Wireless World

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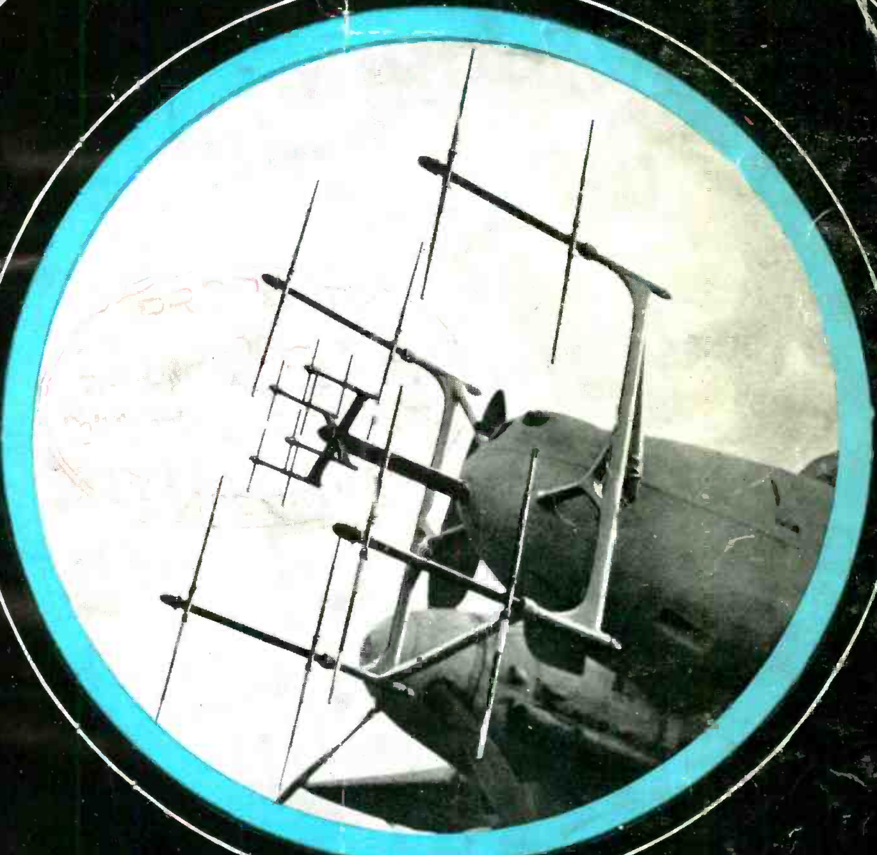
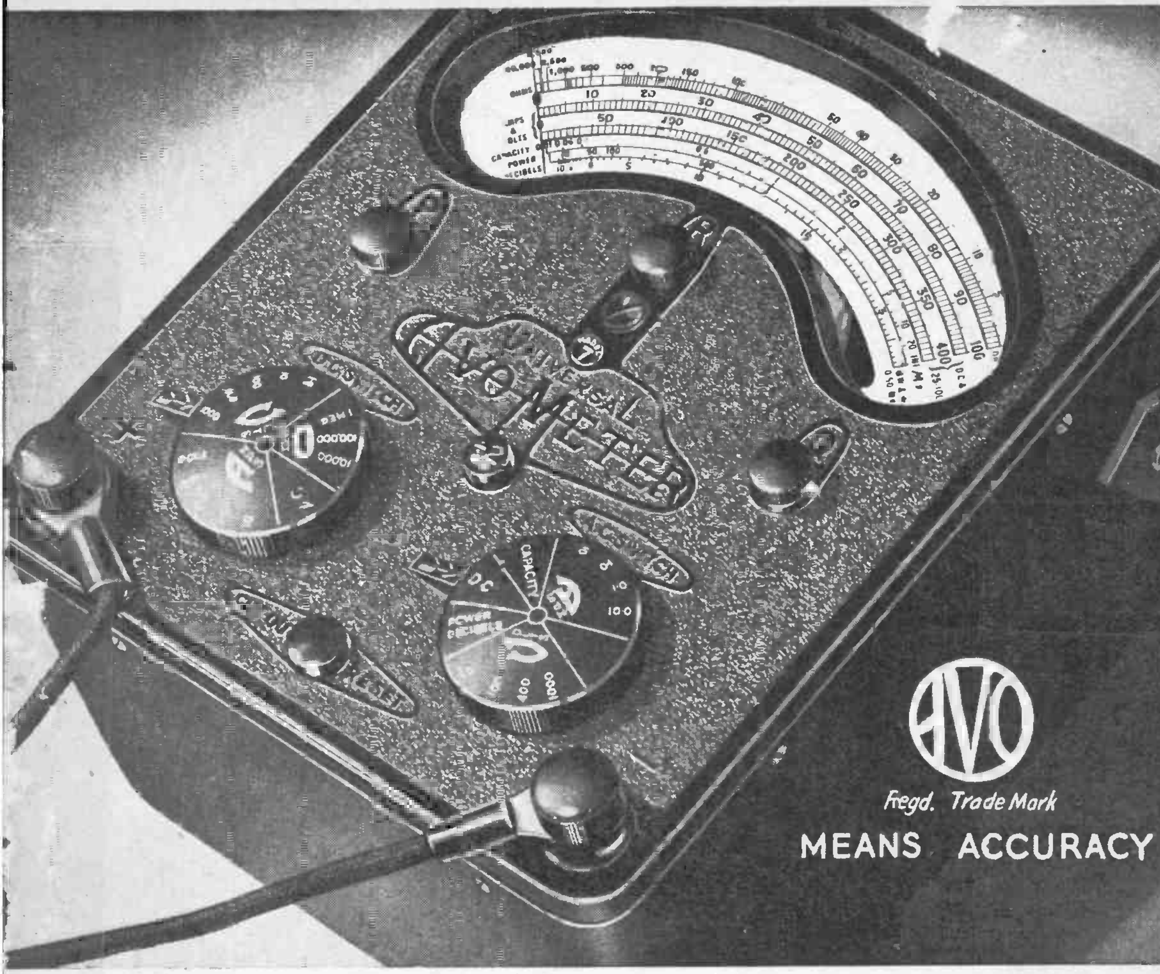


JAN. 1946

1/6

Vol. LII. No. 1

IN THIS ISSUE: NEW QUALITY AMPLIFIERS



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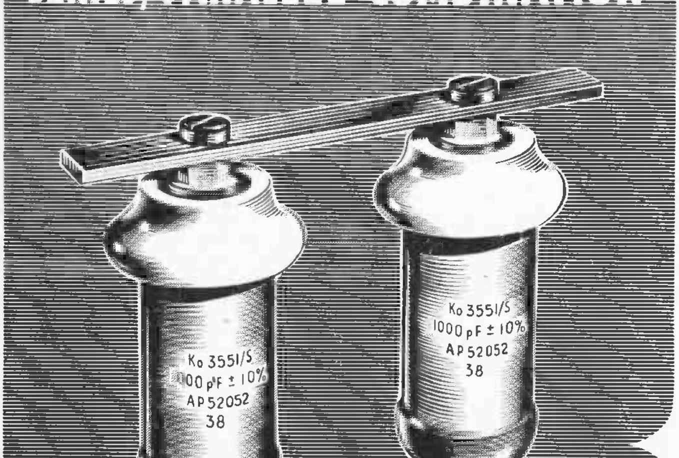

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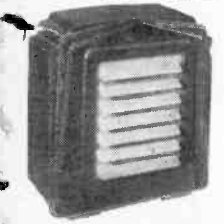

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LOUDSPEAKER TRANSFORMERS.—Pentode output 40 : 1, 50 m.a., **2/6** ; Multi-ratio, 40 : 1, 60 : 1, 80 : 1 **9/6** ; also push-pull, **9/6** ; heavy-duty multi-ratio 24 : 1, 41 : 1, 48 : 1, 58 : 1, 82 : 1, 116 : 1 and P.P. 80 m.a., **14/-** ; 3 : 1 inter-valve, **7/6** ; push-pull output, 20-watt, 4,000-0-4,000 primary, 2.5, 7.5 and 12/15 ohms secondary, **25/-**.

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VOLUME CONTROLS.—5, 20, 50 and 100 thousand ohms, ¼, ½, 1 and 2 meg., without switch, **3/-** each ; as above, with switch, **4/9** ; 100,000 ohms, ½-meg., double-pole switch, best American, **6/6** ; 2,000 ohms only, wire wound, **1/3** ; 1,000 ohms only, carbon screw adjustment, **1/-** ; Midget, ½-meg., with switch, **4/6**, less switch, **1/6**.

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SPECIAL OFFER BATTERY CHARGERS.—1 amp. type, 2, 6 or 12 volt, 200/240 volt input. Finished in black metal cabinet. Small and compact, **£2 19s. 6d.**

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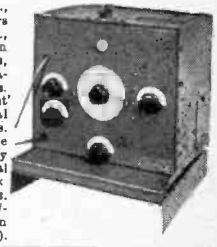

A.C. Mains, 200/250 v., 50 cycles, range covers from 20 M.C. to 100 K.C., all fundamentally in 5 bands, without gaps, S/M dial. Direct calibration in frequencies. Coarse and fine output attentuator. Internal modulation. 400 c/s. Iron-cored coils. The generator is entirely screened in heavy metal cabinet. Dim., 10in. × 10in. × 12in., **16 gns.** Case and packing, 10/- extra (refunded upon return of the case).

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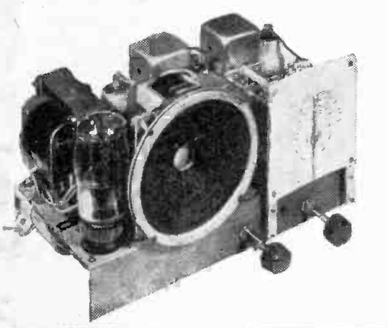

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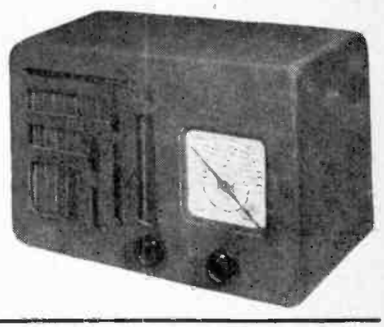
Complete with Cabinet.

16-50, 200-550 metres.

A SUPER-SENSITIVE AND SELECTIVE CIRCUIT.

Brief specification : Frequency changer, 6 tuned circuit, 465 K.C.'s iron cored I.F.'s, 4-watt output. P.M. speaker and output transformer, all valves, chassis, practical and theoretical diagrams. Parts list, nuts, bolts and wire and modern cabinet. Dimensions : 12in. × 8in. × 6in. deep. Ready to assemble. 200/250 volts, A.C. Parts new and ex-television. Including Purchase Tax. Case and packing 10/- extra (refunded upon return of case). **13½ Gns.**



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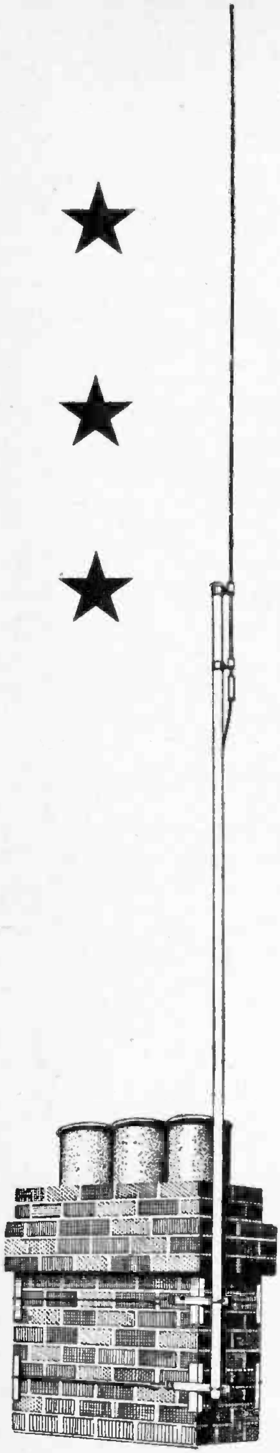

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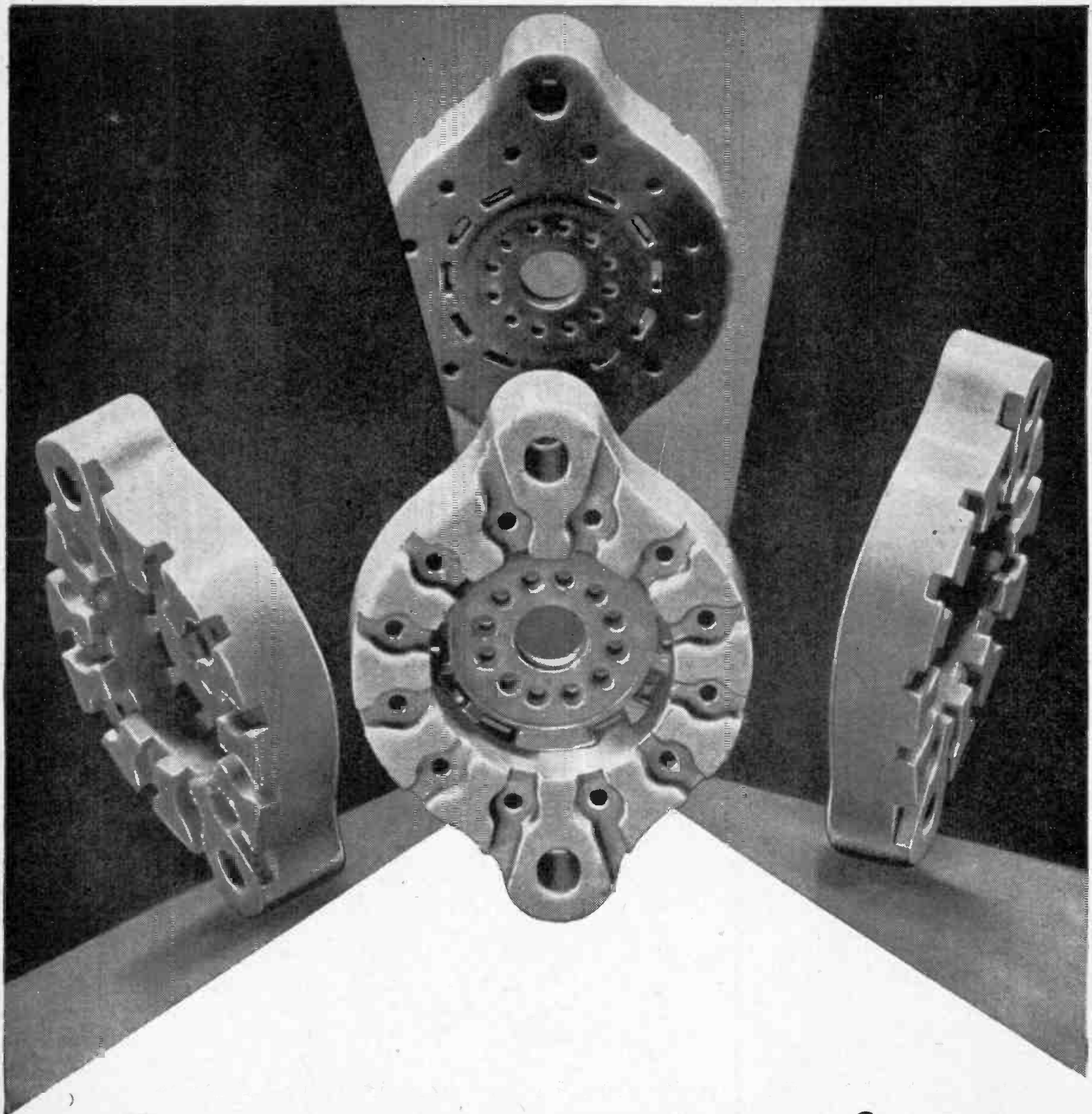

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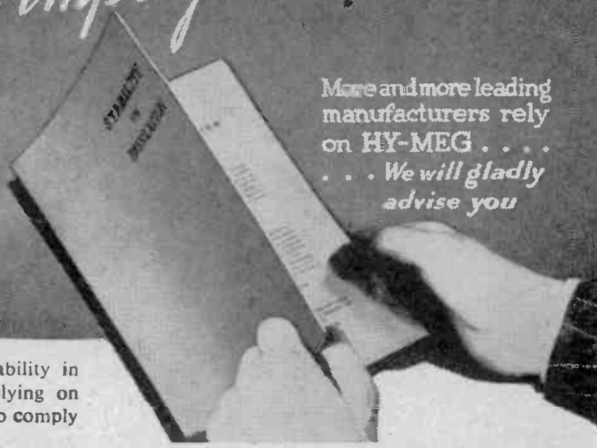

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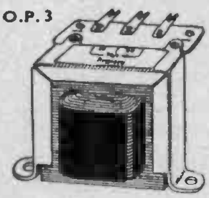
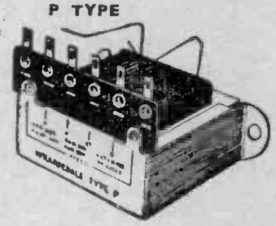


OUTPUT TRANSFORMERS

P TYPE



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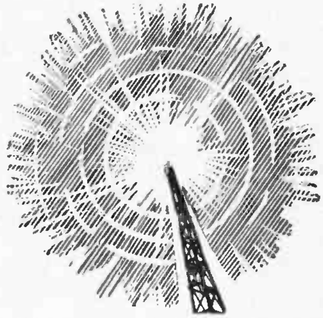

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S481. A small and compact condenser for low-power work, capacity 1.5 to 4 mmfd., size 1⅜in. x ⅜in. 3 6

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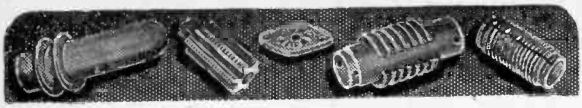

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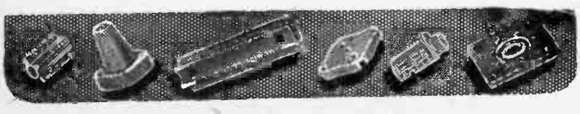

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Frequency range - - 0-600 c.p.s.
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Two $4\frac{1}{8}$" dia. Scales fitted with slow motion.
Output Impedance 600 ohms or to customer's specification
Total harmonic content less than 1%.
Output constant with Frequency to within 2 d.b. from 20 to 15,000 c.p.s. Output meter, single Range Rectifier Type. Mains operation 200/250 v. 50 cycles. Power output ½ watt.

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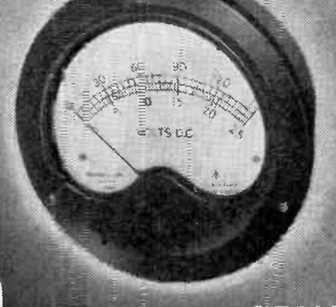

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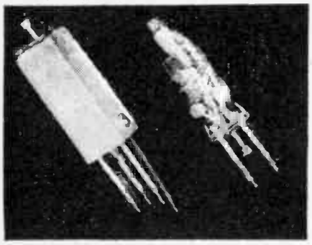

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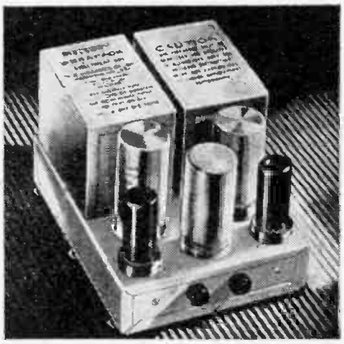

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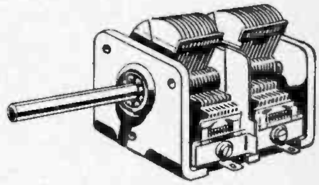

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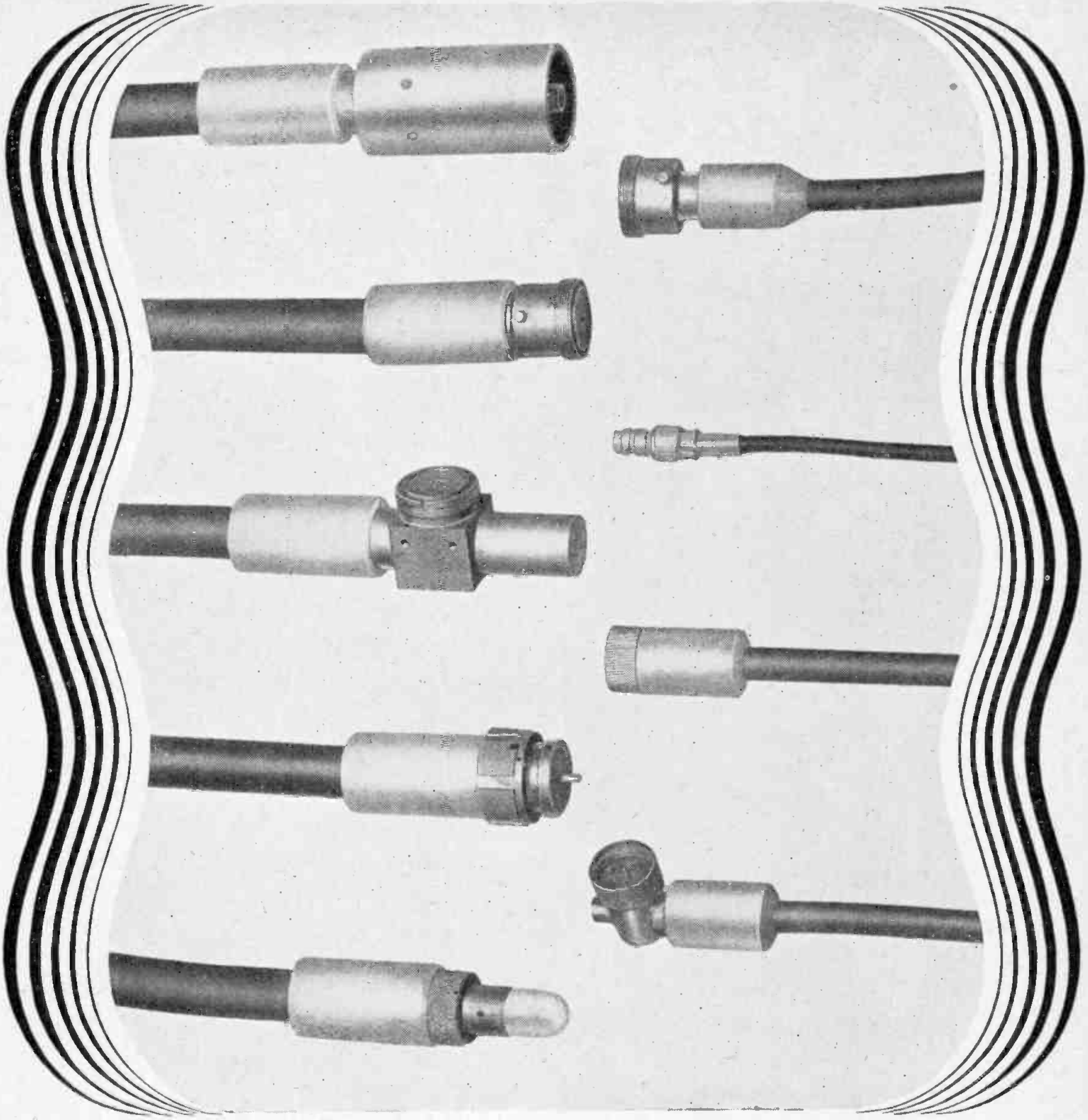

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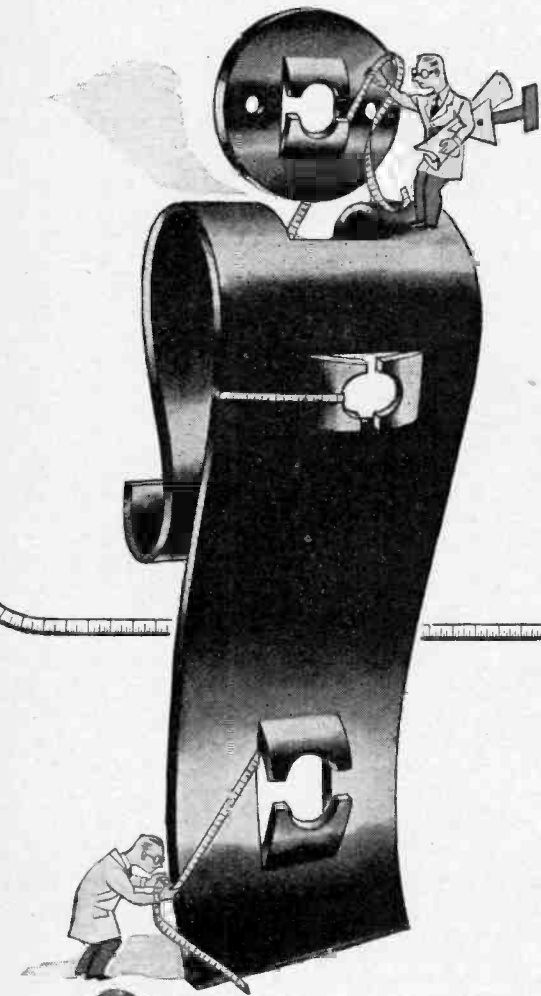

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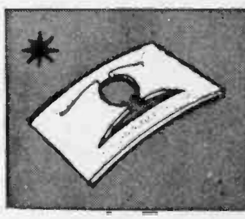

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Wireless World

Radio and Electronics

35th YEAR OF PUBLICATION

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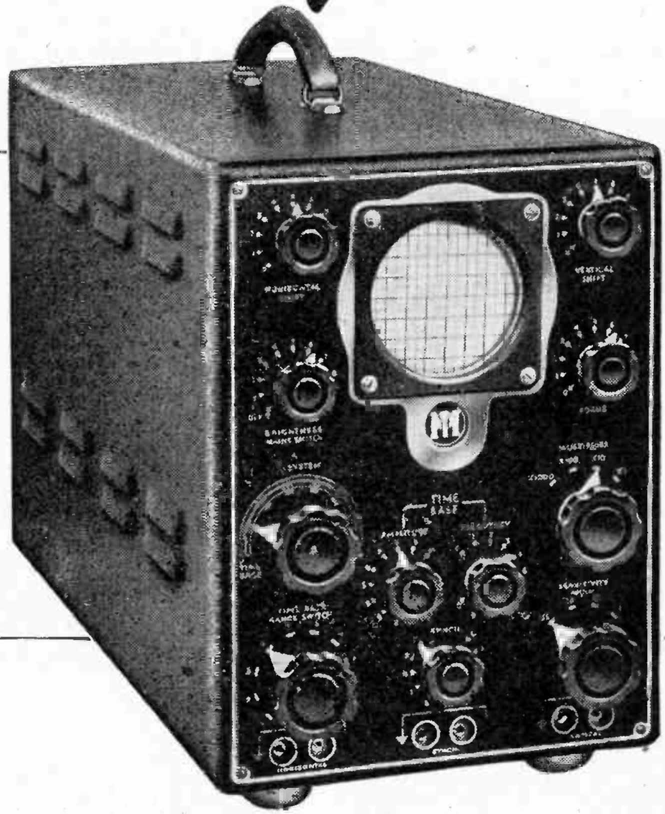

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(134E)

Wireless World

Radio and Electronics

Vol. LII. No. 1 — JANUARY 1946 — Price 1s. 6d.

Monthly Commentary

Control of Wireless

WIRELESS is about to celebrate its jubilee; fifty years ago, in 1896, Marconi came to England and lodged his application for the first patent for a system of telegraphy using Hertzian waves. In the following year that patent was acquired by the newly formed Wireless Telegraph and Signal Company; thus radio waves, demonstrated some ten years earlier by Hertz, were turned to practical commercial use.

In the earliest days there was not even national control; international regulations came later still. But it soon became obvious that anarchy could have no place in the world of wireless. Many of us still have lively recollections of the chaos that existed in the days before universal adherence to international conventions, when deliberate jamming of competing "systems" was commonplace.

So far as this country was concerned, control began with the passing in 1904 of the Wireless Telegraphy Act, which gave effectively complete power to the Postmaster-General, in whose hands it still remains. Ever since wireless attained years of discretion—perhaps respectable antiquity is now the better term—the question has been periodically raised whether it is proper that its fate should be in the hands of a body to whom it cannot be more than a mere side-issue. Another aspect of the matter, to which perhaps more attention should have been given, is raised in an article by a legal correspondent printed elsewhere in this issue. Reading that article, one is left with the inescapable conclusion that English wireless legislation is based on an unsure foundation. The law as it stands is not primarily concerned with ensuring the good governance of the art in the interests of all: on the contrary, it aims merely at the establishment of a monopoly.

It is a high tribute to the benevolent and efficient manner in which the G.P.O. has in general exercised its monopoly that so few protests have been raised during the past 40-odd years against the nature of our legislation. But we think that the time has come when wireless is old enough—and big enough—to stand on its own feet and to have its own controlling body. One of the strongest arguments against the existing system is that the P.O. inevitably finds itself in competition with those it must control and so can hardly be impartial. When this matter was debated in our pages some time ago a contributor put forward a well-reasoned argument* that control should be vested in an independent body which might be called the "National Radio Commission." We think that such a body should have jurisdiction over all forms of radiation within the radio-frequency spectrum, and not merely over communications.

When wartime regulations are withdrawn, some additions to our legislative machinery will clearly be needed. We cannot tolerate a situation where anyone can apparently set up a 1,000-kW radar station without let or hindrance or radiate kilowatts of power in the middle of the broadcast band from an unscreened radio-heating plant. If, as we think, drastic changes in our control mechanism are needed, now is the time to make them.

★ ★ ★

Government Surplus Stocks

ACCORDING to the information available up to the time of going to press, negotiations between the wireless industry and the Government on the question of disposal of surplus radio stocks are still proceeding. As the matter is one of some delicacy, the time is inopportune for comment so far as it concerns the disposal of bulk stocks, through industrial channels, of equipment and components in general use. But there is a widespread feeling that means should be provided whereby specialised surplus equipment should speedily be made available to those capable of using it to the best advantage. For example, much support was given to a suggestion made in our columns about a year ago that ex-Service technicians should, on demobilisation, be able to buy test and measuring equipment—the tools of their trade—on favourable terms.

* *Wireless World*, Feb., 1943; pp. 45-46.

"Wireless World"

QUALITY AMPLIFIERS

Circuit Details: 4-, 8- and 12-watt Designs

IN 1934 there appeared in *Wireless World* a design for a high-quality amplifier having an output of 4 watts. It was a double-push-pull resistance-coupled amplifier designed for quality of reproduction first and foremost, and because of its outstanding performance in this respect it proved exceedingly popular. Since that time various modified amplifiers have been described and the modifications have taken two forms; on the one hand they have been made to obtain increased output and on the other to simplify the amplifier.

The first category of changes resulted chiefly in alterations to the mains equipment and output valves. A change in the makers' rating of the PX4 valve, for instance, permitted increased output to be secured by increasing the voltage, while by substituting PX25-type valves and further increasing the voltage still greater output could be secured. The second type of modification lay in simplifying the circuit as knowledge of the properties of push-pull amplifiers increased. The original design had separate bias resistors for each valve, and these needed individual by-pass capacitors of large capacitance. It was later found possible to use a common resistor for each push-pull pair of valves and to dispense also with a by-pass capacitor. This entails no sacrifice of importance, but rather an improvement, for the common resistor tends to correct for variations between valves.[1]

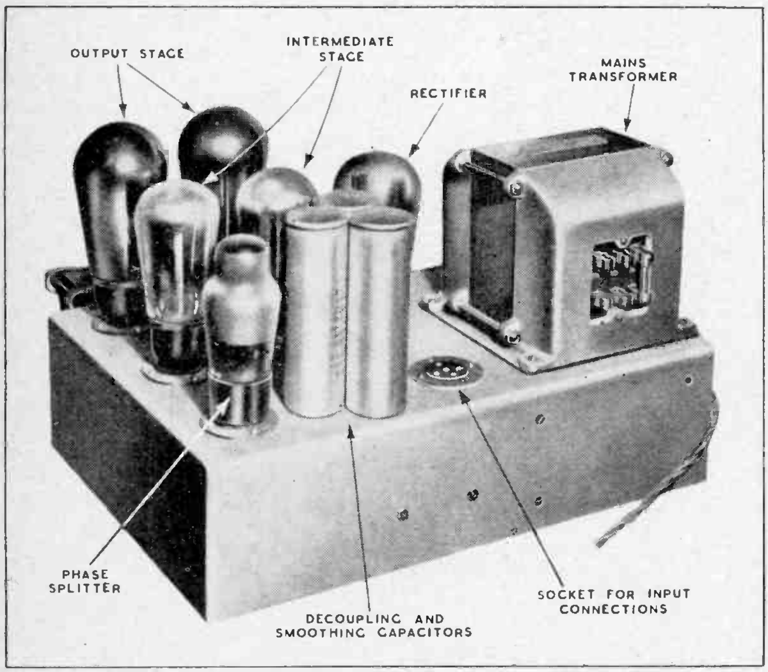
The present position is that there is a number of designs for amplifiers scattered through *Wireless World* and dating back to 1934. The designs vary in output and they progressively become simpler in detail, but they all bear a strong family likeness and it is easy to trace their development from the original.

On looking through these designs one is immediately struck by the fact that there are three basic designs differing only in output, for the simplifications to the original amplifier apply whatever the output. It becomes possible, in fact, to draw a common circuit diagram for all three.

This diagram is shown in Fig. 1, and it will be seen that the amplifier consists of an input phase-splitter V_1, a resistance-coupled push-pull stage V_2, V_3 and an output stage V_4, V_5. There are many other possible phase-splitting arrangements, but the one shown here has been found very satisfactory over a period of many years, and it is very doubtful if there is a better for this purpose. The stage is, in essence, a cathode follower, but having a resistance R_3 in the anode circuit which is equal in value to the cathode resistance R_5. The alternating anode current flows through both, and as they are equal in value, the alternating voltages at anode and cathode are equal in magnitude but opposite in phase with respect to earth.

Grid bias is provided by R_4 and the grid leak R_1 is returned to the negative side of it. There is one point to watch here. There is heavy negative feed-back from the resistance R_5, with the result that the input impedance of the stage is very high. Because of this, the grid of V_1 is more liable to pick up hum from stray electric fields than usual, and it is wise to keep the grid connections very short. With any reasonable layout screening should be unnecessary,

[1] Cathode Bias in Push-Pull Stages; by W. T. Cocking, *Wireless World*, March, 1945.



A typical amplifier layout. Notice that the electrolytic capacitors are mounted well away from the really hot valves.

but if hum is found V_1, C_1 and R_1 should all be screened.

Decoupling is provided by R_2 and C_2 and smaller values than those specified are inadvisable. These values should, however, be in all cases adequate. C_3 R_6 and C_4 R_7 provide the coupling to the first push-pull stage. It is important for the capacitors to have high current, but on subsequent breaking and remaking the circuit there should be no trace of flicker. A current of only a few microamperes is sufficient to cause a perceptible flicker, so that the absence of such flicker is an indication that the insulation resistance is at least several hundred megohms.

Another method, which is simple ences between the two valves. It does, however, tend to accentuate differences between R_9 and R_{10}, and these two components should be chosen to be as nearly alike as possible. The usual 20 per cent. tolerance is quite good enough on their absolute value, but they should be alike within much closer limits and some

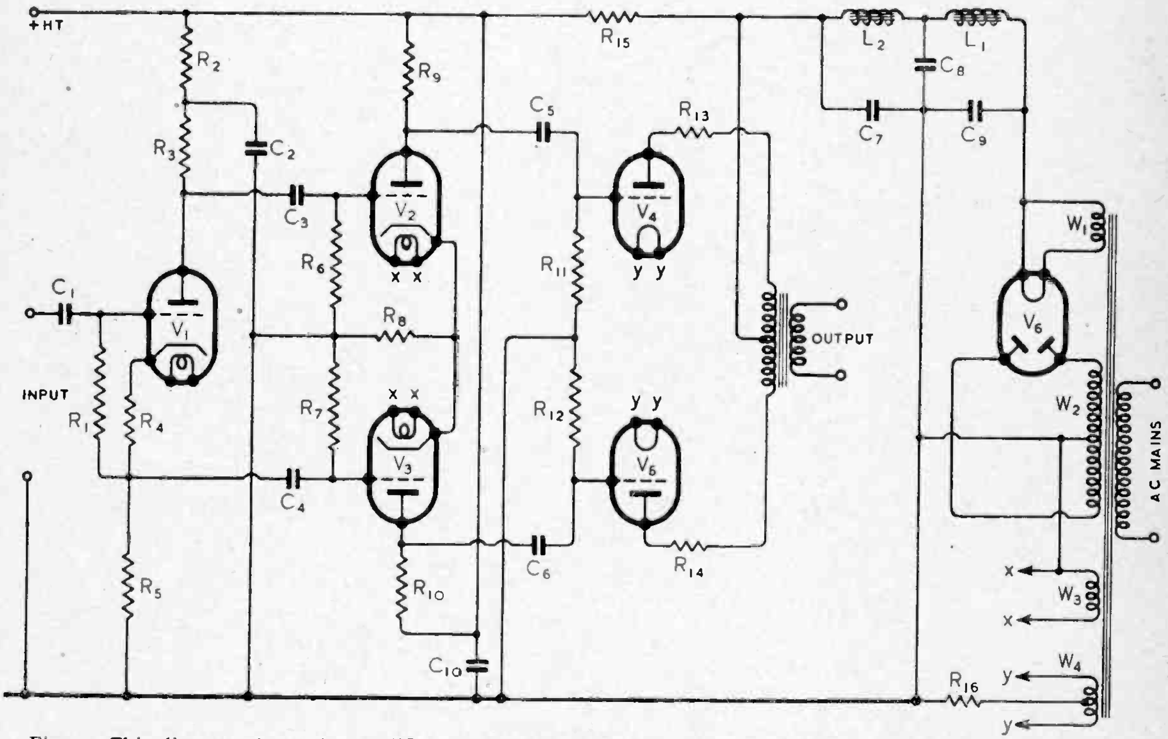


Fig. 1. This diagram shows the amplifier circuit and mains equipment for all three output powers. R_{15} and C_{10} are needed only for the 12-watt output.

insulation resistance, since if they are at all leaky the operation of V_2 and V_3 will be upset. A leak at this point will do no material damage, however, but in the coupling to the output stage a leak in C_5 or C_6 may damage V_4 or V_5, so that it is particularly important to make sure that these capacitors have good insulation.

If a proper measurement of insulation resistance cannot be made, a somewhat crude test usually gives a satisfactory indication of the state of the capacitor. This is to connect it in series with a 1,000-ohms-per-volt voltmeter to a 200-volt or higher supply. On making the connection the meter needle will flick upwards slightly because of the charging to apply to capacitors in the complete amplifier, is to check the anode current of the following valve, with the grid leak short-circuited and normal. Thus, if it is desired to check C_5, insert a meter in the anode circuit of V_4 and note the current. Short-circuit R_{11} and again note the current. If all is in order the two readings should be the same, but if C_5 is leaky, the second reading will be lower than the first.

The first push-pull stage comprises V_2 and V_3, with the coupling resistors R_9 and R_{10}. A common bias resistor R_8 is used and has the effect of providing a self-balancing action to the stage which partially compensates for differ- 2 per cent. is ideal. By checking over a few resistors one can usually pick two sufficiently alike. These remarks also apply to R_3 and R_5, since their values control the input to the push-pull amplifier.

The output stage has a pair of push-pull triodes, again with a common bias resistor R_{16}, and anti-parasitic oscillation resistors R_{13} and R_{14} are included. It is an additional help to arrange the layout so that the grid leads of V_4 and V_5 and the anode leads of V_2 and V_3 are very short.

The mains equipment consists of the usual full-wave rectifier V_6 and a two-stage smoothing circuit, and is quite conventional. R_{15} and C_{10} are needed only when

Quality Amplifiers—

PX25 output valves are used and R_{16} then drops the voltage to the early valves.

So far the amplifier has been discussed on the general circuit which is common to all three outputs and it is now necessary to consider individually the points of difference. It may be remarked at this point, however, that in the mains equipment allowance has been made for a current of 20mA to be available for any preceding feeder or input unit.

For an output of 4 watts, PX4 valves are used for V_4 and V_5 and are slightly under-run. In this condition they can be relied upon to give an exceptionally long life. They are operated with 250 volts between anode and cathode and -35 volts grid bias. Allowing for a small drop in the output transformer, the HT supply needed is 295 volts, and the current is 70 mA, 35 mA per valve. An anode-to-anode load of 10,000 ohms is then required.

The penultimate stage takes some 8.4 mA and V_1 needs about 1.2 mA, so that the amplifier as a whole needs just on 80 mA. Allowing 20 mA for any preceding unit, the mains equipment is designed for an output of 100 mA at 300 volts in round figures. A total resistance of 500 ohms is allowed for the two chokes, making the rectifier output 350 volts at 100 mA. This is obtainable with a valve such as the U14 for V_6 with a transformer winding of about 325–0–325 volts.

For an 8-watt output the same valves are used in the output stage and the bias resistor is unchanged. The valves now work with 300 volts anode-to-cathode and need some -45 volts grid bias. Under these conditions they take 50 mA apiece, and the total HT supply becomes 350 volts at 130 mA. The drop in the chokes becomes 65 volts, so that the rectifier output needed is some 415 volts.

The current of 130 mA is rather beyond the rating of the U14, so that the U18 should be used. Of course, if the preceding stages do not take more than 10 mA the total current becomes only 120 mA and a U14 is still permissible.

The output stage needs a load of 6,400 ohms under these conditions and it requires 45 volts peak input per valve instead of 35 volts. The penultimate stage is now fed from a 350-volt line instead of a 300-volt, so that its output is automatically increased. The amplifier as a whole needs 28 per cent. more signal input for the 8-watt output than for the 4-watt.

It will be seen that the only changes between the 4- and the 8-watt amplifiers are in the voltage ratings of C_8 and C_9, the load resistance of the output stage, the rectifier valve V_6, and the mains transformer.

In the case of the 12-watt amplifier, the main change is in the use of PX25 output valves. These need 400 volts anode-to-

CIRCUIT VALUES

Components common to all three amplifiers

Resistors

Tolerance: ± 20 per cent.
Rating ¼ watt

R_1 = 2.2 MΩ	R_8 = 470 Ω
R_2 = 33,000 Ω	R_9 = 33,000 Ω*
R_3 = 33,000 Ω*	R_{10} = 33,000 Ω*
R_4 = 2,200 Ω	R_{11} = 0.33 MΩ
R_5 = 33,000 Ω*	R_{12} = 0.33 MΩ
R_6 = 0.47 MΩ	R_{13} = 47 Ω
R_7 = 0.47 MΩ	R_{14} = 47 Ω

* R_3 and R_5 should be picked as nearly alike as possible, also R_9 should have the same value as R_{10}. A tolerance of 20 per cent. on absolute value is satisfactory, however.

Chokes

L_1 = 10–20H 150 mA.
L_2 = 20–30H 150 mA.
DC resistance of the two together should be about 500Ω

Components differing in the three amplifiers

Resistors

Tolerance: ± 20 per cent.

	4-watt	8-watt	12-watt
R_{15}	0	0	4,700Ω 5W
R_{16}	470Ω 5W	470Ω 5W	100Ω 2W +150Ω 3W in series

Wattage ratings are minimum and should be doubled if good ventilation is not provided.

Capacitors

		Working Voltages		
		4-watt	8-watt	12-watt
C_1	0.01μF	350 V	350 V	450 V
C_2	8μF	350 V	350 V	450 V
C_3 C_4 C_5 C_6	0.1μF	350 V	350 V	450 V
C_7	8μF	350 V	350 V	450 V
C_8	8μF	350 V	400 V	550 V
C_9	4μF	500 V	550 V	700 V
C_{10}	8μF	Not required	Not required	450 V

Output Transformer

The power-handling capacity must suit the particular amplifier and the ratio must be such that it matches the speaker impedance to the load required by that amplifier. The loads are:—4-watt, 10,000 Ω; 8-watt, 6,400 Ω and 12-watt, 6,000 Ω.

Valves

	4-watt	8-watt	12-watt
Group A			
V_1	MH4	MH4	MH4
V_2, V_3 ...	MHL4	MHL4	MHL4
V_4, V_5 ...	PX4	PX4	PX25
V_6	U14	U18	U18
Pre-amplifier	MH4	MH4	MH4
Group B			
V_1	6J7	6J7	6J7
V_2, V_3 ...	6J7	6J7	6J7
V_4, V_5 ...	PX4	PX4	PX25
V_6	5Z3	5Z3	5Z3
Pre-amplifier	6J7	6J7	6J7

Group A valves are 4-volt types, while Group B are 6.3-volt wherever suitable types exist. There is no equivalent to the PX4 and PX25 in the 6.3-volt range.

NOTE.—Any other equivalents of the valves in these groups may be employed. The 6J7 (or 6J7G, 6SJ7) is a pentode and should have screen, suppressor and anode pins joined. An alternative is the 6C5 triode. Types EF6 and EF36 can also be used if screen, suppressor and anode are strapped.

Mains Transformer

	4-watt	8-watt	12-watt
	For Group A Valves		
W_1	4V 2.5A	4V 4A	4V 4A
W_2	325-0-325V 100mA	375-0-375V 130mA	470-0-470V 150mA
W_3	4V 6A	4V 6A	4V 6A
W_4	4V 2A C.T.	4V 2A C.T.	4V 4A C.T.
	For Group B Valves		
W_1	5V 3A	5V 3A	5V 3A
W_2	325-0-325V 100mA	375-0-375V 130mA	470-0-470V 150mA
W_3	6.3V 2A	6.3V 2A	6.3V 2A
W_4	4V 2A C.T.	4V 2A C.T.	4V 4A C.T.

Primary to suit supply mains.

cathode with − 31 volts grid bias and take 62.5 mA apiece. The HT supply then jumps to 450 volts at 155 mA. R_{15} is introduced to drop the voltage to 300 for the early stages and a by-pass capacitor C_{10} becomes necessary. The unsmoothed voltage needed becomes 530 and a U18 rectifier is again suitable. There is now a considerable increase in the capacitor voltage ratings needed and together with the higher voltage mains transformer the power supply becomes more expensive. The output stage needs a 6,000-ohm load.

Precise details of the values and ratings of components are given elsewhere, but it may be remarked that the voltage ratings given for capacitors are minimum working ones. They are safe ratings for new good-quality components, but if only old stock is available it is a good plan to pick capacitors of higher rating.

The resistor wattage ratings specified are adequate, provided that the ventilation is good. If it is not, the rating should be at least doubled in the case of the higher-wattage resistors. Even then it is bad practice to use poor ventilation, for it means that the heat generated in resistors and valves raises the temperature of the whole equipment and this is likely to be harmful to the life of the capacitors.

If the usual form of chassis construction is adopted, it is a good plan to keep the hot parts above the chassis and the cool ones below. Mount all resistors of over 1-watt rating above the chassis and keep all capacitors away from hot parts.

It will be noticed that the ratings given for capacitors are somewhat higher in the case of the 12-watt amplifier than for the others, in spite of the fact that the working voltages are the same. The reason for this is that higher voltages exist when the equipment is switched on and before the indirectly heated valves start to draw current, and the capacitors must withstand this voltage.

In both the 4-watt and 12-watt amplifiers the HT voltage for all valves except the output is nominally 300 volts, but in the 8-watt amplifier it is 350 volts. By including R_{15} in this last amplifier the voltage could, of course, have been reduced to 300 volts as in the others. This was felt to be undesirable, however, because the output valves need a bigger signal input in this amplifier than in the others and a somewhat higher anode voltage on the preceding stage is consequently desirable.

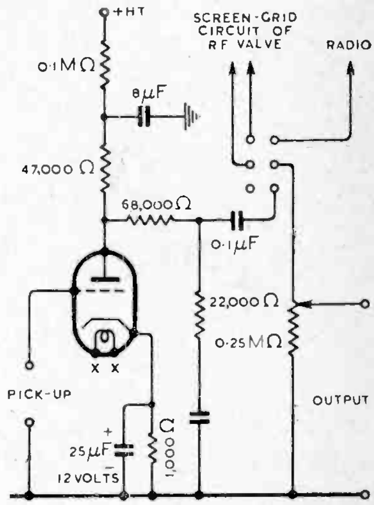
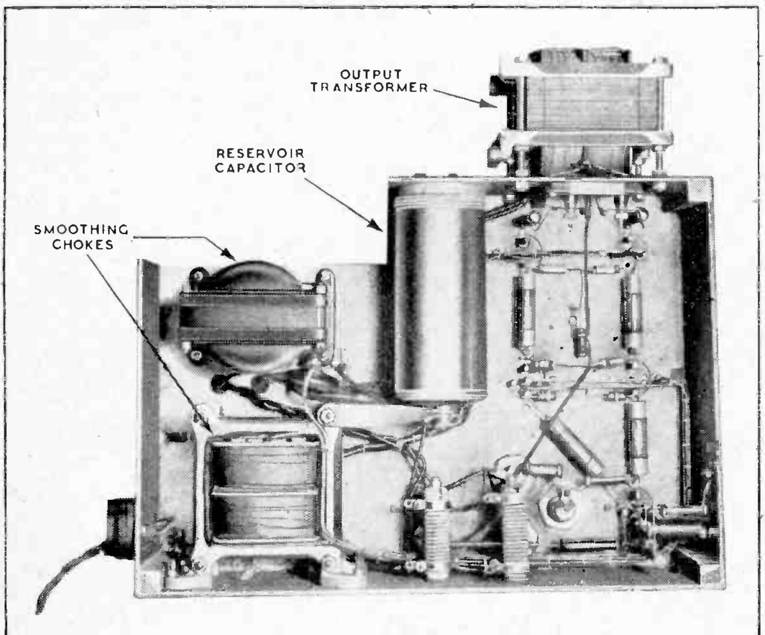


Fig. 2. A pre-amplifier to correct for recording deficiencies is usually necessary. The resistors can all be of $\frac{1}{4}$-watt rating except for the 100,000-ohm, which should be $\frac{1}{2}$-watt. The capacitors should be of 350-volt rating for the 4- and 8-watt amplifiers and of 450 volts for the 12-watt.



An under-side view of the amplifier. The cut-out in one corner of the chassis is merely to clear the speaker pot, for space is restricted in the cabinet used for this amplifier.

The point should be borne in mind, however, when working out dropping resistor values for any early valves.

The signal input needed by V_1 is approximately 2.5 volts RMS for full output. It is slightly less with the 12-watt amplifier and a little more with the 8-watt. It can be fed directly from the detector of a receiver, therefore, but an extra stage will usually be necessary for a gramophone pick-up. This stage must provide the amplification necessary to bring the pick-up output up to the 2.5 volts needed by the amplifier, and it should also have a characteristic rising at low frequencies to correct for the normal loss in the recording.

The amplification required is not high, for there are but few pick-ups giving a smaller output than 0.25 volt and some give well over 1 volt. An amplification of some

Quality Amplifiers—
5–10 times, to suit pick-ups giving from 0.25–0.5-volt output, will therefore meet most needs.

A suitable pre-amplifier and corrector is shown in Fig. 2, and with a valve of the MH4 type the amplification is about 6.5 times. This is sufficient for most pick-ups and caters for types having outputs exceeding 0.4 volt. The gain control is placed after this valve so that it can function on both radio and gramophone. This makes it necessary to be careful to avoid overloading in this corrector stage. There is little fear of this with the magnetic type of pick-up, but it is not unlikely with the piezo-electric crystal kind, which has a large output. If this effect is found the pick-up should be shunted by a fixed potentiometer so that only part of its output is applied to the valve.

The pair of contacts on the "radio - gram" switch labelled "Screen-grid circuit of RF valve" should be wired in series with the screen-grid connection of one or more of the RF stages, so that the screen voltage is removed on gramophone to prevent the break-through of radio signals. The connection should be made at a point of low RF potential.

WIRELESS LEGISLATION

Attitude of English Law to Radio Transmission

By a Legal Correspondent

TO the radio engineer, a transmitter is a device for producing radio-frequency oscillations, which are radiated in the form of electro-magnetic waves and of which a BBC transmitter and the neighbour's vacuum cleaner are merely two extreme examples. The inevitable, but unfortunate, system of controls which the complexity of modern civilisation demands has not, in the case of radio transmitters, included the type of control that the average radio engineer would desire. To him, the unfettered use of radio transmitters—using the word transmitter in the widest sense—can only result in chaos and an unwarrantable interference with reasonable reception facilities.

While the desired control has been indirectly achieved by the Postmaster-General's monopoly over communication transmitters, the complete lack of control over sources of radio interference is something which has frequently evoked unfavourable comment in this journal and elsewhere.

The purpose of this present article is not the suggestion of possible reforms, but merely to discuss the existing legal position in simple terms. Nobody can seriously consider reforms unless they are first aware of what is the present state of the law.

Crown's Monopoly.—The impact of legislation upon transmitters has, apart from wartime controls, been purely concerned with the retention of the Crown's monopoly over the development of communication systems. With the fruits of State monopoly over the Post Office fresh in the Government's mind, it was logical that the advent of line telegraphy in the middle of the last century should be realised as a further means of enriching the public purse. Hence in 1863 was commenced a series of statutes[1] that have vested in the Postmaster-General a complete monopoly over all telegraph undertakings. The telegraph was defined as "any apparatus for transmitting messages and other communications by means of electric signals."[2]

The use of wireless as an added means of communication very naturally brought about an extension of the Postmaster-General's monopoly to this new field which was carefully defined in the Wireless Telegraphy Act of 1904. The conception of wireless as an extension of line telegraphy is apparent from the definition given by the Act to "wireless telegraphy," for it incorporated the definition of telegraphy that has already been seen:—

> "any system of communication by any apparatus for transmitting messages and other communications by means of electric signals, without the aid of a wire connecting the points from and at which the messages or other communications are sent and received."

Under the 1904 Act, a wireless telegraphy station cannot be operated except under licence from the Postmaster-General, exampled by the familiar receiving licence and also the amateur transmitter's licence. This serves to stress the attitude of the legislature, which is solely concerned with the protection of the Crown's monopoly, the powers conferred on the Postmaster-General being confined to the exercise of that protection. The restrictions on operating of radio transmitters are not designed to prevent chaos and interference, but merely to prevent private persons from carrying on a wireless communication business in competition with the State.

Extent of "Wireless Telegraphy."—So long as the conception of monopoly protection is borne in mind, the limitations of the definition given to "wireless telegraphy" are perfectly reasonable. Consequently a licence is only necessary where there is a system for "transmitting messages and other communications." The Oxford Dictionary defines "communication" as—"the imparting, conveying or exchange of ideas, knowledge, etc.," and it is only too evident from this that quite a fine distinction can decide the necessity of a licence or otherwise. The erection of a high-power transmitter to radiate an *unmodulated* carrier does not appear to require a licence, nor would a radar equipment. So that while a licence is not required for a train of pulses carrying no intelligence, a licence would be required for a pulse-modulated communication equipment. It will also be observed that the statutory definition given to "wireless telegraphy" includes what the radio engineer would normally distinguish from it—i.e., "wireless telephony." It is considerations such as these that reveal the inadequacy of the existing legislation in treating the operation of radio transmitters purely as competitors with the State.

Wartime Controls. — Let me hasten to add some words of warning to the reader recently demobilised from REME, who may be rashly considering the construction of a radar equipment in his back-garden! Wartime emergency regulations still govern the use of wireless equipment, and these repay consideration because they reveal the awareness of the Legislature to progress since 1904.

The Postmaster-General was, in 1939,[3] given the power to prevent the use of certain wireless apparatus, except under his written authority. The wireless equipment brought within the PMG's scope indicated the concern of the State in the defence of the realm:—

1. Wireless transmitting apparatus—defined as "apparatus for making communications by means of wireless telegraphy, wireless telephony or wireless television."
2. Wireless reception apparatus designed for use as a transmitter as well as a receiver. This, of course, is intended to include the trans-ceiver.
3. Apparatus other than a transmitter which generates electrical energy exceeding such number of cycles per second as may be specified. (The order could hardly specify radar equipment, but this description obviously includes such apparatus.)

It should be stressed that the above merely indicates the type of apparatus of which the PMG may restrict the use; the actual restriction does not come into force until the PMG makes an order—and then only to such apparatus as he decides to include. In pursuance of these powers he has made orders[4] restricting both the possession and use of:—

1. Communication transmitters.
2. Navigational beacons or direction-finding apparatus.
3. Apparatus for the remote control of machinery.

The relaxation of wartime controls is something that we all hope to be not too far distant, but are we to be left with the pre-war position in which the State's only conception of wireless is as a competitor to its own monopoly over communications?

Radio Interference a "Nuisance"?—Having observed the comparative immunity possessed by sources of radio interference, which can only be overcome by statutory changes, it is profitable to consider whether the common law of the land can be invoked.

The law that has been handed down to the present era through centuries—or the "common law" as lawyers term it, has always attached considerable importance to the rights possessed by an occupier of land in his enjoyment of that land. Above all, he is entitled "to the comfortable and healthful enjoyment of the premises owned by him, whether for pleasure or business."[5]

The violation of such a right is termed a "nuisance," and there are many examples of what acts amount to a nuisance in the eyes of the law. For one person to make such a noise as materially interferes with the ordinary comfort of his neighbour, renders that person liable to a civil action for nuisance, the remedy for which can either be the actual stoppage of the source of noise or sometimes damages. However, it is, rather naturally, not all noises which amount to a nuisance and the test is said to be measured by "plain and sober and simple notions obtaining amongst English people." Hence while it was decided that "a 5,000-h.p. dynamo" amounted to a nuisance[6], a "low humming note" from a transformer did not amount to a nuisance.[7]

The physicist may explain a "noisy nuisance" in different terms, but it still means the same thing. He, for example, might say: Assume that a person installs in his house a vibrating body acting on the medium of air by communicating to it a certain number of impulses per second, which impulses will give rise to waves of condensation and rarefaction travelling through the medium of air, being communicated to the neighbour's organ of hearing. Now if these impulses interfere with the neighbour's comfortable enjoyment of his property—they amount to a nuisance.

The radio engineer may well reply: Assume that a person installs in his house an RF radiator acting on the medium of ether by communicating to it a certain number of impulses per second, which impulses will give rise to electro-magnetic waves, travelling through the medium, being communicated to the neighbour's apparatus for detecting such waves; i.e., his radio receiver. Surely, asks the radio engineer, if these impulses interfere with the neighbour's comfortable enjoyment of the BBC programme—why should they not equally amount to a nuisance?

Such a question has never been decided, nor, so far as I am aware, has the suggestion ever been made that radio interference might be classed as a nuisance. Yet such a suggestion would appear to be perfectly logical, especially as sound and radio waves are but two examples of wave-motion. Unfortunately the answer must remain open until the issue is brought before the Courts.

References

1. Telegraph Acts, 1893-1925.
2. Telegraph Act, 1869; S.3.
3. The Defence (General) Regulations, 1939. S.R. & O., No. 927.
4. S.R. & O., 1939, No. 1688. S.R. & O., 1943, No. 1219.
5. Halsbury's "Laws of England," Volume XXIV.
6. Shelfer *v.* City of London Electric Light Co., Ltd., 1895. I CH.287.
7. Heath *v.* Brighton Corporation, 1908. L.T. 718.

SERVICE VALVES

IN *Wireless World* for August, 1945, we gave a list of the type designations of valves used in Navy, Army and Air Force apparatus, with their equivalents or near-equivalents in civilian types. This back number is now out of print, but reprints of the list can be had from our Publisher, price 4½d. by post.

THE DC RESTORER

Its Uses in Television and Radar

By "CATHODE RAY"

NOW that television is stretching itself after its 6-year sleep, readers who were beginning to take an interest in it before the war may be finding that a certain amount of mental rust or mildew has accumulated on their understanding of those little technicalities that occur in television circuits. Others no doubt are having to learn radar in order to fill the aching voids left by the early age-and-service groups, and are coming up against the same technicalities. One of them is the cathode follower, which I discussed at some length in the November, 1945, issue. Another is the DC Restorer.

Although less genteel, the American term "clamping circuit" is more graphic. For the purpose of DC restorers is to tie either positive or negative peaks of a signal down to some fixed potential instead of allowing them to wander about whenever the amplitude changes. For instance, if Fig. 1*a* represents a signal voltage—of any frequency—varying about zero volts, and the amplitude increases, the final result in most circuit arrangements is that the signal voltage extends farther in both positive and negative directions, as at *b*. In some systems, especially those employing cathode-ray tubes, such as television and radar, this fails to produce the desired effects. What is wanted is something like *c* or *d*, or even *e*.

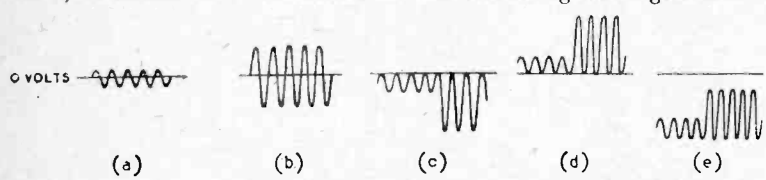


Fig. 1. A purely alternating signal (a) grows both positively and negatively (b) ; but one sometimes wants variations in a negative (c) or positive direction only (d) from zero or from some other chosen level (e).

As a practical example of the difference this "clamping" makes, consider the brightness level of a television scene. Suppose the opening of a play discovers the hero in his lonely attic, working through the night by the light of a candle. Even if the candle is an electric one, the vision signal from the transmitter is likely to be of relatively small amplitude. When the electrician switches on the dawn, the illumination of the scene, and therefore the signal from the transmitter, increases. This effect will be lost if the corresponding signal reaching the grid of the receiver cathode-ray tube increases both ways, as in Fig. 1*b*, for the average brightness will remain much as before and only the contrast will be increased. A dim view will literally be taken of this. What is wanted is more like Fig. 1*d*.

The B.B.C. take care to make their modulating signal increase in this way ; it is in the receiver that it may come unstuck from its darkness-level base-line. The culprit in this and other cases is the coupling condenser or transformer that passes on the variable or alternating part of the signal but not the mean level or "DC" part. Fig. 2 shows the input portion of a stage of amplification, with a condenser C to prevent the highly positive anode voltage of the previous stage from getting on to the grid, and a resistor R to tie the initial grid potential to whatever negative value (in relation to the cathode) the cathode resistor is designed to give it. In the absence of a signal via C, no current can pass through R, and the grid must be at the same potential as the earth line (and, of course, negative with respect to cathode). The only way a signal voltage can be applied to the grid is for a current to pass through R ; and, as we have applied a negative bias to prevent grid current from flowing, the only current that can flow through R has the effect of charging up C.

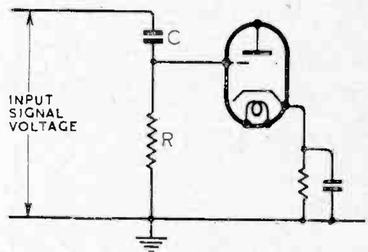


Fig. 2. The input portion of an amplification stage.

So it is impossible for the grid to receive a signal voltage that tends to be either positive or negative for any great length of time ; the condenser would just charge up to that voltage and then the charging current would cease to flow and no voltage would be developed across R. The purely alternating part of a signal gets through all right, provided that the resistance of R and the capacitance of C are sufficiently large for the condenser to have had too little time to be charged to any appreciable voltage in one direction before the signal voltage has got to work in the opposite direction.

You would like that again in slow motion ? Suppose then, for example, R is 1 megohm and C is 1 microfarad. Then the *time constant* of the combination is 1 second ; that is to say it will take 1 second for the condenser to be charged to about 63 per cent. of the applied voltage. In the small fraction of a second during which a signal voltage of any ordinary frequency remains continuously positive—i.e., one half cycle—the condenser hardly has time to charge up to any voltage, and practically the whole of the signal voltage is developed across R by the small charging current, and reaches the grid. Which is as it should be.

At the end of that half-cycle the applied voltage becomes negative, and has to start replacing any small positive charge the condenser has received by a negative charge. But R offers such a large opposition that before reversing process has gone very far the signal voltage has reversed again. It is as if a sergeant were ordering 10,000 men alternately to fill and empty the Royal Albert Hall, and were shouting " In . . . . Out . . . . In . . . . Out . . . . " like a boat race coach. There would be a continual alternating rush through the narrow entrances (R in Fig. 2). But if he were to make up his mind one way or the other, the current of men would ultimately cease. It could not continue indefinitely.

Similarly, then, the voltage across R cannot tend in either direction indefinitely. Over any lengthy period of time, the average voltage must be zero, the positive and negative parts being equal. Over a brief period, however, such as a single half-cycle, it can be unidirectional. The thing that decides whether a period of time is " lengthy " or " brief " is the time constant, obtained by multiplying the number of microfarads (C) by the number of megohms (R). So to make sure that practically all the signal voltage reaches the grid, choose R and C so that their time constant is much greater (at least 10 times greater) than the longest half-cycle of any wanted signal. If you work it out, you will see that it would be very expensive to make sure that long-maintained signal voltages—such as those corresponding to changes in the brightness of a television scene, which might last many hundreds of seconds—were reproduced. What actually happens with coupling condensers of reasonable capacitance is that a signal such as Fig. 3*a* reaches the grid like Fig. 3*b*. The charge on C adjusts itself, more or less gradually, until the mean voltage is zero.

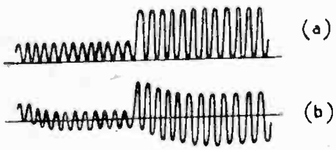


Fig. 3. When a signal such as Fig. 3a is applied through the familiar coupling shown in Fig. 2 it loses its unidirectional characteristics and degenerates into Fig. 3b.

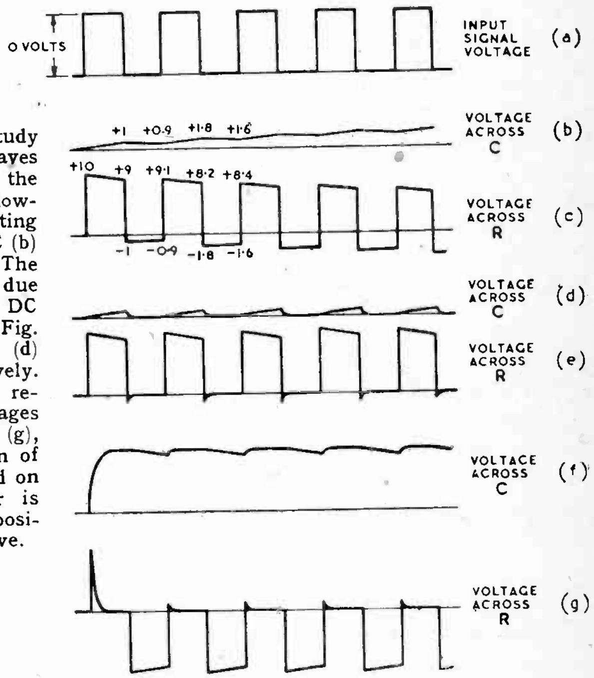


Fig. 4. Detailed study of a train of waves (a) applied to the Fig. 2 circuit, showing the resulting voltages across C (b) and R (c). The modified results due to adding a DC restoring diode (Fig. 5) are shown at (d) and (e) respectively. If the diode is reversed, the voltages are as at (f) and (g), and the direction of the signal passed on to the amplifier is reversed from positive to negative.

To make quite sure that this behaviour is understood, it should be followed cycle by cycle for a little while. This can be done most easily if the applied signal voltage is assumed to have a square or rectangular form, as represented in Fig. 4*a*. Again for simplicity, assume the signal alternates between zero and + 10 volts; and that its frequency is such that during one half cycle the condenser has time to charge to one-tenth of the applied voltage.

During the first half-cycle, then, the condenser charges to + 1 volt (Fig. 4*b*). As the voltages across C and R must always add up to equal the applied voltage, the voltage across R, due to the charging current, must be the difference between the input and the condenser voltages (Fig. 4*c*). By the end of the half-cycle, therefore, it has dropped from + 10 to + 9 volts. It is important at this stage to realise that the condenser is + 1 volt relative to the grid, but is —1 volt relative to the input, and that the actual potentials of the condenser terminals are + 10 and + 9 volts relative to earth. The applied signal then suddenly goes 10 volts less positive. As the voltage across the condenser cannot change instantaneously, its grid side must also go 10 volts less positive; and as it started at + 9 it must go to — 1. If left in this state it would eventually discharge to the present applied signal voltage (zero), but, according to our assumption regarding the duration of a half-cycle, it only has time to discharge by one-tenth, from 1 volt to 0.9. Remember again that the voltages across C and R must invariably add up to the input voltage, so during the even half-cycles they must be equal and opposite to one another. At the end of the second half-cycle the grid is at —0.9 volt, so the beginning of the third half-cycle, when the input again goes 10 volts positive, brings it up to + 9.1; and as the condenser adds one-tenth of this to its charge

The DC Restorer—

during the half-cycle the final grid voltage is + 9.1–0.91, or about + 8.2. If you have time and patience to keep on working it out in this way for a dozen cycles or so you will confirm that the signal voltage at the grid gradually droops until the positive and negative amplitudes are equal. Any change in the positive amplitude of the applied voltage will produce only a transient unidirectional change at the grid; it soon divides itself equally between positive and negative. And similarly for a change in the negative amplitude of the applied signal.

If the positive half-cycles were to last, say, twice as long as the negative, the final amplitude on the positive side would be half as great as on the negative, the average positive and negative voltages again being equal.

If it is necessary to preserve the Fig. 4*a* layout, what is needed is something to prevent the condenser from accumulating a charge. Each positive half-cycle of the signal would then start from scratch, instead of with a gradually increasing handicap. This can easily be done by greatly reducing the resistance of R during the discharging half-cycles—the even ones—and restoring it to its full amount during the others to enable the positive voltages to be developed across it.

The obvious solution is a rectifier, connected across R as in Fig. 5, so as to pass current when the grid side goes negative. During the first half-cycle this diode rectifier does nothing (except

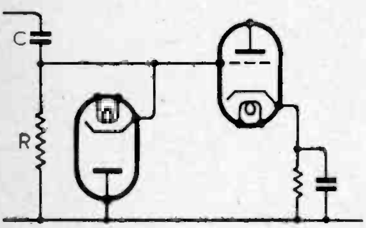


Fig. 5. How a diode should be connected to give the signal a positive polarity as at Fig. 4e.

slightly increase the stray capacitance) because its anode is negative with respect to the cathode; and the waveform picture is as before. During the next half-cycle, when the amplifier grid goes negative, the diode conducts and shunts R by a comparatively low resistance. So the time constant is now very short, and the con-

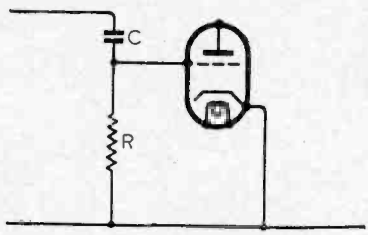


Fig. 6. If a negative-going signal is wanted, the circuit can be simplified to this.

denser discharges quickly (Fig. 4*d*) restoring the *status quo*. Every cycle therefore starts from the region of zero.

If one wants the signal to work negatively from zero, all that has to be done is to reverse the rectifier. The result is that the first positive half-cycle makes it conduct heavily, charging up the condenser to practically the full signal voltage (Fig. 4*f*). This charge, topped up once per cycle, pushes the whole signal voltage below the base-line (Fig. 4*g*). In these circumstances there is no need to have any grid bias; in fact the best use is made of the valve characteristics by leaving it out. The diode is then exactly in parallel with what is in effect another diode—the grid and cathode of the amplifying valve—and becomes superfluous. All this cleans the circuit up nicely, leaving only what is shown in Fig. 6. This is no doubt hailed with a whoop of recognition as a specimen of the cumulative grid detector. But it doesn't do to be too sure, before finding out the values of C and R in relation to the frequencies to be handled. If they were designed for DC restoration, they might be quite unsuitable in a grid detector, where what is wanted is audio-frequency restoration. It is at this point one can easily become muddled; so let's get these frequencies clear.

The stuff that comes from an ordinary broadcasting station consists of radio-frequency waves that vary in amplitude at an audio-frequency rate according to the sort of noise that is going on in front of the microphone. Fig. 7*a* may do to represent a sample. The audio-frequency voltage is here non-existent as such, because the average voltage (shown dotted) *taken over any AF cycle* is zero. If such a signal is applied to a grid detector, it behaves exactly according to the foregoing explanation of a negative-going DC restorer, and the result is Fig. 7*b*. Here the average voltage, again shown dotted, varies at audio frequency; and it only needs the RF voltage to be smoothed out in order to look something like the currents from the B.B.C. microphone. But whereas in the DC restorer the time constant can sometimes hardly be made too long, in the grid detector it is important to make it not only long compared with the RF cycles, but

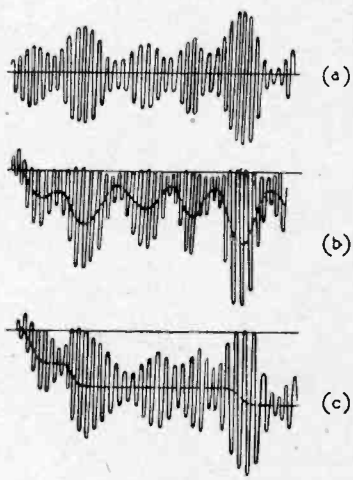


Fig. 7. Although Fig. 6 represents also a grid detector circuit, designed to convert modulated RF (a) into a unidirectional signal (b) from which the AF can be extracted, unsuitable choice of values of C and R might give (c) instead.

short compared with the shortest (i.e., highest frequency) AF cycles. The result of breaking this rule by making C and R as large as possible is suggested by Fig. 7*c*. The condenser is fairly quickly charged through the low-resistance grid-cathode path, and soon reaches the peak amplitude of the RF signal. But the discharge through R, being very slow compared with the AF variations, keeps the mean grid potential almost constant. So the AF is largely ironed out. This can be demonstrated by connecting a large capacitance in parallel with the detector condenser in a receiver. The high audio frequencies suffer most. It is in AGC that the DC restorer finds its vocation in this sort of receiver.

Remembering that we are supposed to be thinking about television, or perhaps radar; consider a television "signal." It has *three* lots of frequencies. First there is the carrier frequency, which is very high RF, say 40,000,000 c/s or more. Then there are the variations in amplitude of the carrier, corresponding to variations in light over the scene, covering a range of 25–2,000,000 c/s or more (known as VF). The synchronising signals come into this range. The third is a comparatively slow variation in the amplitude of the carrier, or even a stationary condition, corresponding to the average brightness of the scene. Its range goes down to zero frequency.

Fig. 8*a* illustrates three consecutive lines of a television picture. The RF cycles are so numerous that they can be represented only by shading, and you have to imagine them. Their amplitude as far as the dotted limits is for synchronising purposes only, and is designed to have no effect on the receiving tube. The interruption at the end of every line causes the cathode ray at the receiver to trip back to start a new line. During each line the RF varies at

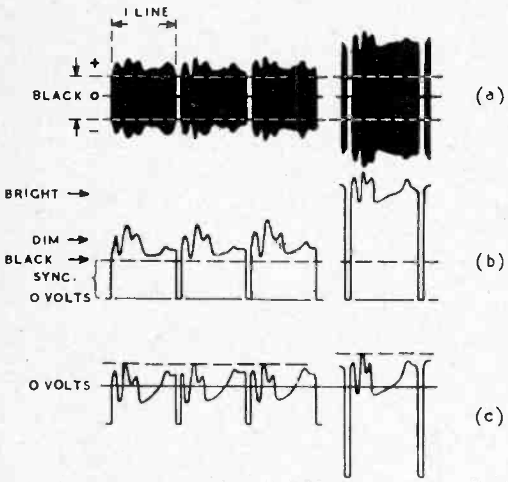


Fig. 8. Sample television waveforms showing three consecutive lines from a dim scene and one from an otherwise similar bright scene. (a) represents the RF as broadcast, (b) the filtered output from the detector, and (c) the result of passing (b) through a coupling condenser.

VF rate, and in the three samples shown its amplitude is only slightly more than "BLACK," so a dim scene is depicted. The fourth sample shows a similar amount of VF contrast in a brighter scene.

In the television receiver the time constant of the detector obviously has to be very short indeed to cope with the highest VF, and the ordinary grid detector won't do. A special diode is generally used, but in principle it is the same. As the cathode-ray tube is brightened by making its grid less negative, the output of the detector (if sufficient to work the tube direct) must be positive-going, as shown at Fig. 8*b*, where the modulation has been recovered and the RF smoothed out. The detector acts also as a DC restorer, and gives a greater voltage output for the greater RF amplitude shown in the fourth line (even though the VF amplitude is similar to that in the other three), and the CRT brightens visibly. The detector is able to do this although its time constant is very short, because the "DC" is represented by the amplitude of the RF

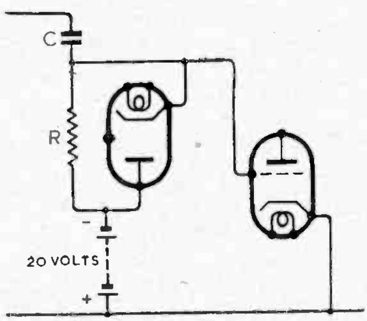


Fig. 9. Example of a DC restorer giving a base-line other than zero volts; in this case −20.

cycles. But if for any reason it is necessary to pass the resulting "VF + DC" signal through a coupling condenser—almost inevitable if a VF amplifier is used—the signal output "droops" in the now familiar manner until it becomes as much negative as positive. Although the negative synchronising signal sticks out much more with a bright picture than with a dim one, its duration is so slight that it doesn't affect the VF level much, and most of the brightening is lost, as in Fig. 8*c*. So a DC restorer must be added to clamp the tips of the synchronising signals to some suitable fixed potential so as to raise bright scenes above dim ones.

Talking about "some suitable fixed potential" reminds me that one is not obliged to base the waveform on zero volts. Fig. 9, for example, shows Fig. 5 modified to bring the base-line to −20 volts.

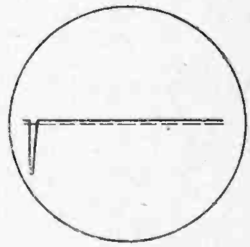
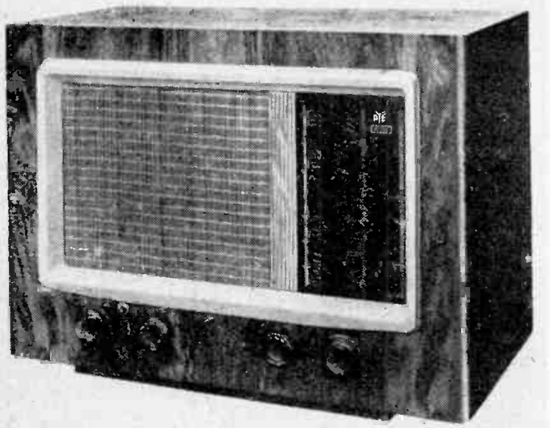


Fig. 10. A radar trace without echoes; base-line above zero.

As regards radar, there are plenty of possible applications. You have no doubt seen pictures of the way echoes are shown on the CRT in some types of radar. The beam is being swept horizontally by the efforts of a time-base generator, and any echoes picked up show as vertical deflections. If the trace were clear from echoes, and only the "ground ray" were being received, the signal via a coupling condenser would set the base-line very slightly above zero (shown dotted in Fig. 10). If a number of large echoes, or interference voltages, were to come up, the signal below the dotted line would then outweigh the thin strip above, and the trace would move upward to restore the balance. Such a shifting base-line would be a nuisance, so a DC restorer can be used to anchor it.



Test Report

PYE Model 15A

AC Table Model Superhet (3 Valves + Rectifier):

Price £15, Plus Tax £3 4s. 6d.

THE designers have succeeded in giving an effective and versatile performance with an economical circuit. An attractive walnut veneer cabinet of adequate size (18in. × 13in. × 9in.) makes a welcome relief from standardisation without suggesting undue extravagance. The tuning dial is well lighted and easy to read and the controls are well spaced at table level.

Circuit.—Three stages are used, their functions being frequency changing, IF amplification and combined detection and power output. A transformer with high-impedance primary couples the aerial to the frequency changer and the arrangement gives efficient coupling on both indoor and outdoor aerials.

The triode-hexode frequency changer is followed by a pentode IF amplifier operating at 465 kc/s. Both these valves are controlled by AVC derived from the primary of the output IF transformer. The signal and AVC diodes are combined with the output stage which is a pentode rated to give 4 watts.

Tone control is effected in four stages by negative feedback between anode and grid circuits of the output valve. The feedback is through a complex resistance-capacity network which is varied to give different degrees of feedback in top, middle and bass.

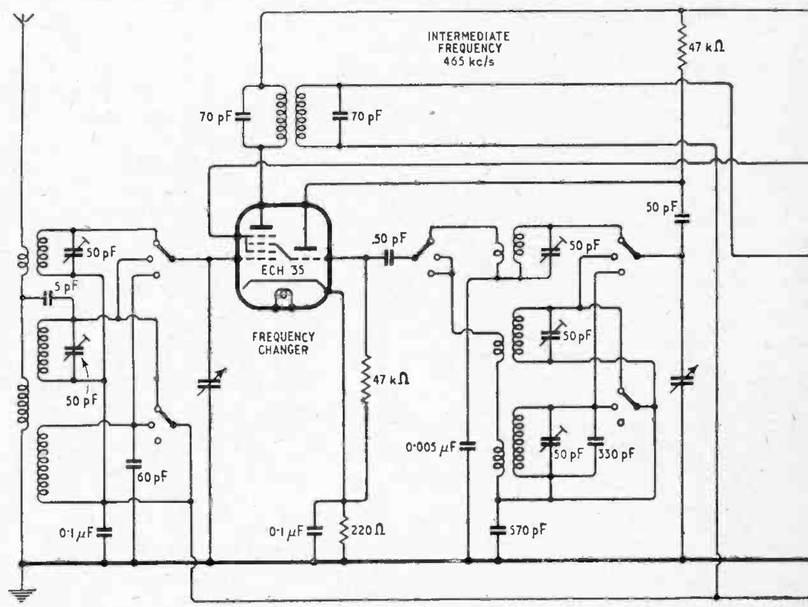
WAVERANGES		
Short	16.3 - 51.8	metres
Medium	185 - 575	,,
Long	1000 - 2000	,,

There is provision for a gramophone pick-up which also enjoys the full range of tone control.

Performance.—Sensitivity is exceptionally good on all wavebands. During the period of test excellent signals were received from America, Singapore and Australia.

Selectivity is entirely satisfactory and gives adequate separation of all worthwhile stations. Self-generated heterodyne whistles were noticeable on all three wavebands but were confined to gaps between stations when sensitivity under the influence of AVC was a maximum.

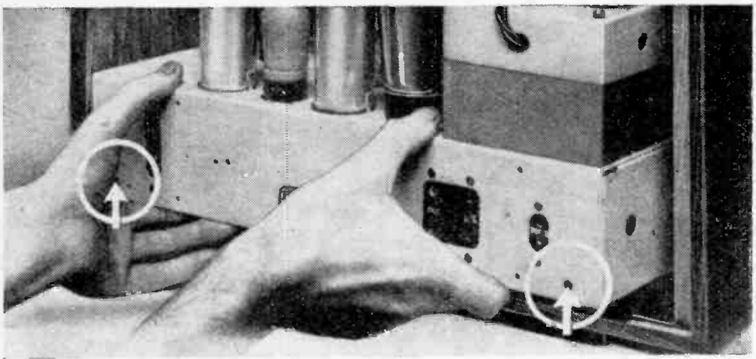
The reproduction of speech and music is free from any noticeable resonance and there is sufficient bass response to give adequate balance. The "Fi" position of the tone control gives a better high - frequency response than most pre-war table models and can be usefully employed when listening to the local station. In the second position ("Bri") the top response is about average and this is the setting one would normally use on foreign stations. There are two further degrees of top cut marked "M1" and



Complete circuit diagram. An interesting feature is the tone control system which makes use of negative feedback in the output stage.

"M2" which may be needed in cases of severe interference.

Constructional Details.—The chassis is very easily withdrawn from the cabinet. Plug-in connections are provided for the loudspeaker, the control knobs are of the push-on variety and only two screws—readily accessible from the back of the set—are used to secure the chassis. It is not even necessary to remove the chassis in order to examine the underside wiring which is reached through a large rectangular hole in the base of the cabinet.



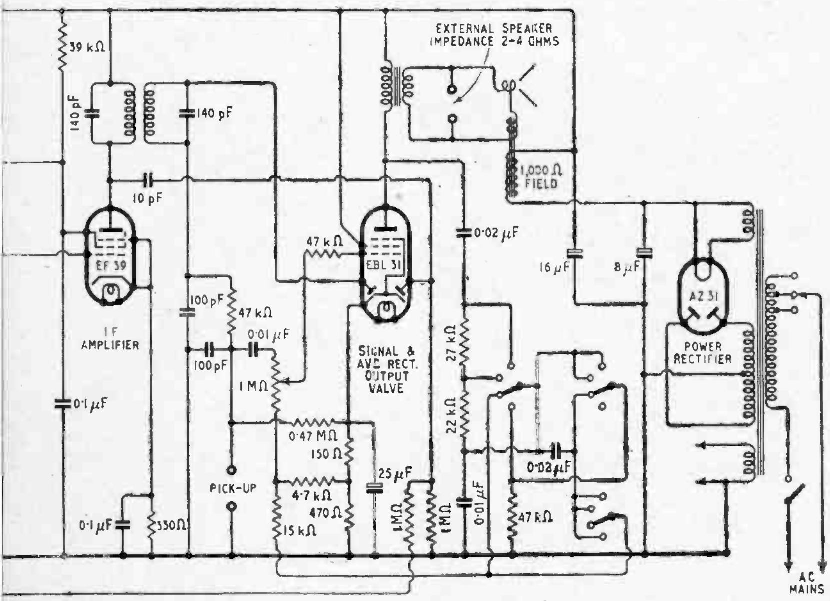
The chassis is easily lifted out after removing only two screws. Detachable leads are provided for the loudspeaker connections.

By comparison with pre-war sets, the wiring layout is simple and well thought out. Instead of the usual tangled undergrowth of resistors, etc., overlying the valve holders one finds ample space for a soldering iron to reach every joint without fear of charring the insulation of neighbouring wires.

Switch contacts are easy to get at and the slow motion tuning drive is of simple design in which the replacement of the cord should present no difficulty.

An engraved tablet on the back of the chassis gives the valve types and their position in the set.

Makers.—Pye Radio Ltd., Cambridge.



AMATEUR LICENCES

FOLLOWING further discussions between the Radio Society of Great Britain and the General Post Office, it has now been announced that the re-issue of transmitting licences to all pre-war holders requiring them is to commence forthwith.

For the present transmission will be restricted to the 28-29 Mc/s and the 58.5-60 Mc/s bands.

The anomalous artificial aerial licence is discontinued and pre-war holders of such licences will be allowed radiating transmitters. However, a morse test will be required, but in the case of those who have served in one or other of the Signal Services during the past few years in trades where proficiency in morse is essential, this may be waived.

The granting of authority to use higher power than generally permitted before the war makes welcome news. The new licences will allow up to 100 watts input on the 28-29 Mc/s and 25 watts input on the 58.5-60 Mc/s bands respectively. This concession will be granted for both telegraphy and telephony to previous holders of the full licence; pre-war artificial aerial permit holders will be allowed, initially, 25 watts input on both bands for telegraphy only.

Operating conditions and station management remain much the same as hitherto, but in view of the slightly narrow bands envisaged particular care will be required in monitoring transmitter frequencies. The avoidance of interference with other services outside these amateur bands is the onus of the station operator.

The insistence on the use of the call "Test" when inviting cooperation of other amateurs has been waived, due, no doubt, to the changed status of the new licences; these now become *amateur* as distinct from *experimental* licences.

Discussions continue regarding the use of the 1.7, 3.5, 7 and 14 Mc/s bands and also in respect to new allocations in the VHF part of the radio spectrum. There is also the question of the issue of permits to those who were not licensed before the war, and it hoped that an announcement on this matter will shortly be forthcoming.

It is learnt that amateur activities have already recommenced in the USA and Canada. The frequency allocations are temporarily: 144-148 Mc/s, 56-60 Mc/s and 28-29.7 Mc/s. This introduces a new 2-metre band and there will later be a new 5-metre band between 50 and 54 Mc/s, which will replace the present allocation.

B.B.C. DISC RECORDING

Some Technical Details of the New Equipment

By H. DAVIES, M.Eng., A.M.I.E.E.
(Research Department, British Broadcasting Corporation)

OF the various systems of sound recording used by the B.B.C., lateral recording on cellulose-coated discs has so far been found to have the widest application, and its use has greatly increased in recent years. None of the disc recording equipment available, however, has entirely met the requirements of the service, and a new equipment, which is the subject of a number of patent applications has recently been developed by the B.B.C. Research Department.

Since, in practice, recordings must often be made under rushed conditions, the aim has been to make an equipment which is both easy and quick to operate and which will at the same time provide recordings of the highest quality consistently and with a minimum of special attention and maintenance. The general construction is therefore robust, with almost complete enclosure of the working parts, but at the same time attention has been given to accessibility, so that when the inevitable fault does occur the faulty unit may be replaced with the least possible delay.

In addition to these general and basic requirements, some special features which experience has indicated to be desirable are incorporated. For example, provision is made for reproducing and listening to a recording whilst it is being made, and to enable full advantage to be taken of this a special " blow and suck " swarf removal system has been developed which is both reliable and sufficiently quiet to permit of loudspeaker listening in the same room.

A recording " channel " is an equipment capable of making continuous recordings of any duration, and it consists of two recording machines with a central control desk, as shown in Fig. 1. Each recording machine is self-contained, with the recording amplifier and its supply unit housed inside the pedestal, while the control desk contains the replay amplifiers and the electrical equipment which is common to both machines.

The recording amplifier and its supply unit have wheels which run on rails built into the machine. These rails are continued on the inside of the machine doors, so that when a door is opened as in Fig. 2 it forms a shelf on which the amplifier or supply unit can run as soon as the connecting cables have been unplugged.

The recording amplifier contains the necessary frequency weighting networks, including the " radius compensation " circuits which increase the amount

Fig. 1. General view of Type D recording equipment.

of high frequencies that are fed to the cutter head progressively as it approaches the centre of the disc. This is commonly done to provide some compensation for the loss of top that occurs on reproduction.

The maximum power output is, of course, much greater than the power actually used, since the cutter head is inductive and the amplifier must therefore be able to deliver both the voltage corresponding to peak level at the highest frequencies and the current corresponding to peak level at the lowest frequencies. This product of maximum volts and maximum amperes is considerably in excess of the volt-amperes actually taken at any moment. But even with, say, 75 V/A available and using a cutter head of quite normal sensitivity, occasions may arise when the power is scarcely adequate, for a peak level at high frequency may occur when the cutter is near the centre of a $33\frac{1}{3}$ r.p.m. disc where radius compensation is a maximum. Such a contingency may be quite rare, but when it does occur the voltage required will be considerably increased. Provision must obviously be made to meet such a case, but to do so simply by increasing the amplifier power has disadvantages both economic and otherwise, for doubling the amplifier output gives only 3 db more power, which in itself is insufficient, yet each successive doubling involves more expense and bulk than the last, and provides against a contingency which at each step becomes more remote.

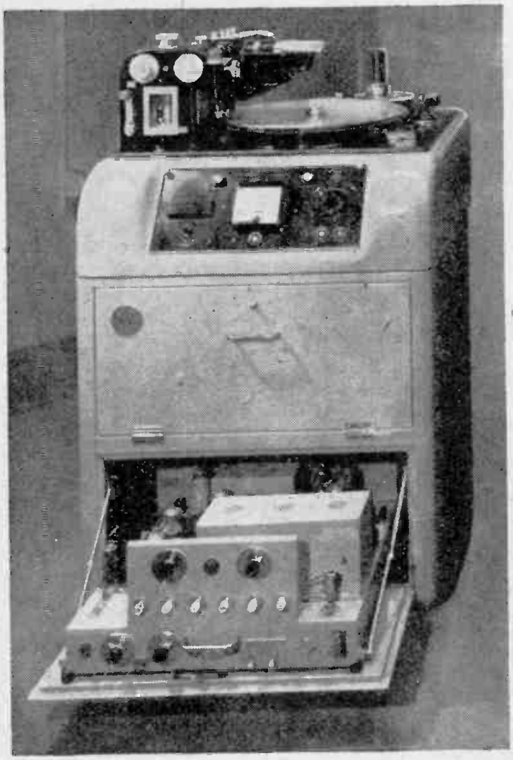


Fig. 2. Amplifiers in the recording unit are readily accessible.

The amplifier output has therefore been fixed at approximately 75 V/A, which is about as high as can conveniently be combined with the advantages of modest HT voltages, and is sufficient to meet all normal requirements. On the rare occasions when still more power is needed, a device known as the "overload protector" comes into action and prevents distortion occurring. In effect the "overload protector" keeps watch on the voltage and on the current delivered by the output stage, ready to reduce the gain of the amplifier if it is necessary to prevent the maximum values for undistorted output being exceeded. The action is somewhat similar to that of a limiter, but the "protector" is not concerned with the general level of the programme; it operates only when required to prevent the output stage being overloaded. By this means an amplifier of relatively modest size may be safely employed without distortion occurring on those few occasions when a greater power could be used.

The "overload protector," of course, operates only very rarely, and when it does the operator is informed by the amplifier pilot light on the control panel blinking. This light also blinks during the time that the amplifier is warming up after being switched on. By means of selector switches all the feed currents and voltages in the recording amplifier can be read on the large square meter seen on the control panel in Fig. 2.

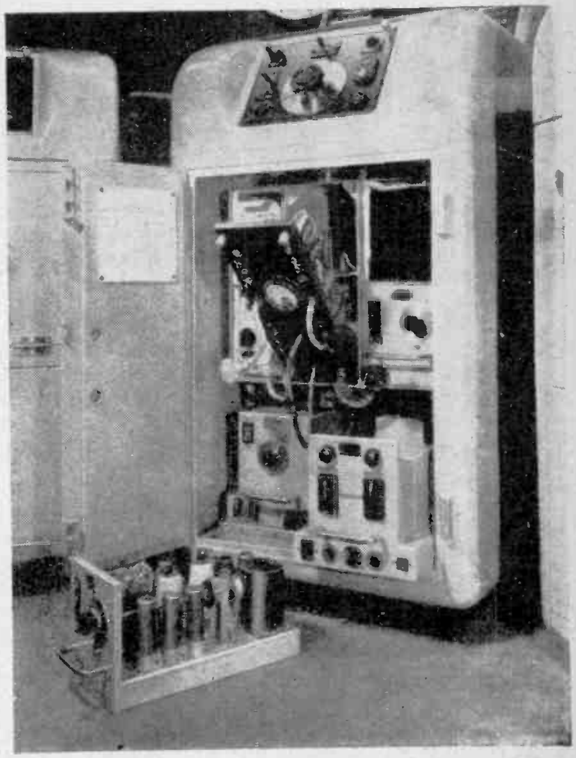


Fig. 3. Control desk—view with amplifiers detached.

B.B.C. Disc Recording—

Fig. 3 shows an inside view of the control desk, with one of the doors removed. The replay amplifiers, one of which is shown withdrawn, are housed in an elastically mounted box to protect them from vibration or shock. Underneath is a high-gain loudspeaker amplifier with 12 V/A output, and, partly withdrawn, a supply unit. Any unit can be instantly withdrawn on removing the plug connector, and the feed currents can be measured on the central meter.

The recording machines are designed to give turntable speeds of $33\frac{1}{3}$ r.p.m. and 78 r.p.m., to traverse either from outside to inside or from inside to outside of a disc, and to give a continuous adjustment of groove pitch from 96 to 136 grooves per inch in either direction.

The turntable is driven by a $\frac{1}{8}$ h.p. 1,500 r.p.m. 3-phase synchronous motor which, with its shaft vertical, is attached to the machine frame by three sets of elastic mountings disposed so as to give adequate stability and, at the same time, to reduce the vibratory forces reaching the machine frame to a negligible value. The motor drives a lay-shaft by a coupling which was specially developed for the purpose, and which, while stiff torsionally, is very free in all other ways. This coupling effectively prevents transmission of vibration from the motor to the lay-shaft. The top of the lay-shaft is stepped, and the turntable can be driven at either of the two speeds by engaging a Neoprene idler wheel between the larger or the smaller diameter and the rim of a wheel which is mounted on the turntable shaft.

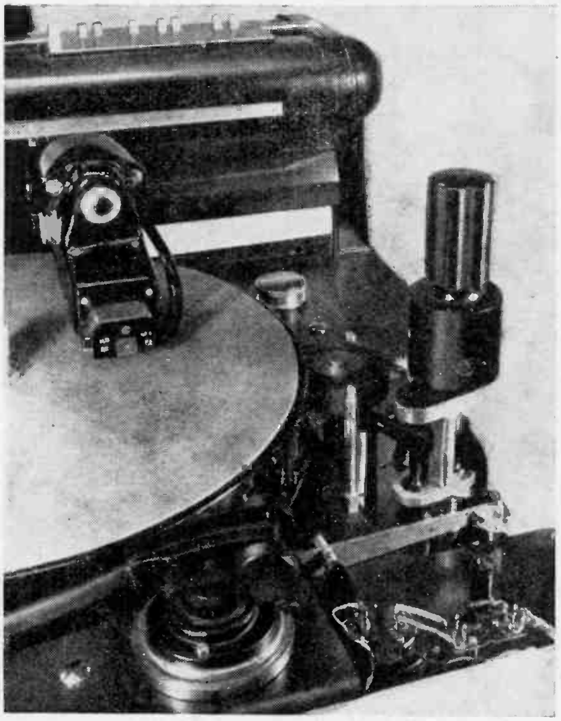


Fig. 4. Close-up of turntable drive showing change-speed control and idler wheel.

The vibration on the motor has been isolated from the lay-shaft by the coupling and from the machine frame by the elastic mountings, and the lay-shaft runs at the correct speed, free from vibration. The idler wheel, therefore, need function only as a form of toothless gear, and its performance in this respect need not be compromised by the need for preventing too much vibration transmission through the wheel as is the case in the conventional arrangement with an idler driven direct from the motor shaft. Even with this simplication of its duties, however, the idler wheel must still meet a number of conflicting requirements, and the wheel actually used has been adopted only after a considerable amount of investigation and experiment.

The idler wheel, with its self-lubricating bearing, is mounted on a link mechanism which is arranged to give a certain amount of servo action whereby the pressure of the idler wheel on the driving surfaces automatically adjusts itself to the torque being transmitted. Relatively light working pressures can therefore be used without wheel slip and consequent irregular wear occurring whenever the drag on the idler wheel is increased. This, of course, will happen during starting and whenever a disc is put on or removed while the turntable is running. It is arranged that the action of changing the turntable speed will automatically change the radius compensation circuits and will suitably adjust the amount of servo action obtained.

When the turntable is stopped the idler wheel withdraws from contact with the driving and driven surfaces, so that "flats" do not develop, and a brake is automatically applied so as to bring the heavy turntable to rest in about three revolutions. When starting a simple snap action of the control knob causes the idler wheel first to engage with the driving and driven surfaces, after which power is applied to the motor. Thus no skidding of the idler wheel occurs. This drive mechanism, some details of which are shown in Fig. 4, gives recordings which are for all practical purposes wow-free.

Fig. 5 shows a view of the top of the recording machine. Within the box-like unit on the left and protected by the detachable covers, is a fine pitch feed screw and two rods on which the moving member, the carriage, can slide. The carriage, which is driven by or disconnected from the feed screw by a retractable self-aligning nut' projects, and the front portion overhanging the turntable can rotate. This portion, called the Traverse Head, is shown in Fig. 4 latched in the working position. When it is necessary to put a disc on the turntable or to remove one from it, the push button on the front of the Traverse Head is pressed, and it immediately rotates round the push button to the position shown in Fig. 5. For replacing the cutting stylus it can be rotated a further 120 deg. so that the stylus projects conveniently towards the operator. The machine in Fig. 2 has its Traverse Head latched in this position. It is released by pressing the button and returns itself to the horizontal position. An adjustment is provided which raises or lowers the Traverse Head to compensate for different thicknesses of disc and different lengths of cutting stylus.

Within the Traverse Head is a pivoted arm carrying the cutter head, and a damped vibration absorber to prevent "patterning" or cyclic variations in the depth of cut on the disc. The cutter head, which is a B.B.C. design, is shown in Fig. 6 with a penny giving a comparison of size. A full description of its construction and performance cannot be given here, but briefly it consists of a double rocker, or balanced, armature, supported between its pole pieces by torsion bars. In addition to the main, or operating, coil it has an auxiliary winding which is connected to an intermediate stage of the recording amplifier to give negative feedback. The head has no adjustment of any kind, for there is nothing in the construction to deteriorate with age, and if the head is properly made in the first place its performance will be maintained indefinitely, provided there is no gross mechanical damage.

Grease, or, more usually, oil is used for damping, but as the top resonance in the dry state is at about 10 kc/s damping is not critical and does not affect the performance in the middle frequency range. When oil is used the head must be replenished at intervals, but this is a simple operation, and the head can quickly be removed for this purpose since the electrical connections are made via a built-in socket, shown in Fig. 6. This socket has two connections for the main winding and two for the feedback winding.

The feed screw is normally driven by the turntable through an adjustable-ratio friction gear, and the number of grooves per inch and the direction of traverse to which this is set can be read on a scale in the rectangular window in the front of the machine. A separate motor is also provided which will drive the feed screw at about fifteen times the normal speed, and this can be used to give a "play-off" or "scrolling" groove or to mark off one item in a recording from the remainder by a temporary increase in groove pitch. In addition there is on the control desk a push button which will energise the scrolling motors of both machines simultaneously, and this gives a convenient arrangement of cue marking, since synchronous points on two discs can be indicated by a momentary increase in groove pitch.

Normally recordings are made with the cutter head traversing from the outside to the inside of the disc, and at the end of each recording it is moved outwards by hand to the proper position for starting

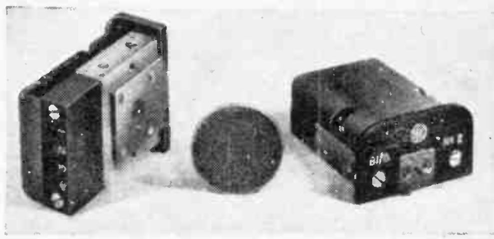


Fig. 6. Type B1/B cutter head used in the Type D recorder.

the next recording. But several different sizes of blank may be used, depending on whether the recording is being made at 78 r.p.m. or $33\frac{1}{3}$ r.p.m., and on whether the disc is to be processed or not, and for each blank size there is a correct diameter at which the recording should start. To enable the various starting positions to be found quickly and accurately a row of interlocking push buttons is provided on the top of the machine, one button for each size of blank, and one to cancel. If, say, the "12in. diameter" button is depressed, a mechanical stop will arrest the outward movement of the carriage when the cutting stylus is at the right position to start recording on a 12in. diameter blank.

Since the machine can traverse in either direction, push buttons are also provided to arrest inward movement of the carriage at positions suitable for commencing recording with an "in-to-out" direction of traverse. To prevent damage occurring if a stop were inadvertently left in the path of the carriage during recording, it is arranged that the stops are effective only when the carriage is moved by hand; as soon as the feed screw commences to drive the carriage the stops become inoperative.

Fig. 5. General view of top of recording machine.

Limit switches are also provided. Their purpose is not merely to protect the machine against damage if the carriage is driven too far in either direction, but also to prevent the recorded disc being spoilt or the cutting stylus damaged if this should occur at the end of a recording. One or other of the two limit switches operates as soon as the cutter has passed the predetermined limits of recording, and this operation stops the turntable and starts an alarm buzzer, which continues to sound until the

B.B.C. Disc Recording—

carriage has been restored to its proper position. The mechanism which renders the push buttons inoperative when the carriage is power driven also inserts protective stops in front of the limit switches when the power drive is removed, and thus prevents the limit switches being operated accidentally when the carriage is being moved by hand.

For swarf removal a jet of air is blown across the stylus to drive the thread towards the centre of the turntable. There it is collected by suction, passes through the long curved arm on the right hand side of each machine, and drops into the tank on which the arm is mounted.

On starting a recording the curved arm is pulled to its lower position with the nozzle end close to the disc. Once the thread has entered the nozzle, however, the arm can be swung up again to the position shown in Fig. 1, and the thread will continue to run from the stylus up to the nozzle and through the arm into the tank. If for any reason the thread should break during a recording the swarf will collect round the centre of the disc, the blow jet keeping it out of the way of the cutter and the pick-up. In due course the suction arm is pulled down again momentarily, and as soon as the swarf enters it can be returned to the up position.

This system is both effective and quiet in operation, but some disc coatings give a very large static charge when cut, and this causes the swarf to adhere strongly to the disc surface. These discs require pre-treatment with an anti-static fluid.

The swarf collects in the tanks beneath the curved arm and is removed at intervals. A separate pump exhausts air from these tanks and returns it under slight pressure to supply the blowing jets, one of which can be seen in Figs. 4 and 5 attached to the side of the Traverse Head. The pump returns a good deal more air than is required for the blow jets, and the remainder is filtered and blown inside the machine casings to reduce dust settlement by maintaining an outward air flow.

It is not easy to specify the performance of a disc recording machine in detail, since it varies somewhat during each recording, but as a general indication of the quality obtainable with this equipment it may be said that at the outside of a 78 r.p.m. disc the overall response is flat from 40 c/s to 8 kc/s. The background noise due to the recording machine is negligible compared with the intrinsic cutting noise, which with good commercial blanks and cutters is about 58 db. below peak level. It should be remembered, however, that the figure obtained for background noise depends on how the measurement is made, and on what peak level is used, or, in other words, on how much distortion is tolerated. Unfortunately this cannot be stated in numbers in a simple or easily comprehensive manner.

On the other hand, recordings are made to be listened to, and the final test of quality is whether a reproduction sounds like the original. With this equipment a recording may be reproduced while it is being made, and the loudspeaker may be switched from the incoming programme to the reproduction of the recording with a time displacement of a fraction of a second between them. Recording at 78 r.p.m. with good discs and cutters, even a critical ear cannot with certainty distinguish between the two under normal listening conditions with high grade equipment. Some sacrifice must of course be made to obtain long playing times, and the average quality of $33\frac{1}{3}$ r.p.m. recordings is necessarily inferior to what can be obtained at 78 r.p.m. The difference, however, is hardly apparent to the ordinary as distinct from the trained and critical ear.

Carrying out a listening test when recording a 1 kc/s tone provides a very stringent test for wow, and therefore for the speed constancy of the turntables. The ear of course is notoriously sensitive to pitch fluctuations on recordings of the piano, but it is still more sensitive to pitch variations on a steady 1 kc/s tone. Nevertheless, in asking a number of technical listeners to say which was the tone direct from the oscillator and which was the reproduction of a recording there were roughly as many wrong answers as right ones, which is what would be expected if, in fact, there were no differences that the listeners could detect.

RADIO COUNTER MEASURES

It has now been made known what a large part radio counter measures played in the war. These were not only defensive, but were effectively employed in an offensive rôle in our bombing of Germany.

When in 1940 it was planned to use R.C.M. against the enemy's blind-bombing attacks on this country, which were carried out by means of radio beams, the temporary apparatus used for jamming was hospital diathermy equipment. By the time D-Day arrived a quarter of the output of the Telecommunications Research Establishment was concerned with R.C.M.

Although the B.B.C. used a synchronised system of transmission which could not be employed by the enemy as a navigational aid, it was known that the transmissions from Athlone could be used effectively for this purpose. The transmissions were therefore picked up and retransmitted from a powerful transmitter in this country to fox the enemy airmen.

When in the summer of 1941 it was established that the enemy was using radar to plot our night bombers for fighter interception, calculations gave the experts its approximate position, and in December, 1941, aerial photographs were obtained which led to the famous raid on Bruneval on Febuary 27, 1942. It was the knowledge gained from captured German apparatus that made possible the successful development of R.C.M.

One of these made use of an air-borne 'phone transmitter with the microphone placed near the engine or in the aircraft's fuselage. Each operator was given a specified frequency band to watch with instructions to "jam" any German radio telephone he heard.

Another was to jam the enemy's early warning system. For this a number of high-powered ground jammers along the south coast were used to "blind" the German stations across the Channel.

A special airborne receiver which automatically searched for a transmission and switched on a jamming transmitter on the same frequency when located was one of the latest measures employed.

The B.B.C., G.P.O. and Cable and Wireless joined in the ether war when, instead of transmitting noise, as is the case in ordinary jamming, it was decided to use a ghost voice to give confusing and contrary instructions to enemy fighters sent up to intercept our bombers.

WORLD OF WIRELESS

TELEVISION COMMITTEE

A TELEVISION Advisory Committee, as recommended in the Hankey Television Report, has now been set up by the Minister of Information, in his capacity as the Minister at present responsible for the television service. He stated in reply to a question in the House that the committee consisted of representatives of the interested Government Departments and of the B.B.C.

The Committee has been asked to press ahead with plans for the re-starting of the London television service and for the extension of the service to the provinces.

The terms of reference are:

The Television Advisory Committee will advise the responsible Minister on television policy with particular reference to the following points:

(a) The planning, after consultation with industry, of the future television service, including the standards to be adopted.

(b) The co-ordination and, where necessary, the initiation of research into the principles and practice of television.

(c) The encouragement of pooling of television patents and their use in the national interest.

(d) The investigation of all developments on television at home and abroad, including its use for cinemas, bearing in mind the importance of the export trade and the desirability of the adoption of international television standards.

The members of the committee are:

G. M. Garro-Jones	Chairman.
R. J. P. Harvey	Treasury.
Col. Sir Stanley Angwin, H. Townsend	Post Office.
H. A. Binney	Board of Trade.
E. B. Bowyer	Ministry of Supply.
Sir Edward Appleton, O. F. Brown	Department of Scientific and Industrial Research.
E. St. J. Bamford, H. G. G. Welch	Ministry of Information.
W. J. Haley, Sir Noel Ashbridge	British Broadcasting Corporation.

The acting secretaries are G. Kirk (Ministry of Information) and H. D. Bickley (Post Office).

MULTI-CARRIER VHF SYSTEM

A NEW system of VHF communication involving the use of two or more transmitters, all operating within the bandwidth of the receiver, was described in a paper read before the Institution of Electrical Engineers by J. R. Brinkley on November 21st last. It was explained that in large built-up areas a much improved service results and the system is thus particularly well suited for communication with mobile units of the police and fire services.

It is hoped to give a description of this system, which might be described as diversity in reverse, in our next issue.

B.R.E.M.A. REPORT

THE first report of the British Radio Equipment Manufacturers' Association, covering a full year's activity since the Association was formed as part of the Radio Industry Council, was presented in November.

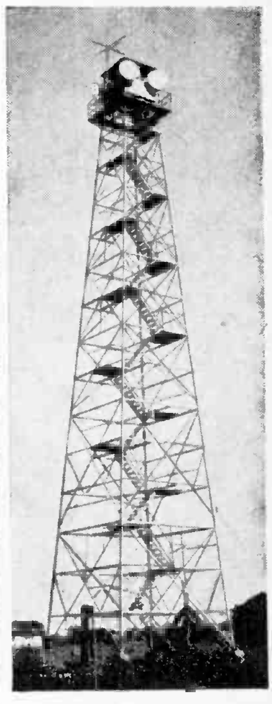
In the section of the report dealing with the technical work of the Association it is stated that a sub-commitee was set up to make a preliminary investigation into the comparative advantages of FM and AM and the related problem of reflection. This Committee will co-operate with the B.B.C. in FM research work on which the Corporation is engaged. A sum of £2,000 has been allocated by the R.I.C. to enable a research programme on the receiver side of the problem to be carried out.

The Technical Committee has given considerable thought to standardisation of components and valves, and on the subject of valve standardisation has stated that it is unanimously agreed that the importance and urgency of producing a technically sound and commercially competitive range of valves are such as to prompt the equipment makers to accept and adopt such a range of standard valves without undue concern regarding the form of standard finally adopted.

It is proposed that a joint technical body representative of valve makers, component makers and equipment makers should deal with this standardisation, and the committee strongly recommends that such a body should be set up by the R.I.C. at once to deal with this matter as one of great urgency.

In view of the Government of India's embarkation on a policy of development of listening among the Indian masses and its determination to place cheap receivers on the market, the export section of the B.R.E.M.A. Report deals at some

RADIO RELAY TOWERS, similar to the one illustrated, erected about 30 miles apart are planned by the Western Union Telegraph Company for its new super-high-frequency radio relay system. The first stage in the development of a nation-wide system is to be the establishment of a triangular circuit linking New York, Washington and Pittsburgh. The radio beams—one in each



direction — could each provide 270 multiplex circuits. On the left is one of the micro-wave aerials.

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length with the problems relating to that market.

It is learned that C. W. Goyder, chief engineer of All-India Radio, has made recommendations to the Association on the best types of receiver to produce for India. He considers that 100,000 ordinary receivers costing about £16 are needed immediately. He made a strong plea for the development of a simple AC/DC set to cost not more than £4 10s., for which he said there was an enormous potential market. A third requirement is the provision of communal receivers for some 750,000 villages.

It is interesting to note that it is considered that the future of car radio, especially in the export field, lies in the development of sets for fitting into new cars, for which provision would be made by the car manufacturers as part of the inherent design of the car.

The report states that up to September 1st, 1945, 176,500 AC models and 75,000 battery models of the civilian wartime receiver had been produced.

According to the report there is little likelihood of a national radio exhibition being held this year.

USW BROADCASTING

IF present plans materialise, Denmark will eventually adopt USW as the main means of distributing home broadcasting; the existing Kalundborg station would serve listeners abroad. When frequency allocations are settled, the Danish Broadcasting Company proposes to erect about 12 stations; some of these would eventually be used for television. Our Copenhagen correspondent estimates that the change-over to USW for sound broadcasting would involve listeners in an expenditure of £5 million for new sets.

PERSONALITIES

Sir Edward Appleton, F.R.S., has been appointed Rede Lecturer for 1946 at Cambridge University by the Vice-Chancellor. Sir Edward is also on the recently formed Government Committee of leading scientists and others to consider policies which will govern the use and development of our scientific man-power and resources in the next ten years.

Lt. Col. H. A. Lewis, T.D., B.Sc.(Eng.), who for the last five years has been the Assistant Director responsible for Telecommunications Engineering in the R.E.M.E. Directorate, War Office, has returned to the Design and Installation Department, B.B.C.

A. Davidson Dunton, former General Manager of the Wartime Information Board at Ottawa, has been given the first full-time chairmanship of the Canadian Broadcasting Corporation.

D. C. Birkenshaw, M.A. has been appointed television superintendent engineer of the B.B.C. He joined the research department of the Corporation in 1932, where he was concerned with the development of television. In 1936 he was appointed engineer-in-charge of the London television station. Since the closing down of the television service in 1939 he has been engineer-in-charge of the Daventry short-wave station.

H. W. Baker, who joined the B.B.C. in 1926 and was assistant engineer-in-charge at Alexandra Palace from 1937-1939, is now engineer-in-charge. During the war he has been in charge of various B.B.C. transmitters.

OBITUARY

It is with regret we record the death of **Raymond Braillard** the founder and chief engineer of the checking centre of the International Broadcasting Union which was operated in Brussels from 1926 until 1940.

IN BRIEF

Radar Training.—It is announced that the training of radar operators for the Merchant Navy will continue at naval establishments until radar equipment is available commercially and facilities are provided at technical colleges.

FM Progress in U.S.—When the Federal Communications Commission issued licences for new FM stations to a further batch of applicants in November it was estimated that there were still over 500 of the 665 applicants awaiting decision.

Safety for Shipping.—Decca Navigator Company has signed a contract with the Société Française Radioélectrique to erect the necessary transmitting stations in France, French colonies and mandated territories to provide a link with the first English chain and chains elsewhere in Europe for using the Decca Navigator. The contract provides for the manufacture of equipment both in England and France.

Back Numbers.—Many requests, especially from countries recently under enemy occupation, are being received for issues of *Wireless World* from 1940 onwards. Readers who have such copies for disposal are asked to communicate with our Publisher.

Physical Society's Exhibition.—The annual exhibition of scientific instruments and apparatus organised by the Physical Society will be held again at the Imperial College of Science and Technology, South Kensington, London, S.W.7, on January 1st, 2nd, and 3rd. It will be open at the following times:—

Tuesday, January 1st, 2.30 to 9.
Wednesday, January 2nd, 2 to 4 (members only) and 4 to 9.
Thursday, January 3rd, 2.30 to 9.

Admission will be by ticket, for which application should be made to the Secretary, The Physical Society, 1, Lowther Gardens, Exhibition Road, London, S.W.7.

Outward Form.—It is understood the radio industry is taking part in the "Britain Can Make It" exhibition which the Council of Industrial Design is sponsoring next July.

For the Troops.—Vocational Information Rooms are an important part of the Army Education Release Scheme. The aim is to keep men awaiting demobilisation informed as to what is happening in the trade or profession to which they hope to return. A Brigade Education Officer (address: HQRA, 3 Brit. Inf. Div., MEF) who is responsible for the upkeep of seven such Information Rooms appeals to readers of *Wireless World* to send their copies to him when they have finished with them.

Northern Ireland.—Regular meetings of the revived Radio Society of Northern Ireland are now being held on the last Friday of each month in the C.I.Y.M.S. Rooms, Belfast. Tom Smith (GI5ZY) is president and A. T. Kennedy (GI3KN), of 38, Donaghadee Road, Bangor, Co. Down, honorary secretary.

Romford Radio Society now holds its weekly meetings on Tuesdays at 8 p.m. at the new premises of the Y.M.C.A. Red Triangle Club (the late Masonic Hall), Western Road, near Romford station.

Newcastle Amateurs are invited to write for particulars of the Northern Radio Club, which holds meetings each Wednesday at 7.0 at 16, Stratford Road, Heaton, Newcastle-on-Tyne, 2, to the Hon. Sec.—A. F. Robson, 522, Denton Road, Newcastle-on-Tyne, 5.

MEETINGS

Institution of Electrical Engineers

Radio Section.—"A Standard of Frequency and its Applications," by C. F. Booth and F. J. M. Laver, on January 16th.

Discussion on "Post-Graduate University Courses in Electrical Engineering including Radio," to be opened by Prof. Willis Jackson, D.Sc., D.Phil., and J. Greig, M.Sc., Ph.D., on January 22nd.

Both meetings commence at 5.30 and will be held at the I.E.E., Savoy Place, London, W.C.2.

Cambridge Radio Group.—"The Servicing of Radio and Television Receivers," by R. C. G. Williams, Ph.D., B.Sc.(Eng.), at 6.0 on January 7th, in the Technical College, Collier Road, Cambridge.

Radio Society of Great Britain

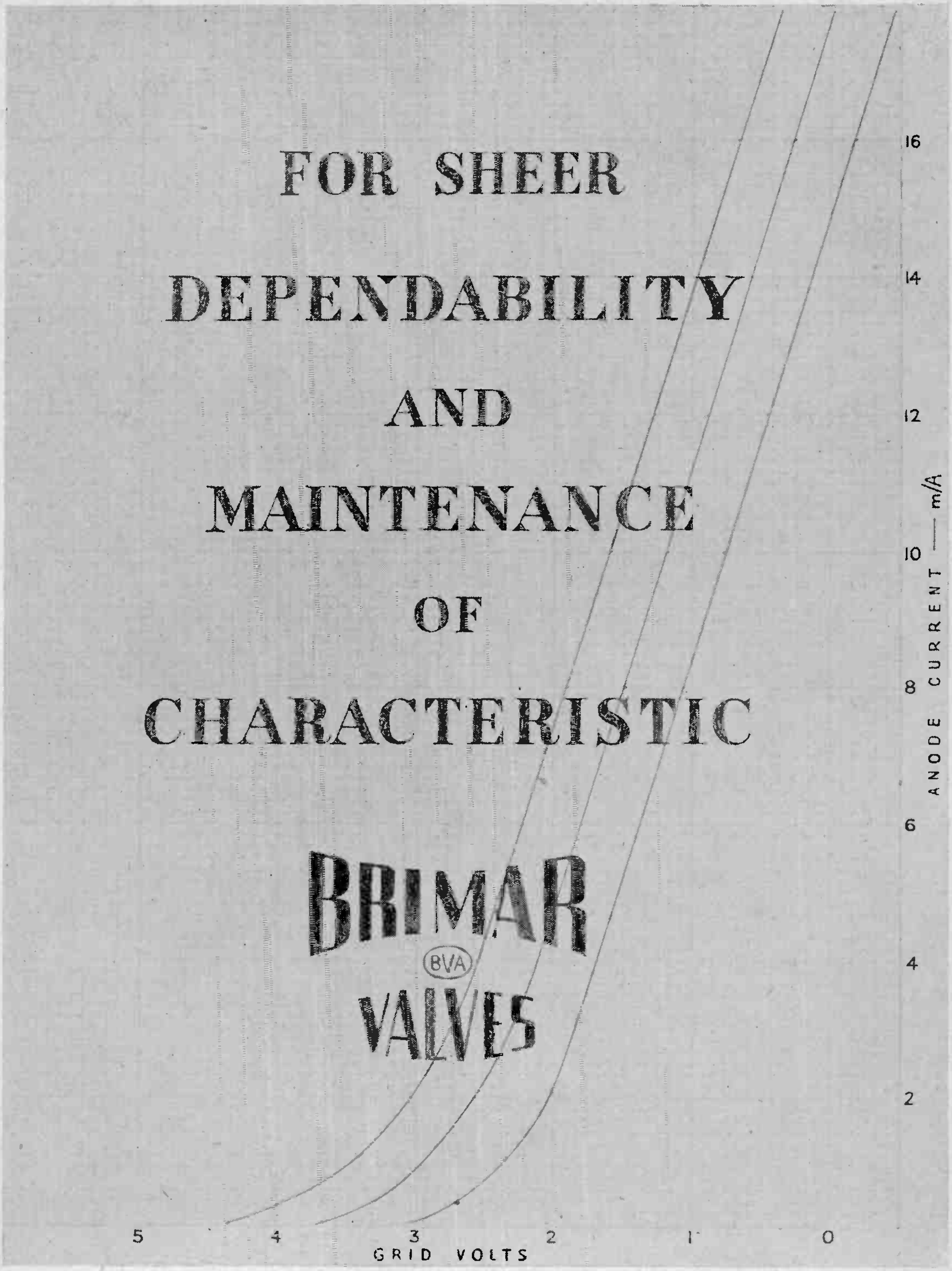
"The Birmingham Police Radio System," by Supt. G. Brown (G5BJ), at 6.30 on January 18th at the I.E.E., Savoy Place, London, W.C.2.

British Institution of Radio Engineers

North-Eastern Section.—"Deaf Aid Systems," by Dr. R. T. Craig, at 6.0 on January 16th at Nevill Hall, Westgate Road, Newcastle-on-Tyne.

British Kinematograph Society

"Electronics and the Kinema (V) Television," by T. M. C. Lance, at 11 a.m. on January 20th at the G.B. Theatre, Film House, Wardour Street, London, W.1.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Design Data (1)

CATHODE BIAS

Effect on Frequency Response

IT is well known that the use of a cathode-bias resistance causes a loss of amplification unless it is shunted by capacitance sufficiently large to act as a short-circuit to alternating currents. The amplification falls because the impedance of the cathode circuit causes negative feedback.

Except where for some reason such feedback is required, a by-pass capacitance is universally employed, and the question arises as to what value of capacitance should be used. The usual advice is to make its reactance small compared with the resistance at the lowest frequency required. This is hardly adequate, however, for it often leads to impracticably large values, and it gives no indication of the effect of using smaller values. This is particularly important in television, where a response down to zero frequency is needed and adequate by-passing is impossible.

The equations given enable the performance to be calculated, and also the capacitance needed for a given performance to be determined. They are exact for the circuits shown and sufficiently accurate approximations for other similar circuits. As an example of their use, suppose the RC stage (*a*) has a valve of mutual conductance 2 mA/V and AC resistance 10,000 Ω and it is used with a coupling resistance R_L of 20,000 ohms and a bias resistance R_c of 1,000 ohms. It is required that the bias circuit shall cause an attenuation at 50 c/s of 1 db. only, and it is required to determine the capacitance C_c needed.

Evaluating R from equation (4), $R = 6{,}600\ \Omega$, so that from (1) $A = 13.2$; that is, the amplification with an infinite capacitance for C_c is 13.2 times. To determine F^2 (5), the attenuation (1 db.) is divided by 10, and this is the logarithm of F^2. It is necessary, therefore, to find the antilogarithm of 0.1, and this is $1.26 = F^2$. Evaluation of equation (6) then gives the capacitance, thus :—

$$C_c = \frac{1}{6.28 \times 50 \times 10^3}\sqrt{\left[\frac{\{1 + (13.2 + 6600/10{,}000)1000/20{,}000\}^2 - 1.26}{1.26 - 1}\right]} = 8 \times 10^{-6}\text{F.} = 8\ \mu\text{F.}$$

If it is required to plot the frequency characteristic, this can be done by evaluating equation (3) for a series of values of F. This has been done for the example just given, and the resulting curve is plotted in Fig. 1. Below 10 c/s, the curve flattens out to a loss of 4.5 db. at zero frequency.

The decoupling circuit can be used to compensate for this loss by using circuit (*b*). The decoupling resistance R_1 must have the value given by equation (8), thus :—

$R_1 = 20{,}000 \times 1{,}000\ (0.002 + 0.0001) = 42{,}000\ \Omega$ and from (7) $C_c/C_1 = R_1/R_c = 42$. The actual values used for C_c and C_1 are immaterial as long as they have this ratio. The obvious thing to do, therefore, is to choose C_1 to give the requisite decoupling and to make the cathode by-pass capacitance R_1/R_c times as great. This immediately reveals a defect of the circuit, for it makes C_c very large. In a high gain amplifier C_1 might well be 8 μF and then C_c would have to be 336 μF.

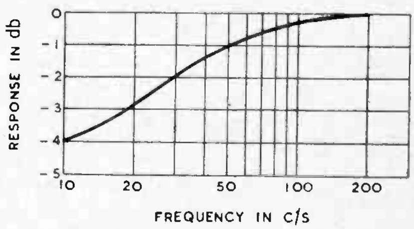


Fig. 1. The low-frequency response of a stage having circuit values given in the text.

The circuit is, in fact, rarely used in ordinary apparatus, but it has applications to television. Suppose that g_m is 8mA/V, and that R_a is so high that it can be ignored—as will usually be the case with a pentode. Considerations of high-frequency response may limit R_L to 3,000 ohms, and R_c might well be 100 ohms. A response flat to zero frequency is desirable so that circuit (*b*) should be applied and $R_1 = 3{,}000 \times 100 \times 0.008 = 2{,}400$ ohms. Then $C_c/C_1 = 3{,}000/2{,}400 = 1.25$. Apart from decoupling, it is only necessary that C_1 should be very large compared with the stray capacitance of the circuit. As this is usually no more than 30 $\mu\mu$F, this requirement is not difficult to meet.

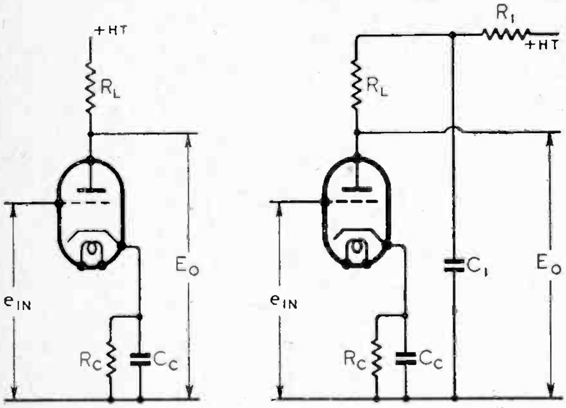
In practice, one would not normally make C_1 less than 0.1 μF nor greater than 10 μF, the choice being dictated chiefly by the amount of decoupling needed.

When a pentode is employed, the valve constants to be used in the formulae depend on whether the screen-grid by-pass capacitor is returned to cathode or to earth. If the former arrangement is used, g_m and R_a are the normal values for the

Design Data—

pentode. If the capacitor is returned to earth, however, the valve functions as a triode as far as feedback is concerned. The result is that the screen-grid-to-cathode potential is no longer fixed, but has the bias circuit variations impressed upon it. In general, the formulae do not hold for this case, but they may be used as approximations in cases where only a small low-frequency attenuation is permitted.

Design Data (1): Cathode Bias



(a) (b)

Circuit (a)

Basic amplification

= (amplification with perfect by-passing of R_c).

$= e_o/e_m = A = g_mR$ .. (1)

Amplification at any frequency $= A/F$ .. (2)

Response due to imperfect by-passing $= 1/F$.

Low-frequency attenuation $= 10 \log F^2$

$$= 10 \log \left[\frac{\{1 + (A + R/R_a)\, R_c/R_L\}^2 + \omega^2 T_c^2}{1 + \omega^2 T_c^2}\right] \text{ (db.)} \quad .. \quad .. \quad (3)$$

where $g_m = \mu/R_a$ = mutual conductance of valve (A/V)

R_a = anode AC resistance of valve (Ω)

R_L = coupling resistance (Ω)

$R = R_aR_L/(R_a + R_L)$ (Ω) .. .. (4)

R_c = bias resistance (Ω)

C_c = by-pass capacitance (F)

$T_c = C_cR_c$

$\omega = 6.28 f$

f = frequency (c/s)

Given g_m, R_a, R_L, R_c and attenuation permissible (db.) at frequency f (c/s) to determine C_c:—

From (4) evaluate R and from (1) evaluate A.

Determine F^2 = antilog (attenuation/10) .. (5)

$$C_c = \frac{1}{\omega R_c}\sqrt{\left[\frac{\{1 + (A + R/R_a)R_c/R_L\}^2 - F^2}{F^2 - 1}\right]} \text{ (farads)} \quad .. \quad .. \quad (6)$$

Circuit (b)

Under the particular conditions:—

$C_cR_c = C_1R_1$ .. .. (7)

and $R_1 = \dfrac{R_L}{R_a} R_c (1 + \mu) = R_LR_c(g_m + 1/R_a)$ .. .. (8)

the amplification is independent of frequency and is $A = g_mR$.

The anode decoupling circuit then provides perfect compensation for the bias circuit.

Given g_m, R_a, R_L, R_c and either C_c or C_1, evaluate (8) for R_1 and then determine C_c or C_1 from (7).

Note.—In general, this circuit is of value only when R_L is limited in value by the high-frequency response required, or when C_1 is necessary for decoupling. Otherwise the same results are obtained with both C_c and C_1 omitted.

B.R.E.M.A. WAVELENGTH PLAN CRITICISED

AN opportunity was recently given to members of the British Institution of Radio Engineers to discuss the British radio industry's Plan for European Broadcasting, details of which were published in our September, 1945, issue. The discussion was opened by R. G. Clark, one of the five members of the sub-committee responsible for the plan. He did not attempt to outline the plan, but painted some detail into the broad outline.

He stressed that the empirical formula,

range (miles) $= \dfrac{\lambda \text{ (metres)}}{4}$, is based on data from a number of sources, including Eckersley, Patrick (South Africa), U.S. National Broadcasting Company, and Gillett and Eager (U.S.). Lantern slides of families of curves giving various values of soil conductivity and ratios of space to ground-wave were shown to justify the adoption of the respective figures of 10^{-13} and 1 : 3.

A general criticism of the plan, stressed by a number of the ten speakers, was that it had endeavoured to make the best use of the existing inadequate broadcasting system instead of taking the bolder step of introducing radical changes. One such suggested change was the use of FM for local broadcasting and medium-wave AM for national transmitters. This twofold coverage, introducing an AM/FM switch on receivers instead of the customary MW/LW, would, it was estimated, double the number of stations in Europe.

It will be recalled that the plan proposed increasing the frequency separation from 9 to 11 kc/s. Whilst this attempt to reduce mutual interference was generally applauded, the suggestion, recently put forward in *Wireless World*, that 10 kc/s separation would have the added advantages of reducing heterodyning by American stations and make for easy dial marking in 10 kc/s channel numbers, was reiterated.

The plan was also criticised by a number of speakers because of the disproportionate allocation of eleven frequencies to this country, and, furthermore, that the planners did not seek the collaboration of other interested parties before publicly presenting the scheme.

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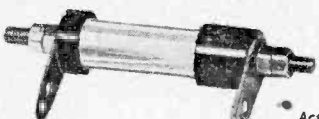
Normal size "Westectors"



Actual size

These have a less positive seal and should not be used where the temperature exceeds 45° C (113° F) for any length of time. They can be supplied with either 6-BA terminals with soldering tags, or axial wires, for connection purposes. These units will carry up to 20 series elements.

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R.114	350–0–350 v. 80 mA. 0–4–5 v. 2.5 A. 0–4–6.3 v. 4 A.	44/6	L.414	0–4–5–6.3 v. 2 A.	27/6
R.116	350–0–350 v. 100 mA. 0–4–5 v. 2.5 A. 0–4–6.3 v. 5 A.	52/6	L.418	0–4–5 v. 2.5 A. 0–4–6.3 v. 4 A.	35/-
R.121	350–0–350 v. 120 mA. 0–4–5 v. 2.5 A. 0–4–6.3 v. 3 A. 0–4–6.3 v. 3 A.	61/6	L.427	0–4–5 v. 2.5 A. 0–4–6.3 v. 3 A. 0–4–6.3 v. 3 A.	42/6
R.125	350–0–350 v. 180 mA. 0–4–5 v. 3 A. 0–4–6.3 v. 3 A. 0–4–6.3 v. 4 A.	75/-	L.430	0–4–5 v. 3 A. 0–4–6.3 v. 5 A. 0–4–6.3 v. 5 A.	47/6
R.132	400–350–0–350–400 v. 180 mA. 0–4–5 v. 3 A. 0–4–6.3 v. 3 A. 0–4–6.3 v. 3 A. 2–0–2 v. 1 A. 2–0–2 v. 1 A.	85/-	L.433	0–4–5 v. 3 A. 0–4–6.3 v. 3 A. 0–4–6.3 v. 3 A. 2–0–2 v. 1 A. 2–0–2 v. 1 A.	49/6
R.137	450–400–0–400–450 v. 180 mA. 0–4–5 v. 3 A. 0–4–6.3 v. 3 A. 0–4–6.3 v. 3 A. 2–0–2 v. 2 A. 2–0–2 v. 2 A.	92/6	L.450	0–4–5 v. 3 A. 3.15–2–0–2–3.15 v. 4 A. 3.15–2–0–2–3.15 v. 4 A. 2–0–2 v. 2 A. 2–0–2 v. 2 A.	58/6
R.143	500–450–0–450–500 v. 180 mA. 0–4–5 v. 3 A. 0–4–6.3 v. 4 A. 0–4–6.3 v. 4 A. 2–0–2 v. 2 A. 2–0–2 v. 2 A.	105/-	A.491	0–4 v. 2 A. 2 kV. wkg. 0–4 v. 2 A. 2 kV. wkg.	37/6
R.148	500–400–0–400–500 v. 250 mA. 0–4–5 v. 3 A. 0–4–6.3 v. 4 A. 0–4–6.3 v. 4 A. 2–0–2 v. 2 A. 2–0–2 v. 2 A.	132/6	A.493	0–4 v. 2 A. 4 kV. wkg. 0–4 v. 2 A. 4 kV. wkg.	4/26
R.165	1.000£02 1,000 v. 180 mA. 2–0–2 v. 3 A. 2–0–2 v. 3 A. 5–0–5 v. 2 A. 5–0–5 v. 2 A.	155/-			

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FUNDAMENTALS OF RADAR

4. Pulse Methods Applied to Navigation

THE navigational aids which will be described in this article may or may not be radar in the purest sense of the word. In the transition from RDF, whose origin no one seems to remember, but which was probably coined in a lazy moment by some early worker, through radiolocation, which has always had a "popular press" sound to the worker in the field, to radar, the present official term, the problem of precise definition has always been overshadowed by the more pressing job of producing a new system. As it was convenient in the stress of war to lump the navigational aids with radar there seems no reason for abandoning this practice in the present series of articles.

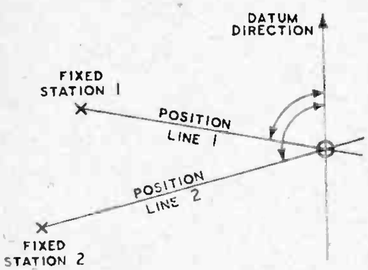


Fig. 1. In a conventional mobile DF system the position lines are straight lines, and the mobile station carries its own "datum direction" (a compass).

The navigation problem is one of determining the position of the observer with respect to an arbitrary frame of reference. In its traditional form the frame of reference is defined by a line through Greenwich and the Poles and another line—the Equator. The early navigators normally measured their position with reference to convenient stars and then translated this into information related to the latitude and longitude frame. The introduction of radio direction finding enabled a technique used by surveyors to be used on a much larger scale: the angle between true north and a line joining the observer to a known fixed point was measured. This gives a position line. The intersection of two position lines passing through two known fixed points gives the "fix," the actual position of the observer. If the observer is to do all the work, he must carry about with him a fixed datum line, which in its practical form is provided by a magnetic compass. In a normal direction-finding system we require either one transmitter at the observer and two direction finders, each with a datum line and known position, or two transmitters with known positions and one direction finder with a datum line at the observer.

A radar navigational system of the types to be described below carries with it not a datum line, but a datum length. For most purposes lengths are more easily set up than lines. The line must be defined either by astronomical observations for fixed stations (accurate but slow) or by a compass for mobile stations (quick, but much less accurate). Length on the other hand is defined by the time of travel of electromagnetic waves; the velocity is known to a very high degree of accuracy, and oscillators can be used as clocks to give very precise measurements of time. The position finding problem is reduced to that of measuring two lengths which are the co-ordinates of position in the reference frame chosen.

In the "Oboe" system of navigation the lengths measured are the actual distances from the observer to the fixed points. This system, although not the first or the most widely used, is probably the easiest to follow, and it is therefore treated first. Two fixed stations are set up, and the positions of their aerial systems are accurately defined. Each station consists of a pulse transmitter, receiver and range measuring equipment. The mobile station, generally an aircraft, carries only a transmitter-receiver. Pulses emitted by the fixed transmitters are picked up by the aircraft receiver and retransmitted by its transmitter. At the fixed stations the retransmitted pulses are received and the time for the round trip is measured. The total time between transmission from the fixed station and reception of the retransmitted pulse is equal to the time of outward travel, plus the delay in the transmitter-receiver, plus the time of return. As long as the second term is known accurately, the range of the aircraft from the fixed station can be found. Each fixed station thus has the information that the aircraft is at a known distance

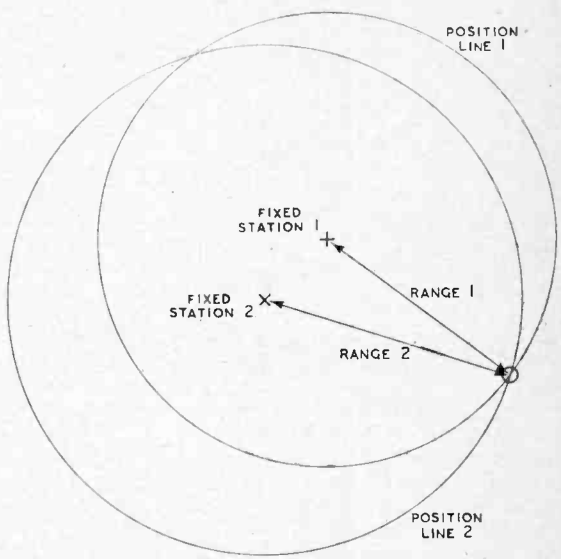


Fig. 2. Position finding by the Oboe principle.

Fundamentals of Radar—

away, so that the position lines are circles with the fixed station at their centres. By comparing notes, the fixed stations can determine the position of the aircraft and can then signal this to the pilot or navigator.

The same arrangement can, of course, be worked the other way round. The mobile station can initiate pulses and measure the time of their return from fixed transmitter-receivers. Such an arrangement means that more equipment must be carried by the mobile station. It will, however, be noted that whichever arrangement is used the mobile station must carry a transmitter. There is no reason why a short-range system of this sort should not be devised using only the reflections from the mobile station, but there is no point in doing this, for the directional accuracy of GCI and H2S is such that no advantage would accrue from the extra complication.

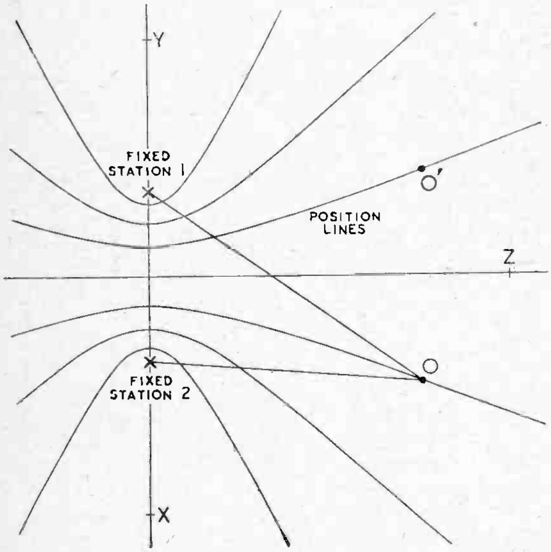


Fig. 3. In the Gee system the difference in distance (time of travel of pulses) from two fixed stations is constant for any particular position line

In the wartime use of Oboe, the observer was not actually interested in knowing his true position, but wished only to reach a predetermined position. To do this, the aircraft was directed to another point, which lay on the desired position line defined by one of the fixed stations, known as the "Cat" station. From this point the course was laid along the position line, and deviations from the position line were indicated by special signals from the ground. For all practical purposes the aircraft was flying along a very sharply defined beam which would bring it to the desired point. The second ground station, known as the "Mouse" station, watched this procedure and from time to time indicated the distance along the beam position line which was still to go. This information was, of course, determined by finding which of the set of second position lines the aircraft was on. The advantage of this arrangement was that all the calculations were done in advance, and the actual observing was done in the relative peace of the fixed stations.

Another system, "Gee," which came into use before Oboe, does not involve a transmitter in the aircraft. In this arrangement the position line is the locus along which the difference in time of travel of the pulses from two fixed stations is constant. The position lines defined in this way are a set of confocal hyperbolæ with foci at the fixed stations. The procedure for defining a position line is as follows: Station 1 transmits a pulse; immediately after this pulse reaches Station 2 another pulse is transmitted by Station 2. At some point O, the pulse from Station 1 arrives first, followed shortly after by that from Station 2. The pulses are displayed on a cathode ray tube, and the difference in time of arrival is measured. The difference in time of departure is a constant of the system, so that the operator can tell the difference in time of travel. This difference defines completely one of the hyperbolic position lines. In the particular case where the lines of travel are equal, the hyperbola becomes a straight line bisecting at right angles the line joining the stations. As the pulse from Station 2 is not transmitted until after that from Station 1 has passed Station 2, the first pulse to arrive is always that from Station 1. Thus if the distance between Station 1 and Station 2 is 93 miles, the pulse from Station 2 will be transmitted say 550 microseconds after that from Station 1. An observer at

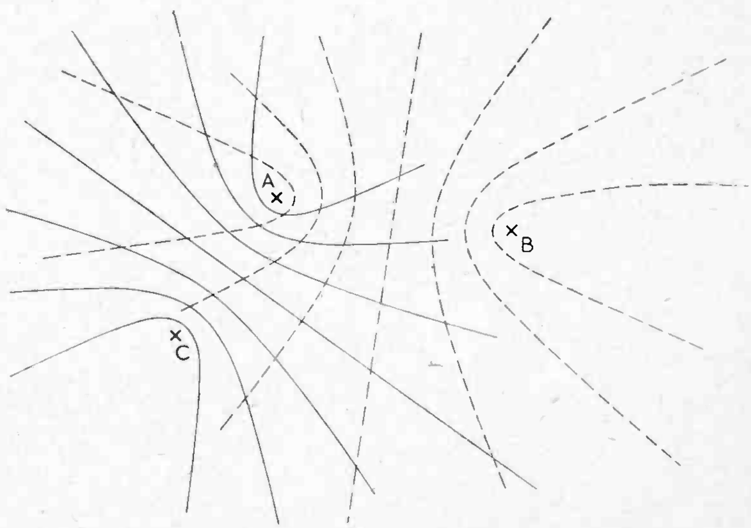
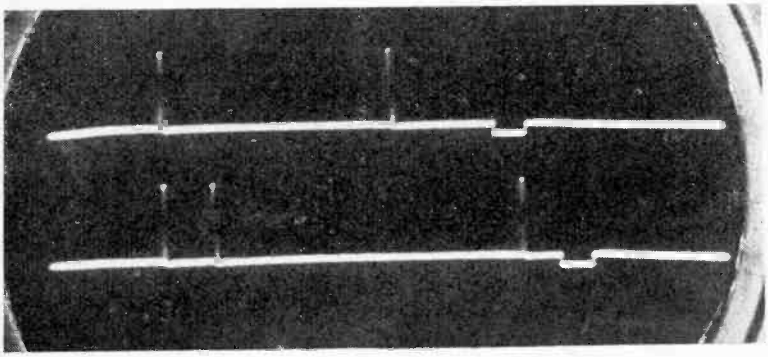


Fig. 4. Gee grid laid down by three stations.

X in Fig. 3 will then find that the pulse from 1, having taken 500 microseconds to go from 1 to 2, arrives 50 microseconds before the pulse from 2. An observer at Y will find the pulse from 1 arrives 1,050 microseconds before the pulse from 2. If the pulses were transmitted simultaneously, an observer at O would find that the pulse from 1 arrived *t* microseconds *after* that from 2, while at O′ the pulse from 1 arrives *t* microseconds *before* that from 2. This is inconvenient, for a special mark must be sent to identify the pulses from Station 1 so that the four possible ambiguous positions may be separated. This is analogous to sense measurement in ordinary direction finding. Furthermore, in the neighbourhood of Z both pulses would arrive almost simultaneously and the measurement of the delay time would present special difficulties.

To get a fix, two position lines are required; this means that two pairs of stations must be used. In practice, one station can be common to the two pairs, and the system takes the form shown in Fig. 4. Here A transmits a pulse, then B, then A again, then C. Of each pair, the pulse from A always arrives first, so that there is no ambiguity from this cause. In addition a distinguishing signal is sent out with the pulse from one of the other stations so that the B and C systems can be sorted out. It will be seen that the repetition rate at A, the master station, is double the repetition rate at the slave stations B and C. In the photograph of a Gee display the upper trace is the B trace, the lower trace the C trace. On the left of each is the A pulse, followed by the identifying "ghost" on the C trace. Farther along the traces are the B and C pulses respectively. The downward step on each trace is the "strobe marker," and this can be moved along to overlap the slave station pulses. By switching in calibrating signals a coarse reading can be made; then the region selected by the strobe marker is displayed on a magnified scale to enable more accurate reading of the two position co-ordinates. The operator is provided with a special map ruled with the two sets of hyperbolæ on it, so that the readings taken from the cathode ray tube can be translated directly into co-ordinates on the map.



Typical cathode-ray tube display of pulses received from three ground stations in the Gee system.

It is of interest to see how accurate these navigational aids can be. If the velocity of propagation is taken as 200,000 miles per second, to simplify the arithmetic, the delay per mile of range in the Oboe system will be 1/10th microsecond. If we can measure time intervals with an accuracy of 1/10 microsecond, therefore, we can determine position lines to within a mile. This does not mean that the position can be determined accurately as within a mile of a chosen point. In Fig. 5 is shown the error diagram when the two fixed stations are 100 miles apart and the position lies on the two 600-mile position lines within measurement accuracy. For this particular example, which is a very simple one, the long diagonal

(*Concluded on page 26*)

Fundamentals of Radar—
of the slightly curved parallelogram is six times the length of the short diagonal, and the short diagonal is approximately equal to the range error. Thus, if the error in time measurement is 1/10th microsecond, the error in position may be as much as ± 3 miles along the arc of the position lines. The chief advantages of this system are that the position lines can be very accurately determined, and that complex ground equipment can be used to give very precise measurements of time.

In the Gee system the error diagram takes the form shown in Fig. 6. A rough calculation for the position shown, with the stations spaced as before, gives about the same dimensions for the uncertainty parallelogram. It will be noted that again the chief difficulty arises from the small angle of cut of the position lines. In Gee the principal error at distances greater than the station spacing is along the line joining the aircraft to the middle of the ground system, whereas in Oboe

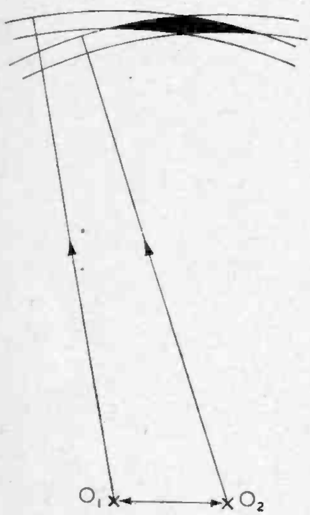


Fig. 5. Error diagram for Oboe.

the main error was at right angles to this direction. Although the error is, in the position shown, of the same order of magnitude as that for Oboe, three stations at 100-mile spacing have been assumed. This means that the baseline measured round the "dog leg" is twice that for the Oboe system, although the theoretical accuracy is the same. Further inaccuracies arise from the fact that the measuring equipment, being mobile, is necessarily more primitive and is thus an important source of error. It would seem possible to com-

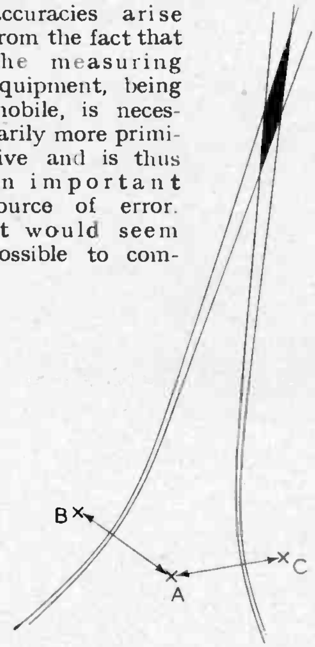


Fig. 6. Error diagram for Gee.

bine the two systems to give a cut between a circular position line of the Oboe type with a hyperbolic position line of the Gee type, thus providing an almost rectangular cut.

At shorter ranges, comparable with the spacing of the stations, much better results are obtainable, and the aim should be to provide enough stations to permit good cuts at all points.

This description has not exhausted the list of radar navigational aids. All it has tried to do is to demonstrate the two fundamental types of aid, one based on direct measurement of distance, the other on the measurement of distance difference. So far as is known, no system using distance sum, in which the mobile station emits a pulse which is received by a fixed station A, transmitted on to a fixed station B and thence on to the mobile station, has been devised. Such a system would provide a set of confocal ellipses as position lines. These would be very attractive if used in conjunction with the hyperbolæ of the Gee system.

TELEVISION SIGNAL GENERATOR

In order to assist in overhauling television sets which have been laid away during the war, and to test them generally at times when no television signal is being radiated, E. K. Cole, Ltd., have produced a test oscillator specially designed for the purpose. This is the Television Pattern Generator Type TSE/1.

It consists of an RF oscillator tunable from 40 Mc/s to 50 Mc/s and modulated by a series of pulses. These pulses represent the line and frame sync pulses and also give bars to form a "picture." The bars appear as two narrow vertical black bands and a single horizontal grey band.

The equipment enables the line and frame controls on a receiver to be adjusted approximately and the picture size to be brought to the correct value. Some idea of the receiver sensitivity can be obtained and even a rough check on the bandwidth by examining the sharpness of the edges of the vertical bars. By tuning to the sound receiver one can also check this and by watching the CR tube at the same time it is possible to make sure that the discrimination of the vision receiver against the sound signal is adequate.

The aerial rod can be seen plugged into its socket adjacent to the cable exit.

The generator is normally connected to the receiver by a cable, but a short rod aerial can be inserted instead and a feeble signal radiated in order to check the aerial. The signal is stated to be adequate for this checking at distances up to about 70ft. The apparatus measures 12½in. by 9¼in. by 8in. and is AC operated. The complete equipment includes the connecting cable with built-in attenuator, two 6in. aerial rods and seven valves. The price is expected to be ten guineas.

Letters to the Editor

Medical Amplifiers • Equity in Channel Allocations • Electrolytic Condenser Standards

"Biological Amplifiers"

DR. PARNUM, in his valuable articles in your November and December issues, mentions (p. 338, para. 2, of his first article) the device employed in the earlier models of the Cossor-Robertson Cardiograph for the elimination of interference picked up by the subject. In commentary, I would like it known that although the idea of opposing the 50-cycle interfering voltage by an anti-voltage, equal in amplitude and opposite in phase, was my own, the actual circuit used (*Journ. I.E.E.*, 1937, **81**, p. 506—Fig. 11) was suggested by my co-patentee for the Cardiograph, L. H. Bedford—that versatile and gifted genius of whom I am glad to see some appreciation in other pages of the November issue.

For electro-cardiography this circuit is perfectly adequate provided the earthing is of really low resistance; if so, then harmonics from the 50-cycle interfering voltage are negligible for practical working; but where the signal voltage is really small (as in electro-encephalography) then, as Dr. Parnum says, such a simple method ceases to be adequate. In later (after 1936) designs of the Cardiograph we abandoned this method and adopted a balanced input circuit followed by a "compressor" stage; the actual circuit used (as in present models of the Cardiograph) is basically very similar to Dr. Parnum's Fig. 7.

DOUGLAS ROBERTSON,
M.A., D.M., M.R.C.P.
Bletchingley, Surrey.

The BREMA Plan: Finnish Reaction

ACCORDING to the "Plan for Europe" (your September issue), Finland would get the national frequencies 388 and 421 kc/s. I do not feel myself competent to say whether these frequencies would be suitable for our country or not (although I am afraid they are not), but one thing is sure, and that is that all our radio sets would then have to be rebuilt, as they are not constructed for these wavelengths. There then arises the question of costs. Who would pay for them? Perhaps you say, Finland, but would it be fair? Surely if we accept, or are made to accept, unsuitable wavelengths in order to please others, the costs that would be incurred should be shared by all nations concerned, and this is a point that should not be overlooked when the matter comes to final discussions. It is true that in these days of "Democracy" small nations have very little to say, but I hope they are at least allowed to make a faint expression of their point of view.

"READER IN HELSINKI."

[Adoption of the proposed Plan would involve modification of receivers in a number of European countries; in fact, in all, if full benefit were to be derived from facilities provided by the Plan for international listening. But if waveband changes are indeed necessary in the interests of broadcasting in Europe, now is the time to make them, when most existing receivers are overdue for replacement. It should hardly be necessary to add that the question of "making" a country accept wavelengths does not arise; the plan could only be put into effect by international agreement.—ED.]

Cracked Valves

THE queer valve fault described by "Diallist" in the November issue of *Wireless World* can probably be attributed to the valve basing cement swelling as a result of absorbing moisture and exerting a pressure on the envelope which cracked the glass. It is the practice of some valve manufacturers to increase ad-

Letters to the Editor—

hesion between the metalising and the glass by sandblasting; this weakens the glass, and valves so treated are particularly liable to suffer from the fault complained of. Cracking of glass envelopes near the base is a common fault in damp, tropical climates, but in temperate zones the trouble is rarely encountered.

C. W. EDMANS (G4KL).
North Harrow, Middx.

24-Hour Clock

I WOULD suggest that the present is an opportune time to introduce 24-hour time into our daily life.

Particularly it would be well for the B.B.C. to adopt it, both in announcements and printed programmes.

With so many people returning to civilian life who have got accustomed to its use in the Services, there can no longer be any suggestion that it would confuse the general public.

E. V. WOOD.
London, N.W.

In Defence of Electrolytics

COMMENTS (your December issue) are welcome from an American company which has pioneered many capacitor applications, including plug-in electrolytics which are now becoming popular in this country also.

I am disappointed, however, that no constructive criticism is given, particularly in respect of my suggestions (*Wireless World*, July, 1945) on choosing voltage ratings, and the casual reader would also be misled into thinking that British voltage ratings are unrelated to working temperature.

Mr. Burnham seems to be unaware of the practices adopted by British manufacturers as a result of war requirements. This is best illustrated by the I.S.C. Tech. C. Specifications (BS/RC Series) on "Radio Components for Service Equipment," published by B.S.I., which reveal a number of interesting features, some of which support the suggestions made by the writer. In the "General Guide" (BS/RC.G/1) temperature categories of all components fall into three grades, running from −40 deg. C. to 71 deg. C. (Grade C), 85 deg. C. (Grade B), and 100 deg. C. (Grade A). Some discussion is given on climatic and other conditions in different parts of the world which contribute to high or low temperatures, humidity, pressure, etc. Three sections of the specifications refer to electrolytics—the "Guide on Fixed Capacitors" (BS/RC.G/130), "Group Test Specification for Fixed Capacitors" (BS/RC.S/130), and "Test Schedule for Electrolytic Capacitors" (BS/RC.S/130.4). Collecting together various features of interest, we find that electrolytics have approximately one-tenth of the volume of corresponding paper capacitors, but have limitations due to temperature, leakage current and film dissolution. Low temperature causes fall in capacitance and increase in impedance, high temperature reduces life. Leakage current increases with temperature, time and load.

For preforming or preconditioning, the capacitor is "aged" by applying working voltage through approximately 1,500 ohms for 1 hour. Reforming of the electrodes at least every twelve months is recommended, applying working voltage through approximately 1,000 ohms.

In regard to ratings, only two temperature ranges are laid down, −30 deg. C. to +71 deg. C. and −30 deg. C. to +60 deg. C. The WVs. for each are quoted on the can, but the first (and lowest) is the major WV. The peak AC ripple must not exceed 6 per cent. of the rated WV at 100 c/s or 12 per cent. at 50 c/s. Outside these limits the ripple materially limits the max. WV and becomes the reason for special design. Leakage current is measured after applying rated WV for 3 minutes and at *90 per cent.* of rated WV.

Dealing with mechanical features, etched or sprayed foils are definitely *not* permitted, nor waxed paper containers and bituminous seals which, although reasonably satisfactory in our climate, allow gradual penetration of moisture which makes them unsuitable in other regions. The containers are therefore of aluminium or plastic, with special fibre or synthetic rubber seals.

While I agree entirely with Mr. Burnham that an electrolytic can be designed for any application and that the best compromise between reliability and volume must be chosen, I feel that the issue of plain *v.* etched foils is one which has to be argued out between experts. At this stage I feel inclined to leave the ring to the manufacturers, because this question is essentially one of technique. Evidently British practice is proceeding on the lines of plain-foil assemblies, the greatest justification of which, in regard to the minimum volume, is given by a yet smaller range known as the "Picopack," produced by T.C.C. I have not yet seen any etched-foil capacitors, even, of this phenomenally small size (whose body measures only $1\frac{9}{16}$in. by 0.34in.), and I doubt very much whether any improvement could be made by using that technique.

JOHN C. FINLAY.
East Boldon, Co. Durham.

SIGNALS FROM THE SUN

The "Hiss Phenomenon" on Short Waves

IN a recent letter to *Nature*[1] Sir Edward Appleton gives some new information about a phenomenon which a few years ago interested, not to say mystified, many radio men. This is the hissing sound which was occasionally heard when receiving on the short wavelengths, more particularly around the time of the last sunspot maximum.

Sir Edward remarks that both Reber and Southworth, working on wavelengths of the centimetre order, have recently succeeded in detecting and measuring radiations coming from the sun. Jansky, however, using the longer wavelength of 14.6 metres, was unable to detect any solar radiation, although his apparatus did detect that coming from the vicinity of the Milky Way. But the hissing phenomenon, states Sir Edward, furnishes evidence which suggests that, during periods of high solar activity, the sun occasionally radiates energy in the radio spectrum of an intensity greatly in excess of that noticed by Reber and Southworth.

Reports describing the hearing of a hissing sound when receiving in the range 10-40 Mc/s were sent to Sir Edward by D. W. Heightman and other amateurs, and from these he concluded that the noise was due to electromagnetic radiation coming from active areas on the sun. The noise was only heard during daylight, and often preceded one of the sudden short-wave fadeouts which take place at the same time as the occurrence of a solar flare, and which are known to be due to a marked increase in the D layer ionisation, caused by an outburst of ultra-violet light from the active solar area. Radio sky-waves are then completely absorbed within the D layer, and short-wave communication across the daylit hemisphere of the earth is stopped. It is natural, therefore, to associate the hissing noise heard before the fadeout with the same solar area.

But, once the increase in D layer attenuation has occurred the noise is no longer heard, at least in the band 10-30 Mc/s, for the solar radiation which causes the noise is itself attenuated within the layer. However, on the extremely short waves this attenuation would be much less, and Sir Edward would expect them to be able to make the single journey through the layer with only slightly diminished strength, and so they ought to be detectable not only before, but also throughout the fadeout.

Sir Edward goes on to show that ordinary solar radiation is of insufficient intensity to be detectable on the type of receiving aerial used in ordinary short-wave reception. When extremely short waves are used, however, highly directional aerial systems, such ae parabolic mirrors, can be used, and in order to detect this ordinary radiation, it is necessary for the aerial to have a power gain of the order of 10^4, relative to a half-wave dipole. Considering the low power gains of the aerials used in actual reception of the hissing noise Sir Edward concludes that, during the periods when it was observed, the intensity of the radiation from the active area must have been about 10^4 times that of the ordinary radiation from the whole disc.

Now that sensitive micro-wave receivers are available, and observing that the sun's activity is increasing towards a maximum, it should, in the future, be possible to obtain some more detailed information about these radiations, both before, and during the course of sudden fadeouts.

[1] *Nature*, November 3rd, 1945, pp. 534-535.

GERMAN RADAR

THE "Christmas tree" radar aerial array illustrated on the front cover of this issue was that carried by the German night fighter-bomber, Messerschmitt 110G. It is now a museum piece at the Royal Aircraft Establishment, Farnborough, Hants.

SMALL MAINS TRANSFORMERS

Suggestions for Preferred Types of Standard Size

By L. A. SHERWOOD

This article deals with mains transformers whose ratings vary from 10 to 1,000 watts. It attempts to show how the design of such transformers may be limited, in the large majority of cases, to 7 types of laminations only, with one bobbin size for each type of lamination.

THE case for standardisation of mains transformers up to a rating of 1,000 watts is that they are relatively easy to design and construct and it is quite possible to produce them in an almost infinite number of shapes and sizes. It is easy therefore to send the same electrical specification to two different manufacturers and receive two transformers whose dimensions are quite different. Although each may be satisfactory electrically, they will have, say, different fixing centres.

The reason for these variations, on investigation, in general proves to be that each manufacturer has accepted certain sizes of coil former as his basis of design and the particular size chosen eventually becomes one of his stocked sizes. Another manufacturer may have found a bobbin for a ¼in. larger core thickness used more frequently and accordingly stocked that size. As a result it is often difficult to proceed with the design of the chassis for the equipment until a sample transformer has actually been received from the manufacturer.

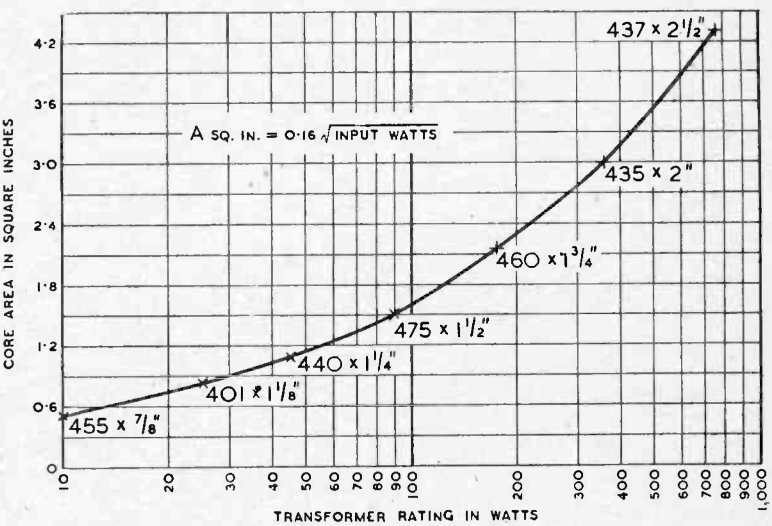
Precise Specifications

In a certain medium-sized factory making radio equipment partly on an experimental basis and partly on a production basis, the problem of getting transformers to fit was so acute that it was decided to attempt a measure of rationalisation. The results are given here, more as a guide to others faced with the same problem than as an attempt to usurp the functions of the B.S.I.

Though it may seem fatuous to say that mains transformers have been designed many thousands of times since AC mains radio sets became popular, the point seems to have escaped many designers. But to anyone who has viewed the making of sets from the production point of view it is clear that the same transformer requirements crop up over and over again, varied only in small particulars. These small variations however prevent the stocking of standard coil formers, laminations and so on, thus considerably delaying production. A designer may specify a Type 475 stamping with a core 1½in. thick for a certain transformer, and again, for a slightly lower rating, specify the same core built up to 1¼in. thick. Now transformer design is not so precise that he could not have specified 1½in. thick core in both cases, making the necessary minor amendments to the windings in the second case to suit the new conditions.

If it is found possible to use one cross-section of core and one stamping size for two slightly different ratings, then it becomes interesting to see how far from a given rating one may safely go, using the same size of stamping and core cross section. Experience rather than any *à priori* reasoning has shown that a transformer of cubic dimensions, i.e., a square shaped stamping and 2 to 3 ratio rectangular core, will stand about 33 per cent. deviation from nominal rating without undue loss of performance. On this basis the range 10 to 1,000 watts can be divided up into steps and, by a combination of evolution, trial and error, and experience the writer has produced 7 standard sizes of transformer to cover the whole range. These sizes have proved eminently satisfactory for at least 90 per cent. of the requirements.

The restriction in core sizes met with some opposition at first from various designers but the opposition came to an end when



Curve showing the relation between the transformer core area in square inches and the power rating in watts. The seven selected core sizes are marked on the curve at the points corresponding to their optimum watts.

it was found that by accepting standard sizes, transformers could be delivered in a matter of days rather than weeks.

Towards Rationalisation

The essential parts of a transformer are :—

1. Core laminations.
2. Coil former.
3. Windings and insulation.
4. Core clamps.
5. Tag-board.

The first step in rationalisation was to cut down the number of lamination sizes specified in the Interim Working Schedule issued by the Inter-Service Components Technical Committee and which shows some 19 different sizes, 12 being preferred. Of these 7 were selected, showing a graduation of tongue width from ⅝in. to 1¾in., viz. :—

I.S.C.O. No.	Width of Tongue
455	⅝in.
401	¾in.
440	⅞in.
475	1in.
460	1¼in.
435	1½in.
437	1¾in.

Although the core cross-section can be square, as is often the case, it is good practice to make it rectangular, in the ratio of 2 to 3. This makes a more economical transformer. On this basis the core sections and nominal ratings are shown in the table.

(Note : Each core is about $\sqrt{2}$ times the preceding one in area. This means that, other things being equal, each size has approximately twice the power rating of the preceding one).

Should an intermediate rating be required, it is easy to use one of the nearest two sizes, to give a "tight" or "easy" transformer as desired. Thus from a table as above a designer requiring a certain input could select the nearest size and try out a set of windings. If they were too tight he could then try the next size. The sizes however are sufficiently near to each other to prevent undue wastage of iron if it should be necessary to use the larger size.

Under this scheme, it was found feasible to stock laminations and bobbins to meet most of the demands. The question of clamps and tag-boards still requires attention, but insufficient experience has yet been gained on this subject. However by always specifying that transformers be mounted vertically, differences in clamp structure and tag-board layout can be more easily dealt with.

Summing up, we can say that a scheme of rationalisation as outlined above does not unduly hamper the design of mains transformers but very greatly steps-up the rate of production.

TABLE

I.S.C.O. No.	Core	Core Area	Step	Increase Ratio	Rating
455	⅝in. × ⅞in.	0.54 sq. in.	1	—	10 watts
401	¾in. × 1⅛in.	0.84 ,,	—	1.5	25 ,,
440	⅞in. × 1¼in.	1.09 ,,	2	1.3	45 ,,
475	1in. × 1½in.	1.50 ,,	—	1.4	90 ,,
460	1¼in. × 1¾in.	2.18 ,,	4	1.4	175 ,,
435	1½in. × 2in.	3.00 ,,	—	1.4	360 ,,
437	1¾in. × 2½in.	4.36 ,,	8	1.4	730 ,,

"ABACS FOR FILTER DESIGN"

A Correction

IT is regretted that in the lower halves of two abacs on pages 333 and 334 of the November issue, giving the rough order of inductance and capacitance, the sub-divisions of the log. decades in the frequency and impedance scales are incorrect. There should be eight and not nine intermediate divisions. The inductance and capacity scales are correct and the sub-divisions are 2, 4, 6, 8.

Corrected scales to paste over the lower half of each abac are being prepared and will be sent to any reader applying for them.

The upper sets of scales giving final significant figures in each abac are not affected by this alteration.

RANDOM RADIATIONS

By "DIALLIST"

The RMO's

ONE body of men who did grand work in the early days of the war has received little mention and scant recognition of its services. In 1940 a call was made for amateur wireless enthusiasts to volunteer for important hush-hush work in the Army and the response was very good indeed. The work actually was to look after radar equipment on anti-aircraft gunsites. The fellows who came along to do the job were given a short, high-pressure course of instruction in the general principles of radar and particularly in the tuning and phasing of GL1 (then almost the only AA radar equipment), and in diagnosing and setting to rights the many tricky faults to which it was subject at times. Then they went to gunsites. Their status was a curious one for quite a long time, for it was not till the end of '41 and the beginning of '42 that those who were able and willing were absorbed into R.E.M.E. At first they were neither fish nor flesh nor good red herring. They weren't exactly civilians, for they were under military orders and lived in officers' messes; but, equally, they were not soldiers, since they did not wear uniform. Theirs was a tough job, for on top of hard routine work they were liable to be called out at any moment of the day or night and in all weathers to attend to some refractory transmitter or receiver. The only trouble was that there were never enough of them to go round: at one time I had seven radar equipments and no Radio Maintenance Officer.

Fiddling Jobs

All old radar hands who served with AA will recall some of the cuss-provoking tasks that the old Mark 1 apparatus could provide if it took a pernickety turn. Tuning the transmitter was one of the worst of these. If all went well, you might accomplish it in ten minutes—I've done it in even less when the thing was in a good mood—but if it chose to be awkward you might be still fiddling at the end of half an hour. When you got the frequency right according to the horrible little neon-lamp wavemeter provided the loading of the power amplifier turned out to be wrong; and when you set that right the frequency was miles out and you had to start all over again. Mark II, with its cathode injection to the PA, its first-class wave-meter and its monitor tube (which worked, whilst that of Mark I seldom did) was child's play by comparison. The phasing of the EF (Bedford) attachment of the Mark I receiver, too, could be an awkward job for those new or fairly new to the game. The Mark II receiver had perhaps rather too many mechanical gadgets about it; but it was fairly plain sailing from the electrical point of view—so far as anything with that number of valves can be plain sailing. I never totted them up exactly, but there must have been 70-80 in it, including the IFF gear.

□ □ □

Medium-wave Americans

IT'S a long time (or rather it was until the last week of October) since I've devoted myself to small-hours searches for medium-wave broadcasting stations on the other side of the Atlantic. Before the war I have more than once been known to make a complete night of it, not leaving the receiver until the arrival of dawn put an automatic end to the session. I can remember many a night, too, when there was such a wealth of stations and so much of interest to be heard that only the realisation that I had a hard day's work ahead of me eventually drove me reluctantly to bed. During the war one lost the habit, mainly because it was so seldom that, if a good set was available, one had the time to use it for such purposes. Nor since I returned to civvy life have I been able until recently to get hold of a receiver worthy of the name. Not long after it arrived I began to feel the old urge and three times I made trips of the medium-wave band between 0130 and 0300 hours. It was like revisiting some part of the world that one used to know well, but had since completely forgotten. I felt utterly lost. Time was when I knew the band so well that I hardly needed to refer to lists of American or Canadian stations. Now I wanted such a list badly and none was available. Worse still, the results of my efforts were sadly disappointing. Whether my hand has lost its skill or whether conditions were just plain bad, I don't know; but I heard very few of the stations that I set out to find and I was unable to identify the majority of those I did hear. For the moment, at all events, I feel that the small hours are more profitably spent abed.

A Gas Blowlamp

NOT a few small tools which simply cry aloud for a place in the wireless man's workshop were designed or invented during the war. They are now beginning to trickle on to the market, and the enthusiast who potters round the toolshops occasionally is more than likely to come across good things. I for one cannot resist the lure of a good toolshop, though I enter one firmly resolved that, whatever the temptations, I will buy nothing but the two twist drills or the small file that I need to replace casualties. My purchases shall be made quickly; there shall be no lingering, no looking at this or that afterwards. . . . Invariably I emerge much later, penniless, but possessing several new tools so obviously essential that I can't think how I ever got on without them. My most recent find, though quite inexpensive (3s. 9d., to be exact), is something that I—and no doubt many readers—have been looking for for years. It is a miniature self-acting gas blowlamp, ideal for "sweating" with ordinary solder, but producing so hot a flame that it can be used for silver-soldering or even for small brazing jobs. Like so many ingenious inventions, it is simplicity itself. It consists of a brass cylinder, one-and-three-quarter inches long and $\frac{7}{16}$-inch in diameter. One end is open; the other is closed, by a screw-on cap, which carries a nozzle of $\frac{1}{8}$-inch brass tube, just over an inch in length. The end of the nozzle is bent downwards at an angle of about 30 degrees. Just over $\frac{1}{4}$-inch below the "root" of the nozzle there is a minute hole in the cap. And that is all there is to it. Slip the rubber tube of a gas connection on the open end of the cylinder, turn the tap full on and apply a light to the nozzle. Instantly a typical blowlamp flame appears, narrow, intensely hot and about 4 inches in length. The flame may be reduced to an inch or so for fine work by partly blocking the nozzle with a piece of wire. The first job the blowlamp was called on to do was the repair of a silver wrist-watch case, in which one of the lugs carrying the strap had broken away from its moorings. A sound piece of silver-soldering was accomplished in a matter of a few minutes. The blowlamp is called the Spitfire. I don't know who makes it, but I bought it from a toolshop in Holborn. The uses of the Spitfire in wireless work are obviously legion. You see, I expect, how it operates. A high-pressure stream of gas issues from the tiny hole in the cap and, carrying air with it, impinges on the flame at the nozzle, thus producing a self-acting and continuous blow-lamp effect.

□ □ □

A Weak Spot

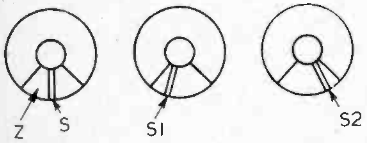
ONE of the commonest causes of trouble in any wireless equipment produced in large quantities by mass production methods is the soldered joint. The proportion of such joints that prove faulty is minute: probably not more than a minute fraction of one per cent. But there are a tidy few soldered joints in any wireless set, and if only one of them in a hundred thousand fails to do its stuff breakdowns due to this cause must run to a considerable number in a year amongst the ten million odd receivers in use in this country. Soldered joints certainly gave us no small amount of bother in radar equipment, particularly when it had to be subjected to the bumps and vibration inseparable from road travel. The average domestic wireless set becomes more or less static once it has been installed in its owner's home; but it has to reach that home by road and rail. And there is a good deal of vibration in many modern homes, especially those situated near roads carrying heavy traffic. I have often wondered whether a means of spot-welding the joints in wireless and other electrical equipment could not be devised. Any radio manufacturing firm which worked out and adopted a successful system of that kind would no doubt reap a golden harvest. The man in the street is beginning to change his ideas about wireless sets. He has found that there is not a great deal to choose in the performance of different "broadcast" receivers at about the same price. What he is now starting to make his most important consideration when buying a new set is reliability. He wants something that will work without an if or a but whenever he switches on and can be depended on to go on doing so not just for the "guarantee period" but for several years. I don't think that radio manufacturers always realise how much the intending purchaser is influenced by the experiences of other people. Half a dozen customers, dissatisfied owing to breakdowns, and ready to expatiate on their grievances to all and sundry, can quickly undo the work of many hundreds of pounds' worth of good advertising.

RECENT INVENTIONS

TUNING INDICATORS

THE tuning of a receiver for frequency-modulated signals is adjusted by equalising two voltages of opposite polarity, derived from the discriminator circuit. In an indicator, however, the developed voltages will also be equal, because both are at or near zero, when no signal is present.

To remove this ambiguity, when using a visual tuning indicator of the "magic eye" type, the biasing voltage applied to the two deflecting rods of the miniature cathode-ray tube is arranged, in the absence of any signal, to be equal to the anode voltage, so that the whole of the fluorescent dial



Visual tuning indicator for FM.

is illuminated. An incoming signal applies a negative voltage to both of the deflecting rods and produces a shadow zone Z within which a sharp pencil of light S is seen. This comes to the centre of the shadow when the circuits are correctly in tune, but falls to one side or another, as shown at S1 and S2, when they are off resonance.

Marconi's Wireless Telegraph Co., Ltd., (assignees of G. F. Elston.) Convention date (U.S.A.) Aug. 29th, 1942. No. 568821.

PIEZO-ELECTRIC OSCILLATORS

PRIMARY potassium phosphate (KH_2PO_4) is stated to be superior to quartz in piezo-electric sensitivity, and to be substantially equal to it in mechanical strength. Among other advantages, the phosphate crystals can be produced synthetically to any desired size, and are also more easily machined than quartz.

They dissolve readily in water but, unlike Rochelle salt, do not tend to lose the water of crystallisation, nor to deteriorate as oscillators, when exposed to the air. The same merits apply equally to certain other crystals which are isomorphic with the first, such as primary potassium arsenate. The use of such crystals is claimed in any piezo-electric device.

"Patelhold" Patentverwertungs—and Elektro-Holding, A. G. Convention date (Switzerland) Nov. 22nd, 1942. No. 569285.

The British abstracts published here are prepared with the permission of the Controller of H.M. Stationery Office, from specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

A Selection of the More Interesting Radio Developments

COLOUR TELEVISION

THE image signals corresponding to each of the primary colours are subject to certain defects which require individual correction in order to secure a properly balanced picture. For instance, the studio illumination is likely to contain a disproportionate amount of light of certain wavelengths; whilst if the transmission is made from coloured films, the arc-lamp used for scanning will favour the red end of the spectrum. Again, the photo-sensitive screen of the signal-generating tube is usually more sensitive to the red than the blue; whilst the colour response of the eyes of the observer, as well as the nature of the lighting under which he views the received picture, may also call for special compensation.

According to the invention, the set of signals for each primary colour is passed in sequence through an amplifier of the electron-multiplier type, the gain of which is controlled by keying-impulses which are peculiar to, and synchronised with, the transmission of each of the different colour-groups. In this way, each one of the distinctive images forming the complete picture can be independently adjusted to any desired level of brightness.

W. W. Triggs. (communicated by Farnsworth Television and Radio Corp.) Application date May 26th, 1943. No. 568326.

STORAGE BATTERIES

THE possibility of any dangerous explosion of the mixture of electrolytic gases generated during the charging and discharging of lead-acid accumulators is avoided by packing the top of the container with small solid bodies, such as glass crystals. The space in which the explosive gases usually collect is thus split up into comparatively small areas, in which combustion can occur harmlessly and without any danger of producing a sustained flame.

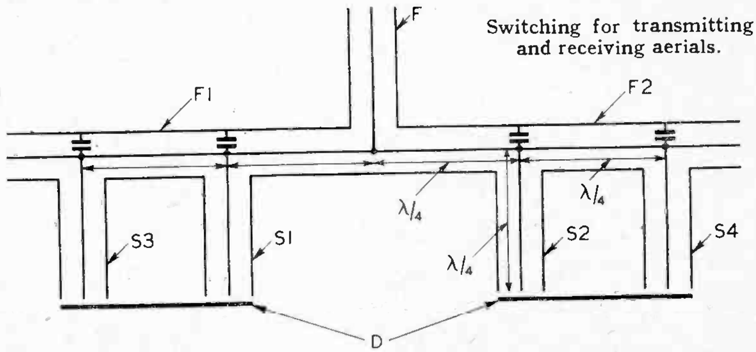
The porous packing is contained between an upper and lower plate, the latter fitting into the container just above the highest level of the acid. Provision is made for the usual filling and vent tubes and level indicator. A further advantage is the reduction of acid spray during charging.

A. A. Thornton (communicated by Philco Radio and Television Corpn.) Application date September 10th, 1943. No. 569612.

TRANSMISSION-LINE SWITCH

A MAIN feeder F alternately energises two branched feeders F1, F2 so as to radiate signal pulses from two spaced aerials in rapid succession, the aerial that is not transmitting at any given instant being prepared to receive incoming signals. The necessary switching can be effected by rotating a slotted disc D so that it intermittently closes the open ends of two quarter-wave stubs S1 and S2, located at opposite sides of the "tee" junction, as shown. When the stub S1 is closed, it presents an infinitely large impedance, when looked at from the feeder F1, so that the latter passes signal energy at full strength from the feeder F to the left-hand aerial. Simultaneously a gapped part of the disc D comes under the end of the stub S2, which is then seen as a half-wave open stub from the main junction. It therefore presents an infinitely large impedance to energy flowing in the feeder F, thus momentarily isolating the feeder F2 so that it can accept signals coming from the right-hand aerial.

In practice, the rotating disc D does not completely close the open end of



Switching for transmitting and receiving aerials.

either of the stubs, so that they fail to develop their maximum impedance, and the receiving aerial is thus not completely isolated from the strong outgoing signals. To compensate for this and other defects, two reinforcing stubs S3 and S4 are arranged, as shown, for synchronous operation with the stubs S1 and S2.

The General Electric Co., Ltd., and D. C. Espley. Application date Nov. 18th, 1941. No. 568379.

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EXTENSION SPEAKERS

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The benefits of specialisation make possible really amazing values. The efficient permanent magnet speakers, giving remarkably pleasant reproductions, are housed in most attractive cabinets, complete with VOLUME CONTROL.

Supplies are limited so please be patient if your dealer cannot supply immediately.

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,, ,,	MC (with Universal Transformer)	-	35/6
Baby ,,	BX (for Low Impedence Extension)		43/6
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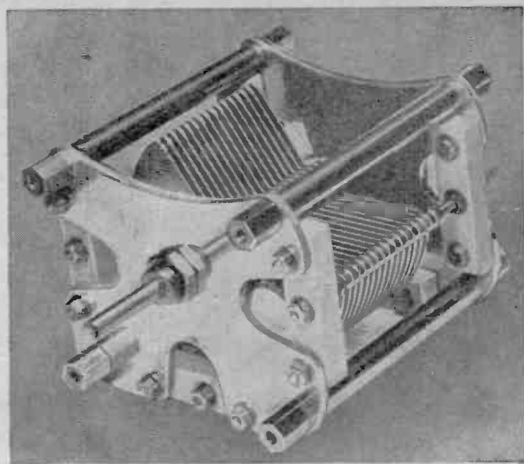
WHITELEY ELECTRICAL RADIO CO. LTD.
MANSFIELD, NOTTS.



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Variable Capacitors

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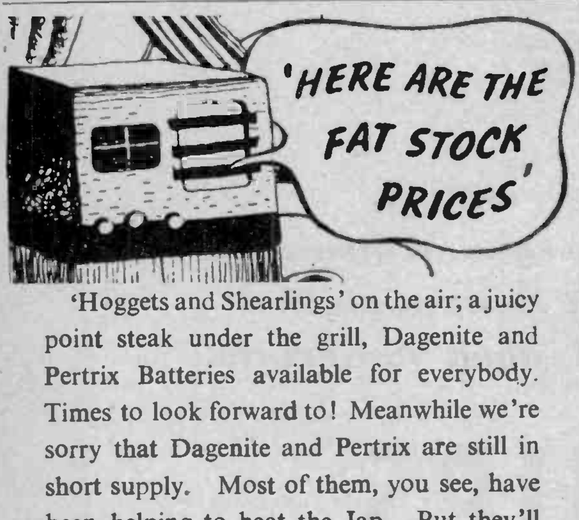

'Hoggets and Shearlings' on the air; a juicy point steak under the grill, Dagenite and Pertrix Batteries available for everybody. Times to look forward to! Meanwhile we're sorry that Dagenite and Pertrix are still in short supply. Most of them, you see, have been helping to beat the Jap. But they'll be back, soon now!

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NEW RECEIVERS AND AMPLIFIERS

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NEW Philips Voxmobile amplifier, 12v or 230v ac 15 watts. Crystal mike, 2 horn, L.S., £58/10: super job. 5-watt amplifiers with valves, neat chassis construction, £6/10.

ROGERSON ac eliminators & trickle charger, £4/15; home chargers, 12v 3amps, 90/-; Atlas ac eliminators (no charger) £4/10.

ROTHERMEL crystal pick-ups, £3/18/9; line cord 3 core 0.3amp, 2/- yd. (180 ohms); Varley 2v 40amp accumulators (charged), 16/9; posted safely.

LOUDSPEAKERS.—Rola 8in 19/6, 5in 18/6, 10in 45/-; Celestion 8in with trans., 25/-; ditto, energised, 2,000ohms, 36/-; Vitavox 12in PM, 10w, £7.

TRANSFORMERS.—Universal output, 6/6; microphone 70/1, 8/6; mains standard type, shrouded (state L.T.S.), 25/-.

ELECTROLYTICS.—B.I. 8mfd 500v 3/1, 8 plus 8 4/11; T.M.C. 25mfd 25v, 2/6; block condensers, 500v 2mfd 1/6, 4mfd 3/-.

COILS (circuits included).—M.W. Midget T.R.F., 5/- pair; aerial and oscillator for superhet, 9/- pair; 465kc if transformers, aluminium cased, with trimmers, 12/6 pair; .0005, with trimmers, 12/6 pair.

H.P. RADIO SERVICES, Ltd., 55, County Rd., Liverpool, 4. Est. 1935. (Aintree 1445.)

BRIERLEY quality amplifiers, 200-250v ac 5-watt, 8½gns.; 12-watt, £14; P.A. and S.O.F. types available.

WE are pleased to announce that we now have in production two pick-ups; performances, obtainable only by means of the entirely new and original design, are matched by a finish and workmanship that cannot be excelled; these two pick-ups have downward pressures of ⅛ and ⅝ oz. only, and the latter has an output in the region of 1 volt; permanent points wearing some 6 times longer than sapphire, ground and polished to an accuracy of 1/50th of 1 thou. are used; illustrated literature on these pick-ups will be available shortly; s.a.e. for illustrated leaflets on amplifiers and copy of "Design for Quality."—J. H. Brierley (Gramophones and Recordings), Ltd., 46, Tithebarn St., Liverpool, 2. [4583

NEW Hallicrafters, SX24, with speaker, perfect; what offers?—Box 2749. [4549

COMMUNICATION receivers.—As soon as civilian supplies recommence we shall be at your service.—A.C.S. Radio, 44, Widmore Rd., Bromley, Kent. [4528

COMMUNICATION receivers. — "Dale" will have them as soon as trading conditions allow.—Remember—Dale Electronics, Ltd., 105, Bolsover St., W.1. Mus. 1023.

THE Arrow Home Constructor's Kit, 4-valve T.R.F., complete kit of parts with full instructions, £6; set valves, 26/- extra.—Charles Britain Radio, 2, Wilson St., E.C.2.

T.R.F. ac/dc medium and long wave kit of parts, with drilled chassis, size 9½×4½×1½, and all components, condensers, etc., and circuit, nothing else to buy, £4; valves, £2/10; 5in speaker, trans., 27/6.

HENRY'S, 5, Harrow Rd., Edgware Rd., W.2.

ANELOY RADIO offer set of components for making M.W. semi-midget ac/dc t.r.f. receiver, including cabinet, valves, drilled chassis, 6½in speaker, screws, etc.; nothing more to buy; complete with circuit. £8.—Aneloy Radio, 36, Hindmans Rd., E. Dulwich, S.E.22.

HALLICRAFTER 329 latest portable 550 kc to 305 mc bandspread and 'phones, perfect order; Eddystone communication receiver, complete with range of coils, new; McMurdo Silver radiogram in cabinet.—Peaty, Coombe Bridge, S.W.20. [4459

QUALITY.—We offer you a receiver combining all the features of the local reception quality and the communications receiver sensitivity; something new, it will be worth while investigating.—Details from the Moreton Cheyney Co., BCM/REME, London, W.C.1.

BAKER'S.—New 7-valve "Wireless World" Quality amplifier with tone control stage, 8 watts push-pull triode output, price includes super Quality triple cone, 12in permanent magnet speaker, with large output transformer and all valves; also as above but with 15 watts tetrode output, ideal for realistic reproduction for public address; 2½d. stamp for particulars, prices, etc.—Bakers Selhurst Radio. Tel. Croydon 4226. [3680

RECEIVERS, AMPLIFIERS—SECOND-HAND

SOUND SALES Quality radio, amplifier, and Voigt spkr.—88, Beaconsfield Rd., Enfield.

H.R.O., with power pack, speaker and 9 coils, as new; £115.—A.C.S. Radio, 44, Widmore Rd., Bromley, Kent. [4531

HAMMARLUND HQ 120 communication receiver, 0.54 to 31 mcs speaker; offers.—Lill, Milton-u-Wychwood, Oxon. [4311

HALLICRAFTER SX 28, complete with Hallicrafter speaker, 15 tubes, 2 RF stages, brand new, in superb condition.

SCOTT, 14 tubes, in beautiful metal cabinet, crackle finished, complete with matching speaker.

RME 69, no speaker, but in perfect condition, late 1939 model.

3½IN Oscilloscope, complete with tube and power supply, no time base, in metal cabinet. All inquiries to J. Couch, 19, North St., Lostwithiel, Cornwall. [4534

COMMUNICATION receiver type 358X, by Eddistone, coils 90 KC to 31 Mc, including power pack & loud spkr.; £60.—Box 2333.

AMERICAN 6v car radio, £16; three unused R.C.A. Acorns, 954, 955, 956, 30/- ea.—110, Alexandra Rd., London, N.W.8.

SALE, small two-valve audio oscillator, two Morse keys, quantity wire, also remote control unit, all as new. Offers?—Box 4499.

A.C.S. RADIO, 44, Widmore Rd., Bromley, Kent, offer small selection com. sets, radio receivers, amplifiers and televisors; list free. [4530

ALL typ[illegible] of amplifiers, microphones and loudspea[illegible] sale.—Send stamp for lists to Potter, 9, White Hart St., Thetford, Norfolk. [4453

HALLICRAFTERS, Skyrider Defiant, SX24 and loudspeaker (5,000ohm), very little used; £40.—Pott, 19, Surbiton Court, Surbiton, Surrey. [4541

HALLICRAFTERS, SX17, 500 kcs, 63 mcs, 230v AC, no speaker, stored 5 years, as new.—Offers to Box W., Smiths Bookshop, West Drayton, Middx [4452

SOUND Sales 12-watt amplifier, complete with output transformer having 15 and 30 ohm secondaries, with new valves; offers; seen Ealing.—Box 2764. [4562

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PORTABLE 25watt amplifier ac, 4 inputs, 2 speakers, Garrard record player, ac, mc mike and stand, 12 hours' use only, complete outfit; £45 near offer.—2, Arbroath Rd., Eltham, S.E.9. [4548

R.C.A., model ACR-111, communications receiver, 0.54 to 30 mcs, 16 tubes, with [illegible]eaker and telescopic aerial, in excellent condition; best offer over £40.—Crace, 3, Elmfeld Ave., Leicester. [4450

HALLICRAFTER S27C 14v receiver, U.H.F., 130/21[illegible] Mcs, 230v AC; offers or exchange R.M.E.69, SX28 or similar; also AC/DC Avominor, new, £8/10.—Jones, 84, Embankment Rd., Plymouth. [4468

PUSH pull quality amplifier (PX.4.s) with straight tuner unit (2 hf stages and diode), for ac mains, complete with speaker (10in energised), £15 or best offer; dc mains amplifier and straight tuner unit, push pull tetrodes, £12 or best offer.—Box 4500. [4439

COMPONENTS—SECOND-HAND, SURPLUS

SUPREME RADIO, 746b, Romford Rd., Manor Park, London, E.12. Est. 15 yrs. Tel. Ilf. 1260.

MIDGET 2-gang variable condensers, 0.0005 mfd with trimmers, fixing feet, 11/6; 3-gang ditto, 13/-; Midget coils, high gain m.w., 7/- pair; M and L, with circuit, 10/-; M and L. s.w. for same, 2/3; A. and osc. coils, L.M.S. 465 k/c with circuit, 12/6; i.f. transformers for same, 465 k/c, 12/6; all-wave dials, coloured, 1/9; Midget chokes 60ma 360v, 6/-; heavy duty, 100ma, 10/-; Midget trans. P.P., 4/6; 40ma Multi Ratio speaker trans., 6/6; 30watt P.P., any matching on primary or sect., £1/1; line cord, 0.3a 3-way 60-70v ft., 2/- yd; mains droppers, 0.2a 1,000v fixing feet, 2 sliders, 4/-; 0.3a 800v 2 slider feet, 5/-; 0.2a 1,000v, less feet, 3/3; Pye replacement droppers, 3/-; 801-802 Fur-gusson droppers, heavy duty, 8/6; volume controls, all valves, with s.w., 4/-; less s.w., 3/-; W.W. controls, 2,000-10,000, less s.w., 2/6; wire wound resistances, 200-240,000v, colour coded, 24 in pkt, 7/6; Midget 0.1+.1 mfd T.C.C., 350v w, dc, or 250v w ac, 1/- ea.; 0.0005 reaction condensers, 2/9; bias condensers, 50v-50mfd, 3/6; 25v 25mfd, 2/6; T.C.C. 2mfd 375v, 2/9; T.M.C. 4mfd, 2/9; 8mfd 450v, 3/6; 8+8 mfd 450v, 6/9; 16+8 mfd 450v, 8/6.

S.A.E. all enquiries; 6d. extra postage orders under £5; no c.o.d. [4525

RADIO REPAIR SERVICE, 36, Stoneyfields Lane, Edgware, Mdx.

HIGH-GRADE goods at the lowest prices; 0.3 amp 3-way line cord, 60-70 ohms, per ft in 10yd lengths, 15/- length; parcel of 24 assorted ½-watt Erie resistors and 24 1-watt, 28/- per parcel; cash or c.o.d.; 1/- packing and post.

B.V.A. and U.S.A. valves, Varley, Wearite, Raymart and Eddystone components, Avo instruments, new goods only; s.a.e. for lists etc.—Radio Supplies, 56, Hughes Ave., Horwich, Lancs. [4478

VALUE! Matt has it!

LINE CORD.—2-way 2/6 per yd., 3-way 3/- per yd. (approx. 60 ohms per foot). SPEAKERS.—"Celestion" P.M. 2½in., less trans., 27/-; 8in. P.M., with trans., 27/6; 6½in. P.M. (multi-ratio trans.), 28/6. TWO-GANG condensers.—0.0005, 12/6; Midget coils, h.f. and aerial, 4/6 per pair. VALVE HOLDERS (all types). Volume controls, less switch, 2/9; with switch, 3/9. MAINS transformers, 4v and 6v, 27/6. ROTHERMEL (crystal) pick-ups, metal, S8, £3/13/6; Senior de Luxe, £3/18/9. LET us quote you for all your requirements. Cash with order, plus postage. MATT RADIO SERVICE, 152, Richmond Rd., Kingston-on-Thames, Surrey. [4159

SOUTHERN RADIO'S wireless bargains:—

LATEST radio publications: "RADIO Valve Manual," equivalent and alternative American and British types with all data, 3/6; "Radio Circuits," fully illustrated receivers, power packs, etc., 2/-; "Amplifiers," fully descriptive circuits, 2/-; "Radio Coil and Transformer Manual," 2/-; "Short Wave Handbook," 2/-; "Manual of Direct Disc Home Recording," 2/-; "Test Gear Construction Manual," 1/6; "Radio Pocket Book," formulas, tables, colour-code, etc., 1/-; "10-Hows for Radio Constructor," 1/-. Just published, "Radio Reference Handbook," comprehensive and up-to-date, covering all branches of radio, 10/6.

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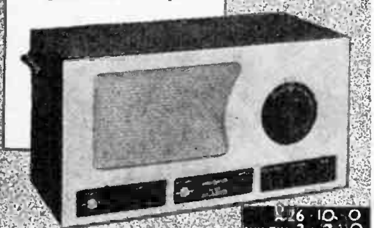

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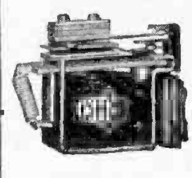

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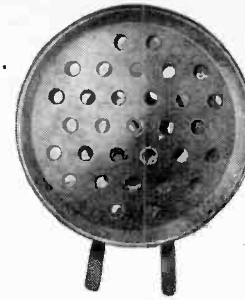

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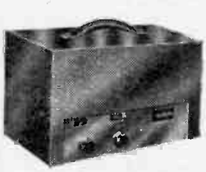

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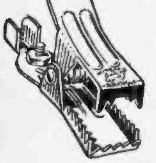

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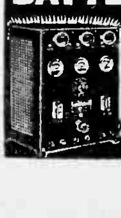

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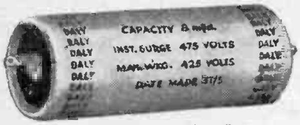

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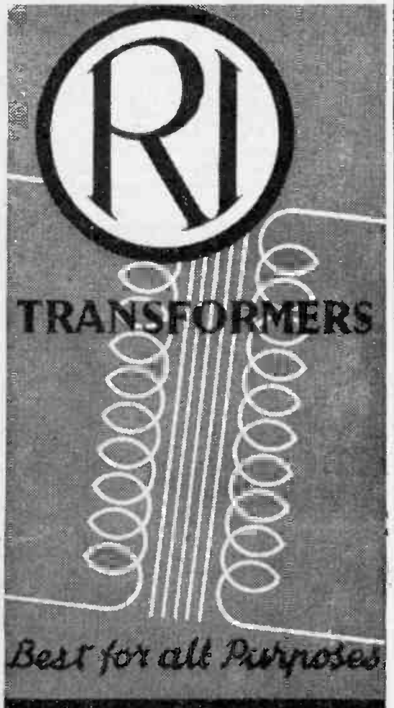

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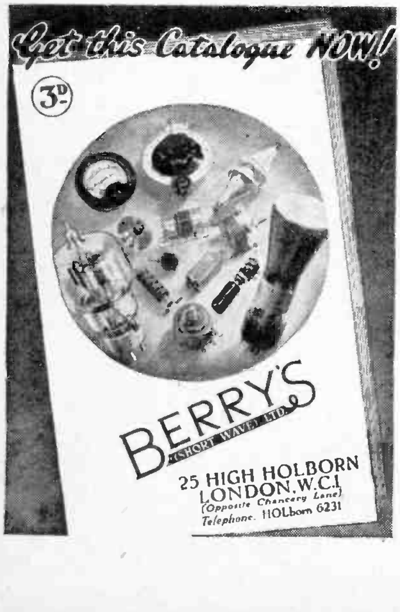

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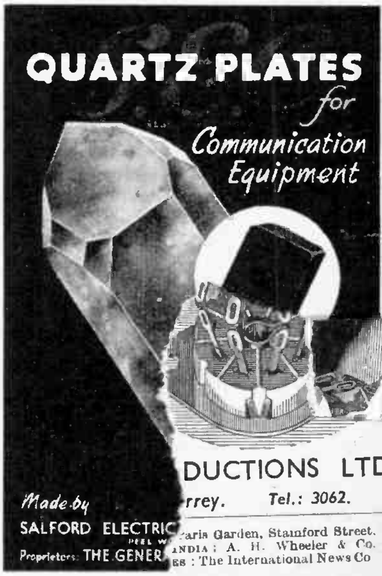

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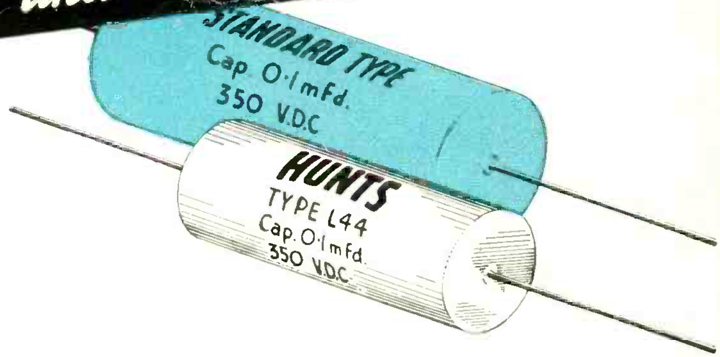

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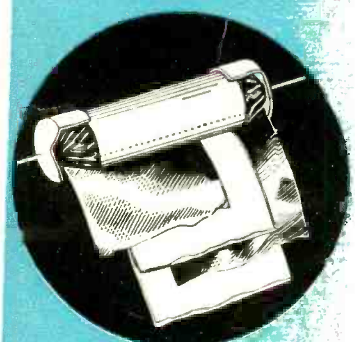

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