves; the giant 140 kW. valve, of which two are used in the last stage.

Taking Your Set to France.

FOREIGN tourists taking wireless sets to France have been granted an important concession through the efforts of the *Office National du Tourisme*. Hitherto, in addition to registering the sets on disembarkation—a formality which is still necessary—tourists had to declare the apparatus in the Post Office of the commune or city in which they temporarily resided. This last requirement has been dispensed with.

"Ultra Shorts" at the Vatican.

THE Vatican is leading the world in one department of radio development by the installation of the first private ultra short-wave link. This will be in service in the next few days between the Vatican wireless station and the Papal summer residence at Castelgondolfo, twenty miles from Rome.

It is understood that a wavelength in the neighbourhood of half a metre will be used.

"Noble Six Hundred."

ALTHOUGH the Madrid Wireless Conference closes its doors to journalists, information is leaking through which suggests that the prospects for listeners are less black than they were two months ago. M. Braillard, chief of the technical committee of the International Broadcasting Union, is optimistic about the future allocation of wavelengths to broadcasting, but is doubtful whether any considerable improvement can be expected this winter.

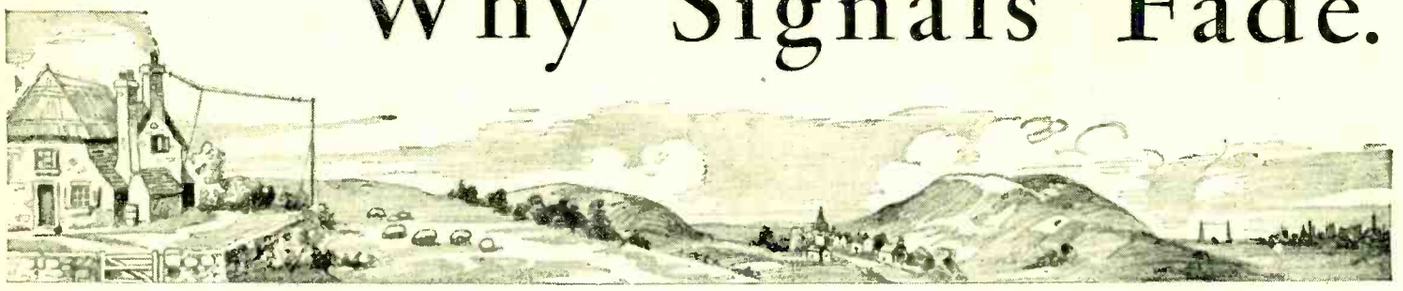
Of the 600 delegates who originally composed the Madrid Conference, 400 still remain, and it is unlikely that the discussions will terminate before the end of this month.

The committees working on wavelength allocation problems are understood to have held ninety meetings, at which technical considerations seem to have been overshadowed by questions concerning economic and legal points of view.

Certain important wavelength decisions may be published within the next day or two.

In the meantime it is cheering to hear that the Nicaraguan Government has just ratified the decisions of the Washington Radio Conference of 1927!

Why Signals Fade.



Part I.—A Simple Account of Ground and Sky Waves.

WITH the advent of winter and dark evenings, long-distance listening is again coming into its own. Sooner or later nearly all listeners discover or rediscover the fascination of this particular branch of broadcast listening. Some tune in foreign stations for æsthetic reasons, some for technical reasons, and some for no reason other than idle curiosity. Year by year the improvement of sets and the acquisition of new and more powerful receivers tend jointly to bring the "distant-listening" public into numbers greater than ever, so that some who have not previously listened much to the Continental stations may now be doing so effectively for the first time. If so, they are doubtless encountering that interesting phenomenon known as fading. While the fact of fading is in these days fairly generally known, it is surprising how frequently it is forgotten that it is due to natural causes—causes which are beyond the control of the broadcasting authority, the set-maker, or the listener himself.

WITH a winter in prospect in which the fascination of long-distance listening is likely to have a greater appeal than ever before, many set owners will be seeking out the causes of fading. This article answers many questions on the behaviour of the reflecting layers in the upper atmosphere, and explains why the short waves are more subject to fading than the long.

For these reasons it is proposed to give in this article a brief and simple outline of the essential facts of radio wave-propagation. A great deal of what is written here is already familiar to many readers, and this outline is intended rather for newer readers or for others who, for any reason, have not troubled to follow the literature of this branch of the subject.

Signal Field Strength.

Before dealing with the general subject, however, it will perhaps be well to consider the method of specifying the strength of a received wireless signal. As explained in a recent issue, this is done in volts-per-metre, or in practice millivolts—or microvolts—per-metre. This conception of expressing the condition of the ether is, of course, quite an old one, and has long been used in expressing the natural electrical potential-gradient of our atmosphere. In this case, of course, the volts-per-metre is a quotation of a steady state or of one varying relatively slowly, and, in this connection, gives us perhaps the closest physical approach that we have in practice to the theoretical definition of potential. In the case of wireless signals the statement of millivolts-per-metre defines the r.m.s. value of the alternating electric force set up in the ether around the receiving aerial. This is, of course, the only absolute value that can be specified, because the strength of signal finally reaching the grid of our input valve will depend jointly on the field-strength, the height and efficiency of the aerial, and the efficiency of the aerial tuning system.

How Wireless Waves Travel.

It is generally known that a wireless aerial radiates its energy in all directions—that is to say, a great deal of it goes upwards as well as going more or less close to the ground from transmitter to receiver. Thus, according to our present knowledge, we can make a simple mental picture of

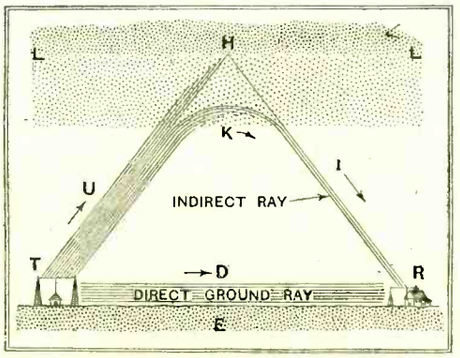


Fig. 1.—Showing the direct and indirect paths taken by the rays from a transmitter.

the process somewhat after the manner of Fig. 1. Here T is the wireless transmitter and R the receiver. The transmitter, as stated above, radiates its energy in every direction, and the energy reaching R may readily be made up of several components. If R is within a certain distance of T, a considerable portion of the signal-energy arriving at R is due to waves which have travelled more or less along the surface of the earth. This ray can conveniently be referred to as the "ground-ray," or "direct-ray," indicated in Fig. 1 as D. At the same time, a ray, U, sent upwards from the transmitter may travel up into the air until it reaches a certain region or layer of the atmosphere which is in the condition known as ionised, an expression the meaning of which we shall consider later. Meantime, however, it may be stated that on reaching this region several things may happen to it.

In certain conditions—for example, those of daylight—the action of the layer may be such that it chiefly absorbs the ray U, which is therefore lost to us for good. In other conditions the ray U, on reaching the ionised region, may be returned towards the earth, either by the gradual bending process shown in Fig. 1 or by the more abrupt reflection process shown at the apex of the triangle. Either process may also be accompanied by a measure of absorption. The net effect of its being returned in this manner is to produce at R an extra ray, which can conveniently be called the downcoming ray, or indirect ray, I, in Fig. 1. A picturesque description of it—primarily American—is "sky-wave." The conditions that cause this ray to be returned to earth are chiefly those of darkness.

The indirect ray is subject to considerable variations, and these variations—which we shall consider later—are the cause of the corresponding variations of audible signal which even the French now describe as "le fading."

Broadcasting Service Area.

Meantime we must consider the direct, or ground ray. The characteristic feature of this ray is its comparative steadiness, both in dark or light, and also from moment to moment. It is thus to the direct ray that we must trust for a steady and reliable broadcast service. It is now some years since Capt. P. P. Eckersley, then Chief Engineer to the B.B.C., suggested the specification of the "service

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area" of broadcast stations, the values which he allotted being as follows:

"A."—Service area with field-strength of 10 millivolts-per-metre, or more, where the listener can be guaranteed a service whatever (within obvious limits) the sources of extraneous interference, but will need a reasonably selective receiver to get distant or weak stations. (The modification implied by "reasonably" is now rather out of date.)

"B."—Service area greater than 5 mV./m., giving crystal reception with a good outdoor aerial, but liable to the worst types of interference which occur in, perhaps, 5 per cent. of cases normally met with. (Again, the 5 per cent. is certainly out of date.)

"C."—Service area greater than 2.5 mV./m., liable to various interferences (with which listeners are already sufficiently familiar).

The specifications are, in the main, quite sound, but modern receiver tendencies, both in sensitivity and in selectivity, have indicated the need for considering a "D" service area with a field-strength of 1 millivolt-per-metre. Additionally, the figures do not have great significance to the ordinary listener, since the B.B.C. have not, to our knowledge, published maps of the measured field-strength values

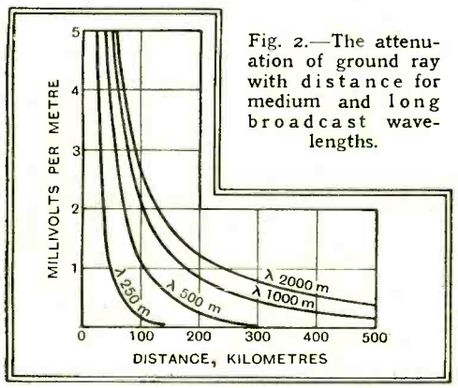

Fig. 2.—The attenuation of ground ray with distance for medium and long broadcast wavelengths.

The curves apply to one kilowatt radiated where the intervening country is pastoral and sparsely wooded.

for their Regional stations. Nor is there reliable information on the field-strength of adjacent wavelength stations, which may, in the dark hours, reach quite high values.

Attenuation of Long and Short Waves.

Some further features of the ground ray, however, must be considered in relation to the general matter of signal strength. One is the fact that, although the ground ray is of relatively steady value at one place, its absolute value falls off rather rapidly with distance. Additionally, the rate of its falling off is a very definite function of wavelength, being much more rapid for short than for long waves. Moreover, the rate of falling off depends also on the nature of the "ground" intervening between transmitter and receiver, being more rapid over land than over sea, and over certain types of ground than over others. The action of the terrain is due to its effective resistance, and approximate "orders of merit" for different types of terrain are as follows:—

(1) Sea water.
(2) Flat marshy ground.
(3) Pastoral country, sparsely wooded.
(4) Wooded flat country, or hilly country.
(5) Forest or mountainous country, or wooded hilly country.
(6) Very broken, mountainous country, thickly covered with forests.

Besides these large-scale considerations, more local factors have also an influence. Thus large cities have been proved to show a marked absorption of the energy of the ground ray, thus causing a diminution of its strength on the far side of the city. Even residential suburbs with many aerials tuned to one wavelength have been shown to add a marked loss of strength, which was found to be most pronounced round about the particular wavelength. Lastly, local topography is not without its influence also, the low signal-strength received in Cornwall having been shown to be largely due to a hill (ridiculously named Brown Willy) which lies in the path between 5XX and the greater part of the Duchy.

The great difference between long and short waves—for example, as between the 1,000-2,000-metre band and the medium-wave (200-550 metre) broadcast band—is a matter of considerable importance in the international allocation of wavelengths for broadcasting purposes. The differences are well shown up in the curves of Fig. 2, which gives the field-strength at various distances for four different wavelengths, radiated at a power of 1 kilowatt from a transmitting aerial. The intervening country is assumed to be of the average character assigned No. 3 in the above order of merit. The rapid increase of attenuation (or reduction of strength) with increasing distance is seen to be very much greater for short waves; for example, with the aerial power quoted, at 100 km. distance the 2,000-metre wave is about ten times as strong as the 250-metre wave, and will therefore give a much better service area. The curves of Fig. 2 show very clearly how 5XX has come to be the backbone of British broadcasting.

The conclusions which may be drawn from a family of such "attenuation curves" is that a 200-metre wave is as good over sea as a 2,000-metre wave is over land. It is for this reason that considerable agitation—overt and covert—is now going on in broadcast circles to get ship traffic moved down to 200 metres so as to give more room for broadcast services in the region between the present medium- and long-wave bands.

The Ionised Region.

We can turn now to consider the whole story of what happens at the region L in Fig. 1. Quite early in the history of wireless it was found that signals were being received at distances much greater than were to be expected from the then known conditions of propagation of the ground ray. More or less simultaneously it was suggested by the English mathematician, Oliver Heaviside, and by the American, Prof. Kennelly, that this was due to energy being returned to the earth from a region of the atmosphere which was "ionised,"

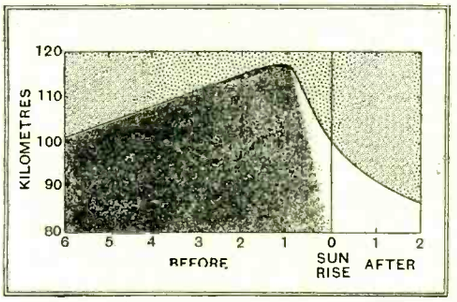

Fig. 3.—How the light of the lower ionised layer varies during darkness.

or electrically active. The word ionised is used to mean that, by some action, separation has occurred between the electrical charges of atoms, so that electrons have been freed and small carriers of electricity are moving about comparatively freely.

For many years after the Kennelly-Heaviside suggestion scientists were divided in their belief of the existence of such an ionised region, until Prof. E. V. Appleton, working in conjunction with the Radio Research Board, proved conclusively that its existence was beyond dispute. The proof involved experiments which first showed that signals were reaching R (of Fig. 1) by a path other than the ground ray; next that these extra signals were coming from aloft, after the manner of the indirect ray I; and, lastly, that the angle at which I was inclined to the earth could be measured. Experiments also showed that the layer was effective at a height of about 100 km. (60 miles), so far as concerns its activity in returning waves of the medium broadcast band, and rather lower—e.g., 70 to 80 km.—in its effect on longer waves.

Two Layers.

Later, Prof. Appleton showed that there was still another region, at a height of about 230 kilometres (145 miles), and that upon occasion broadcast waves might penetrate the lower region and reach this greater height before meeting enough ionisation to return them to earth. At the same time, it was also shown that still shorter waves—say, below 100 metres—were mostly returned from this region rather than from the 100 km. region.

The exact mechanism by which the ionisation is produced is still not too clear, and is not a matter of concern here. It is beyond doubt, however, that it is due to the effect of the sun, but it is still less clear how the two different regions are formed. The present state of our knowledge suggests that the lower layer is due to heavier ions and the upper layer to

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lighter carriers, effectively pure electrons.

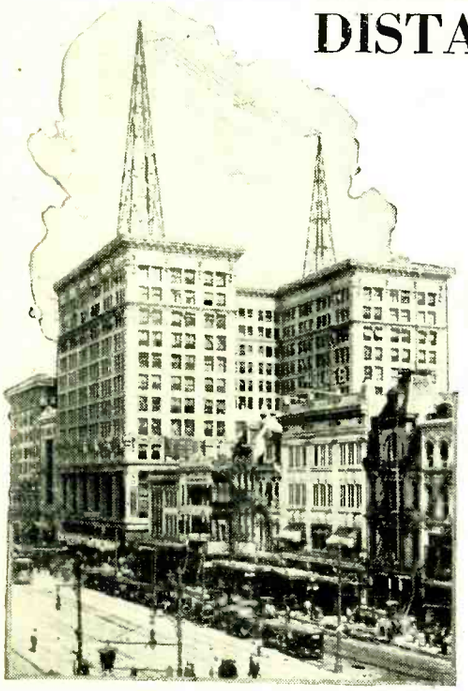
The general picture is therefore that during daylight the sun's influence produces ionisation and free electric carriers at heights in the atmosphere which may be as low as 50 to 60 kilometres. The amount of energy absorbed from electric waves depends on the pressure of the atmosphere (which is, at this height, still fairly considerable), and is greater when the electrons exist in a region of lighter pressure. The absorption effect depends also on the frequency, being greater for the higher frequencies. Thus in day-time the ionisation occurs at a region of such high pressure that absorption and non-return of the waves is the predominating factor and the indirect ray is, in general, negligible. After dark, when the sunlight's ionising effect is withdrawn, the electrons in the lower levels re-combine with positive ions and become inactive.

At higher levels, on account of the greater scarcity of molecules with which to re-combine, the rate of their re-combination is slow, so that it is readily possible for electrons to exist throughout the dark hours in numbers sufficient to give the required bending effect. The process, however, occurs higher up in the atmosphere, and as re-combination proceeds throughout the night it gradually rises higher. The curve of Fig. 3 shows the typical manner in which the height for returning waves of the (medium) broadcast band increases during the dark hours, reaching a height of between 110 and 120 kilometres. Sunrise very rapidly restores the lower absorbing layer, as shown in Fig. 3, while actually the layer comes under the influence of the sunlight before the sunrise effect reaches the ground. This is also clear from Fig. 3.

In the conditions of dark, therefore, the absorption effect mentioned above disappears, and the layer, at about 100 km. in height, exists at an atmospheric pressure which permits movement of the ions under the influence of the ray sent upwards from the transmitter. The electric charges are thus set oscillating and effectively become like a wireless aerial, re-radiating energy which is returned towards the earth as the down-coming ray. Thus the indirect ray which has been absent in daylight comes into prominence and is capable of producing signals at places much beyond the range of the direct ray.

(To be concluded.)

DISTANT RECEPTION NOTES.



RADIO DOMINATES this street in New Orleans, where Broadcasting station WSMB is situated. The wavelength is 227 metres and the Power ½ kW.

ANY reader who wants to test out the selectivity of a receiving set has a splendid opportunity for so doing now. Between 322 and 331.5 metres there are four stations, Gothenburg, Breslau, the Poste Parisien, and Milan, which occupy successive channels. Of these Milan is now rated at 60 kilowatts, though it does not yet appear to be using the full amount; both Breslau and the Poste Parisien have the same output and definitely *are* making use of it; Gothenburg, though rated at only 10 kilowatts, is at present one of the most strongly received of European stations. Since the separation between any pair of these stations is only 9 kilocycles, a very selective receiving set is required to receive each or any of them clear of interference. The most stringent test at the moment is that provided by Breslau owing to the great field strength of its neighbours upon either hand.

The Variable-Mu Valve.

This group of four stations enabled some particularly interesting comparative tests to be made between ordinary screen-grid and variable-Mu valves as high-frequency amplifiers. One of the benefits conferred by the variable-Mu valve is that it effects a considerable reduction in cross-modulation defects. If reception of Breslau is attempted first with "fixed-Mu" screen-grids, and then with multi-Mus, the difference may be found to be quite surprising. One very effective way of making full use of the multi-Mu's variable properties occurs in any set which has reaction arrangements. A very high degree of selectivity can generally be reached by increasing the grid bias until interference from an unwanted station disappears. This may, of course, have the effect of reducing the volume from the wanted station to something very small, but it can be worked up again by the use of the reaction control.

Readers have no doubt taken note of the wavelength change that has been made between Frankfurt and Leipzig. Frankfurt is now transmitting with 17 kilowatts on 259 metres, and Leipzig will presently work up to 150 kilowatts on 390 metres. When at full strength Leipzig will be the most powerful station in Europe, its nearest rivals being Warsaw and Prague, each with 120 kilowatts. Frankfurt is too near London's wavelength to be well received, except possibly by owners of very selective sets who live at some little distance from Brookmans Park. Leipzig, though, is already very well heard, and the station should shortly provide a reliable service all over this country both in daylight and after dark. Mention has already been made of the excellent reception obtainable from Gothenburg. Another station which demands special notice is Lyons Doua on 465.8 metres. This station is now to be received on most evenings, and frequently comes in at full loud-speaker strength. Though Munich is officially credited with 60 kilowatts, the station cannot yet be using more than a fraction of this power as a general rule. Within a short time Munich should vie with Budapest for the honour of being the best received station near the top of the medium waveband.

The medium-wave stations now providing first-class reception make a very lengthy list. Working upwards from the bottom of the band some fine transmissions are to be found below the neighbourhood of the London National. The pick of these are Budapest No. 2, Fécamp, Nurnberg, and Trieste. Above the London National come Turin, Heilsberg, Bratislava, Hilversum, and Bordeau Lafayette. The last-named station has for some little time been receivable at full loud-speaker strength and with good quality on any evening. The group of stations between 322 and 331.5 metres has already been referred to. Immediately above them Brussels No. 2, Brno, and Strasbourg are the best. In the remaining part of the waveband excellent transmissions are provided by Toulouse, Leipzig, Katowice, Stockholm, Langenberg, Prague, Florence, Brussels No. 1, and Budapest.

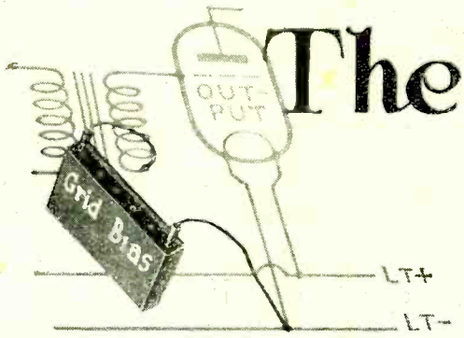
D. EXER.

NEW BOOKS.

Admiralty Handbook of Wireless Telegraphy, 1931.—A standard work prepared at H.M. Signal School and superseding the previous Handbook dated 1925. Containing practical information on Electricity and Magnetism as applicable to Wireless Telegraphy. Transmissions by spark, arc and valve; reception, radio telephony, direction-finding, etc., with appendices on the elementary principles of W/T mathematics, mechanics, physical and mathematical tables, etc. Pp. 1012+viii, with 567 diagrams and illustrations. Published by H.M. Stationery Office, 1932, price 7s. 6d. net.

Motion Pictures with the Baby Ciné, by Harold B. Abbott, 3rd Edition, revised and enlarged, with a new chapter on Negative-Positive and Direct Reversal processing. The book, although primarily intended for users of the 9.5 mm. Ciné camera (as the Baby Ciné is now called), contains a mass of information applicable to other apparatus. This edition has been brought thoroughly up to date, all important new apparatus is dealt with, and all obsolescent matter expunged. The taking of the picture, developing and finishing of the film, and the final stage of projecting, are all described in a clear and interesting manner. Pp. 144+xvi, with numerous illustrations. Issued by *The Amateur Photographer*, and published by Iliffe & Sons Ltd., London, price 2s. 6d.

Newnes Complete Wireless in about 24 weekly parts, containing articles by well-known writers on the theory, design, construction, and upkeep of wireless sets. Edited by E. Molloy and Ralph Stranger. Part I includes the first article on "Wireless Theory Made Plain," Mains Transformer Construction, A Screen-grid Pentode Two, Modernising Old-Style Wireless Sets, Simplified Testing of Wireless Components, A Double-Cone Transportable Receiver, Batteries and Accumulators, and Useful Hints on Servicing and Overhauling Some of the "Ekco" Receivers. Each part comprises about 60 pages, with many illustrations and diagrams. Published by George Newnes, Ltd., London. Price 1s. each part.



The Reason for Grid Bias

By W. I. G. PAGE, B.Sc.

The Dangers of Neglecting the Grid Battery.

THAT grid bias *is* necessary few people will dispute; and few people will question the statement that more valves are ruined and more unnecessary distortion is endured every day by the omission to renew old bias batteries than from any other cause. And yet, if a great national examination were held, how many of the five million licensed listeners could explain what grid bias happens to be, and why no one can afford to neglect it?

Without embarking on a theoretical treatise on valve theory, we may find it necessary to discuss for a moment just how the grid fulfils its function in co-operation with plate and filament. To put it very baldly, the grid acts as a tap, checking or accelerating the flow of electrons from the hot filament to the plate. When the grid is negative it repels electrons, and when positive it attracts them, causing grid current (which is undesirable) to flow through the external grid-filament circuit.

But this, unfortunately, is not the whole truth.

When a filament is heated to a sufficiently high temperature the electron emission rather resembles steam from a pan of boiling water. The electrons are shot off in an irregular way, some having a high enough initial velocity to overcome the repulsion of a slightly negative grid. Thus it happens that grid current can flow in certain valves when the grid is negative by as much as one volt.

Avoid Grid Current.

With battery valves there is not likely to be a flow of grid current unless the grid is actually made positive with respect to the filament. Taking a 6-volt valve—such as the P.625—as an example, it will be realised that if the grid is returned to the negative end of the filament it is at a potential which is 6 volts negative with respect to the positive end of the filament, and only a small portion of the negative end of the filament will tend to produce grid current. On the other hand, in an indirectly heated mains valve in which the electron emitter (the cathode) does not actually pass the heating current, there is no potential difference, and the whole surface of the emitter contributes towards grid current, which will certainly flow with a slightly negative grid.

Considerable space has been devoted to a simple explanation of grid current, and the reader may rightly ask what connection it has with the title of the article. The answer is that if grid current is allowed to flow either in an H.F. or L.F. amplifying valve, when using conventional intervalve couplings, distortion and lack of selectivity will inevitably result.

A short time ago the writer happened upon a receiver with an indirectly heated variable-mu H.F. valve in which the volume control was so connected, by the accidental omission of a bias resistor, that, at the maximum position, grid current flowed. The results were most illuminating, for, when the grid was sufficiently negative to prevent grid current, selectivity was of a high order. Station after station was received without interference until the volume level was increased, when, suddenly, at the point where grid current started, three or four stations would tune in simultaneously, and no single transmission could be obtained separate from its neighbours.

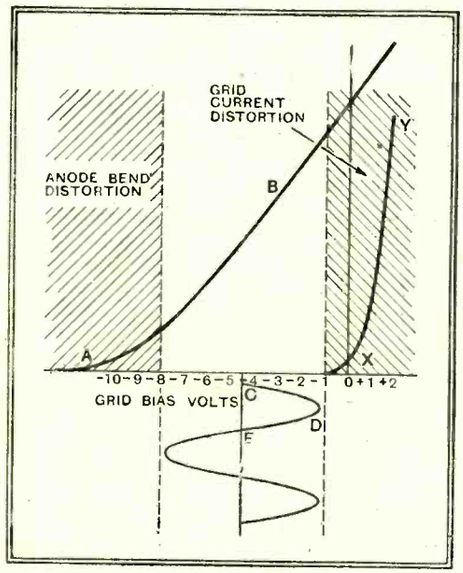


Fig. 1.—When a signal, CDE, is applied to a valve with a characteristic such as AB, the peaks must not enter the shaded danger zones of anode bend detection or grid current. A grid bias voltage of 4½ is seen to be necessary.

If grid current is allowed to flow in a valve preceded by a tuned circuit, it is equivalent to shunting that circuit with quite a low resistance, thus extracting energy from it. Selectivity will suffer considerably, and signals will be weakened. In a low-frequency resistance-coupled amplifier grid current will cause an excessive negative charge to collect on the grid and reduce the flow of anode current to a point at which distortion will occur. With a transformer-coupled stage the effect is to load the secondary, again resulting in distortion.

From the foregoing it should be clear that there are pernicious effects if grid current is allowed to circulate in an amplifying stage. To ensure its complete elimination we must maintain the grid permanently at a sufficiently high negative potential or bias, as it is called, to prevent even a momentary excursion by the signal into the grid-current region of the valve.

Danger Zones.

Let us examine Fig. 1, where the shaded area on the right represents the danger zone of grid current, which is shown by the curve X Y to start at one volt negative grid. Obviously, from what has already been said, the signal, which can be represented by a wave such as CDE, must be applied to the valve characteristic AB so that the right-hand peaks just avoid the grid-current danger zone. But there is another danger zone on the left, which is also shaded. Here the curvature of the valve characteristic AB becomes serious, and, should the left-hand peaks of the signal encroach beyond minus 8 volts, anode-bend distortion will occur. Distortion due to the signal peaks entering the left-hand danger zone is not so unpleasant as that associated with the right-hand zone, but is, nevertheless, to be avoided.

To prevent distortion from either zone a signal of the amplitude shown must have its imaginary centre CE applied at only one value of grid voltage, namely, halfway between minus 8 and minus 1 volts. This is minus 4½ volts, and a grid-bias battery of this value would be required.

As the voltage of this battery drops it drags CE to the right, along the decreasing grid-voltage scale until, in a rather extreme case, it might, just before its demise, reach minus 1 volt when the whole of the right-hand half-cycle CDE of the signal would be within the danger zone, and grid current would flow. A valve worked in this condition would soon become useless, and the reproduction of the receiver would be badly muffled.

What is the moral of this story? It is that the renewal of the grid battery at intervals of, say, six months is a sound investment. However, human nature being what it is, there is much to be said in favour of automatic grid bias in battery sets, which aroused so much interest at the Olympia.

What's Watt?

I DO wish certain manufacturers of moving-coil loud speakers would differentiate between field watts and "speech" watts in describing their wares. Before me as I write I have a catalogue. In brackets after each instrument a wattage figure is quoted, and, although it is rather obvious that field watts are meant, the makers concerned might as well say so, there being plenty of people who might be misled. Again, I think the manufacturers ought to quote a "speech" watts figure in order to give the general public some idea of what the instrument will stand before it begins to rattle and roar.

Fair Play for Playing Desks.

I AM of the opinion that the many "playing desks" which are appearing on the market at present ought to have a warm welcome, for surely no one in his right senses wants to sit right up against the loud speaker of a hefty radio-gramophone and have his head blown off by the very considerable volume emanating from the built-in moving-coil loud speaker. It may be argued that nobody but a fool like Free Grid *would* sit right up against a modern radio-gram when it was churning out its stuff, and my retort to this is that nobody but a gastronomic moron who breakfasted off monkey-nuts or some other so-called breakfast food would want to keep jumping up from his seat at the other side of the room to change the record every few minutes.

Gastronomic moron.

To those who would point scornfully to the fact that such things as record-changers exist I would reply that I have already informed the manufacturers that these devices are of no use to me while they continue to stick the rejector button on the cabinet instead of embodying it in a neat remote control unit, as I have done. If I have to keep hopping across the room to push the rejector button I might just as well change the record myself. Having thus settled the hash of all those who would fain disagree with me I once more assert that these "playing desks" ought to receive a warm welcome.

Are Magnets "Permanent"?

QUITE a number of readers have written to ask me questions about the permanence or otherwise of the magnetism of the various permanent magnet moving-coil loud speakers which are now upon the market. I have had occasion previously to disclaim all power and authority to answer technical questions on this page, but I have had such a large number of queries on this point that I am making an exception, though this must not be regarded as a precedent.

The answer to the problem is, of course, that, although nothing is permanent in this transitory life, it will be found that if reliable firms are dealt with, the loud speaker itself will be out of date several years before its magnets have appreciably wilted.

Some Common Sense.

NO one will deny that the rotary converter, or inverted rotary converter, as the technical pedants insist on calling it, which enables an A.C. set to be run off D.C. mains is a boon and a blessing. I cannot, however, see a fortune awaiting the many firms of manufacturers who have marketed machines to enable a D.C. set to be run off A.C. mains. The idea is to encourage a D.C. user, whose mains are likely to be changed over to A.C. in a few months time, to indulge in the luxury of an all D.C. set. When the nature of his supply is changed, argue the vendors of these machines, he need not scrap his D.C. set as he need only buy one of their converters to enable him to operate his D.C. set from A.C. mains. Surely this is about the sublimest instance of muddled thinking that you are likely to meet in a day's march. If he were really going to invest in a converter wouldn't it be best for him to buy a D.C. to A.C. instrument in the first place rather than an A.C. to D.C. instrument later on? He could then at least sell the converter when the nature of his supply was changed, and so raise a bit of capital for further radio purchases.

The Proper Quarter.

FAITH is a great thing, but a listener from Hendon who has written to the Editor of his local newspaper appears to carry it to extremes. After complaining of the interference caused by oscillations in his neighbourhood he concludes with the somewhat naïve threat that, "if it continues I shall be obliged to take the matter up in the proper quarter." I am afraid that those in the "proper quarter" have cried wolf too often for the offending oscillators to quake in their shoes at this threat.

Humbugging Questions.

ALTHOUGH I do not usually reply to technical questions, much as I should like to do so, I have received so many queries lately dealing with the idiosyncrasies of humbugging coils that I have been constrained to investigate the matter. The queries do not, as I at first supposed, refer to the products of the baser sort of

. . . imagine I am the Mayor of Nottingham.

coil manufacturer, but to the hum-bucking coil associated with M.C. loud speakers. It is, I fear, the terrible looseness of expression among the younger generation which leads to these deplorable misnomers. I recollect that when *The Wireless World* published its first band-pass set over two years ago—"the Band-Pass Four" was its name—many people, including an eminent manufacturer, insisted upon calling it the Bandmaster Four.

While I am on the subject may I disillusion several of my Colonial readers who seem to imagine that I am the Mayor of Nottingham, or at least possess powers equal to his? As is well known, it is quite common for Colonials to write to the chief magistrate of that city, whence England's most beautiful girls are reputed to emanate, asking him to choose for them a wife from the constructional details which they send. From recent letters which have been reaching me it is obvious that it is considered that I am able to render them a similar service. I trust that this warning will suffice and that I shall not have to resort to sterner measures.

BROADCAST BREVITIES.

By Our Special Correspondent.

H.R.H. in Vaudeville Studio.

BROADCAST vaudeville will receive a signal honour on Tuesday next, November 15th, when the Prince of Wales will attend personally in Studio BA for the "all star" birthday week programme. His Royal Highness has not hitherto visited Broadcasting House, and it is considered a singularly happy gesture that the Prince should take the opportunity to witness an actual programme.

A "Command Performance."

In a sense it will be a "Command Performance," for I understand that His Royal Highness has personally inspected the "bill" and approved it. The artists to appear are Jeanne de Casalis, Clapham and Dwyer, Cicely Courtneidge, Florence Desmond, Marion Harris, Jack and Claude Hulbert, in addition to Henry Hall and the B.B.C. Dance Band.

A Royal Precedent?

Just the other day the French were complaining that broadcasting in their country is nobody's child; that no important official, not to mention a President, ever deigned to visit a wireless station or studio. What will our French colleagues say now?

I venture to say that Royalty has never before been present in a European broadcasting studio during an actual performance.

Sir Gerald Du Maurier's Appeal.

At the end of the vaudeville programme Sir Gerald du Maurier will make an appeal on behalf of stage charities in which the Prince of Wales is specially interested.

And Now for Birthday Week.

Tuesday's special vaudeville is, of course, only one high light in the glittering array which the B.B.C. is offering us next week—the five hundred and twenty-first in the history of British broadcasting. The "Tour of Broadcasting House," A. J. Alan, "The Three Musketeers," Haydn's "Creation," "Romeo and Juliet," Christmas Dinner Hints—these are only a few of the attractions already mentioned in these columns.

Radio "Effects."

"Communications—1922-32," by L. du Garde Peach, promises to be a *tour de force*, with its realistic wireless and transport "effects." This takes place on Saturday, November 19th. Mr. H. G. Wells will participate with a prophecy which may make our flesh creep.

Contributions from Abroad.

Germany, as well as the United States, has announced her intention of contributing to the B.B.C.'s birthday week celebrations. The land of the Stars and Stripes will relay Paul Whiteman's Band, said to be the world's best dance orchestra, on Saturday, November 19th. On the previous Monday, November 14th, a relay from Berlin is entitled "Halloh! London, hier ist Berlin." The point of origin is the "Funkhaus," the great German rival to the British Broadcasting House. The programme will consist of a light opera potpourri, conducted by Edward Kunneke, composer of "The Cousin from Nowhere."

Programmes for Empire Listeners.

A PRIVILEGED glance at the draft programmes to be radiated from the new Empire short wave aerials during the inaugural week (December 19th-25th) has removed any doubts in my mind as to whether Empire listeners are to have a good share of what's going in the B.B.C. programmes. All the popular favourites are there—the Savoy Sextet, the Gershom Parkington Quintet, Christopher Stone, Vernon Bartlett's "Way of the World" (recorded by Blattnerphone)—and there are other features, such as "The Foundations of Music" and "The Week at Westminster," which should take the rough edges off life in the prairie.

Sundays Included.

The Empire station will broadcast on every day of the week, *including Sundays*.

How We Listen.

LISTENERS' preferences are revealed in frank fashion by the charts kept by the Nottingham Re-Diffusion Service, Ltd., which supplies alternative programmes to 1,600 Nottingham homes.

The load readings on the control board dials indicate approximately the percentage of subscribers utilising each programme. Some of the readings are startling.

85 Per Cent. for Radio Paris.

For instance, I hear that on a recent Sunday the reading for the *Radio Paris* gramophone concert in the morning was 85 per cent., although the period was also filled with British concerts and organ and orchestral music. At 2.30 p.m. British gramophone records registered only 10 compared with Radio Paris at 80. A Sunday afternoon variety concert from Paris registered 50 compared with less than 20 for the R.A.F. Band, though it is comforting to know that the readings became level when a French band struck up!

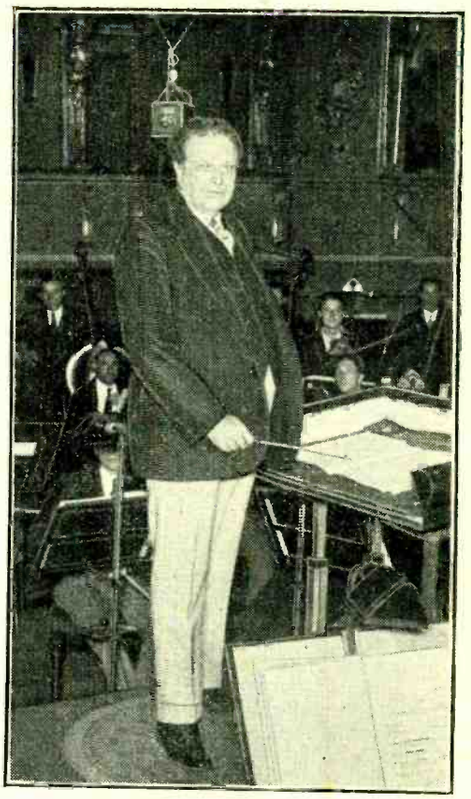
Other readings showed that two-thirds of the listeners switched off a talk in 20 minutes, tending to show that a talk was less popular than an interval!

A Play that "Went."

Alas, school broadcasts are not popular in Nottingham and—oh dearie me!—Chamber Music cuts no ice at all. When, at 5.15, the B.B.C. Dance Orchestra competes with the Children's Hour, 60 per cent. of the subscribers listen to the former and 20 per cent. to the latter. When a play was the alternative to a Promenade Concert, 30 per cent. of the subscribers listened to the concert, while a larger reading for the play gradually decreased as the play proceeded!

State Control of the B.B.C.

APROPOS my recent note on the possibility that the State may take over the B.B.C., lock, stock and barrel, I now hear that a strong defence is being prepared by the champions of the Corporation. In fact, they are counter-attacking with the plea that the Charter, which expires in 1936, should be extended for another five years.



A RENOWNED COMPOSER. — Signor Mascagni, of "Cavalleria Rusticana" fame, photographed at the Turin theatre in which he recently conducted a broadcast performance of his opera, "Isis."

Days Numbered.

Certain financial embarrassments threaten to crop up owing to the Corporation's short expectation of life; for instance, long-term loans are now out of the question.

Ten Million Licences.

Not that the B.B.C. needs money. It is, perhaps, the most flourishing concern in Great Britain to-day, notwithstanding the "raids" on its resources by the Treasury. Losses in this direction have been fully compensated for by the increase in the number of licences taken out. When the figure reached three million, people began to talk of "saturation point," but now that the five million mark has been passed, one begins to wonder whether the limit will be reached on this side of ten million.

Should Licences be Cheaper?

I have heard it suggested (not in Portland Place!) that the cost of the listener's licence should be reduced.

There is certainly a case for a reduction to 7s. 6d.—the price of a dog licence. From my experience dogs make just as much noise as loud speakers.

Cinematographic Gramophone Record.

THE introduction of film directing methods in the preparation of a gramophone record is an interesting innovation. A distinction of this kind is claimed by the Columbia Company for their new record "The Boys of the Old Brigade" (12 inch, No. DX.379), and I hope the B.B.C. will give listeners an opportunity to hear it. Episodes from the days of the Crimea to the Great War are staged so vividly by the aid of music and sound effects that one can almost see history in pictures.

If you please, Mr. Stone.

WIRELESS ENCYCLOPEDIA.

Brief Definitions with Expanded Explanations.

IT was discovered by Georg Simon Ohm, at the beginning of the nineteenth century, that when the potential difference or voltage applied to the ends of a wire was varied the current in the wire changed in direct proportion. This relationship, now known as Ohm's law, may safely be said to form the very foundation of the theory of electric circuits. In these days, when Ohm's law is so very well known, it is accepted for granted, and one is apt to imagine that the discovery was not as great as its fame would indicate; but one must realise that, at that time, there were no facilities for making electrical measurements, and the instruments were very crude indeed compared with modern ones. What seems to us now a very simple measurement required the utmost skill and ingenuity by early pioneers such as Ohm.

A current of electricity in a conductor is, according to modern theory, a stream of electrons passing within the conductor from one end to the other, and its passage is opposed or resisted to an extent depending chiefly on the material from which the conductor is made and on its dimensions, and to a small extent upon the temperature. This opposition is known as electrical *resistance*, and to drive a current through a conductor, against its resistance, an electromotive force, or electrical driving force, is required, just as hydraulic pressure is required to drive a stream or current of water through a pipe.

In the practical system of units the unit of current is the ampere, and the unit of E.M.F. the volt. Unit resistance is that through which an electromotive force of one volt will drive a current of one ampere, and is called the *ohm*. Internationally, the ohm is defined as the resistance of a column of mercury 106.3 cms. long and 1 square millimetre in cross-section at the temperature of melting ice.

At a given fixed temperature the resistance of a conductor is constant and independent of the value of the current through it. Of course, in practice, a flow of current causes a rise in temperature and a (usually) slight change in the value of the resistance. Ohm's law tells us that the ratio of current to electromotive force in a conductor is a constant, and in the practical system of units this constant is the resistance in ohms. Using the orthodox symbols E, I, and R for voltage, current, and resistance respectively, Ohm's law for a simple resistance as depicted in Fig. 1 (a) can be expressed in three different ways, namely, $I=\frac{E}{R}$ amperes, $R=\frac{E}{I}$ ohms, and $E=I\,R$ volts, enabling any one of the three quantities to be found when the other two are known.

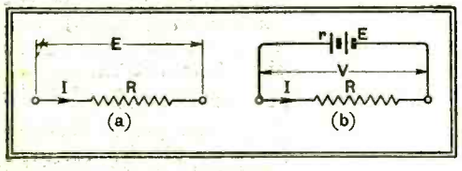


Fig. 1.—For the resistance at (a) the current is given by $I=E/R$ amperes, whereas for the closed circuit (b) it is given by $I=E/R+r$ amps., where r is the battery resistance, or by $I=V/R$.

Ohm's law is obviously a very simple one as applied to a single resistance, but

OHM'S LAW. A fundamental law of the electric circuit, stating the relationship between electromotive force, current, and resistance in any branch. The current is proportional to the applied electromotive force and inversely proportional to the resistance.

when a circuit contains branches or consists of more than one resistance, or if there are internal electromotive forces within one or more branches of the circuit, care must be exercised when applying Ohm's law.

A resistance R connected across the terminals of a battery whose open circuit E.M.F. is E volts, as in Fig. 1 (b), provides a useful example for illustrating the use of Ohm's law. Before the resistance is connected across the circuit the potential difference between the latter is equal to E, the electromotive force produced by electro-chemical action within the battery. But when R is connected a current I flows round the closed circuit so formed. Now, the battery itself must possess some resistance, which will be denoted by r. So the current, in flowing round the circuit, passes through r and R in series, the total resistance of the loop being $R+r$ ohms. The total E.M.F. acting round this circuit is E volts, and so the current is given by $I=\frac{E}{R+r}$ amperes. Strictly speaking, this arises from Kirchhoff's first law (see "Wireless Encyclopedia," No. 23), but for this simple closed circuit, without branches, both laws coincide.

Now, out of the total E.M.F. available, namely E, some of this pressure will be required to drive the current through the resistance r of the battery itself, and according to Ohm's law the voltage so absorbed will be Ir volts. This is called the *voltage drop* in the battery, due to its internal resistance. So, when current flows, the potential difference at the terminals of the battery will be less than E by the amount Ir. Denoting the terminal potential difference, then, by V, we have $V=E-Ir$ volts. In words, the terminal voltage of a battery is equal to the E.M.F. of the battery minus the voltage drop. Applying Ohm's law to the external resistance R only, we have $I=\frac{R}{V}$ amperes, or $V=IR$ volts.

Numerical Example.

A battery gives 10 volts on open circuit. When a 5-ohm resistance is connected across the terminals the voltage falls to 9.5 volts. What is the internal resistance of the battery? This is a problem which can be solved by the aid of Ohm's law. Applying this to the external resistance alone, we obtain the current, namely, $I=\frac{9.5}{5}=1.9$ amperes, since the voltage applied to the ends of the resistance is 9.5 volts. Now, the voltage dropped in overcoming the internal resistance r of the battery is equal to the difference between the open circuit voltage (which is equal to the internal E.M.F. of the battery) and the terminal voltage on load, namely, $10-9.5=0.5$ volt. And so, by Ohm's law, the internal resistance of the battery is $r=\frac{0.5}{1.9}=0.263$ ohm.

Some Useful Applications.

It often happens that one has a milliammeter which it is desired to use as a voltmeter or an ammeter to read over some definite range. By the aid of Ohm's law we are able to determine the necessary value of series resistance, in the case of the voltmeter, or of the shunt resistance in the case of the ammeter. For instance, suppose that a milliammeter, whose maximum reading is 5 milliamps. and whose resistance is 20 ohms is to be used in conjunction with a suitable series resistance to read up to 5 volts. The arrangement would be as shown in Fig. 2 (a), where R is the extra resistance to be connected in series with the instrument.

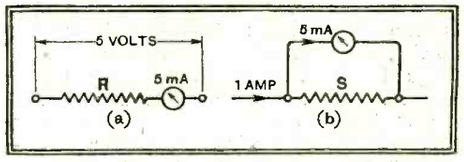


Fig. 2.—Use of a milliammeter as voltmeter (a), or ammeter (b). The values of R and S are found by the aid of Ohm's law.

Now, maximum scale reading must occur when 5 volts is applied to the ends of the circuit, and therefore the current must be 5 milliamperes, or 0.005 ampere. So, by Ohm's law, the total resistance of the complete circuit must be, dividing volts by amps., $\frac{5}{0.005}=1{,}000$ ohms. Since the instrument itself has a resistance of 20 ohms, the added resistance R must be $1{,}000-20$, or 980 ohms.

Now let it be supposed that the same milliammeter is to be used as an ammeter reading up to 1 ampere. A shunt resistance S is connected in parallel with the instrument, as shown in Fig. 2 (b). The value of S is chosen so that, with 1 ampere in the main circuit, a current of 5 milliamperes, or 0.005 ampere, will flow through the instrument itself, giving full-scale deflection. Under these conditions the current in the shunt works out as follows:

$$1.0-0.005=0.995 \text{ ampere.}$$

Applying Ohm's law to the instrument branch, the potential difference between the instrument terminals is equal to the product of current and resistance, namely, $0.005\times20=0.1$ volt. Since the instrument and the shunt are in parallel, this same voltage must exist between the terminals of the shunt S. And, therefore, applying Ohm's law again, the resistance of $S=\frac{0.1}{0.995}=0.1005$ ohm.

LABORATORY TESTS.

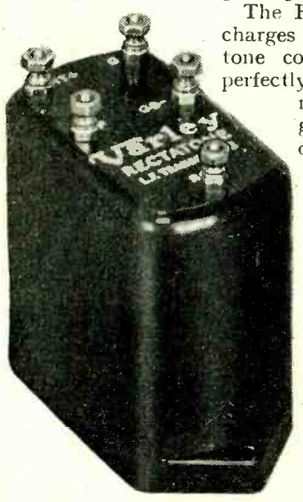
VARLEY RECTATONE TRANSFORMER.

THIS component has been designed especially for use in tone correction circuits when compensation is required for the high note attenuation due to sharply tuned H.F. circuits. It can be achieved without the addition of an extra L.F. stage, for a step-up ratio of 1 : 7 is provided in the transformer. The degree of compensation is controlled by means of an external variable resistance which can have a maximum value of some 5,000 ohms. A separate terminal, marked "RES," is provided on the component to which one end of the resistance should be connected, the other end being joined to the "H.T.+" terminal.

With this addition the primary winding is shunted by a resistance and an air-cored choke connected in series, the latter being embodied in the transformer.

Tests made to determine the amount of correction afforded by different values of resistance show that with 3,000 ohms in circuit a 5,500 cycle note, where the greatest amplification was obtained with the specimen tested, is amplified 3.2 times that of a 100 cycle note. With but 1,000 ohms the difference in amplification becomes 6.6 times. These measurements were made using an L type valve of 10,000 ohms A.C. resistance, and with the transformer connected in its anode circuit the steady D.C. current flowing in the primary winding being 1.5 mA.

The Rectatone discharges its function of tone correction in a perfectly satisfactory manner, and gives adequate compensation for the most severe cases of high note loss. It imparts a brilliance to the reproduction that with normal L.F. coupling devices cannot be obtained without considerable modification to the L.F. amplifier.

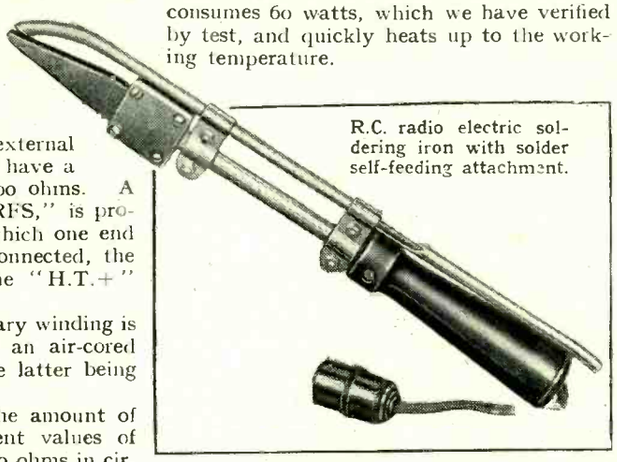


Varley Rectatone L.F. transformer provides for true correction when an external resistance is used.

The price is 15s., and the makers are Varley (Oliver Pell Control, Ltd.), Kingsway House, 103 Kingsway, London, W.C.2.

R.C. ELECTRIC SOLDERING-IRON.

FEW who have used an electric soldering-iron would willingly revert to the old-fashioned type heated in the fire or by a gas jet, but there must be many home constructors who have not given due consideration to the claims of this up-to-date pattern. At the present time the price need not prove an obstacle, for a very satisfactory article can now be purchased at a reasonable price. The R.C. Model 1 is a case in point, and it is an ideal size for all work connected with wireless set construction. It consumes 60 watts, which we have verified by test, and quickly heats up to the working temperature.



R.C. radio electric soldering iron with solder self-feeding attachment.

The copper bit is of generous size, and quite suitable for all normal requirements, and models can be obtained for use on supply mains of from 100 to 250 volts, either A.C. or D.C. For an additional sum of 3s. a self-feeding attachment to hold a stick of solder not exceeding $\frac{1}{2}$in. in diameter can be obtained.

The makers are R.C. Radio-Electric, Ltd., 51, Whitcombe Street, Leicester Square, London, W.C.2, and the price is 10s. 6d. A larger model, consuming 150 watts, is obtainable at 15s.

NEW RADIO PRODUCTS REVIEWED.

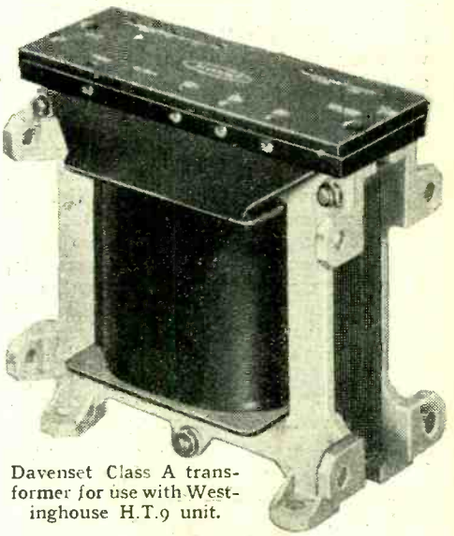
DAVENSET MAINS TRANSFORMER.

THIS transformer is one of a range designated the Class A series which was introduced recently by Partridge, Wilson, and Co., Davenset Works, Evington Valley Road, Leicester. It appears in their list as the No. 12 model, and is intended for use with the Westinghouse H.T.9 rectifier. There are two secondary windings, the one giving 240 volts A.C., while the other is rated at 4 volts 4 amps., and is centre-tapped.

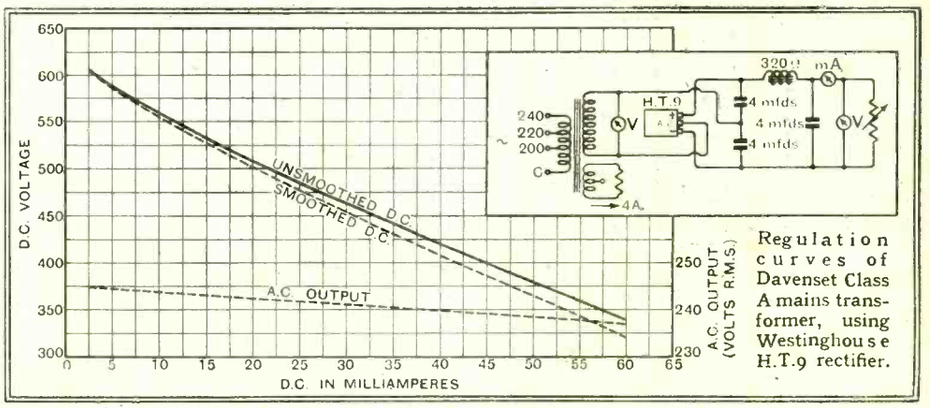
Since the H.T.9 rectifier will be employed as a rule with the voltage doubler circuit, our tests were made with this arrangement, using 4-mfd. condensers throughout. The regulation of the transformer is very good indeed, for under maximum load conditions the A.C. output voltage fell by the small amount of 3 per cent. only. All measurements were made with a resistance passing 4 amps. connected across the L.T. winding, the output from which was 3.96 volts, with 60 mA. flowing in the H.T. circuit. The A.C. input during the time of test was 240 volts at 50 cycles, the 240-250 tapping on the primary winding being employed.

In addition to being well above the average in performance, these transformers are exceptionally well made. The windings are carried on a bakelite bobbin, which is fitted with a core of generous size. Provision is made for mounting the transformer in the most convenient position, for which purpose fixing lugs are included on three sides of the end clamps. Incidentally, these are particularly clean, the castings being manufactured, we understand, by a special process.

The leads are brought out to a moulded bakelite cover plate, on which is mounted sunk connectors. Apart from enhancing the general appearance, these serve a useful purpose, since all high-voltage leads and terminal connections are completely insulated. Although the performance of the specimen tested is well above the average, the price is very reasonable, for this model costs only 47s. 6d.



Davenset Class A transformer for use with Westinghouse H.T.9 unit.



Regulation curves of Davenset Class A mains transformer, using Westinghouse H.T.9 rectifier.

curves here reproduced show the rectified output before and after smoothing; in the one case correction has been made for the voltage dropped across the 320-ohm choke. From this the voltage available after smoothing can be calculated where chokes of different resistance are employed.

○○○○

The latest catalogue issued by Radio Instruments, Ltd., Purley Way, Croydon, Surrey, contains forty pages of illustrations and descriptive matter relating to their range of receivers and components.

READERS' PROBLEMS.

THESE columns are reserved for the publication of matter of general interest arising out of problems submitted by our readers. Readers requiring an individual reply to their technical questions by post are referred to "The Wireless World" Information Bureau, of which brief particulars, with the fee charged, are to be found at the foot of this page.

Loud Speaker Matching.

WHEN a simple untapped choke is used as a link between the anode circuit of the output valve and the loud speaker, the inductance of the choke need not be taken into account in determining the load impedance.

The inductance of this choke should be—and almost invariably is—very much higher than that of the loud speaker winding, and so it is only necessary to take into account the impedance of the latter, which will be effectively in parallel with the choke.

This is in reply to a reader who has apparently overlooked the fact that, when two impedances are in parallel, the net impedance can never be quite as great as that of the smaller of the two impedances.

Checking Matched Coils.

WE may hazard a guess that matched tuning coils, of the type designed for use in receivers with single-knob tuning, do not always receive the careful handling that is their due. No "ganged" receiver can work properly unless inductance values are accurately matched, and lately several readers have asked us how their windings may be checked from this point of view. Nearly all these questions apply to modern "potted" coils, and many of our querists add a footnote to the effect that the windings have been damaged or displaced.

For the benefit of readers who suspect for any reason that their tuning coils may be badly matched we will describe two simple methods of making a test. The first, illustrated diagrammatically in Fig. 1 (a), is crude, but is capable of yielding satisfactory results. Each of the coils to be tested is shunted in turn by a variable condenser (or, better, a variable condenser plus a parallel vernier), and is joined in series with the aerial circuit of an existing receiver in the manner shown. The receiver is now accurately tuned to a transmission, and then the condenser across the test coil is adjusted so that the incoming signals are reduced to a minimum. The setting will be critical; when it has been located accurately a careful record should be made.

Each of the remaining coils is substituted in turn, and the procedure is repeated, great care being taken to avoid any alteration in conditions. If the coils are accurately matched, each will resonate to the frequency of the incoming signal with precisely the same amount of parallel capacity.

For the more ambitious scheme illustrated in diagram (b), the circuits associated with an existing regenerative detector valve, *plus* a milliammeter connected as shown, may be employed. A coupling coil of some three turns, wired in series with the coil under test, is placed in inductive relationship with the detector grid coil, means being provided for fixing its position when the best coupling has been determined. The detector valve is made to oscillate gently by applying reaction, and resonance between the test circuit and the oscillating circuit is indicated by a "kick" of the milliammeter needle, which will take place as the former is brought into tune.

As before, conditions should remain fixed while a series of coils is being tested; too much care cannot be given to these details, and even the length and positions of connecting wires should not be altered when changing coils.

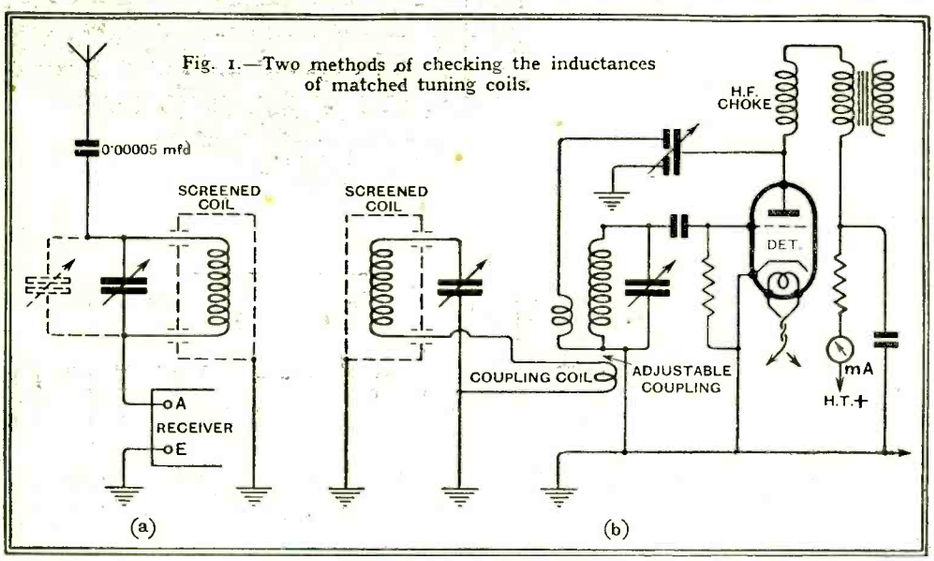


Fig. 1.—Two methods of checking the inductances of matched tuning coils.

Stable and Unstable.

IT is fairly well known that certain types of receiver having one or more H.F. stages tend to become unstable when the loading of the aerial is removed. Sometimes this effect becomes evident even when the aerial load is lightened, as it might be, for instance, by the fitting of a smaller aerial, or even by inserting a low-capacity aerial series condenser in an attempt to improve the apparent selectivity.

In connection with this effect of aerial loading, a reader has noticed a rather unusual manifestation, and asks us to explain it. Briefly, his receiver, of an admittedly somewhat out-of-date type, is quite stable with a full-sized aerial, but uncontrollable self-oscillation takes place when a short indoor aerial is substituted. But what our correspondent cannot understand is the fact that stability is completely restored by removing the aerial altogether. He assures us that it is not brought about by mistuning, as all the circuits are separately tuned—not ganged.

This seems to be a clear case of interaction between the aerial lead-in wire and some other part of the set—probably the loud speaker leads. It is also possible that the aerial wire is run along the back of the set in such a way that it couples up with the H.F. anode circuit. No doubt matters are complicated by the fact that the H.F. stage is not very far from the point of self-oscillation when the load of a large aerial is removed.

The American "Ground."

IN the issue of this journal for June 8th, there was published a résumé of a specification issued by the American Bureau of Standards for a special form of earth connection. A reader who has not access to this back number asks us to repeat the information; after reading a recent article dealing with avoidable interference he has come to the conclusion that a noisy background, which tends to mar his reception, might be improved by a better earth, and he wishes to try this arrangement.

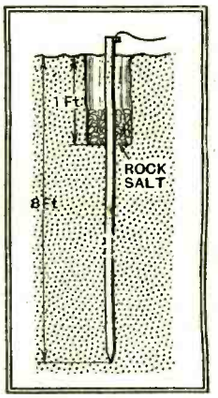


Fig. 2.—A special form of earth connection for which low resistance is claimed.

The method of making an earth connection to which our correspondent refers is shown diagrammatically in Fig. 2. Briefly, a hole 1 foot deep is dug in the ground, and in it is placed 5 lbs. of rock salt; water is poured in until the salt is dissolved, and then a metal tube or rod about 1in. in diameter and 8 feet long is driven into the ground through the centre of the hole.

A certain amount of care should be taken in making the electrical connection. If it is impossible to solder the wire to the top of the tube, a brass bolt or set screw should be tapped through it.

The official American specification concludes by recommending that, where the ground is abnormally dry, three or four of these earth tubes should be joined in parallel.

The Wireless World INFORMATION BUREAU.

THE service is intended primarily for readers meeting with difficulties in the construction, adjustment, operation, or maintenance of wireless receivers described in *The Wireless World*, or those of commercial design which from time to time are reviewed in the pages of *The Wireless World*. Every endeavour will be made to deal with queries on all wireless matters, provided that they are of such a nature that they can be dealt with satisfactorily in a letter.

Communications should be addressed to *The Wireless World* Information Bureau, Dorset House, Tudor Street, E.C.4, and must be accompanied by a remittance of 5s. to cover the cost of the service. The enquirer's name and address should be written in block letters at the top of all communications.

The Wireless World

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EDITORIAL COMMENT.

Serving the Empire.

British Manufacturers' Obligations.

EMPIRE Broadcasting, designed to be operative throughout the British Empire, will be inaugurated next month, and the aim of the B.B.C. is, we understand, to make the service British in every respect. The Empire in all parts of the world looks forward to this event as one which will bring about a closer understanding between all the scattered units which go to comprise the Empire as a whole.

The service which the Empire should receive does not end with the B.B.C. Listeners abroad must have apparatus suitable for receiving the home programmes. What, we ask, is being done to meet their requirements? We are afraid that the answer is that at the moment manufacturers here are taking little or no interest in supplying the potential demands for short-wave receiving apparatus which the inauguration of the short-wave service will stimulate. It would surely be an admission of incompetence, or worse, on the part of our manufacturers if it should be found that throughout the Empire British programmes from the home station were being received on foreign apparatus because sets of British manufacture were unobtainable.

We are constantly receiving letters from overseas, expressing regret and even disgust at the apparent apathy of set manufacturers and others to take steps to meet this demand.

Some collective effort should be made here before it is too late and before foreign sets have so established themselves that the task of ousting them becomes too formidable.

There may not, at the moment, appear to be a large amount of business of this nature to be had, and this may be an excuse put forward, but the potentialities are enormous. It is important to remember that there are probably few industries in which the tendency to adopt whatever type of apparatus is first available is more marked. Those who sell and service wireless sets will always prefer to keep to those types with which they are familiar and for which spare parts are already in stock, rather than change over to unknown and untried brands.

If the British manufacturer is to get in first and establish himself in the market the Empire offers, he must do so now and procrastinate no longer.

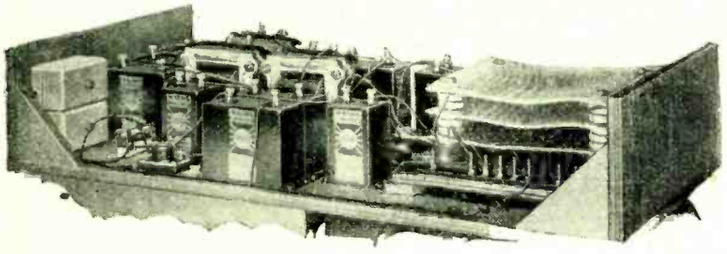
How Many Valves?

Should we Include the Rectifier?

RECENTLY we commented on the fact that there was no satisfactory definition of a kit set, and pointed out that, since there were many divergent views as to what constituted a complete kit, it was in everyone's interest to settle the question.

Another matter of the same kind which requires clearing up is in connection with mains rectifiers when they happen to be valves. It has been quite customary to include the valve rectifier in the number of valves and describe as, say, a four-valve set one which, in point of fact, consists of three valves plus the rectifier, which by no stretch of the imagination can be regarded as in the same category as the amplifying valves in the receiver itself. We have ourselves fallen into the same error in the past, if error we may term it; but we are of the opinion that in the description of a receiver the rectifier valve should always be treated separately in stating the total of valves in the set.

Design of D.C. Sets.



Problems Peculiar to Direct Current Supply.

By W. T. COCKING.

MAINS-OPERATED receivers have been developed chiefly for use on alternating current supply systems, and such success has been reached that few difficulties are experienced in constructing and operating the most complex types of set. The position in regard to the employment of D.C. mains, however, is inherently more difficult owing to the impossibility of obtaining the same circuit isolation as with alternating current. It has not, moreover, received the same attention, since it was believed that direct current supplies would be rapidly converted to A.C. This conversion, however, is taking place more slowly than was at first anticipated, and it is probable that it will not be complete for many years. It is obvious, therefore, that direct current claims far more attention on the part of the set designer than it has had in the past.

THE change-over from direct to alternating current mains has proceeded less rapidly than was anticipated, and as a result the design of D.C. sets has been somewhat neglected. There are a number of problems peculiar to D.C. sets, particularly the elimination of hum and H.F. currents in the supply mains. Various practical solutions are given in this article.

The three-wire system is usually employed for D.C. distribution; the current is generated at a potential of some 400/500 volts, but is supplied to the consumer at one-half of this voltage. The mechanism of this may readily be seen from Fig. 1; the current is supplied along three wires, one of which is 400/500 volts positive and the second 200/250 volts positive with respect to the third wire, which is connected to the negative of the generator. The 200/250 volts positive line is usually earthed at the power station; with respect to this line, therefore, the other two are 200/250 volts positive or negative. Thus the supply never exceeds 200/250 volts in a consumer's house, and yet the economy and advantages of generating current at a high voltage are retained.

H.T. Smoothing.

From a wireless point of view, the chief fact which emerges from this is that one of the mains leads is earthed, but not always the same one. Indeed, 50 per cent. of the houses on a D.C. system have the negative mains lead earthed, while 50 per cent. have the positive earthed. Actually, of course, it will be clear that it is always the same wire which is earthed, but that in one case it will be the unearthed lead which is positive (negative earth), and in the other the unearthed lead will be the negative (positive earth).

In A.C. sets it is the commonly accepted practice to include the smoothing chokes in the positive lead, but this may only be satisfactory on a D.C. supply if the mains have the negative wire earthed. A circuit of this nature is shown in Fig. 2, and it will provide a satisfactory degree of smoothing for many purposes. Suppose, however, that the positive of the mains be earthed, as shown dotted. The receiver earth, or local earth, will be connected in the usual way through a condenser to the negative of the supply, and the result is effectively to short-circuit the smoothing choke by the condensers C and C_1 in series.

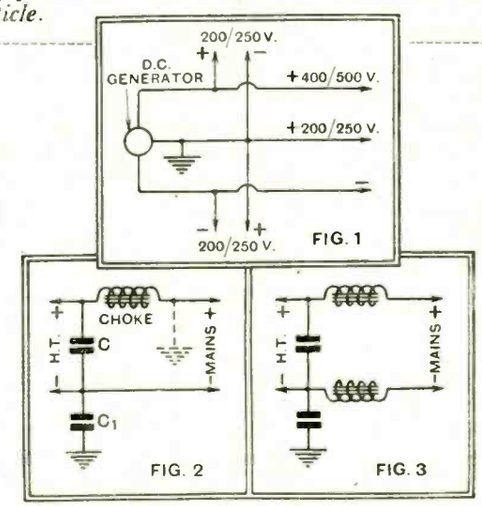


Fig. 1.—The three-phase system of D.C. mains supply, illustrating how the positive and negative earths occur. Fig. 2.—When the positive mains lead is earthed, the choke is effectively short-circuited by C and C_1 in series. Fig. 3.—It is usually advisable to include a choke in each mains lead, for the set is then not so greatly affected by the mains being earthed.

Obviously, this will seriously reduce the efficacy of the smoothing equipment.

In practice, a complete short-circuit may not be obtained, since there will usually be an appreciable resistance between the local earth and the mains earth at the power station. The smoothing equipment may then give an appreciable reduction in the hum level, even although its efficiency is impaired. The correct procedure when the positive lead of the mains is earthed, however, is to include the smoothing choke in the negative lead. Full efficiency is not obtained even then, for although the negative mains lead may not be earthed, it has a large capacity to earth, and this is effectively in parallel with the smoothing choke. This explains why it is sometimes found that D.C. sets work better without any local earth connection.

In general, however, it is advisable to include a choke in each mains lead, as in Fig. 3, for the smoothing circuit will then remain in action whether the positive or the negative of the mains be earthed, although it will usually be more effective with a negative earth. This procedure was commonly adopted in early D.C. receivers in which low-consumption-type battery valves were employed with their filaments connected in series, but it has largely fallen into disuse since the introduction of indirectly heated types of mains valve.

Smoothing of the negative lead is still advisable, however, and its rarity seems to be largely due to the idea that it cannot be economically obtained on account of the comparatively large heater current of the valves. This is not the case, for it is quite unnecessary to pass the heater current through such a choke. By adopting the circuit arrangement of Fig. 4 it is readily possible to obtain smoothing of both the positive and the negative H.T. leads while still using ordinary type chokes. It will be seen that the valve heaters are all series-connected and supplied directly from the mains, and that no direct connection is made in the receiver itself between the heaters and the H.T. circuit.

The Heater Circuit.

Although the inclusion of adequate smoothing equipment is the first and most important step towards the elimination of hum, it must not be thought that this alone will suffice. The heater circuits are supplied with unsmoothed current, and stray couplings with the wiring are responsible for much trouble. The

Design of D.C. Sets.—

ripple on D.C. mains is usually of much higher frequency than any encountered in A.C. working, and the effects of stray couplings are correspondingly greater.

The detector is usually the most critical point, and it is often essential that its heater be effectively at earth potential for hum frequencies. In many cases this can be arranged by wiring the heaters of the various valves in such an order that the detector comes at the most negative end of the chain. Owing to the layout adopted for other reasons, however, it may so happen that this leads to such a complication of the heater wiring that there is a grave risk of interaction occurring with other components. The simplest way out of the difficulty is then to wire the heaters in a straightforward order, and to connect a 2 mfd. condenser between the detector heater and the earth line, or in some cases the negative of the mains. Where it proves effective the latter connection is the better, since it permits of greater smoothing of the H.T. supply. The connection to the earth line, it will be noted, places the 2 mfd. condenser (C. of Fig. 4) in series with some of the valve heaters, in parallel with the negative lead smoothing choke. Nevertheless, this connection is sometimes the only satisfactory one.

H.F. Currents.

It is essential to avoid hum pick-up on the detector grid, and it is said by some that this can only be done by enclosing the detector valve with all its associated components, including the radio-gramophone switch, in a metal screening box. It has been the writer's experience, however, that it is really unnecessary to go to such lengths as this, and that all pick-up can actually be avoided by the judicious use of screened wire for the connections.

By adopting these principles there should be little difficulty in obtaining hum-free operation, even with very "rough" mains. The precise details of the receiver may vary somewhat in different cases, since different supplies differ considerably and the receiver is not isolated from the mains in the same way as an A.C. set. It must not be expected, therefore, that a set designed on paper will be entirely successful at the first attempt, but if the various points outlined above are borne in mind, it should be readily possible to arrive experimentally at the best connections.

Even when hum has been successfully eliminated, however, a further difficulty remains, owing to the fact that H.F. currents in the mains can pass into the receiver circuits. The mains transformer largely prevents this occurring in the case of an A.C. set, and where a component with an electrostatically screened primary is used it completely prevents it. The designer of a receiver usually assumes that H.F. currents will enter only by the aerial which is provided for that purpose. Currents entering from other sources may not pass through all the tuning circuits, and they will then reduce the selectivity and, in the case of a superheterodyne, give rise to "whistles"; in addition, since they may be modulated by the mains ripple, they are a prolific source of modulation hum.

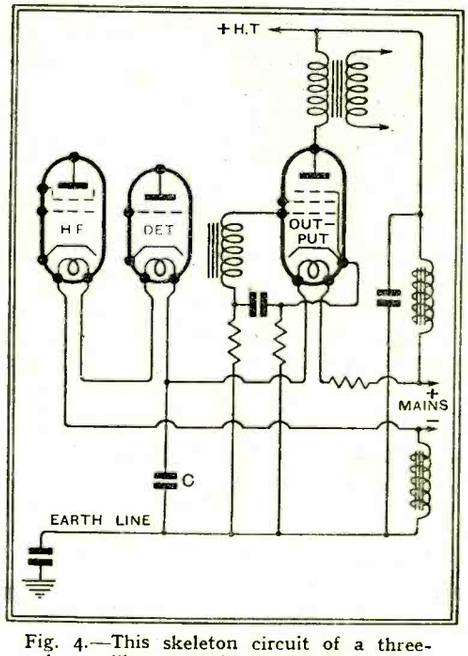


Fig. 4.—This skeleton circuit of a three-valve set illustrates the method of obtaining negative smoothing with an ordinary choke when indirectly heated valves are used.

The methods adopted for the prevention of these troubles in an A.C. receiver cannot be applied in the case of a direct current supply, and in the ordinary D.C. set the smoothing chokes provide the only barrier to H.F. currents. That they are not very effective in this will be recognised when it is remembered that they are designed for operating upon low frequencies, and have a very appreciable self-capacity. It is necessary, therefore, to insert H.F. chokes in the mains leads if trouble is to be avoided and a D.C. mains superheterodyne made as free from whistles as an A.C. set.

These chokes must be inserted at the point of entry of the mains and before any other components if they are to be fully effective; and they must, therefore, carry the total current consumed by the set. Fortunately, a very simple construction will suffice, and a choke consisting of 85 turns of No. 24 D.C.C. wire wound in a single layer on a 1½in. diameter tube will be found entirely satisfactory when the 0.25 ampere-type valves are employed. One choke should be inserted in each mains lead, as in Fig. 5, but coupling between the chokes is unimportant and they can safely be mounted side by side. It is very important, however, that the mains leads be kept well away from the output side of the chokes. For some reason which is not altogether clear, it will often be found that the use of these chokes not only reduces trouble due to H.F. currents in the mains, but gives an increase in signal strength.

In no set is the earth to be considered of little importance, but with D.C. it will be found to have a far greater effect than in a battery or A.C. type. Paradoxically enough, so great is its effect that the best results are sometimes obtained without it. Generally speaking, the earth should be connected through a 2 mfd. condenser to the earth line of the set, but even in those cases where no earth connection proves the most satisfactory, it should be retained for the earthing of those parts which it is essential to keep at earth potential for safety's sake.

In some cases it has been found that the best results are obtained by connecting the earth through 1 mfd. condensers to both the positive and the negative of the mains, but to the set side of the H.F. chokes. This arrangement is shown in Fig. 5, and when it is employed no earth is attached to the earth line of the set. This scheme was recently tried out in a superheterodyne with which it proved very effective, giving about five times the signal strength of the more normal connection, with complete freedom from whistles. So much do different supply systems vary, however, that it is quite possible that other mains would be better treated with an alternative earth, and this should be tried.

The explanation of why such a connection should give improved results is not entirely clear, but it is probably due to there being a difference of H.F. potential between the local earth and the mains earth at the power station. The removal of the H.F. chokes, it should be noted, gave a considerable reduction of signal strength.

Summarising.

It will thus be seen that the problems of D.C. mains working are really three: first, the obtaining of efficient smoothing of the H.T. supply; secondly, the elimination of hum pick-up in the receiver; and, thirdly, the isolation as regards H.F. currents of the receiver from the mains. Since the relative magnitudes of the problems vary with different supplies no single solution is possible, and something must always be left to the user of the set to try out for himself. This something, however, may be no more than finding out the best way of connecting the local earth, or whether such connection is desirable at all.

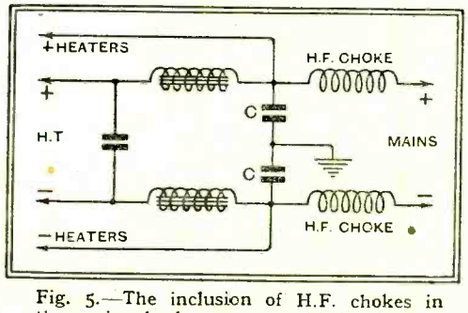
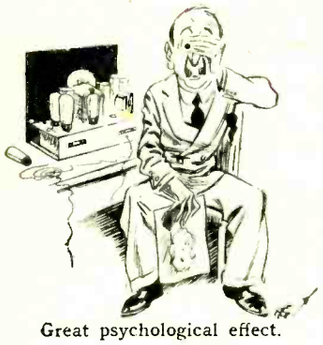


Fig. 5.—The inclusion of H.F. chokes in the mains leads removes whistles from a superheterodyne, and in some cases the connection of the local earth between condensers C gives increased efficiency.

UNBIASED

By FREE GRID.



Great psychological effect.

Physiognomy and Radio.

A READER has sent in a very interesting suggestion to me, and that is that in future all "W.W." articles should contain a photograph of the author. He says that such a policy would have a great pschological effect in helping a reader to make up his mind concerning which of the "W.W." set designs he ought to tackle. The idea has been put into his head, he states, by the fact that my own features appear in the journal about every week.

I have submitted the idea to the Editor, and his reply, which the postman has just delivered to me, is distinctly evasive. He states that he is perfectly willing to consider the suggestion provided that "W.W." readers who write to him or to the Information Bureau are prepared to submit their photographs so that a reply can be prepared which is suited to their mentality as revealed by the aforementioned photographs.

Drastic.

I HAVE always favoured the lynching of those owners of electrical apparatus who refuse to take the necessary steps to prevent their machines radiating obnoxious electrical noises to the annoyance of broadcast listeners.

I do think, however, that the worthy Mayor of Montereau, a small but now highly important town in France, has been a little harsh in issuing an edict forbidding the use of vacuum cleaners and electrically driven floor-polishing machines after mid-day. I think that he might at least have given the offenders the option of fitting anti-interference units to their machines. I dare say, though, that they have had quite sufficient warning and are undeserving of my sympathy.

A Delicate Mission.

DURING the course of a somewhat turbulent life I have been entrusted with missions of some delicacy which have required tact and finesse to carry them through, but none more so, I think, than one which has just been thrust upon me. Briefly, I have been entrusted with the task of approaching a somewhat formidable female, of uncertain years and temper, with a request that she take a bath at a more reasonable hour than is the case at present.

The unfortunate position in which I find myself is the result of being too meddlesome in my eagerness to track down a mysterious fault which was afflicting the radio sets in a whole series of bungaloid excrescences which have grown up in a district once sacred to the beauties of nature, where, as the poet put it, "every prospect pleases and only man is vile."

The fault took the form of distortion and loss of volume affecting each all-mains set in the neighbourhood for a period of about twenty minutes at the same time each evening. When I heard that simultaneously all the lights in the houses became dimmed the problem was, of course, half solved, as it was obvious that a drop in the voltage of the mains was at the root of the trouble.

An Appetite for Watts.

Having arrived in the district in response to an invitation from a friend who vegetated there, I speedily found that the affected dwellings (save the mark) were at the end of a long electric power feeder, and that the mains voltage was only 105; it became instantly obvious, therefore, that the fault was caused by some piece of electrical apparatus with a voracious appetite for watts.

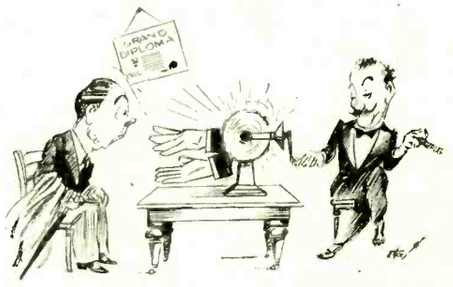
My task was to find out what the apparatus was, and in which house it was used. Now, there are better ways of getting information than pretending to be the man come to read the gas meter, and, after making myself known to the manager of the local dairy, I was enabled to take over the milk round for a few days. Then, having ingratiated myself with the maidservants with my usual *bonhomie*, I soon learnt all there was to be known about the habits of the occupants of these repellant doss-houses. The trouble was caused by an electric geyser of somewhat antique pattern, which was used to supply bath water for the lady already mentioned. It was, I found, the only piece of electrical apparatus in the neighbourhood which consumed energy to the tune of several kilowatts.

Took over the milk round.

Now, of course, I am faced with the job of approaching the lady, and this I am finding the most nerve-racking part of my self-appointed task. I have not yet summoned up sufficient courage, but, like Mr. Britling, I mean to see it through. But if any of you who are ladies' men can help me with suggestions, I do implore you to write without further delay.

Send Your Money.

ALTHOUGH I have heard vaguely of their existence, I have never actually come across a professional applauder. A well-known journal has just given an interview with one, who states that his pay is five shillings per performance. It is true that he does not directly assert that his bookings at the vaudeville studio at Broadcasting House are any better remunerated than at the music halls, to which he has been accustomed. I am, however, seriously thinking of starting a fund to outbid the B.B.C. in their competition for these professional gentlemen.



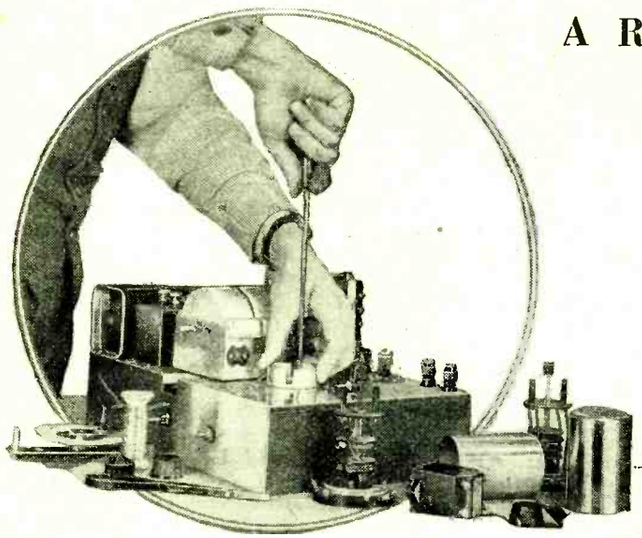
Interview with professional applauder.

If any of you care to join me I feel sure that we shall raise enough wind to be able to pay the professionals to go and clap in the next street and enable us poor listeners to hear the jokes and other dialogue emanating from the vaudeville studio; the studio claque renders such a feat quite impossible at present.

Watts Through the Wall.

IT is surprising to learn that the inhabitants of a council house have to stuff cotton wool in their ears and shove their heads under the bedclothes if their sleep is not to be disturbed by the loud speaker next door. Such was the tale of woe told at one of our police courts the other week. This state of affairs must mean either that the walls of council houses are so flimsy that these dwellings are unfit for human inhabitation or that the owner of the loud speaker is able to afford a very plutocratic amplifier, and is, therefore, far too well off to be allowed to live in a council house.

Now a receiver with an undistorted output of two watts is ample for any man who does not live in a baronial mansion, while according to rumours one hears of the cramped space in council houses, one watt would probably be all that could be tolerated by the inhabitants. Yet somebody must be exceeding this power output, for in spite of all the jokes about council houses I can scarcely believe that any builder would be so unprincipled as to put up a house with a party-wall so flimsy that the output of a two-watt amplifier was appreciably audible on the other side.



A Reader's Experience with "THE WIRELESS WORLD" Baby Superhet.

Practical Notes on Construction and Operation.

By W. WINDER.

AS one constructor to another, the writer of these notes points out certain small problems he encountered in building "The Wireless World" Baby Superhet and shows how, with a little enterprising experiment, he achieved a receiver with "selectivity well ahead of that of any straight set he has known."

A FEW years ago there was a vast army of amateur constructors with no theoretical knowledge of wireless. To-day conditions have changed; technical learning has spread, and it may be assumed that any constructor of such a set as the Baby Super will have an elementary grasp of the underlying principles, and will approach the task of assembly and adjustment with intelligence.

The designers have made that task as simple as possible, but one naturally comes up against small troubles, and these notes are merely the record of a few points met with by an ordinary amateur in constructing the Baby Super, the object in mentioning them being to help, if necessary, other constructors.

Constructional Hints.

Regarding the actual assembly of components and wiring there is little of value to say, as the job is quite straightforward when the ready drilled and covered baseboard is used. In connection with the "Polar" gang condenser three longer bolts than those provided will be necessary, and as the writer scoured a large Midlands town without being able to buy the correct size and thread, similarly placed readers will be glad to know that the bolts used to fasten the Rola speaker to its temporary protecting baffle are the very size wanted. When mounting the Wearite I.F. transformers one finds the fixing holes inclined at an awkward angle, and the writer suggests carefully working a small round file vertically through the holes until their section is elongated sufficiently to allow the screws to go straight down into the baseboard. It will also be found that one of the bolts holding the 0.0001 μF under-baseboard condenser comes perilously near one of the 200-volt terminals on the second intermediate, so that it is wise to use a flat-headed bolt in a countersunk hole for this position. Soldered joints to the valve pins are the most satisfactory, but one should remember that if the set is turned completely upside down for this job, the solder is apt to run down the hollow valve pin and prevent subsequent entry of the valve.

The simple directions for ganging were carried out, and the set at once showed that its range was a good deal better than the average straight three-valver with which it is supposed to compete. Closer examination, however, showed that these results were obtained in spite of the ganging not holding over the whole range, and as many adjustments failed to improve matters, longing thoughts were directed to a calibrated oscillator, such as was recently described in this journal. One cannot these days afford such a luxury as well as a superhet, so a collection of spares was brought out, the simple circuit shown in Fig. 1 built up, and the intermediates tuned exactly to their correct frequency. Apart from efficiency, accurate ganging is of importance in obtaining freedom from second channel interference and background hiss.

This spare part oscillator is by no means a laboratory instrument, but it is infinitely better than no oscillator, and the improved results following its use amply repay the trouble. I trust the designer will not read the next remark: a modulated note of 100 cycles was obtained by connecting the H.T. supply for the oscillator to the wrong end of the smoothing choke in a friend's eliminator, the right end of the choke being used when for any purpose an unmodulated signal was required.

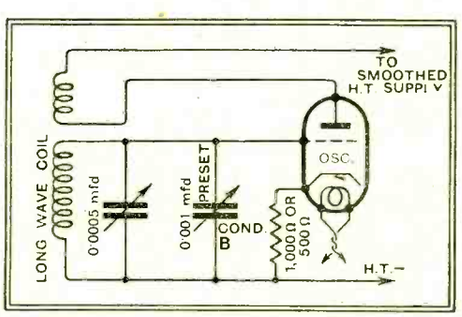


Fig. 1.—A simple oscillator for ganging which can be built from spare parts.

Ganging.

Calibration is simple. With condenser B screwed right down, the instrument has a frequency range of roughly from 90 kilocycles to 120 kilocycles. Such long-wave stations as 5 XX, Eiffel Tower, Warsaw, and Motala, especially the last-named, are tuned in on any receiver (the partially ganged Baby Super will do), and each in turn heterodyned by the oscillator. Actually it will be the second harmonic of the oscillator that does the heterodyning, as, of course, the fundamental frequency will be only half that of the broadcasting station. A graph is then made by plotting oscillator readings against half the frequency of the respective broadcasting stations, and we have a curve showing the fundamental frequency of the oscillator for any position of its tuning dial. The oscillator dial is now set to the position corresponding to 110 kilocycles, and—hey presto!—the much desired frequency of 110 kilocycles is produced.

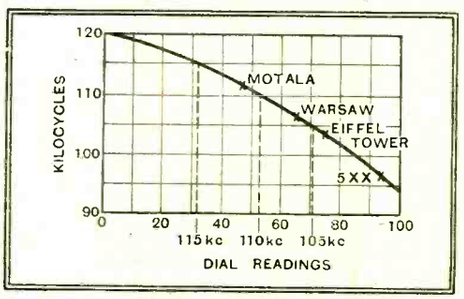


Fig. 2.—The calibration curve of the experimental oscillator.

Terminals 4 and 6 of the oscillator coil in the Baby Super are now short-circuited, the intermediate coils set far apart, and the home-made oscillator brought sufficiently near to the Baby Super chassis to produce a 100-cycle hum in the loud

"The Wireless World" Baby Superhet.—

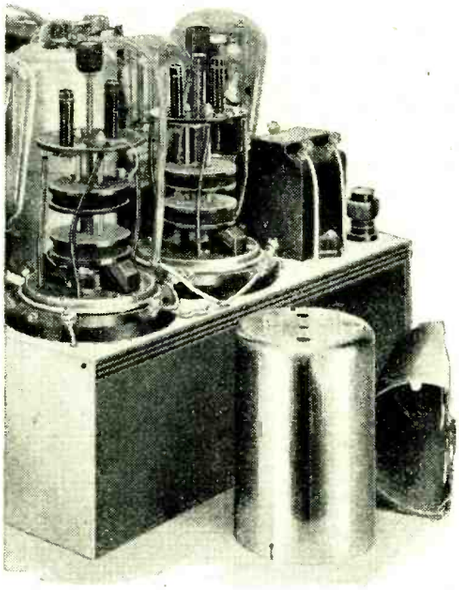
speaker. It is possible that the intermediate coils will have to be brought into closer contact to find the hum, but for fine adjustment they should be screwed right down. The intermediates are tuned, of course, by setting the four trimmers to produce maximum hum, and the coupling of the coils is adjusted until the hum remains constant whilst turning the oscillator dial from 105 to 115 kilocycles. The coupling should not be so tight that the hum remains beyond these limits, or adjacent channel selectivity will suffer. The rest of the ganging is carried out on the gang condenser trimmers and the two Varicap condensers as explained in the constructional article.

Final Touches.

With the range, quality, and selectivity now satisfactory, there were only two troubles to overcome. Background hiss on the weaker foreigners was still rather troublesome, and, secondly, operation of the volume control caused a fireworks display in the loud speaker. With the object of getting a bigger ratio of signal strength to background noise the wire connecting the aerial terminal to volume control was cut out, thereby removing the damping effect of the potentiometer on aerial input. This had the desired effect of reducing oscillator hiss, and also had the unexpected effect of entirely removing the second trouble. In the writer's district, twenty miles from Daventry, the first detector could easily handle all signals fed to it. Nearer to a main station, however, this removal of aerial input control would probably necessitate a local distance switch to prevent overloading on the locals, but this should be an easy matter to arrange.

In conclusion, perhaps a word on the set's performance would not be out of place. Selectivity is well ahead of that of any straight set the writer has known, irrespective of the number of tuned circuits, and quality is in no way sacrificed to attain this desirable state of affairs. Non-technical friends with modern commercial sets have so far forgotten their pride of ownership as to allow a note of envy to creep into their comments on the Baby Super's quality of reproduction. Bass, without being unduly prominent, is well produced, and the crisp clarity of speech and music shows plenty of "top."

In the Midlands we count ourselves fortunate in having only one high-powered short wave local to deal with. This previous bugbear of the district is easily handled by the Baby Super, for although it forms a background to Sottens it quite disappears 18 k.c. from resonance, so that Katowice is free from interference. Prague, North Regional, and Langenburg are all easily separated, whilst London Regional and Muhlacker are no longer Siamese twins. On the long waves Radio Paris is quite separate from either neighbour, and Eiffel Tower has no background from Daventry. Zeesen, though intelligible, suffers somewhat from interference by 5 XX. Range is better than that of any straight three-valve set and equal to that of most four-valve sets, but if undue hiss is not to form a background to the weaker foreigners a reasonably good aerial is essential. On an aerial consisting of ten feet of wire slung under the eaves, with a drop of 16 feet to the set, all the main foreigners, such as Rome, Langenburg, and Brussels, were received with the volume control well turned down and therefore without background noise. On a better aerial, albeit still only average, the tendency for background hiss on the weaker stations disappeared, and in one tour of the dial thirty-five stations were received free of interference, and of



The method of coupling the coils of the intermediates is visible in this photo, where the screening covers have been removed.

definite entertainment value. This does not take into account those too weak to enjoy.

In the Midlands second channel interference is non-existent, as the frequency at which it would occur is off the top of the dial. Slight whistles caused by the two London stations disappeared with accurate ganging.

DISTANT RECEPTION NOTES.

EVERYONE admits that a good earth is essential if a wireless receiving set is to do itself justice, except, of course, when a frame aerial or a counterpoise is employed. It is surprising to find how thoroughly bad are the earth connections used by a remarkably large proportion of wireless enthusiasts; and, curiously enough, it is by no means always the beginner whose earth is the most unsatisfactory. Time and again I come across first-rate sets which are putting up poor performances simply and solely because the earth connection is a poor one. Only the other day a friend who had purchased a set of a type which I know to be quite first rate complained bitterly of the poor results that he was obtaining with it. I gathered from him that its sensitiveness and its selectivity were beneath contempt, and that distortion was manifest unless the volume was kept down to very small proportions.

As I had obtained remarkably good reception with a similar set I was very interested in this report, and I decided to investigate. I suspected the earth connection, but he was very definite that there was nothing wrong with this. It consisted of a large copper tube, driven well into a flower-bed lying just under the aerial. On digging down to the point of the tube we found that it was embedded in the lightest of gravelly soil. By deepening the hole a further eighteen inches we came upon a bed of good, honest clay, and, as soon as the earth tube was driven into this, the set became a completely different thing. I am convinced from what I have seen that about 25 per cent. of the wireless sets in use at the present time are handicapped by being worked with poor earths.

Fading Effects.

During the latter part of October and the first few days of November fading was more pronounced and more annoying upon the "broadcast" waveband than I have ever previously known it; and, as I mentioned in these notes, its effects were noticeable upon long-wave transmissions as well on certain evenings. Fading has now disappeared almost entirely except at the very bottom of the medium waveband, and it is possible to hold distant stations for long periods without any objectionable waxing and waning of signal strength. Budapest is a remarkable station just now. With a sensitive set it can be received at any time when it is working. I have had wonderfully good reception at ten o'clock in the morning. Other medium-wave stations which are available in daylight when conditions are at all favourable are Heilsberg, Hilversum, Breslau, the Poste Parisien, Leipzig, Stockholm, Rome, Langenberg, Prague, and Brussels No. 1.

After dark the number of first-rate transmissions is now very large indeed. Valencia is becoming better and better, whilst Trieste and Turin provide enormous strength when required. Gleiwitz, Bratislava, and Bordeaux are nearly always to be well heard. Gothenburg is not, perhaps, quite so good as it was, but Milan is much improved. Brussels No. 2, Strasbourg, and Toulouse can hardly be missed. Leipzig is almost overpowering, and Katowice is generally received without difficulty at good loud speaker strength. The strength of Berlin Witzleben is improving, but recently heterodyne troubles have set in. Despite the mere 700 watts with which it is credited, the Ecole Superieure is a real loud speaker station, and Lyons Doua is frequently receivable at the same strength.

D. EXER.

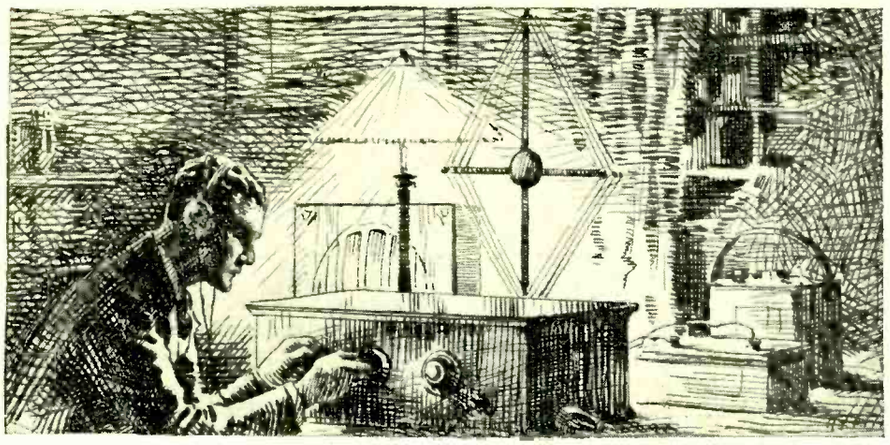
The Wireless World

INFORMATION BUREAU.

THE service is intended primarily for readers meeting with difficulties in the construction, adjustment, operation, or maintenance of wireless receivers described in *The Wireless World*, or those of commercial design which from time to time are reviewed in the pages of *The Wireless World*. Every endeavour will be made to deal with queries on all wireless matters, provided that they are of such a nature that they can be dealt with satisfactorily in a letter.

Communications should be addressed to *The Wireless World* Information Bureau, Dorset House, Tudor Street, E.C.4, and must be accompanied by a remittance of 5s. to cover the cost of the service. The enquirer's name and address should be written in block letters at the top of all communications.

Why Signals Fade.



Part II.

The Effect of Indirect Rays.

THE facts outlined in the first article enable us to trace the cause of fading. Reverting again to Fig. 1, if the signal reaching R is due to both ground ray and indirect ray, the total signal activating the aerial will depend on the "phase" of these two components, i.e., whether they are in step or not. This is illustrated in Fig. 4, which shows the combination of two waves of nearly equal amplitude but of different phase in the three cases. In (a) the two waves are strictly in step or phase with each other, rising and falling together. The resultant is a wave of their added amplitudes. Thus if the thin continuous curve D is the direct ray, the dotted curve I the indirect ray signal, the total signal S is the heavy continuous curve shown. If, however, it should happen that I arrives in opposite phase, the conditions are those shown in (c) where I now systematically opposes D, and the resultant is the low value shown for S. Actually, if I had been exactly equal in amplitude to D (instead of being slightly less, as shown in the drawing), the resultant would have been zero. The middle curve illustrates an intermediate condition when I is 90° out of step from D. It is thus easy to see that if D remains constant, but I is, for any reason, caused to vary in its phase relation with D, all sorts of variation may be encountered between the extremes shown. To take a concrete case, if in Fig. 1 the distance between transmitter and receiver is 100 km., while the layer height is also averaging 100 km., then a variation of only 3 or 4 metres in height is sufficient to reverse the phase of a 300-metre wave arriving at R.

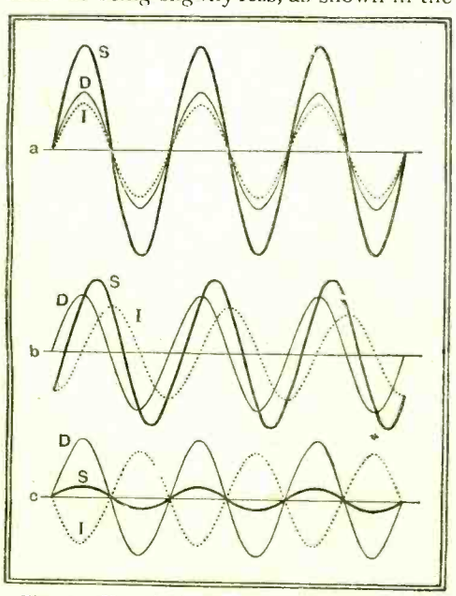


Fig. 4.—How fading occurs. The combination of two waves of nearly equal amplitude but with different phases.

Actually, however, the conditions may be, and indeed are, usually much more complicated than those shown in Fig. 1. For example, the indirect ray at R is there shown as being the result of only one downcoming wave. In practice the whole downcoming signal at R may be the result of several reflections. Thus in Fig. 5 the indirect ray I_2 is exactly the same as that shown in Fig. 1, but it is also accompanied by another downcoming ray, I_1, which has been sent up to the ionised layer and returned from it to the earth at an intermediate point, whence it has been reflected back to the layer and then again to earth. The effective signal at R will thus depend on the amplitude and phase both of these downcoming rays in relation to each other and in relation also to the direct ray, if any.

Long Waves.

According to the wavelength and distance, it has been shown by experiment that the downcoming signal at R may actually consist of a number of rays which have gone up and down several times in the manner shown. The various facts considered above now bring us to the position of reviewing how the different groups of waves behave at different distances.

(1) At short distances, on all wavelengths, reception is due entirely to the direct ray, and is thus constant and stable.

(2) At medium distances the direct ray is still of considerable strength. On long waves, say over 1,000 or 2,000 metres, the indirect ray remains very constant in its phase relation to the ground ray, and may give positions where the two systematically assist or oppose each other. This is still approximately true of the long broadcast waves of 1,000 to 2,000 metres. Moreover, the direct ray is still little attenuated, and thus gives, for the same power, a much greater range of daylight reception than the waves of the medium-wave broadcast band. On these medium waves (200-550 metres) at distances of about 100 miles there is in daylight very little indirect ray, the waves sent up into the air being heavily absorbed by the ionised layer, as discussed earlier in this article. Reception is then by the direct ray alone, allowing for the more rapid attenuation which has also been illustrated. There is thus no fading—the signals, even if they are weak, remain of relatively constant strength (or constant weakness). In dark hours the indirect ray appears with a strength which is, at the distance stated, roughly equal to that of the ground ray. If the layer were a perfectly stable and smooth layer—as it more or less is for longer waves—the same stable conditions would exist. But at these wavelengths the layer is not uniform and smooth, but is more like a cloudbank of ions, and therefore varies widely and rapidly in its ability to return waves of this length. The result is that the total path of the indirect ray is liable to sudden changes, causing it to fall in and out of phase with the ground ray as already considered. Fading is therefore bad and is indeed usually at its worst at this sort of distance where the direct and indirect rays are of about equal strength

WAVE reflection from the two ionised layers in the upper atmosphere was discussed in the first part of this article, which appeared last week. It is now shown that when the ground and sky waves arrive together at the receiver they may be periodically out of step and thus cancel each other. In this way the well-known phenomenon of fading can be explained.

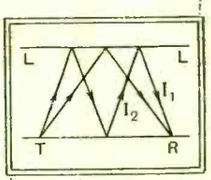


Fig. 5.—It is possible that two indirect rays may be received at R.

Why Signals Fade.—

but liable to sudden variations of phase.

At greater distances of over 300 to 400 miles, on long waves, including the 1,000-2,000-metre band, conditions are little altered from the above. The ground ray is, of course, still further attenuated and the general difference between day and night is more pronounced, but conditions

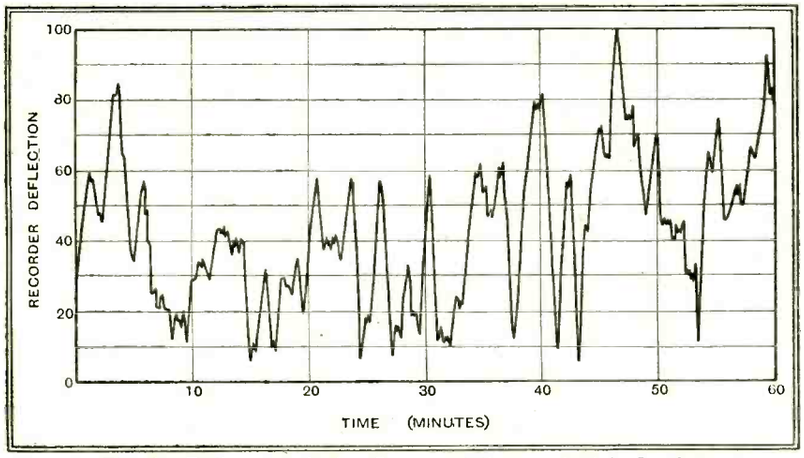


Fig. 6.—Fading-record of a German station received in London.

are still characterised by long-period stability. On waves of 200-500 metres the ground ray is heavily attenuated and very little of it is received. In daylight there is no indirect ray, so that the signal due to the feeble direct ray can only be picked up from relatively powerful transmitters by relatively sensitive receivers, but fading will be marked by its absence. In dark the indirect ray (or rays) assume high values, and signals may be well received. Fading is, however, still liable to occur, due jointly to actual variation of the *strength* of each downcoming ray reaching the receiver, and also to variations of phase between different downcoming rays that may be present (in a manner such as has already been considered). This effect is well known to all listeners to distant stations, while it may be mentioned that the variation of signal which occurs is frequently much worse than is apparent to the ear. This is due to the fact that the ear is not notably sensitive to changes of strength, while the effect is also liable to be masked by actual variations of modulation. By way of illustrating the degree of fading that can occur, Fig. 6 shows a record of reception in London of a medium-wave German station during the evening hours, the variations shown being those of the actual carrier wave. During the hour-record, variations of at least 20 to 1 are shown, representing practically complete disappearance of the indirect ray, as the ground ray was such as to give about five divisions on the recorder chart, representing an aural signal of low value.

(3) At great distances, e.g., over 1,000 miles, the conditions are simply a continuation of those already considered. At still greater distances, on all wavelengths the direct or ground ray is entirely absent, and reception is due entirely to the indirect ray. It was this fact, of course, that first led to the postulate of the Heaviside layer, and it is certain that if it were not for the layer no signals could reach even a quarter way round the earth. The indirect ray is always present to some extent, but is much more intense during the dark than in daylight. Signals are therefore strongest when darkness covers the whole path of the waves. Indeed, in very-long-distance communication (e.g., to Antipodean points) it has been found that signals frequently preferred to travel by paths which were geographically longer but all dark, rather than by a shorter path all or mostly in daylight.

Short Waves.

On short waves (below 100 metres) a new set of conditions is encountered. At these high frequencies there may not be enough electrons at low pressure to return rays arriving at the layer at a sharp angle. The conditions are approximately as shown in Fig. 7. The direct ray is received near the transmitter, but the attenuation on these waves is very rapid, and the ground ray is effectively reduced to zero at such a point as A. The layer has not yet returned waves at sufficiently sharp angles to produce any indirect ray at A, and it is not until such a further point as B that the downcoming ray makes its appearance. There is thus between A and B a region where no signal is received —usually called the skip-distance. Beyond this point the downcoming ray may be of very considerable strength, and is, indeed, frequently of such strength as to span half (sometimes the whole) of the earth's circumference. On the other hand, reception is entirely at the mercy of the indirect ray, and therefore of its variations of strength. Fading is thus always liable to occur, and it is, of course, well known that fading on short waves does occur at extraordinary rapidity. The whole subject of the propagation of short waves is one of the greatest interest, and of the utmost importance in the future of wireless communications. Already they are being used in regular working to an extent quite undreamed of eight or ten years ago, but we have still much to learn about short waves and their ways.

A very important point of practical broadcast policy arises out of what has been said above about the effects at various distances on waves of the medium broadcast band. This is the matter of aerial design with a view to improving the ratio of direct to indirect ray. An obvious method of attack is an aerial system designed so as to send most of its energy along the ground and little up into the air.

Advantage of Special Aerials.

Several advantages will accrue. First, the increased strength of the ground ray would increase service area and also move farther away the region of serious fading. It also appears that even at greater distances, when the ground ray is effectively zero, an aerial of this kind gives a stronger and less variable indirect ray, and therefore lessens fading. This is apparently due to the fact that, on account of less energy being shot up into the air, the waves have to travel a long way before they reach the reflecting layer. They thus reach it at a more grazing angle and are more gradually bent than waves which are shot up more directly. They are therefore less affected by irregularities of the layer than are waves of sharper incidence, and consequently less liable to fading. This generalisation is well confirmed by reception in England of various Continental stations which are known to have aerials of the "$\frac{1}{2}\lambda$" type, which gives an improved ratio of ground to indirect ray.

The whole subject of the propagation of waves is still one largely of experiment, on which, in England, a great deal of

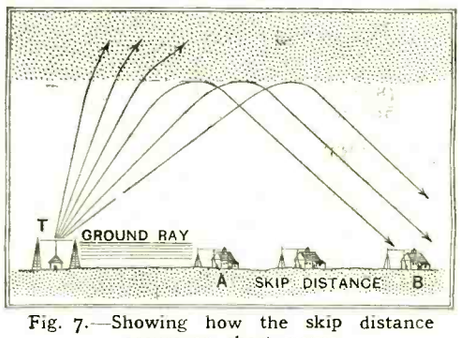


Fig. 7.—Showing how the skip distance occurs on short waves.

valuable work is being done by the organisation under the Radio Research Board, as well as by the Post Office, B.B.C., and the Marconi Co. In reviewing the complete theory the effect of the earth's magnetic field must come largely into consideration, since it is known that the ionised particles, in the course of their oscillations, are certainly acted upon by the earth's magnetic lines of force. These effects are not, however, of such direct bearing on the primary subject of fading, and no account of them has been attempted here.

It is impossible, however, to conclude this article without indicating some of the methods by which it has been established that waves are returned from aloft. The first experiments by Prof. Appleton were on lines which, although giving the direct result, were not of themselves so directly obvious. The method now being used in many countries for investigation of the ionised region can be understood from

Why Signals Fade.—reference to Fig. 8. Suppose we have a transmitter and receiver only a few kilometres apart; then a signal will travel by the direct-ray path in such a brief time as effectively to be quite instantaneous. On the other hand, a signal sent upwards will have to travel up to 100 kilometres and down again the same distance before reaching the receiver. A path of 200 kilometres

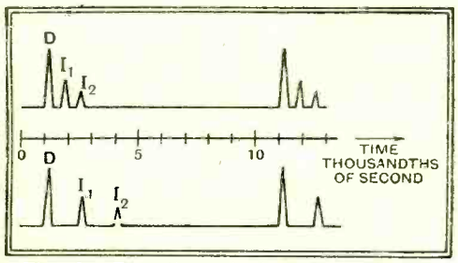


Fig. 8.—Reception of short-wave signals for measurement of layer heights.

thus takes two-thirds of a thousandth of a second, as compared with the ground ray, which effectively takes no time at all. In the same way, a wave which travels up to the higher region at 230 kilometres will take about 1½ thousandths of a second. It is therefore possible to send out a very short signal—just like an extremely brief morse dot—lasting only a small fraction of a thousandth of a second. This signal can be received and fully recorded at the receiver before the first echo has been received from the ionised region. The time between the receipt of the ground-ray signal and that of the first echo is thus a direct measure of how high that echo-signal has been. The instruments used for recording such signals have, of course, to be very speedy in their response, and the cathode ray oscillograph is being much used on this account, although other types of rapid oscillograph have also been employed.

The type of record so obtained, but drawn on a continuous time scale, is shown in Fig. 8. The upper diagram is for a wave returned from the 100 km. region. The first impulse D is the direct, or ground-ray signal, shown as lasting for about one-third of a thousandth of a second. The next impulse, I_1, is shown received two-thirds of a thousandth of a second later, being the first indirect ray, once up and down; the impulse I_2 is similarly the record of an indirect ray which has been twice up and down between transmitter and receiver. In practice, of course, still other echoes might also be recorded. The whole process is then repeated, say 1-100th of a second later, and so on.

The lower trace shows a similar type of record for a shorter wave, which has been up to the higher region at 230 kilometres before being returned, D being again the direct ray and I_1 and I_2 typical first and second indirect-ray signals, the longer time taken being due to their further travel.

Thinking in fractions of a thousandth of a second must take a little practice. Fortunately the observers are able to record photographically and can translate these results afterwards.

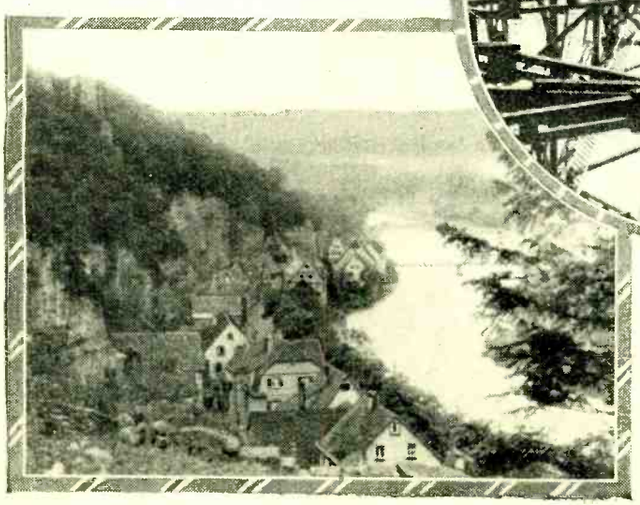
ON THE SPOT.

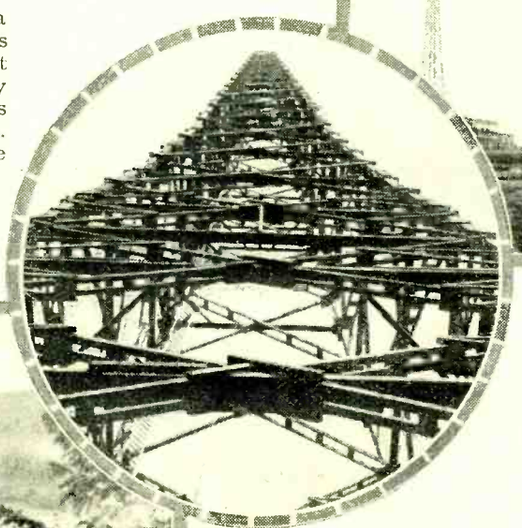
Visits to Foreign Broadcast Stations.

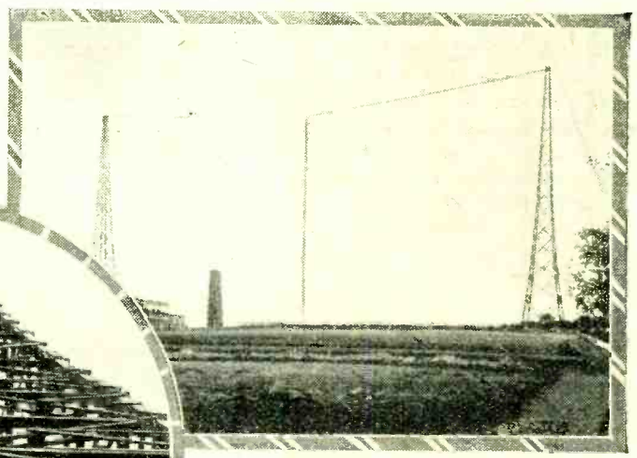
II.—Südfunk (Mühlacker, Freiburg-im-Breisgau).—Mühlacker (832 kc. 360.5 m. 60 kW.); Freiburg-im-Breisgau (527 kc. 569 m. 0.3 kW.).

STUTTGART I always look on as a friendly station. The visitor is always welcome, and I think some of this spirit permeates the programmes. Stuttgart, by the way, is one of the few German stations inviting British artistes to the microphone.

Süddeutscher Rundfunk is the name of the broadcasting company responsible for the Württemberg and Baden programmes in Germany. The main studios are at Stuttgart, subsidiary ones at Freiburg-im-Breisgau, Karlsruhe, the capital of Baden, and at Mannheim, the industrial town. Actually, of course, Stuttgart is closed, the high-power station at Mühlacker on the Württemberg and Baden border having taken its place. The Stuttgart studios are, however, as active as ever. They are situated in what was once a convent, though the main studio has since been used as a cinema.







Left: Durrmenz-Muhlacker, the picturesque little village above which the transmitter stands.

Centre: A study in perspective: a ground view of one of the Muhlacker masts.

Right: A general view of the station. The transmitter hall can be seen on the left.

Südfunk supplies one of the less densely populated areas of Germany, and it is therefore ranged among the "poor" German companies. Thus close co-operation is maintained with the Südwestfunk of Frankfurt, and actually Stuttgart and Frankfurt each supply half a week's programmes covering the two areas.

Male announcers are usually employed at Stuttgart, though occasionally, during the summer months, a woman's voice is heard.

WANDERING WAVE.

Practical HINTS AND TIPS.

AIDS TO BETTER RECEPTION.

I.F. Coupling Transformers.

BEFORE finally mounting in position the I.F. transformers of a superheterodyne receiver, it is wise to examine the simple mechanism provided for adjustment of the built-in trimming condensers which are shunted across the windings. The capacity of these condensers is usually varied by means of levers which project sufficiently far for their ends to be accessible, or, alternatively, by extension rods, through which a screw or nut is rotated.

There should be no doubt that operation of the control actually causes the position of the moving plate or plates to be altered.

Pre-tuned Band-pass Sets.

AT first sight the band-pass principle of tuning would seem to offer an ideally simple solution of the problem of designing a high-quality local-station set. The circuits might be tuned with inexpensive semi-variable condensers of the compression type; accurately matched, and therefore relatively expensive ganged condensers and corresponding tuning coils would seem to be unnecessary, and thus very considerable economies could be effected.

The idea could be carried a little farther and by the inclusion of an easily devised switching scheme arrangements could be made to change over at will to the wavelength of either one of a pair of twin stations, the tuning of the circuits having been "pre-set" with certainly a higher degree of accuracy than would be possible even with the best of filters arranged for continuous tuning in the ordinary way.

But illusions as to the attractiveness of this simple scheme are apt to be rudely dispelled if it be put to a practical test.

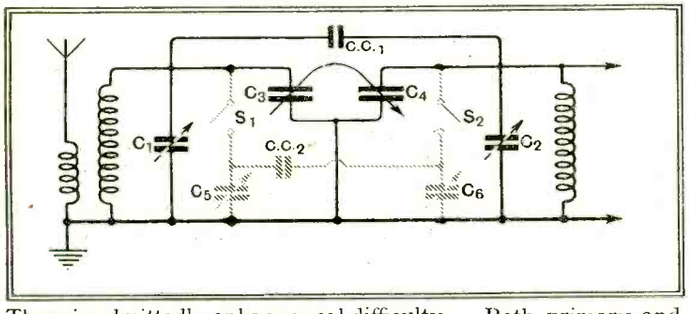


Fig. 1.—For twin station reception: the filter is tuned to the shorter wavelength by compression condensers C_1 and C_2. A change-over to an alternative programme is effected by linked switches S_1 and S_2.

There is admittedly only one real difficulty, but it is a serious one. Those who have tried it need hardly be told that it is an extraordinarily difficult business, without special apparatus, to set up a true filter circuit designed to embrace a wide band of modulation frequencies, unless the individual circuits are tuned by a ganged condenser. The usual procedure is to "trim" the circuits very carefully, when coupling between them is made so loose that there will be no tendency to double-humped tuning. When both circuits are in exact resonance, coupling is increased to the extent necessary to widen the response curve, and thus to avoid side-band attenuation. Without linked tuning controls it is almost impossible to do this; in practice, one finds that the resonance curve of a filter with individual tuning adjustments is a lop-sided affair, bearing hardly any resemblance to the idealistic form usually taken to illustrate the advantages of the system of tuning in question.

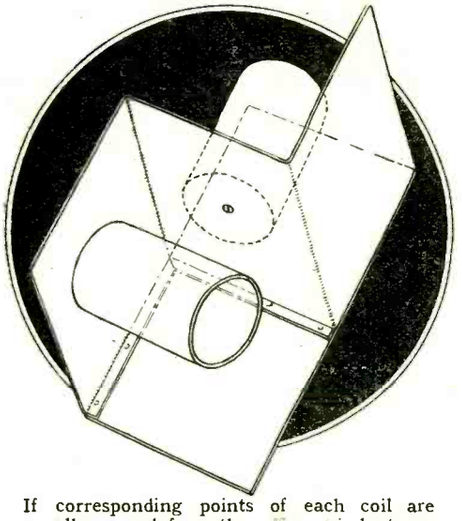
A partial solution of the problem is suggested in Fig. 1, which shows diagrammatically a pre-tuned filter which has proved itself to work "according to plan." Unfortunately, the original ideals of extreme simplicity, and to a lesser extent of cheapness, have not been realised, but, on the other hand, it affords almost perfect tuning at two wavelengths, and—an important point—adjustments seem likely to remain constant for an indefinite time.

To avoid complications, we may ignore for the moment the part of the circuit which is applicable to the reception of the second station, and which is shown in faded lines. The condensers C_1 and C_2 are of the compression type, specially chosen for constancy, while the coupling condenser CC_1 is an improvised affair, adjusted by trial and error to give control of coupling. In order to overcome the difficulty of separate controls, the condensers C_3 and C_4, which act as ganged trimmers, have been added. For this purpose a series-gap short-wave condenser, of which each section has a capacity of about 0.00005 mfd., is used. Both primary and secondary tuning coils are fully screened.

In setting up the circuit the procedure is to adjust C_1 and C_2 accurately to the wavelength of the desired station, the coupling capacity CC_1 being set at such a low value that there is no trace of true band-pass tuning; the moving vanes of C_3 and C_4 are about half enmeshed.

With everything carefully adjusted for "peaked" tuning, the capacity of CC_1 is increased to broaden tuning, and all future adjustments are done by small variations of the ganged trimmer.

To turn the set into an alternative-programme receiver, another pair of compression condensers, C_5 and C_6, are thrown into circuit by switches S_1 and S_2; these extra capacities are, of course, used to tune the circuits to the local station of higher wavelength. The extra coupling needed to maintain the same degree of sideband retention as on the shorter wavelength is provided by CC_2, which, like the other coupling condenser, need have a maximum capacity of only a few micromicrofarads.



If corresponding points of each coil are equally spaced from the screens, inductance matching will be unaffected.

Symmetrical Screening.

ORIGINALLY brought into being by the requirements of single-knob control, the "potted" tuning coil, mounted under its own individual screening cover, has at present no serious competitor. By adopting this method of screening in place of the older idea of metal boxes or compartments for the various pieces of apparatus associated with each stage, the accurate matching of coil inductances becomes easier, and it can be assured that, when once matched, inductance will not be changed by external influences such as the proximity of masses of metal.

But occasions still arise where it is desired to use large coils which cannot conveniently be totally enclosed. Of course, precautions against interaction between the coils must almost always be taken, and in a ganged control receiver there is probably no better method of screening than that shown in the accompanying sketch. The coils are so mounted that interaction between them is at a minimum, and they are equally spaced from the metal.

NEWS of the WEEK.

Cuckoo!

RADIO-LJUBLJANA, the Yugo-Slavian station famous for its cuckoo interval call, has just celebrated its fourth birthday. The station, which now has 8,000 regular listeners, is controlled by the Roman Catholic Church, the director of programmes being a priest.

Toulouse Working on 60 kW.

RADIO TOULOUSE has now started experimental transmissions after midnight from the Château de Saint Agnan on a power of 60 kW. Requests for reports are made in French, English, German, and Spanish. The signals can be heard in London at great strength, although fading, which has always spoilt the Toulouse transmissions, is still apparent.

Post Office permission for regular high-power transmissions is being eagerly awaited.

P.O. Radio Film.

THE Post Office is justly proud of its Radio Department. Their work has been enshrined in a new propaganda film which was shown to M.P.s at the Pathé Studios last week. The film includes vivid glimpses of the work at Rugby Radio and at the Carter Lane Exchange, where thousands of overseas calls are handled daily.

This film would form a useful interlude at the average cinema, and we hope that it will shortly be circulated.

What of Luxembourg?

THE fanfare of trumpets over the imminent arrival of Radio Luxembourg with its unprecedented power of 200 kW. seems to have died down. Enquiry at Junglinster, where the station is situated, elicited the reply that the station could not begin its relay tests until the Madrid conference gave it a wavelength. Now that the Madrid conversations seem to be coming to an end, there is a likelihood that Luxembourg may at last find a niche in the ether. It will be a big niche, and no normal station will feel safe until it is known where that niche will be.

Leipzig v. Prague.

THROUGH a UFA news film, Prof. Neubeck, the programme director of the new Leipzig station, has let the cat out of the bag. Discussing the glorious future of the new high-power transmitter, the professor mentioned that it would now be possible for Germans living beyond the frontiers to listen in to the Fatherland. This, it is assumed, proves that one of the main aims in placing Germany's highest-powered station near Leipzig was to give Germans in Czecho-Slovakia an alternative programme to that radiated from the powerful Prague station.

It is worth noting that German broadcasting authorities have denied, on previous occasions, that increase in power ever aimed at covering other than German territory.

Their Own Fault.

THE Danish broadcasting authorities recently asked for original radio plays suitable for the microphone. They are now ploughing through 1,398 manuscripts.

Current Events in Brief Review.

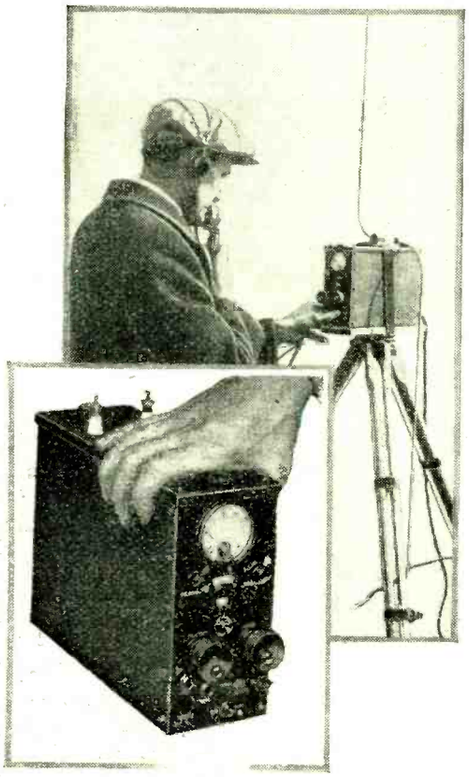
Coming Shortly.

TWO new German 60-kW. broadcasting stations are about to make their first bow. Munich on 533 metres is expected to begin a regular service almost immediately, while January should see the opening of the new Berlin high-power transmitter.

And Now 300-kW. Valves.

VIENNA will be the first European broadcasting station to use the new Telefunken 300-kW. water-cooled transmitting valves. It is rather surprising that the new German stations have not had the preference, but we understand that the German Post Office specified the use of a number of lower-powered valves in preference to one or two of the 300-kW. specimens.

The Germans prefer not to put all their eggs in one basket!



A 5-METRE PORTABLE. The new R.C.A.-Victor "Tranceiver," on which telephony can be transmitted or received on ultra-short waves at a moment's notice. Note the camera tripod. The weight of the instrument, including batteries, is only 22 lbs.

Organ Music on Tap.

AT the inauguration of the thermionic organ at Poste Parisien the other day, M. Givelet, the inventor, declared that a new era was opening for organ music. Soon a single organist at the keyboard could distribute the music simultaneously to all the cinemas of a town, or all the churches of a diocese.

Picture Music.

AN Austrian composer, Herr Bartholomaus, has gone to the trouble of recording on a disc a "symphony" produced by unrolling an ordinary silent film before a photo-electric cell. It is stated that this musical *morceau*, while possessing little artistic value, "is none the less a remarkable realisation."

Konigswusterhausen in Trouble.

GERMANY'S long-wave broadcasting station ran into a train of misfortune last week. On Sunday, November 6th, Konigswusterhausen broke down for a period of nearly one hour, although the gap was filled with a transmission on low power. The next day the station was silent for a quarter of an hour during the European relay of the concert from Dublin.

A Real Test.

AN excellent test of microphone, transmitter, receiver and the listener's musicianship has been organised by the Philco Radio and Television Corporation of Great Britain. The Corporation announces a radio competition in which the contestants must try to identify the fifteen instruments which will be played by the Philco Legionnaires in the course of the Sunday broadcast from Radio Paris on November 27th, from 5.30 to 6.30. A second part of the competition consists of writing 50 words on the listener's favourite revue artiste.

The first prize will be a forty-four-guinea seven-valve superheterodyne Philco set, and the second a Philco 56 Baby Grand or a short-wave converter. The third prize will be a Philco moving-coil extension loud speaker.

World's Best Ship Radio?

LT. VITTORIO ROLLANDINI, Chief Radio Officer of the new 50,000-ton Italian liner "Rex," proudly announced, when the vessel steamed into New York Harbour recently on her maiden voyage, that "on this ship more space is devoted to radio than on any other passenger ship afloat."

The Lieutenant's claim is borne out by an inspection of the gear. Three lifts are provided especially for the purpose of bringing first-, second-, and third-class passengers up to "Radio Central," as the spacious accommodation which houses the equipment is called.

The "Rex" is equipped with seven wireless transmitters and associated receiving apparatus, all built in the Marconi works at Genoa. Four of these transmitters and receivers are lifeboat sets. The wireless telephone outfit is exactly the same as that fitted aboard Marconi's yacht, the "Elettra." The two telegraph transmitters are designed for communication on any wave from 18 to 5,000 metres. The receivers cover a wave range from 12 to 30,000 metres. The receiver used for long-distance telephony is a super-heterodyne using 37 valves. All the instruments are mounted in shock-absorbing cradles or are suspended from the ceiling by large

coil springs. This precaution is necessary, especially with short-wave apparatus, to protect the various parts from the vibration of the ship's engines and the shock of heavy waves. The direction-finder is installed in the chart room, adjacent to the bridge.

As the "Rex" approached New York, direct telephone communication was established with Genoa, and as a final gesture of contempt for distance, the operators turned around and immediately established communication, also by direct 'phone, with the Italian liner "Santo Rosso," which was then tied up in Shanghai Harbour. The call letters of the "Rex" are ICEJ, and Lieut. Rollandini has under him a staff of six operators.

The Ferrié Prize.

THE friends of the late Gen. Ferrié do not consider that the name of an Avenue and a monument in the Champs-de-Mars, Paris, are an adequate memorial to the late head of the French military radio service. So great was the public response to appeals for funds to commemorate the late General that nearly £3,000 has been collected. In the circumstances it has been decided to devote part of the subscription to a Ferrié Grand Prix, to be awarded as an incentive to radio research.

R.N.W.A.R.

FOR the benefit of London amateurs interested in the recent formation of the Royal Naval Wireless Auxiliary Reserve, another London meeting, open to all, is to be held at the Admiralty, Whitehall, S.W.1, on Wednesday next, November 23rd.

Previous meetings have enabled a number of keen amateurs to "get together" and discuss the scheme, which has as its object the provision of a reserve of operators for Naval Service afloat or ashore in times of war or emergency.

The meeting will be held in Room 60, First Floor, West Block. Entrance is by the Central Hall, Spring Gardens.

Taking Your Set to Italy.

WIRELESS sets may now be taken into Italy by British visitors on payment of a licence fee of five lire a month, approximately 1s. 6d., to the Italian Broadcasting Company. The payment is made through the Customs Offices at the frontiers in the same way as motor car licences.

All that is necessary is the completion of a form, either in advance or at the frontier station, giving the value of the set, the number of valves in it, and a statement as to whether or not it is fitted with a loud speaker.

Madrid to Abolish Interference?

IN the House of Commons, Capt. Fraser has recently asked the Postmaster-General if, in view of the demonstration by the Post Office at the National Radio Exhibition that practically all kinds of electrical interference with wireless reception could now be inexpensively prevented, he would take the first opportunity of securing powers to enforce the reasonable use of interference-preventing apparatus.

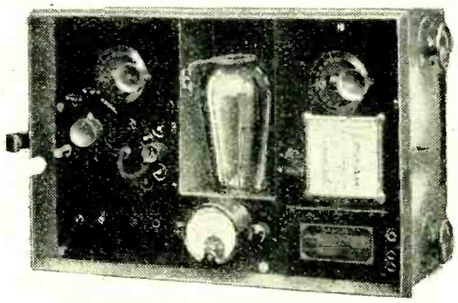
Sir E. Bennett, who replied, said the desirability of introducing such legislation would be considered, in connection with any amendment or law which might be necessary as the result of the deliberations of the International Radiotelegraph Conference now in session at Madrid.

Cubans Hate Radio Tax.

IT is rather a violent shock, after a life of free listening, to be asked to pay a 12-dollar radio licence fee per annum. The Cubans, who, according to our Washington correspondent, are faced with this unpleasant threat, are up in arms, and are not mollified by the thought that the fewer the valves the cheaper the licence. No one with a multi-valve set likes to be seen operating a single-valver, even if, as in this case, it means a licence drop from 12 to 3 dollars.

Radio Lessons of U.S. Election.

HOW American politicians "floundered" in their efforts to use radio during the Presidential Election is the theme of many complaints by listeners. Candidates and their spokesmen, it seems, repeatedly exceeded their scheduled periods at the microphone, a practice which was not merely expensive, but taxed the patience of a large share of the radio audience. Secondly, radio "cleared all wires" for political speeches regardless of the fact that



A MIDGET TRANSMITTER. A single pentode valve is used both for the generation of low power oscillations and for their subsequent amplification in this new Marconi A.D. 25A telegraph-telephone transmitter. It is fitted in the Bristol "Bulldog" fighter aircraft at the Paris Aero Show.

the favourite programmes of millions of listeners had to be shunted aside. Finally, political speeches were booked without regard to their possible conflict with speeches simultaneously broadcast from other stations, thus spoiling the opportunities of both parties.

Strangely enough, the winning candidate was a greater offender on the radio than President Hoover, who has an acknowledged radio technique. President Roosevelt, it appears, has many radio lessons to learn, including the art of brevity.

Exit Interference—Cost, $570,000.

IT has cost American broadcasting stations $570,000 during the past few months to install apparatus for the elimination of howls and whistles. This estimate was made by the Federal Radio Commission, who decreed last June 22nd that all American stations must, in future, curtail their "wave wobble" from the previously allowed 500 cycles on either side of the assigned frequency to a maximum of 50 cycles on either side. The Commission gave the stations one year in which to install the necessary apparatus. All stations were required to install visual frequency monitors, at an average cost of $655 each. In addition, a considerable group of stations had to improve their main equipment. That the Commission's new ruling is proving effective is proved by many appreciative letters from listeners.

New Zealand is Wondering.

PEOPLE in the Dominions sometimes wonder whether English manufacturers really want overseas business. According to our Wellington correspondent, the New Zealand distributor of a well-known English firm recently placed an order for 8,000 resistances, to be followed by another for 12,000. Two months after the promised shipment the goods had not arrived, and in reply to an urgent cable the factory promised delivery in another fortnight. The resistances were for New Zealand set manufacturers, whose output was considerably disorganised, and both orders were cancelled.

The order was eventually fulfilled with American stocks in New Zealand and by cable to Canada, which obtained delivery within three weeks!

BRUSSELS KEEPS WATCH.

Station Vagaries During October.

THE Brussels checking station of the International Broadcasting Union has just published its 66th graph showing to what degree the European stations adhered to their allotted wavelengths during October. The month must be regarded as comparatively satisfactory. Several stations which had appropriated the wavelengths of others resolved to turn over a new leaf with the approach of the winter season, consequently there has been less direct interference.

Kaunas, which has the longest European wavelength (1,935 metres) shows an increase of power. A mysterious station working on 178 kc., causing interference with Radio Paris and Ziesen, has been identified as a Russian telephony station without a name.

Vienna has continued its tests on 241 kc., between Baku and Boden, while Luxembourg has been testing on low power on 251 kc. Tashkent on 256 kc. is a newcomer, and will probably interfere with Kalundborg.

On the medium waveband there has been some reshuffling around 527 kc. Hamar has left Augsburg and Kaiserslauten and has gone on to Ljubljana's wavelength, causing considerable distortion.

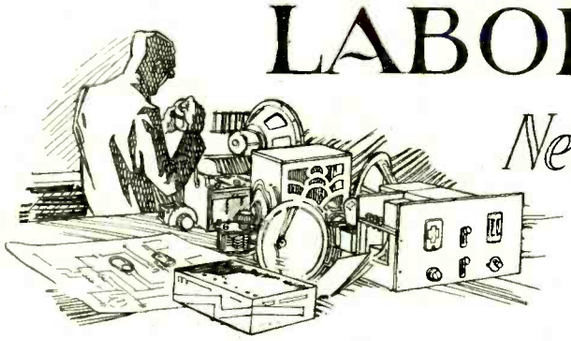
Russian Interference.

Perhaps *the* event of the month is the departure of Palermo from the Riga wavelength. It has now gone down to 558 kc., where it will probably heterodyne Munich and possibly Sundsvall. There is a Russian newcomer called Tartu between Vienna and Brussels. There is still an unknown transmitter working on the same wavelength as Florence, while a Russian with the aggressive name Ivanov-Vosneszensk is working on the North Regional wavelength.

Radio Stalino is interfering seriously with Radio Toulouse on 385.1 metres. Another Russian, namely, Uraspol, has managed to sandwich itself between London and Muhlacker. Radio Vitus has at last left Cardiff's wavelength and now shares one with Zagreb and Falun.

The worst offender as regards wave wobbling was Bremen, which moved from 1,121 kc. down to Bari's frequency of 1,112 kc. and back again several times during the month. Barcelona did not adhere to its wavelength, although free from interference.

Perhaps the least said about the remaining wavelengths the better. Bunches of unknown stations are working wherever they can find a footing or dislodge someone else; indeed, the wonder is that interference is not more obvious than it is.



LABORATORY TESTS

New Radio Products Reviewed

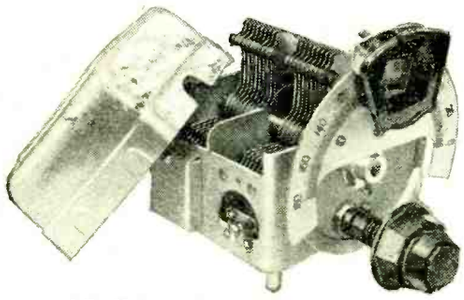
J.B. UNITUNE CONDENSERS.

IN the Unitune gang condensers, made by Jackson Bros., 73, St. Thomas' Street, London Bridge, London, S.E.1, the small trimmer fitted to the front section is controlled from the panel, its adjusting knob being mounted concentric with the main tuning control. The condensers are assembled in strong die-cast frames of compact design fitted with end bearings of generous size. The vanes are made from stout gauge aluminium and a wide spacing is used, the general construction being of a nature likely to ensure permanent accuracy provided the condenser is handled with the usual care.

They are supplied fitted with a slow-motion drive, giving a reduction ratio of 7 to 1 and a 0-180 division scale engraved on translucent material, so that a dial illuminating lamp can be mounted at the back.

The two-gang model is particularly compact, for it measures but 4in. wide, $3\frac{1}{2}$in. high, and occupies a total depth of $4\frac{3}{8}$in., and each section has a capacity of 0.0005 mmfds.

The panel-controlled trimmer affords a variation in capacity of 48 mmfds., but the one connected across the back section and operated by a small star wheel has a very limited range only, and shows a variation of 16 mmfds.



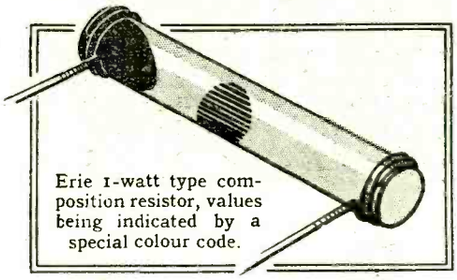
J.B. Unitune two-gang condenser.

Used in a normal circuit with the front section of the condenser tuning the aerial coil, the circuits can be maintained accurately in tune over the whole range of the condenser. The two-gang model is supplied complete with dial and bakelite escutcheon plate, and costs 18s. 6d., while the price of the three-gang type is 27s. 6d.

ERIE RESISTORS.

MADE by The Radio Resistor Co., 1, Golden Square, Piccadilly, London, W.1. Erie resistors come under the definition of the composition type, for the resistance element forms the body of the resistor. Extensive research carried out by the Erie Resistor Corporation of America has now enabled practically all the defects hitherto associated with this type of resistance to be overcome, and the very latest specimens are entirely satisfactory in every respect for wireless purposes. Their values remain constant under operating conditions, provided the rated wattage is not exceeded by an appreciable amount.

A number of specimens were taken at random and their resistances measured, but, although the makers' tolerance is 10 per cent., we did not find a greater deviation from the marked value than 3 per cent. When dissipating the maximum rated wattage there is a slight increase in the temperature of the resistor, and this is accompanied by a decrease in its value of the order of 0.5 per cent. After cooling to room temperature the resistance reverted to its original value.



Erie 1-watt type composition resistor, values being indicated by a special colour code.

These resistors can be confidently recommended, and the price is 1s. for any value in the one-watt type.

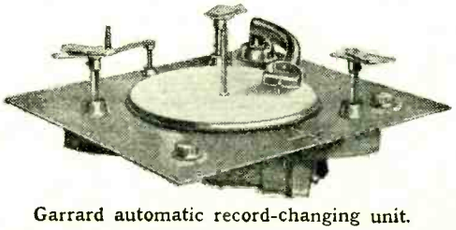
GARRARD RECORD CHANGER.

AS a result of the interest created by this component at the Olympia exhibition this year we have received numerous enquiries regarding the performance of the pick-up supplied as an integral part of the unit.

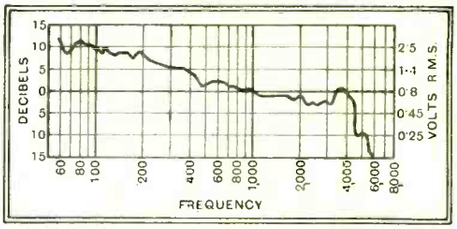
The curve was taken with an H.M.V. loud tone needle and with a shunt of 100,000 ohms, and it will be seen that the general shape is a very close approximation to the ideal. The rise in the bass is of just the required degree to compensate for the restriction of amplitude in recording, while the armature resonance, which is outside the range of fundamental tones used in music, is followed by a rapid cut off which minimises needle scratch. The average output is of the order of 1 volt R.M.S., and from the behaviour of the pick-up at low frequencies it is obvious that record wear is negligible. All the tone-arm joints are free from rattle, and the mechanical noise during playing is reasonably low.

We have had an opportunity of observing the record changing mechanism during an extended run, and can vouch for its certainty of action and reliability.

The makers are Garrard Engineering and Manufacturing Co., Ltd., Newcastle Street, Swindon, Wilts, and the price is £10.



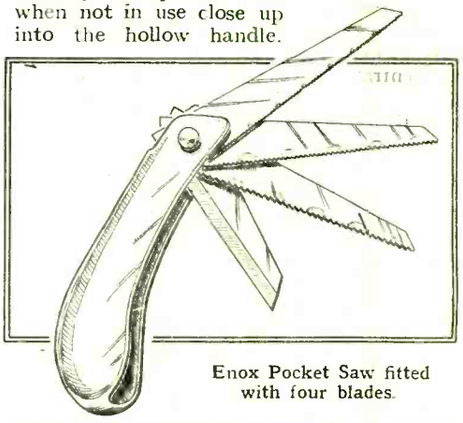
Garrard automatic record-changing unit.



Characteristic of pick-up fitted to the Garrard record changer; measured with 100,000 ohm shunt and H.M.V. loud tone needle.

A HANDY WORKSHOP TOOL.

A COMBINATION tool which should prove very useful to the home constructor, and known as the Enox Pocket Saw, is obtainable from Fry's (London), Ltd., 24-25, King Street, London, E.1, at the price of 3s. The tool consists of a highly polished nickel-plated handle, and is fitted with three saws and one short-bladed knife. The saw blades are about 4in. long and sufficiently stiff to deal with all the usual materials, such as ebonite, paxolin, and metal rod, strip, or sheet that the experimenter is likely to use in the construction of a wireless set. They are made from the finest quality steel and suitably tempered, and when not in use close up into the hollow handle.



Enox Pocket Saw fitted with four blades.

The blades are easily removed for replacement, and spares cost 3d. each.

Trade Notes.

The British Clarion Co., Ltd., Clarion Works, Miller Street, London, N.W.1, have acquired new premises at Clarion Works, Canterbury Road, Kilburn, London, N.W.6.

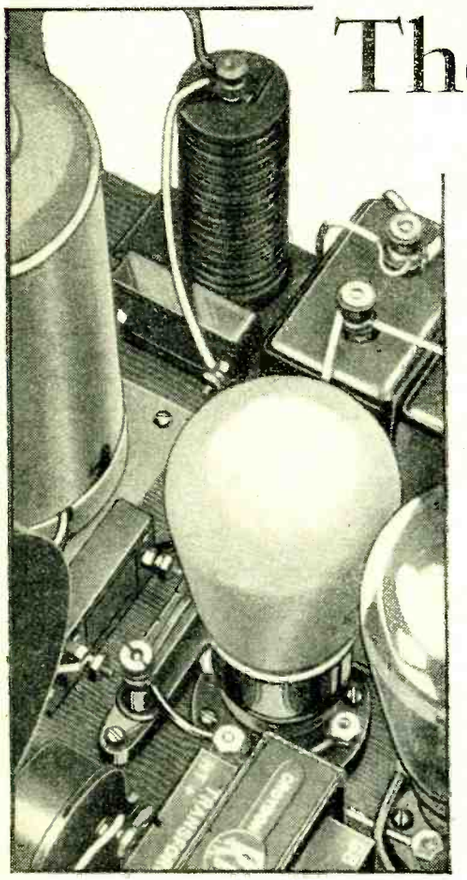
The Wego Condenser Co., Ltd., announce that they have closed their City office at Spence House, South Place, London, E.C.2, and that the department has been transferred to the Wego Works at Bideford Avenue, Perivale, Greenford, Middlesex. The telephone number is Ealing 2477.

W. & T. Lock, Ltd., St. Peter's Works, Bath.—Illustrated folder of new season's Kabilok radio cabinets.

Wilkins & Wright, Ltd., Utility Works, Holyhead Road, Birmingham.—Eighteen-page catalogue dealing with Utility components for the 1932-1933 season.

The Signal Through the Receiver.

Part VI.—The Grid Circuit of the Detector.



A typical modern detector stage, showing a metallised HL2 type valve.

THE last instalment of this series left us with an amplified high-frequency signal across L_7C_7, the tuned circuit immediately preceding the detector valve. We now have to consider the effect produced within this valve by the signal, to do which we shall require to make use of the grid-voltage/grid-current curve of the valve.

Suppose we set up the measuring circuit shown as an inset to Fig. 26, varying the voltage applied to the grid and observing, with a suitable meter, the resulting grid current I_g. As long as the grid is heavily negative it will repel the flying electrons sufficiently strongly to prevent any of them from coming to rest upon it, though some will be pulled through its meshes by the very positive anode. As the grid is made less negative its repulsion decreases, until eventually electrons begin to alight upon it in small numbers, the current that they form returning to filament by way of the meter registering the grid current I_g. The more positive the grid is made, the greater the number of electrons that it will intercept on their way to the plate, and if the grid current I_g, corresponding to a number of different negative and positive grid voltages E_g, be represented as points on squared paper, and the curve that these points outline is then filled in, we shall obtain some such curve as that of Fig. 26.

In this figure it is assumed that, in taking the measurements, there is a clear path by which the grid current can return to the filament. In the actual receiver the arrangement is that of Fig. 27, where the only route by which an electron can get back from grid to filament is by way of the grid leak R_3, which may have a resistance of half a megohm. Further, we see that the bottom end of R_3 is taken to L.T. positive, so that, assuming a 2-volt valve, a positive bias of 2 volts is applied to the bottom end of the leak.

On the analogy of an amplifying valve, where the bias actually on the grid is equal to the voltage applied at the earthed end of the grid circuit, we might think that in the present case the grid would have a bias of 2 volts positive. Suppose for the moment that it had. The curve shows that at this voltage the grid current is 19 microamps., which, by Ohm's law, would necessarily cause a voltage-drop of $\frac{1}{2} \times 19 = 9\frac{1}{2}$ volts across R_3 in its passage. To make the grid take the potential +2 volts, therefore, R_3 would have to be connected to a point $11\frac{1}{2}$ volts positive with respect to L.T. *minus*; of these $11\frac{1}{2}$ volts $9\frac{1}{2}$ would be lost in the leak owing to the passage through it of the grid current.

Self-bias.

In the receiving circuit of Fig. 27 a positive bias of only 2 volts is applied external to the grid leak; since some of this voltage will be offset by that set up by the passage of the grid current through the leak, the actual grid voltage will necessarily be less than 2 volts. The exact figure will be settled by the grid-current curve, and the equilibrium eventually reached will be such that the voltage on the grid and the voltage-drop across the leak will add up to the 2 volts applied.

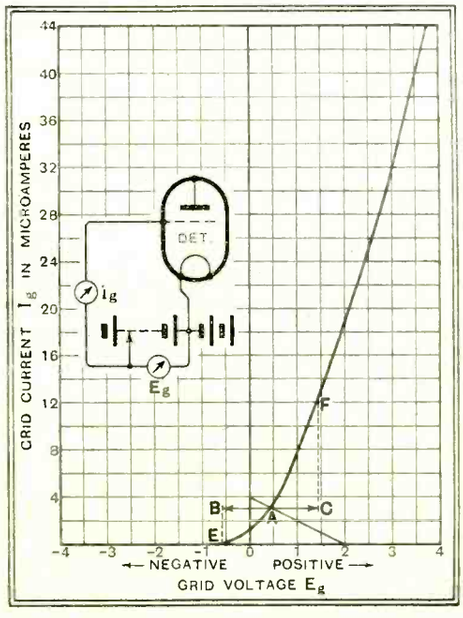


Fig. 26.—Curve showing the amount of grid current I_g flowing for different values of grid voltage E_g. (Inset) A suitable circuit for measuring grid current for different values of grid voltage.

It can be shown that the grid will set itself at 0.45 volt positive in the case under discussion (at A in Fig. 26), because the grid-current at that voltage is such as to produce a voltage-drop across R_3 that absorbs the remaining 1.55 volts applied. (At $E_g = +0.45$ $I_g = 3.1$ μA; volts on $R_3 = \frac{1}{2} \times 3.1 = 1.55$.) This, then, defines the voltage taken up by the grid when no signal is being applied.

Now let us imagine that a signal is applied to the grid through the condenser C_8 of Fig. 27; in the receiver the signal will, of course, be the voltage developed across the tuned circuit preceding the detector. For the moment we will content ourselves with an unmodulated carrier-wave as signal, this being represented at *a* in Fig. 28. As suggested on that diagram, we will assume that the peak voltage of the signal is 1 volt.

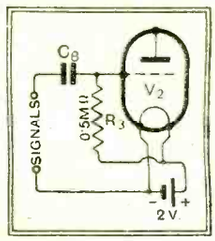


Fig. 27.—The essential circuit of the detector valve as used in the set: C_8 = 0.0001 mfd.: R_3 = ½ megohm. Note that the bottom end of R_3 is taken to L.T.+, making it 2 volts positive.

On the first application of the signal, the voltage of the grid will be swung rapidly to a distance of 1 volt on either side of the "no-signal point" A of Fig. 26. This swing is shown by the line BC on that figure. At the peak of the negative half-cycle the grid voltage will be B, and the corresponding current shown at E must necessarily flow at that instant. Similarly, C, corresponding to the grid current F, is reached at the peak of the positive half-cycle. Since the increase in grid current CF is much greater than the decrease BE, the *average* grid current will be greater than it was before the signal was applied. This increased current will increase the voltage-drop in R_3, with the result that the average voltage of the grid will move from A towards B—that is, the grid will become more negative.

The second complete wave will repeat this performance, swinging the grid voltage about the point reached at the end of the first. Again, the average grid voltage will retreat to the left, but this time by a lesser amount. Eventually, as the signal continues, the grid will find for

The Signal Through the Receiver.—itself a new equilibrium-voltage, the exact value of which will depend partly on the shape of the grid-current curve and partly on the amplitude of the applied signal.

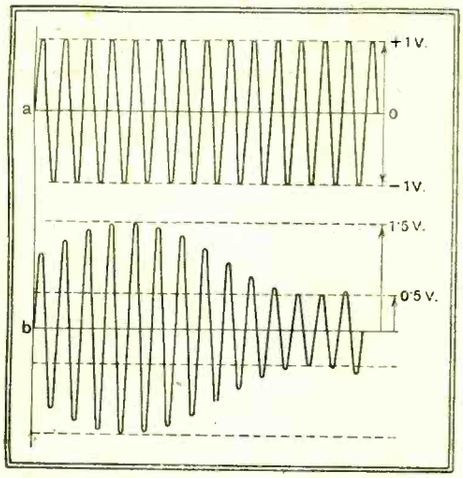


Fig. 28.—An unmodulated carrier of peak amplitude 1 volt is shown at (a) while (b) represents the same carrier modulated. The amplitude now varies from 0.5 to 1.5 volts at the frequency of the note being transmitted.

Once reached, this voltage will be held as long as the signal remains constant.

Clearly, the new voltage attained will be more negative the stronger the signal; we can therefore plot a curve showing the voltage at which the grid finally sets itself for signals of different strength. Such a curve is shown in Fig. 29, from which the effect of the carrier-wave in lowering the average grid voltage is very evident.

IN this article, the sixth of the series, the somewhat complex process of grid rectification is explained with the aid of simple diagrams. In the next instalment the part played by the L.F. coupling will be discussed.

It is important to notice that, after the initial reluctance to drop that extends over the first half-volt of applied signal, the curve is a straight line. This straightness is of the utmost importance in dealing with a *modulated* carrier, such as is involved when telephony is being received. It will be remembered that a modulated carrier varies in amplitude at the frequency of the musical note that it carries, as symbolised at *b* in Fig. 28. Suppose that, as suggested in the diagram, the modulation swings the voltage of the carrier between the limits 0.5 and 1.5 volts. What will the grid voltage do?

Distortionless Detection.

Reference to the curve of Fig. 29 shows that, starting at A with the grid voltage −0.15 volt due to the steady carrier, the rhythmic rise and fall in carrier-strength due to the modulation will swing the signal voltage backwards and forwards between 0.5 and 1.5 volts—that is, from B to C. As the curve shows, the grid voltage will vary in sympathy between E and D. If, over this range, the curve is a straight line, CE will be equal to BD, the mean grid voltage will not change, and the excursions on either side of this mean voltage caused by the modulation will be equal. In such a case the detector is distortionless, and the voltage on its grid duplicates exactly the variations in amplitude of the carrier.

But these variations are, in turn, a duplicate of the speech or music derived from the microphone at the transmitting station, so that the detector has managed to isolate from the complex carrier supplied to it that portion which represents the music or speech being transmitted.

So far, to prevent confusion, we have separated in our thoughts the modulation and the carrier; actually, both are present all the time. The grid voltage of the detector does not, therefore, copy the modulation-voltage *only*, but swings simultaneously at the much higher rate set by the carrier. Fig. 30 will make this point clear. In the upper diagram we see how, when a steady carrier is applied, the mean grid voltage is lowered—but always, superimposed on this new mean voltage, there is the rapid fluctuation due to the carrier itself. This represents the detector grid voltage during an interval in the transmission, and corresponds to the reception of a carrier like that at *a* in Fig. 28. If, now, the tuning note starts, the carrier changes to a form like that at *b* in Fig. 28; since the average strength of the carrier is unchanged, the average grid voltage is also unchanged; but, as shown below in Fig. 30, it now rises and falls with the rise and fall of the carrier amplitude, exactly as we deduced in different terms from the curve of Fig. 28. But the more rapid rise and fall due to the carrier itself still remains.

Although there is nothing wrong with this mode of regarding the variations in grid voltage as varying with time in a manner that makes a complex curve like Fig. 30, it is often more convenient to look upon it from a slightly different angle, and to separate out in our minds the three effects of the signal. On this view we can say that, on receipt of a modulated carrier, the mean grid voltage falls—neglecting for the moment the radio-frequency and audio-frequency voltages simultaneously present. Or we can say that the grid voltage varies at the frequency of the modulation, and forget the rest, because they do not happen to matter for the particular line of thought we are pursuing. And if we are dealing with questions of high frequency only we shall have to remember that there is a high-frequency voltage on the grid, but there may be no reason to take into account at all the audio-frequency or steady voltages that accompany it.

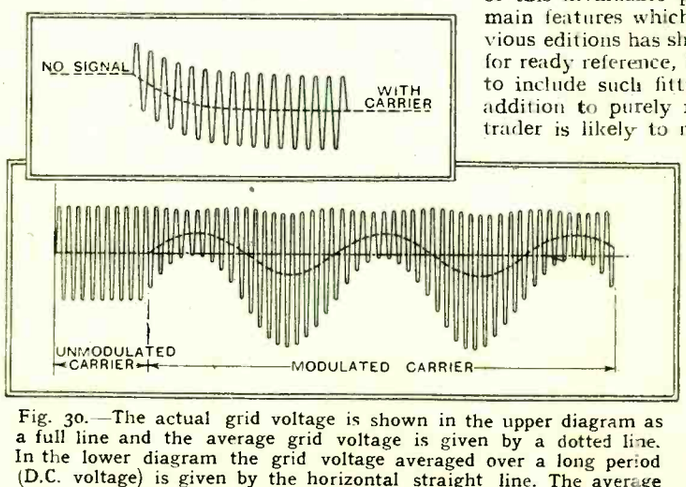


Fig. 30.—The actual grid voltage is shown in the upper diagram as a full line and the average grid voltage is given by a dotted line. In the lower diagram the grid voltage averaged over a long period (D.C. voltage) is given by the horizontal straight line. The average grid voltage is given by the wavy line.

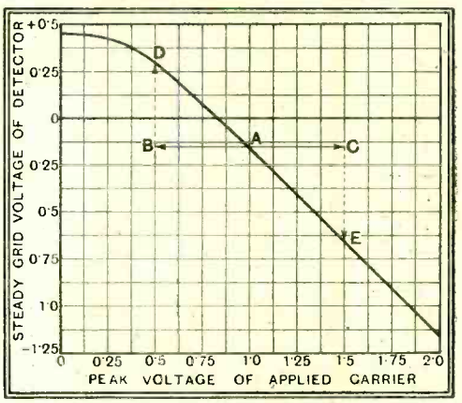


Fig. 29.—Curve showing final steady voltage taken by grid of detector when carrier oscillations of different amplitudes are applied to it.

Reference is made to this possibility of regarding each voltage in turn as though it were the only one, because in next week's instalment, where we shall consider the effect that these various voltages have on the current through the valve and on the components present in its anode circuit, this point of view will be found to save both time and possible confusion.

The Wireless and Gramophone Trader Year Book and Diary, 1933.—*Supplied to the Trade only.*

The Directory section of the ninth issue of this invaluable publication contains the main features which experience in the previous editions has shown to be so serviceable for ready reference, but it has been enlarged to include such fittings and equipment, in addition to purely radio apparatus, as the trader is likely to require in the course of his business, and the "Factors" Section has been extended to give a brief summary of the "Fair Trading Agreement" entered into by some of the leading Radio Manufacturers in 1931, and the list of subscribers to that agreement.

The Technical Section gives, as usual, much useful information concerning Practical Service Methods, the Care and Maintenance of Accumulators, Useful Tables and Data, and a concise Summary, with short specifications, of the principal Receivers, Radio-gramophones and Kit Sets. The Trader Publishing Co., Ltd., London, E.C.4. Price 5s. 6d. Post Free in Great Britain, or 7s. 6d. overseas.

Philco Superheterodyne.

Model 56.

A Midget Four-valve A.C. Receiver with an Equivalent Model for D.C. Supply.

EXPERIENCE with the older types of straight receiver leads one to associate small physical dimensions with a poor electrical performance. There is a definite minimum to the number of components which must be included, and space can only be conserved by packing them closely together. This often leads to instability, which can be prevented only by methods which lower either the efficiency or selectivity or both.

When one finds a complete superheterodyne, therefore, packed into a space less than that occupied by many two-valve sets, one's first reaction is to say that it cannot possibly work efficiently. A little thought soon reveals that the problems of building a compact superheterodyne are less grave than those of reducing the straight H.F. receiver to modest dimensions. The superheterodyne is split up, as it were, into three separate sections which operate upon three distinct frequency bands. The signal enters on its normal frequency and is operated upon by certain circuits, it is changed to a lower frequency and amplified and selected, and it is then rectified and again amplified at low frequency. The chance of stray couplings giving rise to unwanted feed-back effects, therefore, are not as great as would at first appear, for the different circuits between which the couplings might occur are operating upon different frequencies.

Details of the Circuit.

In the receiver under review a total of five valves is employed, of which one is the H.T. rectifier. The output of this valve is smoothed by the field winding of the moving-coil loud speaker, which it also energises, in conjunction with electrolytic condensers.

The first valve in the set is a screen-grid type connected to act as a single valve frequency changer. The tuned oscillator circuit is connected to the anode circuit, which also contains the primary of the first I.F. transformer, and is coupled to a coil connected in the cathode circuit. This latter coil is really in the path between the cathode and control grid, so that oscillation is maintained by coupling between the anode and control grid. The incoming signal is passed through a two-stage pre-selector and applied to the control grid, so that mixing takes place in the usual way in the grid circuit.

Two similar I.F. transformers are included, each having both primary and secondary tuned to the intermediate frequency of 125 kc., so that there is a total of four I.F. tuned circuits with a single variable-mu I.F. amplifier. The bias of this valve is controlled by means of a potentiometer so connected that one-half acts as a variable resistance in the valve cathode lead, while the other half forms a shunt between the aerial and earth terminals. Thus both the signal input to the set and the I.F. amplification are controlled simultaneously by a single component.

Another screen-grid valve, connected to act as an anode bend rectifier, acts as the second detector, and it is resistance capacity coupled to the output pentode, from which the loud speaker is fed through a transformer.

Performance.

The receiver is assembled on a steel chassis, and is unusually sturdy, while the controls are sweet to operate. The waverange switch gear in particular is a fine example of careful design, and both mechanically and electrically is beyond reproach. A point showing the careful attention to detail which has been given to the design of this receiver is the mounting of the chassis on rubber blocks in order to avoid acoustic feed-back, while in the fixing of components free use has been made of locking washers.

In its performance the receiver sets a high standard, and its sensitivity leaves nothing to be desired. The selectivity, too, is of a high order, and during the tests it proved possible to receive Muhlacker without great interference from the London Regional at a distance of no more than six miles from the latter station. The volume control is silent in action and very effective in its control, for it permits the local station to be reduced to zero without introducing distortion.

Quality.

As one might expect from the small dimensions of the loud speaker and the small baffle area provided by the cabinet, the bass response is rather weak. Nevertheless, the tone is well balanced, and quite large volume may be obtained before the output valve reaches its overload point. Mains hum is reasonably low, and tuning is simplicity itself.

We recently had an opportunity of visiting the factories at which Philco receivers are built in this country, and we were impressed by the thoroughness of the testing methods employed. Each component is tested during the several stages of its manufacture, and before inclusion in the chassis, and the completed set undergoes a test in which a known modulated H.F. input is applied, and the voltage set up across the loud speaker terminals is measured.

D.C. Model Available.

A D.C. mains model of this receiver is also available, and on test it gave a performance in no way different from that of the A.C. set. On the particular mains used for testing hum reached small proportions, but was quite inaudible during modulation. A moving-coil loud speaker is included, the field winding of which is energised by the heater current of the series connected indirectly heated valves, and it serves also as a smoothing choke for the H.T. supply to certain valves. The main dropping resistance, however, for the heater supply is a regulator lamp, which takes the place occupied on the chassis in the A.C. model by the H.T. rectifier.

In both receivers American valves, with American type bases, are at present employed, but we understand that it is hoped in later models to fit British built types of identical characteristics. Both models have the same price of 16 guineas, and represent good value.

FEATURES.

General.—*Four-valve A.C. superheterodyne with built-in moving-coil loud speaker. Ganged tuning and waveband switching for the input filter and oscillator circuits; four I.F. tuned circuits.*

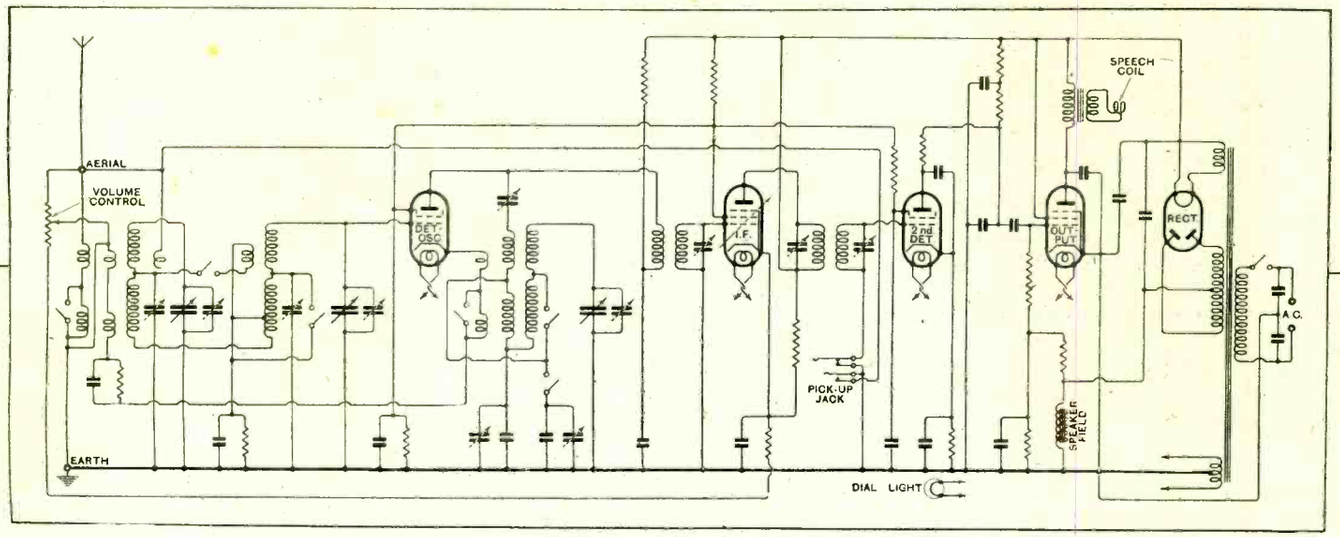
Circuit.—*Combined screen-grid detector-oscillator with two-stage pre-selector, variable-mu I.F. stage, with anode bend second detector resistance coupled to the output pentode. The H.T. supply is rectified by a valve and smoothed by the loud speaker field in conjunction with electrolytic condensers.*

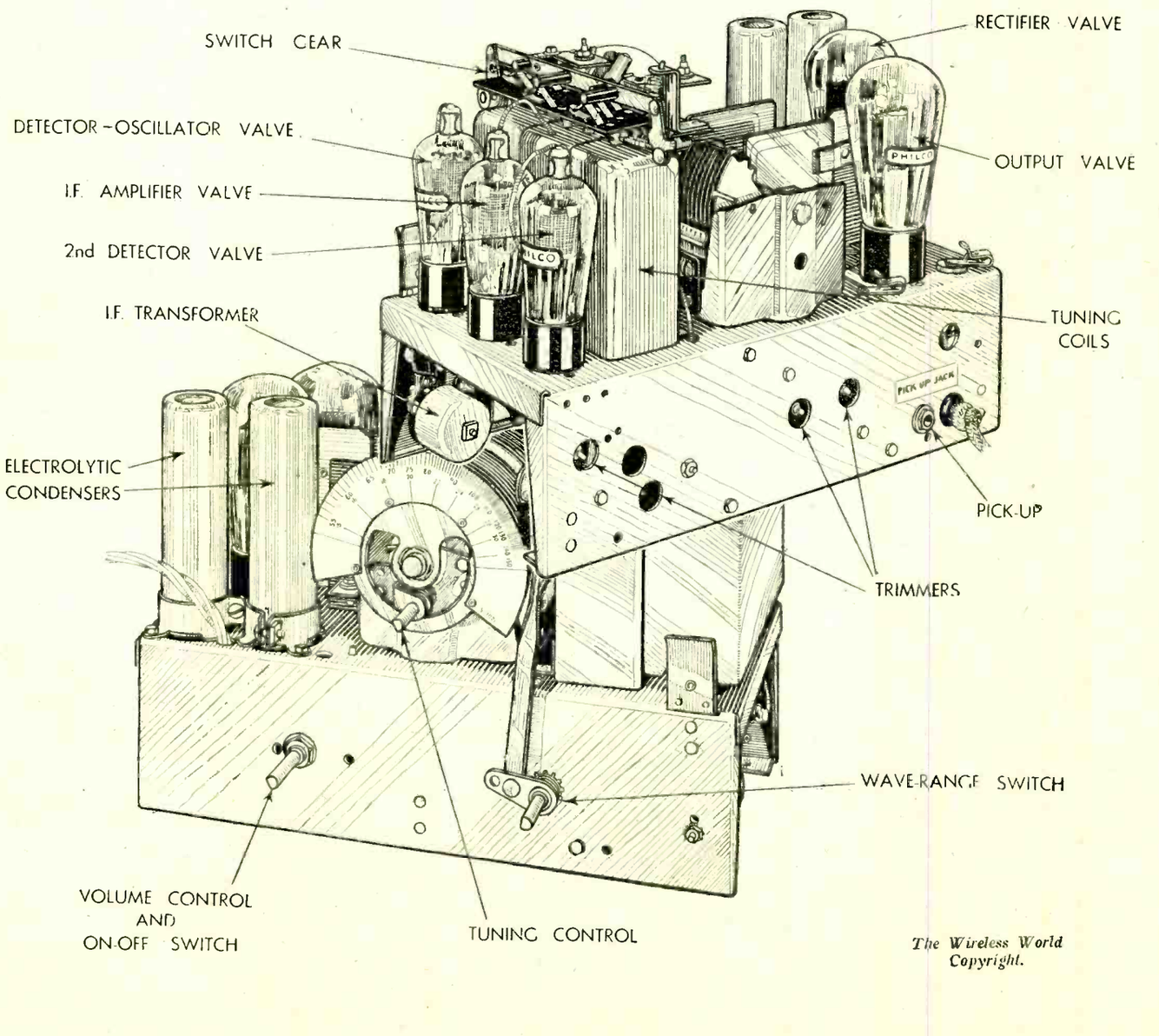
Controls.—*(1) Single tuning control with illuminated dial calibrated in kilocycles. (2) Combined volume control and mains on-off switch. (3) Waverange switch.*

Price.—*16 guineas.*

Makers.—*Philco Radio and Television Corporation of Great Britain Ltd., 1, Argyll Street, Oxford Circus, London, W.1.*

COMPACT FOUR-VALVE SUPERHETERODYNE.





Circuit diagram and two views of the chassis—the upper showing the overhead switch gear.

Letters to the Editor.

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

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

What is a Kit?

WE note your Editorial of the 4th inst. with great interest.

There is undoubtedly a decided need for a definition of what comprises a "kit set." We are in agreement with your specification that every collection of parts sold as a "kit" should comprise all the pieces necessary to build a workable receiver: components, wire, insulating covering flex, screws and nuts, and valves. The additional accessories, such as batteries and cabinets, are not essentially a part of the kit, as in many cases the home-constructor has suitable items which he can utilise.

Our Skyscraper Kit, with which you are familiar, is complete down to the very last nut, and when the parts are assembled is ready for working as soon as the batteries and the loud speaker are connected up.

In order to cover those home constructors who do not already possess a suitable cabinet, we produce two types, one which houses the receiver only and the other which is complete with a loud-speaker unit and cone. Even these cabinets, although sent out in a "knocked-down" form, are complete, in that every screw to put them together is packed with each set of parts, even including the flexible wire, in the case of the Consolette cabinet, to link up the loud speaker with the receiver.

You will agree that all forms of the Skyscraper conform fully to your specification.

W. H. FULLER,
p.p LISSEN LIMITED,
Publicity Department.

B.B.C. Frequency Tests

BEING the possessor of a Monodial A.C. Super, slightly modified to work with an existing push-pull output stage, I eagerly awaited the series of fixed frequency tones broadcast during the talk, "The Ordinary Listener and his Set," on Saturday, November 5th. These tones consisted of a series of pure notes ranging from 50 cycles to 6,000 cycles, transmitted with a constant modulation depth. The frequency response of a receiver, therefore, could be simply determined by measuring the output at the different frequencies.

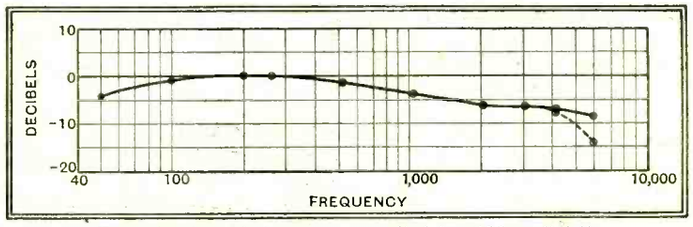
Although quite satisfied with the quality of my Monodial, the frequency response of which I had adjusted by ear, I decided to obtain a definite record. I tuned the receiver accurately to the London National station, and disconnected the loud speaker from the secondary of the 1-1 ratio output transformer which normally fed it. Across the secondary I connected in parallel a 6,000 ohms resistance and a copper-oxide type A.C. voltmeter having an internal resistance of 20,000 ohms, thus giving the correct load resistance of 4,600 ohms to the valves.

The voltage developed across the load by the signal could then be read directly on the voltmeter. In order to keep an audible check on the programme and to follow the announcements, I joined a pair of phones in series with a 0.25 meg. resistance, and connected the combination in parallel with the L.F. transformer primary. This gave comfortable phone strength, and altered the characteristics of the receiver by a negligible amount.

The voltage readings were converted to voltage ratios, taking 256 cycles as the frequency of standard output, and thence to decibels. The resulting curve is enclosed and shows the remarkably high quality obtainable from a modern superheterodyne, possessing selectivity sufficient to permit reception of Muhlacker within a few miles of London Regional.

The characteristics are overall and include the losses in the output transformer, which are probably chiefly responsible for the loss of 4.4 DB. at 50 cycles. The series of notes was broadcast twice, and I kept a note of each set of readings, and, although the general level changed, all points coincided with the exception of those for the 4,096 cycles and 6,000 cycles notes. At these frequencies the probable error in my readings is up to —2 DB., so that the curves are likely to be rather better than recorded. On speech and music a loss of 5 DB. is barely audible in a rapid comparison, so that the curve closely approaches perfection over the 50 cycles to 5,000 cycles range. Even at 6,000 cycles the loss lies between 8.5 DB. and 14 DB., and most superheterodyne curves which have been published show a loss approaching 20 DB. at 4,000 cycles.

The value of tests such as this cannot be overestimated, for at present the amateur has to rely entirely upon his ear for the correct adjustment of his receiver. How much simpler it would be if the tests were made a regular feature of the B.B.C. programmes. Five or ten minutes weekly would be sufficient, and an actual response curve could be plotted by any amateur possessing a copper-oxide type A.C. voltmeter or milliammeter or a valve voltmeter. If the aim were to obtain a completely flat curve, even an uncalibrated instrument could be used.



Reproduction of the curve supplied by "Monodial."

The Wireless World has many times in the past advocated the transmission by the B.B.C. of such a series of frequencies, and now that one has actually taken place it is to be hoped that, in the interests of all music-loving amateurs, you will press for the transformation of this isolated item into a regular feature. The B.B.C. could do nothing more calculated to increase the standard of reproduction, and hence the enjoyment to be derived from the programmes, than to continue such a series.

London, N. "MONODIAL."

Morse Interference.

IN reply to "G. G.'s" letter in the issue of October 28th of *The Wireless World*, referring to Morse interference, I would suggest that it is not due to fixed land stations but to passing ships using obsolete apparatus.

Coast stations in Great Britain use the frequency of 500 kilocycles for most of their traffic, and are invariably fairly sharply tuned.

Being a resident near the G.P.O. station at Seaforth I speak from experience. My receiver is not sharply tuned, and I experience very little interference on the band 550-1,000 kCs. I admit that in the region of 1,365 kCs. there is severe jamming, due to trawlers using spark transmitters.

In reply to "G. G.'s" questions, it must be admitted that the interference from shipping is growing less, due to the installation of more modern gear, but the total abolition of the trouble must necessarily take some considerable time.

In the P.M.G. handbook for wireless operators there appears the following paragraph: "Communications between two stations must be exchanged with the minimum of radiated energy to ensure good communication," and if all operators were to take notice of this rule most of the interference would disappear. W. O. WILLIAMS.

Liverpool.

Audiphone Hearing Aids.

IN your issue of April 20th, 1932, you published a letter from us on the subject of hearing aids. You will be interested to know that the Western Electric Company are now producing an improved model of Audiphone, designed and developed for Western Electric by the Bell Telephone Laboratories.

In utilising the very latest knowledge obtained in the fields of research and practice, the aim of the laboratories has been to secure optimum sensitivity whilst preserving those qualities which make for faithful reproduction of the sounds picked up. We feel confident in stating that in this instrument such an end has been achieved, and its extraordinarily successful performance is largely due to the special construction of the supersensitive microphone, which is responsive to a very wide range of frequencies on the audible scale.

We shall be delighted to forward full particulars on receipt of a postcard from anyone interested.

WESTERN ELECTRIC CO., LTD.,
G. JACQUES.

BROADCAST BREVITIES.

By Our Special Correspondent.

Laugh, Fool, Laugh.

LANCE SIEVEKING'S new *régime* for studio audiences is at least a conscientious attempt to control the fulsome applause which comes so spontaneously from the occupant of a free seat. All laughter and applause in the studios of Broadcasting House is now rigorously directed by hand signs during the performance.

The Aberdeen Difficulty.

As a member of the studio audience you must laugh to order, and woe betide the unfortunate who sees a joke at the wrong moment.

This trouble has always been to the fore in the Aberdeen studio, but an improvement has been noticed since someone conceived the idea of spacing the jokes at regular intervals. Under the new arrangement it is not obvious that the audience is laughing at the previous joke.

Empire Records.

JUST before Mr. Malcolm Frost, the B.B.C.'s "Empire Ambassador," left London with his stock of programme records, he told me that he was confident his wares would sell. These eleven 12-inch records make an attractive bunch; they are representative of the lighter side of the B.B.C. programmes, covering such items as Manx songs, typical vaudeville, A. J. Alan, the Children's Hour, and old English choruses.

The funny part is that their grooves are so narrow that the records cannot survive more than about eight playings!

Limited Performance.

Apparently there is method in this madness. By contract with the B.B.C. the stations purchasing the records will be under solemn obligation not to broadcast any one of them more than three times.

The Grand Tour.

Mr. Frost's tour has been mapped out almost to the minute. December will find him in Cape Town, January in India, February in Japan, and March in Australasia.

The itinerary continues with Fiji, Vancouver, Ottawa, New York, Jamaica, and South America. He will be back in London next August, in time, I hope, for his summer holiday.

The 7-Metre Mystery.

WRAPPED as they are in mystery, the 7-metre tests on the roof of Broadcasting House are not more mysterious than the source of some of the reports that get about. The truth is that, at the moment, ultra-short-wave research in Portland Place has come to a standstill pending the opening of the Empire station at Daventry, which is absorbing most of the superfluous energy in the engineering department.

Hush!

So do not, please, believe all that is said and written on the subject. Lithe figures are not to be seen lifting suitcases over steel girders, and there are no "ultra short" men in the streets at the present moment.

Dr. Boult on Tricks of the Trade.

HONEST men acknowledge that the broadcasting of music still holds special problems and that a peculiar technique is necessary before the microphone. No less an authority than Dr. Adrian Boult is lecturing on the subject before the Royal Institution on December 3rd, 10th, and 17th.

Perhaps, for those of us who cherish illusions, it is a good thing that Dr. Boult's description of studio tactics and artifices will not be broadcast.

Another Book About "B.H."

TO everyone whose interest in broadcasting ventures a little beyond the programmes, I can commend the B.B.C.'s latest five-shilling publication, issued today, entitled "A Technical Description of Broadcasting House." The book, which is lavishly illustrated in half-tone and line, is concerned with the construction of the building itself and the plant it contains.

The account of the studio and control room equipment is alone fascinating enough to fire many listeners with a yearning to transmit instead of being restricted to reception.

Figures That Dazzle.

Statistics have always dazzled the B.B.C., and I confess that some of those regarding Broadcasting House dazzle me.

Who would guess that the cubic capacity of the building is 2,260,161 cubic feet or that the number of doors is 800?

There are approximately 660 thermionic valves in the place; the average filament heating load is 1,790 watts, and the H.T. load 1,300 watts. The total length of wiring in broadcasting circuits would join London to Crewe. The average daily electricity consumption is 5,300 units.

Phew!

The moisture given off in twelve hours by people in the tower, when it is fully occupied, is one ton.

A Brontë Masterpiece.

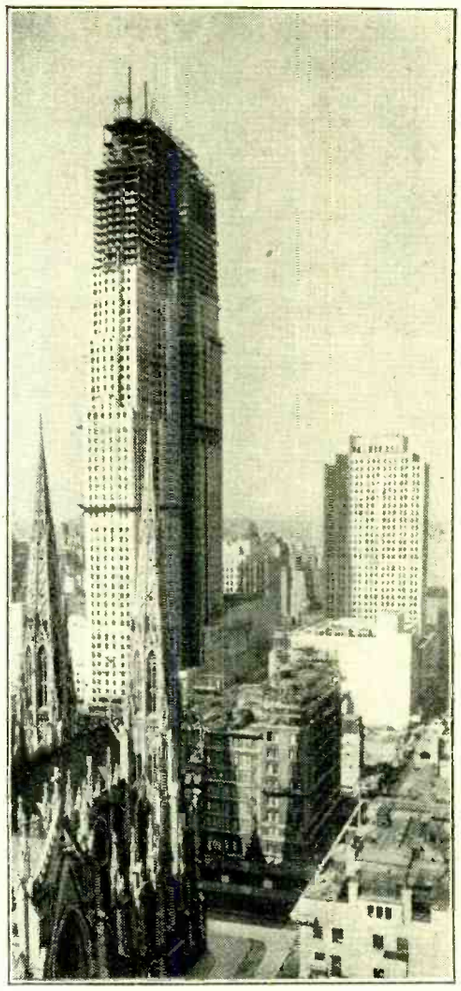
ONE of the most successful radio plays—to judge from the many requests for a repeat performance—was "Jane Eyre," the microphone adaptation of Charlotte Brontë's masterpiece. The play is to be broadcast again on January 1st, under the direction of Howard Rose, who was also responsible for the original production.

A Matrimonial Query.

"MUST I take out a new wireless licence in December next when I get married?" a young lady asks me. Apparently she is following the age-old custom of leaving the parental roof when the happy day arrives. But her future husband has no wireless licence, and her parents listen by virtue of the licence taken out in her name. When her name is changed, does the licence lapse? This would mean that papa and the bridegroom would both have to take out new licences.

My reading of the situation is that the happy bridegroom wins bride and wireless licence simultaneously.

The only sufferer is poor Pa.



RADIO CITY, NEW YORK. This view, specially taken for "The Wireless World," shows the progress which has been made in the construction of America's centre of entertainment between Fifth and Sixth Avenues.

Christmas in Sight.

TWO of the usual transmissions of carols will be heard by National listeners on Christmas Eve. In the afternoon a relay takes place of the Carol Service at King's College, Cambridge, and in the evening Cyril Dalmaine conducts carol singing at Whitechapel Parish Church.

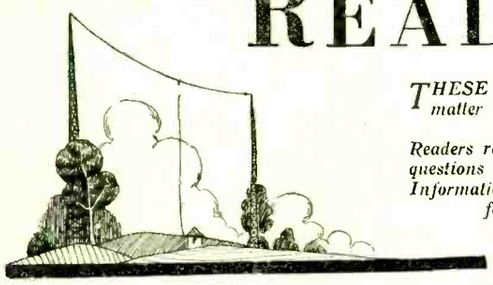
Chance Encounters.

FOR once in his life The-Man-in-the-Street had his say over an American network recently, when the Columbia Broadcasting System sent its star announcer out into the streets of New York with a lapel microphone. The purpose of the series of five-minute broadcasts at intervals throughout the day was to find out, a week before the presidential election, how the Man-in-the-Street intended to vote, and what he thought of the candidates. The announcer simply stopped people in the street and asked them a series of questions, and the conversations were broadcast.

"Free" Language.

Some of the answers, I am told, were remarkably terse and to the point, and in some cases the language was refreshingly free from the restraint of the studio; in fact, the announcer occasionally had to make rapid use of the small microphone cut-off switch concealed in his pocket in order to protect sensitive ears in the audience.

READERS' PROBLEMS.



THESE columns are reserved for the publication of matter of general interest arising out of problems submitted by our readers.

Readers requiring an individual reply to their technical questions by post are referred to "The Wireless World" Information Bureau, of which brief particulars, with the fee charged, are to be found on page 454.

End Cells.

ACCUMULATOR batteries of private house-lighting plants are often provided with one or two extra cells—known as end cells—which may be connected in series when necessary, in order to maintain voltage at the correct value. The equipment belonging to one of our querists has actually two of these cells, and he asks whether it would be permissible to employ them for charging a two-volt L.T. battery, of which the charging rate is given as 1 amp.

When the equipment is well maintained it is comparatively rarely that it is required to put these end cells into service, and so they are likely to benefit rather than otherwise by being used for this purpose. They may be connected in series with a resistance of about 2 ohms across the terminals of the cells to be charged.

Condenser Tests.

WITHOUT specifying the precise nature of the instrument he proposes to use, a reader asks how a condenser, suspected of having broken down, may be tested with the help of a meter.

Actually, a condenser may be subjected to the same types of continuity tests as are applicable to other components; the important difference is that in this case continuity is a definite indication of a fault, while with other components the existence of this condition always implies that everything is in order.

Another point to be borne in mind is that certain forms of condenser break-down do not become evident unless a fairly high testing voltage is applied. Consequently, the output of an H.T. battery eliminator, or, if available, a D.C. mains supply, will generally provide a convenient source of voltage.

When a milliammeter is used for testing it should be connected as shown in Fig. 1 (a), not forgetting that a lamp or other resistance of such a value that the maximum current flowing through the meter in the event of a short-circuit cannot exceed the

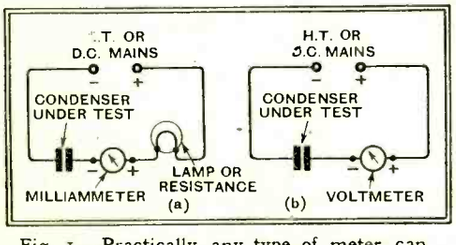


Fig. 1.—Practically any type of meter can be used in testing fixed condensers, but the precaution of inserting a limiting resistance, as in diagram (a) should be observed if there is any risk of exceeding the current rating of the testing instrument.

rating of the instrument. If this precaution be ignored the tester may find himself with a burnt-out meter as well as a burnt-out condenser. If everything is in order the meter needle will "kick" momentarily on completing the testing circuit (if the condenser is of high capacity) and will then return to zero.

A voltmeter with a maximum reading not less than that of the source of testing voltage may be employed equally well in the manner suggested in diagram (b). Again, a "no-voltage" reading is an indication of satisfactory insulation.

By Way of a Change.

IT is a common occurrence for us to receive requests for information as to the best way to add an H.F. amplifier to an existing receiver, but it is unusual for readers to ask how an H.F. stage may be permanently eliminated. The querist who now proposes to make this alteration has a somewhat out-of-date H.F.-det. L.F. three-valve set, which is insufficiently selective for present needs. The H.F. valve has just failed, and instead of replacing it he has decided to convert the receiver for purely local-station reception, and to make a new set for long-distance work. A circuit diagram is submitted to us, and we are asked how the H.F. amplifier might be cut out of circuit in such a way as to ensure separation of the local twin stations.

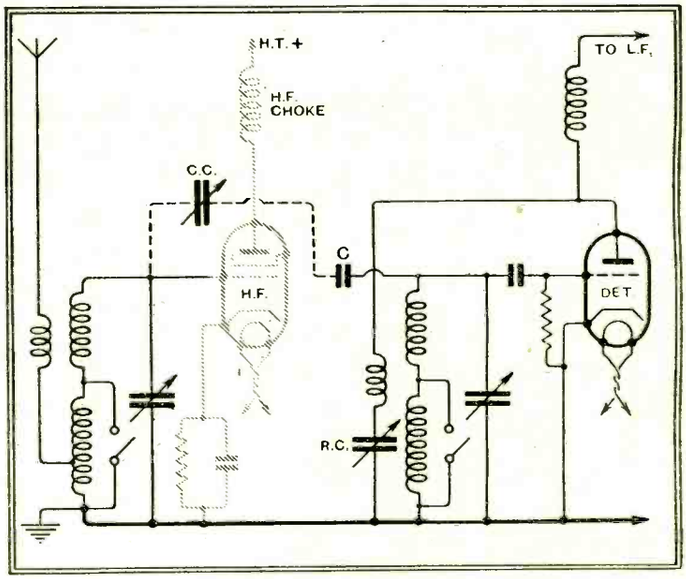


Fig. 2.—Eliminating an H.F. stage without sacrifice of selectivity.

Our reader's proposal is quite practicable, and it so happens that the set lends itself very easily to modification in the way required. The circuit arrangement of the H.F.-detector part of it is reproduced in Fig. 2, in which the recommended addition is shown in dotted lines, the H.F. valve and its connections being "faded out."

By altering the receiver in the manner suggested the two existing tuned circuits will be retained, and together will constitute a filter, linked together by the additional condenser CC, which need not have a maximum capacity of more than some 10 to 20 micro-microfarads. Its minimum capacity should be as low as possible.

Although the set would work as a detector-L.F. combination with the H.F. valve in position, provided that the connection between the blocking condenser C and the anode is interrupted and changed over in the manner shown, it is, of course, desirable that all the H.F. valve connections should be removed. Arrangements could be made to offset the consequent rise in voltage, but are hardly likely to be necessary.

Better Bass.

WE are always inclined to counter requests for information as to how bass response may be improved by asking what type of L.F. transformer is employed in the receiver in question. If it is found to be a cheap one, with low primary inductance, then the obvious thing to advise is that a better transformer should be substituted.

In these matters one generally gets what one pays for, and it cannot be denied that the characteristic curve of a cheap transformer generally exhibits a tendency to droop at the lower end of the frequency scale.

Unfortunately, this simple piece of advice cannot be put forward without a saving clause. As a result of an increase in the amplification of low frequencies, the efficiency of an existing decoupling scheme may be rendered inadequate, and so those who take our advice in this matter may find it necessary to be more generous in the matter of by-pass condensers; the addition of extra decoupling resistance would have a similar effect, but will not always be practicable.

Range of the "Diode Quality Four."

SEVERAL requests have been received for information as to the range of reception to be expected with the "Diode Quality Four." (September 30th issue.)

Although it is difficult to give anything like a definite answer to these questions without having a practical knowledge of the receiving conditions under which the receiver will be used, we think that a fair idea of its sensitivity is given by saying that its performance approximates to that of a three-valve H.F.-det.-L.F. set when the latter is operated with a fair amount of reaction.

The "Diode Quality Four" has no reaction control. Unlike the more conventional type of set with which we have compared it, its detector does not impose heavy damping on the preceding circuit, and so there is no need for reaction, of which the main purpose is to offset this damping.

The Wireless World

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EDITORIAL COMMENT.

France Sets an Example.

Legislation to Prevent Interference.

IT is rumoured that machinery has been set in motion in France to introduce new legislation in connection with the control of broadcasting, the principal object of which will be to provide funds for the maintenance of broadcasting stations, presumably on lines similar to our own B.B.C. What is, however, of even greater interest is that it is proposed to legislate at the same time to control interference of the type which in America is referred to as "man-made static," that is to say, interference with reception created by electrical apparatus and machinery.

It would seem that France, which as a country has been regarded as far behind most of the other nations of Europe in the matter of organising broadcasting, is about to make up for lost time by setting an excellent example in tackling at the same instant this very serious question of electrical interference.

Control Future Sales.

It is always a difficult matter to introduce legislation to correct a state of affairs which has grown up gradually over a long period, so that we can hardly feel surprised if our own Government does not feel prepared to introduce legislation which would insist upon the suppression of electrical interference of all kinds ; that would, perhaps, be asking too much, but surely it would not be unreasonable to suggest that legislation might be established to ensure that after a given date (allowing reasonable notice) it should become illegal to sell electrical apparatus capable of causing unnecessary radiation with consequent interference with reception.

A Task for the I.E.E.

The Institution of Electrical Engineers is a body truly representative of the electrical industry of this country, and we do not think we are making an unreasonable suggestion if we say we look to the Institution to investigate the whole question and put forward the guiding principles on which legislation might be based. It would be a comparatively easy matter for the Institution of Electrical Engineers to appoint a Committee representative of all branches of the electrical industry. It is generally recognised that the bulk of the causes of electrical interference can be overcome when suitable precautions are taken ; we do not suggest that the Institution should complicate the issue by asking a Committee to deal with these technical details, but it could confine its activities to the immediate problem of deciding how far legislation could fairly be introduced to ensure that future electrical apparatus should not interfere, wherever it was reasonably possible to avoid it. Electrical Apparatus is being sold now in ever increasing quantity, and prompt measures are imperative.

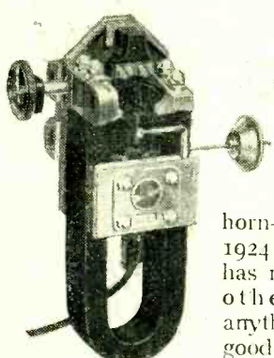
The Future.

We should then be left with the existing apparatus in use which causes interference ; little by little we could hope to remedy this nuisance. At the worst, the apparatus would become obsolete in the course of time, but nothing short of prompt and adequate legislation to control future equipment will, we feel, provide us with any assurance that the nuisance of interference will be abated as time goes on.

Choosing a Speaker

Advantages and Limitations of the Principal Commercial Types.

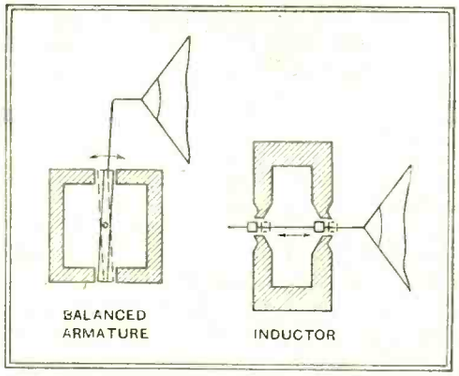
THE number and range of types of loud speakers available to-day is so large that the average non-technical radio enthusiast may well be diffident about choosing that which is most suitable for his requirements. In many cases, of course, the listener is contemplating the purchase of a replacement or additional loud speaker, and by wise buying will be able materially to increase his pleasure; by being casual in his choice disappointment will follow in greater or lesser degree. One man may be passionately fond of music, and in his search for superlative quality at all costs may not know where to turn for what he wants. The professed "low-brow" may be quite convinced that what he gets at home is not what he would really like, but is unable to say what is wrong, and cannot tell if the new speaker he is turning over in his mind will be any material improvement. Finally, we have our old friend, "the faithful heart," who still has his horn-type speaker of 1924 vintage, and has never heard any other wireless set anything like so good as his own.



Blue Spot 66R balanced-armature unit.

To all of these we have something to say, and if our outline of the various types of speakers is not given in some predetermined order, which would appear to be the obvious way, it is because there is a possibility that the best method of attacking the subject is from the point of view of what we are able to supply to the speaker. Few of us would go to the trouble and expense of designing a set for a particular speaker, but we can all select a speaker to suit our own particular set.

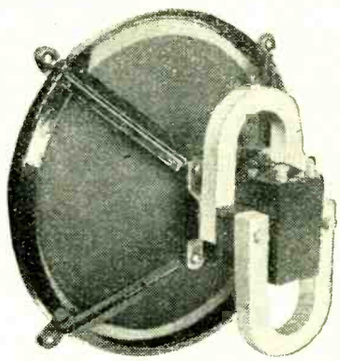
As the majority of listeners are still without electricity in their homes, the battery-driven set calls for treatment first. In the greater number of cases the battery set has to do a lot with little current; there is little reserve power to provide audio-frequency watts for the loud speaker, and none at all to energise a field magnet. Our choice is restricted to moving-iron (electro-magnetic) and moving-coil (electro-dynamic) speakers of the permanent-magnet type. Electro-magnetic speakers may have a simple reed or a balanced armature, and the choice is determined by the depth of the purchaser's pocket. The former can be obtained for as modest a sum as five shillings, and the results betray its price. There are one or two speakers of this type which are surprisingly good, having regard to their simple design, and will give good service to the man who is really limited in his expenditure.



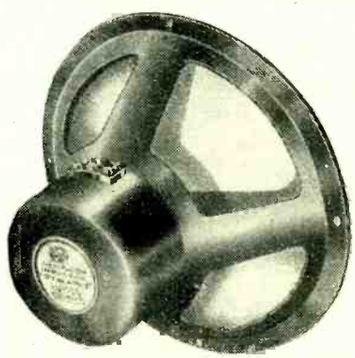
The inductor principle permits the development of larger amplitudes than the balanced armature, but is not always so sensitive.

Balanced-armature Units.

The balanced-armature loud speaker, on the other hand, *can* be very good, and the special properties of this type are worthy of consideration. First, as to frequency response. New readers will, perhaps, be unacquainted with earlier contributions on the subject of broadcast reproduction, in which it has been shown that to secure realistic reproduction of music, speech, and other matter broadcast it was necessary for the receiver, amplifier, and loud speaker to maintain a level output from 32 to 9,000 cycles, as a minimum frequency range. Very few installations get anywhere near this standard, so that if it is said that the average balanced-armature loud speaker is good for that part of the frequency spectrum between 150 and 5,000 or 6,000 cycles the reader must not lose heart nor the manufacturer take umbrage. The reproduction of very low frequencies calls for a large displacement of the air by the diaphragm, but the movement of the armature is inevitably restricted by the proximity of the pole pieces; so that, although one could get a fifty-cycle note through such a speaker, the applied A.C. power would have to be small to prevent chattering. Unfortunately the ear is insensitive to low

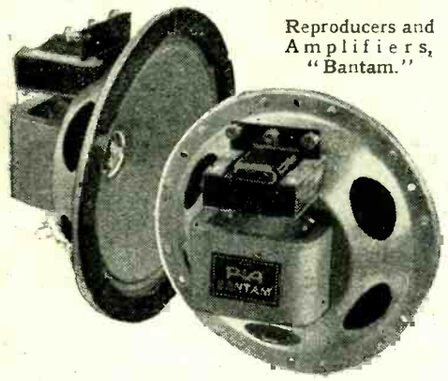


Ferranti inductor loud speaker.



Lamplugh "inductor-dynamic" loud speaker.

Choosing a Speaker.—frequencies, thus calling for even more power. On the assumption, therefore, that there will be a bass cut-off, it is only fair to consider the good points. The response at higher frequencies is generally good, although characterised by resonances; but as nearly all loud speakers, of whatever type, suffer from similar defects, the point is not of great import-



Reproducers and Amplifiers, "Bantam."

ance. Speech and transients are usually reproduced well, and the whole reproduction is brisk, if somewhat lacking in body and "depth."

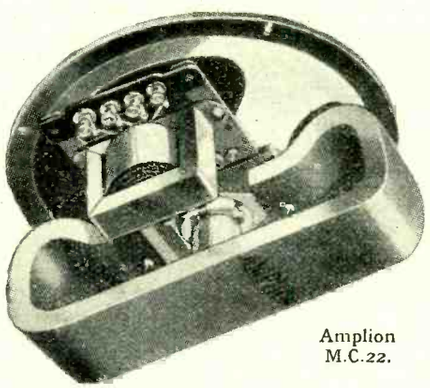
The Inductor Principle.

The inductor-dynamic speaker, on the other hand, if properly designed, is capable of giving very fair bass reproduction indeed. The reason for this is that the armature moves parallel to the pole faces and its movement can be increased without chattering. If, however, the cone is of such material that there is a marked top cut-off then the whole reproduction is generally too low-pitched entirely to be

W. B. "Mansfield."

pleasing. If a good design is chosen, and the ear is the only judge for the non-technical, there is no doubt that the results are very much better than those obtainable from the ordinary balanced-armature unit, but the price is much higher, which is only right and proper. It should be borne in mind, however, that the inductor type, as a whole, is not so sensitive as its forbear, a point of some importance with very low power sets.

So we come to the permanent-magnet moving-coil speaker. There are strong arguments to support the contention that they are not always the best type for battery-driven sets, although they have their rightful niche in the whole scheme. To take the cheap ones first; we have a small magnet with a comparatively low flux density in the gap, and, as a consequence, lack of sensitivity. As they are sold on a price basis in competition with the balanced-armature unit, it is only fair to compare the performances. More bass, it is true, but less top; perhaps, on the whole, a more pleasing reproduction, but the sensitivity is so greatly inferior to a good balanced-armature unit at a time when sensitivity is a *sine qua non*, that a big price is paid for the gain in quality. The inductor will give, as a rule, equally good reproduction, and, with better sensitivity, is the more attractive, but the price is higher. Again, the expensive moving-coil models are not lacking in sensitivity, but they are expensive enough and good enough to justify a better output than the average battery set is capable of giving. The final recommendation is, therefore, a balanced-armature or inductor-dynamic speaker for the battery set, with a preference for the latter if the buyer can afford it.

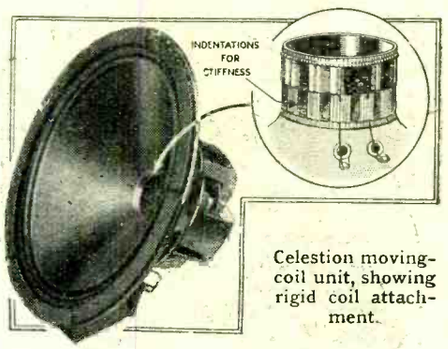


Amplion M.C.22.

When we come to consider mains-driven sets, the problems are very different. As a general rule the A.C. power output is not less than 2 watts, and the cheap moving-coil speaker is now a practicable proposition. If D.C. mains are the source of power, then the energised type is better, for the sensitivity, shilling for shilling, is greater than that of the permanent-magnet; with A.C. mains, considerations of economy may dictate the use of the latter, as the cost of a suitable rectifier and condensers would be nearly as high as that of the speaker. Of course, the field can be

Motor (Tekade) permanent-magnet moving-coil.

wound to a suitable resistance and used as a smoothing choke, and this, in addition to providing "free" energising current, saves the cost of a choke. In the case of an existing A.C. set, it would, therefore, be advisable to choose a permanent-magnet speaker, as, apart from the saving in cost of the rectifier and its associated equipment, there is the very real advantage of complete absence of a hum which can be quite prominent through imperfect



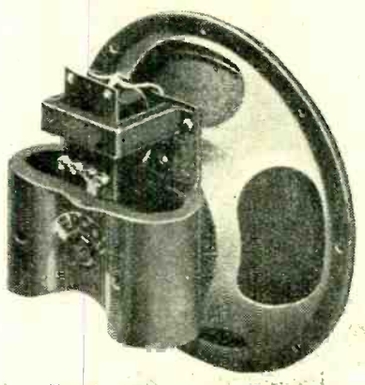
Celestion moving-coil unit, showing rigid coil attachment.

smoothing of the energised type's field supply, unless the winding is fitted with "hum-bucking" coils.

Although the inductor speaker is generally quite satisfactory on most mains-driven sets, it is becoming standard practice to use a moving coil, and as there is a multiplicity of different makes available—one might well say that the market is flooded with them—it would be as well if the prospective purchaser had some idea of what to look for.

Basis of Moving-coil Design.

The underlying principle of the moving-coil loud speaker is quite simple. If a coil of wire be suspended in a strong magnetic field then the passage of currents through that coil will cause it to be displaced. The amount of the displacement



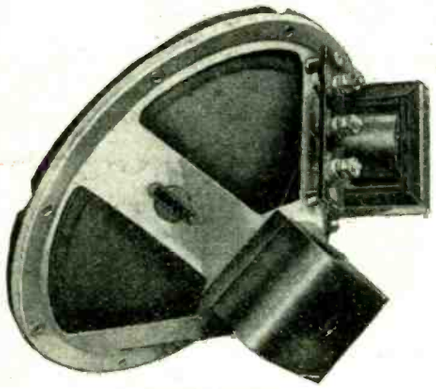
Epoch "Twentieth Century."

is governed by the amount of current, the frequency and the method of suspension, and if a diaphragm be rigidly attached to the coil then the air in front of and behind the diaphragm will be displaced in sympathy with the applied currents. As the frequency varies so the frequency of the sound set up by the vibration of the air varies, and it is the theoretically correct function of the moving-coil speaker to emit a constant sound output for a constant applied current at all audible frequencies. In practice this ideal seems to be impossible of attainment, and, except in cases where the finished article was built

Choosing a Speaker.—

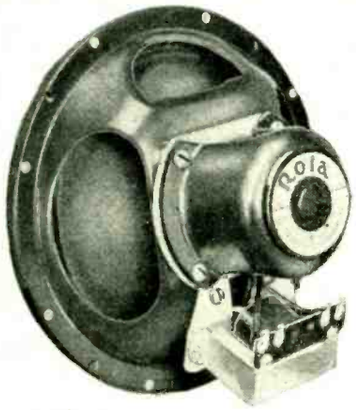
down to a price, it is the aim of the designer to approach as nearly as can be done to the theoretical criterion.

Let it not be thought for one moment that the cheap moving-coil speaker is something to be despised; they are simply wonderful value for money, and a loud



Igranic type D9.

speaker of this type costing 30s., for example, is miles ahead of a similarly priced loud speaker of five years ago. The point that requires stressing is that where a manufacturer is faced with the problem of turning out at a given price a device which has a cone, a coil and a field magnet, the cheapest possible method of assembly must be instituted, and opportunities of modifying that design as a result of research in acoustics are not afforded to the technical departments. The most expensive single item is wire, or, alternatively, a permanent magnet, for the field, and as the gap has to be reduced to the smallest possible dimensions to keep the sensitivity at a reasonable value the size of



Mains-energised Rola type "F."

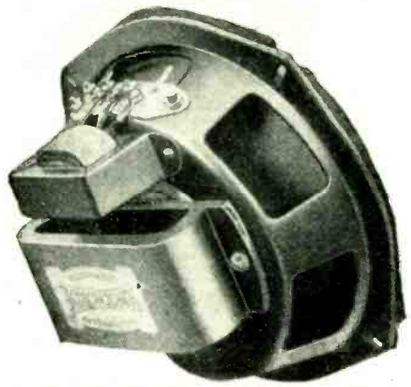
the cone and coil tend to become standardised on several makes of speaker, resulting in a similarity in performance which is rather surprising to the uninitiated. In one or two outstanding cases the sensitivity is much above the average, and this is due to cleverness of production.

That the present-day cheap speaker is better than that of former years is a tribute to the excellence of the electrodynamic principle, and among the more expensive models of the type we can begin to look with some decided discrimination, for it is these which reveal whether the manufacturer has an able research department or not. The differences between various makes are as striking as the differences between one maker's expensive and cheap models, differences apart from such considerations as size and finish.

It has been said that the perfect loud speaker should reproduce all frequencies at constant sound output, and, since this is impossible in practice, it should at least make some show of being constant from 32 to 9,000 cycles. What does this involve? The cone is the instrument whereby the air is moved, and it should act as a rigid piston; if it is going to "break up," or bend, in other words, then it is quite obvious that distortion will be set up, for it is a matter of extreme difficulty to arrange that the break-up should compensate for deficiencies in other parts of the moving system.

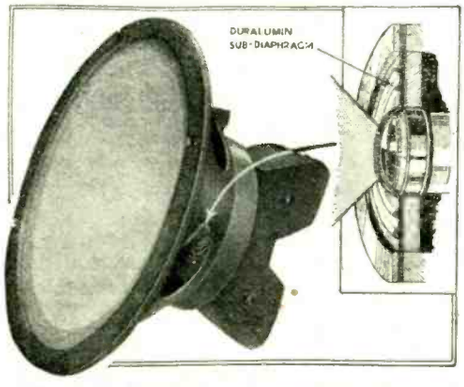
Cone Material.

The cone is about the best shape into which a flexible material can be formed to

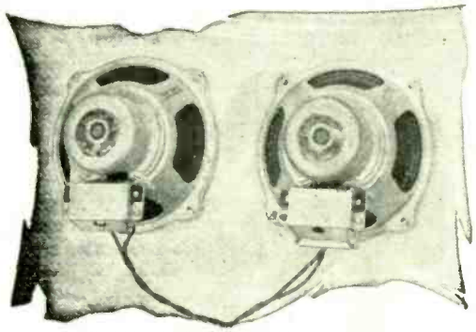


Sonochorde P.M. moving-coil unit.

give the maximum rigidity, and the best angle which compromises between greatest strength and minimum focusing of the higher frequencies is somewhere between 90 and 100 degrees. The material from which the cone is made is critically important. Paper of one form or other is nearly always used, and ranges from a hard, stiff bakelised paper to something approaching blotting paper. The harder and stiffer the material for a given thickness, the better will be the high-frequency response; but if a hard paper be used without regard to other factors of design the result will in all probability be a very shrill resonance at about 3,000 cycles, resulting in rough top. This resonance is nearly always caused by that portion of the speech-coil former between the end of the winding and the apex of the truncated cone acting like a concertina at the frequency mentioned; the defect is emphasised by a weak cone-to-coil joint, and, as



Film Industries P.M. unit, showing method of centring moving coil.



Magnavox dual compensated units.

the critical parts cannot be stiffened except by a great deal of cunning in design, the 3,000-cycle peak is usually got rid of by the use of soft paper for the cone. Unfortunately this apparently simple remedy works only by virtue of the fact that soft paper eliminates the high frequencies fairly completely, which is rather like curing rheumatism by severing the offending limb!

Permissible Amplitude.

The other main point of design is in the suspension of the cone and coil, for the truth of the bass response is directly dependent on this part of the speaker. If the cone is mounted in such a manner that it can only move a small amount, then two things will happen if an amplifier capable of delivering about 5 watts A.C. is driving the speaker, and some frequency be-

Celestion twin permanent-magnet loud speaker unit.

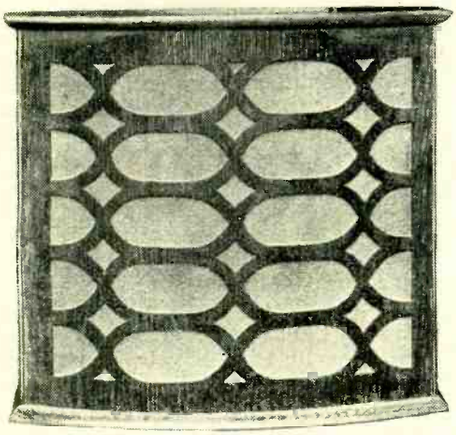
tween, say, 50 and 100 cycles comes from the detector. The cone will be unable to move a sufficiently great distance to reproduce this low-frequency note, and "frequency doubling" will take place; that is, instead of a 60-cycle note being emitted, it will come out as 120 cycles, or even as high as 180. In the second place, even if the amplifier only calls for a small movement of the cone, the natural frequency of the suspended system will be such that a well-marked resonance in the bass will spoil the balance of reproduction. This is quite a common fault, and is caused by the cone and coil being too tightly suspended. The obvious cure is to allow the cone to move

Choosing a Speaker.—freely and with a fairly large amplitude, which will result in the natural frequency being very low; in several makes this frequency is well below 50 cycles per second, and there is consequently no audible bass resonance.

Such a scheme cannot be adopted without very great care, however, as if the coil can move into and out of a weaker field there will be modulation of the high frequencies by the low, than which there is no more unpleasant form of distortion.

Dual-unit Loud Speakers.

In describing points to look for in moving-coil speakers we cannot conclude without referring to the double loud speaker idea. There are at least three schools of thought here, and their various advantages can be described. One is a combination of electrostatic and electrodynamic speakers. The former is well able to stand by itself and is very good in the



Primustatic loud speaker working on the electrostatic principle.

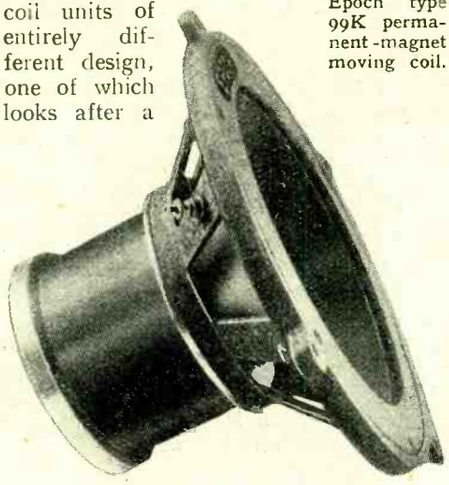
middle and upper register and in the reproduction of transients, but the moving-coil speaker will give better reproduction of the extreme bass.

Secondly, we have the possibility of using "matched pairs" of nearly similar moving-coil speakers. This has much to commend it, for it is a cheap and not-too-difficult business to have two cones of such substance that where a resonance occurs

Baker Selhurst "super-power" moving coil.

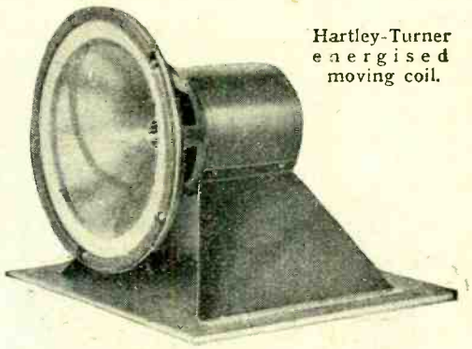
in one we have a dip in the response of the other, when the two together will give something approaching a straight-line response. It should be remembered, however, that the total frequency range of the pair cannot be greater than that of either of the speakers taken separately, and that the putting together of two identical units or of two chosen at random is useless. The generalised statement that two loud speakers are better than one is fiction; they must be designed specifically for that purpose. Finally, there is the plan of using two moving-coil units of entirely different design, one of which looks after a

Epoch type 99K permanent-magnet moving coil.



portion of the frequency range and the other reproduces the remainder. With this method a wider frequency range can be covered than by any other means. There is the necessity of keeping bass out of the treble unit and treble out of the bass unit,

Hartley-Turner energised moving coil.



which calls for filter circuits which add to the cost. The resultant pair will, however, handle an enormous input, so that the cost per watt of power-handling capacity is likely to be lower than of a single unit.

In conclusion, it is hoped that the reader will now realise the necessity of choosing his new loud speaker with due regard to the set with which it is to be used, and without depending too much on what his friends tell him of their own pet instruments. With so many types to choose from he will be very hard to please if he finds nothing to satisfy his own special requirements.

DISTANT RECEPTION NOTES.

THE outstanding medium-wave stations at the present time are the Italians. No other country has a sextet of stations giving such fine reception in this country as Trieste, Turin, Genoa, Milan, Rome, and Florence. All are reliable; all are receivable, except under phenomenally bad conditions, at good loud-speaker strength with any reasonably good three-valve set. Germany, though, is a good second with Frankfurt, Heilsberg, Breslau, Leipzig, Langenberg, and Konigswusterhausen. She would probably gain first place but for the frequent interference that takes place with Nürnberg's transmissions and the constant heterodyning of both Mühlacker and Hamburg. Next I would place France with Bordeaux, the Poste Parisien, Strasbourg, and Radio-Paris. Fécamp fades too badly to gain a place in the list; stations such as Lille, Rennes and the Ecole Supérieure are really well received only on occasion; the Eiffel Tower is not worth hearing except when Warsaw is silent. Sweden makes a good showing with Hörby, Göteborg, Stockholm, and Motala. Switzerland is well represented by Söttens, and Berömunster, and, thanks to the two Brussels stations, Belgium is a regular provider of entertainment.

Country by Country.

It is most interesting to spend a long-distance evening in touring Europe, not station by station, but country by country. Actually there are few countries which cannot be visited in this way on any reasonably good evening. Spain will probably be represented by Barcelona with Madrid (Union Radio) and Valencia as possibles. Czecho-Slovakia has three good stations in Bratislava, Brno, and Prague. Warsaw is Poland's most powerful station, though Katowice provides the best reception. Lwow can be received when Moscow is not working on the adjacent wavelength, and Poznan is sometimes to be heard on 335 metres. Vienna is the only Austrian station that people hear, but you may find Graz coming in well if you choose a time when the London Regional is silent. Norway (Oslo), Hungary (Budapest), Latvia (Riga), Holland (Huizen and Hilversum), Roumania (Bucharest), Yugoslavia (Belgrade), Estonia (Tallinn), and Denmark (Kalundborg), almost exhaust the list of European countries that are now within the range of the receiving set.

D. EXER.

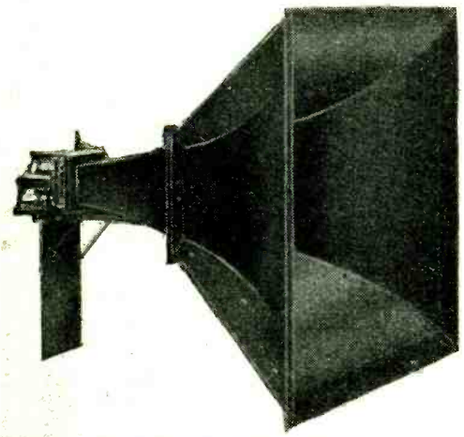
The Wireless World

INFORMATION BUREAU.

THE service is intended primarily for readers meeting with difficulties in the construction, adjustment, operation, or maintenance of wireless receivers described in *The Wireless World*, or those of commercial design which from time to time are reviewed in the pages of *The Wireless World*. Every endeavour will be made to deal with queries on all wireless matters, provided that they are of such a nature that they can be dealt with satisfactorily in a letter.

Communications should be addressed to *The Wireless World* Information Bureau, Dorset House, Tudor Street, E.C.4, and must be accompanied by a remittance of 5s. to cover the cost of the service. The enquirer's name and address should be written in block letters at the top of all communications.

Loud Speaker Curves *and their* Interpretation.



Frequency and Response Scales and their Influence on the Appearance of the Curve.

By P. G. A. H. VOIGT, B.Sc., A.M.I.E.E.

IT has been said that statistics can be made to prove anything. One might almost say the same of frequency-response characteristic curves, for they can be wangled to look nearly straight when they should really look anything but straight.

When examining a characteristic curve, the first thing to do is to examine the scales on which it is plotted, as its shape is largely dependent upon these.

Next, the limit of frequencies covered should be examined. Many a bad curve can be made to look good by leaving out the ends.

The effect of juggling with the scale and limits is shown clearly in Figs. 1 to 3, the five different curves being actually all curves of the same (imaginary) loud speaker.

Figs. 1 (*a*) and 3 are the curves which might be used to convince a customer what a marvellous "nearly straight-line" loud speaker he is buying, whereas the curves in Fig. 2 are those which the Research Department might use to see what is wrong with the speaker, and which fault should be remedied first.

THE curves illustrating this article are all of the same fictitious loud speaker and show that close attention must be paid to the horizontal and vertical scales of the curve in order that a true interpretation of the performance of the unit under normal working conditions may be obtained.

Horizontal Scale.

The curve, Fig. 1 (*a*), is drawn to a scale which is now happily out of date. This scale is one on which the base is proportional to frequency; that is to say, the frequencies from 0 to 1,000 take up as much space as those from 3,000 to 4,000. In the days of bad transformers, the efficiency below 250 cycles was often so poor that this scale was used to obscure the performance in this region. As 250 cycles was practically in the margin, the fact that there was a bit missing hardly showed. Since frequencies 2 octaves below 250 are of considerable importance, such an omission is intolerable. When next it is considered that the four important octaves from 64 to 1,000 are crowded into a space of the same size as half an octave around 4,000 cycles, it will be obvious that this base does not give a true picture.

When a curve is plotted on a frequency base it is the part which is nearest the left-hand side which is most important, and the bit which is left out is often more important still.

The base which gives a better distribution of the frequency is the one which gives each octave the same space. Since for each octave increase the frequency is doubled, and since the log of a number increases by a fixed amount if the number is doubled, the octave base is often referred to as a logarithmic base, and drawn out on log paper. They are actually two names for the same thing.

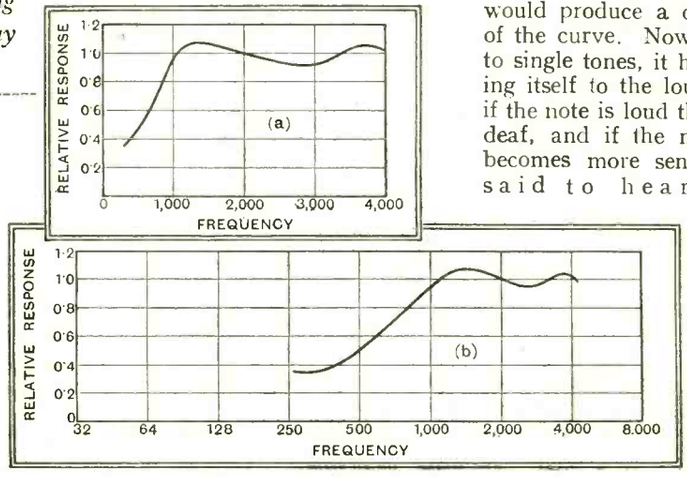


Fig. 1.—Response curves of the same loud speaker on (a) a linear frequency scale and (b) an octave or logarithmic frequency base. Curve (b) reveals that important information regarding the lower half of the musical scale is absent from curve (a).

Fig. 1 (*b*) shows the same curve as Fig. 1 (*a*), but on an octave or logarithmic base instead of a linear-frequency base. (For convenience 32, 64 and 128 are used instead of 31.25, 62.5 and 125 as being near enough for all practical purposes.) It will be seen, on referring to the frequencies, that the two octaves from 250 to 1,000 cycles are now occupying as much space as the two octaves from 1,000 to 4,000 cycles. This is only right, as they are, if anything, more important, at least for music, whereas the old curve made them look only about one-quarter as important.

The curve Fig. 2 (*a*) covers a wider frequency scale than Figs. 1 (*a*) and (*b*). It shows one additional octave at the high and three at the low end of the scale. Of these three the lowest, i.e., that between 32 and 64 cycles, is probably unimportant, but it is generally of interest, even if only to show whether the loud speaker is going to reveal 50-cycle hum or not.

In Figs. 1 (*a*), 1 (*b*), and 2 (*a*) the vertical scale shown is one of direct proportion, that is to say, a doubling in response would produce a doubling in the height of the curve. Now, if the ear is listening to single tones, it has the habit of adjusting itself to the loudness—that is to say, if the note is loud the ear becomes slightly deaf, and if the note is weak the ear becomes more sensitive; it is therefore said to hear "logarithmically." Supposing, now, that a sound suddenly drops to one-hundredth of its previous strength, shown on a curve with a proportional scale, this one-hundred would not be enough to show at all, and from the curve one would not expect to hear anything; actually, however, the ear would readjust itself and hear the note quite well. It is, therefore, now common practice to plot the vertical scale on a similar scale to that on which the ear hears single tones, namely, on a logarithmic scale, or, what is the same thing, a decibel scale. In curves plotted in this fashion violent peaks tend to look less dangerous, and poor responses tend to be magnified.

Loud Speaker Curves and their Interpretation.—Now, for certain classes of work, the decibel vertical scale, on account of its logarithmic basis, has much to commend it, but I am not fully satisfied that the considerations which gave rise to it hold good for the combination tones of which all music is composed. For example, let us assume a note, with a fundamental at 140 cycles, strong harmonics at 280, 420, and 560, and two secondary harmonics of equal strength at 3,510 and 7,020, reproduced on a loud speaker having a characteristic as shown in Fig. 2 (*a*). It will be obvious at once from the curve that the main harmonics will be reproduced at about one-third their proper strength, relative to the 140-cycle fundamental. The secondary harmonic at about 7,000, which is reproduced at about one-twentieth its proper strength, will probably be quite inaudible in spite of the ear's best efforts to hear logarithmically, because it will be blotted out by the 3,510-cycle secondary harmonic which is reproduced so much more efficiently.

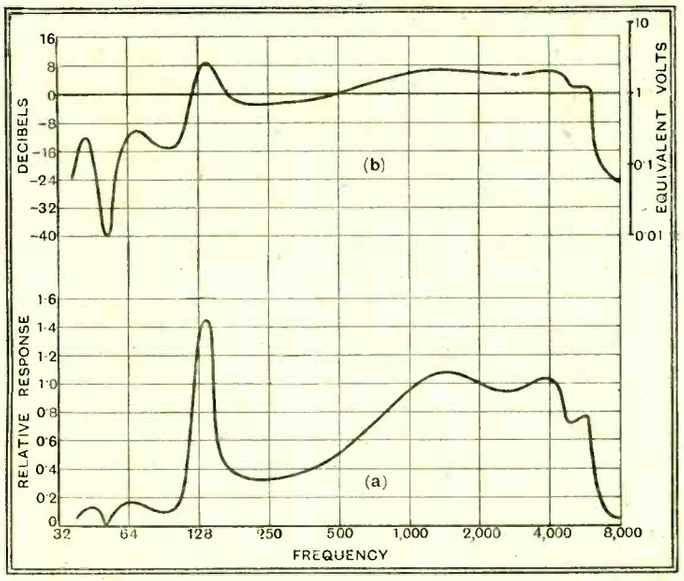
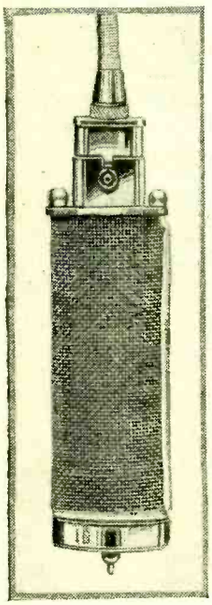


Fig. 2.—Curves of the same loud speaker plotted (a) in terms of relative response and (b) on a decibel scale. Note that on the decibel scale the unimportant dip at about 50 cycles in the region of low output is exaggerated, while the peak at 130 cycles is minimised.



The Edison Bell (Voigt) electrostatic microphone gives an output proportional to sound pressure, is non-directional and does not introduce any appreciable obstacle effect when suspended in the sound field.

Fig. 2 (*b*) shows the same curve over the same limits as Fig. 2 (*a*) but with a decibel vertical scale, and it is interesting to see how this scale levels out the major irregularities, and makes unimportant irregularities in the region of low efficiency look serious.

Fig. 3 is a fake made possible by a misuse of the decibel scale. It will be seen, on looking carefully, that the decibel scale has been deliberately crowded. This has the natural effect of flattening out the curve, and by crowding up the scale more this curve could be made as flat as desired. For the decibel scale some standard relation between the vertical and horizontal scales should be established, and in this connection I would suggest that the relation used in Fig. 2 (*b*), i.e., 20 decibels vertically equals 1 octave horizontally, is if anything, not so good as a ratio of 10 decibels to one octave.

To convert from a proportional scale to a decibel one it is convenient to remember that a 2:1 peak, or trough, is roughly a six decibel change in level. The table below gives the exact conversion:—

Percentage Response	D.B.	Percentage Response.	D.B.
10	−20.0	110	+0.8
20	−14.0	120	+1.6
30	−10.5	130	+2.3
40	− 8.0	140	+2.9
50	− 6.0	150	+3.5
60	− 4.4	160	+4.1
70	− 3.1	170	+4.6
80	− 1.9	180	+5.1
90	− 0.9	190	+5.6
100	0	200	+6.0

As the apparatus I use for taking characteristic curves gives me results directly in proportion, and as the human animal is a lazy beast, I have got so used to reading a curve on a proportional basis that I always think on that basis. Nevertheless, the decibel scale is in such general use that I think a curve published on a proportional scale should be accompanied by one on a decibel scale. Other scales, such as the power scale, and the square-law scale, are sometimes used, but these exaggerate peaks out of all reason, and will, I hope, soon die a natural death.

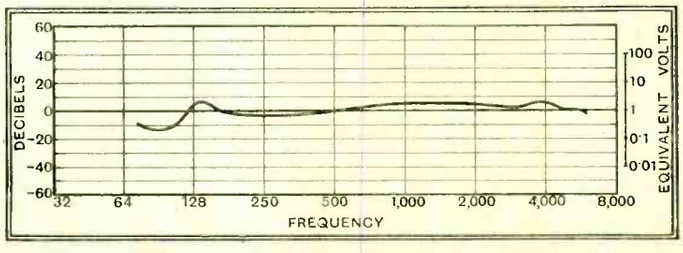
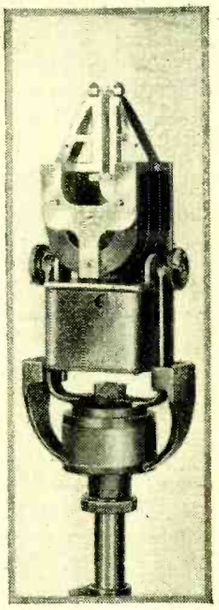


Fig. 3.—By crowding the units of the vertical scale and omitting the extreme ends, the decibel curve of Fig. 2 (b) can be made to appear substantially flat.

Effect of Microphone Characteristic.

The next question with which we are concerned, especially with loud speaker curves, is the question of whether the curve is a true curve of the loud speaker output or whether it includes the faults of the microphone.

When experimenting with different loud speakers, the ultimate test is always, "Well, switch on, let's hear it"! and the natural result is that loud speakers in general tend to have a curve which is the inverse of that of the average transmission, or record and pick-up. In other words, if the average transmission, or pick-up and record, contains an excess of top, then the loud speakers which sound best are those which are deficient in top by the corresponding amount. In fact, a loud speaker which is uniformly efficient over the scale sounds definitely harsh on such transmissions, or pick-ups and records. Suppose now that a microphone which actually has an excess of top is believed by its makers to have a straight line characteristic, then every loud speaker curve taken with such a mike will show much more top than is actually due to the speaker. Now, this state of affairs has actually occurred, and for several years mikes which had an excess of top were believed to have straight characteristics. The error arose through the fact that these microphones were calibrated when placed at one end of a closed tube filled with hydrogen, and under these conditions did, in fact, have a substantially straight characteristic. When, however, these microphones are used in "free air," they present an obstacle to the sound field in which they are placed. This causes the sound to react differently to the way it did in a closed tube. With these mikes, there is also a cavity resonance, which did not



R.C.A. electromagnetic ribbon microphone which gives a response proportional to the air particle velocity.

Loud Speaker Curves and their Interpretation.—show up in the closed tube, and both these effects cause an excess of top.

As the direct result, there are many loud speaker curves which have not been corrected for the "free air" curves of the mike, and this is important, since a loud speaker, the uncorrected curve of which looks straight, will sound dull on a straight line transmission, and vice-versa, a loud speaker, the corrected curve of which is straight, will sound harsh on a transmission from an uncorrected mike. Fortunately, this obstacle and cavity effect is now recognised on both sides of the Atlantic. Absolute standards of sound pressure have been independently produced by different methods and checked against one another, and microphones have been made which are free from the faults mentioned. These newer microphones, which are of several different types, are coming more into use, and where the old microphones are used suitable correction circuits are sometimes included, so that the speech current approaches straight-line working more closely.

To recapitulate: when examining a characteristic curve, the first thing to notice is the horizontal frequency base. Next, the vertical ordinate; thirdly, the limits shown; and lastly, in the case of loud speaker or microphone curves it is necessary to find out if the curve is the "free air" curve in the case of a mike and whether it is corrected for the "free air" curve of the calibrating mike in the case of a loud speaker.

(To be concluded.)

TRANSMITTERS' NOTES.

South African Amateurs.

Mr. C. A. Alder, whose address is P.O. Box 32, Witbank, Transvaal, writes that he is willing to enter into correspondence with amateurs in this country who are interested in communication with South Africa. He informs us that South African amateurs are usually on the air from 6.30 to 7.0 p.m. (South African time) on weekdays, and from 10.0 a.m. to 2.0 p.m. on Sundays, the most powerful being ZS6Y (R. Keir, Largo Colliery, Welgedacht, Transvaal), ZU5A (R. Page, Umtata, Cape), and ZS1P (H. J. R. Rieder, Three Anchor Bay, Cape), who all transmit on the 40-metre waveband.

Transmitters in Jamaica.

Through the courtesy of Mr. M. W. Pilpel (G6PP), we are able to give a complete list of the amateur transmitters in Jamaica, which has been issued since the Amateur Call Book went to press.

VP2BR	B. A. Richards, Trevennion Road, St. Andrew.
VP2CC	C. M. Corinaldi, Port Antonio.
VP2DD	D. van B. Dun, c/o Jamaica Telegraph Co., Kingston.
VP2GM	G. E. MacCulloch, Sackville Road, Vineyard Pen, Kingston.
VP2IJ	I. J. Arscott, c/o United Fruit Co., Kingston.
VP2IS	W. H. J. Stephens, Stony Hill.
VP2MK	C. M. Lyons, 2b, North Street, Kingston.
VP2NH	N. H. Wiles, "Nordene," Park Avenue, Collins Green, St. Andrews.
VP2PA	C. L. Isaacs, Port Antonio.
VP2PZ	J. F. Grinan, Liguanea Club, St. Andrew.
VP2RJ	Radio Association of Jamaica, 68½, King Street, Kingston.
VP2SI	S. I. Jones, 8, Dumphries Street, Kingston.

In Next Week's Issue:—

The Wireless World

MONODIAL D.C. SUPER.

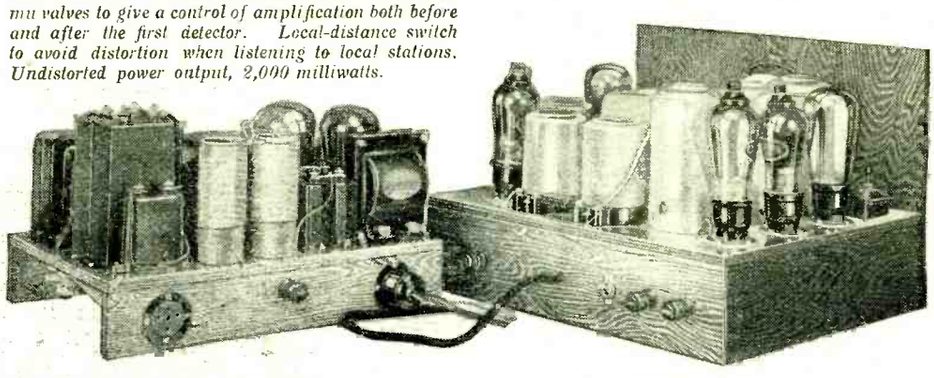
SO great is the reputation which *The Wireless World* Monodial A.C. Super has achieved that readers on direct-current supply have for some months past clamoured for a D.C. version of this now famous receiver. We give some brief details here of a D.C. model which has now passed its final tests and will be described in next week's issue.

FEATURES.

A seven-valve single-control D.C. mains superheterodyne, employing variable-mu H.F. and I.F. stages. Screened grid first detector, triodes for the oscillator and second detector.

Parallel pentode output stage with automatic tone correction.

Eight tuned circuits of semi-band pass type, giving very high selectivity and quality in conjunction with tone correction. Volume control acts on both variable-mu valves to give a control of amplification both before and after the first detector. Local-distance switch to avoid distortion when listening to local stations. Undistorted power output, 2,000 milliwatts.



LIST OF PARTS.

After the particular make of component used in the original model, suitable alternative products are given in some instances.

2 Fixed condensers, 2 mfd., 500 volt D.C. test — **Dubilier, Type "B.B"**

3 Fixed condensers, 1 mfd., 500 volt D.C. test (Ferranti, Formo, Peak, T.C.C., Telsen, Wego.) — **Dubilier, Type "BB"**

5 Fixed condensers, 0.1 mfd., 500 volt D.C. Test, non-inductive (T.C.C., Telsen, Wego.) — **Dubilier, Type 9200**

1 Fixed condenser, 0.001 mfd. — **Dubilier, Type 620**

1 Fixed condenser, 0.0001 mfd. — **Dubilier, Type 620**

1 Fixed condenser, 0.0005 mfd. — **Dubilier, Type 620**

1 Fixed condenser, 0.002 mfd. (Ferranti, Loewe, T.C.C., Telsen, Wego.) — **Dubilier, Type 620**

1 Fixed condenser, 0.0001 mfd. (T.C.C.) — **Dubilier, Type 670**

1 Potentiometer, 2,500 ohms, wire wound (Colvern, Claude Lyons, Rothermel, Wearite.) — **Watmel, Type No. 1**

1 Semi-fixed condenser, 0.0005 mfd./0.002 mfd. (Formo, Goltone, Polar.) — **R.I. "Varicap"**

1 5-Way insulated connector — **Wilburn**

1 Variable condenser, 0.0005 mfd., 3-gang, screened superhet type, with trimmers on the right, and cover — **British Radiophone**

1 Slow-motion dial, for above — **British Radiophone**

2 Metallised resistances, 100 ohms, 1 watt — **Dubilier**

2 Metallised resistances, 1,000 ohms, 1 watt — **Dubilier**

1 Metallised resistance, 6,000 ohms, 1 watt — **Dubilier**

1 Metallised resistance, 30,000 ohms, 1 watt — **Dubilier**

2 Metallised resistances, 250,000 ohms, 1 watt — **Dubilier**

1 Metallised resistance, 4,000 ohms, 2 watts — **Dubilier**

1 Metallised resistance, 5,000 ohms, 3 watts (Colvern strip type, Erie, Claude Lyons, Wearite strip type.) — **Dubilier**

1 Strip resistance, 25 ohms — **Claude Lyons, Type FW25**

3 I.F. Transformers, 110 kc. (Varley.) — **Colvern "Colverdynes"**

5 Valve holders, 5-pin (British Radiophone, Bulgin, Eddystone, W.B.) — **Clix Chassis-mounting type**

1 Screened superhet H.F. Choke (Keystone, Wearite.) — **Bulgin, H.F.10**

1 Battery cable, 5-way (Belling-Lee, Concord, Goltone, Lewcos.) — **Harbros**

1 Set of canned coils — **Varley "Square Peak" BP.19**

4 Ebonite-shrouded terminals Pick-up (2), aerial, earth (Burton, Clix, Eelex, Igranic, Swain.) — **Belling-Lee, Type "B"**

1 Single-pole D.M.B. change-over switch — **Claude Lyons, B.A.T.729**

1 Single-pole D.M.B. switch, on/off (Bulgin, Keystone.) — **Claude Lyons, B.A.T.728**

Metal screened sleeving, 3ft. (Concord, Harbros, Lewcos.) — **Goltone**

1 Plymax baseboard, 12in. by 14in. by ⅜in. — **Peto-Scott**

1 Panel, oak-faced ply, 14in. by 9½in. Plywood, ⅜in., screws, 2 oz. No. 22 tinned copper wire, systoflex, etc., etc. — **Peto-Scott**

Power Pack.

1 L.F. transformer — **Ferranti, A.F.5**

1 Double-pole D.M.B. on/off mains switch (Claude Lyons.) — **Bulgin, S88**

1 Twin fuseholder, complete with 1 amp. fuses (FF) (Bulgin, Goltone, Microfuse.) — **Belling-Lee, 1033**

2 10-Henry chokes (Ferranti B2.) — **Sound Sales**

2 20-Henry chokes (R.I. "Hypercore.") — **Varley, DP10**

2 Fixed condensers, 4 mfd., 500 volt D.C. test — **Dubilier, Type "BS"**

1 Fixed condenser, 2 mfd., 500 volt D.C. test — **Dubilier, Type "BB"**

4 Fixed condensers, 1 mfd., 500 volt D.C. test — **Dubilier, Type "BB"**

1 Fixed condenser, 0.5 mfd., 500 volt D.C. test — **Dubilier, Type "BB"**

2 Metallised resistances, 50,000 ohms, 1 watt — **Dubilier**

2 Metallised resistances, 5,000 ohms, 1 watt — **Dubilier**

2 Metallised resistances, 250 ohms, 1 watt — **Dubilier**

2 Metallised resistances, 100 ohms, 1 watt (Colvern strip type, Erie, Claude Lyons, Wearite strip type.) — **Dubilier**

4 Valve holders, 5-pin (British Radiophone, Bulgin, Eddystone, W.B.) — **Clix Chassis-mounting type**

2 Plugs, 5-pin (Eelex, Keystone.) — **Bulgin, P3**

1 Ebonite-shrouded terminal, earth (Burton, Clix, Eelex, Igranic, Swain.) — **Belling-Lee, Type "B"**

1 Asbestos woven wire resistance net, 200 ohms — **Cressall, Type "ERF"**

1 Asbestos woven wire resistance net, 250 ohms — **Cressall, Type "ERH"**

1 Asbestos woven wire resistance net, tapped, 195 ohms — **Cressall, Type "SSR.36"**

2 doz. porcelain washers, unglazed — **Cressall, Type 9031**

2 H.F. chokes (See Text.)

1 Plymax baseboard, 9in. by 12½in. by ⅜in. Plywood ⅜in., screws, 2oz. No. 20 tinned copper wire, systoflex, etc., etc. — **Peto-Scott**

Valves: Osram 2 V.D.S., 1 D.S., 2 D.H., 2 D.P.T. (Marconi).

NEWS of the WEEK.

Wireless on the Stage.

A RADIO set plays a grim part in a French talkie now running at the "Ambassadeurs," Paris. In the last act, when the heroine is dying over the corpse of her husband, the broadcast receiver in the corner of the flat fills the apartment with ironic jazz melodies.

Breslau v. Poste Parisien.

THE new 60-kW broadcasting station at Breslau on 325 metres is seriously clashing with Poste Parisien on 328.2 metres. We understand that French listeners are considering a petition to the International Broadcasting Union for a readjustment of wavelengths.

O.C. Air-route Radio.

FLIGHT-LIEUTENANT R. F. DURRANT, who has frequently contributed articles to *The Wireless World* on aviation wireless, is shortly proceeding to Egypt to take charge of the wireless organisation of the Imperial air routes. Mr. Durrant's description of his pioneer flight to the Cape to establish wireless points throughout the journey from Cairo to Cape Town appeared in our issue of August 26th last.

Brighter Broadcasting in Russia.

THE recently celebrated fifteenth anniversary of the formation of the Soviet régime coincided with a decision to develop the musical and dramatic side of Russian broadcasting. The new intention is not entirely unconnected with an official order that radio must soon "pay its way" by means of listening licences. Evidently it is felt that Russian listeners can only be induced to pay up if the programme fare is attractive.

Licences for French Listeners?

STRANGE tales are going the rounds of the French Press to show the anxiety of listeners concerning the proposed listeners' tax. Our Paris correspondent sends a specimen story.

A listener consulted a fortune teller on the subject. The prophetess, after some cabalistic arithmetic, announced that the name of the French P.M.G. (M. Queuille) is equivalent to the verb "cueille" (gather), and that therefore listeners will have to pay. "My fee," she added, "is 50 francs." This happens to be the amount of the proposed licence for valve sets.

Cross-channel Messages on 15 Centimetres.

"MICRO-RAY" equipment giving radio communication on a wavelength of 15 centimetres is being supplied by Standard Telephones and Cables, Limited, for use between Lympne air port and the French Air Ministry air port of St. Inglevert, near Calais. The system, which operates over "optical" ranges, will be employed for announcing the arrival and departure of planes not fitted with radio and for routine service messages. It is interesting to note that teleprinters will be used at each end.

The "micro-ray" system was described in *The Wireless World* of April 15th, 1931.

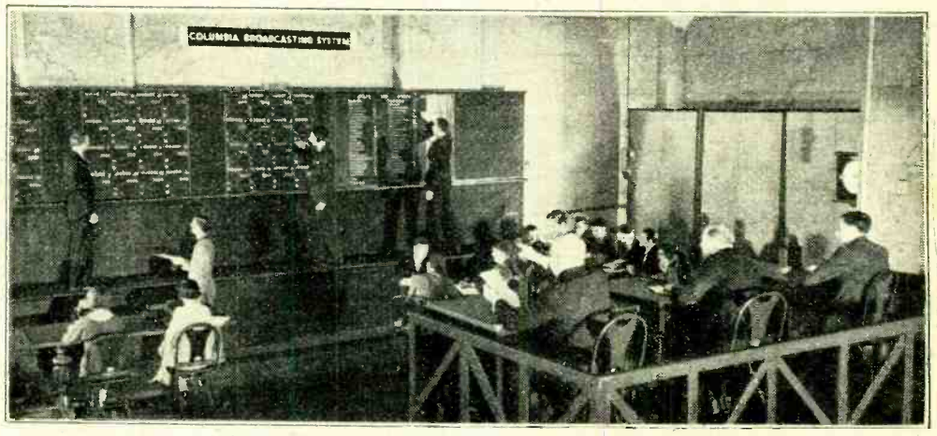
Current Events in Brief Review.

"Radio-Thesalonik."

THIS is the title of the first Greek broadcasting station, which will shortly begin transmissions on a wavelength of 270 metres. Provisional programme times are from 11.45 a.m. to 12.45 p.m. and from 7.15 to 8.15 p.m. daily (G.M.T.).

Caruso's Voice Electrically Recorded.

MUSIC lovers can now hear the voice of the great tenor, Enrico Caruso, recorded in such a manner as has only been possible since the invention of electrical recording. It is learnt that the "His Master's Voice" Gramophone Company have taken a Caruso record originally made in the early days of horn recording, and after amplifying the waves in the wax, have passed them through filters which correct the deficiencies in the original recording.



BUSY DAYS ON THE NETWORKS. U.S. broadcasting underwent an upheaval during the period of the Presidential election. This picture shows the biggest studio at the Columbia station WABC, New York, transformed for the purpose of broadcasting the results. On the extreme right is Dr. Salo Finkelstein, lightning calculator, who gave out the national totals at short intervals.

A new orchestral accompaniment was provided after the conductor had played Caruso's original disc over many times and thus become thoroughly acquainted with every inflection of the singer's voice in order to ensure absolute synchronisation. The record was then played through for re-recording, the conductor listening by means of headphones. The first record made under this process (DB1802) is "Vesti la giubba," from *Pagliacci*, and "M'appari tutt' amor," from *Maria*.

The B.B.C. Pays.

REPLYING to a suggestion of a reduction in the present amount paid to the B.B.C. out of wireless licence receipts, the Postmaster-General, Sir Kingsley Wood, stated in the House of Commons last week that the matter would come up for reconsideration in connection with the next financial year. He pointed out, however, that the Corporation had already agreed to the withdrawal of the opera subsidy and that it had also undertaken for the present to defray the whole cost of the Empire broadcasting service.

The Wireless League.

THE annual general meeting of the Wireless League will be held on Thursday, December 8th, at 3.15 p.m., at 12, Grosvenor Crescent, Hyde Park Corner, London, to receive the Annual Report and Statement of Accounts, and elect the Committee for the ensuing year. Sir Arthur Stanley will be in the chair, and all members of the League are cordially invited to attend.

Facts About AWA.

AWA spells wireless in Australia, nor is this surprising when one studies the immense amount of radio work conducted by Amalgamated Wireless (Australasia), Ltd., as outlined in a new AWA booklet entitled "Facts."

Besides carrying 70 per cent. of the total telegraphic traffic between Australia and England by means of the beam system, the company handles the famous broadcasting stations 2FC, Sydney, and 3LO, Melbourne. The AWA Radio Centre at Pennant Hills, Sydney, is the largest of its kind in the Southern Hemisphere; it possesses 15 transmitters covering all classes of radio work, from ship messages to Empire broadcasting, the latter through VK2ME.

To cap the lot, AWA supplies the Commonwealth with broadcast receivers.

A Ferranti Triumph.

THE Ferranti seven-valve superheterodyne receiver has won "the-best-value-for-money-set" competition organised by the *Manchester Evening Chronicle* in connection with the Northern National Radio Exhibition. The result was arrived at by ballot among visitors to the show.

This success had a happy sequel a few days ago in the form of a presentation of a silver trophy to Mr. V. Z. de Ferranti, managing-director of the company, by Miss Ann Penn, the celebrated radio impersonator, on behalf of the *Evening Chronicle*.

Soviet Message via Rugby?

LAND lines *via* Berlin and London may shortly form part of the link between Moscow and New York (writes our Washington correspondent) to enable Stalin, the Soviet dictator, to broadcast a speech to American listeners.

Practical HINTS AND TIPS.

AIDS TO BETTER RECEPTION.

SO far as battery-fed receivers are concerned, the substitution of a variable-mu H.F. valve for one of the older type is a very simple matter. All that is necessary is to make provision for continuous variation of the value of negative bias applied to the grid of the new valve.

Maintaining Screening Grid Voltage.

When dealing with a set fitted with battery valves which is fed with H.T. current through an eliminator, it is often desirable to elaborate this procedure by making provision for the maintenance of screening grid voltage at a

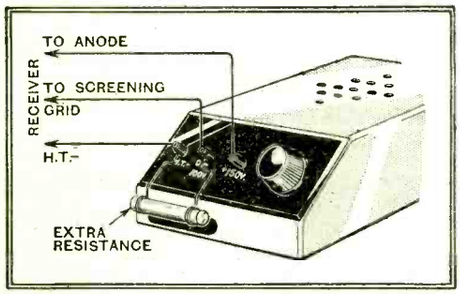


Fig. 1.—Screening grid voltage fluctuations may be reduced by adding an external resistance to an eliminator.

reasonably constant value which will not be seriously affected by variations in current brought about by changes in bias.

In the simpler type of eliminator a main output voltage terminal delivering approximately 150 volts is provided for feeding the anodes of all H.F., L.F., and output valves; a special detector feed may be fitted, and, in addition, there is almost always a variable voltage output, generally controlled by a potentiometer for supplying the screening grid. As a rule, the fixed and variable resistances of which this potentiometer is composed are of high resistance, and consequently regulation of voltage output will be bad. In other words, it will tend to fluctuate violently in sympathy with alterations in current loading.

This is not a serious objection when ordinary S.G. valves are employed, as the screen grid voltage is usually set initially to the best value, after which nothing is likely to occur which will alter it.

Regulation of most eliminators may generally be improved by increasing the normal current consumption of the potentiometer by shunting an extra loading resistance across the H.T. negative and variable output terminals in the manner shown in Fig. 1. In most cases, a resistance value of 20,000 to 30,000 ohms will not be too low, but care must be taken that this addition does not result in overloading the built-in potentiometer or reducing voltage output excessively. The guiding principle should be to use as low a resistance as possible.

WHEN carrying out the somewhat delicate, but none the less intriguing, operation of adjusting the trimming condensers of a newly built receiver, it will often be found that one of these trimmers must be set to its minimum value. In practice, this means that the maximum spacing allowed by the manufacturer must be given between the sprung condenser plate and the fixed back-plate which together constitute the usual balancing condenser. An indication is thus provided that the stray capacities existing across the individual circuit which requires a minimum of trimming capacity is already unduly high. Anything that can be done to reduce it will be all to the good, as it will allow a more extended waverange to be covered by the receiver.

Extending Waverange.

Apart from such drastic expedients as tapping down the connections of tuning coils, etc., a good deal may often be done by rearranging the high-potential leads in such a way that they do not run in close proximity to earthed masses of metal. But the trimming condenser itself has often quite a high minimum capacity, and it is the purpose of this note to point out that matters may generally be improved by removing it altogether from the one circuit which is found to suffer from excessive "strays." As often as not these built-in trimmers may be unscrewed and removed without risk of damage to the main condenser assembly. But even if the trimmer support forms a part of the stator it may be possible to make a considerable reduction in its minimum value by removing the adjusting screw and bending the sprung moving plate clear of its fixed counterpart.

Having removed or disconnected the trimmer, it will be realised that there remains no means of balancing out discrepancies in the stray capacity of the particular circuit with which it was associated. Consequently it must be ensured that this particular circuit "takes charge" when the operation of ganging the set is begun. This is best ensured by reducing artificially the efficiency of all other tuned circuits by shunting a comparatively low value of resistance across each of them. The resistors may be of the composition or metallised type, and the safest points of attachment for them are the coil terminals. It may appear to be more convenient to apply the artificial load across the tuning condenser terminals, but one runs a risk of upsetting bias arrangements by doing so.

This method of procedure is illustrated diagrammatically in Fig. 2, where it is assumed—it will generally be the case in practice—that the maximum strays will be associated with the intervalve coupling circuit L_3 and C_3. Consequently the trimmer across C_3 will have been removed. The loading resistors R_1 and R_2 are joined across the filter input circuits.

After having accurately tuned-in the signal to be employed as a guide in ganging, the next step, without touching the ganged tuning condenser, is to remove the loading resistor R_2 and to adjust the trimmer of C_2 for maximum response. The resistance R_1 is then removed, and the circuit L_1 C_1 is similarly treated.

In other circumstances than those under discussion, it is often worth while to employ the same plan for ensuring that any particular unit of a series of ganged circuits shall "take charge" while trimming.

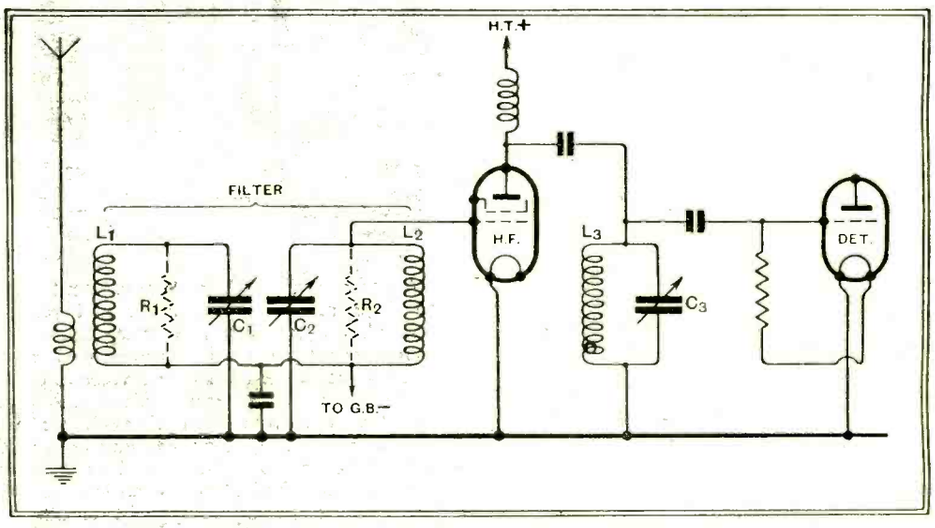


Fig. 2.—Adjusting a single-knob tuning system: to ensure that the circuit C_3, L_3 is accurately tuned to an incoming signal, the efficiency of the remaining tuned circuits may be temporarily reduced by adding parallel resistances of 5,000 ohms, or even less.

The Position of the Loud Speaker.

Quality of Reproduction in Relation to Room Acoustics.

IT is a far cry to the days when we used to be advised to try placing our loud speakers so that the bell mouth of the inevitable horn was facing the corner of the room. Such advice, even if it did no good, did not, at any rate, do much harm, since high notes which are usually cut off by this procedure were already conspicuous by their absence in the early days of loud speakers, which for the most part confined their attention to the region of a thousand cycles or so. Nowadays such advice, if put into practice, would have a very marked effect on reproduction, an effect which, in nine cases out of ten, would be very detrimental, the converse holding good in the tenth case, due perhaps to some peculiar acoustic properties of the room or other unforeseen factor.

Suggestions for Experiment.

Much improvement in reproduction can frequently be obtained with modern loud speakers by such things as altering the position of the loud speaker, either in respect of its height above the floor or the angle between the axis of its cone and a line drawn from the centre of the cone to the listener; but, of course, no very definite rules can be laid down, as the acoustic properties of rooms vary so largely, not only according to their size and shape, but also according to the amount of sound-absorbing material in the shape of the furniture which they contain. Thus, to ascertain the best position for a loud speaker becomes very largely a matter of trial and error. There are, however, a few general rules which can be laid down, provided that it is borne in mind that at any time it may be found necessary flagrantly to break one of them to suit the acoustic peculiarities of any particular room or occasion.

One of the first snags in using a loud speaker to the best advantage is the almost universal habit of building them into the same cabinet as the receivers. This makes for compactness, of course, but at times it can be a very great nuisance, as it may sometimes be found desirable to put the loud speaker in such a position as the bulk of the receiver into which it is built would render impossible; it is, indeed, fortunate that turning the front of the loud speaker towards the wall is not a thing to be recommended with modern instruments, otherwise tuning would be a matter of some difficulty. Fortunately, many modern receivers are arranged so that an external loud speaker may be used and the internal one cut out, and so in any special difficulty advantage may be taken of this extra provision, but it may seldom be necessary to use it except in the case of the radio-gramophone.

The first thing to be borne in mind is that, in order to obtain the best balance between the two ends of the musical register, it is desirable for listeners to sit as far as possible in line with the axis of the loud speaker, or, to put it more plainly, they should sit in front of it and not at the side, in which position a good deal of the high-note response may be lost. Indeed, so marked is the effect of high-note loss, when listeners sit outside the arc subtended by the loud speaker cone, that the phenomenon can be put to good use where a receiver with an uncorrected or inadequately correct pentode output stage is employed; in other words, it is possible to find by experiment a position for the loud speaker where just the right amount of high-note attenuation is experienced, thus counterbalancing the over-exuberance of the pentode in this respect. If little or no falling-off in high-note reproduction is experienced when sitting at the side of the loud speaker there are strong grounds for suspecting that its reproduction in the upper register is not as irreproachable as might previously have been supposed.

Directional Effects.

It will often be found that where several people are listening a good position for the loud speaker is over in a far corner with, of course, the back of the instrument turned towards the wall. In this manner good use can be made of the sound-reflecting and focusing properties of the adjacent walls, and a somewhat similar state of affairs occurs if the loud speaker is put against a remote wall. Such a large number of factors call for consideration, however, that no hard and fast rule can be laid down, and, indeed, in some cases a procedure such as that just outlined will result in very undesirable effects being introduced, more especially if the loud speaker is pushed too far into the corner. Experiment is the only way in which a decision can be reached concerning the desirability or otherwise of this positioning of the loud speaker.

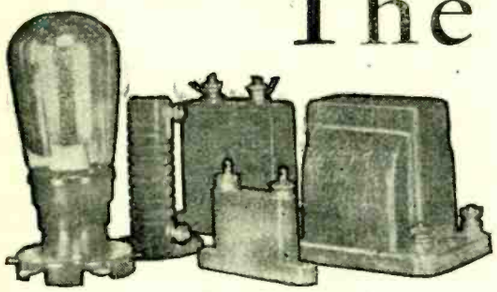
Another point of considerable importance is that it is desirable to keep the loud speaker at the same level as the ears of the listeners when in a sitting position. Standing the loud speaker on an ordinary table meets the case very nicely. Many people prefer to mount the loud speaker on a baffle placed six feet or more above the ground, but even if it is inclined so that listeners are in line with the axis of the loud speaker, reproduction is apt to sound rather unnatural; it is impossible to be dogmatic on this point, however, as it may well be that in a particular case acoustic conditions are such that they favour this particular arrangement above all others.

If the loud speaker is mounted too low down results are apt to be less pleasing than they might be, and it is on this score that a just criticism may be levelled at certain radio-gramophones. It is true that if the loud speaker position were exchanged with that of the tuning controls it would in the case of many instruments be necessary to go on hands and knees in order to tune in, but the placing of the controls on the motor board removes this difficulty. It must be admitted, however, that the necessity for opening the lid of the radio-gramophone for tuning purposes is open to objection from some points of view, and much might be done by manufacturers in the matter of designing an instrument with the loud speaker mounted high up, the tuning controls being at the side of it.

Reverberation.

The general rules already given may in many cases have to be considerably modified to deal with reverberation or its opposite. All articles in the room, including furniture and listeners themselves, tend to absorb sound, as is somewhat strikingly shown when a previously crowded talkie theatre becomes empty. In certain of these places where suitable corrective measures are not taken reproduction is apt to sound dull and lifeless when the house is very crowded, ranging through pleasing reproduction when it is comfortably full to hollowness sufficient to make speech barely intelligible when the hall is empty. It may well be, therefore, that the loud speaker, which gives the most pleasing results in a certain position in the room, may be productive of a totally opposite effect if placed in a similar position in a room having identical dimensions and shape, due solely to the different absorption effect of the two rooms.

Patient experiment, bearing in mind the few general rules which have been outlined in this article, will be amply rewarded.



The Signal Through the Receiver.

Part VII.—The Anode Circuit of the Detector.

IN this article the author continues the story with what happens in the anode circuit of the detector valve. In the previous instalment the effect of the signal on the grid of the detector valve was discussed.

AT the end of the preceding instalment of this series we came to the conclusion that when we apply a modulated high-frequency voltage to a leaky-grid detector the action of the valve is such that its grid varies in voltage in a very complicated manner (see Fig. 30 *b*). We also saw that these variations could be regarded as a change of steady bias, a variation at the modulation frequency (audio-frequency), and a variation at high-frequency, all happening at once. On the basis of that conclusion we will proceed to consider the further passage of the signal through the set.

First, we know that all the variations in grid voltage will be exactly reflected in corresponding variations in the current through the detector valve V_2. The change in mean grid voltage brought about by the application of the carrier, whether modulated or not, results in a decrease in the steady direct current flowing in the anode circuit. This decrease can be shown by any ordinary milliammeter, which will dip down below its normal reading when a station is tuned in. The extent of the dip can be used to indicate the strength of the received station, but in the ordinary set this change in steady anode current is ignored.

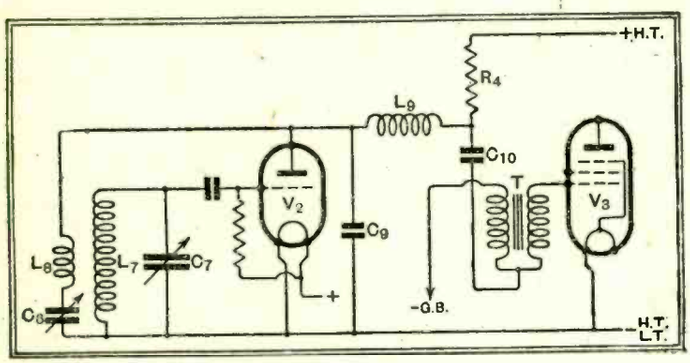


Fig. 31.—Portion of the complete receiver, showing components included in, and therefore affected by, the anode circuit of the detector V_2.

Next in order, so far as the set is concerned, we must consider the high-frequency voltage variations on the detector grid. These give rise to corresponding high-frequency currents through the detector valve, and this current must pass back to filament by some path or another. Reference to the circuit of the complete set (Fig. 9), or to Fig. 31, which repeats the particular section of the set with which we are here concerned, shows that the anode circuit of V_2 contains the high-frequency choke L_9. The purpose of this is to prevent, so far as possible, the passage of high-frequency currents through the resistance R_4 or the primary of the transformer T. As alternative paths, they are offered the fixed condenser C_9, which runs from the anode of the valve direct to the filament, or the reaction path through L_8 and C_6. Each of these paths carries some proportion of the high-frequency current, the exact proportions naturally varying with varying setting of the reaction condenser C_6.

It has already been pointed out that the passage of the amplified current through the coil L_8 induces a voltage in L_7 in such a way as to increase that due to the signal, and attention has been drawn to the fact that L_8, in supplying power to the tuned circuit, tends to counterbalance the resistance naturally and inevitably present in L_7 and C_7, thereby increasing the amplification provided by the variable-mu valve. If this were all the reaction arrangements would hardly earn their salt, for the losses inherent in the tuned circuits are not large. But the grid-current flowing in V_2, which we have seen to be a necessary part of the process of rectification, is provided at the expense of the signal voltage across L_7C_7. In addition, the capacity between grid and anode of the detector feeds back from anode to tuned circuit a voltage tending to obliterate the signal. The combined effect of these two sources of damping is such that the resistance of L_7C_7, measured with V_2 in action, may be twenty or more times as great as the natural losses in coil and condenser when measured out of the set. It is in counterbalancing these enormously enhanced losses that the reaction circuit finds its true justification; by removing their effects the provision of reaction adds a very large contribution indeed to both the sensitivity and the selectivity of the set.

In practice the condenser C_6, by adjustment of which the amount of current flowing through the reaction coil L_8 is controlled, will usually have a maximum capacity of 0.0003 to 0.0005 mfd. Since it is not part of a tuned circuit, high-frequency losses in it are of no great account, and for that reason the compact type of variable condenser interleaved with bakelite or other insulating material is generally chosen.

The function of the by-pass condenser C_9 is to provide an additional path for the high-frequency currents. If this path were not provided several unpleasant things would be liable to happen. For one thing, the anode circuit as a whole would offer an impedance high enough to accentuate very considerably the negative reaction through the capacity between anode and grid; L_7C_7 would then become a circuit of very high losses indeed. Tuning would in consequence be flat and sensitivity low.

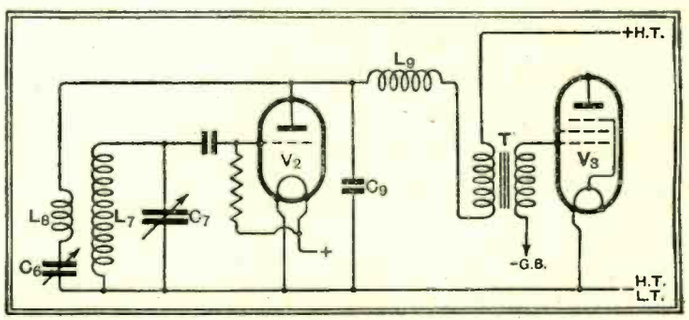


Fig. 32.—Showing an alternative method of connecting the transformer. The steady anode current of V_2 now passes through the primary, and this may be injurious to the fidelity of reproduction.

Then, again, an appreciable proportion of the current would find its way, especially when C_6 was set at minimum, across the stray capacity of the choke L_9, and so would pass through the low-frequency side

The Signal through the Receiver.—of the set, there to impair quality and endanger stability.

From these considerations it is clear that when the detector has extracted the low-frequency modulation from the signal, the high-frequency carrier is of no further use to us except for reaction, and our one desire is to throw it away as one would throw away an empty envelope. For this, a large capacity at C_9 would appear desirable, but it has to be remembered that this condenser must not drain away any appreciable fraction of even the highest notes of the audio-frequency signal. A suitable compromise is therefore made, and C_9 will, in an average set, have a capacity of 0.0002 to 0.001 mfd.

The high-frequency choke L_9 has to carry both the steady anode current of the valve and the low-frequency currents extracted from the carrier by the action of the detector, while rejecting only the high-frequency currents. The inductance of the choke must be high enough for the latter

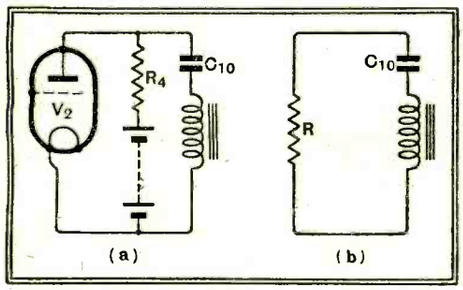


Fig. 33.—(a) The presence of V_2 and R_4, in parallel, in series with C_{10} and the primary of the transformer prevent the low-frequency tuned circuit from resonating sharply; (b) shows the effective circuit, R_4 and the valve resistance being amalgamated to give R.

purpose, while still being low enough to offer no serious impedance to audio-frequency signals. An inductance not less than 100,000 microhenrys, nor much more than 300,000 microhenrys, is found satisfactory in this respect. The lower of the two inductances mentioned offers an impedance of about 90,000 ohms at 150 kc. (2,000 metres), and some 3,000 ohms to an audio-frequency note of 5,000 cycles, thus giving a reasonably complete separation.

Alternative Transformer Connections.

After passing through L_9, alternative paths again make their appearance. The steady anode current has, of course, to pass through R_4, because the presence of C_{10} in the branch comprising it and the primary of the transformer T prohibit its passage by this route. The signal, on the other hand, divides, part going through the resistance and part through C_{10} and the transformer. It is evident that in the interests of amplification it will be desirable to make R_4 as large as possible, thereby increasing the proportion of the signal that passes through T. Too large a resistance, however, will so restrict the anode current of V_2 that it will not be able to handle a signal large enough to give the pentode that follows it an adequate input. The detector will, in fact, overload before the pentode is delivering its full signal.

The alternative circuit of Fig. 32, in which the transformer primary directly replaces R_4, is sometimes a very satisfactory method of overcoming detector overload, but in practice it is possible to choose for R_4 a resistance of value high enough to ensure that the difference in amplification between the two circuits is hardly noticeable. Further, many modern transformers, especially those with high-permeability cores, lose a great deal of their excellence if called upon to carry the steady current of the valve. The iron is so heavily magnetised by the steady current that it can no longer respond properly to the signal current superimposed upon it.

Choice of Resistance Value.

In the circuit used in the set, Fig. 31, the value of the R_4 will generally be about 30,000 ohms if V_2 has an A.C. resistance of about 10,000 ohms. Since it is desirable so to arrange matters that the voltage dropped across R_4 is about half the available battery voltage, the resistance chosen will have to be higher or lower than the value suggested if the valve has an impedance widely different from the value mentioned.

Besides its obvious duty of preventing the passage of current from the high-tension battery to earth, the condenser C_{10} serves to tune the primary of the transformer to some note in the bass register. Owing to the presence of R_4 and the valve in series with the tuned circuit (see Fig. 33) the tuning is far too flat for any audible resonance to be produced; instead, the effect is simply that of maintaining the bass response at full value over a region where it would otherwise fall away. The sketched response-curves of Fig. 34 give a good idea of the alteration in bass produced by using for C_{10} a condenser of suitable capacity. In nearly all cases 1 mfd. is found to give the best response curve, but the instructions of the transformer makers should be followed implicitly.

In passing through the many turns of the transformer primary, the low-frequency signal sets up a magnetic field which follows exactly the fluctuations of the current. This field is almost entirely concentrated in the iron core, for the iron offers an impedance several thousands of times less than that of air to the passage through it of lines of magnetic force. The secondary of the transformer is usually interleaved with the primary, or wound over it, so that the iron core passes equally through both. As a result, practically all the magnetic lines set up by the passage of the signal through the primary pass through the secondary too, and induce a corresponding voltage in this. The link through which the signal is passed on from primary to secondary thus consists of a magnetic field the fluctuations of which, like the current in the primary, are an electrical equivalent of the audio-frequency

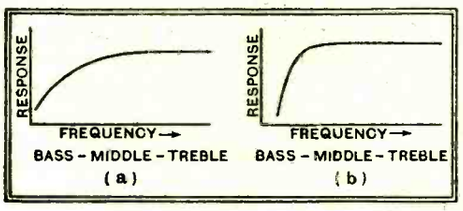


Fig. 34.—Type of response curves to be expected of transformers (a) without, and (b) with, series condenser C_{10}. A properly chosen condenser keeps the bass response up as far as a certain frequency, below which it tails off very rapidly.

signal originally sent out on the carrier wave of the transmitter.

In order to increase amplification there are more turns on the secondary of the transformer than on the primary; the effect of this is to make the signal voltage on the secondary greater than that across the primary in the ratio of the number of turns on the two windings. A limit is set to the possible ratio by the fact that too few turns on the primary will lead to loss of bass through insufficient inductance, while too many turns on the secondary will lead to a loss of top notes by increasing the stray capacity of the winding. In most cases the secondary contains from three to five times as many turns as the primary.

In the circuit of our receiver it will be noticed that primary and secondary are joined in series, C_{10} being connected to the junction of the two. This makes T into an auto-transformer, in which the primary does duty twice over, once as primary and once as part of the secondary. Reference

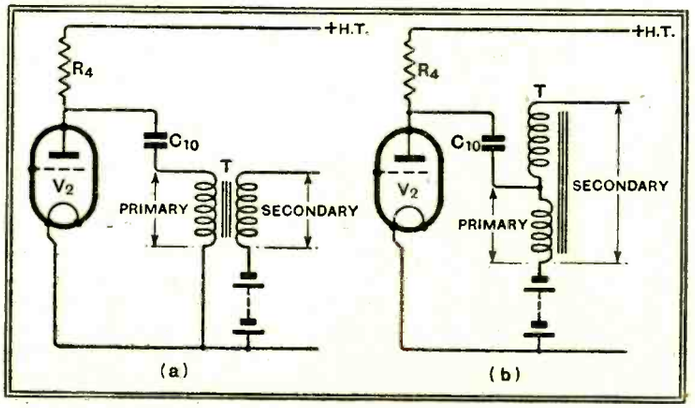


Fig. 35.—(a) Normal connection of transformer, in which primary and secondary are separate. (b) Auto-transformer connection, as used in the set, in which *both* windings form the secondary. The ratio is higher by one than in (a), using the same transformer.

to Fig. 35 will make this clear, and will show that there is a slight gain in amplification by this arrangement. The extra gain so obtained may be set off against the loss resulting from the passage of a portion of the signal current through the resistance R_4.

UNBIASED

By

FREE

GRID.

Visit a Czech Barber.

I MAKE it an invariable rule to get my hair cut whenever I happen to be on the Continent because, being unfamiliar with the majority of European tongues, I am thus mercifully prevented from understanding the polite back-chat of the wielder of scissors and soap.

While awaiting my turn in a Czecho-Slovakian hairdresser's the other day I was pleasantly surprised to be handed a pair of 'phones, and I then noticed that each man receiving tonsorial attention was also equipped with 'phones. Actually each ear-piece was held on a separate arm projecting from either side of the head

Loath to leave the chair.

rest. In this manner listening could be carried out irrespective of whether the sufferer was being shaved or having his hair cut. When my turn came I was greatly pleased by the comfort of the headpieces, which were fitted with pneumatic cushions to shut out all external sounds and to ease the pressure on the ears. Projecting from the arm of the chair was a convenient volume control knob.

The set was evidently tuned to the local station, and although I could not understand the announcements, the programme was mainly musical, and I thoroughly enjoyed myself, so much so, in fact, that when my hair-cut was concluded I was loath to leave the chair. In fact, I followed up with a shave, although I did not really need one, facial massage, and several other luxuries which ordinarily I do not permit myself. In the end my bill came to a pretty penny.

Here was a lesson for hairdressers in this country. I advise them to have their premises similarly equipped, even if only for the sordid motive of inducing their customers to spend more money.

Short Waves for the Sleepless.

A LONDON newspaper clamouring for the B.B.C. to put on an occasional vaudeville show in the afternoon supports the plea by stating that the innovation would be a boon to hospital patients who cannot listen to an evening show owing to the early "lights out" rule. I can scarcely believe, however, that these institutions are so barbarous as to switch off the radio at the same time as the lights. What greater boon could there be to the unfortunate sufferer unable to sleep than the ability to listen to a radio programme? I consider that hospitals should be fitted with short-wave equipment so that listening to America can be carried on into the small hours of the morning by those unfortunate patients who suffer from insomnia.

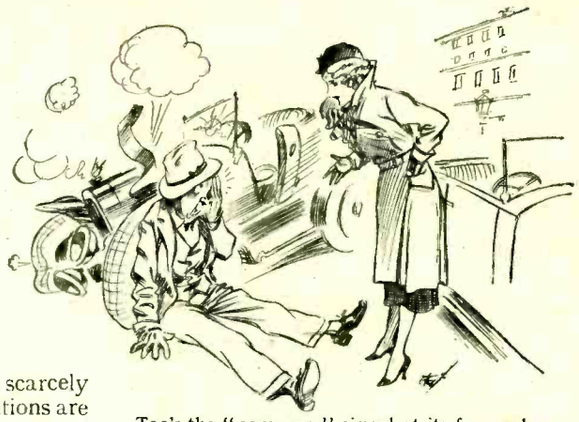
Those Hospital Sets.

I HAVE had occasion recently to visit a friend who was an occupant in a bed in a provincial hospital as a result of foolishly taking at its face value the "come on" signal of the woman who was driving the car in front of his. We had not been chatting long before my eyes fell on the telephones hanging at the back of his bed, and, since I knew that he had recently been a Radiophobe, I at once asked him if he had been converted yet. For answer he handed me the 'phones with a somewhat pitying smile, which rather mystified me. No sooner had I donned them, however, than my mystification was dispelled, for worse quality I had rarely heard.

The voice of the announcer, although intelligible, was far from pleasing. My friend explained to me that it was always the same. This caused me to make diligent enquiries into this matter, and I have discovered that, even in one or two smaller metropolitan hospitals, results are poor, not because of bad apparatus, but because there is no competent person to look after such things as grid batteries and 'phone connections.

I would commend all such hospitals to radio societies, who ought to be willing and able to do a public service by arranging for a weekly visit of inspection by a member. It is with some confidence that I recommend this course, as it happened to fall to my lot some years ago to pay a visit to a hospital in Southend, where I found that the radio installation was in perfect trim, because, as a little tablet at each plug point announced, it was kept in order by the local radio society.

I believe that a much larger hospital has recently made its appearance in this famous Thames-side town, and that the local society are taking on part at least of the maintenance work. The problem must be rather acute in some of the numerous cottage hospitals which are dotted about the country.



Took the "come on" signal at its face value.

Those Evening Bells.

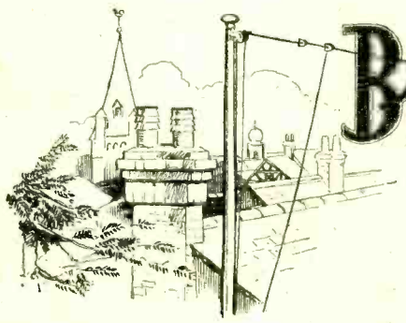
A QUEER experience befell me the other Sunday night when I chanced to be staying with a friend who possesses what he believes to be a *ne plus ultra* in the matter of quality receivers. It so happened that on that particular night the B.B.C. was broadcasting evensong from the local parish church. They were doing the thing thoroughly with a broadcast of the bells beforehand, and it occurred to me that since the sacred edifice was only a few hundred yards away I had a golden opportunity of comparing the pealing of the bells with the interpretation given by my friend's much-vaunted set.

Oft in the stille night.

Seating myself on the rain-barrel outside the house I listened for the bells with one ear while directing the other through the window towards the loud speaker. A merry peal was ringing out from the instrument, but to my surprise this did not coincide in tune with the sound from the church.

I walked down the garden and listened intently for a few minutes. All was quiet and there came to me the opening words of Tom Moore's famous poem: "Oft in the stilly night," and, like a flash, came the probable explanation of the mystery, for what else could the word "Stilly" suggest but "Stille"?*

* Dr. Stille is the inventor of the Blattnerphone recording system used by the B.B.C.—Ed.



Broadcast Brevities

By Our Special Correspondent.

First Broadcast of Complete Savoy Opera.

BROADCAST history will be made on Christmas Eve when "The Yeoman of the Guard" will be relayed in its entirety from the Savoy Theatre. Act. I will begin at 8.10 p.m., and, after a brief interval for the news bulletin, Act II will follow at 10 o'clock.

Hitherto special copyright restrictions have limited the B.B.C. to brief excerpts from the Gilbert and Sullivan operas. Welcome to the new era!

The B.B.C. Staff Dinner.

ONE must forgive the B.B.C. staff for banning journalists at their festive dinner at the Grosvenor Hotel on Monday last. I hear that, for once, officialdom was thrust well into the background and that some of the revellers almost forgot their association with the B.B.C.

I understand that the only notable absentee was Lady Snowden.

In the Studio with Henry Hall.

IT is certainly a stimulating experience to sit in Studio 3A while Henry Hall and the reorganised B.B.C. Dance Band are "doing their stuff" there, but the other evening I found it much easier to judge the general effect by listening on a loud speaker in the little silence cabinet which overlooks the studio.

In the studio itself the vocalist, breathing his sweet nothings into a microphone only three inches from his lips, was almost inaudible against the clashing rhythm of the instruments. Likewise, many of the instruments—the bass especially—seemed unduly prominent until heard on the loud speaker.

Trials of a Dance Vocalist.

There can be no doubt, I think, that Henry Hall meets the popular taste much more successfully with the new combination. It is a little early to appraise "Les" Allen, the new vocalist, but if first impressions are reliable he should prove an excellent choice. Much is required of a singer making almost nightly appearances, and a voice must be of a peculiarly pleasing quality if listeners are not to get bored with it.

The Sure Test.

THERE are searchings of heart at Broadcasting House over the marked preference for foreign programmes revealed by listeners on the Nottingham Re-diffusion System, to which I referred a fortnight ago.

Help for Programme Board.

The B.B.C. are wishing that they, too, possessed an infallible guide to the proportion of listeners choosing any particular programme. It would be an immense help to Mr. Roger Eckersley and his associates on the Programme Board.

B.B.C. Relay System.

I can only suggest that the Corporation run a relay system of its own to a hundred picked listeners representing all classes of the community. The meter readings would provide a perfect guide to the percentage popularity of any item. But I fear there would be some shocks for the B.B.C. mandarins.

Telling the Empire.

SOMEONE is learning a job which will be bound by no trade union rules. The hours of duty will extend from 9.30 a.m. to 3 a.m. (clockwise), leaving six and a half hours free per diem for rest and self-cultivation.

The holder of this post will be the announcer for the Empire broadcasting service.

Eighteen-hour Day.

The eighteen-hour day will start with the Australasian programme at 9.30, which will continue till 11.30. After a decent interval for routine work there will come the Indian programme between 2.30 and 4.30 p.m., followed by the two-hour African period, beginning at 6 p.m.

Good-night, Everybody!

Snatching a brief rest between 8 and 8.30 p.m., the Empire announcer will call up West Africa and Tristan da Cunha at 8.30 p.m. and give them good-night two hours later. No good-night for him! At 1 a.m. he will be greeting Canada and the Indies.

The First Day.

Here are typical programmes to be broadcast from the Empire station. They are for the opening day, Monday, December 19th:—

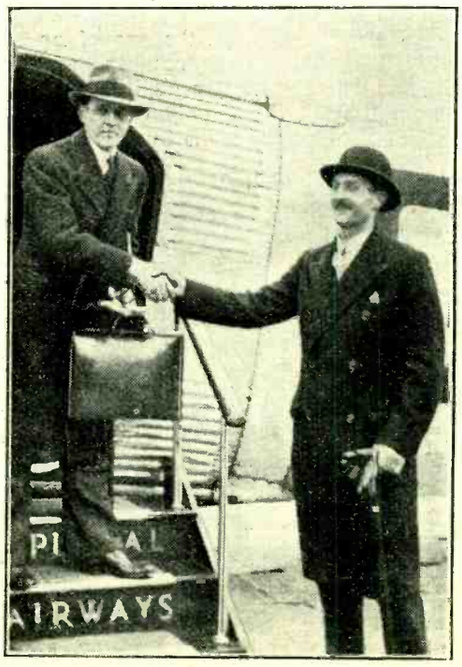
Australasia. — Pianoforte recital by Berkeley Mason; "The World and Ourselves," by Vernon Bartlett (Blattnerphone); Dance Music on Gramophone Records; News Bulletin.

India.—Organ Recital from Church of the Messiah, Birmingham (Regional); Light Classical Concert (National); "The World and Ourselves" (Blattnerphone); News Bulletin.

Africa.—Catterall Quartet (Regional); National News Bulletin; "New Books," by E. M. Forster; Concert (Regional).

West Africa.—The Wireless Military Band; News Bulletin (National); Vaudeville (Regional); Talk: "To an Unknown Listener."

Canada.—Dance Music on Gramophone Records; "The World and Ourselves" (Blattnerphone); Pianoforte Recital by Berkeley Mason (Blattnerphone); News Bulletin.



EMPIRE BROADCASTING. Mr. Cecil Graves, director of the Empire Broadcasting Service, bidding farewell last week to Mr. Malcolm Frost, who left Croydon on a world tour to dispose of B.B.C. programme records.

Is Canada Unlucky?

African listeners, being situated on or near the Greenwich longitude, naturally get the pick of British broadcasting at first hand. Our cousins in India also have a good share of direct programmes, and even the Australians can count on a few actual performances.

But unless Canada cares to send over a special subscription for flesh-and-blood performances in the small hours it looks as if the Dominion will have to subsist on the potted variety, though there will always be the Empire announcer to liven things up with the news bulletin.

Yuletide Message to the Empire.

CHRISTMAS DAY, which falls this year on a Sunday, is to be distinguished by a special broadcast programme for the Empire.

On Christmas Day.

The Rev. Pat McCormick is to officiate at a special service to be broadcast on Christmas morning. In the evening a service will be broadcast from Winchester Cathedral.

Pantomime and Bransby Williams.

Boxing Day will be marked by Pantomime on the National wavelength by that inexhaustible producer, Ernest Longstaffe.

Earlier in the evening Bransby William will give selections from his Dickensian repertoire.

New Voices.

I HEAR that the Headquarters announcing squad are beginning to look upon their job as one of the most monotonous and arduous in London.

Quite often a London announcer will be "on" and "off" at short intervals from 10.15 a.m. to midnight.

Listen for some new official voices in the near future.

Lissen

TWO-VALVE A.C. RECEIVER.

An Inexpensive Self-contained Mains Set.

FOR those who require reception chiefly from the local stations there is no doubt that the two-valve receiver represents an entirely suitable type. Although it cannot pretend to compare with more ambitious sets in its power of receiving distant stations, for it is neither so sensitive nor so selective, it can certainly provide good reproduction from near-by stations, and it is inexpensive. In addition, quite a number of Continental programmes will often be available.

The Lissen two-valve set under review is an excellent example of compact design, and the whole apparatus is contained in a moulded bakelite cabinet of quite modest dimensions. The major portion of the front is occupied by the balanced-armature cone loud speaker, and the illuminated drum dial is mounted in the upper right-hand corner. The tuning controls are placed at the back of the cabinet, and consist of small edgewise mounted wheels, which are rotated by placing a finger behind the set. There are two such controls—tuning and reaction.

Circuit Details.

The circuit consists of a triode detector with a single tuned input circuit, provided with four alternative aerial tappings. There are two connecting points on the aerial coil, and either may be used with or without a fixed aerial series condenser. Some considerable control is thus available over the selectivity, and it is always possible to obtain the maximum sensitivity consistent with freedom from interference. The detector naturally operates upon the grid rectification principle, and is transformer-coupled to the output pentode. A special feature is made of the transformer, in that it contains a third winding of a few short-circuited turns, which is claimed to prevent any tendency to howling when the set is first switched on.

The output pentode is connected in an unusual manner, for instead of the third grid being connected internally to the centre point of the filament, it is connected to the control grid. The loud speaker is specially wound to match the pentode, and compensating devices become unnecessary.

Half-wave rectification is employed in the H.T. circuit, and it is probably this which is responsible for the unusually low hum level in the output. With half-wave rectification, of course, the main hum frequency is 50 cycles instead of 100 cycles, and although it may be of greater amplitude, neither the ear nor the loud speaker is as sensitive to this frequency, and a considerable gain results. A single tapped choke is used for smoothing, in conjunction with a number of condensers,

FEATURES.

General.—*A two-valve self-contained receiver. Balanced-armature loud speaker. Provision for external loud speaker.*

Circuit.—*Triode detector with single-tuned input circuit and alternative aerial tappings. Grid detection with reaction. Pentode output to speaker wound to match.*

Controls.—*Milled wheel tuning control and reaction.*

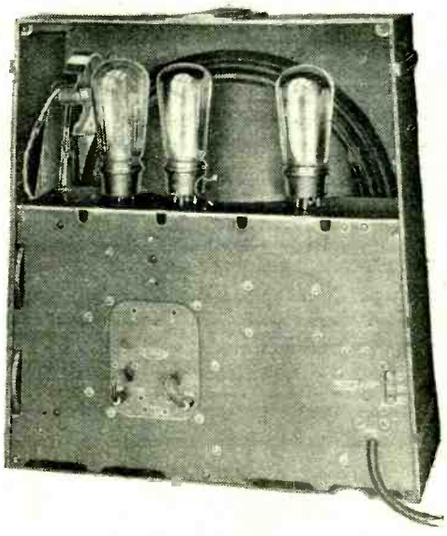
Price.—*£7 7s.*

Makers.—*Lissen, Ltd., Lissenium Works, Worple Road, Isleworth, Middlesex.*

and the grid bias for the output valve is derived from the voltage drop across a portion of the choke.

Provision is made for the use of an additional external loud speaker, and both the detector and pentode screen H.T. supplies are thoroughly decoupled.

The earth return is made by means of an adjustable potentiometer, which may be balanced by the user to eliminate the last traces of hum.



The tuning and reaction controls are located at the back of the receiver and can be seen on the left. The visual scale is at the front.

The Receiver on Test.

The receiver has been tested at about twenty-eight miles from Brookmans Park, and was found to give a very satisfactory performance. Even with the aerial connected to the most unselective tapping, it proved just possible to separate the two London transmitters; when the selectivity was increased by using a looser aerial coupling, stations situated in wavelength midway between them were obtained clear of interference. The increase of selectivity resulting from a loosened aerial coupling clearly does not reduce the sensitivity to a prohibitive degree, although a considerable degree of reaction must naturally be employed for foreign reception.

The quality of reproduction reaches a satisfactory standard; there is no trace of pentode shrillness, and the general tone is well balanced. Mains hum is inaudible, and the controls are simple to operate, the milled wheels at the rear of the cabinet falling naturally to the hand.

The model tested was for A.C. mains, but a similar receiver for D.C. supplies is available at the same price of seven guineas, and they represent excellent value.

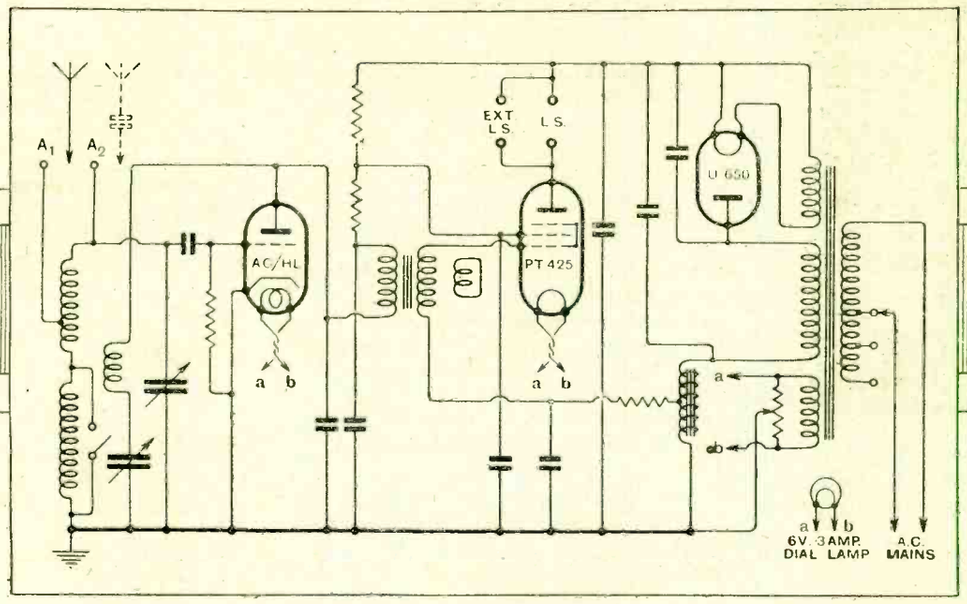
NEW BOOKS.

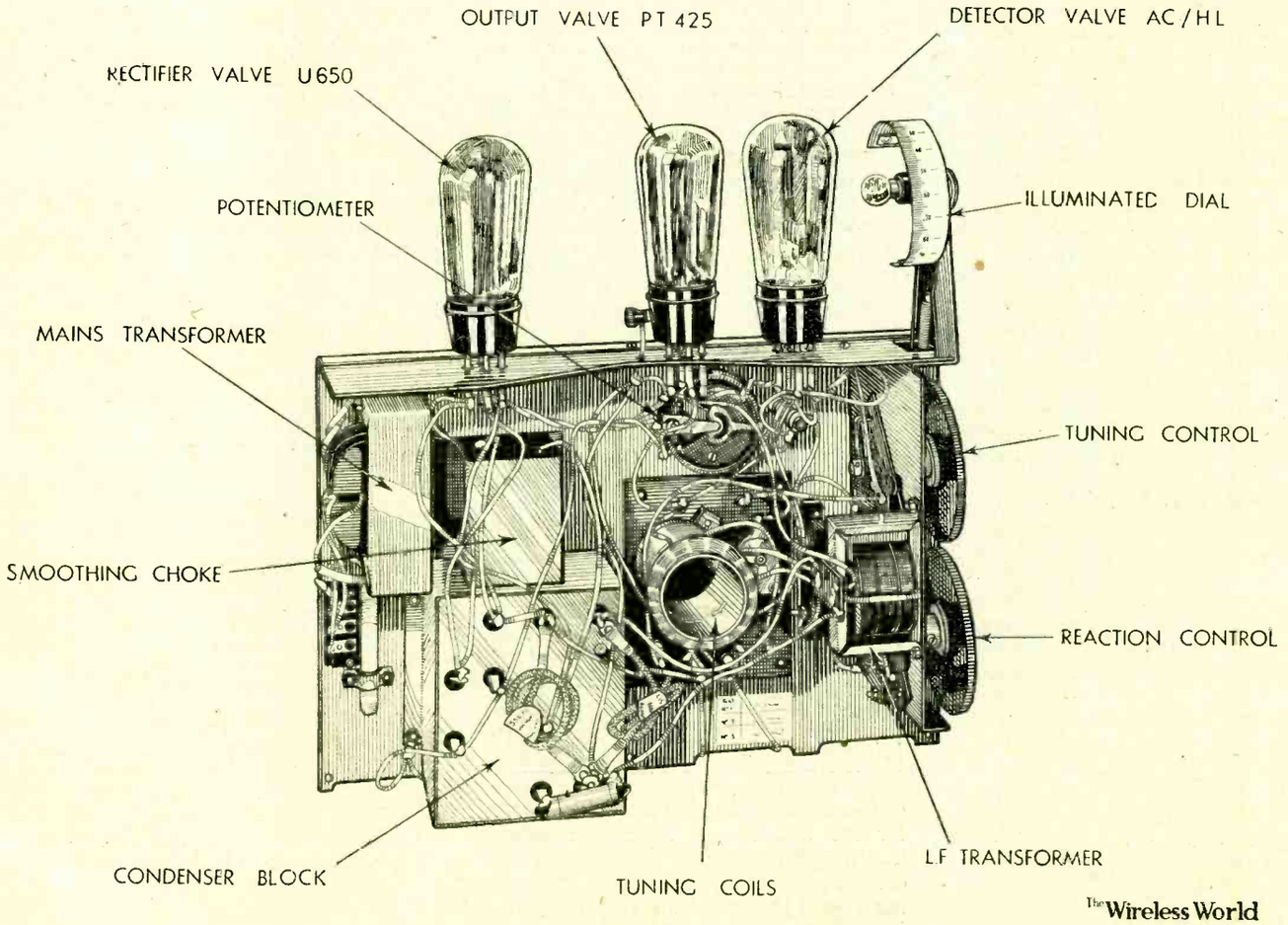
Modern Radio Communication (4th Edition), by J. H. Reyner, with foreword by Prof. G. W. O. Howe.—A text-book on the theory and practice of Wireless Transmission and Reception, originally written to cover the City and Guilds examination, but somewhat enlarged to increase its scope. Pp. 318+xiii, with frontispiece and 155 diagrams and illustrations. Published by Sir Isaac Pitman and Sons, Ltd., London, price 5s.

Patents, Trade Marks and Designs: Their Commercial Aspect and Development, by C. W. Thomas, with a foreword by Sir Richard Gregory. Practical Advice on the Procedure necessary for obtaining patents, Summary of Patent Agent's Duties, and Hints on the Commercial development or disposal of patents and patented articles. Pp. 88. Published by the Ocean Publishing Co., London, price 4s. 6d.

This Unknown Island, by S. P. B. Mais. Reprints of talks broadcast by the author, describing the beauties and points of interest in some of the less well-known parts of Great Britain seen during walks and short tours in various parts of the country. Pp. 390+xx, with 17 sketch maps and 34 illustrations, several being from photographs taken by the author. Published by C. P. Putnam's Sons, Ltd., London, price 7s. 6d.

COMPACT MAINS SET AT AN ATTRACTIVE PRICE.





HIND

The circuit arrangement and an interior view of the Lissen Two-valve A.C. Mains Receiver.

Judging Quality by Ear.

Common Loud Speaker Faults and their Effect on Reproduction.

By H. A. HARTLEY.

SO much ink has been spilt over the question of high-quality reproduction that the non-technical listener may well ask what it is all about, and how it affects him. It is a reasonable assumption that nearly everybody appreciates the real thing, and I propose to outline a few tests which the ordinary listener can apply to his own radio set and speaker to determine whether the results he is getting are truthful or not. In the complete absence of measuring instruments one cannot hope to arrive at definite results, but there are some main points to look for, or, rather, listen for, which will show if the loud speaker is doing its job properly.

The most prevalent fault is a resonance at somewhere round about 3,000 cycles; this is manifest by a very shrill "edge" to the violin, rather suggestive of wire strings being used instead of gut. A very good imitation of this effect is provided by the average restaurant orchestra, where the conductor or leader endeavours to achieve prominence by the use of a steel E string and aluminium-loaded A and D strings. If, however, one is listening to the B.B.C. Orchestra and the massed strings sound "wiry," then the loud speaker has this fault, and if, at the same time, the sibilants in speech are unduly emphasised, one can be sure of it. Hissing speech is not an infallible test alone, as a speaker may be beyond reproach on the upper middle frequencies and yet emphasise the "esses." This is due to the fact that the fundamental frequencies of such sounds are very high, and if there is insufficient top being reproduced the absence of the upper harmonics will give a distorted effect. Again, it is customary for the B.B.C. announcers to speak very quietly, and subsequent amplification in the control room shows an incorrect balance between head and chest tones, so that to assess the quality of speech it is desirable to listen to a radio play where the persons in the caste are talking in a more or less normal manner. With high-quality apparatus I have found in these circumstances that speech is indistinguishable from the real thing. It is more difficult to reproduce speech than any other studio matter, and if this is good, then nearly everything else also will be good.

Top Cut-off.

Another common fault is attenuation of the upper frequencies—in other words, top cut-off. To a trained musical ear the overall effect is one of flatness and obscurity. The orchestra sounds as though it were a single musical instrument of complex quality, and there is difficulty in picking out one instrument and following its career through the composition being played. The violins sound like flutes, the brass loses its edge, and the characteristic sour tone of the oboe is lost, the result being more like a clarinet. Transients, too, are usually mutilated, and as these are responsible for the attack which is so delightful a feature of the first-class orchestra or artist the loss of pleasure is very great.

Transients and Attack.

As the terms "transients" and "attack" are constantly cropping up in discussing reproduction it would be as well for the uninformed to realise what is meant by these words. If a pianist has the correct technique and fingering and is playing a good instrument, then it cannot have passed unnoticed, at a concert, that the spontaneity and brilliance of the performance is of a totally different nature from that at home on one's own piano. Our second-rate domestic performances seem to lack the fire of those of the renowned artist, and this is brought about by slovenly technique, resulting in the keys not being struck with that incisiveness which is so necessary. We slur over the keys instead of being precise. As the characteristic tone of the piano is dependent on sudden precision of playing or "attack," it is obvious that if the loud speaker is weak in this respect our virtuoso is reduced to the ordinary pianist; furthermore, the sudden "explosive" sound which is a "transient" is directly responsible for the excellence of tone of the good instrument, so the piano will suffer as well as the artist with such a speaker. Similar effects are produced on the orchestra. The first-class orchestra, by its precise playing, has a liveliness not experienced when listening to a mediocre one, and if, when listening to one of the test pieces suggested in this article as played by, say, the B.B.C. Symphony Orchestra, there is any suggestion of lifelessness, then the listener may be sure that his loud speaker is not giving him the best possible reproduction of transients.

SUGGESTED TEST PIECES.

Tests of Good High Frequency Response.

Wagner. Maestersingers Overture, especially the Homage to Hans Sachs theme for the brass.

Strauss (Richard). Almost any of the Symphonic poems.

Borodin. Second Symphony. Second movement. The surge of the strings if particularly good.

Tests of Good Bass Response.

Beethoven. Seventh Symphony. Second movement.

Tschaikovsky. Fourth Symphony. Third movement.

Dukas. L'Apprenti Sorcier.

César Franck. Symphony.

Tests of Good Transient Response.

Beethoven. Ninth Symphony. Second movement.

Rimsky-Korsakov. Cappricio Espagnole, especially the last section commencing with the roll of drums.

Stravinsky. Petroushka Ballet.

Bach. Toccata and Fugue, as arranged by Klenovsky.

Tests of Piano Reproduction.

Tschaikovsky. Piano Concerto No. 1. First movement.

Saint-Saëns. Carnival des Animaux. "Pianists."

Test of Violin Reproduction.

Beethoven. Violin Concerto. First movement.

Test of Individual Instruments and everything else as well.

Ravel. Bolero for Orchestra.

Bass Resonance.

The last fault which is likely to be experienced is a resonance in the bass. This may be anywhere between about 90 and 250 cycles, and inevitably produces a boom, especially when a dance band is playing. If Ambrose's or Henry Hall's band goes "thud—thud—thud," then there is something wrong, because they do not sound like that in real life. In symphonic compositions, which are scored for much work by the double basses, it will be found, when the fault we are discussing is present, that one particular note comes out much louder than the others, and this is a sure sign that the speaker resonates at that frequency, as I cannot think of any musical work which sounds so in the concert hall. The greatest sufferer from this fault is the organ, whose pedal notes convey a feeling of physical effort, which is entirely absent if the loud speaker cannot reproduce them faithfully, which it may not, either by a bass resonance or a bass cut-off. As everyone can go to church, it would be instructive to listen to the Thursday evening service from St. Michael's and follow this up with a church service on the next Sunday.

In conclusion, I have prepared a list of works which are good tests of a speaker's capabilities. It would be best, of course, to hear these in the concert hall as well as at home, but in many cases this will be almost impossible, so it is suggested that the reader invites a friend who knows what music sounds like at first hand to listen to these compositions on his loud speaker and say what he thinks. If this cannot be done the reader will, perhaps, from what I have said already, be able to form some sort of opinion, as I have selected works which would show up defects when present.

READERS' PROBLEMS.

THESE columns are reserved for the publication of matter of general interest arising out of problems submitted by our readers.

Readers requiring an individual reply to their technical questions by post are referred to "The Wireless World" Information Bureau, of which brief particulars, with the fee charged, are to be found on page 473.

A Permanent Wavemeter.

AFTER reading a note in the "Hints and Tips" section of our issue for November 11th, a reader intends to instal an absorption wavemeter as a permanent part of his receiving equipment. We are asked to suggest how the instrument may be connected to the set so that it may be thrown in or out of circuit at will.

The most obvious method of doing this is illustrated diagrammatically in Fig. 1, from which it will be seen that a double-pole double-throw switch is wired in such a way that a small coupling coil, through which energy is fed to the meter circuit, may be inserted at will in series with the aerial. With the switch in the left-hand position normal connections are restored.

Some half-dozen turns of fine wire should be adequate for this primary coil, and in order that coupling may be adjusted to the

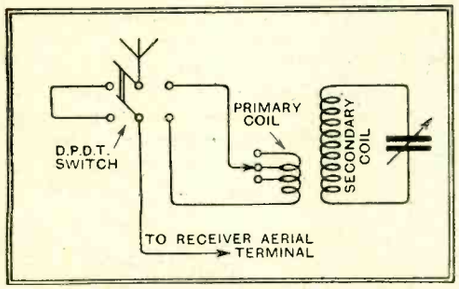


Fig. 1.—An aid to station identification: switching connections for inserting a wavemeter in series with the aerial.

value found to give most definite indications, two or three tappings may be provided. With fairly obvious alterations, the wavemeter could be elaborated in order that the long waveband might be embraced in its range.

Electrolytic Condensers.

A READER has noticed that electrolytic condensers do not seem to be customarily used for smoothing purposes in sets which derive their current supply from D.C. mains. He goes on to ask whether there is any inherent objection to the use of these condensers in such sets.

The danger of reversed polarity is the controlling factor in this case. Electrolytic condensers are inherently as suitable for use in a receiver fed from D.C. as from A.C. mains, and offer just the same advantages, but, unfortunately, are liable to be damaged by the accidental application of a high voltage of incorrect polarity. Provided that precautions are taken to prevent reversal of the mains connection, there is no reason why they should not be used. For instance, in a "universal" A.C.-or-D.C. set, where the necessary protection is afforded by the rectifier, an electrolytic condenser might safely be fitted.

Overcoming D.C. Limitations.

USERS of D.C. mains supplies must of necessity avoid wastage of voltage if the maximum possible volume of undistorted output is to be obtained. The supply voltage may be no greater than the maximum rated anode voltage of the output valve, and this voltage will inevitably be decreased to some extent by the inclusion of the necessary smoothing choke. But, by taking special precautions, this loss of anode voltage may be reduced to an almost negligible value.

To those readers who labour under the twin handicaps of a taste for ample volume and a somewhat noisy D.C. mains supply of about 200 volts, and who have written to us for suggestions, the output arrangement of Fig. 2 can be recommended.

As is well known, a comparatively small amount of smoothing is necessary for the output stage, as any ripple introduced here will not be magnified. Accordingly, anode current for this stage may be smoothed satisfactorily by means of a low-inductance choke of correspondingly low D.C. resistance, in which the loss of voltage will be small. But the amount of smoothing afforded will probably be insufficient for the preceding H.F. and detector stages, and so the H.T. supply for these valves will require extra smoothing; this will be provided by the high-inductance choke shown in our diagram.

It will be observed that parallel-connected pentodes of the D.C. indirectly heated type are indicated; this represents what is probably the best and most practical method of obtaining an exceptionally large output with a limited H.T. voltage. Any tendency towards parasitic oscillation may be checked by the conventional precaution of inserting stopping resistances of respectively 5,000 and 100 ohms in the grid and anode circuits of each individual valve.

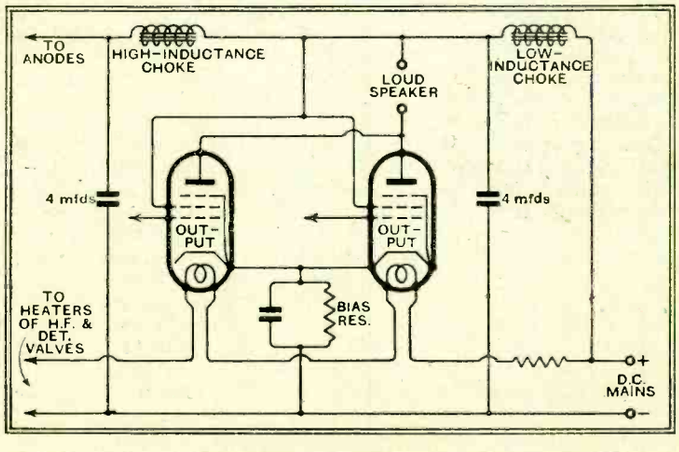


Fig. 2.—Progressive smoothing, as applied to a D.C. set with parallel output pentodes.

Although we have shown a bias resistance for the output stage, this reply should not be closed without pointing out that, where H.T. volts are precious, it may be considered preferable to avoid this additional source of loss by reverting to the use of a grid bias battery.

Non-interchangeable Components.

ALTHOUGH there is generally a great deal of latitude in the choice of component parts for *Wireless World* receivers, there are occasions where the designer's specification should be followed implicitly, or at any rate where any departure from the specification is fraught with risk, unless the constructor is alive to the possible consequences. When no alternative products are given in the "List of Parts" it is wise to go cautiously when a change is proposed.

A case in point occurs in the tone-correction circuit of the "Monodial A.C. Super," in which a McMichael H.F. choke is employed; here this component does not perform its usual function, but acts rather as an inductance coil which is tuned to a predetermined audio frequency by the associated condenser C_{11}. This being realised, it will not be difficult to see that the substitution of a different make of choke which has a different value of inductance may have a serious effect on the quality of reproduction; this in spite of the fact that the substituted choke may be of good design and well suited for its normal purpose.

The substitution of a different form of choke is undoubtedly responsible for a defect in reproduction which is described at length by one of our correspondents.

Output and Sensitivity.

WE are asked to say whether the substitution of a power valve rated to have a greater undistorted A.C. output than the type at present in use will automatically result in a greater volume of sound from the loud speaker. It is understood, of course, that arrangements can be made to supply the new valve with the extra anode current that it needs.

This is an assumption that cannot be justified either on practical or theoretical grounds. If both valves have the same sensitivity the result of making the change will be nil; in order to take advantage of the increased power output of the valve that it is proposed to use as a replacement, it will be necessary to feed to its grid circuit a greater signal voltage. Provided that the receiver has a reserve of sensitivity, and that its detector (and intermediate L.F. stage, if any) can deal with increased voltages, this is easily done by turning up the volume control.

Of course, it often happens that a valve capable of delivering a large output is at the same time extremely efficient, and so may be capable of giving its full output when fed with an input no greater than that required by the type which it displaces. It is only in such cases that the assumption made by our correspondent is justifiable.

Second-channel Interference.

SEVERAL readers who have constructed modern superheterodynes of the simpler type seem to be perturbed by the fact that indications of instability are evident at one or two positions of the tuning dial; a beat note is produced, and its pitch varies with tuning in the manner which usually suggests that uncontrollable self-oscillation is taking place.

We are inclined to think that readers who have written to us on this subject are confusing instability with second-channel interference, which is always likely to occur in the immediate vicinity of a powerful Regional station, and for which the only real cure is the addition of signal-frequency tuned circuits—a course that is generally impracticable. In making this statement we are assuming that the receiver has been properly ganged; misalignment will often provoke the trouble.

When second-channel interference is found to mar the reception of a station to which it is particularly desired to listen, the trouble can generally be overcome by making a slight change in the intermediate-frequency wavelength by adjustment of the trimming condensers, which are invariably shunted across the I.F. couplings.

The Whistle Suppressor.

THERE seems to be some doubt as to how the "Whistle Suppressor," described in *The Wireless World* of October 28th, should be connected to a loud speaker

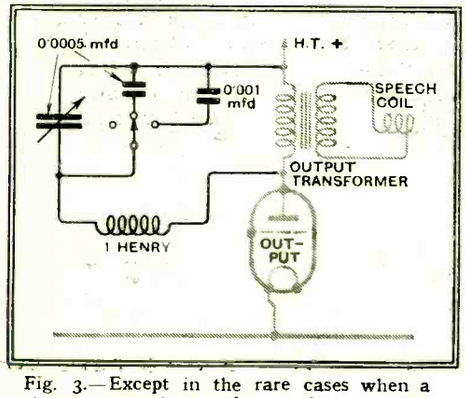


Fig. 3.—Except in the rare cases when a step-up output transformer is used, the "whistle suppressor" should be joined across the primary winding, as shown.

of the moving-coil type; several readers are under the impression that it should be joined across the speech coil of the instrument.

As stated in the article in which this very useful "gadget" was described, it should preferably be joined across a circuit of high impedance. Most moving-coils are of very low resistance, and consequently, if the suppressor is to be joined to the loud speaker end of the receiver, the right place for it is across the primary winding of the output transformer. The appropriate connections are indicated in Fig. 3.

Absorbing Surplus A.C. Voltage.

WHEN it is desired to connect a power transformer to a supply system of which the voltage is appreciably higher than that for which the transformer was designed, there is no other course but to insert in series with its primary winding and the mains a suitable resistance for absorbing the surplus voltage—i.e., the difference between the mains voltage and that at which the transformer is rated.

We often receive requests for information as to the right value of resistance to be used in such cases, but for reasons that have already been explained it is quite impossible for us to give a definite answer unless we happen to have full technical details of the transformer in question.

A reader who appreciates this point is nevertheless anxious to use temporarily a 220-volt transformer on a 240-volt system, and although he does not expect us to be able to tell him exactly what value of limiting resistance to use, he asks whether we can suggest a method of calculation which will enable him to arrive at a rough approximation of the correct value.

This is neither a difficult nor a very involved matter. First, he should add altogether the wattages of the various secondary outputs and then add, say, 30 per cent. for the transformer losses. Next, the current which should flow through the primary winding may be calculated by dividing "watts" (the figure arrived at by the previous calculation) by "volts" (the voltage rating of the mains). Lastly, the value of limiting resistance necessary is ascertained by dividing "surplus voltage" by "current" in amperes (this figure is that ascertained by the second calculation).

It should be realised that the possibility of an appreciable error is introduced in the allowance for transformer losses; some makes have considerably higher efficiency than we have allowed.

More Stray Capacity.

AFTER adding a pick-up to a commercial H.F.-det.-L.F. receiver, a reader finds that both sensitivity and selectivity are slightly, but quite definitely, impaired. The set works admirably with a pick-up, but he is no longer satisfied with its behaviour as a radio receiver, and asks our advice. The pick-up connections have been added in the simplest and most conventional manner.

The set to which the pick-up has been fitted has a fully ganged tuning system, and we expect that what has happened is that the incidental capacity across the grid circuit has been increased by the addition of the pick-up terminals, switch, and their connecting wires. Indeed, it is almost inevitable that these extra connections should add appreciably to stray capacity.

A fraction of a turn, in an anti-clockwise direction, of the screw controlling the trimming condenser shunted across the detector grid circuit tuning condenser should put matters right, and as this trimmer happens to be very accessible in the set which our querist is using, he should experience no difficulty. It might be worth while to emphasise the fact that neither of the other trimmers should be touched, as the stray capacities across the circuits which they control cannot have been affected by fitting a pick-up.

For the benefit of other readers who propose fitting a pick-up to an existing set, it may be pointed out that the addition of capacity which inevitably results will often pass unnoticed, as tuning of the detector grid circuit is normally quite "flat." The fact that our present querist has noticed a definite falling off may be ascribed mainly to the use in his receiver of a screen grid detector valve, of which the constants are arranged in such a way that the damping which it imposes on the preceding tuned circuit is much less than usual. But in any case it is always worth while to try the effect of a slight readjustment of the trimmer after making the addition.

CLUB NEWS.

Cambridge University Wireless Society.

THE first meeting of the season was recently held in the Engineering Laboratories, Trumpington Street. All members of the University, especially freshmen, are welcomed.

The term's programme includes talks by Mr. G. Parr (Mazda), Dr. R. L. Smith-Rose (N.P.L.), and Messrs. H. A. Hartley and P. K. Turner, in addition to a visit to the Mazda Works.

Enquiries will be gladly answered by the Hon. Secretary, Mr. V. G. Mellor (G5MR), 65, Chesterton Road, Cambridge.

New Essex Society.

A NEW Radio Society has been formed covering the Walthamstow, Chingford and Leyton districts. Known as the Walthamstow and District Radio Society, the new body will work in conjunction with the Leytonstone and Woodford Society, holding weekly meetings at the British Legion Club, 354, Hoe Street, Walthamstow, at 8.15 p.m.

Hon. Secretary: Mr. C. H. Oliver, 44, Grove Road, E.17.

Mains Transformer Design.

AT a recent meeting of the Derby Wireless Club, Mr. F. G. Sawyer, of Messrs. Partridge, Wilson and Co., lectured on "The Design and Construction of Mains Transformers and Power Smoothing Chokes for Radio and Industrial Purposes."

The talk not only dealt with the technical aspect of the design of apparatus of this type, but also the details of modern methods of production which are utilised.

Secretaries of associations who are desirous of arranging a repetition of this lecture for their society should communicate with Messrs. Partridge, Wilson and Co., Davenset Works, Evington Valley Road, Leicester.

Catering for All.

EVERYONE, from the rawest beginner to the old hand, is welcomed to membership of the Burton-on-Trent Amateur Radio Society. All enquiries should be sent to the Hon. Secretary, Mr. W. A. Mead "Addiscombe," Branstone Road, Burton-on-Trent.

Accommodation for 2,000 Broadcasting Stations.

SHORT wave evening was celebrated by the Huddersfield Radio Society on November 14th, when Mr. Ingham gave some interesting facts concerning short wave theory. He pointed out that over two thousand broadcasting stations could be accommodated between the wavelengths of ten and one hundred metres. Commercial uses for short waves and methods of reception were dealt with by Messrs. J. T. Thornton and F. W. Dewhurst respectively, the latter demonstrating an effective set operating down to twelve metres.

Hon. Sec.: Mr. E. G. Whitfield.

Radio Veteran of Seventeen.

YOUTH triumphed at the Horse and Groom, Croydon, at a recent meeting of the Croydon Radio Society, at which Mr. F. Betteridge, aged seventeen, demonstrated his 20-24,000-metre receiver. The first thing on which the young experimenter insisted was the use of a stage of screened grid high frequency amplification. He said that the screened grid stage was untuned and used periodically, tuning being used on the long waves. By this method less amplification was obtained on the short waves of about twenty metres, but one advantage was the absence of "dead spots" at certain frequencies.

There was certainly no reason to doubt the young lecturer when he described the set's results. Philadelphia Park, Massachusetts, Boundbrook and Cincinnati were usually heard well. On one occasion he had heard Pittsburgh talking to a ship near Spain. Amateurs were often heard, and a British voice was always to be heard from some part of the world.

Hon. Secretary, Mr. E. L. Cumbers, 14, Campden Road, S. Croydon.