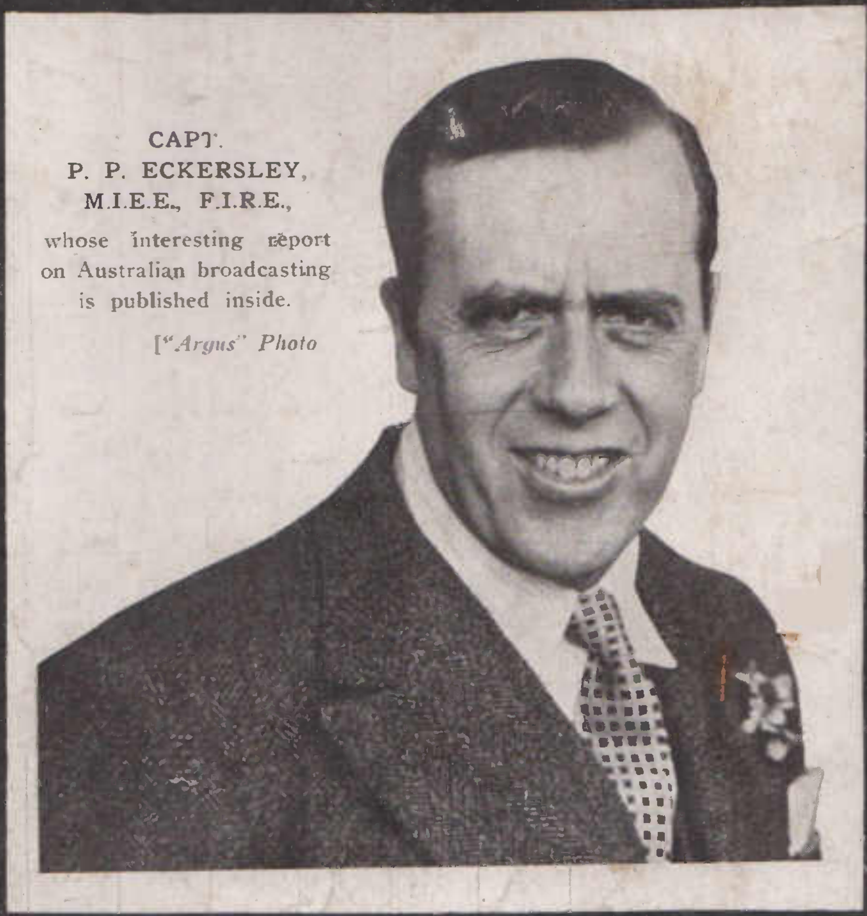
MODERN SETS

MONTHLY

SEPT 1932



CAPT.
P. P. ECKERSLEY,
M.I.E.E., F.I.R.E.,
whose interesting report on Australian broadcasting is published inside.
["*Argus*" *Photo*

PRICE 9^D

PHILIPS VALVE CHARACTERISTICS

THE "P.H." 2.5-VOLT A.C. SERIES

Type.	Purpose.	Filament. Volts.	Filament. Current (Amps.).	Plate. Volts.	Plate. Current (m/A).	Neg. Grid Bias.	Aux. Grid Volts.	Aux. Grid Current (m/A).	Mutual Cond.	Amp. Factor.	Impedance (Ohms).
P.H.235	Selectode	2.5	1.75	250	6.5	− 3	90	(A)	1	370	350,000
P.H.224A	S.G.R.F. Amp.	2.5	1.75	250	4	− 3	90	(A)	1	615	600,000
P.H.227	General	2.5	1.75	180	5	−13.5	—	—	1	9	9,000
P.H.247	Penthode	2.5	1.75	250	32	−16.5	250	7.5	2.5	90	35,000
P.H.245	Power	2.5	1.5	250	34	−50	—	—	2	3.5	1,750
P.H.280	Rect., Full Waves	5	2	A.C. Volts per plate 350, D.C. Output Current 125 m/A.							
P.H.281	Rect., Half Wave	7.5	1.25	A.C. Volts per plate 750, D.C. Output Current 110 m/A.							

THE "P.H." 2-VOLT D.C. SERIES.

P.H.230	Detector	2	.06	90	1.8	− 4.5	—	—	7	9.3	13,000
P.H.231	Power	2	.13	135	6.8	−22.5	—	—	.76	3.8	4,950
P.H.232	Screen Grid	2	.06	135	1.4	− 3	67.5	(A)	.5	580	1,150,000
P.H.233	Penthode	2	.26	135	14	−13.5	135	3.5	1.5	75	50,000
P.H.222	Screen Grid	3.3	.132	135	3.3	− 1.5	67.5	(A)	.48	290	600,000

THE "P.E." 4-VOLT A.C. SERIES.

E445(M)	Selectode	4	1.1	200	6	−2/−40	100	1.75	1.2	300	250,000
E452T(M).	Screen Grid	4	1.1	200	3	− 2	100	.5	3	1000	300,000
E442S	Screen Grid	4	1	200	3	− 3	60	1	1	200	200,000
E443N	Penthode	4	1	250	48	−39	250	9	2.7	60	22,000
E424	Spec. Detector	4	1	200	5.5	− 6	—	—	3.5	24	7,000
E406	Power	4	1	250	48	−24	—	—	6	6	1,000
1561	Rect., Full Wave	4	2	A.C. Volts per plate 500, D.C. Output Current 120 m/A.							

ADDITIONAL 4-VOLT A.C. TYPES

E442	Screen Grid	4	1	200	1.5	−1.25	100	.5	1.2	1000	830,000
E415	General	4	1	150	6	−6	—	—	2	15	7,500
E409	General	4	1	150	12	−9	—	—	3	9	3,000
E438(M)	Res. Cap. R.F	4	1	200	2.5	−3	—	—	1.5	38	25,300

STANDARD D.C. VALVES.

A109	General	1.3	.06	150	2	−9	—	—	.45	9	20,000
A209	General	2	.08	150	4	−9	—	—	1	9	9,000
B242	Screen Grid	2	.1	200	4.5	—	100	—	.6	—	—
A409	General	4	.06	150	3.5	−9	—	—	1.2	9	7,500
A415	Detector	4	.08	150	3	−4.5	—	—	2	15	7,500
A425	Res. Cap. R.F.	4	.06	150	.8	−3	—	—	1.2	25	20,800
A435	High Imp. R.F	4	.06	150	1.4	—	—	—	.5	35	70,000
A442	Screen Grid	4	.06	150	2.8	—	75	—	.8	—	—
A609	General	6	.06	150	4	−9	—	—	1.5	9	6,000
A615	Detector	6	.08	150	4	−4.5	—	—	2.4	15	6,250
A630	R.F	6	.06	150	.7	−1.5	—	—	1.5	30	20,000
A635	High Imp. R.F	6	.06	150	1.2	—	—	—	1.5	35	23,300
A642	Screen Grid	6	.06	200	.4	—	100	—	[illegible]	—	—

PENTHODE POWER VALVES.

Type.	Filament. Volts.	Filament. Current (Amps.).	Plate. Volts.	Plate. Current (m/A).	Neg. Grid Bias.	Aux. Grid Volts.	Aux. Grid Current (m/A).	Mutual Cond.	Amp. Factor.	Impedance (Ohms).
C243	2	.27	150	17	−15	150	—	1.5	60	42,000
D243	2.5	.6	300	25	−20	200	—	1.5	60	42,000
B443	4	.15	200	12	−16	150	—	1.5	60	40,000
C443	4	.25	300	22	−22	200	—	1.5	60	40,000
E443N	4	1	250	48	−39	250	9	2.7	60	22,000
F443	4	2	550	45	−39	200	6.5	4	60	15,000
C643	6	.25	300	21	−20	200	—	1.5	60	40,000

STANDARD POWER VALVES.

B205	2	.15	150	7	−18	—	—	1.2	5	4,200
B403	4	.15	150	15	−30	—	—	1.5	3	2,000
B405	4	.15	150	8	−18	—	—	2	5	2,500
B406	4	.1	150	7.5	−15	—	—	1.4	6	4,300
B409	4	.15	150	6.5	−9	—	—	2	9	4,500
E408N	4	1	400	30	−34	—	—	4.5	8	1,800
F410	4	2	550	45	−36	—	—	8	10	1,250
B605	6	.12	150	9	−18	—	—	1.8	5	2,800
C603—(171A)	6	.25	180	18	−40	—	—	2	3	1,500
C606	6	.25	250	24	−25	—	—	3.35	6	1,850
F704—(UX250)	7.5	1.25	450	55	−84	—	—	2.1	3.8	1,800

(A) Not exceeding 1-3rd Plate Current. (M) Metal Clad.

2R14

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MODERN SETS

Edited by A. K. BOX.

Published by Pickwick Publishers Pty. Ltd., 309 Little Lonsdale Street, Melbourne. 'Phone: Central 1981.

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EDITORIAL

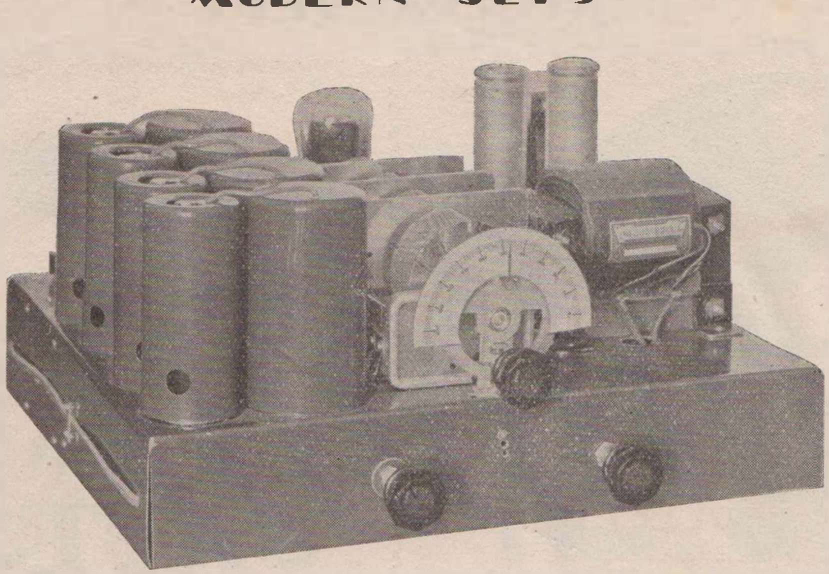
THERE is an aspect of the Australian character that distinguishes it from other peoples, and it is not a very nice one. It is suspiciousness. To anticipate a catch in any proposition that may be put forward is sound business—to carry this suspiciousness to the extent of downright churlishness is distinctly bad form. As a nation, we have innumerable good qualities, but most of us are, we think, familiar with the attitude of which we spoke. This attitude of mind was never more conspicuous than in the reception accorded by the Australian people to Captain Eckersley's plan.

We do not mean to imply that this was a personal antagonism. Captain Eckersley is probably looking back with pleasure to the very true hospitality shown to him during his visit. But, frankly, the departmental, trade, and public reaction to the scheme outlined by him has been one of suspicion and ridicule.

And why is this? Is it because he did not turn up in the usual trappings of the engineering expert—blue overalls—or that instead of giving his technical message in dry-as-dust formulas and endless mathematical problems, he was able to put it over in a manner that not only highly diverted his audience but made his message clear to the least technically minded member of the community?

How often could it be said that women have listened to radio lectures delivered over the air?. Very rarely, we venture to say, but we affirm that when Captain Eckersley spoke scarcely a woman switched the dial on to another station. He said: "Long waves are like the fabulous long league boots of the fairy stories, leaping over mountains and valleys," and his meaning became clear even to the children.

A great technician and unique amongst his fellows, in that he has discovered a way to make himself intelligible to the man in the street, Captain Eckersley deserved a more sympathetic technical hearing than he received, for, in our mind at least, the "Eckersley Plan" must ultimately exert a powerful influence on the development of Australian broadcasting. —The Editor.



A front view of the "Compass Six" shows that despite the number of tuned circuit, the controls are kept down to three.

The COMPASS A.C. SIX

The Receiver described in this article is a real performer. At the present time it is consistently bringing in overseas broadcasting stations at full loud speaker strength, and is selective enough to meet the most severe conditions.

By W. G. GRIMWOOD.

THIS receiver was built by the writer for the purpose of checking up the performance of a tuned radio frequency receiver against a superhet employing a similar number of valves. It was realised early in the piece that it would be a difficult matter to build a t.r.f. receiver which would be as selective as a super-het. but, excluding some notably fine factory produced models, it was felt that in range, tone quality, and comparative freedom from background noise, the t.r.f. receiver would win. Naturally, the building of a five valve super, which would employ a first detector, an oscillator, one i.f. stage, a second detector and an audio stage would need to be very carefully carried out to get as much signal amplification as would be obtained from a three stage r.f. receiver, and to the writer's way of thinking this is not possible for the average set builder who has not at his disposal fairly elaborate test equipment.

As built, the receiver looks and performs like a first-grade commercial job. of which there are, alas, only too few at present. From the viewpoint of results it outperformed a five valve super-het on every point except that of selectivity, and even in this respect was not far behind.

The average selectivity of the receiver was found to be about 11 k.c., so that no difficulty was experienced in separating the majority of stations. However, on the lower wave band the super performed better, and we could tune in only three stations between 3AW and 3KZ. Even so, the log list for the receiver totalled 46 commercial broadcasting stations, in addition to a good swag of local and inter-State amateurs operating on the 200 metre wave band. Only on two dial positions was any interference experienced. These were 4BH and 2KO, who were interfered with by 3KZ and 3AW respectively. This is pretty fair for a tuned r.f. receiver, particularly in view of the fact that all reception was carried out on a long aerial and in Ascot Vale, which is pretty well under the aerial of both 3LO and 3AR.

As the building of this receiver is no job for the absolute novice, we do not propose to go into a point to point wiring description. We shall content ourselves by setting out a key-lettered list of components, together with their values. All details of lay-out can be obtained from the picture of the receiver, whilst the wiring connections are supplied in the schematic circuit diagram.

Coil Winding Data.

One point which needs some elucidation is the tuning coils. It will be noticed that we have specified a set of radiokes r.f. coils in the list of parts. Actually the coils in this receiver were home-made, and were novel, inasmuch as they used resistance wire primary windings. Although the technical arguments for this type of primary winding for r.f. tubes is a little difficult to follow, there is no doubt about the efficiency and stability of well-designed coils which use resistance wire primary windings. It is possible to get either enamelled or

CIRCUIT CONSTANTS

1 Metal Chassis, 17½ x 15 in. x 2 in.
1 Set Radiokes Standard R.F. Coils (L1 to 8).
1 Stromberg Carlson 4 Gang Condenser (C1, 2, 3, 4).
1 Grand Opera Power Transformer .350-0-350, 2.5, 2.5 and 5v.
2 Polymet 500 Volt 8 mfd. Electrolytic Condensers (C7, C8).
6 H.C.R. UY Sockets.
1 H.C.R. UX Socket.
1 Radiokes 10,000 Ohm Potentiometer (R1).
1 Radiokes 125 ohm Resistor (R2).
3 Radiotron 235 Valves (V1, V2, V3).
1 Radiotron 224 Valve (V4).
1 Radiotron 247 Valve (V5).
1 Radiotron 280 Valve (V6).
1 T.C.C. .00025 mfd. Fixed Condenser (C12).
4 Radiokes R.F. Chokes (RFC 1, 2, 3, 4).
1 Hydra 2 x .1 mfd. Condenser (C5, C11).
1 Hydra 3 x .5 mfd. Condenser (C10, C15, C18).
3 T.C.C. 2 mfd. Fixed Condensers (C14, C20, C21).
1 Hydra .1 mfd. Fixed Condenser (C13).
3 T.C.C. .25 mfd. Fixed Condensers (C6, C16, C17).
2 T.C.C. 1 mfd. Fixed Condenser (C9, C19).
1 Power Switch (S.1).
2 100,000 ohm Carborundum Resistors (R3, R4).
2 10,000 ohm. Carborundum Resistors (R5, R12).
2 50,000 ohm. Carborundum Resistors (R8, R9).
1 250,000 ohm. Carborundum Resistor (R10).
1 500,000 ohm. Carborundum Resistor (R11).
1 25,000 ohm. Carborundum Resistor (R6).
1 400 ohm. Bias Resistor (R7).
1 50 ohm. Centre Tap Resistance (R13).
4 Valve Screens.
4 Coil Screens.
1 Full Vision Tuning Dial.

double silk covered resistance wire from O. H. O'Brien and Co., Bourke-street, Melbourne. The best results will be found to be obtained from the use of the silk covered wire.

The coil turns are as follows:—

L2, L4, L6, L8, 90 turns of 26 gauge double silk covered copper wire wound on 1½ inch diameter formers. The primary windings are laid on 1 inch daimeter formers, which are fastened inside the secondary formers by means of machine screws. The method of mounting should be such that the bottom of the primary winding is in line with the bottom of the secondary winding.

The primary windings are as follows: L1, 30 turns of 34 gauge d.s.c. wire tapped at the 15th turn. The r.f. primaries, L3, L5, and L7, consist of 60 turns of 34 gauge d.s.c. wire tapped at the 40th turn from the plate (top) end. The idea of the tap is that if the gain is so great that instability and lack of selectivity should result, the plate lead may be connected to the tap point.

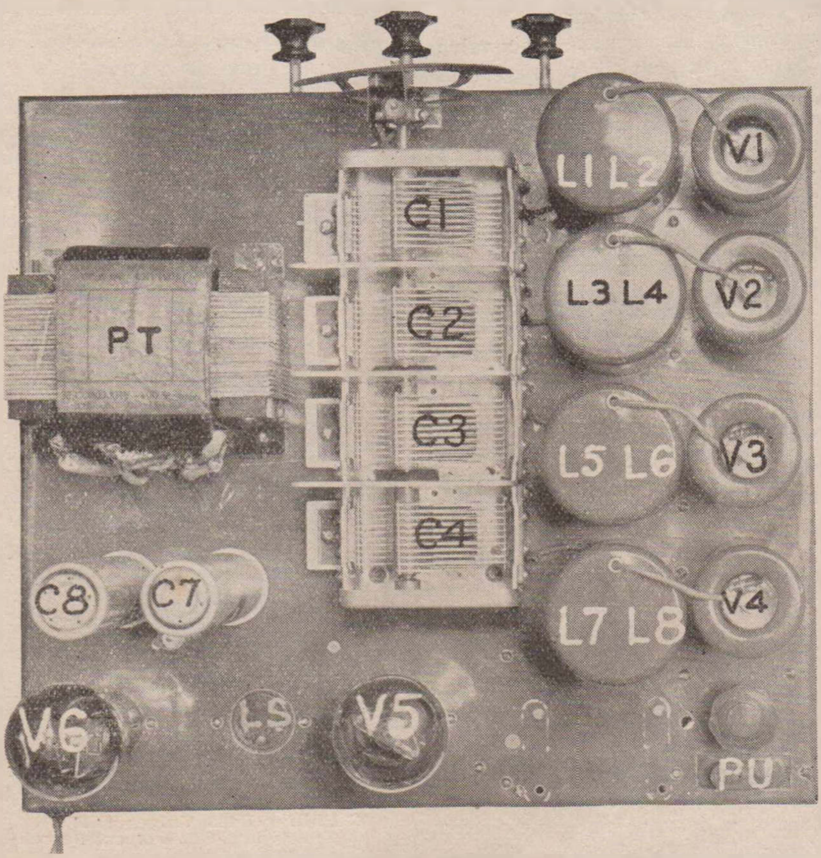
Constructional Points.

The pictures of the receiver show the various constructional points, which we now shall elaborate. The top view of the set shows the lay-out arrangement of the r.f. and detector valves, coils, and the gang condenser. The Grand Opera power transformer did not have its cover on at the time the photograph was taken. The UY socket is used for the speaker outlet, the fifth contact being reserved in case at any time it was decided to change the receiver over for a push-pull output stage. Note that in the lay-out of components on the top of the chassis particular care has been paid to the question of direct leads.

Underneath the chassis is the usual mess of wiring and collection of by-pass condensers, resistances, and r.f. chokes, which are necessary for filtration. It is impossible to letter this picture, so that the intending constructor will have to use his own judgment in duplicating the lay-out of the original receiver. The main points to watch are to see that all r.f. carrying leads are by-passed and filtered as close to their outlet from the coils as possible, and to do the same with the supply leads to the screening grids.

Remember that when operating properly the receiver has an r.f. stage gain of around 30,000, so that it won't need much feedback at any stage to set up a state of uncontrollable oscillation. This is why such attention has been paid to filtration. On the audio

(Continued on page 49.)

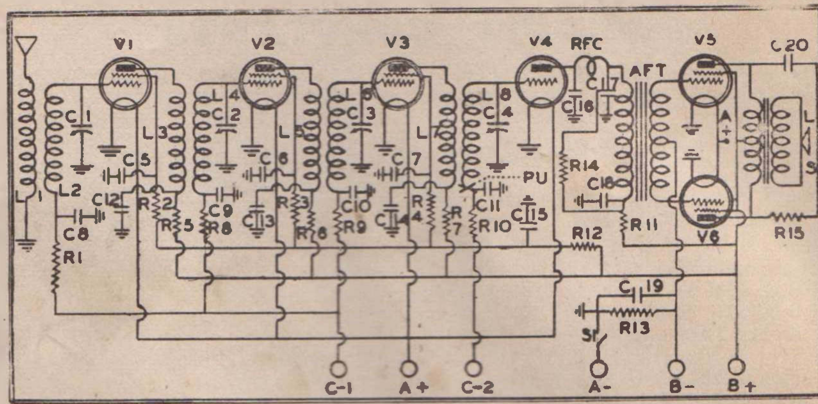


Simplicity of lay-out can be allied with efficiency of operation, as this picture of the finished receiver shows.

The Screen Grid Super 6

Full constructional information on an extraordinarily sensitive battery receiver is contained in this article.

By A. K. BOX.



The schematic circuit diagram of the "Super Six" is lettered to agree with the list of parts.

THE object in building this battery receiver was to obtain the best results which modern equipment permits.

Besides having exceptional sensitivity, it was necessary for the present set to be extremely selective and to be capable of delivering a high-quality signal to the loud speaker.

To achieve these results a six-valve receiver, employing three stages of tuned radio frequency amplifieation, a power detector operating on the anode bend principle, and coupled by means of a transformer to the grids of a pair of pentodes connected in push-pull, was built up.

Although no departure was made at any time from the r.f. amplifier system, which had been set out on paper, several changes were made in the detector and audio amplifier system before we got the results for which we were looking.

The original design called for the use of a screen grid detector driving a push-pulling pair of low impedance three-element valves. For this reason we connected the primary winding of a Ferranti AF5 transformer in series with the primary of the AF5c Ferranti push-pull transformer, so that the impedance of the primary load would provide a reasonable match for the high-plate impedance of the screen grid detector.

The scheme worked fairly well, but when, for several reasons, we hoisted out the s.g. detector and the audio triodes and replaced them with a three-element detector and a pair of pentodes, we left the AF5 still on the chassis, although it was not connected. This will clear up the possible mystery of the two audio transformers. which can be seen in the pictures of the finished receiver.

Now take a look at the schematic diagram while we elaborate a few of the constructional points. Probably the first thing which will strike the reader of this article is the complete filtering which is employed in both the r.f., detector and audio circuits. Decoupling resistors in series with the screen grid supply leads to all tubes, similar resistors in the plate supply circuits to r.f. and detector tubes, and filter resistances in the grid circuits, all help to keep the receiver stable when it is operating at full gain.

LIST OF PARTS.

- **1 Stromberg-Carlson 4-Gang Condenser (C1, C2, C3, C4).**
- **1 Kit of Fonr Radiokes Standard Coils (3 r.f. and one aerial) L1, 2, 3, 4, 5, 6, 7, 8.**
- **4 T.C.C. or Hydra .1 mfd. Condensers (C8, 9, 10, 11).**
- **1 3 x .1 mfd. Hydra Condenser (C12, 13, 14).**
- **3 T.C.C. or Hydra .5 mfd. Condensers (C5, 6, 7).**
- **1 T.C.C. or Hydra 1 mfd. Condenser (C15).**
- **1 T.C.C. or Hydra 2mfd. Condenser (C18).**
- **1 T.C.C. .01 mfd. Condenser (Type M), (C20).**
- **2 T.C.C. .0001 mfd. Condensers (Type M), (C16, 17).**
- **1 Concord 10 mfd. 25-V. Electrolytie Condenser (C19).**
- **4 10000 ohm Carborundum Resistances (R5, 6, 7, 15).**
- **3 25,000 ohm Carborundum Resistances (R2, 3, 4).**
- **4 100,000 ohm Carborundum Resistances (R1, 8, 9, 10).**
- **1 62.500 ohm Carborundum Resistance (R12).**
- **1 15,000 ohm Carborundum Resistance (R11).**
- **1 100,000 ohm Wire Wound Variable Resistance (R14).**
- **1 Filament Switch (S1).**
- **1 Ferranti AF5C Audio Transformer (AFT).**
- **1 Radiokes R.F. Choke (RFC).**
- **6 H.C.R. UX Valve Sockets (V1-6).**
- **1 H.C.R. UY Valve Socket (L.S.).**
- **3 Mnllard P.M.16 Valves (V1, 2, 3).**
- **1 Mullard P.M.6d. Valve (V4).**
- **2 Philips B443 Valves (V5, 6).**
- **1 Alumininm Chassis and Screening Box.**
- **1 450 ohm Bias Resistor (R13).**

A further safeguard against a.f. instability and loss of tone is the use of an r.f. choke and by-pass condensers in series between the plate of the detector and the audio transformer.

In the output circuit a compensating network. consisting of a fixed condenser and a fixed resistor, is connected across the primary of the output transformer to clean up the pentodes' reproduction and enable the tendency towards over-emphasis of higher musical register to be corrected.

It will be noticed that, although automatic bias is used on the audio tubes, the detector and r.f. tubes are biassed by "C" batteries. This does not imply any weakness in the auto bias system, but was done simply because at the time the set was built it was impossible to get a resistor (R13) which was long enough to permit accurate adjustment of the bias voltages on the detector of r.f. valves.

Another point of interest is that the 100,000 ohm fixed resistor (R14) was later replaced by a 100,000 ohm variable resistor, which was employed as a volume control.

An important point is that very thorough shielding is used throughout the receiver. The three r.f. valves are contained in an aluminium box measuring 10½ inches by 4 inches by 6 inches. A shelf mounted 2 inches from the bottom of the box has three holes cut in it to take the three tubes which pass through this shelf to fit into the sockets mounted on the chassis proper. Four small dividing shields, two at the top and two at the bottom, isolate the grid and the plate circuits of each valve from the other.

The screening arrangement can best be explained by imagining a letter H formed out of aluminium. The centre bar of the H is the shelf fitted inside the screening box. The two top sections are the plate shields and the two bottom ones the grid shields. In practice the second r.f. valve is mounted in the middle of the H, the first and third r.f. tubes being on the right and left respectively.

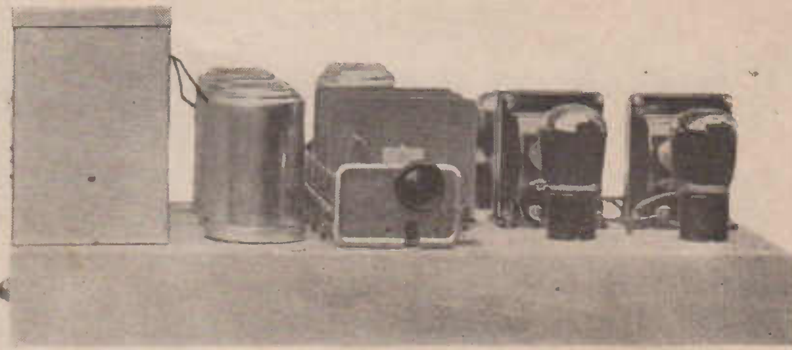
Coil Troubles.

The four tuning coils are similarly shielded. These inductances are the standard Radiokes r.f. transformers. Note particularly that we do not advise the use of the latest Radiokes "Constant Impedance" coils for this receiver.

In our case they were "constant nuisances," for it was found impossible to bring the gain of the receiver "up" between 3UZ and 3AR.

Above and below these limits the set operated perfectly, but a trapping effect absolutely defied all efforts, in which we were aided by a line-up oscillator and an output meter, to get the set to "gee."

Replacement of the coils with the older type cleared up all the troubles, although there was a noticeable fall off in gain on the higher frequencies. However, the receiver still had ample sensitivity, so that the change was well worth while. The tubes used were Mullard P.M16's as r.f. amplifiers, a Mullard P.M6D as detector, and a pair of Philips B443 pentodes as audio amplifiers.



A front view of the completed chassis, showing the arrangement of the various components.

The reason for the switch in the case of the last stage tubes was "B" battery economy. The Philips pentodes delivered greater output for a given plate power than the Mullards, although in other respects the Mullard pentodes are equal to any.

Because the r.f. and detector tubes operate on 6 volts, a 10 ohm rheostat is connected in series between the A— terminals on the audio sockets and earth. This rheostat is not shown in the schematic diagram, but can be seen in the pictures of the completed set.

Following standard a.c. set practice, the pick-up is connected in series between the grid coil and the decoupling resistor and by-pass condenser (R10, C11).

A switch is used to short-out the pick-up when it is desired to receive broadcasting.

In the pictures of the set two resistors labelled R12 will be seen. This is because the total resistance of R12, which is used to reduce the 165 volt "B" supply to the 75 volts required by the screening grids of the r.f. tubes, is 62,500 ohms. In our case this was made of three resistors, a 50,000 ohm one connected in series with two parallel connected 25,000 ohm resistors.

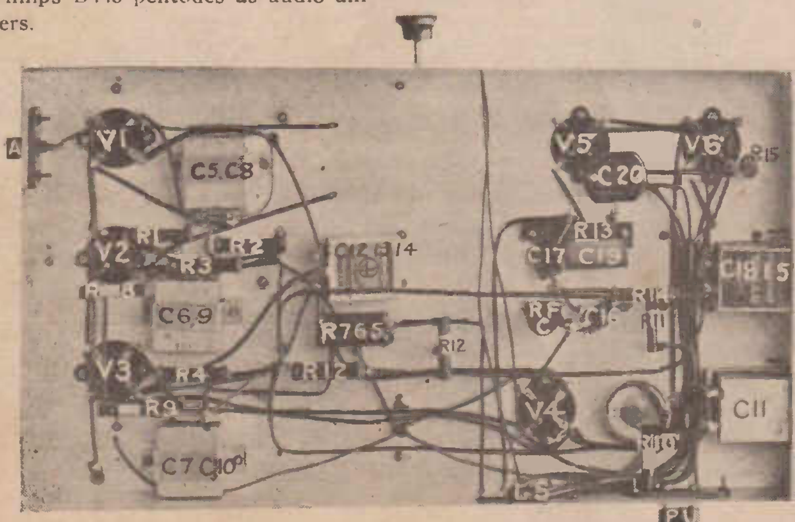
The second one of these latter two is hidden by the top one.

This just about clears up any odd points in the construction of the receiver, and we are in a position now to deal with the actual wiring connections. The values of the various resistors and condensers are tabulated in the key-lettered list of parts.

Assuming that all the components have been assembled on the top of the chassis, and that the various fixed condensers are mounted underneath, we can start the wiring by connecting the fixed-plate terminal lug on C1 to the G terminal on V1, the same lug on C2 to the G terminal on V2, the same lug on C3 to the G terminal on V3, and the corresponding lug on C4 to the G terminal on V4. Before we can hook up the grid coils it will be necessary to unsolder the black wire on each coil and replace it with a wire long enough to reach the G lug on its respective valve socket.

This done, connect the G lead on L2 to the G lug on V1, the G lead on L4 to the G lug on V2, the G lead on L6 to the G lug on V3, and the G lead on L8 to the G lug on V4. Now connect the aerial terminal to the aerial lead on L1 and connect the earth lead on this coil to the earth terminal. From the earth terminal take a wire to the one side of the filament switch, and thence run a lead to the A minus lug on the sockets V1, V2, V3 and V4. From the A minus lug on V4 a lead is taken to one side of the filament

(Continued on page 43.)



Looking at the under-side of the chassis, we find that although a fairly large number of components are used there is no crowding or haphazard wiring.

The Importance of A GOOD EARTH

A Very Interesting Article on a Usually Neglected Part of the Receiving Equipment.

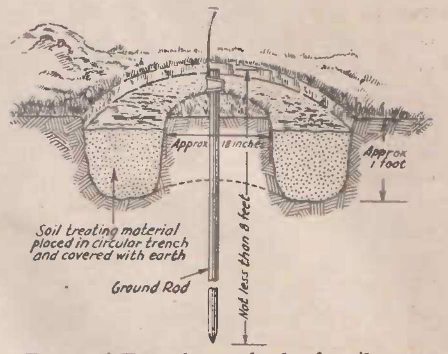


Fig. 5.—Trench method of soil treatment. Probably the most effective scheme of utilising chemicals in lower soil resistance.

IN these days of highly-sensitive receivers the aerial and earth system is not given serious attention by the set user. When one remembers the care and attention which was lavished on aerial and earth systems in the old crystal receiver days, one is even more ready to marvel at the developments which have taken place in receiver design. Nevertheless, there are many circumstances—notably, in the case of short-wave reception—where every effort must be made to bring both the aerial and the earth system to the highest state of efficiency. In these circumstances the following short article, reprinted from "Q.S.T.," should be of interest to the serious experimenter.

The following information, extracted from a bulletin published by the Copperweld Steel Company of America, should prove to be useful in such cases, particularly if there is any reason to suspect that the standard water-pipe earth is not working out so well.

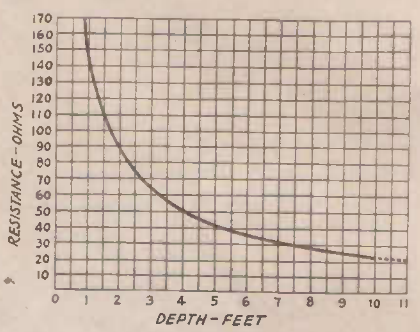


Fig. 2.—Calculated effect of depth on the resistance of a ground connection.

There are four principal factors affecting the resistance of an earth connection. These are the length of the earth rod, the diameter of the rod, number of rods used, and the character of the soil. Taking the rod itself

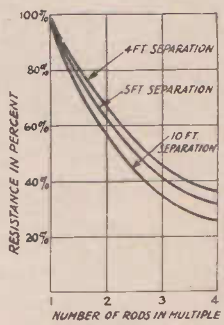


Fig. 4.—This graph shows how the resistance of a ground decreases as the number of ground rods is increased.

first, its length should be such that it will reach below the permanent moisture level of the soil.

Of course, the depth of the moisture level will vary with different localities, but experience indicates that to fulfil this requirement the rod should be at least 8 ft. long. Fig. 2 is a curve, taken from the American Bureau of Standards Technical Paper No. 108, showing the calculated effect of the length of the earth rod on the resistance of the earth connection for one type of soil. In practice it is likely that a greater decrease in resistance than the curve indicates will be obtained at the lower depths, because there is usually more permanent moisture at the lower depths than near the surface. A deep earth is also likely to maintain a more constant resistance under all sorts of weather conditions for the same reason.

Rather surprisingly, the diameter of the earth rod has comparatively little effect on the resistance. There is little advantage in using a rod of greater diameter than one inch, as Fig. 3 shows quite clearly. Even smaller rods will be quite satisfactory—in fact, some authorities recommend that the rod be only large and strong enough to be driven into the soil without bending or splitting. But if the use of a rod of large diameter is unnecessary, there is an advantage in employing a number of earth rods connected in multiple, provided the rods are spaced sufficiently far apart. Fig. 4 shows the decrease in the resistance of the earth connection with an increasing number of rods with three different

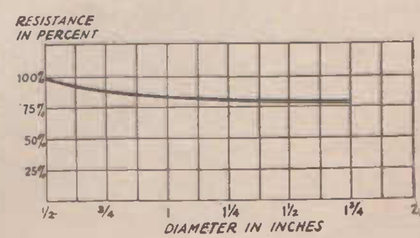
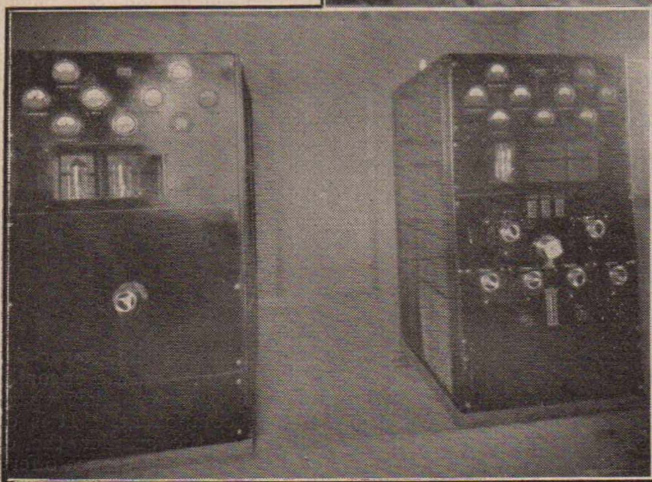
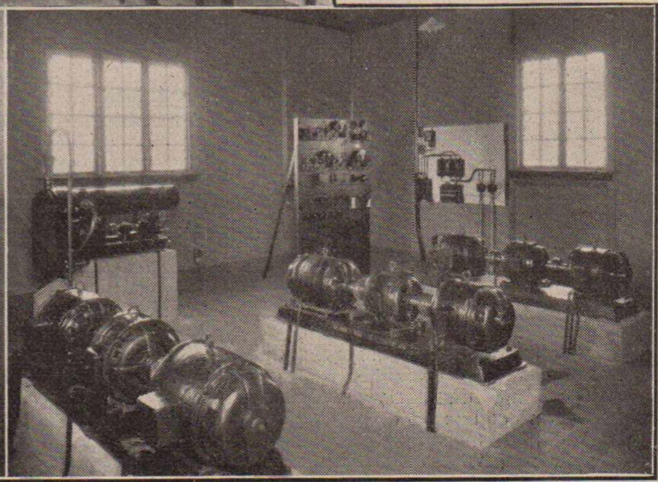


Fig. 3.—Effect of diameter of driven ground rod on ground resistance.

4BH Brisbane

Leading Northern Broadcaster Employs Most Modern Equipment





A view of portion of the 4BH studio (top). At the left is shown the modulator and the oscillator-amplifier stages of the transmitter. The right hand picture shows the power supply equipment, with the water-cooling pump system in the left background.

MOST modern equipment, progressive commercial and engineering staffs, and a comprehensive knowledge of broadcasting technique all have combined to make 4BH, Brisbane, the most popular broadcaster in the State.

Testimony to the range of the station is furnished by the regular reception of 4BH's broadcasts in Melbourne, whilst, from reports sent in to the station management, it can be seen that the coverage in the north and north-west of Queensland, the north of N.S.W., and the majority of the Northern Territory and northern parts of South Australia is a regular feature of the station's transmissions.

The station was first placed on the air in January this year, and since then its already modern equipment has been brought into step technically with the latest overseas practice. The transmitter is located at Bald Hills, some seven miles from the city of Brisbane. The actual transmitter em-

A Description of a Leading Australian "B" Class Broadcaster is Contained in this Article.

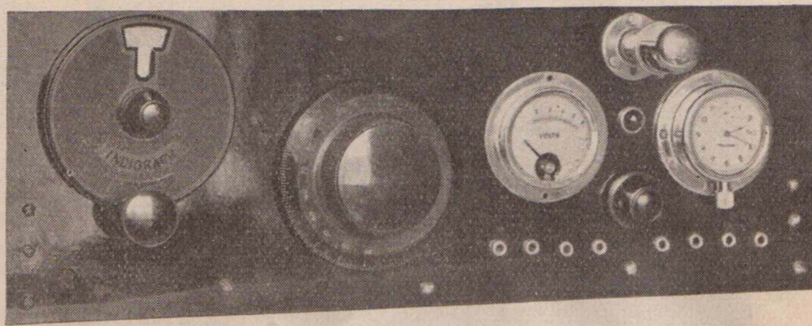
ploys low power modulation, using the Hiesing Latour system. It incorporates many of the exclusive Telefunken features, and the master oscillator is crystal controlled. The final amplifier tube is a water-cooled tube, which, although operated well below capacity, still permits 3BH to radiate a greater aerial power than any station in Brisbane, with the possible exception of 4QG.

D.C. Carrier Improves Range.

The use of a crystal controlled oscillator and a power supply for plates, grids and filaments of all tubes, drawn from d.c. generators, results in an exceptionally "clean" carrier, which, no doubt, has a great deal to do with the distance covering ability of the station.

The transmitter is connected by wire lines with the studio, which is in the building of G. J. Grice Ltd., Queen-street, Brisbane. Besides the

(Continued on page 38.)



Complete with every gadget, including a clock, a filament voltmeter, and a dash light, which allows both to be easily read, this experimenter's s.w. set presents an imposing appearance.

An Experimenter's Short Wave Receiver

For the benefit of the dyed-in-the-wool radio experimenter who may not wish to build up an immovable receiver which cannot easily be changed round, the writer of this article gives details of his own short wave receiver.

By C. M. SCOTT.

THE set I propose to describe in this article is one which was built along distinctly amateur lines. My object has been to produce a receiver with sufficient stability and over-all gain to bring in all the short-wave broadcast and telephone stations at good speaker strength, with a minimum number of valves and controls.

The outstanding feature is the method by which band spreading is obtained, and at the same time the normal wave-length coverage is retained. For locating stations quickly a few coils and a fairly large wave-length coverage is necessary, but when a particular station has been located, say on the 49 metre band, a special coil can be inserted, and the whole 49 metre band can then be spread over the whole dial. This has many advantages over the knife-edge tuning found in many sets of to-day. The set has been built up in the old bread-board fashion, which is a very convenient form when experiments are carried out fairly regularly.

It will be noticed that the filaments of the first two tubes are heated from a d.c. source, while the final tube is a.c. operated. The reason for this is because headphones are used after the first audio at times when the speaker cannot be used; thus, a lower noise level is possible, and very weak stations can be clearly heard.

It is quite a common thing to find in many short-wave receivers tuning condensers as large as .0005 mfd., or even larger. This is just as absurd as using a .0015 or .002 mfd. condenser on the normal broadcast band. By using these large capacities, however, the all-wave receiver is somewhat simplified, and if high-ratio vernier dials are used and plenty of amplification is obtainable it is possible to get away with such an arrangement.

In the detector circuit of my own receiver the standard Schnell arrangement is used, but each component has been adjusted for maximum efficiency, and a definite increase in range and ease of operation thus has been obtained.

One of the things which will strike the set-builder who studies the schematic circuit diagram is that the main circuit is tuned by two variable condensers (C1, C2) connected in series. The purpose of this unusual arrangement is to obtain what is known as "series tuning," which permits us to cover a wide range of frequencies and at the same time to get the maximum efficiency from the receivers tuning system.

Tuning Plays Important Part.

The disadvantage of high tuning capacity, commonly known as high C tuning, is that the ratio between inductance and capacity is far from the correct value and the general efficiency of the detector circuit is greatly reduced, and as a result there will be a loss in signal strength. The detector depends for its operation entirely on the voltage applied to the grid; therefore, it should be our object to get as much voltage as possible from the given signal supplied by the aerial. In any oscillatory circuit, such as L1, C1, C2, the inductance takes charge of the voltage component of the power supplied to the circuit by the incoming signal, and the capacity takes charge of the current component. It is obvious, then, that the smaller the capacity the greater the reactance offered to the current; consequently the current will be reduced. The power input in milliwatts, W, equals the voltage component multiplied by the current component, or W=EC, for a given power. If we reduce C, E must rise, as the power is approximately constant. This will result in a greater voltage being available, and, consequently, an increase in signal strength—a result which is effectively achieved by connecting the two condensers, C1 and C2, in series.

When condensers are connected in series the resultant capacity is always less than that of the smallest capacity. In this case the total capacity of C1 and C2, when the plates are "all in" in both condensers, will be .000125 mfd., which will cover quite a big range on one coil. C1 is the band spreading condenser and C2 is the main tuning condenser. C1 can be adjusted to give the desired band spread, varying from three or four degrees to the complete dial reading on C2.

As the moving plates of C1 are brought out of mesh, the band spread becomes wider and wider until, when the plates are almost all out, the particular band on which it is desired to listen will cover the whole dial of C2. While C1 is being adjusted, C2 is tuned to ascertain the degree of band spread. By bringing the plates of C1 into mesh again, we are back to the normal condition of wide coverage.

Now that these details have been dealt with, we can go ahead and deal with the point-to-point wiring description of the receiver for the benefit of those who may like to construct a similar set. The actual lay-out of components can be clearly followed from the pictures of the original receiver, so that, except for one or two points, no further comment is necessary. The wiring is started by connecting the aerial terminal to one side of the variable coupling condenser, C, the other side being taken to the grid end of the inductance, or tuning coil, L1.

Connect the same end of L1 to the fixed plates of the .00025 mfd. condenser, C1, and to one side of the .0001 mfd. grid condenser, C3, the other side of C3 being taken to the G terminal of the valve V1, and to one end of the 10 megohm grid leak, R1.

The moving plates of C1 are now connected to the fixed plates of the .00025 mfd. condenser, C2, the moving plates of this condenser being connected to the remaining end of L1, and then on to the earth terminal, E. The F— terminal on the valve socket V1 is connected to the F— terminal on the socket V2 and earthed.

The remaining filament terminals, F+ on the sockets V1 and V2, are now connected together and joined to the A+ terminal.

From the A— terminal take a lead to one side of the switch, S, and to the terminal carrying the B— and C+ leads; the other side of the switch is connected to the earth.

From the F— terminal of V1 connect across to one side of the 440 ohm fixed resistor, R2; the other side of this resistor connects to the remaining end of R1 and to one side of the 160 ohm resistor, R3; the other side of R3 is then connected to the F+ terminal on the socket V1.

The P terminal of the socket V1 is connected to one side of the reaction coil, L2; the other side of this coil then connects to the fixed plates of the .00025 mfd. condenser, C4, and to one side of the radio frequency choke, Ch.

The remaining side of Ch is connected to the P terminal of the primary of the audio frequency transformer, AFT1. The remaining terminal of the primary, marked B+, connects to the detector, B+, terminal, and to one side of the 2 mfd. by pass condenser, C5. The other side of C5 then connects to the moving plates of C4, and then to earth.

The G terminal of AFT1 now connects to the G terminal of V2. The remaining terminal, C—, on AFT connects to the C— terminal.

Join the P terminal on V2 to the P terminal on AFT2. The other end of the primary is connected to one side of the 2 mfd. by pass condenser, C6, and to the B+ terminal.

The remaining side of C6 is taken to earth.

Join one end of the secondary, marked G, of AFT2 to the G terminal of the socket V3. The remaining terminal of the transformer then goes to the C— terminal.

One leg of the loud speaker is connected to the P terminal of the socket V3, and to one side of the .001 mfd. condenser, C8.

The other leg of the loud speaker, LS, is connected to the screen grid terminal of the valve V3, and to one side of the 1 mfd. condenser, C7; also to the B+ maximum terminal.

The remaining terminals on C7 and C8 are connected together and earthed.

Two leads are taken from the secondary of the four-volt filament transformer to the terminals marked F— and F+ on V3.

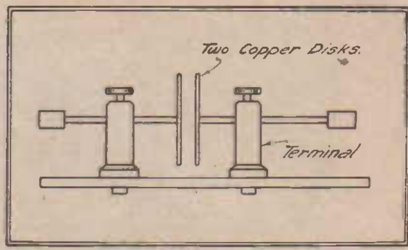
From the F— terminal on V3 connect a lead to one side of a 50 ohm centre tapped resistor, R4, the remaining side being connected back to the F+ terminal.

The centre tap is connected directly to earth. The 0-6 volt meter and pilot light seen on the front panel are connected across the A battery supply.

After earthing the cores of the transformers, AFT1 and AFT2, the wiring is completed.

The bakelite panel is shielded at the back with a sheet of copper; also, it is absolutely essential to have a shield tacked to the under side of the baseboard under the whole set. This shield cuts out any hum which would otherwise be picked up from the house wiring.

Condenser C is made from two copper discs about the size of two pennies fitted up and mounted as shown in Fig. 1 It must be of rigid construction, and the moving plate should be clamped firmly after adjustments have been made; otherwise it is likely to vibrate slightly, and will, therefore, become microphonic on the verge of oscillation.



Details of the aerial coupling condenser used in the receiver are provided by this drawing.

Coil Data and Operating Hints.

When winding tuning and reaction coils on a former, it is well to remember that the elements of the valve —that is, the grid and the plate—must always be connected to the two outer ends of the windings, or, if you wish, to the two inner ends, but no other way. Valve base coils are used, having the reaction turns wound on the top half and the secondary coil ⅛ inch away below. It is very difficult to give the exact coil data, as nearly every set requires different sizes of and various degrees of coupling between the two coils. When fringe howl occurs, it can often be eliminated by merely altering the coupling between the coils just a fraction of an inch. A coil table will be given as a guide, and will be found approximately correct. If any of the coils oscillate too much, take a few turns off from the top of the reaction winding.

The signal strength will depend to a certain extent on the reactance of the aerial coupling condenser. Over 26 metres the set works best with a tight coupling. The two copper discs can then be jammed tightly together, but separated by a piece of mica or paper. If the valve goes out of oscillation at certain places, the coupling will have to be loosened to overcome these "dead spots." Below 26 metres greater stability, and even better signals, can be had by using a looser coupling.

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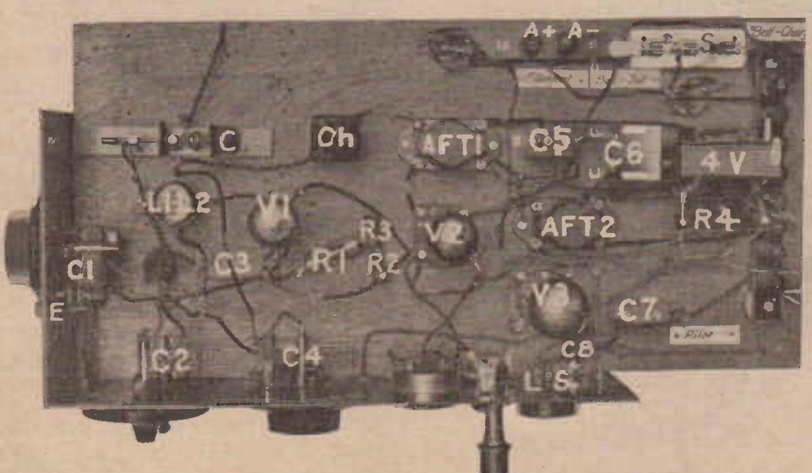
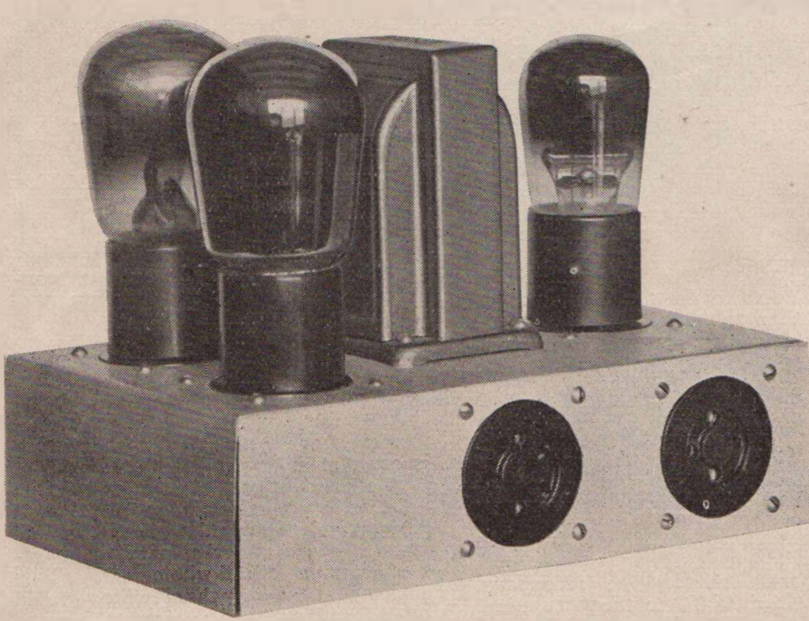


The baseboard view of the receiver, key-lettered to agree with other technical dope which has been provided. Note the unusually wide spacing of parts, which is such a feature of the set's construction.



The top (back) view of the amplifier, showing the positions of the two connector sockets.

A Battery Operated P.A. Amplifier

Complete constructional information contained in this article will enable the battery set user to construct a high quality high-gain audio amplifier.

By C. A. CULLINAN.

ONE of the greatest difficulties the battery set user is up against is that of obtaining a fairly high audio frequency output at a reasonable battery cost. Where the a.c. set user has access to unlimited cheap power from the mains, the battery set man is forced to use power which costs him something like £4/4/- per kilowatt hour. A similar power costs the more fortunate city radio set owner anything between 1½d. and 5d.

Thus, it can be seen that when we come to a question of fairly high audio power output, which, of course, means a corresponding increase in the power consumption of the receiver, we want to be sure that we get the most for our money. If we decide that a power output of something in the vicinity of two watts undistorted is necessary for an amplifier which, like the original one described later, is to be used to amplify recorded music for dances in a small country hall, we have three courses open to us. We either may use a single last-stage valve of low impedance and high audio output, a pair of medium impedance valves as a class "B" amplifier, or a pair of pentodes in push-pull. Properly arranged, there is nothing much to choose from the viewpoint of tone quality between any of these arrangements, although, possibly, the single low-impedance tube will give slightly better results.

The pros. and cons. for the three systems are:

No. 1 requires a fairly big tube, which will have a "B" battery consumption of anything between 26 and 50 m.a. at a plate voltage ranging from 200 to 350—a watt consumption (power) of, say, from 5 to 10 watts.

No. 2 will economise considerably on power consumption, but suffers from the disadvantage that it is practically impossible to get the special transformers which are necessary.

No. 3 seems to offer the greatest possibilities. The selection of proper valves makes it possible for us to get something like 2 watts undistorted output from our amplifier at a plate power cost of only 3.6 watts, which is pretty good. Naturally, a driver tube must be used ahead of the push-pull stage, but as this tube will be needed in any arrangement we use, it can be disregarded except in the final check up of power consumption.

Economical Power.

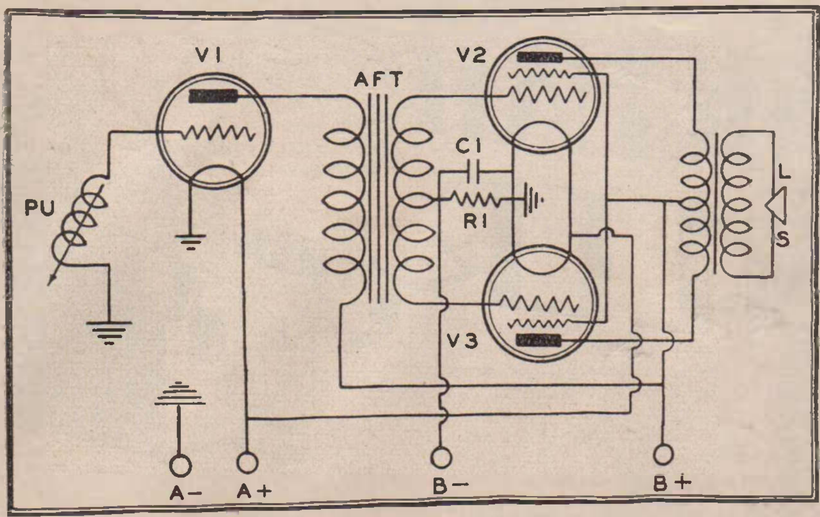
These were the points which the writer went over before attempting the design of the amplifier it now is proposed to describe. The power output delivered to the speaker is sufficient to cover a hall which will hold up to 500 people; the total power consumption of the amplifier, "A" and "B" supply, is 6.38 watts, of which the "A" battery accounts for 1.52 watts.

A brief description of the amplifier will be useful at this juncture. In all three valves are used. The first of these is a Philips A415 driver tube, and the other two are Philips B443 pentodes. The first tube is transformer coupled to the final tubes, which operate in push-pull and feed into the coupling transformer of a permanent magnet type of dynamic speaker.

Automatic bias is obtained for the final tubes by means of the resistor connected in series between B minus and earth.

Because of the difficulty of obtaining a variable resistor which could be easily tapped, we have not arranged for a negative bias on the first tube. However, the new Radiokes resistor, which has just been released, should overcome this difficulty. Note that the bias resistor is by-passed with a 2 mfd. fixed condenser, C1, to provide a good audio path.

One of the features of this amplifier is that it requires very few components, and so may be built cheaply. Following is a list of the material required:—



The schematic diagram of the amplifier shows that very few components are necessary for its construction.

What is Wanted.

1 A.W.A. Push-pull Transformer (AFT).
4 Marquis UX Sockets (for V1, V2, V3 and Pick-up input).
1 Marquis UY Socket (for l.s. and battery input).
1 Aluminium Chassis, 7½ in. x 5 in. x 2 in.
1 Hydra .2 mfd. Fixed Condenser (C1).
1 650 ohm Velco Wire-wound Resistor (R1).
3 Lengths Sphagetti.
26 ⅛ in. Machine Screws and Nuts.
1 Philips A415 Valve (V1).
2 Philips B443 Valves (V2, V3).

The assembly of the unit is absurdly simple. All that it is necessary to do is to cut out three 1 9-16 in. holes in the top of the chassis for the Marquis valve sockets, and the two similar sized holes in one side of the chassis for the sockets which are to carry the loud speaker, battery and pick-up plugs. This done, the five sockets can be mounted.

The audio transformer is mounted on the top of the chassis by means of four securing bolts. Two quarter-inch holes also must be drilled to take the leads from the transformer through the chassis. The final job of assembly involves the drilling of the two holes for the bolts which hold the 2 mfd. condenser to the side of the chassis.

Once the assembly has been completed, we are ready to wire the amplifier.

Point-to-Point Connections.

Start the wiring by connecting the A plus lug on the UX pick-up socket to the G lug on the first valve socket, V1. The P lug on the pick-up socket is connected to the metal chassis. The G lug on the same socket is wired to the A plus lug on the socket of V1 and to the corresponding lug on the sockets V2 and V3. The A plus lug on the pick-up socket is wired to the A minus lug on the socket V1, and thence to the metal chassis.

The red lead from the audio transformer, AFT, is soldered to the P lug on the socket of V1. The black lead from AFT is soldered to the G lug on the socket, V3. whilst the yellow lead from AFT is soldered to the G lug on the socket, V2. The blue lead from AFT is soldered to F1 lug on the UY socket, and this lug is linked by a lead to the G lug on the same socket, and carries also the two leads to the screen grids of the B443 pentodes. The green lead from AFT is connected to the F2 lug on the UY socket, from which lug a lead also runs to one lug on the 2 mfd. condenser, C1, and to one lead on the resistance, R1. The other lead on R1 is soldered to the remaining lug on C1, and to the metal chassis.

The plate lug on the socket, V2, is soldered to the P lug on the UY socket, whilst the plate lug on the socket, V3, is soldered to the C lug on the UY socket. The remaining connection is the soldering of a lead to the A minus lugs on V2 and V3 and the connection of these to the metal chassis.

Plug Wire Code.

The lead wires connecting pick-up, batteries and loud speaker now must be soldered into their respective burnt-out valve bases, which are to be used as plugs. Connect the lead wires to these plugs as follows:—

A plus pin on UX base to one pick-up lead pin on UX base to other pick-up lead.

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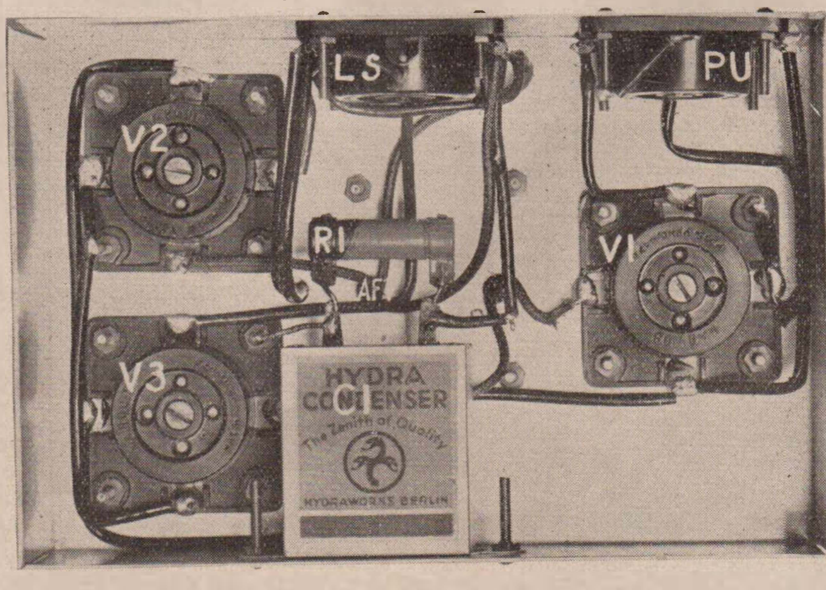
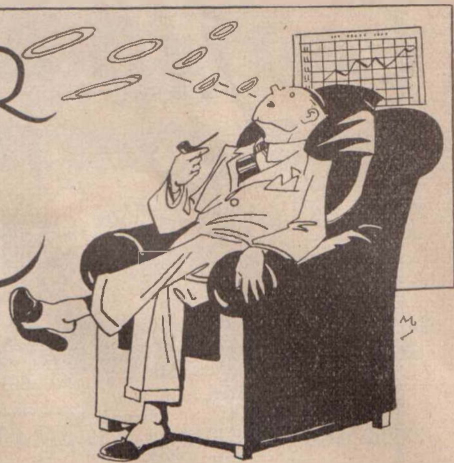


An under-chassis view of the amplifier, showing the components key-lettered to agree with the schematic diagram, the list of parts, and the wiring description.

The ARMCHAIR ENGINEER



WE'RE still chuckling at a very apposite remark we struck in an American technical paper anent the pentode. The writer, a big noise in one of the leading radio set factories, in dealing with audio amplification, the possibilities of Class "B," and the results of some tests with standard triodes, gave the pentode a kick in the pants with the remark, "As for pentodes—one year of 30 per cent. distortion in a bottle was quite enough."

Seriously, though, it behoves us in Australia to take notice of this engineer's comment, for his is only one of the worth-while criticisms of the pentode we have heard.

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ONE point about this audio power argument, which now is raising Cain among American set designers, is that at last a real attempt is being made to provide the set user with high quality output. Incidentally, the old audio transformer is coming back into its own, though in a re-vamped form. Instead of the impedance match being the *raison d'être* behind transformer design, we now find them being used under circumstances which call for straight-out power transformer design—merely a question of delivering a certain audio frequency wattage from one tube to the next.

Against the host of designers who consider class "B" audio a kind of poor relation who may be tolerated but not encouraged, we have the Magogs of the General Electric Co. merchandising a 12-valve super-het employing automatic volume control, a whole host of other interesting gadgets, and, above all, a pair of 46 tubes Class "B"-ing the audio output to the speaker.

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PROBABLY the brightest spot in Australian radio circles this month has been the publication of the report on broadcasting made to A.W.A. by the British engineer, Captain P. P. Eckersley. Whatever may be the outcome of this crusade to extend the Australian broadcasting service, we must hand it to the captain. Without doubt, he is the best showman we have come in contact with, although behind his geniality and showmanship there is such a solid technical background that one cannot help but be convinced by his arguments.

His plan to instal up to 12 long-wave stations throughout the country districts is an admirable one to our way of thinking. Besides providing a complete cover for the country listener, that unfortunate yet softly spoken individual who is forced to take what the gods, in the form of the P.M.G.'s department, like to give him, the installation of new stations would do much to solve our interference problems.

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APART from the radio trade's reaction to the scheme—in the main they are suspicious because they believe it to be an A.W.A. stunt—one wonders what the P.M.G.'s department is thinking. In the course of his report on the present system and his proposal for a better one, Captain Eckersley made no bones about the fact that he considered that the majority of the new National stations put in under the P.M.G.'s department supervision, including notably 2CO, Corowa, and 5CK, Crystal Brook, were unnecessary. This is not a very nice pill for the department's engineers to swallow, particularly when it is remembered that these expensive new stations are considered to be up to date in every particular.

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ONE of our regrets is that we, unfortunately, were unable personally to meet Captain Eckersley. However, after reading his published report to A.W.A., we take off our hat to him for his proposed solution to the country listener's difficulties, and hope that the powers that be will not be powerful enough to cause the Eckersley plan to be stillborn.

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IN 1857 one Leon Scott is said to have constructed the first instrument for making a graphical record of a sound wave. The stylus used by Scott made a lateral cut in the surface of the cylinder. Edison, in 1877, brought out a machine similar to Scott's, but instead of making a lateral-cut record his stylus traced an impression of variable depth in the tinfoil cylinder. The next important advance was the electric recording stylus developed by the American Bell company's laboratories, which extended the frequency range to 5000 cycles. This stylus, although fundamentally different from Scott's, still used the lateral cut principle.

During the past few months a further great advance in the art of gramophone recording has been developed by the Bell laboratories, in which the "hill and dale," or vertical cut groove again has come into favour. While using Edison's original method, the new records far surpass anything that has gone before. The frequency range has been extended to 10,000 cycles, whilst the volume range has been increased from 30 to 50 d.b., or from 10,000 to 1,000,000.

According to releases from the Bell laboratories, and from independent opinions of Australian technical men who recently have returned from abroad, the new records give one a sense of actual presence during the original rendition.

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APROPOS of our remarks last month regarding the slaughtering of the Australian radio set market by local manufacturers and the tendency to get the price level down by sacrificing the quality of components, it is interesting to note that the far-sighted (?) individuals who thought to get rich quick by selling more receivers at lowered prices—perhaps—are now getting quite concerned about the possibility of American competition when the set embargo is lifted at the end of the year.

We only wish the scare would become general, for then, perhaps, we would see an endeavour to meet possible American competition by the selling of extra high quality receivers at reasonable prices instead of the junk stuff which at present is being put out at ridiculously low prices.

Incidentally, the following excerpt from American "Electronics" seems to show that there still is a market, even in America, for a high quality product at a fair price:

> "There is more fact than rumour in the results secured by a prominent set manufacturer in selling expensive remote control radios. The hoped-for quota of 50,000 dollars for 1932 has not only been attained already, but at the present rate the year's sales of 300 dollar radios of this type will mount up to the imposing figure of 200,000 dollars or more. Thus, one of the things 'which can't be done' is being accomplished with considerable success."

●

WELL, we really heard some music the other day. We had prided ourselves on knowing a good amplifier and speaker combination when we heard it, but never in our wildest dreams had we listened to such wonderful reproduction as that which was turned on for us in a speaker manufacturer's laboratory the other day. The secret of the whole thing was the use of dual speakers, which were arranged to have different resonance peaks, and which were mounted close together in the same baffle and had their voice coils connected in parallel to a single output transformer.

The quality of output and the frequency range, particularly on the lower register, was remarkable, whilst the freedom from those disturbing overload symptoms which characterise the functioning of most loud speakers when connected to a fair-sized amplifier had to be heard to be appreciated.

Some day soon the set manufacturers will wake up to the advantages of dual and triple speakers, but in the meantime the experimenter has a chance to show how high quality input can be reproduced.

SOMETHING seems to be moving in the automobile radio business. The local branch of the American Bosch Co. has landed a complete auto radio receiver, and there is every possibility that Victorian manufacturers will take up the Bosch mag-motor, which provides the power supply for the seven valve super-het which comprises the original receiver. There seems a good opening in Australia for an auto receiver, provided that it is both good and reasonably cheap. The difficulty, though, will be to provide a really sensitive receiver, with all its trappings, such as aerials, remote control, speaker and power unit, at a figure which will not bankrupt the already badly bent car owner. In the meantime, there seems plenty of room for amateur built battery operated auto receivers, which could later on be changed over for use with a power unit.

●

JUDGING by reports we have had recently, our old friends, sun-spots and the Heaviside layer, are working in cahoots to give the long-waves a chance to pile up some records. A short-wave friend of our tells us that on his three valve s.w. receiver he tunes in the 50 metres Moscow broadcaster, and, after checking up the programme, plugs long-wave coils into the set and tunes in the regular Moscow transmitter on about 1500 metres. This, in a Melbourne suburb, gives some idea of what might be expected *from a sensitive tuned r.f. receiver* employing about three radio stages and operated on the long waves.

On the medium waves, too, things are happening. Some of our expert super-het users are tuning in things which sound like American Pacific Coast broadcasters, so we may expect that a decent t.r.f. receiver probably would provide reception of the Atlantic coast stations.

On the other hand, the short waves have gone pretty hay-wire, and amateurs throughout the world are turning their attention again to the 80 and 160 metre bands, which were scrapped for long distance communication around about 1926. Perhaps it's the depression that is causing all these bothers!

●

AMERICAN technical papers are again giving prominence to experiments which have as their object the conversion of sunlight into electricity. Although the field is still far from exploited, and there seems no immediate possibility of this scientific dream being realised, much work of interest has been carried out. The latest attempts involve the use of cuprous oxide rectifiers, which most radio experimenters will recognise as the standard dry-rectifier units of dynamic speakers and power packs.

Latest developments in the manufacture of this type of rectifier give overseas experts reason to believe that in some fields the dry rectifier will displace the photo-electric cell. Despite the fact that the German, Lange, has succeeded in operating a small motor with energy received direct from the sun, and that the American, Wilson, has been able to get a power output of 1 watt per square yard of sunlit surface, much remains to be done. The full energy output of bright sunlight is in the vicinity of 200 watts per square foot, so that even at 50 per cent. efficiency the present results must be bettered tremendously before we can expect to get "free" power.

●

THE publicity announcement that the next Chicago World's Fair is to be opened by a beam of light first sent out from the star Arcturus 40 years ago brings to mind the fact that the photo-electric cell is being used widely by the astronomer. Many important light measurements which previously could be conducted only with the aid of powerful and expensive telescopes are now being made possible with the aid of the photo-electric cell and a comparatively inexpensive lense system. At the present time experts in the Melbourne Observatory are busily engaged in building up apparatus which will permit the p.e. cell to be put to work on the astrograph which is used to chart the positions of stars.

●

JUDGING by present indications, this decade must go down in history as an electronic decade. The versatile electron is being put to work at every conceivable job. These range from fairly conventional jobs of guarding safes, jewel boxes and strongrooms to comparing the colours of milady's dress materials and counting all kinds of mass production operations, such as the output of high-speed printing and folding machines.

A novel burglar alarm was devised by a lamp manufacturer who wanted to discover the business spies who were peeping into his laboratories. A photo cell using the conventional light circuit was hooked by means of relays to an alarm system and to a camera a flashlight lamp which automatically took the intruder's photograph. Coming nearer home, we understand that a big chemical works in Melbourne employs photo-electric cells to watch the temperature of some of its special retorts.

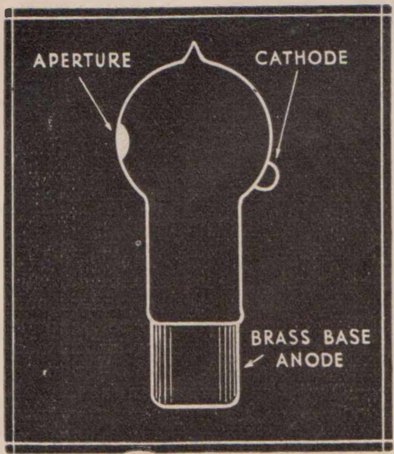


Fig. 1.

All About the Photo-Electric Cell

The function and method of operation of the light sensitive cell is interestingly told in this article which also gives operating data on available P.E. cells.

By G. V. HUME.

NOWADAYS we often hear about photo-electric cells, but few people have stopped to consider their properties or application. The P.E. cell may be compared to the microphone. The latter device possesses the necessary characteristics to change sound waves into electric current, while the P.E. cell does the same thing with light waves.

It was known many years back that certain substances emitted electrons when exposed to light, but the idea was not developed commercially until comparatively recently. Even the early type of P.E. cells was not used to any great extent, as suitable high gain amplifiers were not available.

High output is the most important point so far as P.E. cells are concerned, for their output is minute when compared with even the most economical types of radio valves. The photo-electric current is measured in microamperes. This unit represents one-millionth part of an ampere.

The output from a P.E. cell depends on several factors, the most important being the operating voltage and the amount of light falling on the window. The area of the window plays a part in determining the amount of light to reach the cell.

The cell consists of two elements, known as the cathode and anode. See Fig. 1. As in the radio valve, which they resemble in several ways, these elements are contained in a glass bulb, which is partly evacuated. It is a well-known fact that in the ordinary receiving valves the filament emits electrons, which flow to the plate or anode when a potential is applied.

The anode of the P.E. cell is made positive, and the cathode emits electrons when exposed to light. The cathode is a special preparation which usually contains caesium, and is actually located on the glass of the bulb. Reference will be made later to the various cathodes available.

Let us consider some simple circuit arrangements for amplifying the output from P.E. cells. These are shown in Figs. 2 and 3. It is interesting to note that relays are used to control the operation of the apparatus used in conjunction with the cells.

Photo-electric cells are mainly used to perform operations embracing one or more of the following applications:—

(a) Cell responds when light appears or disappears.
(b) Variations of light intensity are converted into corresponding variations of electric current in a circuit.
(c) Cell functions as a substitute for human eye in determining the type of colour or intensity of illumination.

Figs. 2 and 3 show the fundamental circuits for using photo-electric cells. Fig. 2 is a suitable circuit for uses under heading "A," given in the foregoing. Note that the triode is operated as an ordinary amplifier, and, therefore, requires a negative grid bias. The necessary anode voltage is applied to the P.E. cell, and when a light is thrown on to the window a current flows through the cell. Through the action of the valve a larger current flows in the anode circuit and through the relay. The relay in turn operates the apparatus to which it is connected. In this way a P.E. cell may be used to operate an automatic switch, an alarm, a bell, etc.

Special anti-burglar alarms are installed in many places operating from photo-electric cells. In America P.E. cells are used in traffic control apparatus to control street signal lights.

Fig. 3 shows how the cell must be wired to respond to continuous light variations. Such conditions are met in sound film

(Continued on page 37.)

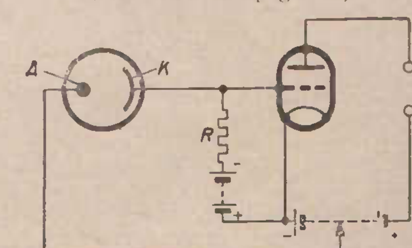


Fig. 2.

AN English flying lieutenant took a radio receiver with him in his aeroplane, and as soon as he heard the dance music which the transmitter on the aerodrome broadcast on this occasion, he had his machine do a few mad capers in time to the music. This is not a bad idea for a variety item in an open-air entertainment.

* * *

FRENCH papers claim that medical lectures are often broadcast at the time of the principal meals. Generally, listening to these lectures does not sharpen the appetite, and this is the reason why the papers, backed by the French writer, Paul Reboux, claim that medical lectures be eliminated during meals, and replaced by light music.

* * *

THE loan of 10,000,000 francs in favour of the Belgian broadcasting, recently ratified by Royal decree, will chiefly serve to cover the expenses incurred for the placing of special broadcasting wire lines between the two Belgian transmitters and the most important localities of the country.

* * *

THE Spanish short-wave station at Aranjuez (30.4m.) transmits every Saturday from 6 to 8 p.m. (local time). The announcements are made in Spanish, French and English. The aim of these transmissions is to give an idea to foreign countries concerning the Spanish artistic and intellectual life. In this connection first-class Spanish artists have been called upon to collaborate.

* * *

DURING the "Pedestrian Week" which was inaugurated at Berlin recently, extensive use was made of loud speakers placed at busy crossings. During the day, a number of broadcasting speakers spread a stream of warnings and advices in order to protect pedestrians against misfortune. Motor cycles and cars provided with loud speakers rushed on to unsuspecting pedestrians, but stopped in the nick of time. When the pedestrian recovered from his fright, the loud speaker advised him what he has to do under similar real circumstances.

* * *

A TESTING station has been fitted up at Troms, in Norway, by the well-known Professor Appleton, who will make investigations as to the northern lights and the ionisation phenomena, particularly with regard to their influence on radio waves.

* * *

IN the recent American election campaign, broadcasting stations were widely used by the various parties.

These services are far from being inexpensive! The two largest broadcasting companies, the National Broadcasting Company and the Columbia Broadcasting System, ask, for one hour per day of propaganda for the elections, the trifling amount of 41,650 dollars for the complete network, if the transmission takes place during daytime. If a better programme time is desired, for instance some time during the evening, this price is increased to 50,000 dollars. We understand that in 1928, when the tariffs were still much lower, the American stations collected an amount of 1,078,685 dollars, approximately £275,000, for placing the broadcasting time at the disposal of the election campaigners.

* * *

AMERICA has made another move in radio. It concerns the use of short-wave transmitters for the giving of signals to motor-cycles on the street. Naturally, with the starting point that in future all cars and motor-cycles will be provided with a radio receiver, it is suggested that these receivers be tuned in on a specific wave-length during the whole trip.

Short-wave stations working on this wave-length will then be erected at every dangerous point. These stations will transmit special gramophone records. When a motor-vehicle passes through this station's zone of oscillations, the driver will hear a warning emanating from his loud speaker saying, "Take care, dangerous curve; maximum speed 20 miles per hour," or such similar warnings, which the local authorities will bring to the attention of the parties concerned.

* * *

WE recently advised that the Egyptian Government meant to instal a broadcasting system with a power station as central point, which would be the first Egyptian transmitter. It now appears that, after all, Egypt has a small transmitter, erected at Port Said, and which belongs to a local radio club.

* * *

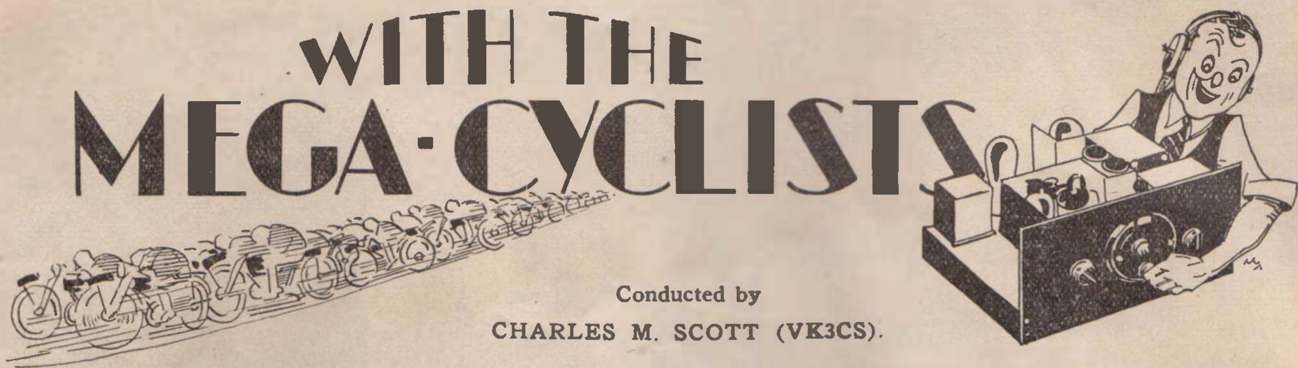
FOR the time being, it is practically impossible to find a spot in Leningrad, Soviet Russia, where one is not pursued by loud-speaker performances. The situation threatens to become worse, as the local authorities have ordered not less than 32,000 loud-speakers to be mounted in factories, workmen's clubs, and even on the streets.

* * *

THE Berlin Broadcasting, Funkstunde-Berlin, is now looking for special broadcasting reporters for literature, art, politics, sport and sciences. Because the quality of a reporter can only be judged in practice, the Funkstunde is organising so-called "blind reporting"—i.e., the reporter speaks through the microphone, but it is not transmitted. The jury listens to the reporting in an adjacent room.

The examination which the candidates have to pass is organised as follows: They receive a few photos of one or the other topical event concerning which they must immediately speak through the microphone. This permits to judge as to their presence of mind, how quickly they grasp matters and how they express their ideas.

This test-reporting is registered on records and the candidates are invited to listen to the reproduction immediately following the examination. This enables them to exchange points of view with the jury. So far results are most disappointing.



Conducted by
CHARLES M. SCOTT (VK3CS).

The "Best" Aerial for Short Waves

By HUGO GERNSBACK.

ALL short-wave experimenters are aware of the fact that there is such a thing as location—good or bad—when it comes to the reception of short-wave signals. It might be said here that not much is known about the subject, and that in many respects it is still a closed book with seven seals.

It has been noted time and again that you can take the identical short-wave receiver and move it from one location to another, and obtain totally different results. In one location the results may be poor or mediocre, and in another they may be excellent. I do not necessarily refer to the difference in reception between country and city, because it has often been proved that in certain locations, even in large cities, short-wave reception is extraordinarily good. As a rule, however, the large city, with its huge steel buildings, absorbs so much energy that in most cases results are not anywhere near as good as in the country. Again, however, there are many exceptions. In some instances, steel buildings can reflect short-waves to such an extent that if conditions are favourable the signals will actually come in stronger than if the buildings were not there!

On the other hand, steel buildings might affect the receiving aerial in a directive manner. For instance, it often happens that signals from the west come in strong, while signals from the east cannot be received at all, or vice versa. These are the peculiarities of the short-waves.

We still know next to nothing about the propagation of radio waves in space. We know nothing about what happens between the distant transmitting aerial and the receiving aerial; all we can do is guess at it.

If any general remarks can be made on the subject, they can be stated briefly as follow:—

Broadly speaking, the reception of short waves is different from the reception of "broadcast" waves, and the shorter the waves, the greater becomes the difference.

It should be noted that an aerial of the "L" type is directional, and that the signal as a rule, comes in best from the direction **opposite to the free end of the "L."** For this reason, "L" type aerials may not be the best for short wave work. It would seem that the umbrella type aerial, which has a number of wires strung in the shape of an umbrella, would be best for reception from all points of the compass. A single vertical wire is also recommended.

The insulation of the short wave aerial is frequently neglected by the experimenter, because he has been brought up to believe that any insulator is good enough. On the short waves, where the available energy is usually lower than on the broadcast band, particular care should be taken in the insulation of the aerial. Insulators should not be used singly. It is best to use three of the glass type, or at least two in tandem, to get the maximum insulation. Wherever connections are made to the lead-in, these must be soldered. Be careful not to have any sharp projections on the aerial itself. Every experimenter in high frequency work knows that points on conductors will make for leakage into the surrounding air.

If you have to make turns, do not have sharp ends protruding from the aerial itself, but file them off, round them carefully, and solder them over to do away with all sharp points. It is needless to say that all connections to the aerial must be soldered, if any worthwhile results are to be obtained.

Most important, however, is the distance separating the aerial from the building. **This is the one point on which practically everyone falls down.** Wires are carelessly strung parallel to buildings an inch or two away from walls, and in many cases, even touching walls for long distances. You might just as well not have an aerial for short waves if you follow these tactics. It simply will not do in short wave work.

The main aerial should be at least ten feet or more away from the roof, or any other obstruction for that matter, and the lead-in should never come closer than one foot to the wall of a building. If you must go around corners, you should erect a small pole, at the end of which is fastened a good insulator on which the lead-in itself is fastened. The pole will thus keep the lead-in away from the building as far as it is consistent to do so.

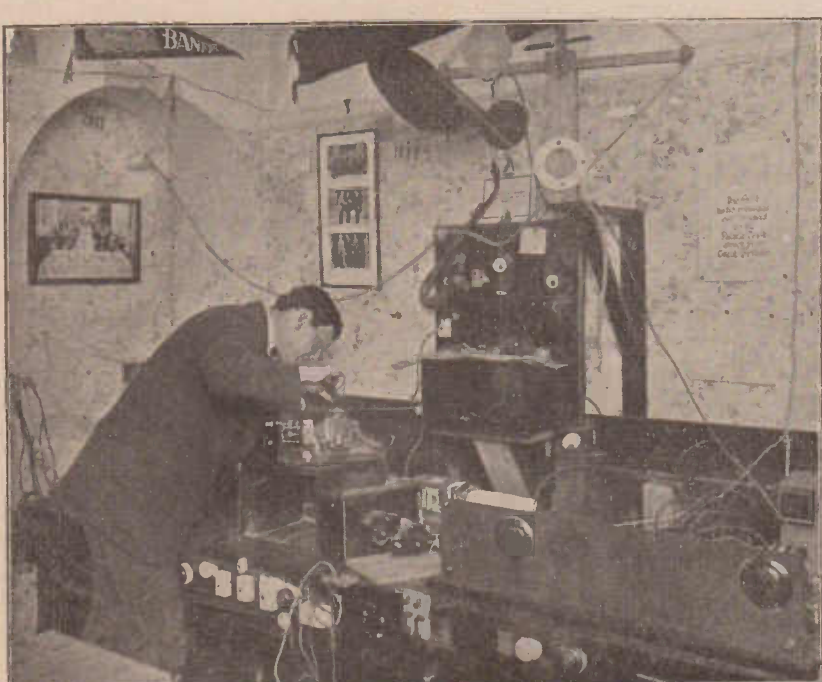
When it comes to the point of running the lead-in wire into the house, more sins are committed, because usually here is where most of the energy of the incoming waves is lost. Most amateurs use the usual insulated lead-in strip, which is about three-quarters of an inch wide, and is laid flat under the window, connections being made to the two ends. Such a lead-in strip forms an excellent condenser, exactly where you do not want to have it, because it actually acts as a transferer of energy from aerial to ground, (which is the building in this case) at a point where you can least afford the loss.

There is really only one good method of bringing the wire in, and that is, drill a hole in the upper pane of the window, and to put the wire through it. This gives a clear space all around the lead-in wire, and no energy will be lost.

In apartment houses it is sometimes impossible to do this (that is, drill holes in the glass), but the amateur can easily get around this by following a simple system which has proved itself valuable in many cases:

Obtain two pieces of heavy copper foil. Paste one piece on the outside of the window glass, the other piece on the inside. The foil should be four to five inches square. The pieces are shellacked to the window by means of good, clear shellac. They should be exactly opposite each other, to form a condenser. The outside insulator should be first secured rigidly to a pole, with an insulator anchored on same; then a thin insulated piece of flexible lamp cord is soldered to the outside lead-in and also soldered to the heavy foil fastened against the outside of the window. Another flexible piece of lamp cord is soldered to the inside sheet of foil, from which point connection is made to the set. Even on the inside of the room, care should be taken that the wire coming from the window is not nailed against the wall. It should run at least six inches away from the wall wherever possible.

As to the ground, no ground can be too good! It should only be a cold-water pipe ground, never a radiator connection. For the ultra short waves, no ground at all is necessary; an aerial comprising two pick-up sections (Hertzian di-pole) being used.



Gerald Marcuse, the pioneer British Short Wave Broadcaster, is now reported to be experimenting with the ultra short waves.

How to Get Results from your S.W. Receiver

TO both the newcomer and the experienced listener it is rather annoying to hear a new station and not be able to identify it.

When a new station appears for the first time, check its wavelength roughly, either by an absorption wavemeter or by the dial setting.

From the wavelength the band in which the station is located can readily be found by referring to the wavelength-frequency allocation table.

This will at once give the nature of the service, whether it be broadcast, fixed, etc. Say the wavelength is 31.5 metres, we at once know that the station is a broadcaster.

However, there are a few Russian and Javanese stations who broadcast regular programmes outside the allotted frequencies for broadcast stations.

Stations of different nationality usually possess certain characteristics, which in themselves are a guide to identification.

The type of music played will, as a rule, indicate whether the station is from the East, Siam, China, Japan, etc., or whether it is situated in a westernised country.

If the call letters are given in English, refer to the list of prefixes or the commercial call list, which will give the nationality straight away.

If the call is given in a foreign language, refer to the list of pronunciations.

Practically every short-wave station has at some time used the English language; so, if an unknown station is concentrated on, it will not be long before an English announcement is heard.

INTERNATIONAL EXPERIMENTAL PREFIXES.

THE following list of prefixes is as nearly accurate and up to date as it is possible to compile.

A short explanation of how to use this list in the identification of some new station will be helpful.

These prefixes are the first letters used in the call sign, and signify the country in which the transmitter is located.

They are mainly used by amateur and shortwave broadcast stations.

In the United States a form of call letters is used which identifies the station as a broadcast, amateur, commercial or shortwave broadcast station.

An amateur station uses a number to designate the section or State of the country it is located in, such as W6BN.

The shortwave broadcaster uses the same form with the letter X following the number, like W2XAF, W8XK, etc.

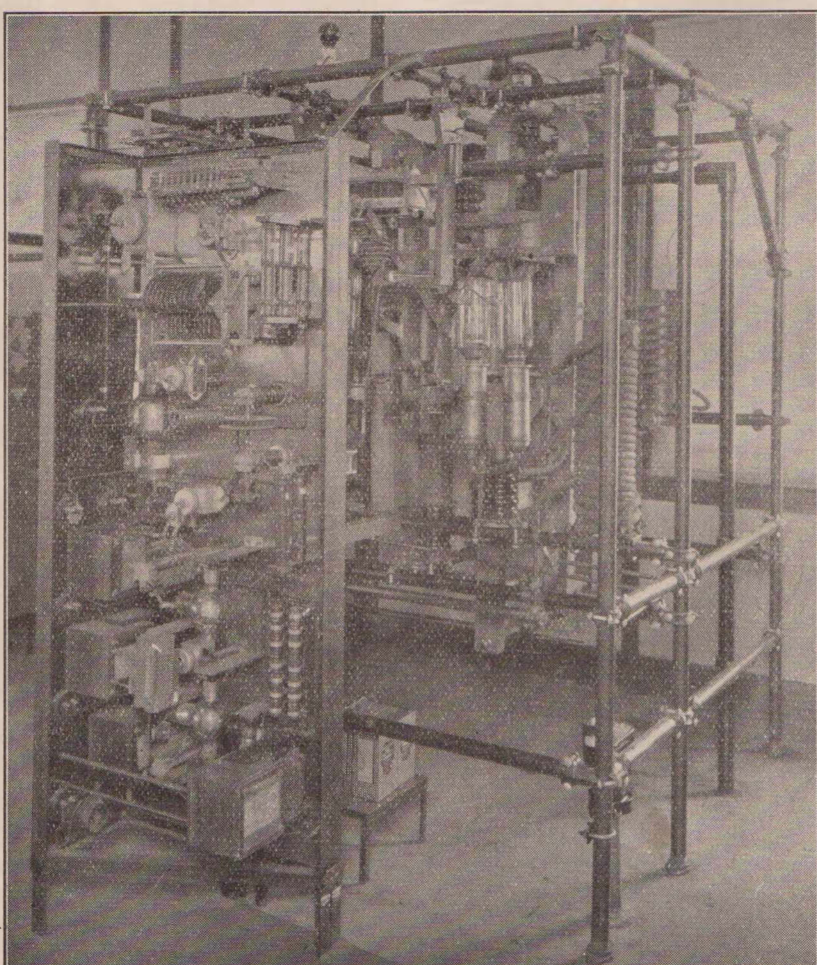
Broadcasting stations use four letters, such as WENR, although there are some which use three letters, such as WGY, and commercial stations three letters, such as KKW.

Commercial stations adhering to the Washington International Radio Conference of 1927 are allotted calls from the following series.

The call consists of three letters for fixed land stations, such as VLK, four letters for ships, such as VJNR, and five letters for aircraft installations.

COMMERCIAL CALL LETTERS.

CAA-CEZ, Chili.
CFA-CKZ, Canada
CLA-CMZ, Cuba.
CNA-CNZ, Morocco
CPA-CPZ, Bolivia
CRA-CRZ, Portuguese Colonies.
CSA-CSZ, Portugal
CVA-CVZ, Roumania
CWA-CXZ, Uruguay
CZA-CXZ, Monaco
D, Germany
EAA-EHZ, Spain
EIA-EIZ, Irish Free State
ELA-ELZ, Liberia
ESA-ESZ, Esthonia
ETA-ETZ, Ethiopia
F, France, Col. & Protectorates
G, Great Britain
HAA-HAZ, Hungary
HBA-HBZ, Switzerland
HCA-HCZ, Ecuador
HHA-HHZ, Haiti
HIA—HIZ, Dominican Rep.
HJA-HJZ, Colombia
HRA-HRZ, Honduras
HSA-HSZ, Siam
I, Italy and Col.
J., Japan
K., U.S.A.
LAA-LNX, Norway
LOA-LVZ, Argentine Rep.
LZA-LZZ, Bulgaria
M., Great Britain
N., U.S.A.
OAA-OBZ, Peru
OHA-OHZ, Finland
OKA-OKZ, Czecho Slovakia
ONA-OTZ, Belgium and Col.
OUA-OZZ, Denmark
PAA-PIZ, Netherlands
PJA-PJZ, Curacao
PKA-POZ, Dutch East Indies
PPA-PYZ, Brazil
PZA-PZZ, Surinam
Q., Reserved for code abbreviations
RAA-RQZ, Union of Soviet Soc. Rep.
RVA-RVZ, Persia
RXA-RXZ, Rep. of Panama
RYA-RYZ, Lithuania
SAA-SMZ, Sweden
SPA-SRZ, Poland
SUA-SUZ, Egypt
SVA-SZZ, Greece
TAA-TCZ, Turkey
TFA-TFZ, Iceland
TGA-TGZ, Guatamala.
TIA-TIZ, Costa Rica
TSA-TSZ, Territory of Saar Basin
UHA-UHZ, Hedjaz
UIA-UKZ, Dutch East Indies
ULA-ULZ, Luxemburg
UNA-UNZ, Kingdom of Serbs, Crotes and Slovenes
UOA-UOZ, Austria
UWA-UZZ, Canada
VAA-VGZ, Canada
VHA-VMZ, Australia
VOA-VOZ, Newfoundland
VPA-VSZ, British Col. and Prot. not autonomous
VTA-VWZ, Brit. India
W, U.S.A.
XAA-XFZ, Mexico
XGA-XGZ, China
YAA-YAZ, Afghanistan
YHA-YHZ, New Hebrides
YIA-YIZ, Iraq
YLA-YLZ, Latvia
YMA-YMZ, Danzig
YNA-YNZ, Nicaragua
YSA-YSZ, Rep. of El Salvador
YVA-YVZ, Venezuela
ZAA-ZAZ, Albania
ZKA-ZKZ, Cook Islands
ZLA-ZLZ, New Zealand
ZNA-ZNZ, Samoa
ZPA-ZPZ Paraguay
ZSA-ZUZ, Union of South Africa



A view of the final stage of the Westinghouse Co's. 40 K.W. crystal controlled S. W. station W8XK.

Following is a list of international prefixes listed for amateur and experimental stations:—

AMATEUR AND EXPERIMENTAL PREFIXES.

*AU—Russia in Asia
CE—Chile
CM—Cuba
CN—Morocco
CP—Bolivia
CR—Portuguese Colonies
CT—Portugal, Azores, Madeira and Cape Verde Is.
CV—Roumania
CX—Uruguay
CZ—Morocco
D—Germany
EAR—Spain
EI—Irish Free State
EL—Liberia
ES—Esthonia
*EU—Russia in Europe
F—France
FA—Abyssinia
FB—Madagascar
FI—French Indo-China
FM—Algeria and Tunis
FQ—Cameroons
FR—Canary Isles
G—Great Britain
GI—Northern Ireland
HAF—Hungary
HB—Switzerland
HC—Ecuador
HH—Haiti
HI—Dominica
HJ—
HR—Honduras
HS—Siam
I—Italy
J—Japan
KA—Philippine Islands
K4—Porto Rico and Virgin Is.
K5—Panama
K9—Hawaii
K7—Alaska
LA—Norway
LU—Argentine
LZ—Bulgaria
OA—Peru
OH—Finland
OK—Czecho-Slovakia
OM—Guam
ON—Belgium and Belgian Congo
OZ—Denmark and Faeroe Is.
PA—Holland
PK—Dutch East Indies
PY—Brazil
RV—Persia
RY—Lithuania
SM—Sweden
SP—Poland
ST—Sudan
SU—Egypt
TF—Iceland
TI—Costa Rica
TS—Sarre
UL—Luxemburg
UN—Jugo-Slavia
UO—Austria
V1—Barbados
VE—Canada
VK—Australia
VO—Newfoundland
VP—Southern Rhodesia and Jamaica
VQ2—Northern Rhodesia
VQ3—Tanganyika
VQ4—Kenya Colony
VQ5—Uganda
VS1—Straits Settlements
VS3—Malay States
VS6—Hong Kong
VS7—Ceylon
VT—India
VU—
W—U.S.A.
X—Mexico

*Unofficial and temporary.

XU—China
YI—Iraq
YL—Latvia
YM—Danzig
YS—Salvador
YV—Venezuela
ZC—Palestine
ZL—New Zealand
ZM—Samoa
ZP—Paraguay
ZS, ZT, ZU—South Africa.

International Time

WHEN dealing with local broadcasting we naturally talk in local time, but when we start talking in local time on the short waves confusion results.

It has become necessary in short wave radio to adopt a standard time, and the different nations of the world have agreed upon Greenwich Mean Time (G.M.T.), as a standard, to which all local time must be converted.

Obviously G.M.T. is the same at any moment all over the world, and is not affected by daylight saving time.

To convert Melbourne standard time to G.M.T., subtract 10 hours. With G.M.T. the 24-hour clock has been chosen zero time or 0000 G.M.T., starting at midnight, the first two figures representing the hour and the last two the minutes.

For example, if the Melbourne standard time is 10.30 p.m. on the 24-hour clock, this is equivalent to 22 hours 30 minutes; now to convert to G.M.T., subtract 10 hours, which equals 22.30—10.00=1230 G.M.T.

The conversions of local time into G.M.T. shown in the table should be learnt, as they will prove very helpful as most of the programme schedules received either by letter or over the air are given in G.M.T.

Most of the European countries and America use daylight saving time during the summer period, from April to September in the Northern Hemisphere, when the local time is advanced one hour.

This accounts for our local time during the winter being 9 hours ahead of London local time, and 10 hours ahead in summer, but we are always 10 hours ahead of G.M.T.

Melbourne Standard Time	G.M.T.
10-00 A.M.	0000
11-00 A.M.	0100
12-00 Noon	0200
1-00 P.M.	0300
2-00 ,,	0400
3-00 ,,	0500
4-00 ,,	0600
5-00 ,,	0700
6-00 ,,	0800
7-00 ,,	0900
8-00 ,,	1000
9-00 ,,	1100
10-00 ,,	1200
11-00 ,,	1300
12-00 Midnight	1400
1-00 A.M.	1500
2-00 ,,	1600
3-00 ,,	1700
4-00 ,,	1800
5-00 ,,	1900
6-00 ,,	2000
7-00 ,,	2100
8-00 ,,	2200
9-00 ,,	2300
10-00 ,,	2400

Foreign Pronunciation List Aids S.W. Listeners

THIS list of pronunciations of the alphabet in German, French, and Spanish will aid every short-wave listener to identify stations they may hear giving their call letters in these languages.

These pronunciations are as nearly correct as possible.

The list of the days of the week will prove handy when reading letters received from countries using these languages.

English	Spanish	German	French
A	Ah	Ah	Ah
B	Bay	Bau	Bay
C	Say	Tsay	Tsay
D	Day	Day	Day
E	Ay	A (as in Hay)	A (as in Hay)
F	Effay	Ef	Ef
G	Hay	Gay	Gay
H	Achay	Ha	Ash
I	Ee	E	Ee
J	Hotah	Yut	Yat
K	Kah	Kah	Kah
L	Ellay	El	El
M	Emmay	Em	Em
N	Ennay	En	En
O	Oh	O	O
P	Pay	Pay	Pay
Q	Coo	Coo	Coo
R	Erray	Err	Err
S	Essay	Ess	Ess
T	Tay	Tay	Tay
U	OO	Oo	Oo
V	Vay	Fow	Fow
W	Doovel-oo	Vay	Vay
X	Aykis	Ix	Ix
Y	Ee Griega	Ipsilon	Eegreg
Z	Thaday	Tset	Tset

English	German	French	Spanish	Dutch
Sunday	Sontag	Dimanche	Domingo	Zondag
Monday	Montag	Lundi	Lunes	Maandag
Tuesday	Dienstag	Mardi	Martes	Dinsdag
Wednesday	Mitwoch	Mercridi	Miercoles	Woensdag
Thursday	Donnerstag	Jendi	Jueves	Donderdag
Friday	Friestag	Vendredi	Viernes	Vrijdag
Saturday	Samstag	Samdi	Sabado	Zaterdag

What's On and When to Listen

Reports of Outstanding Receptions and Details of Regular Transmissions Which Can be Tuned In by the Owners of Reasonably Efficient Receivers

LISTENING to distant stations is becoming quite a common thing nowadays, and short wave listeners are looking for new thrills and new worlds to conquer.

How would you like to hear all the continents and all in one day?

It can be done at the present time with careful tuning.

Australia.

By setting your dial half a degree above the position for W2XAF-VK3ME Melbourne will be found on 31.5 metres every Wednesday and Saturday night, between 8.00 and 9.30 p.m., and 8.00 and 10.00 p.m. respectively.

A little lower down VK2ME will be found on 31.28 metres every Sunday after 4.30 p.m. Every week day VLK may be heard between 1.00 a.m. and 6.30 a.m., on 28.51 metres, working duplex 'phone with GBP Rugby on 28.00 metres.

Between 4.00 p.m. and 6.00 p.m., VLZ, another Sydney station, may be heard on 30.5 metres, working with ZLT, Wellington.

North America.

Listeners everywhere are able to tune in some of these stations daily:—

First there is W8XK, Pittsburgh, audible on 25.25 metres, between 7.00 a.m. and 10.00 a.m., (it may also be heard between 1.15 p.m. and 2.30 p.m.); W2XAF, on 31.48 metres, and W1XAZ, on 31.35 metres, operate between 8.00, and 9.00 a.m. There is also KKW, Dixon, on 21.77 metres, broadcasting programmes to Japan and Hawaii, between midday and 2.00 p.m. each day.

South America.

These stations are usually hard to hear, but with careful tuning LSN and LSX may be heard on 30.3 and 28.98 metres respectively, between 6.00 and 8.00 a.m.

Asia.

These stations are usually easy to find particularly RV15 at Khabarovsk, on 70.2 metres. Tune in between 7.30 p.m. and 11.00 p.m. for this station.

The Radiophone station, FZS at Saigon, of 25.02, may also be heard after 12.30 a.m. working duplex 'phone with Paris.

Africa

Although there are a number of stations in South Africa, there is only one which is consistently heard.

VQ7LO on 49.5 metres can be heard daily between 2.30 a.m. and 6.30 a.m., usually at R6, QSA4.

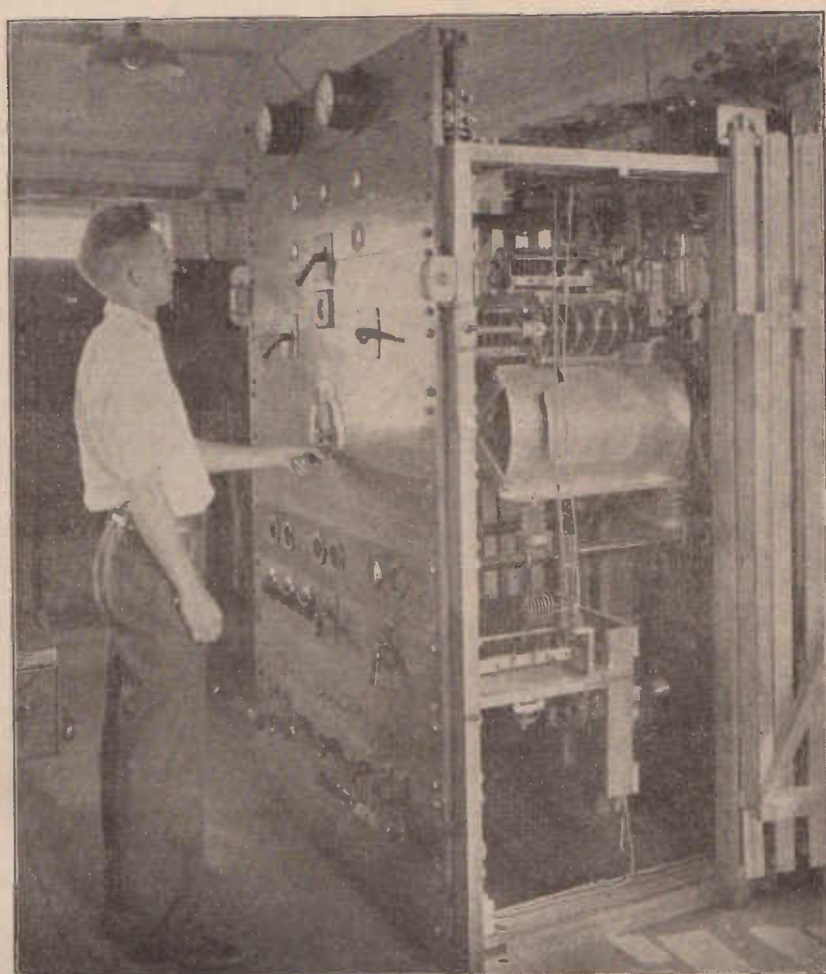
Europe.

The best time to tune for European stations is in the mornings.

Tune for G5SW and Radio Coloniale, Paris, on the 25 metre band daily, between 7.30 a.m. and 9.00 a.m.

On the 31 metre band Zeesen, Germany, is to be found on 31.38 metres between 6.00 and 8.00 a.m.

Going a little further up RV62 at Mousk, will be tuned in on 46.72 metres at good strength between 1.00 a.m. and 6.00 a.m., and RV59, Moscow, on 50 metres, can be heard between



One of the experimental transmitters at the G. E. Co's. Schenectady works. This particular transmitter is the original W2XAF.

2.30 a.m. and 8.00 a.m. at excellent strength.

Other stations are:—

J1AA, Tokio, Japan, 30.00 metres, fairly regularly, between 7.00 p.m. and 11.00 p.m.; PLF 29.25 metres and PLV 31.86 metres, both at Bandoeng, Java, come in fairly regularly between 8.30 p.m. and 9.30 p.m.; HVJ daily on 51.28 metres, 5.00 a.m. to 5.30 a.m.; EAQ, Madrid, 30.4 metres between 4.00 and 6.00 a.m.; PMY, Bandoeng, 58.3 metres, daily, 9.40 p.m. to 12.40 a.m.

UNKNOWN STATIONS.

TWO unknown stations have been heard recently, one on 38.2 metres, broadcasting recorded music, between 2.00 a.m. and 8.00 a.m., and between 4.30 and 5.30 p.m., at excellent speaker strength. The other station is on 52 metres and appears to be a new Javanese.

FZS, SAIGON, INDO-CHINA, HEARD.

THE first sign of the expected changing conditions was experienced recently by the faint reception of FZS, Saigon, on 25.02 metres at 12-30 a.m.

FZS usually works with one of the French stations FRE or FTN at St. Assise, and can easily be identified by the call "Hello, Hello, Paris, ici Saigon."

ANOTHER RUSSIAN STATION HEARD.

A RUSSIAN station, believed to be RV62 at Monsk, has been heard at good strength, R7,QSA5, after 1.0 a.m. on a wavelength of 46.72 metres.

This station is on the air daily and broadcasts musical programmes.

RV15, KHABAROVSK, U.S.S.R.

OWING to the season and the closing down of a few of the evening stations, RV15 has been the only station on which we could depend. Perhaps a few words about this station will be of interest.

The station first opened up in the early days of short-wave broadcasting under the call sign of RFM, with a power of 20 KW, the transmitter being the same type as the original KDKA.

The call sign was later changed to RA97, and broadcasts were conducted on 70.2 metres.

Fairly recently a further change in the call sign was made, this time to the present RV15.

The station is situated at Khabarovsk in far Eastern Siberia, U.S.S.R.

It is crystal controlled, and is used for local broadcasting as well as for propaganda purposes.

Owing to the wavelength there is practically no skip distance effect, and a great coverage, without much fading, can be obtained in daylight as well as at night, and, being so far north, the static does not cause much interference. Propaganda is broadcast in Chinese and occasionally in English.

One of the interesting features in the programme is the short music interlude, sometimes only a few bars, played between different talks, which are chiefly educational.

It is an old Russian custom to play a few bars of appropriate music as an introduction for the speaker.

The call sign is given as "Err Vay pyatnadsat, govorit, Khabarovskye" (accenting the second "a" in the place name), "semdyesyat metre;" which means "RV15 speaking at Khabarovsk on 70 metres."

WHAT "SERVICE AREA" MEANS.

AN "A" service area of a broadcast station is an area in which the field due to that station is greater than 10 mv. per metre.

A "B" service area of a broadcast station is an area in which the field due to that station is greater than 5 mv. per metre and less than 10 mv. per metre.

A "C" service area of a broadcast station is an area in which the field due to that station is greater than 2.5 mv. per metre and less than 5 mv. per metre.

"A" service conditions give a reception free from background interference in 99 per cent. of the cases met with even in an industrial area. Local thunderstorms, electro-medical apparatus, and tramcars may, on rare occasions, give an unwanted background.

"B" service conditions give a reception free from background noises typically in country or suburban conditions, but background may be experienced if the receiver is installed near tramway routes, electro-medical installations, etc.; static will cause interruption during about 5 per cent. of the total time of transmission.

"C" service conditions give reception which suffers slightly from background always, but which is not so pronounced as to make the service unacceptable to listeners in rural or semi-rural districts. Static may cause unpleasant background about 20 per cent. of the total time of listening.

With a typical aerial, 30 ft. high and consisting of 150 ft. of wire in all, and a good earth, crystal reception is possible up to the boundaries of the "B" service area.

OXY, SKAMBLEBACK, DENMARK.

IT has been reported that OXY broadcasts daily on 31.51 metres, between 5.00 a.m. and 9.30 a.m., our time.

The station was put on the air purposely to serve Danish subjects living away from their homeland. Just recently it was moved from Lyngby to its present location at Skambleback.

W8XK, PITTSBURGH, ACTIVE.

W8XK has been heard broadcasting the programme of KDKA as late as 2.30 p.m.

Transmission is carried out simultaneously on 25.25 metres and 48.86 metres, but only the 25.25 metre transmission can be heard at this time.

During the Olympic Games at Los Angeles a résumé of the day's games was given at 2.0 p.m., Melbourne time, each day for the benefit of overseas listeners. W8XK is now being moved to a new location.

The change in location is being made in the interests of centralisation, and with the completion of the transfer, the short waves will go on the air from the ultra-modern plant at Saxonburg, Pa., approximately 30 miles from Pittsburgh.

New transmitters are being installed at Saxonburg for frequencies of 15,210 KC. and 21,540 KC, their respective wavelengths being approximately 19.72 and 13.90 metres.

Other frequencies being moved are those of 6,140 KC, 48.86 metres, and 11,870 KC, 24.25 metres.

KKW, DIXON, STILL CONTINUES.

STATION KKW of Dixon, California, still continues its daily broadcast between midday and 2 p.m. on 21.77 metres, but the signal strength has fallen off somewhat lately.

They have been working duplex 'phone with JIAA, Tokio, for some weeks, and broadcasting Olympic results in Japanese for the benefit of Japanese listeners.

Shall Australia Go On or

BELOW we publish a complete technical review of the proposal for the use of long waves in Australian broadcasting, as set out by the eminent British radio engineer, Captain P. P. Eckersley. There seems so much misapprehension about the various points of his plan that we ask our readers, in justice both to Captain Eckersley and to the development of broadcasting in this country, to read this report carefully.

Some of the features which attract most attention from the radio engineer are—

(1) None of the existing radio receivers are rendered obsolete before their time. Any developments and improvements in the way of receivers which will cover both the long and the medium waves will be gradual.

(2) Practically everybody in the Commonwealth will be able to receive a high quality broadcasting service at all times of the year.

(3) If the various stations are grouped in centres instead of being spread haphazardly around the cities, the interference problems of metropolitan listeners will be overcome.

(4) All latest technical developments, notably the present Soviet broadcasting plan, call for the use of both long and medium wave length transmitters.

(5) The present broadcasting system provides good reception for only 56 per cent. of the population of the Commonwealth, whilst the Eckersley plan would make it possible for 95 per cent. of the population to obtain reliable radio reception.

(6) The plan provides for the gradual technical development of the medium wave stations so as to give the metropolitan listener better quality reception, freedom from interference, and much louder signals than can be obtained at present.

No single radio pronouncemen[t] amongst listeners, technical men, a[nd] set out by Capt. P. P. Eckersley, M[.] ment of a dual wave length plan fo[r] purpose of his plan, the means b[y] operation, and its effect on radio lis[teners] wealth are clearly explained in t[he] official r[eport]

AFTER dealing with long and medium wave broadcasting from the straight-out technical angle, Captain Eckersley says:—

We can sum up things in general terms as follow—

(1) True broadcasting service is only given in terms of steady and uninterrupted signals. Thus, the true service from a station can be defined in terms of the area around the station in which clear, unwavering, good quality signals may be received by day or by night.

(2) Stations radiate upward shooting rays which, hitting the underside of an "atmospheric roof," come down to earth again with great but, unfortunately, varying strength. The "roof" or Heaviside layer only reflects during the hours of darkness, and because of this and because the strength of the down coming space ray is variable they do not give true service. They may, however, interfere, at great distances, with the ground rays of stations attempting to create service area conditions unless the wave-lengths or frequencies of stations are separated by a given amount. Thus one station too close in carrier wave frequency to another will seriously limit the service area of that other, and/or will force receivers to be made so selective as to militate against good quality reproduction.

(3) If stations are widely separated in frequency in consequence of (2) so that each shall enjoy a free channel of communication and allow good receiver reproduction, there can be, in one continent, only a very few stations. The limitation of the number of stations results in the necessity for their increased power, which, in turn, calls for a wider wave-length separation, which again means fewer stations, and so on.

(4) It is easier to prevent the vicious circle of events described in (3) as the wave-length of stations is longer. Thus, with long waves, service area per given power is more extended, the zone of intolerable fading is pushed out further from the station, the interference producing attenuating space rays are usually weaker than those produced by medium wave stations, and so the required frequency separation between big wave stations less, and a greater number of stations can be located in the same continent.

(5) Ideally all broadcasting stations should have a carrier frequency separation commensurate with their power.

(6) If an alternative programme service is to be given, the sending stations should be located at the same point.

It is again emphasised that the above conclusions are based upon the fact that true service must be defined in terms of clear, good quality, invariable signals.

Some have argued that the space ray radiations do give a satisfactory service.

Writing in 1929 in a pamphlet published by the B.B.C. the author states—

"The argument that the indirect ray constitutes a service can be dismissed on two counts, first that it should not be necessary for listeners to tolerate so serious a technical imperfection as the periodic disappearance of broadcast programmes as coherent sound; and secondly, that since indirect rays only form at night this enormously limits service. Daylight broadcasting would seem essential in any community; in the highly developed industrial state for the night worker, the housewife, children; in the sparse agricultural populations for the housewife, whose leisure is more probable in the afternoon hours, and for educational work. There is the further question of the o'der people, children, and invalids, to all of whom broadcasting is more than a casual evening pastime."

Furthermore, in the same pamphlet, the writer made a calculation which shows that with a long-wave technique 83% of the area of Canada could be covered with true service broadcasting, whereas with a medium-wave technique only 7% of the area could be similarly served. It seems particularly relevant to call the reader's attention to the Australian problem, where there are vast tracts of thinly populated country and where

an Broadcasting Go Back ?

has aroused so much interest and radio traders as has the plan , M.I.E.E., F.I.R.E., for the develop- for Australian broadcasting. The s by which it will be placed into listeners throughout the Common- n the following extracts from his l report.

those living in the country come to rely upon wireless more than do those who live in towns. Long-wave technique could be of more service in Australia than almost anywhere else.

The conclusions relating to long-wave technique have received complete acceptance in Europe; in fact, there is not a single European administration which does not seek to use long waves for broadcasting.

WE shall now proceed to make a quantitative study of the existing system in Australia in terms of the percentages of populations served by "C" service or better conditions, and percentage of population able to receive alternative programmes in "C" service or better conditions. Thus, see Table II. and Table III.

TABLE II.

Percentage of Population Served by Existing "A" Class Stations.

LOCATION.	Call Sign.	Frequency.	Power in Aerial.	Population Served.	% of Total Population Served.
		Kc./Sec.	watts.	x 1000	Number.
Corowa	2CO	560	6000	25*	0.395
Hobart	7ZL	580	1800	59.5	0.92
Melbourne.	3AR	610	3000	1050.0	16.50
Melbourne.	3LO	800	3000	—	—
Crystal Brook	5CK	635	6000	25.0*	0.395
Sydney	2FC	665	3300	1183.0	18.70
Sydney	2BL	855	3000	—	—
Perth	6WF	690	3000	200.0	3.18
Adelaide	5CL	730	3000	346.0	5.45
Brisbane	4QG	760	3000	324.0	5.12
Rockhampton	4RK	920	2000	31.5	0.50
Newcastle	2NC	1245	2000	108.0	1.70
				TOTAL =	52.850

*Taken as more than population of Corowa and Crystal Brook themselves, and assessed from population map (see Fig. 6).

Method by Which Figures in Table II. and Table III. are Calculated.

An analysis of Table II. gives us:—

"A" Class Stations.

1. Average power in aerial of "A" class stations = 3.5 kw.
   Average power radiated = 2.8 kw. (approx.).
   ,, frequency = 825 kc./Sec.
   ,, wave-length = 364 metres.
   The calculated "C" service radius = 26 miles.

TABLE III.

Percentage of Population Served by Existing "B" Class Stations.

LOCATION.	Call Sign.	Frequency	Power in Aerial.	Population Served.	% of Total Population Served.
		kc./sec.	watts.	x 1000	
Melbourne	3UZ	930	300		
,,	3DB	1180	300	1100	17.0
,,	3KZ	1350	200		
,,	3AW	1450	300		
Sydney	2GB	960	1000		
,,	2UE	1025	300		
,,	2KY	1070	500	1250	19.3
,,	2UW	1125	900		
,,	2CH	1210	1000		
,,	2SM	1270	1000		
Perth	6PR	880	500	200	3.06
,,	6ML	1135	300		
Hobart	7HO	890	50	60	0.9
Brisbane	4BC	1195	600	320	5.0
,,	4BK	1200	200		
Adelaide	5DN	960	300	400	6.1
,,	5AD	1310	300		
Bendigo	3BO	970	200	34	0.5
Wagga	2WG	990	50	10	0.15
Toowoomba	4GR	1000	50	26	0.4
Hamilton	3HA	1025	200	5	0.08
Canberra	2CA	1050	50	2(?)	0.03
Swan Hill	3SH	1080	50	5(?)	0.08
Launceston	7LA	1100	200	30	0.46
Townsville	4TO	1170	200	31	0.48
Mackay	4MK	1190	100	9	0.19
Kalgoorlie	6KG	1220	100	5	0.09
Wangaratta	2WR	1260	50	4	0.062
Sale	3TR	1280	50	3	0.046
Ballarat	3BA	1300	50	43	0.66
Gunnedah	2MO	1330	50	3	0.046
Lismore	2XN	1340	50	10	0.15
Broken Hill	2XL	1365	50	24	0.37
Goulburn	2GN	1390	50	13	0.2
Geelong	3GL	1400	50	43	0.66
Wollongong	2WL	1435	50	9	0.14
Albury	2AY	1480	50	10	0.16
				TOTAL (say)	56.0

2. With two exceptions (marked * in table) the stations are located in or near towns and cities. The density of population in Australia is unexceptional in urban, but very small in rural areas. Thus, it is fair to assume that a 24-mile radius round the Australian urban areas in which the stations are

located includes all the urban population plus (say) 5%.

3. There has been no census since 1921, but the official Year Book of the Commonwealth of Australia gives populations as at 1928. Since we are dealing in percentages the information therein given appears to be accurate enough for this analysis. Thus the population served in C service area conditions by the "A" class stations is taken as the population in the towns, plus five per cent. There are two exceptions to this rule, viz., the stations at Corowa and Crystal Brook, which places are in themselves very small but which are the centres of relatively dense populations. In the case of Corowa and Crystal Brook we generously estimate a 25,000 population served.

"B" CLASS STATIONS.

An analysis of Table III. gives us:

1. Average power in aerial . . . = 0.3 kw.
   ,, power radiated . . . = 0.24 kw.
   ,, frequency . . . . . . = 1170 kc./Sec.
   ,, wave-length . . . . . = 256 metres.
   Then C service area radius with 0.24 kw. radiated . . . = 10 miles.
2. Thus, it is fair to assume that the "B" class stations serve the urban populations in the towns in which they are located.

Summary Table II. and Table III.

Thus, analysis shows that the "B" class stations serve about 3% more of the population that the "A" class because, while there are many more "B" than "A" class stations, they are located in small towns, and are, on the whole, less powerful. Only the urban population is served.

Extension of Present System.

Obviously, no one would dare to leave the country listener so badly served as he is to-day. Table IV. thus sets out a theoretical comparison of methods by which service to the country listener might be extended by the erection of regional stations, located in rural areas. A comparison is made between a medium-wave and long-wave technique.

Methods by Which Figures of Table IV. are Calculated.

1. **Number of Stations.** There are now about 50 stations in Australia. We might, at the expense of perfect quality, arrange in the whole wave-band, 200 to 550 metres, for 25 more stations than exist at present, giving an average minimum separation between stations of 15 kc.

   Assuming the long waves to live between 1000 and 2000 metres, the minimum separation is 12.5 kc., which, remembering there is less space ray interference, is justifiable.
2. **Power.** Stations at present erected for regional work have been given the approximate power of 5 kw. But, naturally, the greater the power the greater the service area. Thus, an example is given for a power of 100 kw. The scheme is detailed only to show the absurdity of medium-wave technique for regional stations—it would not be practicable both on account of the jamming it would cause, and the cost of upkeep of stations.
3. **Cost.** Assume—

TABLE V.
Cost of Stations.

Station power (Aerial).		Capital cost of station complete with buildings, power supply, masts, etc.		Revenue per annum for 10 years write off.
kw.		£ (Australian).		£ (Australian).
5	..	15,000	..	1,500
50	..	50,000	..	5,000
100	..	100,000	..	10,000

Personnel. 10 men per station (at average salary of £400 per annum).
Power. Assume total power taken from source as 8 times power in aerial. Assume 3000 hours working per annum. Assume cost of power as 1.5 per unit.

These costs are very approximate, are based largely upon the writer's experience in Britain, and are shown to indicate comparison and generalities, not as accurate estimates.

Land Lines. Assume lines 100 miles long, at rent of £1 per furlong per circuit per annum and 2 circuits.

4. **Area Covered.** For 5 kw. medium-wave stations use assumptions as shown page 45, para. 1, for calculation of service area of "A" and "B" class stations, i.e., conductivity = 0.5 x 10^{-13} c.g.s. units mean wave-length 300 metres, making C service area for 5 kw. about 20 miles.
   For High Power Medium-Wave Stations. Assume maximum possible service area limited by zone of intolerable fading and see calculations in writer's work, "Service Area of Broadcasting Stations," published by B.B.C.
   Long-Wave Stations. Assume average wave-length 1340 metres.
   Assume the total inhabited area of Australia as 1,500,000 square miles.

TABLE VI.
Summary of Statistics on Existing Service.

1.	% of population now served in C service or better conditions	= 56% (approx.)
2.	% of population now served in C service or better conditions with service of more than 5 alternative programmes	= 35% (approx.)
3.	% of population now served in C service or better conditions with service of alternative programmes	= 50% (approx.)

TABLE IV.
Methods to Extend System to Cover All Areas of Populated Australia. (Excluding Northern Territory.)

MEDIUM WAVES.							LONG WAVES.						
No. of Stations.		Power in Aerial.		Cost expressed as revenue per annum.		% of area covered in C service or better conditions.	No. of Stations.		Power in Aerial.		Cost expressed as revenue per annum.		% of area covered in C service or better conditions.
Number.		kw.		£ (Australian).		Number.	Number.		kw.		£ (Australian).		Number.
25	..	5	..	160,000	..	3	12	..	50	..	120,000	..	100
25	..	100	..	750,000	..	14							

TABLE VII.

Summary of Statistics on Comparison of Alternative Methods (Long-Wave or Medium-Wave Technique) to Extend C Service Conditions to Rural Areas.

Cost, with medium-waves and low power stations, to cover 3% of area to be covered	= £160,000 annum
Cost, with medium-waves and high power stations, to cover 14% of area to be covered	= £750.000 annum
Cost, with long-waves and medium power stations, to cover 100% of area to be covered	= £120,000 annum

(Note.— Costs not strictly accurate, but directly comparable.)

Analysis of Existing Method for Giving Alternative Programmes.

Although it is generously stated that approximately 50% of the population can get alternative programmes in C service areas or better conditions, the haphazard placing of stations does not, in fact, allow tens of thousands of listeners to pick out programmes clearly without interference from other stations.

Assuming that the selling price of every receiver has been increased by £2 on account of its extra and unnecessary complication to meet the conditions set up by the unplanned arrangement of stations, and, assuming that 500,000 sets have been sold during the years of the development of Australian broadcasting, we see that the public has had to spend, roughly, £1,000,000 more than was strictly necessary.

Thousands of people living in the shadow of a station can pick up only one programme whatever the design of their sets, and yet pay the same amount as those who can pick up two, or three, or more programmes.

Observations on the Technique of Transmission.

The writer has not yet had the opportunity to study the performance of existing transmitters quantitatively. Having listened to a few typical stations, it is fair to say that technique is variable, and that in very few cases does it equal, nor does it ever surpass, the best European practice.

The analysis set out shows clearly that the existing system could be improved, particularly in regard to the extension of service area and service for the country listener. The percentage of those served under good conditions of listening is smaller than the comparable figure for most European countries. In Britain, for example, practically 100% of the listeners get C service or better conditions of the service of one programme, and 85% get a C service or better conditions of listening to an alternative programme. The alternative programme can be selected without interference on the simplest sets.

A PLANNED SYSTEM FOR AUSTRALIAN BROADCASTING.

The Plan.—The essence of the proposed new plan for Australian broadcasting can be described in three sentences as:—

1. **To erect immediately six new long-wave regional stations and thereafter two more lower powered long-wave stations, so located as to give service in rural areas and in small towns in rural areas not now served by medium-wave stations.**
2. **To leave the existing medium-wave urban system untouched for the present, but to suggest a gradual change-over, whereby all "A" class and "B" class medium-wave transmitters would be located at the same geographical point, just outside the boundaries of densely populated areas.**
3. **Gradually to introduce the most modern transmitter technique in the change-over proposed in (2) and the new construction work as proposed in (1).**

Table VIII. sets out the salient points of the proposed Australian regional scheme.

Method for Calculating Figures in Table VIII.

An approximate survey has been made and a typical calculated attenuation curve, based upon the use of a 40 kw. station operating on 2000 metres, has been drawn up.

A resulting map of field contours is given in Fig. 8. In Fig. 9 these contours are drawn over a map, taken from Commonwealth Year Book of Australia, on which the density of population is also diagrammatically indicated. Each dot of Fig. 9 represents 5000 persons. Compare Fig. 6 with Fig. 9. It will be seen from the Table VIII. that the scheme, which will involve a maintenance cost of the order of £80,000 per annum, will give all but about 5% of the population of the Commonwealth C service or better conditions. The introduction of the scheme will thus raise the figure of 53% served by medium-wave stations to 95% served by medium plus proposed long-wave stations.

Recommendations as to the Existing Medium-Wave Stations.

The power, wave-length, technique, and geographical distribution of the medium-wave stations give, today, a much more satisfactory service to the urban than to the rural population, but, nevertheless, the system is far from ideal. Power is, on the whole, too

TABLE VIII.

Outline of Proposed Long-Wave Regional Scheme for Australia.

Proposed Location of Stations.		Proposed Wave-length.	Frequency.	Proposed Power.	Estimated Maintenance Cost.	% of Australian population outside C Service Area or better.	Remarks.
State.	Township.	Metres.	kc./sec.	Kw.	£ per an.	Number	
New South Wales	Bathurst	2,000	150	50	17,500		
	Armidale	1,540	195	5	7,500		Not to be built at once
Victoria	Seymour	1,250	240	12	10,000		
	Hamilton	1,050	285	5	7,500	about 5%	Not to be built at once
Queensland	Toowoomba	1,430	210	12	10,000		
South Australia	Crystal Brook	1,666	180	12	10,000		
Western Australia	Meredin	1,100	270	12	10,000		
Tasmania	Parattah	1,000	300	5	7,500		
				Total	£80,000		

small to overcome the interferences notably present in urban areas and created by electrical machinery. The wave-length distribution appears somewhat haphazard, but suffices. The technique would seem to be uneven, and could, in the writer's opinion, be improved.

The siting of the stations in the cities obeys no coherent plan and results, as has been said before, in forcing unnecessary selectivity problems before the receiver designer, and militates against a complete freedom of choice of programme for the average listener.

The writer, therefore, recommends a gradual change-over from the present system to an arrangement in which the present medium-wave transmitters are of higher power, more modern design, and are all located at one geographical point. This point will be on the boundary of the densely populated area to be served by these stations.

If the stations are all located at one point, there will be a substantial reduction in the overhead costs of working them, but the chief reason which recommends the scheme is that **every listener will get an equal strength of signal and proper frequency separation between different stations.**

If the obsolescent high power modulation system is abandoned there will be an improvement in the quality of reproduction in the average receiver.

Objections to the Proposed Scheme.

If the foregoing analysis is correct, and assuming it it possible to pay for the running of these stations, there seems no reason to make any further recommendations for the scheme, but, for the sake of emphasis, it has been considered advisable to tabulate what appear to be, to the author, reasons why the scheme should be proceeded with, as answers to possible objections, thus:

1. Objection that the cost is too great.

If the service is to be extended to the country districts, then the long-wave technique has proved to be the most economical method for so doing.

It is not necessary to put the whole scheme into operation at once.

It is not unfair to suggest that the cost of the scheme, when it is ready to be put into operation, can be reckoned in terms of 400,000 paying license-holders. The B.B.C. spends one-third of its revenue upon its technical service, and serves 100% of the population. In Australia the Postmaster-General takes one-third of the license fee and gives a service to about 50% of the population. We can thus fairly assume a revenue for the future around £160,000 per annum. This must suffice for the running of ten medium-wave stations because one* will be substituted by new long-wave stations, and one† is unnecessary. Assuming that the medium-wave stations cost £50,000 per annum and the studios £20,000 per annum to run there would be a surplus of the order of £90,000 per annum. Thus the revenue available for technique seems sufficient to cover the extra cost of the long-wave scheme even if all the stations were erected. We can sum up the reply to this objection as:—

(a) The scheme is not unduly extravagant.

(b) That in any case it can be built up gradually.

2. Objection that the introduction of long-wave technique will seriously affect the design of receiving sets.

It seems possible to dispose of this difficulty by reminding the reader that all European sets are designed for double wave-length working, and that the prices of European sets are not greater than that of sets made elsewhere under similar conditions.

Moreover, the Australian medium-wave receivers will still be suitable for urban use. It is suggested that the rural listener, as soon as the new scheme is put into operation, will create a demand for the new type of receiver which can thus gradually be met.

It is understood that there is in Australia a practical prohibition on the importation of foreign-made sets. Long-wave technique automatically prohibits the importation of American sets. The British industry has thus enormously benefited by the B.B.C.'s adoption of a long-wave technique of transmission.

3. Objection that the rural listener is satisfied with the present service.

If this is so, it would seem to constitute a serious criticism of Australian programmes. It would mean that the occasional disappearance of the wireless entertainment, as coherent sound, does not worry the rural listener. It would mean, furthermore, that the rural listener is not interested in any daylight programme. And it has been proposed to erect more medium-wave stations!

4. Objection that the moving of the "B" class transmitters from their present location to a point outside the cities or towns will prevent those at present operating these stations from controlling their programmes.

This need not be so. The "B" class station owner is only asked to move his property to another location. He would still have complete control over programme and over the transmitter, and he could locate his studio where he wished. The proposed arrangement would give every "B" class owner a larger audience, and would give the listener a better service, purer quality, and a simpler receiver. A similar technical scheme in Britain is remarkably successful.

5. Objection that listeners who live under the shadow of a proposed high power long-wave station will only get the programmes sent out from that station.

The number of persons so affected is extremely small. If one is ten miles from the station he will not have any difficulty in eliminating that station's programme and picking up alternatives. It must be remembered that there is at least a 200 kilocycle frequency separation between the shortest long and longest medium wave.

6. Objection that atmospherics are worse on long than on medium waves.

The writer's impression is that the difference of atmospheric level is small. In any case the A service area of a station using an average long-wave would be nearly twice the C service area of a station using an average medium-wave. So the atmospheric level would have to be five or six times greater with long-waves to make this objection count seriously. Atmospherics are not present every hour of every day of every year!

The proposed long-wave regional station scheme would not need recommendation in Europe, where every nation clamours for the possession of a means to give the whole population of their country a good broadcasting service. Australia is particularly happily situated in that she can at once use the long waves without fear that they will interfere with or be interfered with by the stations belonging to other nations. Thus, a chance exists to give the isolated Australian inhabitant a true service of broadcasting which he has not so far enjoyed.

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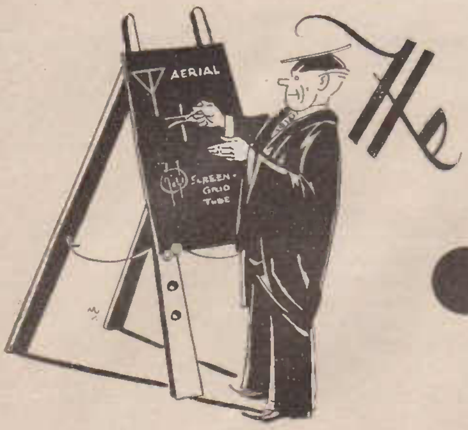
*Crystal Brook. †Corowa.



The THREE "R's" of RADIO

AT the the receiving station, the radio waves in the air are separated, amplified, and made to reproduce as faithfully as possible the original programme from the radio station it is desired to receive. It will be remembered from the previous lesson that the modulated high frequency current, flowing in the antenna circuit of the broadcasting stations sets up an electro-static, and an associated electro-magnetic field, which travels outward in space in all directions at about 186,000 miles, or 300 million metres, per second.

As the fields spread out continuously over a larger and larger area, their intensity decreases as the distance from the station increases. When they reach a receiving antenna, or aerial of the common type, consisting of one or more elevated wires, the electro-statics field sets up an alternating voltage between the wires and the ground. If the circuit between the antenna and ground is complete, this E.M.F. causes a current of the same frequency as that of the broadcasting station to flow, the strength of the current being determined by the impedance of the circuit.

Of course, as the radio waves spread out in all directions from the transmitting station, their strength naturally decreases. At twice the distance their amplitude is halved, at four times the distance it is only one quarter. The strength is inversely proportional to the distance. There is also a decrease in strength, due to the fact that whenever the waves strike any object in which they can produce electric current (such as the steel framework of a building), currents are produced at the expense of the energy of the waves and heat up, to a minute degree, the material in which they flow. This dissipation of energy acts simultaneously with the inverse distance effect to reduce the strength of the waves and the signals received, as the distance from the transmitter increases.

The latter effect is especially great around large cities, and is one of the reasons for poor "distance" reception in these cities.

The current, however, is practically an exact duplicate, as regards wave form, of that sent out from the broadcasting station. It is possible, by means of certain apparatus, to convert this current back into sound waves similar to those put into the microphone at the studio.

It may be said that with the ordinary aerial system at the receiving station, the potential is produced by the sweeping action of the moving electrostatic field on the exposed aerial and ground, as the intensity of the impinging lines of force varies and changes in direction, at the same time frequency as the waves. The aerial and ground really form a condenser, having the aerial wire as one plate, the ground as the other plate, and the air between them as a dielectric. This is a complete circuit and an alternating current will flow in it when an alternating voltage is introduced. (Fig. 25.)

If a loop aerial is used at the receiving station, the current set up is due practically entirely to the action of the electro-magnetic field. This will be discussed in greater detail when explaining loop aerials. The object of the receiving apparatus is to amplify and convert the aerial current into corresponding sound waves.

The Fourth Lesson of Alfred Ghiradi's Radio Course for beginners deals with the principles of Detection.

Headphones and Their Uses.

In the ordinary telephone, the current is changed into sound by means of the telephone receiver. The same type of instrument, modified slightly, can be used for radio reception. It is commonly known as the headset, or earphones. Earphones, like the ordinary telephone receiver, operate on the electro-magnetic principle. However, they are made much more sensitive than those used in telephone work, as the radio currents are usually much weaker than those encountered in telephone work, and, therefore, cannot exert much force.

They usually consist of two separate earpieces connected in series, and held to the ears by a metal headband. Each earpiece has a metal or hard rubber cup, with a hard rubber cap. In the bottom of the cup is a strong permanent horseshoe magnet, with pole pieces. Around each pole piece, a coil of many thousands of turns of fine insulated wire (No. 40 to 50) is wound. The two coils are connected in series, so the current passes through both windings. Sensitive headsets have 10,000 or more turns of wire on the coils, so that even very feeble current flowing through them produces an appreciable magnetic field. Suspended above the pole pieces, and very close to them, is a thin, flexible, soft iron diaphragm, about .004 inch thick. When no current flows through the coil, the magnetism of the permanent magnet attracts the iron diaphragm, and bends it slightly, producing an initial deflection. Assume the left-hand pole piece to be a north pole, and the right-hand one a south pole. If one complete wave of an alternating current is flowing through the receiver, so that the current during the first half of the wave flows through the coils in such a direction as to produce magnet poles similar to those of the magnets, then this magnetism adds to that of magnets, and the field is strengthened. This increases the attraction on the diaphragm, and pulls it down further to point B.

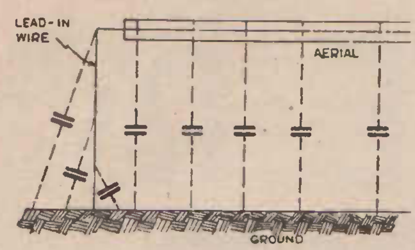


Fig. 25. The condenser effect existing between aerial and earth.

On the next half wave, the direction of the current reverses, and so the magnetic field produced by its flow through the coil also reverses, and opposes that of the permanent magnet. The resultant field is now weaker than that of the magnet alone, so the diaphragm springs back. At the end of the cycle it goes back to its original position, C. This back-and-forth movement of the diaphragm sets the air in motion, and creates sound waves that travel out through the opening in the cap.

If the frequency of these waves lies within the audible range—about 15 to 20,000 cycles—they can be heard by the human ear. At first thought it might seem that the currents set up in the aerial circuit could be changed into sound waves directly by connecting a pair of earphones in it, as shown in Fig. 27. This would not work, as is evident from the following considerations:

In order to transmit the broadcast programmes over a considerable distance, it has been found necessary to use carrier currents of high frequencies, because they are capable of being radiated into space. They are modulated by the currents of voice frequency. The carrier current frequencies used in most broadcasting at the present time range from 1,500,000 to 500,000 cycles, corresponding to 200 to 600 metres, respectively. The range of frequencies to which the ordinary human ear will respond is from 16 to 20,000 cycles. Therefore, even if the high frequency current received by the aerial could be made to flow through the earphones, and the diaphragm made a complete vibration for each cycle, it would be vibrating so rapidly that the ear would not respond to it. Actually, it is impossible for the diaphragm, which is not perfectly flexible, and has some inertia, to vibrate this fast. And lastly, the magnet coils of the earphones, having a necessarily large inductance, due to the great number of turns of wire wound on an iron core, offer a very high impedance-opposition to the current flow (to currents of such high frequency); so that practically no current at such high frequencies is able to flow through them anyway. A set of earphones having a direct current resistance of 2000 ohms may have an impedance as great as four or five thousand ohms at a frequency of only 1000 cycles. It is evident from these considerations that the circuit shown in Fig. 27 is impracticable.

The Rectification Problem.

To make the signal audible, and the voice currents heard, the circuit must be arranged so the diaphragm does not follow the current variations in

Fig. 27 shows the supposititious connection of headphones in a radio circuit.

each individual cycle of the carrier wave, since this is a high frequency, and we are not interested in hearing it. The diaphragm must be made to follow the variations in the maximum strength of the current in one direction—i.e., follow the wave form or envelope of the high frequency current, Fig. 28a. This, it will be remembered, is the true wave form of the voice waves. To do this, it is necessary to make only one or the other half of the alternations effective, so the current flows through the earphone coils in one direction only. This is accomplished by the detector, and the process of cutting off or eliminating half of the received wave is called rectification or detection.

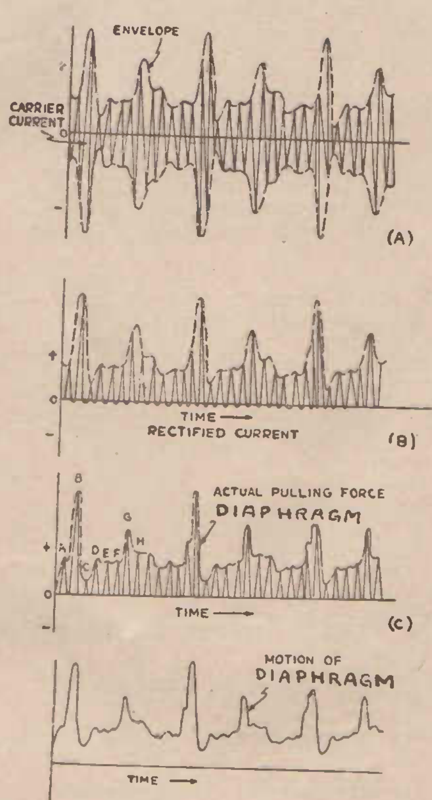
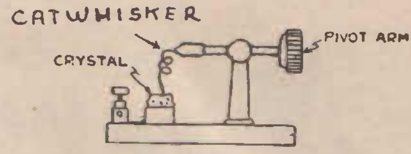


Fig. 28. The motions through which the diaphragm passes during reception of signals.



A diagrammatic view of a crystal detector. Fig. 29.

The simplest rectifier is the common crystal detector, Fig. 29. This usually consists of a very fine wire called a catswhisker, making light contact with a crystal of a particular mineral, such as galena. Other mineral combinations can be used, but for our purpose of explanation the galena detector will suffice. When an alternating voltage is applied to the combination, it tends to make current flow from the catswhisker to the crystal (Fig. 29) during the first half cycle. The resistance which the crystal and contact offer to current flow in this direction is low, so the current is able to flow through easily. On the next half cycle the voltage is reversed, and tends to send current in the opposite direction. The detector contact offers a very high resistance to current flow in this direction, so very little current is allowed through. The action is repeated for each cycle. This is shown graphically in Fig. 29 and B, where A is the impressed alternating current, and B is the rectified pulsating current. Notice that practically all of the current in the direction represented below the axis line has been eliminated, and that which does net through, flowing from catswhisker to crystal, consists of a series of pulses of current of varying amplitude.

It is the difference in strength of these two currents which determine how well or how poorly the crystal operates as a detector. A good crystal will eliminate the current in one direction practically entirely. The pulses of fluctuations of current would still seem to be too rapid to actuate the diaphragm, since their frequency is that of the carrier current. Their effect on the receiver diaphragm, however, is for each wave train to give force by successive addition, as can be seen from the following: The first impulse, A, Fig. 28c, passes through the earphone coils and produces a movement of the diaphragm. If the station is transmitting at, say, 200 metres, corresponding to a frequency of 1,500,000 cycles per second, the time interval between two successive maximum values of current as A and B is one 1,500,000th second. Obviously, since the diaphragm has inertia and stiffness, it is somewhat sluggish in action, and cannot possibly make a complete vibration in this time, so the second impulse, B, will occur before the diaphragm has had time to spring back in place, and will, therefore, deflect it further. So will the following impulses: C, D, E, etc., the result being that the diaphragm is deflected once for every wave train, and its motion follows more or less faithfully the shape of the envelope of the carrier current, as shown in Fig. 28C.

Since this is the same shape as the wave form of the sound impressed at the broadcasting station, the movement of the diaphragm sets up similar sound waves, which can be heard by the listener at the receiving station. The changing of the electric currents induced in the aerial into corresponding sound waves is accomplished in this way.

Crystal detectors are not used much now, having been supplanted almost entirely by the valve detector. Fig. 31a represents one of the simplest basic receiving circuits.

The volume, and frequently the quality, of the sound in the receivers is improved by connecting a small fixed condenser, C, of about .0005 mfd. capacity across them, as shown in Fig. 31a. The operation is then as follows: For the duration of one impulse, A, of the rectified current of Figs. 28C and 31B, the current flows through the earphone coils, and also charges the condenser, C. During the next half cycle no current flows through the detector, D. At this instance the condenser, C, however, being connected across the 'phone coils, and having an electric charge on it, partially discharges through them.

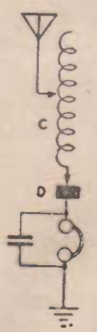


Fig. 32 shows how a receiving circuit is tuned by the inclusion of an inductance.

The discharged current of the condenser is in the same direction as that of the impulse A. This acts to keep the diaphragm in position until the next impulse, B, comes along. The current flowing in the telephone receiver is then like that shown in the somewhat enlarged and exaggerated drawing in Fig. 31b. There is, then, during each wave train a more continuous attraction on the earphone diaphragm, with resulting improved reproduction, since the diaphragm follows more nearly the outside curve or envelope of the current. In most modern earphones there is some capacity existing between the individual turns of wire on the coils, and the usual five foot external connection leads being close together also form a condenser. This combined capacity is usually enough to give the above action, so that no additional condenser, C, is required. In diagrams in future lessons, the condensers will be omitted, although the reader should remember that a capacity really does exist.

It is evident that the circuit of Fig. 31a will respond to waves from any station, provided enough current is induced in the antenna circuit by these waves to operate the phones. This suggests at once the two important shortcomings of this arrangement. Since it will respond only to waves of comparatively great strength its receiving range is limited to five to 25 miles, depending on local conditions. These facts make it evident that if programmes from distant stations are to be heard, some form of amplifying device must be employed to strengthen the currents induced in the antenna circuit. This will be considered later.

Selectivity and How it is Acquired.

Since it is desired to hear only one station at a time, some provision must also be made for selecting the programme of any one station to the exclusion of all others. This is accomplished by having all the stations in the same locality operate with carrier currents of different frequencies or wave lengths. In order to select the station desired, and exclude all others which may be transmitting at the time, some means must be provided for excluding the induced currents of the frequencies of the unwanted stations, and at the same time to allow the currents of the frequency of the receiving apparatus. The ability of a receiving set to do this satisfactorily is a measure of its selectivity. This is called tuning, and the process is commonly spoken of as "tuning in a station." Practically all tuning in radio sets at the present time is accomplished by making use of the resonance effect of alternating currents explained in Lesson 2, to reduce the impedance of the circuit to a minimum for the particular frequency which is to be received.

The circuit of Fig. 31a can be roughly tuned to any frequency by the introduction of an inductance coil, C (Fig. 32), consisting of a number of turns of insulated wire wound on a cylindrical form. A sliding contact is arranged to make connection with any number of turns of the coil. The inductance is increased or decreased by increasing or decreasing the number of turns respectively. By moving the slider, more or less inductance can be inserted in series with the aerial, thereby changing the frequency to which the circuit will respond most strongly, and the station it will receive. This receiver is not selective enough for present-

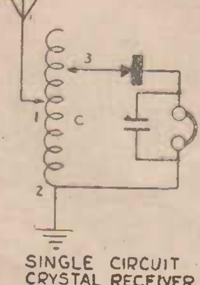
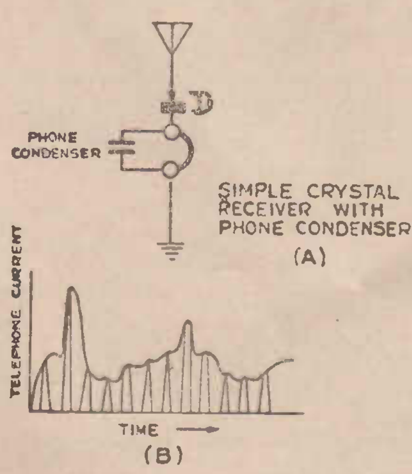


Fig. 33 illustrates one method of sharpening the tuning of a crystal set.



Figs. 31a and 31b illustrate the effect of connecting a condenser in parallel with the headphones.

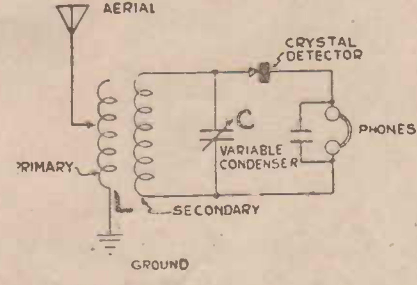


Fig. 34.—An even more selective arrangement, which is known as a "loosely coupled" circuit.

day use. Since the crystal detector and phones have a high resistance, and they are in the path of the aerial circuit, the tuning is very broad, and the volume is small. The tuning can be sharpened considerably by removing the detector and 'phone resistance from the aerial circuit, and putting them in a circuit by themselves, as in Fig. 33.

Coil C has two sliding contacts. The aerial circuit includes all the turns of wire between 1 and 2, while the secondary circuit containing the crystal detector and receivers, includes the turns between 2 and 3. It is thus possible to tune both the aerial and secondary circuits to the proper frequency. This is known as the single circuit receiver. The single circuit crystal receiver is not usually selective enough in congested districts, where many stations are operating at once on frequencies which are close together.

As will be explained later, in order to get a maximum response and maximum selectivity, it is important to keep the resistance of the aerial and tuned circuits to a minimum, provided this does not have an unsatisfactory effect on the receiver as a whole in some other way. To do this with a crystal receiver, the crystal receiver and 'phones are placed in a secondary tuned circuit, coupled in some way to the aerial circuit, the latter responding to the maximum degree to the incoming signals.

Such a circuit is shown in Fig. 34, and is known as a two circuit receiver. The primary and secondary coils of the inductance, L, are wound near each other (usually on the same form), so that the magnetic fields produced by the antenna current flowing through the primary coil links and unlinks with the turns of wire of the secondary, and induces a similar current in it. The variable condenser, C, connected across the secondary coil, tunes the coil and produces resonance in the circuit. This makes the passage of the infinitesimally small currents as easy as possible, thus greatly increasing the current in the tuned circuit, LC.

This sets up the largest possible potential differences across the coil and condenser, and, since these are applied to the detector and earphones, causes an increase in volume over that produced if the circuit were not tuned. The primary circuit can be tuned independently by the taps, which vary the number of turns included in the aerial ground circuit. By varying the taps and the settings of the variable condenser, the circuit will respond to any desired frequency within the range for which the coil and condenser have been designed.

The Carborundum Detector.

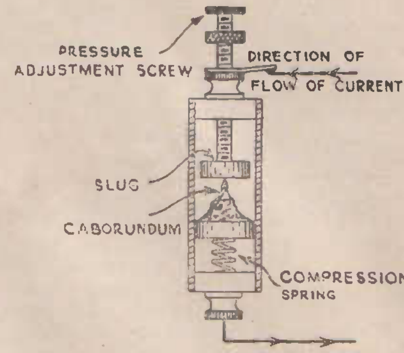
The carborundum crystal detector has become very popular as a rectifier, due to its very stable operating characteristics.

Fig. 35 shows a view of a commercial form of carborundum detector cut open to expose the various parts. It consists of a crystal of carborundum held in contact with a slug of metal under a pressure of about five pounds by a compression spring. The pressure may be regulated for best operation by the pressure of adjusting screw, which comes out at one end. The entire unit is enclosed in an insulated protective casing. This combination offers a very low resistance to the flow of current from slug to crystal, but presents a very high resistance to current flow from crystal to slug, thus acting as a detector or "rectifier." Fig. 36 shows two practical circuits for a carborundum detector. In 36a the rectifier is placed across the entire tuned circuit. In 36b the rectifier is placed across only a portion of the circuit.

The arrangement in 36b is preferable, as it gives much better selectivity with very little loss in efficiency, when the tap is properly located. A very cheap and efficient crystal set for earphone reception can be constructed from the circuit diagram in Fig. 37. The primary coil, P, consists of a total of 32 turns of 28 gauge B and S double silk or cotton covered copper wire wound in a single layer on a tube 4 inches long and 2 inches in outside diameter. The coil is tapped at 2, 4, 8, and 16 turns. In winding the coil twists should be made for each turn from which taps are made, so as to make connections to the taps easily. The secondary coil consists of 90 turns of 28 gauge d.c.c. wire wound in a single layer on the tube next to the primary and separated from it by 1-8th inch. A tap is made at the 20th and 45th turns. The tap which gives best volume consistent with good selectivity should be used. An aerial from 75 to 100 feet long should be employed. Tuning is accomplished by the .00035 mfd. variable condenser. The 'phones are by-passed by a .001 mfd. fixed condenser. The carborundum crystal should be connected as shown. Adjustment for best selectivity can be made by operating the set with the ground connected to the various taps by the primary coil in turn.

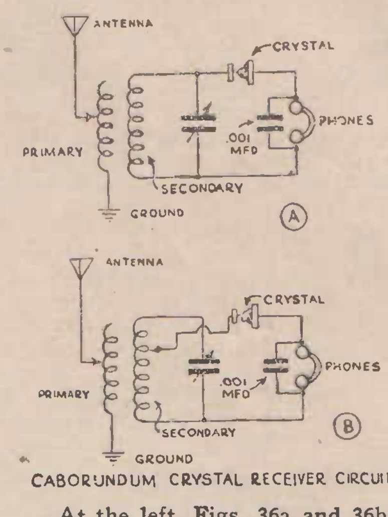
Checking Detector Efficiency.

The operating characteristics of crystal detectors can be determined easily by the arrangement shown in Fig. 38. The battery is single 1½ volt dry cell. The volt meter is a good low reading instrument, sufficient to register the voltage of the battery. The milliammeter has a range from 0 to 1 milliampere. The 200 ohms potentiometer, P, is used to apply any definite voltage to the cry-

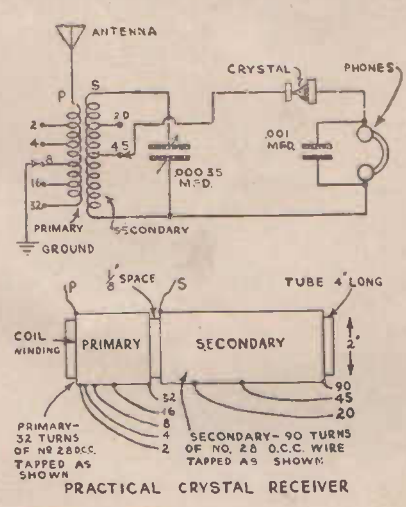


CARBORUNDUM CRYSTAL DETECTOR

Fig. 35 shows a sectional view of a carborundum detector.



CABORUNDUM CRYSTAL RECEIVER CIRCUITS



PRACTICAL CRYSTAL RECEIVER

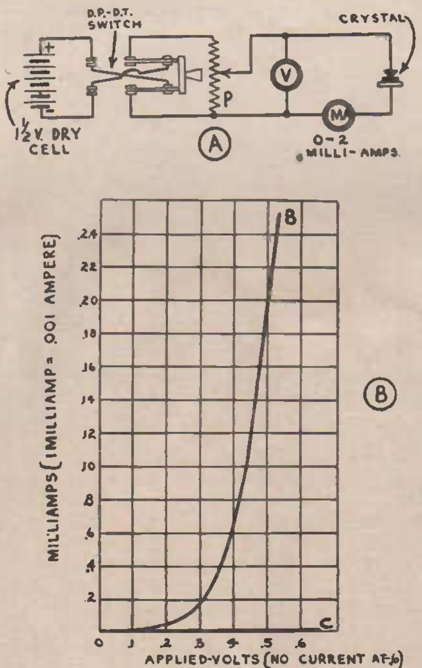
At the left, Figs. 36a and 36b show practical circuits for use with carborundum detector. The right-hand diagrams, Fig. 37, give constructional information on a cheap and simple crystal set.

stal. The milliammeter measures the current which the crystal allows to flow. The reversing switch, S, is used to apply either a positive or negative potential to the detector. The potentiometer is set for voltage steps of 0.1 volt, and the corresponding currents are read on the milliammeter.

This is done for both positive and negative voltages.

In Fig. 38b, a graph of current flow against applied voltage is shown for the carborundum crystal detector of Fig. 38. Curve A-B is for the e.m.f. in the positive direction (plus terminal to slug). Curve A-C is for the e.m.f. in the negative direction (plus terminal to crystals). Notice that practically no current flows through the crystal in this direction (unless the applied voltage is made quite high). This illustrates the rectifying properties of the crystal. Most crystal detectors can be roughly checked for rectification by connecting a dry cell (1½ volt) pair of 'phones and the detector in series.

A strong click should be heard when the detector is connected in one direction, and almost no click when reversed. This indicates that the detector rectifies properly.



Figs. 38a and 38b illustrate a practical method of deciding on the efficiency of a given detector.

Limitations of Crystal Sets.

This gives us a system of radio reception in which the volume of sound produced depends entirely on the strength of the received waves. Since the amount of energy decreases very rapidly as the distance from the transmitting station is increased, it is evident that simple crystal sets cannot be used for long-distance reception, because the received currents are not strong enough to operate the earphones. The use of earphones is becoming unpopular, as people desire to hear their programmes in comfort with loud speakers which produce enough volume to fill good-sized rooms.

Loud speakers require a stronger operating current than do ordinary earphones, so amplifiers have been developed for amplifying the received radio currents to make loud speaker operation possible. These employ valves in their operation. The crystal detector, while producing remarkable clarity of reception, is unable to handle either very weak or very strong impulses of current satisfactorily. Crystal detectors have been superseded almost entirely by valve detectors, due to their greater selectivity, ease of adjustment, and property of not only rectifying but amplifying at the same time. The rectifying ability of a crystal is an inherent property of the crystal and cannot usually be altered or improved. The point of best selectivity must be determined by trial by moving the catwhisker over the ssurface of the crystal.

In most cases, this point is never located. The adjustment is not permanent, and heavy currents such as those received from powerful nearby broadcasting stations may make the detector inoperative by setting up a comparatively great amount of heat at the contact point, thus oxidising the catwhisker and destroying the conducting properties. The use of the carborundum crystal detector eliminates the adjustment difficulties.

Some receivers have been devised for the use of a carborundum crystal detector with radio and audio frequency amplifiers employing vacuum tubes. Such hybrid receivers are capable of very fine performance if correctly designed.

THE Columbia Broadcasting System has adopted the Saturday evening for the broadcasting of most original lectures. Under the direction of a few scholars of the New York University, sounds are transmitted which arise when effecting scientific researches.

One of the tests consisted in broadcasting the voice of the planet "Venus." This was done by directing a telescope towards the planet, and by placing a photo-electric cell in front of the ocular; the cell caught the light beams radiated by the planet and changed them into electrical currents, which in their turn were converted into sounds. The voice of Venus appears to be in a high key, and produces the sound of the violin.

Moreover, sounds were transmitted, originating in light beams, which were reflected by various colours. On another occasion, sounds were transmitted, emanating from the breaking of various objects which were submerged into liquid air.

AN EXPERIMENTER'S SHORT WAVE RECEIVER.

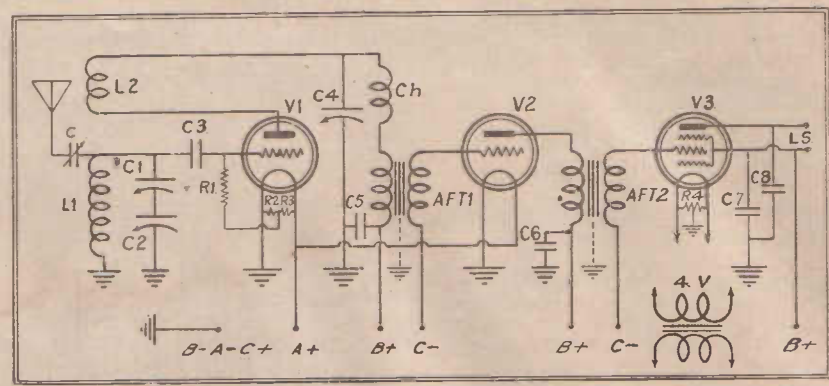
(Continued from page 13.)

For the best results always operate the reaction condenser with the moving plates about one-half or two-thirds of the way in. If operated with the plates almost right out—i.e., just near the minimum capacity—the change in capacity becomes very great, and the valve will go out of oscillation very suddenly with a plop which may result in a slight fringe howl.

When using coils A.B.C., etc., leave C1 at its maximum capacity and tune with C2. This will give a fairly wide range. If desired, however, C1 can be shorted out and tuning done directly with C2, which will now have a capacity of .00025, which will cover a much larger range. If, for example, we wish to listen for a while to stations on the 49 metre band, we plug in the special coil for that band. Now, with C1 and C2 again connected in series, we reduce the capacity of C1 until the plates are almost all out. The aerial coupling capacity and C1 must now be adjusted so that the band will come on and cover the dial of C2. A slight alteration of the capacities of C1 and C will cause the band to disappear off the dial. After having found the correct position of the condensers, it would be advisable to make a note of the dial reading for future reference. As the total capacity of C1 and C2 when arranged to just tune over the 49 metre band is about .000005 mfd., it is obvious that, even if there is a to-and-fro movement of the shaft in the condenser bearing, the effect is negligible, as the capacity variation is so small. If, on the other hand, this condenser was used alone as a .00025 mfd., any small movement would cause the receiver to swing off the station being received.

PARTS WHICH ARE NEEDED.

3 Variable Condensers, .00025 mfd. (C1, C2, C4).
1 Fixed Condenser, .0001 mfd. (C3).
2 By-pass Condensers, 2 mfd. (C5, C6).
1 Fixed Condenser, .001 mfd. (C8).
1 Fixed Condenser, 1 mfd. (C7).
1 Radio Frequency Choke (Ch).
1 Fixed Resistor, 10 megohm (R1).
1 Fixed Resistor, 160 ohms (R3).
1 Fixed Resistor, 440 ohms (R2).
1 Fixed Resistor, 50 ohms (R4).
2 Audio Frequency Transformers (AFT1 and AFT2).
4 UX Valve Sockets (V1, V2, V3, and coils).
2 Philips A415 Valves (V1, V2).
1 Philips B443 Valve (V3).
1 4V Filament Transformer.
1 Battery Switch (S1).



The schematic diagram of the receiver will place the experimenter in possession of full circuit details.

It will be a great advantage to use a straight line frequency condenser for the main tuning condenser, C2, so that the stations will be fairly well distributed over the 180 degrees of the tuning dial. Tuning is done with a vernier dial of good manufacture on the main tuning condenser, C2.

It is absolutely essential that a high-grade vernier dial be used. Some of the dials on the market to-day are quite all right for the first few months, but noise, backlash and slipping develop after a few months' use.

The aerial used is a single 66 ft. rubber-covered wire placed horizontally at a height of 20 ft. Great care should be taken to see that the aerial does not run very near and parallel to other wires. This will result in instability on a windy day, due to changing capacity between the two wires when they begin to swing.

The values of R2 and R3 will vary somewhat for different valves, so that the best way would be to use a potentiometer of about 500 ohms and adjust the moving arm until the best position is found. The value of the resistance on either side of the arm can then be measured and fixed resistors substituted. If the potentiometer is of good manufacture, it could be used instead of the fixed resistors, but in most cases noise soon develops.

The valves used are: A415 for the detector and first audio; B443 penthode as power valve in the last stage.

Coil Data.

Coils used when using a tuning capacity of .000125 mfd. are:—

Grid. No. Turns.	Reaction.	Wave-length. Metres.	Coil.
3	4	15-20	A
5	8	19-32	B
9	9	31-52	C
16	11	50-80	D

For the grid coil, L1, use No. 22 SWG, DSC; and for the reaction coil, L2, use No. 30 SWG, DSC.

When using the series condenser, C1, near its minimum capacity, the special coils required for the broadcast bands are as follows:—

Grid. No. Turns.	Reaction.	Wavelength. Metre Band.
19	12	49
12	9	31
7	7	25
4	5	19

Items of Interest

GROWTH OF RADIO IN ENGLAND.

POST Office figures show that 900,000 new licences were issued during 1931, and a statistical survey reveals that a total of 1,250,000 radio sets were sold during this period, 600,000 to new listeners, 650,000 as replacements. It is anticipated that 1,800,000 new sets will be sold in 1932. Of the 11 million homes, 4.3 million were equipped with radio at the end of 1931.

SMALLER AND BETTER CONDENSERS.

THE Bell Telephone Company announces a new method of making fixed condensers which are much smaller than present types. The reduction in size has been made possible by creating an assured and adequate source of paper of 0.4 mil thickness and by developing a better impregnating compound, chlorinated naphthalene, known commercially as halowax. The use of aluminium in place of tinfoil reduces the cost. After rolling two sheets of metal foil and four of paper, the unit is pressed into shape, dried in vacuum ovens and impregnated with the halowax.

TELEVISION ON ULTRA-SHORT WAVES.

IT is hoped that the u.s.w. broadcasting will commence in Berlin as a regular feature by June next, using directed waves (probably as regards limiting radiations near the vertical). Television is to be specially pushed, with 10,000 elements and 5:6 dimension of frame, corresponding to the normal film image—i.e., with 90 lines.

ALL ABOUT THE P.E. CELL.

(Continued from page 18.)

and television work. In sound film equipment the "sound track" on the edge of the film is passed between the light source or exciting lamp, as it is called, and the photo-electric cell. The light intensity passing through the film is varying continuously, and sets up corresponding variation in the P.E. current. In fact, it is through the photo-electric cell that sound film reproduction has been made possible. To operate the large speakers installed in the "talkie" theatres a large amount of power is required, and, therefore, it is necessary to pass the output from the P.E. cell through several stages of amplification until sufficient voltage is available to swing the grids of the power valves used in the final stage.

The photo-electric cells available to-day may be divided into two classes, vacuum and gas-filled. Generally speaking, the gas-filled types give greater sensitivity, and are used mainly for sound picture work. The sensitivity increases with the applied voltage, and so it follows that these cells operate at relatively high anode potentials. The time lag in the cell is higher than in the case of the "vacuum" types. The anode voltage is limited by the characteristics of the cell and the permissible tube noise level.

The Philips P.E. cell type 3531 is a gas-filled cell, and for this type of cell 220 volts may be considered as the maximum operating voltage, and care should be taken that the cell does not blue-glow if higher voltages are tried. The adjustment of the anode voltage is critical. With the vacuum cells the sensitivity is constant for all voltages above the saturation value, and this means that a lower operating voltage than is required for the gas-filled cells may be used. The photo-electric current also increases in proportion to the illumination. The time lag factor is much lower, and the vacuum cells are for this reason to be preferred for television apparatus. These cells are not critical so far as voltage adjustments are concerned.

Philips market two vacuum cells, types 3512 and 3513. This latter cell is of small construction, and resembles the 3531 in appearance. The 3512 is similar to the 3513 in general characteristics, but is made on a larger scale. The curves for these cells are shown in Fig. 4a and Fig. 4b.

The curves show the sensitivity in microamperes per lumen (uA/1m), plotted for various anode voltages at a constant degree of illumination. The average sensitivity for the 3531 is 20-30 uA/lm, and 18 uA/lm for the 2512/13 cells. The sensitivity for the vacuum types is particularly good when compared with the 3510, which was the original P.E. cell introduced here by Philips. The sensitivity figure for this older cell was only 3 uA/lm. In view of the high sensitivity of the new vacuum types, they may be used for talking picture work in place of the gas-filled type.

Earlier in this article reference was made to the fact that various substances were available for cathodes. For P.E. work it is important that the cell gives the greatest response to red light. The high sensitivity of the Philips cells is due to the special cathodes used. How the sensitivity to colour may be changed can be seen by referring to the table.

SUBSTANCE FOR CATHODE.	GREATEST SENSITIVITY.
Caesium	Ultra Violet Rays
Rubidium	Ultra Violet Rays
Sodium	Blue Light
Lithium	Green Light
Caesium & Calcium Flouride	Red Light

The cells 3531 and 3513 are so constructed that the metal base is the anode contact. The cathode is joined to a special terminal on the side of the bulb, to which is joined a short length of wire for connections. The diameter of the windows is 10 and 12 mm. respectively. The 3512 is fitted with a standard English valve base, and the anode is joined to the filament pins. Contact to the cathode is by means of the screw cap on top of the bulb. The diameter of the window is 20 mm.

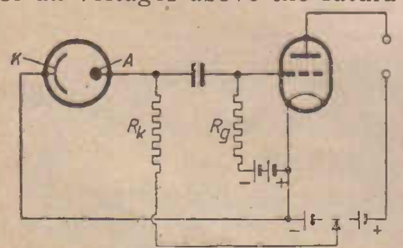


Fig. 3.

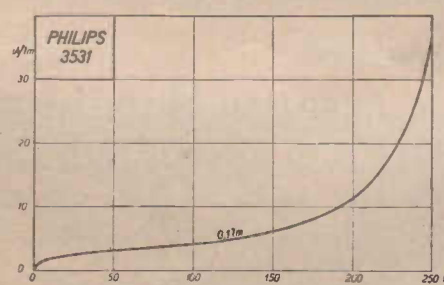


Fig. 4a.

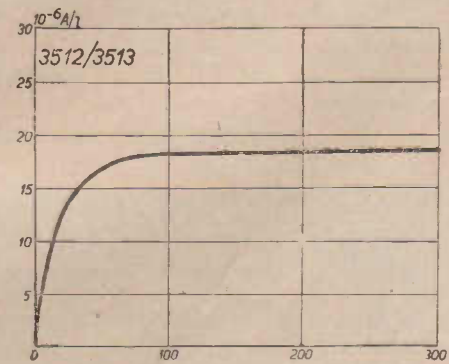


Fig. 4b.

4BH, BRISBANE.

(Continued from page 11.)

usual compensating network to preserve the audio quality, the lines are fitted with tuned rejector circuits to prevent interference from radiation from 4BH's aerial system.

The direct 'phone line, which also connects the studio with the transmitting station, provides an additional programme carrying line should this be necessary. In the studio the most up-to-date system of pilot light control keeps the announcers in constant touch with developments.

Stand-by Equipment.

The fine tone quality of 4BH is due in no small measure to the care which its engineers have taken to adjust every section of the transmitter and its associate audio equipment. During the first six months of the station's existence continuous tests were carried out with a view to improving the tone quality, the range, and the general efficiency of the transmitter. Line equalisers and stabilisers and a specially designed line amplifier were only a few of the improvements which were added to the equipment. The next move was to fit up the Bald Hills transmitting station with a turntable, a control amplifier, and a microphone, so that, in the unlikely event of a land line breakdown, the station would still be able to keep on the air.

As we indicated at the start of this article, 4BH is probably one of the best stations in the Commonwealth, and certainly, judging by the staff's correspondence with Queensland listeners, is the most listened to station in the northern State. The 600-watt aerial output on a frequency of 1380 kilocycles (217 metres) certainly knocks a hole in the ether, and it is no surprise to find that 4BH is the only station which is providing a reliable service in the far north of Queensland.

Heard in America.

Peculiarly enough, it has been found that the station "gets over" in the Gulf country, where the other Queensland stations apparently have the greatest difficulty in being heard. Talking of freak receptions, we believe that an American listener sent in an authentic programme report which he claims to have received on a two-valve receiver.

At the programme end similar care to that exercised by technicians on the transmitter itself is devoted to supplying the right kind of entertainment. The station is on the air daily, except Saturday and Sunday, at the following times:—7 to 8.30 a.m.; 11 a.m. to 2 p.m.; 5.45 to 10.30 p.m. The Saturday schedule starts with the first session, but eliminates the second, and continues the third until 11 p.m. The Sunday programme starts at noon and goes on until 2 p.m. The second session starts at 7 and closes at 10 p.m.

Commercially, 4BH gets over exceptionally well. A recent slogan competition conducted by a national advertiser resulted in 4BH heading the list of stations with the largest number of entries. Apart altogether from its commercial success, however, the management of 4BH deserve credit for their station, which is a shining example of how a good "B" class station should be built and operated.

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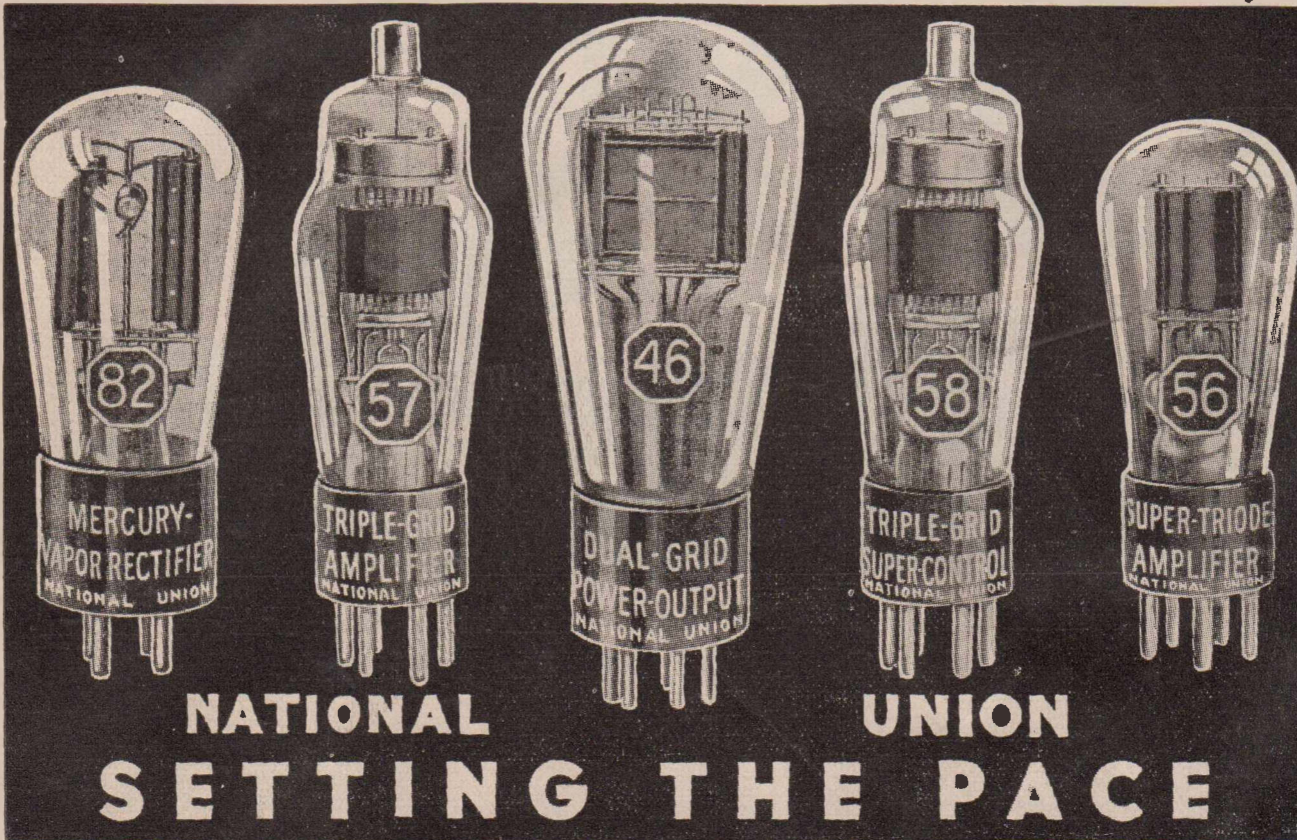

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My crystal receiver will not separate 3AW, 3DB, and 3KZ, even after the application of a wave trap. Do you think that the locality in which I live would influence this type of receiver, and if so, could you supply me with a circuit which would separate these stations in this locality?—B. J. Bailey (Prahran, Vic.).

In your locality, a very selective crystal receiver will be required to separate the above-mentioned stations. For a suitable circuit refer to the Radio Course in this issue.

* * *

I am desirous of building the "Mantel Three" described in "Modern Sets" 1932, but before doing so, I want to see what parts I now have that will be suitable for this circuit.—K. F. Scott (Prospect, S.A.).

The value of the voltage divider R3 is 12,000 ohms. R4 and R5 are each 30 ohms centre-tap resistors. Any high impedence coupling choke will be suitable for AFC. A suitable choke R.F.C. can be made by winding a ¾ in. former for a length of 3 in. with No. 30 S.W.G. D.C.C. wire.

* * *

I have constructed the "Mystery Short Wave A.C. 4," described in "Modern Sets" 1932, and found it most satisfactory. I am thinking seriously of buying a complete new set of valves as the ones in use at present have been in use for some time. What types would you advise?—J. B. Turner (Christchurch, N.Z.).

The most suitable types of valves to use in this receiver are: for the radio frequency stage, the S4V6 type; the detector, E442 type; the first audio, E415 type; the output, E406 type; and the rectifier, 280 type.

* * *

I purchased the 1932 edition of "Modern Sets" with the object of building up a small short wave set. I was particularly attracted by the "International Two," which should suit my requirements admirably. Before doing so, I would like to know the values of the following components, C1, C2, C3, C11, C4, C5, C9.—O. K. Neilson (Wellington, N.Z.).

C1 is the grid tuning condenser and has a capacity of .00015 mfd.; C2 is a 23 plate midget reaction condenser; C3 is a .0001 mfd. T.C.C. grid condenser; C4, a .5 mfd. by-pass condenser; C5, a .006 mfd. T.C.C. condenser: C9, a .01 mfd. T.C.C. condenser; C11, a 4 mfd. fixed condenser.

* * *

Is it possible to use a pickup with the Diamond All Wave Battery Two, if so, where would it be connected?—R.F.J. (Camberwell, Vic.).

Fig. 2 C gives the necessary circuit information. There are a number of ways in which a pickup can be connected, but for a small set, we suggest the method shown in the schematic diagram, where it is connected between the grid of the detector valve and earth. Various other methods are shown in Fig. 2, A, B, and D.

* * *

I am converting my two-valve resistance coupled receiver to choke coupling. Would you tell me if my circuit is correct? — C.R. (Lilydale, Vic.)

The method of choke coupling you suggest is incorrect. The audio frequency choke should be connected between the r.f. choke and the B+. The plate side of the audio frequency choke then connects to the .01 mfd., which in turn is connected to the grid of the second tube.

This Free Technical Information Service is Open to All "Modern Sets" Readers. When Forwarding Your Question Be Sure to Give Every Detail Possible Regarding the Type of Receiver, Make and Type of Valves and Speaker, and All Details Which You Consider May Help Us to Solve Your Trouble. Only in Special Circumstances Can We Answer Enquiries by Post.

Would you supply me with particulars and a circuit of a two-valve d.c. short-wave adaptor using a screen grid radio frequency valve followed by an ordinary three element detector.—G. Scott (South Yarra, Vic.).

The schematic diagram of a short-wave adaptor which will suit your requirements is shown in Fig. 1. L1 and L2 are the aerial and grid coils of the R.F. stage, L2 being tuned by a .00015 mfd. condenser C1. V1 is an A442 type screen grid tube, the screen grid is by-passed to earth by a .5 mfd. condenser C6. L3 and L4 are the grid and reaction coils of the detector stage, L3 is tuned by a .00015 mfd. condenser C2, C4 is a .0001 mfd. grid condenser and R1 a 10 megohm grid leak. R.F.C.1 and R.F.C.2 are standard radio frequency chokes. C3, a .00025 mfd. reaction condenser, and C5, a .5 mfd. blocking condenser. The detector valve V2 is of the A415 type. All coils are wound on valve bases, the necessary turns are shown in the table.

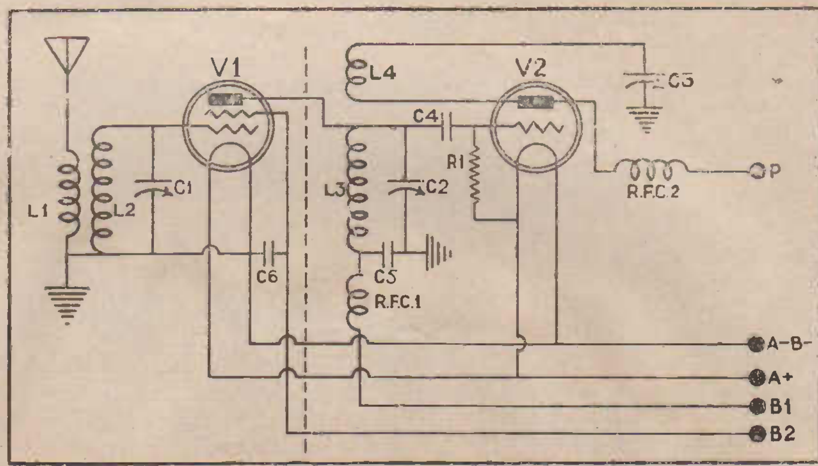


Fig. 1.—The schematic diagram which shows the circuit arrangements of the d.c. short wave adaptor.

COIL TURNS.

Aerial.	Grid.	T. Anode.	Reaction.	Wave.
2½	2½	2½	2½	9–15
3½	3½	3½	3½	14–20
5½	6½	5½	5½	19–30
6½	9½	8½	9½	28–50
12½	17½	15½	14½	45–90
15	95	95	30	200–390
15	195	195	30–40	320–550

During the last week or so I have been troubled with noises in the form of crackles, which interfere even with the local stations. Could you suggest where the trouble may be coming from? — "Battery User" (Preston, Vic.).

The first thing we suggest is to remove the aerial from the receiver; if the noise is not reduced the trouble is certainly in the set. Test both the A and B batteries as these are the first thing to suspect. If all these are o.k., you will probably find the trouble is due to broken down transformer primaries, or a faulty fixed condenser. Check up all the soldered connections, and make sure there are no "resin joints."

* * *

Recently I constructed a Direct-Coupled Two Valver using a C643 as power valve, and am wondering if it could be made to work as an all-wave receiver?—A.F. (Woodville, Vic.).

This receiver could be made to work on short waves by making the following alterations:—Connect a 5 plate midget condenser in series with the aerial, and break the connection between the fixed plates of the tuning condenser and the coil, and insert a .00025 mfd. fixed condenser. Special plug-in coils will also have to be constructed. For complete details refer to the Diamond All Wave Battery Two in the August issue.

* * *

I have built the All Australian Three and up to date, to a degree, it has proved very efficient. The trouble I find is that I cannot tune down to stations below about 300 metres. I have tried tapping the coils but this has not remedied the fault. Could you advise me in the matter?—H. P. Doyle (Wareek, Vic.).

The trouble you are experiencing is in the coils. Make sure the coil connections are correct, particularly those of L1 and L2. You may possibly have the aerial connected to the lower end of L1, which is joined to L2. If connections have been made in this way, the aerial would be directly coupled to L2, the result would be that the R.F. stage would not tune below 300 metres. Shorted turns in the grid windings will throw the wave range out considerably. Make sure that the r.f. primary is not shorting.

* * *

How can "C" bias be obtained on an A.C. receiver by the grid resistor method? Also, how can the value in ohms of bias resistors be calculated for any valve? — V.W. (Bondi, N.S.W.).

If you are using a transformer coupled audio frequency amplifier, connect the "C" minus terminal of the secondary of the transformer to one end of the bias resistor, and connect the remaining end of the resistor to earth. In the case where resistance coupling is employed, connect the grid return to earth in a similar manner. For the R.F. stages earth the cathode through the bias resistor. By-pass all audio bias resistors with a 4 mfd. condenser, and r.f. resistors

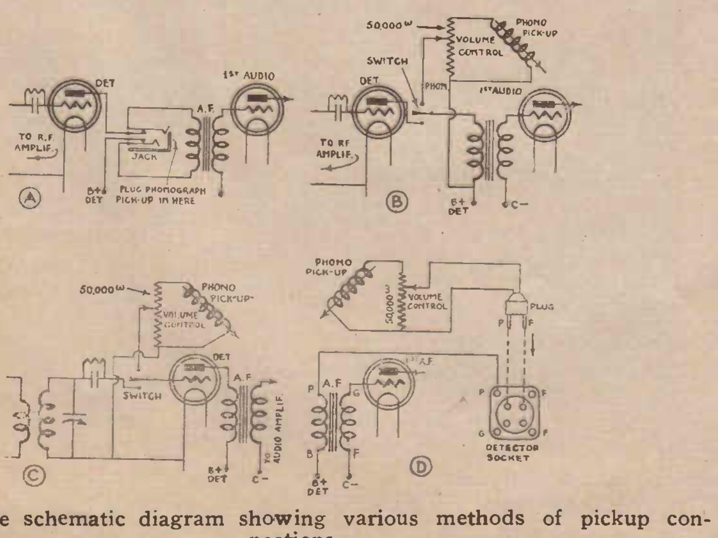


Fig. 2.—The schematic diagram showing various methods of pickup connections.

with a .25 mfd. condenser. The formula for calculating the value of all grid bias resistors in ohms equals. the required bias volts multiplied by 1000, divided by the plate current in milli-amps.

* * *

I have a three-valve short wave receiver, detector and two audios, which I have just constructed. When the detector comes into oscillation, a severe howl is heard at the most critical point. How can this trouble be overcome?—A. J. (Albert Park, Vic.).

This howl is very common in short-wave receivers, and is known as fringe howl. Fringe howl is principally caused by audio or radio frequency feed back, and in some cases due to a microphonic detector valve. All audio frequency currents should be by-passed to earth as soon as they pass through the primary of the transformer. Connect a 2 mfd. condenser between the B+ terminal of each transformer and earth. Between the B+ leg of the speaker and earth, connect another 2 mfd. condenser, and between the remaining leg and earth. connect a .001 mfd. condenser. If the howl is not totally eliminated, connect a 10,000 ohm decoupling resistor in each of the high tension leads to the transformer. If the valve is the trouble, the only thing to do would be to substitute.

* * *

What is the lowest wave at which a screen-grid or space-charge detector will oscillate?—C.J. (Richmond, Vic.).

This is around 15 metres, but will depend upon the individual tube.

* * *

Can an A.C. meter be used to measure direct current? — "Doubtful," (Ringwood, Vic.).

Yes, but not very accurately.

(Continued on page 47.)

THE IMPORTANCE OF A GOOD EARTH.

(Continued from page 10.)

separations. Taking the resistance of the earth connection as being 100 per cent. with a single rod, it is evident that 2 rods separated by 4 ft. will show only 65 per cent. as much resistance, while with 4 rods and the same separation the resistance will be down to about 37 per cent.

The benefits to be obtained by using a number of rods are markedly less if the separation is smaller than 4 ft., while the decrease in resistance is slow beyond that separation. We may, therefore, conclude that rods in multiple should be not less than 4 ft. apart. and that a greater separation is slightly more desirable.

The effect of the soil on the earth resistance depends upon the type of soil, and cannot very well be predicted. The resistance of the connection can be measured if suitable instruments are available, but few experimenters are so equipped. Naturally-moist soil probably has the least resistance. The resistance of any earth connection can be reduced by soil treatment, although treatment usually gives comparatively better results in high-resistance soil. For example, an earth connection which shows a resistance of 30 ohms in low-resistance soil may be improved 50 per cent. by treatment; on the other hand, the same treatment may reduce a resistance of the order of 1000 ohms by 90 per cent.

Fig. 5 shows the method which has proved to be most effective in treating soil to reduce resistance. A shallow trench is dug around the earth rod about 18 inches from it, and the treating material poured in, after which the trench is covered with earth. The chemicals used chiefly are magnesium sulphate, common rock salt and copper sulphate. The salt crystals should be placed in the trench—the salt should not be dissolved in water before being used—after which the trench may be flooded with water.

Normal rainfall will furnish enough water for carrying the cystals in solution into the earth. The solution seeps downward through the soil around the electrode, thus taking the most effective position for reducing the resistance.

Fifty pounds of crystals placed at the top of the soil in this fashion will have an effective life of two to three years for the first treatment. Subsequent treatments show longer life than this.

The resistance measurements which form the basis for this discussion were made with direct current, and it should be realised that the r.f. resistance of the earth may be quite different from the d.c. resistance. It seems logical to suppose, however, that the benefits obtained by these methods would be applicable to radio frequency.

A BATTERY OPERATED P.A. AMPLIFIER.

(Continued from page 15.)

A minus pin on UX base to A battery negative lead.

G pin on UX base to A battery positive lead.

G pin on UY base to B battery positive lead.

F2 pin on UY base to B battery negative lead.

F1 pin on UY base to centre tap lead on dynamic speaker transformer.

P pin on UY base to one outside lead on dynamic speaker transformer.

C pin on UY base to other outside lead on dynamic speaker transformer.

To operate the amplifier at full output we shall need 4 45-volt "B" battery blocks, giving a total of 180 volts less the drop in the "C" bias resistance, R1. The "A" battery supply may be furnished by either a 4-volt accumulator or, for short period work, by three 1½-volt dry cells.

The loud speaker may be any high-grade dynamic speaker, but we suggest either of the new Rola or Amplion permanent magnet dynamic speakers, because these require no field supply. Actually the original receiver was tested out on a Rola speaker provided with a specially-matched input transformer.

The results, whether judged from the viewpoint of tone quality or output, were excellent, although it was found that a compensating "pad," consisting of a .01 mfd. mica condenser connected in series with a 10,000 ohm resistance, the resulting combination being connected from the plate of V2 to the plate of V3, improved the tone considerably.

The amplifier can be specially recommended to the countryman who requires a reasonably economical public address amplifier for dance hall work, or to the owner of a battery-operated receiver who is able to get his plate power from the d.c. mains.

All the material for the original receiver was made available to us through the courtesy of Messrs. A. Veall. Geo. White and Co. were responsible for the aluminium chassis.

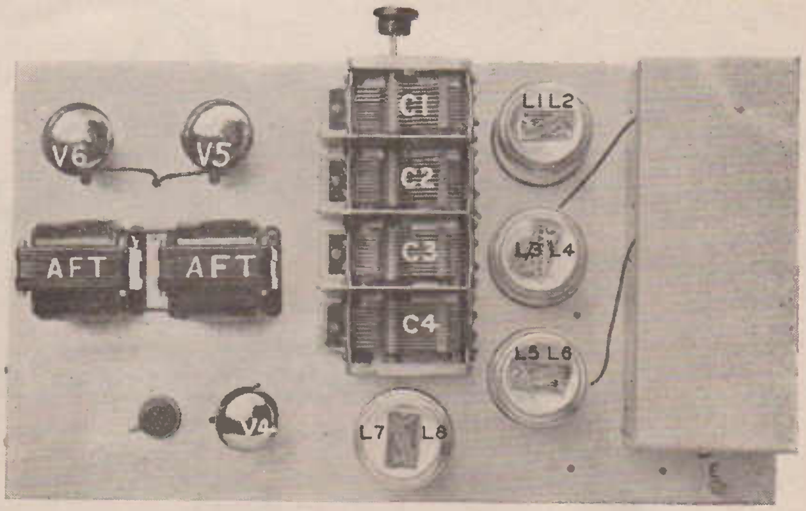
THE SCREEN GRID SUPER 6.

(Continued from page 9.)

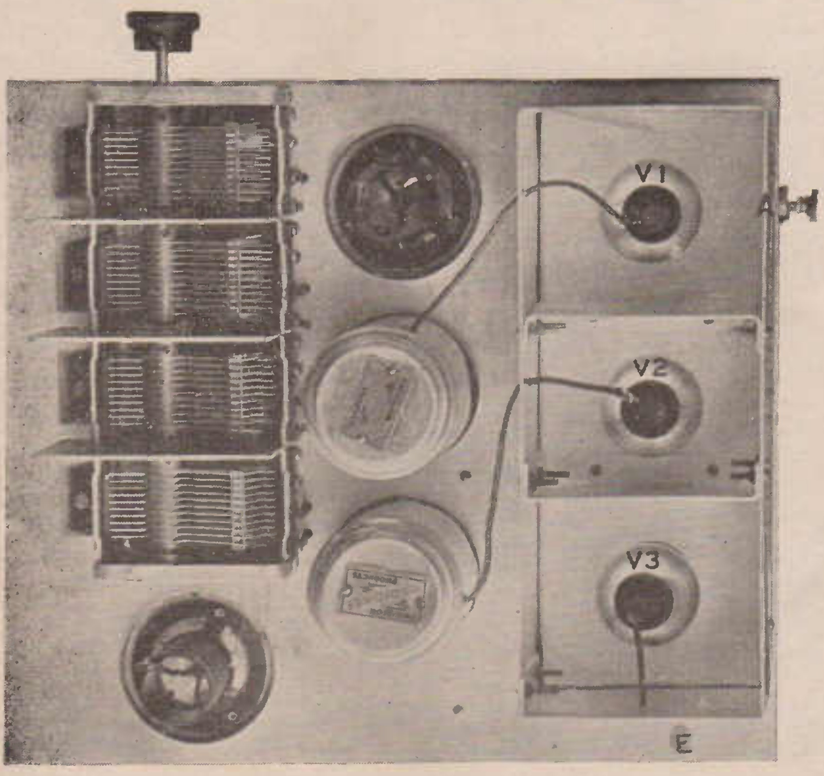
resistance, and from the other side of this resistance to the A minus lug on the sockets V5 and V6. A wire now is connected to the A plus lug on the sockets of V1, V2, V3, V4, V5 and V6.

We now are ready to hook in the earth side of the grid circuits. Connect the blue lead on L2 to one lug on C8, and to the same lug on this condenser solder one lead on the 100,000 ohm resistor, R1. Connect the blue lead on L4 to one lug on C9, and to the same lug solder one lead on the resistor, R8. Connect the blue lead on L6 to one lug on C10, and to the same lug solder one lead from the resistor, R9. Connect the blue lead on L8 to one socket of the pick-up connection, PU. To the other socket solder one wire of the resistance, R10, and run a lead to one lug of the condenser, C11. The remaining leads on R1, R8 and R9 are joined together and soldered to a flex lead which is to be the C minus 1 lead. The remaining lead on R10 carries a similar flex lead which is the C minus 2 lead.

From the P lug on the socket, V1, a lead is taken to one lug on the condenser, C5, to which is soldered one lead on the resistor, R2. The P lug on the socket, V2, carries a lead to one lug on condenser, C6, to which is soldered one lead on the resistance, R3. The P lug on the socket, V3, carries a lead to one lug on the condenser, C7, to which lug is soldered one lead on the resistor, R4. The vacant leads on R2, 3 and 4 are soldered together and connected to one side of R12 (see text for details of this resistor) and to one lug on the condenser, C15. Earth the vacant lugs on C5,8 to the A minus lug on V1, the vacant lugs on C6,9 to the A minus lug on V2, and the vacant lugs on C7,10 to the A minus lug on V3.



Looking down on the completed receiver we note the simplicity and "cleanness" of lay-out which is one of its design features.



A view of a section of the receiver, showing the r.f. valves mounted in their screening boxes, and showing also two of the r.f. coils with their screens removed.

Now for the plate connections. The yellow lead on each of the four coils is unsoldered and replaced with a flex lead long enough to reach, in the case of L1, to the nearest earth point; in the case of L3, to the plate (top) terminal on V1; in the case of L5, to the plate (top) terminal on V2; and in the case of L7, under the chassis to the plate (top) terminal on V3.

The green lead on L1 is connected to the aerial terminal, whilst the green lead on L3, L5, L7 is connected to the respective by-pass condenser and series resistor.

The green lead on L3 is connected to one lug on C12, to which is soldered one lead on the resistance, R5. The green lead on L5 is connected to one lug on C13, to which is soldered one lead on the resistance, R6. The green lead on L7 is connected to one lug on C14, to which is soldered one lead on resistance, R7. The vacant lugs on C12, 13 and 14 are connected together and to earth.

The vacant leads on R5, 6, 7 are soldered together and connected to the vacant lead on R12, from which a lead now is taken to the G terminal on the UY battery socket, LS. Three earth connections which now should be made are: The moving plate lug on the

(Continued on page 45.)

THE SCREEN GRID SUPER 6.

(Continued from page 43.)

gang condenser, C1, 2, 3, 4; the vacant lug on C11, and the vacant lug on C15.

We now are in a position to go ahead with the wiring of the detector and audio circuits. Connect the P terminal on the socket of V4 to one terminal on the r.f. choke, and to one lug on the T.C.C. .0001 mfd. condenser, C16. The other terminal on the r.f. choke is connected to the P terminal on the Ferranti transformer, AFT, and to one lug on C17. The vacant lugs on C16, 17 are connected to earth.

The 100,000 ohm volume control resistance, R14 (see text), has one of its terminals connected to the P terminal on AFT, and the other terminal to the B plus terminal on the transformer. From this same terminal on AFT a lead goes to one lug on the fixed condenser, C18, and to which is soldered one lead on R11. The other lead on R11 is connected to the G lug on the UY socket, L.S. The remaining lug on C18 is connected to earth.

One G terminal on AFT is wired to the G lug on V5, whilst the other G terminal is wired to the G lug on V6. The C minus terminal on AFT is connected to the F1 lug on the socket, L.S., the negative (black) to lead on the Concord 10 mfd. electrolytic condenser, C19, and to one terminal on the bias resistor strip, R13. The other lead on C19 and the other lug on R13 are connected together and to earth.

The P lug on V5 is connected to the P lug on the UY socket, L.S. The P lug on the socket of V6 is connected to the C lug on the UY socket, L.S.

From the G lug on the UY socket, L.S., a lead is taken to the screening grid terminal on the valves V5, V6 themselves. From the P terminal on V5 a lead is taken to one lug on the condenser, C20. The other lug on this condenser is soldered to one lead on the resistance, R15. The other lead on R15 is soldered to the P lug on V6.

From the A plus lug on the socket of V4 a lead is taken to the F2 lug on the UY socket, L.S. A flex lead from the vacant side of the filament switch carries the A minus battery supply. This completes the wiring of the receiver, and we are ready to consider its operation and to tell of the results we obtained with the original.

TESTS AND ADJUSTMENTS.

In placing the receiver into operation we shall need 180 volts of Triple Duty Diamond "B" batteries.

When the usual preliminaries have been settled, connect the batteries, aerial, earth, and speaker, and plug in the valves into their respective sockets. The C plus terminal on the battery is to be connected to the earth terminal on the receiver, the C minus 1 lead to the 3 volt negative tap on the battery, and C minus 2 to the 10½ volt negative tap.

Assuming that the "C" voltage on the r.f., detector, and audio valves is correct, the receiver will take a total plate current of 33 milliamperes. Admittedly this is too high for economical battery operation. Even the robust triple duty "Diamonds" would stand up to it for only about six months. However, the receiver is intended mainly for the man who has access to a source of d.c. supply, or who has a bank of accumulator "B" batteries. For the unfortunate who has neither, but who wants a highly sensitive receiver such as this, we suggest a modification of the audio stage.

The main difficulty in getting the receiver to "mote" is in lining-up the gang condenser. The best way to start this is to tune down to a station like 3KZ. Don't go down to the very bottom of the wave band, because it will be extremely difficult to get a real line-up at this point, and there is a possibility that the whole job will be made too difficult if an attempt is made to gang at this point. Tune in 3KZ or a similar station and carefully adjust the trimmer condensers until the loudest signals are heard.

Tune-up a little until 2NC or a similar inter-State broadcaster is heard, and then, by means of a long, flat-bladed wooden skewer, try pushing the already enmeshed split plate section of each gang condenser closer to the moving plates. If this decreases volume (note, we expect you only to adjust one condenser at a time), try pushing the section further away from the stater plates. Perform these operations gently and carefully, otherwise you are likely to damage the alignment of the whole condenser. Repeat this line-up procedure every few metres right up to the top end of the band, and when once you have the set adjusted to your satisfaction, don't touch it again.

Furthermore, when adjusting at any point after the first don't touch the trimmer condensers and don't try to line the receiver up by starting at the top end.

When the set is built and is operating properly it is capable of excellent results. Tests with the original, operating on a medium-sized aerial, in a Melbourne suburb, resulted in the tuning-in at full loud speaker strength of the following inter-State stations:—2CO, 7ZL, 5CK, 2FC, 6WF, 2YA, 5CL. 4QG, 2BL, 4RK, 2GB, 2KY, 7LA, 2UW, 4BC, 2CH, 2NC, 2SM, 4BK. 4BH, and 2KO, in addition to the usual run of local stations and country transmitters. During the tests of the receiver KZRM also was tuned in each night at loud speaker strength, so that there is little doubt that consistent reception of the Japanese stations would be possible.

Used with one of the new Rola permanent magnet dynamic speakers provided with a special input transformer to match the Philips pentodes, the receiver delivered amazingly fine tone quality, whilst the volume on all the local stations and the majority of the inter-State broadcasters was sufficient almost to bring down the house.

The chassis dimensions are 12 in. x 21 in. x 2½ in. Both the chassis and the screening box are made of 16 gauge aluminium, and were supplied to order by Geo. White & Co.

Tune In on the World
with the
Compass A.C. 6

SEE ELSEWHERE IN THIS ISSUE FOR FULL CONSTRUCTIONAL DETAILS

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1 Metal Chassis, 17½ in. x 15 in. x 2 in.	£0	15	0
1 Set (4 coils) Radiokes, standard r.f. coils (Aerial and three r.f.) at 10/- each	2	0	0
1 Stromberg Carlson, 4 Gang Condenser	1	12	6
1 Grand Opera Power Transformer. 350-0-350, 2.5, 2.5, and 5 v.	2	7	6
2 Polymet 500 Volt 8 mfd. Electrolytic Condensers	0	15	6
6 H.C.R. UY Sockets, 9d. each	0	4	6
1 H.C.R. UX Socket, 9d. each	0	0	9
1 Radiokes, 10,000 Ohm. Potentiometer, 10/- each	0	10	0
1 Radiokes. 125 Ohm. Bias Resistor, 2/2 each	0	2	2
3 Radiotron 235 Valves, 20/- each	3	0	0
1 Radiotron 224 Valve, 20/- each	1	0	0
1 Radiotron 247 Valve, 20/- each	1	0	0
1 Radiotron 280 Valve, 18/6 each	0	18	6
1 T.C.C. .00025 mfd. Fixed Condenser 2/1 each	0	2	1
4 Radiokes R.F. Chokes, 3/9 each	0	15	0
1 Hydra 2 x .1 mfd. Condenser, 5/- each	0	5	0
1 Hydra 3 x .5 mfd. Condenser, 7/11 each	0	7	11
3 T.C.C. 2 mfd. Fixed Condensers, 4/5 each	0	13	3
1 Hydra .1 mfd. Fixed Condenser, 2/6 each	0	2	6
3 T.C.C. .25 mfd. Fixed Condensers			
2 T.C.C. 1 mfd. Fixed Condensers, 3/4 each	0	6	8
Power Switch, 2/3 each	0	2	3
2 100,000 Ohm Carborundum Resistors, 2/7 each	0	5	2
2 10,000 Ohm Carborundum Resistors, 2/7 each	0	5	2
2 50,000 Ohm Carborundum Resistors, 2/7 each	0	5	2
1 250,000 Ohm Carborundum Resistors, 2/7 each	0	2	7
1 500,000 Ohm Carborundum Resistors, 2/7 each	0	2	7
1 25,000 Ohm Carborundum Resistors, 2/7 each	0	2	7
1 400 Ohm. Bias Resistor, 3/5 each	0	3	5
1 50 Ohm Centre Tap Resistor, 2/8	0	2	8
	£17	10	6

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SERVICE, PLEASE.
(Continued from page 42.)

Would you please forward me, if it is too much to ask you to describe in your journal, a description of a six-valve battery operated wireless set for use on the ordinary broadcast wavelengths, incorporating screen grid valves, and, perhaps, a penthode and one-dial control?—Jack Oliver, Tamar, Tas.

In this issue you will find a receiver similar to the one you require. You could, at the expense of tone and power handling capacity, use a single pentode.

* * *

Would you tell me what the present day objection is to using 5000 metre intermediate frequency, also does the ultradyne radiate? Authors say it does not. I have tried the Tropadyne principle (amateur's Wireless Handbook). I used air core 1F transformers, 1SG, 1F amplifier, and the oscillator coupler was not as described. The circuit works; I can get all the A class stations and some of the B's. The rest, as well as some Japs., are as a continuous heterodyne whistle. Is this because the oscillator coupler is too tight? Whilst referring to this circuit, would the 1F tropaformers described be suitable with battery SG valves without further windings on primary?—T. L. Brown (Hamilton, Vic.).

The use of 60 kilocycle intermediate frequency transformers is discountenanced in these days because of the difficulty of obtaining single spot tuning. The separation between the received signal and the locally generated one is too small, so that most modern super-hets. use a 175 k.c. intermediate and there is talk of a further increase in the intermediate frequency to 485 k.c. Any super-het. must radiate to some extent, although the degree of radiation can be minimised by correct design of the oscillator, shielding, and the use of radio frequency amplifier stages between the aerial and the first detector. You do not indicate the intermediate frequency on which your super-het. is working, so it is difficult to say definitely what the trouble is. It may be due to oscillating intermediate stages, the generation of parasitic oscillations in the first detector circuit by a too closely coupled oscillator tube, or may be caused by the use of a low intermediate frequency, which would result in straightout heterodyning between the upper and lower positions. We have no data on the coils used in your super-het., but should say that the coil data given for three element valves would not be suitable for use with S.G. tubes.

* * *

I have built up a two-valve short-wave adaptor using an untuned R.F. stage followed by a three element detector. I find that the detector will not oscillate even after trying new coils and adjusting the plate voltage. Will you comment on the enclosed circuit and make any necessary alteration? Could a 13-plate reaction condenser be used instead of an 11-plate? —Short Wave (Kadina, S.A.).

Your troubles are due to incorrect circuit arrangements. In the circuit you supply, the moving plates of the reaction condenser are shown connected to the B max. lead, instead of to earth. We suggest you refer to the schematic diagram in Fig. 1, for a good short wave-adaptor. The valve combination you suggest will be quite O.K., although the A209 is not really a short-wave detector. A 13-plate reaction condenser will work just as well as an 11-plate.

* * *

How does a superheterodyne compare with a tuned R.F. receiver as far as short-wave reception is concerned? —B.M. (Bendigo, Vic.).

A one tube tuner will bring in stations from all over the world, but not as consistently as a multi-tube set. Tests have definitely proven that a screen grid, tuned R.F. amplifier cannot result in a gain factor of more than four or five at wavelengths of 20 metres; in which case a two stage R.F. amplifier would result in an overall gain of 16 to 25. In the case of a superheterodyne, the R.F. amplifiers are operated at a frequency where a gain of 50 to 100 per stage is easily possible. A two stage L.F. amplifier would give an overall gain of at least 2500. The resulting sensitivity of a super. would be very much greater than that of a two stage tuned R.F. arrangement, even allowing for considerable losses in the frequency changing process.

* * *

Are three stages of A.F. amplification suitable for short wave work, or is this combination too noisy?—T.M.G. (Lilydale, Vic.).

Such a high degree of A.F. gain cannot be used successfully for short-wave reception. Howling, due to feedback, is of great proportions, and is far more serious than in normal broadcast receivers. A resistance-coupled first and transformer-coupled second stage are sufficient.

Listen In

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The First Organised Radio Session for the Fan in Victoria

THE COMPASS A.C. SIX.

(Continued from page 7.)

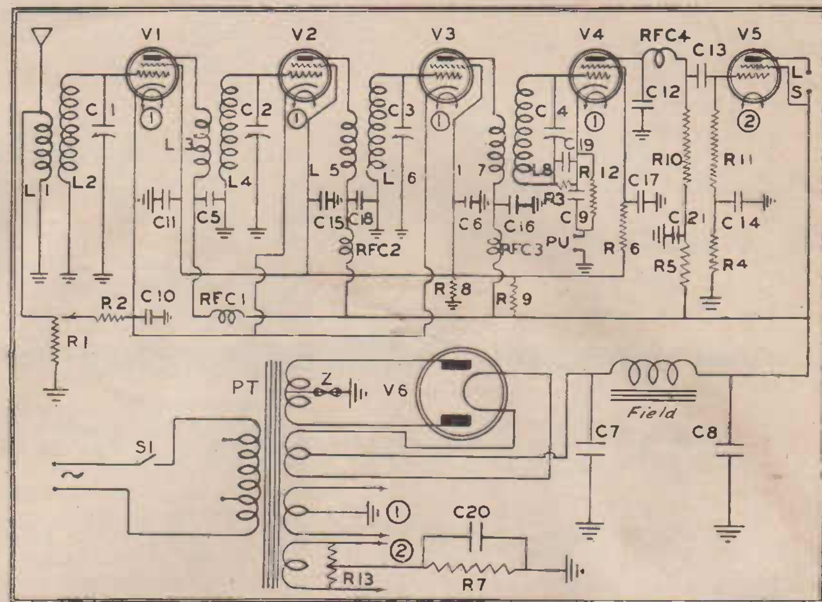
side, particular care has been devoted to the filtering of the detector plate supply and the audio grid circuit..

Incidentally, owing to a draughtsman's error the .1 meg. resistance R3, which is connected in the filament end of the detector grid coil, is wrongly shown. This resistor goes from the filament end of L8 to earth, and not, as shown in the schematic diagram, to the cathode. When once the receiver has been built up, the greatest trouble in getting it to function properly is in aligning the gang condenser properly.

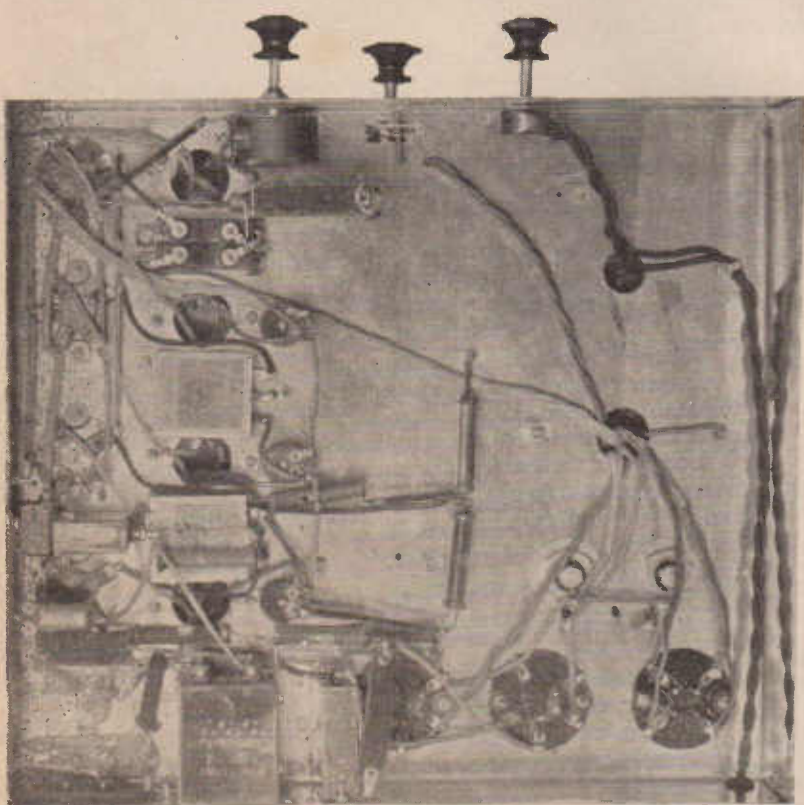
Initial Adjustments Important.

In the first place this will depend upon the accurate matching of coils, which means that each grid coil must have the same number of turns and must, as far as possible, have the same length of connecting leads. Balancing the condensers was, the writer found, fairly difficult, particularly when neither an oscillator nor an output meter was available. Both time and patience must be expended on this job, for a quarter of a turn out on one of the trimmer condensers will mean a big difference in reception of inter-State stations. It is best to start off at the bottom end and adjust the trimmers until 2KO or 4BH comes in at maximum strength. If the condensers and coils are properly balanced, which they hardly ever are, the tuning should be perfect all the way up the scale.

However, any humps and flat points in the tuning range can be cleaned up by carefully bending the correct split plate section of each particular condenser. When properly lined up the



The schematic circuit diagram shows that great attention has been paid to the filtration of the r.f. and audio supply lines, so that no unwanted feed-back will be present.



An under-chassis view gives some idea of the amount of material which is needed to build this super-receiver. Because of the necessary crowding of components at the r.f. end of the receiver it has been impossible to key-letter each part.

"MODERN SETS" AIR SERVICE.

Don't forget to listen for the nightly radio sessions broadcast by the Technical Staff of "Modern Sets" through station 3AW.

They'll be bright, pithy and instructive, so tune your set to 210.5 metres and combine entertainment with education.

receiver is really capable of amazing results, and the only difficulty may be to control the volume sufficiently on the locals and nearer inter-State stations. If any trouble is experienced

The Receiver's Log List

Frequency K.C.	Wave-length Metres.	Call Sign	Dial Reading.
560	535.7	2CO	99
580	517.2	7ZL	94½
610	492	3AR	88
618	485.1	KZRM	86½
635	472	5CK	83½
665	451	2FC	78
690	434.8	6WF	74½
720	416.7	2YA	70
730	411	5CL	69
760	394.7	4QG	65
770	390	JOBK	63½
800	375	3LO	60
855	351	2BL	53½
870	345	JOAK	53
880	340.9	6PR	50
910	329.7	4RK	47½
930	322.6	3UZ	46
950	315.8	2GB	44
960	312.5	5DN	42
970	309.3	3BO	41
1010	297	3HA	38
1025	292.68	2UE	36½
1070	280.3	2KY	32½
1080	277.8	3SH	32
1100	272.3	7LA	30
1110	270	2HD	29¼
1125	267	2UW	28½
1135	264	6ML	27
1145	262	4BC	26
1170	256.4	4TO	25
1180	254.2	3DB	24
1200	250	5KA	22½
1210	248	2CH	21¼
1220	246	6KG	22½
1245	241	2NC	19½
1270	236.2	2SM	18¼
1280	234.4	3TR	17
1290	232.56	4BK	16¼
1310	229	5AD	15½
1350	222	3KZ	14
1380	217.4	4BH	13
1400	214	3GL	11¼
1415	212	2KO	10
1425	210.5	3AW	9
1500	200	3AK	6

in this direction, the writer will be glad to show how the difficulty can be overcome. All the parts for the original receiver were obtained through the courtesy of Messrs. A. J. Veall.

INTERESTING NEW APPARATUS

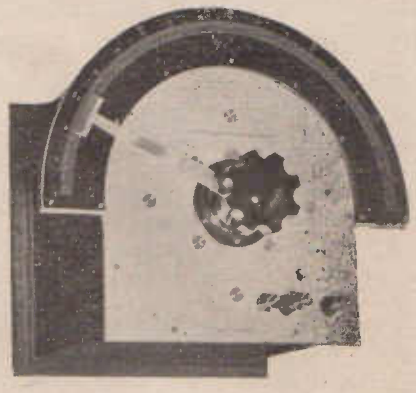
PRECISION TEST EQUIPMENT.

ONE of the past troubles with Australian radio manufacturers has been their dislike towards any precision methods of manufacture. Whether components or complete sets were being made the average manufacturer preferred to rely on rule of thumb methods rather than on accurate measuring instruments.

This attitude gradually is changing, and more and more we find precision equipment being used in Australian radio factories. Possibly, of all work, the making of fixed condensers demands most accuracy. Therefore it is of particular interest to note the attention being paid by the manufacturers of T.C.C. condensers to the question of capacity standards.

Although the Australian factory long has employed capacity bridges as standards from which to check the thousands of Type "M" condensers which are produced daily, the principals felt that until they had a laboratory standard from which to check the production bridges that they were falling short of their ideal—the production of condensers of unassailable accuracy.

This state of affairs has been remedied this week by the importation of a Sullivan Precision air condenser which will be the superstandard against which all the Gambrell capacity bridges used both in the Melbourne factory and the laboratories of the inter-State representatives. The



The Sullivan Precision Air Condenser

condenser has a capacity range from 90 to 2100 mmfd., and by suitable series and parallel capacities this range can be extended almost indefinitely. The guaranteed accuracy of the Sullivan condenser is .0000005 mfd. or .5 mmfd.

As can be seen from the picture the instrument is no midget. It measures approximately 16 inches by 16 inches, and is 14 inches high. It is beautifully finished, and is provided with a 180 degree dial and a vernier action capable of splitting one degree into 10ths with accuracy.

A check against the standard Gambrell bridge used in the Melbourne factory showed that the discrepancies of the production instrument were too small for consideration.

It is very pleasing to note this new move to safeguard the capacity ratings of T.C.C. mica condensers, which already have such a reputation for accuracy, as well as for robustness of construction and excellence of finish.

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224A	226
227	230
231	232
235	245
247	280

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