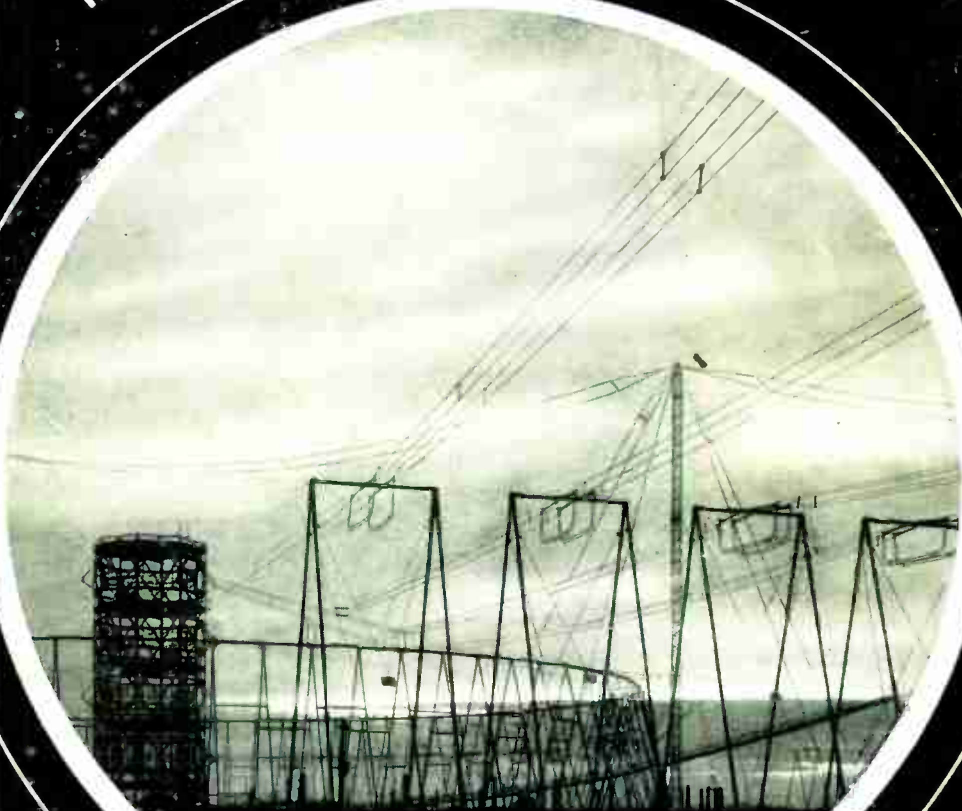
Wireless World

RADIO AND ELECTRONICS

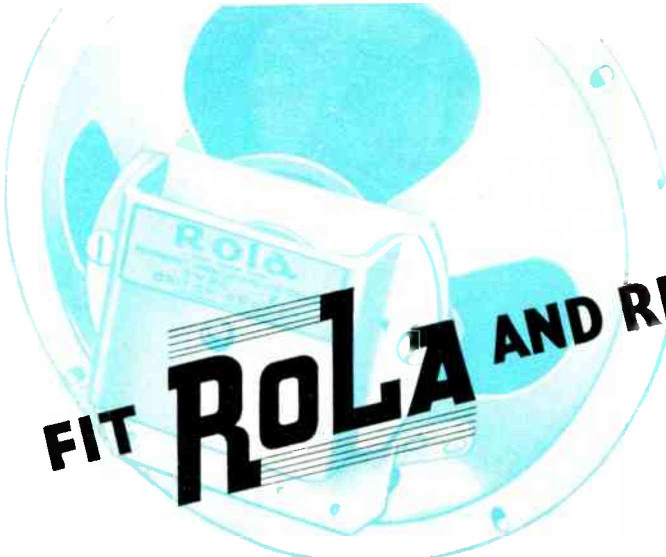


APRIL 1947

1/6

Vol. LIII. No. 4

IN THIS ISSUE: NEW HIGH-QUALITY AMPLIFIER



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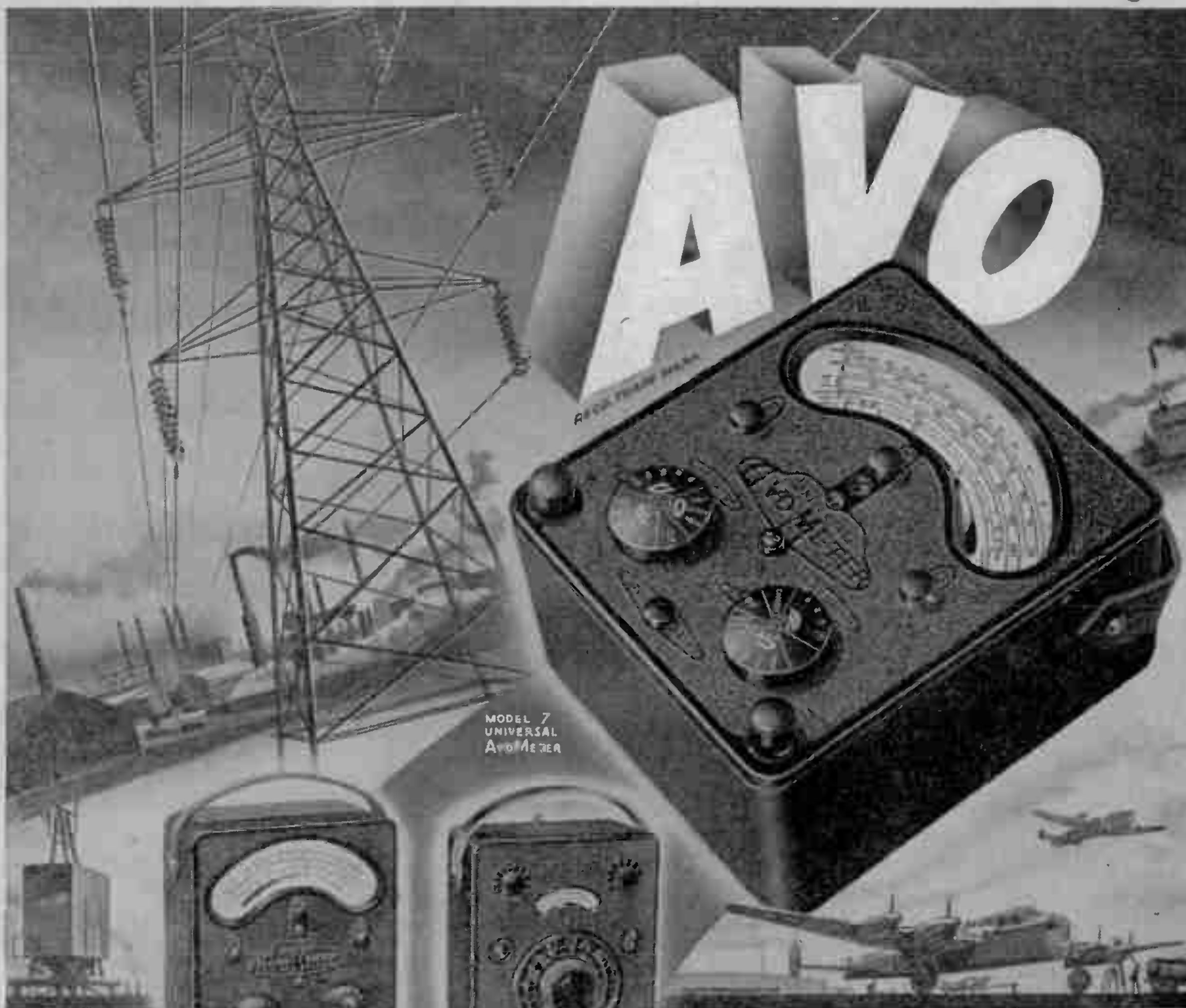

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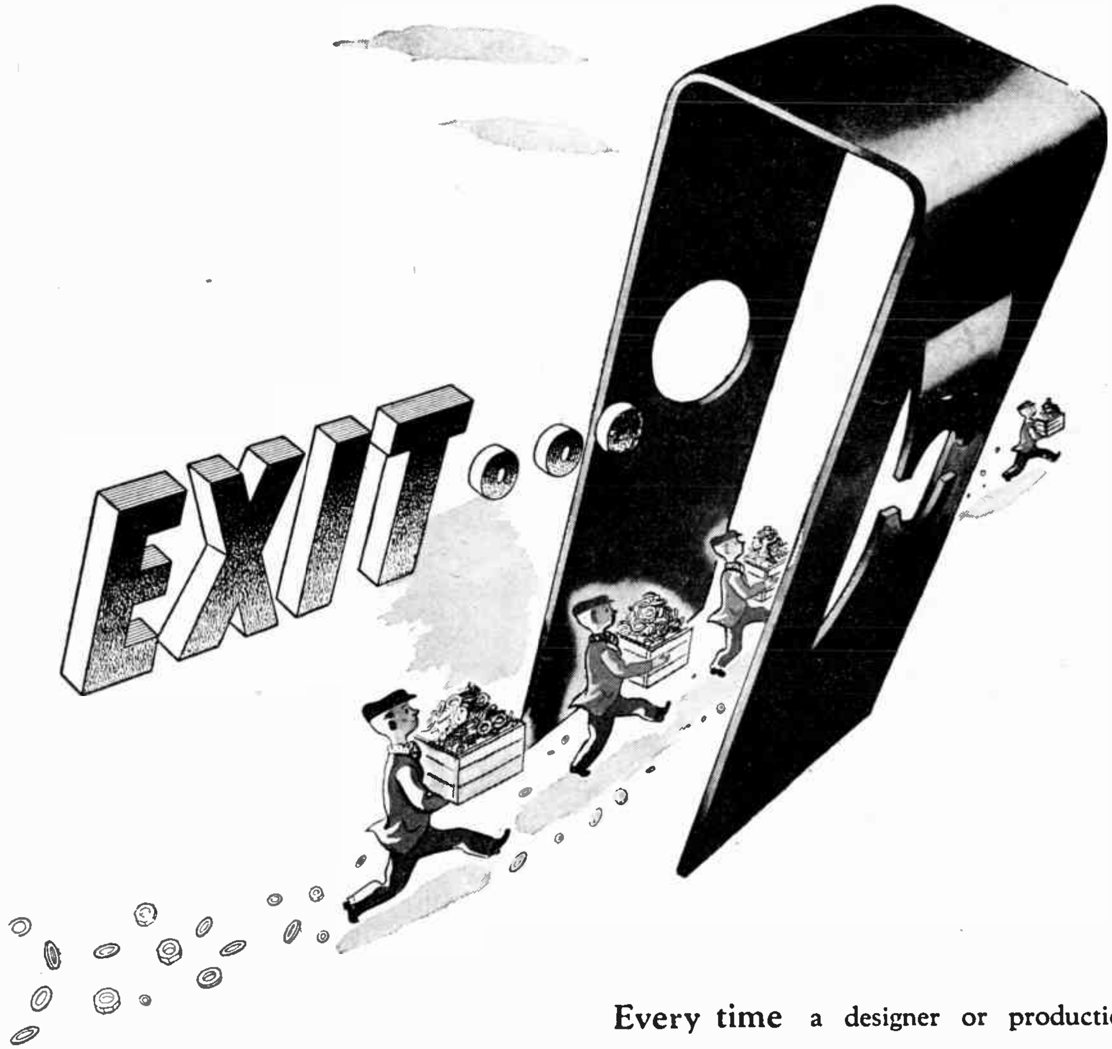

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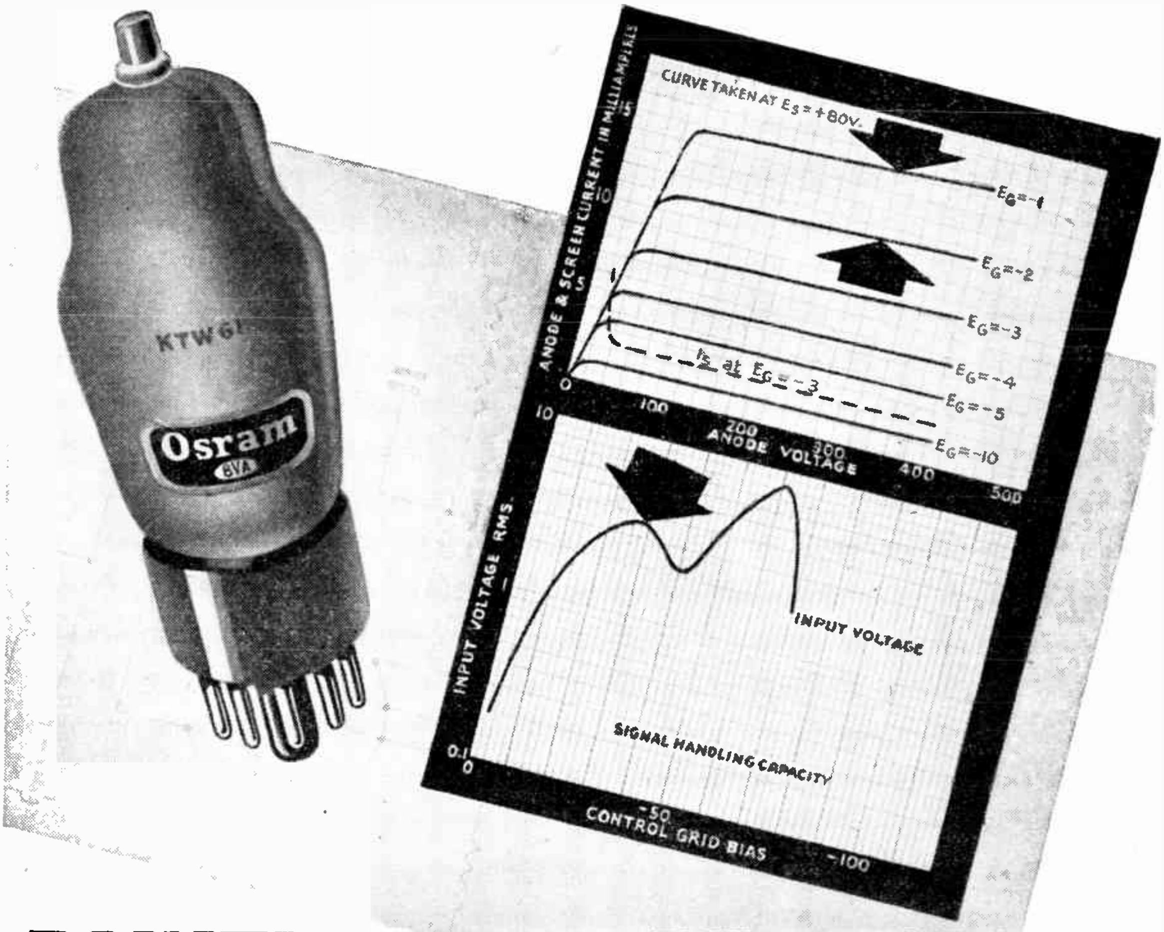

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A detailed technical data sheet is available on request.

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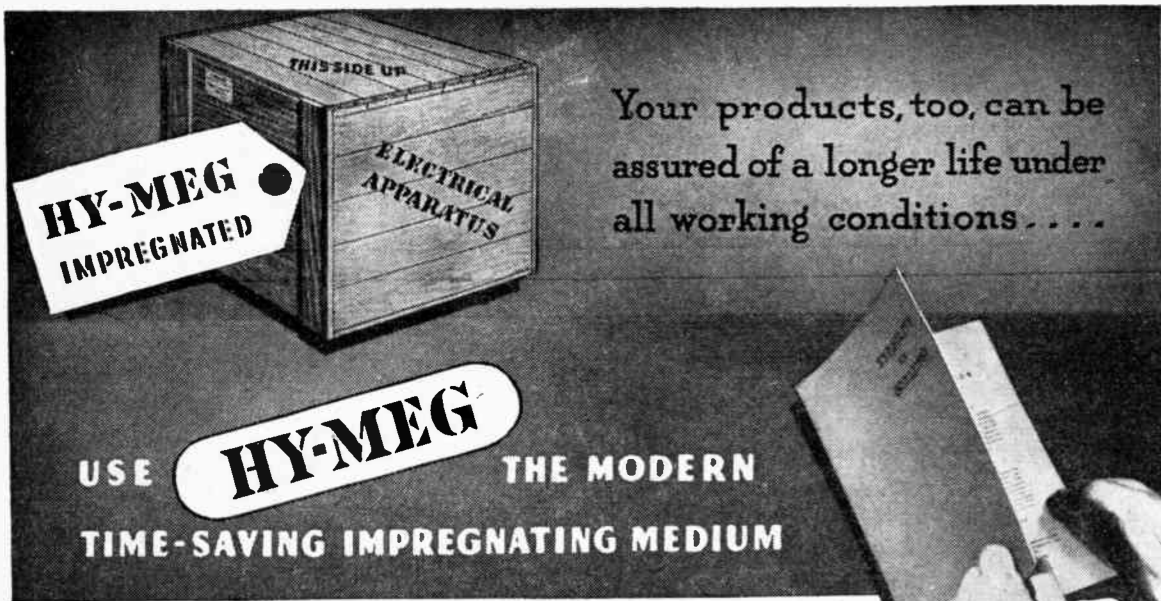

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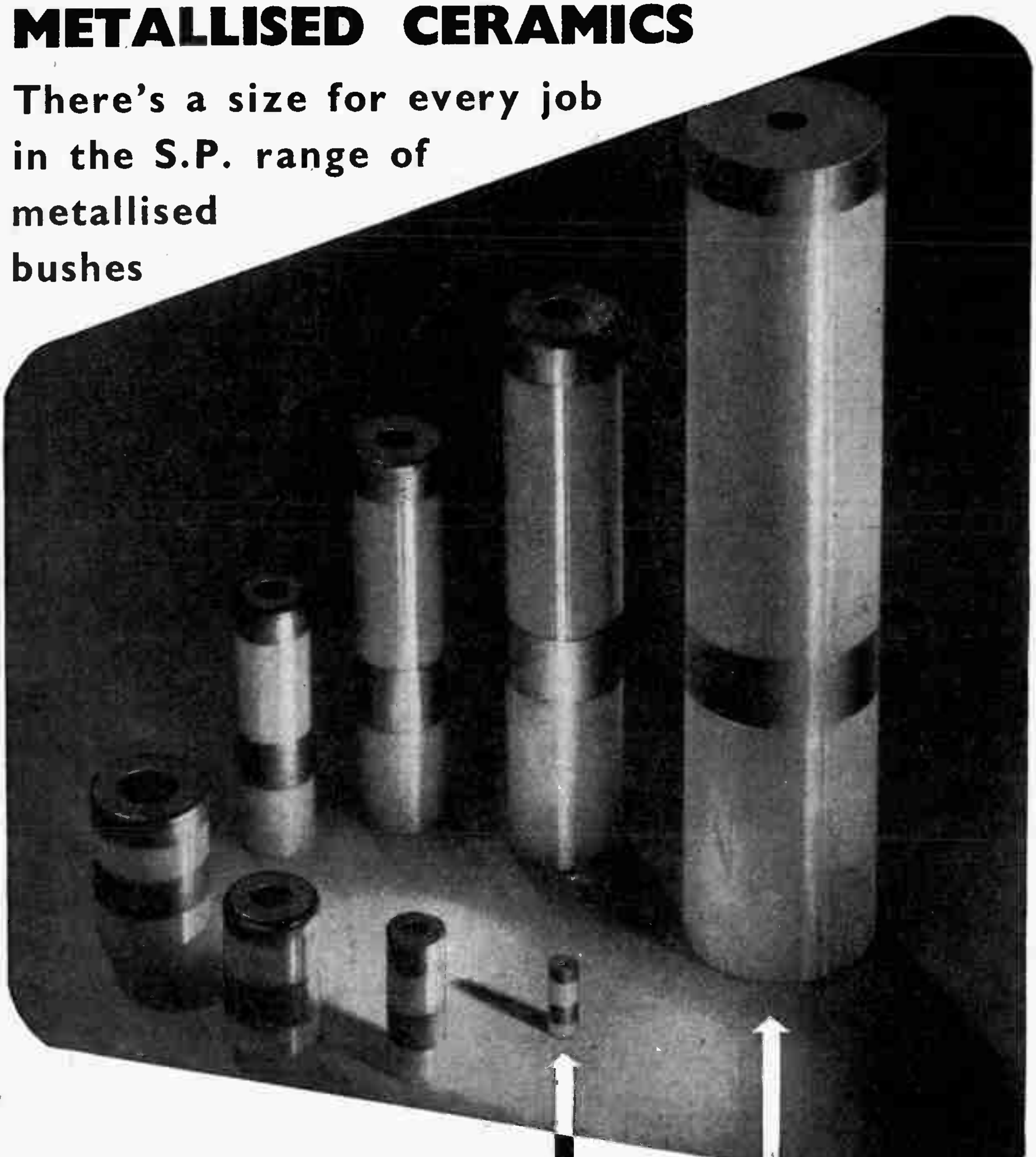

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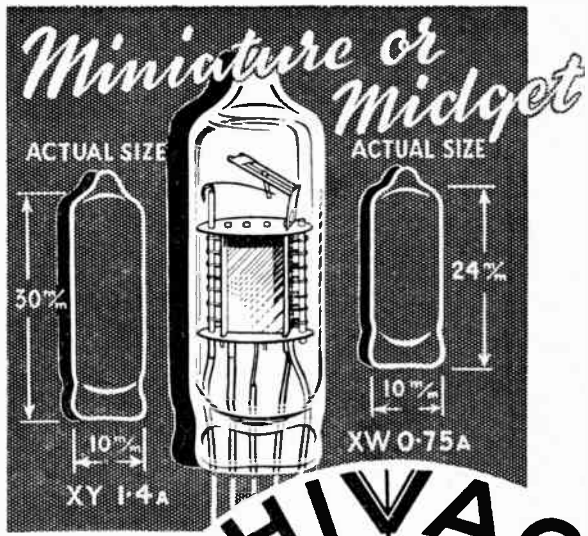

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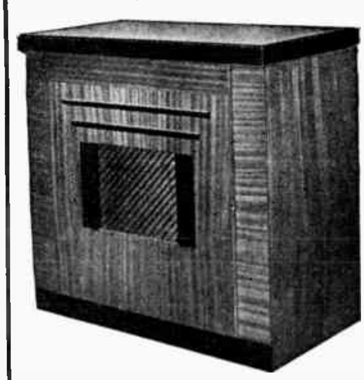

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10 × 8 × 2½in.	7/-	12 × 9 × 2½in.	7/9
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250-0-250 v. 60 m/a. 4 v. 1-2 a. 4 v. 3-5 a.	25/-
300-0-300 v. 60 m/a. 4 v. 2-3 a. 4 v. 3-5 a. 4 v. 1-2 a.	25/-
350-0-350 v. 100 m/a. 5 v. 2-3 a. 6.3 v. 2-3 a.	29/-
350-0-350 v. 100 m/a. 4 v. 2-3 a. 4 v. 2-3 a. 4 v. 3-5a.	29/-
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350-0-350 v. 150 m/a. 4 v. 2-3 a. 4 v. 3-6 a. 4 v. 1-2a. 4 v. 1-2 a.	39/-
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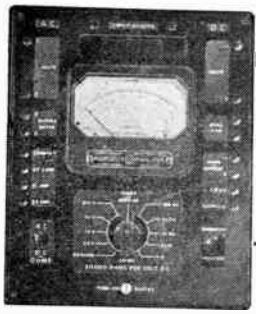

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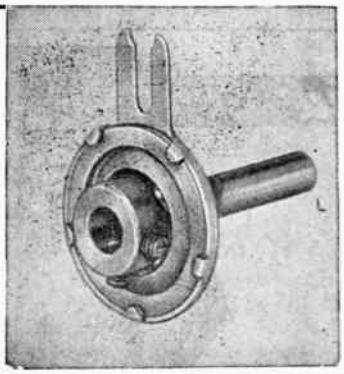

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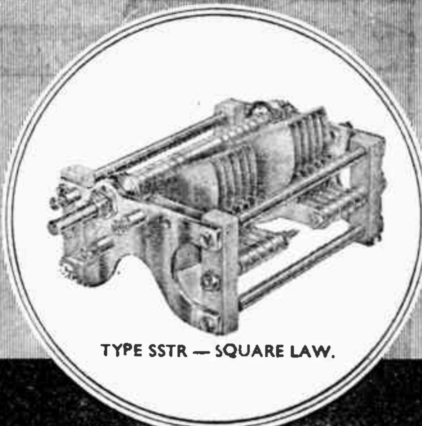

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,, III	96—103	440–460	95	8.0	—	Lead and Lime
,, V	95—105	—	67	7.6	160	Soft Lead
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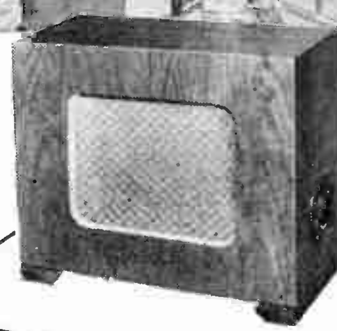

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As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

VALVES AND THEIR APPLICATIONS

By M. G. SCROGGIE, B.Sc., M.I.E.E.

No. 4: Mullard R.F. AMPLIFIER TETRODE QV04-7

THE last two valves discussed in this series were particularly suitable for V.H.F. receivers, though I did mention that the EC52 triode is capable of putting out a sufficient number of watts to be useful in a transmitter. Normally, a V.H.F. transmitter is crystal-controlled via one or two frequency-multiplier stages, and it simplifies the design if back-coupling through the valves in these stages and in the output stage is minimized by using tetrodes or pentodes.

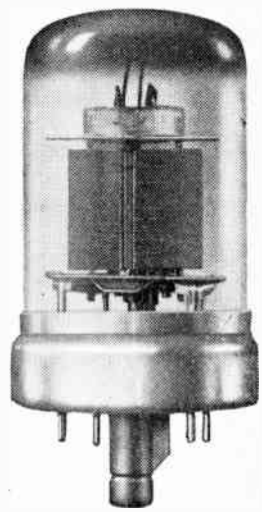
The QVO4–7, shown here, is a tetrode with characteristics that fit the needs of V.H.F. transmitters very nicely. Used as a Class " C " amplifier, the R.F. output per valve is about 8 watts at frequencies up to 30 Mc/s, and at least 6 watts at 150 Mc/s. This is at the rated maximum anode voltage, 300, which incidentally seems rather conservative. G_2 voltage is not critical; 150-250 is suitable, and owing to " beam " construction G_2 current is low — 5–6 mA at full output. Heater current is 0.6 A at 6.3 V.

Physically, it is the same size as the EC52, and like it is mounted on the " EF50 " base. The pins, being rather small, are silver plated to minimize loss at the higher frequencies. Capacitances are: input, 8.2 pF; output, 6 pF; anode to grid, 0.1 pF.

The last is small enough to give no trouble in frequency-multiplier stages, but prevention of self-oscillation needs attention in the output stage. The input circuit should be carefully screened right up to the grid pin, and have low impedance, which is the easier on account of the fact that only about 50 volts peak drive is needed, so a step-down from the driver stage is feasible. At the highest frequencies a quarter-wave coaxial line, tapped at the lowest point that gives sufficient grid drive voltage, is a convenient form of screened input circuit. If a touch of neutralization is found to be necessary, a bent wire is sufficient capacitance.

For the output stage there is little or no advantage in greatly exceeding cut-off grid bias, and with 150 volts on G_2 about –30 to –35 volts is enough. The optimum for frequency-doubling is appreciably greater; and for trebling is slightly more still.

The limiting cathode current is 50 mA, which, after deducting G_2 current, leaves about 44 mA for the anode. Maximum anode input at 300 volts is therefore a little over 13 watts. But as the anode is rated at 7.5 watts maximum dissipation, it is necessary to take care that the R.F. output is always at least equal to the wattage by which the input exceeds 7.5. For example, a short-circuited feeder would be rather hard on a valve receiving 13 watts input.



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Monthly Commentary

Classifying Frequencies and Wavelengths

A GOOD deal of unnecessary confusion is still being caused by the lack of a generally accepted classification of the wavebands, and particularly the frequency bands, used in radio communication. Without belittling the work of those standardizing bodies and others who have devoted much thought and ingenuity to devising classifications it is fair to say that none of their efforts have been accorded widespread acceptance. We think that this is because most of the classifications produced suffer to some extent from three major defects. They make use of unfamiliar terms; then fail to allow for the vagueness that is so often necessary at this stage of development of the art in speaking or writing of frequencies above 30 Mc/s, and they include arbitrary comparatives and superlatives that are not easily memorized.

Take the British Standard Glossary (BS204) classification of frequency bands in col. 3 of the table printed below. The relative highness of "very," "ultra" and "super" is by no means self-evident, and, perhaps worse still, the arbitrary assignment of precise significance to these words leaves us nothing to use when we wish to refer in general terms to all those frequencies having, say, visual-range propagation characteristics. The wave-band classification (col. 4) is rational and seemingly has all the advantages of potential international acceptance. But it has never been widely used, perhaps because it employs certain prefixes —myria-, hecto-, and deca- —that are unfamiliar even to the most fervent of English-speaking advocates of the metric system. And the word "metric" itself, as applied to waves, seems to contain the seeds of confusion, suggesting as it might to the intelligent layman that it relates not to a band but to waves in general classified or measured according to the metric system.

Of all the systems of classification so far presented the best and most realistic seem to us to be that devised by the Inter-Services Radio Circuit Symbols Committee, and given in col. 5 below. It starts by using terms that, though vague in themselves, have acquired generally accepted meanings and relate to wavebands in easily memorized round numbers. For the shorter wavelengths, where there is no risk of running counter to accepted usage, the terms are precise. Where precision is not needed, no barrier is placed in the way of calling all waves shorter than 10m "very short." This classification deserves wider currency.

Unfortunately the Inter-Services Committee has not produced a companion frequency classification, and here we venture to step into the breach, putting forward for consideration the very simple classification of col. 6. The only real departure from precedent is the abandonment of all attempts to sub-divide the frequency band below 30 Mc/s. When there is need for greater precision than is implied in "very high" the bands can always be defined in terms of their frequency in Mc/s, or, when dealing with the higher numbers, perhaps in kMc/s (kilo-megacycles per second). The ultra-, super- and hyper- prefixes in this context have always been a nuisance, and few will regret their loss. We find—admittedly with rather malicious pleasure—that few of those who advocate the retention of these out-dated and vague superlatives can say off-hand what is the significance officially assigned to them.

(1) Freq. Bands	(2) Wavebands (Metres)	(3) BS204 Freq. Bands	(4) BS204 Wavebands	(5) Inter-Services Wavebands	(6) Proposed Freq. Bands
Below 30 kc/s	Above 10,000	Very low	Myriametric	Long	Low
30— 300 kc/s	10,000—1,000	Low	Kilometric		
300— 3,000 kc/s	1,000— 100	Medium	Hectometric	Medium	Medium
3— 30 Mc/s	100— 10	High	Decametric	Short	High
30— 300 Mc/s	10— 1	Very high	Metric	Metre	Very high
300— 3,000 Mc/s	1— 0.1	Ultra-high	Decimetric	Decimetre	
3,000—30,000 Mc/s	0.1— 0.01	Super	Centimetric	Centimetre	

DESIGN FOR A HIGH-QUALITY AMPLIFIER

I—Basic Requirements : Alternative Specifications

By
D. T. N. WILLIAMSON
(Late of the M.O. Valve Co.)

RECENT improvements in the field of commercial sound recording have made practicable the reproduction of a wider range of frequencies than hitherto. The useful range of shellac pressings has been extended from the limited 50-8,000 c/s which, with certain notable exceptions, has been standard from 1930 until the present, to a range of some 20-15,000 c/s. This increase in the frequency range has been accompanied by an overall reduction in distortion and the absence of peaks, and by the recording of a larger volume range, which combine to make possible a standard of reproduction not previously attainable from disc recordings. Further improvements, notably the substitution of low-noise plastic material for the present shellac composition, are likely to provide still further enhanced performance.

The resumption of the television service with its first-class sound quality, and the possible extension of U.H.F. high-quality transmissions, increase the available sources of high-quality sound.

Full utilization of these recordings and transmissions demands reproducing equipment with a standard of performance higher than that which has served in the past. Extension of the frequency range, involving the presence of large-amplitude low-frequency signals, gives greater likelihood of intermodulation distortion in the reproducing system, whilst the enhanced treble response makes this type of distortion more readily detectable and undesirable.

Reproduction of sound by electrical means involves the amplification of an electrical waveform which should be an exact counterpart of the air pressure waveform which constitutes the sound. The purpose of the amplifier is to produce an exact replica of the electrical input voltage waveform at a power level suitable for the operation of the loudspeaker. This in turn reconverts the electrical waveform into a corresponding sound pressure waveform, which in an ideal system would be a replica of the original.

The performance of an amplifier intended to reproduce a given waveform is usually stated in terms of its ability to reproduce accurately the frequency components of a mythical Fourier analysis of the waveform. While this method is convenient and indeed corresponds to the manner in which the mechanism of the ear analyses sound pressure waveforms into component frequencies and thereby transmits intelligence to the brain, the fact that the function of the system is to reproduce a waveform and not a band of frequencies should not be neglected. Sounds of a transient nature having identical frequency contents may yet be very different in character, the discrepancy being in the phase relationship of the component frequencies.

The requirements of such an amplifier may be listed as :—

(1) Negligible non-linear distortion up to the maximum rated output. (The term " non-linear distortion " includes the production of undesired harmonic frequencies and the intermodulation of component frequencies of the sound wave.) This requires that the dynamic output/input characteristic be linear within close limits up to maximum output at all frequencies within the audible range.

(2) (*a*) Linear frequency response within the audible frequency spectrum of 10–20,000 c/s.

(*b*) Constant power handling capacity for negligible non-linear distortion at any frequency within the audible frequency spectrum.

This requirement is less stringent at the high-frequency end of the spectrum, but should the maximum power output/frequency response at either end of the spectrum (but especially, at the low-frequency end) be substantially less than that at medium frequencies, filters must be arranged to reduce the level of these frequencies *before* they reach the amplifier as otherwise severe intermodulation will occur. This is especially noticeable during the reproduction of an organ on incorrectly designed equipment where pedal notes of the order of 16–20 c/s cause bad distortion, even though they may be inaudible in the sound output.

(3) Negligible phase-shift within the audible range. Although the phase relationship between the component frequencies of a complex steady-state sound does not appear to affect the audible quality of the sound, the same is not true of sounds of a transient nature, the quality of which may be profoundly altered by disturbance of the phase relationship between component frequencies.

(4) Good transient response. In addition to low phase and frequency distortion, other factors which are essential for the accurate reproduction of transient waveforms are the elimination of changes in effective gain due to current and voltage cut-off in any stages, the utmost care in the design of iron-cored components, and the reduction of the number of such components to a minimum.

Changes in effective gain during " low-frequency " transients occur in amplifiers with output stages of the self-biased Class AB type, causing serious distortion which is not revealed by steady-state measurements. The transient causes the current in the output stage to rise, and this is followed, at a rate determined by the time constant of the biasing network, by a rise in bias voltage which alters the effective gain of the amplifier.

(5) Low output resistance. This requirement is concerned

with the attainment of good frequency and transient response from the loudspeaker system by ensuring that it has adequate electrical damping. The cone movement of a moving-coil loudspeaker is restricted by air loading, suspension stiffness and resistance, and electromagnetic damping. In the case of a baffle-loaded loudspeaker, the efficiency is rarely higher than 5–10 per cent, and the air loading, which determines the radiation, is not high. In order to avoid a high bass-resonance frequency, the suspension stiffness in a high-grade loudspeaker is kept low, and obviously the power loss in such a suspension cannot be large. Electro-magnetic damping is therefore important in controlling the motion of the cone. This effect is proportional to the current which can be generated in the coil circuit, and is therefore proportional to the total resistance of the circuit. Maximum damping will be achieved when the coil is effectively short-circuited, hence the output resistance of the amplifier should be much lower than the coil impedance.

(6) Adequate power reserve. The realistic reproduction of orchestral music in an average room requires peak power capabilities of the order of 15–20 watts when the electro-acoustic transducer is a baffle-loaded moving-coil loudspeaker system of normal efficiency. The use of horn-loaded loudspeakers may reduce the power requirement to the region of 10 watts.

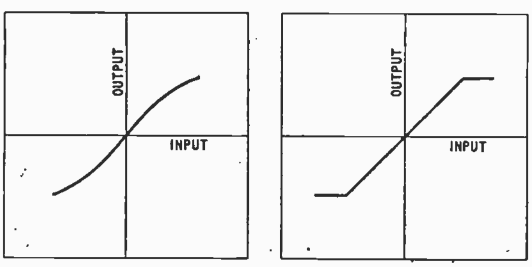
The Output Stage

An output of the order of 15–20 watts may be obtained in one of three ways, namely, push-pull triodes, push-pull triodes with negative feedback, or push-pull tetrodes with negative feedback. The salient features of these methods are of interest.

Push-pull triode valves without the refinement of negative feedback form the mainstay of present-day high fidelity equipment. A stage of this type has a number of disadvantages. With reasonable efficiency in the power stage such an arrangement cannot be made to introduce non-linearity to an extent less than that represented by about 2–3 per cent harmonic distortion. The output/input characteristic of such a stage is a gradual curve as in Fig. 1 (a). With this type of characteristic distortion will be introduced at all signal levels and intermodulation of the component signal frequencies will occur at all levels. The intermodulation with such a characteristic is very considerable and is responsible for the harshness and "mushiness" which characterizes amplifiers of this type. In addition, further non-linearity and considerable intermodulation will be introduced by the output transformer core.

If the load impedance is chosen to give maximum output the load impedance/output resistance ratio of the amplifier will be about 2, which is insufficient for good loudspeaker damping.

It is difficult to produce an adequate frequency response characteristic in a multi-stage amplifier of this type as the effect of multiple valve capacitances and the output transformer primary and leakage inductances becomes serious at the ends of the A.F. spectrum.



(a) (b)

Fig. 1. Output/input characteristics (a) without feedback (b) with negative feedback.

The application of negative feedback to push-pull triodes results in the more or less complete solution of the disadvantages outlined above. Feedback should be applied over the whole amplifier, from the output transformer secondary to the initial stage as this method corrects distortion introduced by the output transformer and makes no additional demands upon the output capabilities of any stage of the amplifier.

The functions of negative feedback are :—

(*a*) To improve the linearity of the amplifier, and output transformer.

(*b*) To improve the frequency response of the amplifier and output transformer.

(*c*) To reduce the phase shift in the amplifier and output transformer within the audible frequency range.

(*d*) To improve the low-frequency characteristics of the output transformer, particularly defects due to the non-linear relation between flux and magnetizing force.

(*e*) To reduce the output resistance of the amplifier.

(*f*) To reduce the effect of random changes of the parameters of the amplifier and supply voltage changes, and of any spurious defects.

A stage of this type is capable of fulfilling the highest fidelity requirements in a sound reproducing system. The output/input characteristic is of the type shown in Fig. 1 (*b*), and is virtually straight up to maximum output, when it curves sharply with the onset of grid current in the output stage. Non-linear distortion can be reduced to a degree represented by less than 0.1 per cent harmonic distortion, with no audible intermodulation. The frequency response of the whole amplifier from input to output transformer secondary can be made linear, and the power handling capacity constant over a range considerably wider than that required for sound reproduction.

The output resistance, upon which the loudspeaker usually depends for most of the damping required, can be reduced to a small fraction of the speech coil impedance. A ratio of load impedance/output resistance (sometimes known as "damping factor") of 20-30 is easily obtained.

"Kinkless" or "beam" output tetrodes used with negative feedback can, with care, be made to give a performance midway between that of triodes with and without feedback. The advantages to be gained from the use of

Design for a High Quality Amplifier— tetrodes are increased power efficiency and lower drive voltage requirements.

It must be emphasized that the characteristics of the stage are dependent solely upon the character and amount of the negative feedback used. The feedback must remain effective at all frequencies within the A.F. spectrum under all operating conditions, if the quality is not to degenerate to the level usually associated with tetrodes without feedback. Great care must be taken with the design and operation of the amplifier to achieve this, and troubles such as parasitic oscillation and instability are liable to be encountered.

When equipment has to be operated from low-voltage power supplies a tetrode stage with negative feedback is the only choice, but where power supplies are not restricted, triodes are preferable because of ease of operation and certainty of results.

It appears then that the design of an amplifier for sound reproduction to give the highest possible fidelity should centre round a push-pull triode output stage and should incorporate negative feedback.

The most suitable types of valve for this service are the PX25 and the KT66. Of these the KT66 is to be preferred since it is a more modern indirectly-heated type with a 6.3-volt heater, and will simplify the heater supply problem. Triode-connected it has characteristics almost identical with those of the PX25.

Using a supply voltage of some 440 volts a power output of 15 watts per pair may be expected.

The Output Transformer

The output transformer is probably the most critical component in a high-fidelity amplifier. An incorrectly designed component is capable of producing distortion which is often mistakenly attributed to the electronic part of the amplifier. Distortion producible directly or indirectly by the output transformer may be listed as follows :—

(*a*) Frequency distortion due to low winding inductance, high leakage reactance and resonance phenomena.

(*b*) Distortion due to the phase shift produced when negative feedback is applied across the transformer. This usually takes the form of parasitic oscillation due to phase shift produced in the high frequency region by a high leakage reactance.

(*c*) Intermodulation and harmonic distortion in the output stage caused by overloading at low frequencies when the primary inductance is insufficient. This is primarily due to a reduction in the effective load impedance below the safe limit, resulting in a very reactive load at low frequencies.

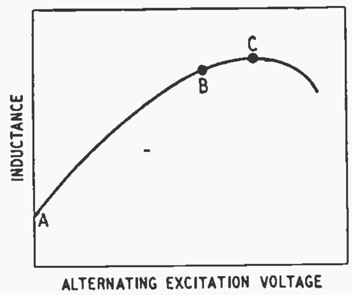


Fig. 2. Variation of iron-cored inductance with A.C. excitation.

This may cause the valves to be driven beyond cut-off since the load ellipse will tend to become circular.

(*d*) Harmonic and intermodulation distortion produced by the non-linear relation between flux and magnetizing force in the core material. This distortion is always present but will be greatly aggravated if the flux density in the core exceeds the safe limit.

(*e*) Harmonic distortion introduced by excessive resistance in the primary winding.

The design of a practical transformer has to be a compromise between these conflicting requirements.

At a low frequency f_b, such that the reactance of the output transformer primary is equal to the resistance formed by the load resistance and valve A.C. resistances in parallel, the output voltage will be 3db below that at medium frequencies. At a frequency $3f_b$ the response will be well maintained, the transformer reactance producing only 20° phase angle. Similarly at the high frequency end of the spectrum the response will be 3db down at a frequency f_t such that the leakage reactance is equal to the sum of the load and valve A.C. resistances. Again at a frequency $f_t/3$ the response will be well maintained.

If then the required frequency range in the amplifier is from 10–20,000 c/s, f_b may be taken as 3.3 c/s and f_t as 60 kc/s. A transformer which is only 3db down at frequencies as widely spaced as these would be difficult to design for some conditions of operation, and where this is so the upper limit may be reduced, as the energy content of sound at these frequencies is not usually high. The limiting factor will be the necessity of achieving stability when feedback is applied across the transformer, i.e., that the loop gain should be less than unity at frequencies where the phase shift reaches 180°.

To illustrate the procedure, consider the specification of an output transformer coupling two push-pull KT66 type valves to a 15 ohm loudspeaker load.

Primary load impedance $= 10{,}000\ \Omega$

$$\text{Turns ratio} = \sqrt{\frac{10{,}000}{15}} = 25.8 : 1$$

Effective A.C. resistance of valves $= 2500\ \Omega$

Low-frequency responses

Parallel load and valve resistance $= \dfrac{2500 \times 10{,}000}{12{,}500} = 2000\ \Omega$

$f_b = 3.3$ c/s$(\omega_b \simeq 21)$ response should be 3db down.

Primary *incremental* inductance

$$L = \frac{2000}{21} = 95 \text{ H.}$$

High-frequency Response

Sum of load and AC resistances
$= 10{,}000 + 2500$
$= 12500\ \Omega$

At $f_t = 60$ kc/s $(\omega_t = 376{,}000)$ response should be 3db down.

$$\therefore \text{ Leakage reactance} = \frac{12{,}500}{376} = 33 \text{ mH.}$$

A 20-watt transformer having 10 primary and 8 secondary sections and using one of the better grades of core material can be made to comply with these requirements. Winding data will be given in an Appendix to the second part of this article.

Some confusion may arise when specifying an output transformer as the apparent inductance of the windings will vary greatly with the method of measurement. The inductance of an iron-cored component is a function of the excitation, the variation being of the form shown in Fig. 2. The exact shape of the curve is dependent on the magnetization characteristic for the core material.

The maximum inductance, corresponding to point C occurs when the core material is nearing saturation and is commonly 4–6 times the "low excitation" or "incremental" value at A, which corresponds to operation near the origin of the magnetization curve. In a correctly designed output transformer the primary inductance corresponding to the voltage swing at maximum output at 50 c/s will lie in the region of B in Fig. 2.

In specifying the component, the important value is the incremental inductance corresponding to Point A, since this value determines the frequency response at low outputs.

The reduction of phase shift in amplifiers which are to operate with negative feedback is of prime importance, as instability will result, should a phase shift of 180° occur at a frequency where the vector gain of the amplifier and feedback network is greater than unity. The introduction of more than one transformer into the feedback path is likely to give rise to trouble from instability. As it is desirable to apply feedback over the output transformer the rest of the amplifier should be R-C coupled.

Although the amplifier may contain push-pull stages it is desirable that the input and output should be "single ended" and have a common earth terminal. Three circuit arrangements suggest themselves.

The block diagram of Fig. 3 (*a*) shows the simplest circuit arrangement. The output valves are preceded by a phase splitter which is driven by the first stage. The feedback is taken from the output transformer secondary to the cathode of the first stage. This arrangement is advantageous in that the phase shift in the amplifier can easily be reduced to a low value as it contains the minimum number of stages. The arrangement, however, has a number of disadvantages which render it unsuitable. The input

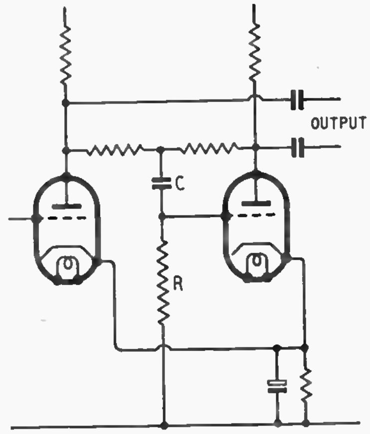


Fig. 4. "Paraphase" circuit combining the functions of phase splitter and push-pull driver stages.

voltage required by the phase splitter is rather more than can be obtained from the first stage for a reasonable distortion with the available HT voltage, and in addition the phase splitter is operating at an unduly high level. The gain of the circuit is low even if a pentode is used in the first stage, and where a low-impedance loudspeaker system is used insufficient feedback voltage will be available.

The addition of a push-pull driver stage to the previous arrangement as in Fig. 3 (*b*), provides a solution to most of the difficulties. Each stage then works well within its capabilities. The increased phase shift due to the extra stage has not been found unduly troublesome provided that suitable precautions are taken.

The functions of phase splitter and push-pull driver stage may be combined in a self-balancing "Paraphase" circuit giving the arrangement of Fig. 3 (*c*). The grid of one driver valve is fed directly from the first stage, the other being fed from a resistance network between the anodes of the driver valves as shown in Fig. 4. This arrangement forms a good alternative to the preceding one where it is desirable to use the minimum number of valves.

(*To be concluded.*)

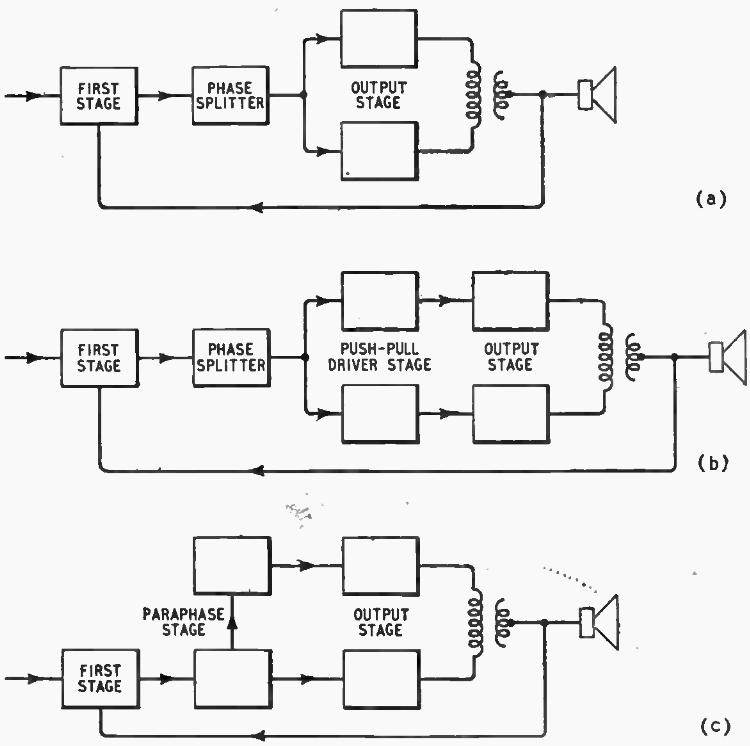


Fig. 3. Block diagrams of circuit arrangements discussed in the text.

AUTOMATIC RECEIVER PRODUCTION

Details of the E.C.M.E. System

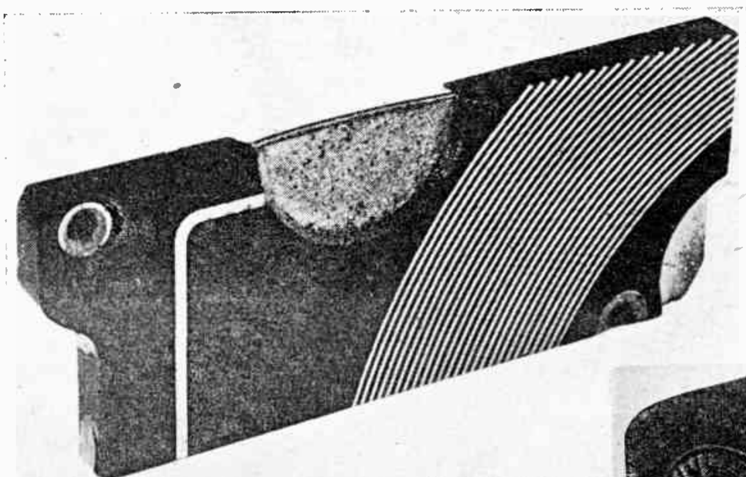
General view of E.C.M.E. from the input end.

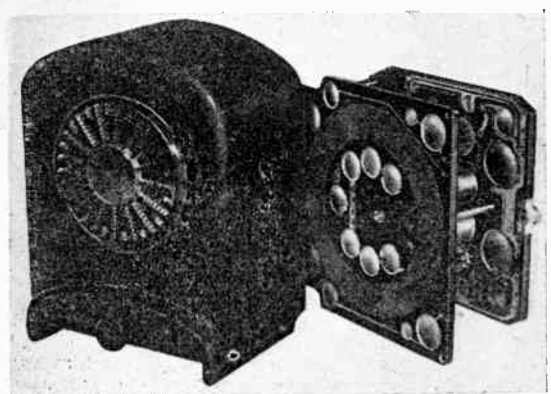
A SYSTEM of broadcast receiver production containing a number of novel features not only in receiver design but in the method of manufacture has been evolved by John Sargrove in conjunction with Sargrove Electronics, Walton-on-Thames.

The basic idea is to eliminate conventional component assembly and wiring and to make wiring and components an integral part of a moulded panel or panels which can be brought together with the minimum of manual labour in a cabinet with loudspeaker, valves and perhaps plug-in electrolytic condensers to form a complete set. Once the moulding dies have been made, errors in wiring are impossible and manufacture is so cheap that servicing for the failure of any part consists in replacement of the entire panel rather than in the precise location of the fault.

Inductances are formed by spiral grooves filled with molten metal from a spray gun and it is claimed that the repetition accuracy is $\pm\frac{1}{2}$ per cent for "L" and ± 25 per cent for "Q." Resistances are of the graphite dispersion type and after spraying are subjected to burnishing and ageing processes, after which they are capable of operating at a dissipation of 1 watt per sq in.

Capacitors consist of a thin web of moulded material integral with the panel and metal-sprayed on both sides. The thickness of the web is accurately controlled to 0.01 inch in moulding, and capacitances can be repeated to ± 10 per cent. Normally a flat or slightly concave web (to allow for thermal expansion) is used which provides a capacitance of 30pF per cm², but this can be increased to 100pF/cm² by corrugation and by a further factor of 10 or 20 if pellets of high dielectric constant material are used in the condenser apertures when





Section of panel showing reduced thickness and metal sprayed electrodes forming fixed capacitors. Part of a spiral-groove inductance is also shown. Two-valve universal mains receiver (right) constructed on the E.C.M.E. moulded panel system.

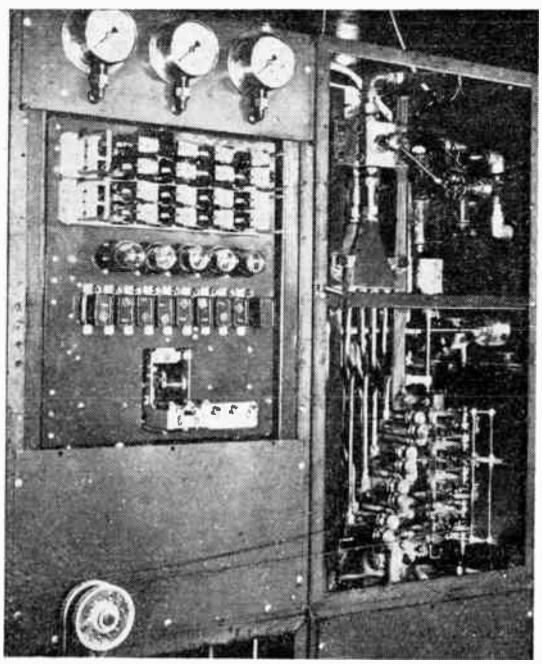
moulding the panels. In this way capacitances up to 0.005μF can be incorporated in the panel.

A two-valve A.C./D.C. mains set has already been designed and a most ingenious electronically-controlled continuous processing plant has been built for fabricating the panels. A photograph of this machine, which has been named E.C.M.E. (Electronic Circuit Making Equipment), appears at the head of this article.

Moulded plastic plates with the required grooves and depressions are fed in vertically and conveyed through units carrying out the following sequence of operations: Sand blasting to remove surface skin; metal spraying simultaneously on both sides; face milling to remove metal on surface between indentations; electrical test; graphite resistance spraying through stencils, drying and burnishing; insertion of sockets for valves, etc.; electrical test; electrical and thermal ageing followed, while hot, by lacquer spray. The panels now pass to conventional conveyor machines for the addition of valves, loudspeaker, etc., and any other manual operations leading to the assembly of the set in its cabinet and a test on radio signals.

Many ingenious electronic control devices are incorporated in the circuit-making equipment to start up the metallizing flame spray guns, diamond high-speed cutters and other operations only when a panel arrives for treatment. Safety devices and quality control are also on an electronic basis, and one advantage of this independent stage-by-stage control is that if for any reason two successive panels are rejected for the same fault, the sections up to the point at which the fault is detected are stopped, but any sound panels which have passed this point continue through the machine until they are finished. This is a notable advance on most conveyor belt systems.

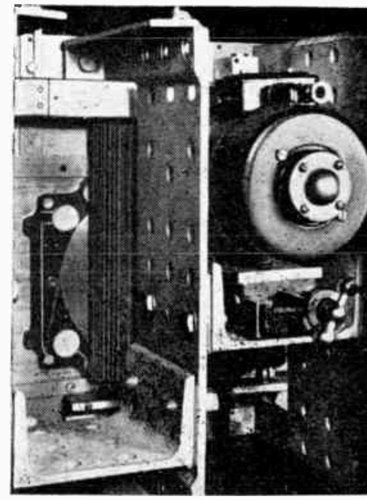
When the system gets into full production it should be possible to reduce costs to an unprecedently low level — at least for simple local-station receivers.



Metal spray guns for one side of panels. On the left are the relays for flame ignition and control.

There should be a wide market for these sets in Asia Minor, Africa, India, Central and South America and China, where the high cost of sets made by conventional methods has so far prevented further extension of sales.

Although this new manufacturing technique has so far been developed to the point where only the simplest of complete receivers can be said to have reached the practical production stage, there is little doubt that it could be employed with advantage for the manufacture of sub-assemblies in the more complex receivers at present wired throughout with the soldering iron. The simplification of stock-holding problems by the regulation of supply to demand, with virtually no time lag, will commend itself to production managers, while the economy of power supply and wear and tear in the circuit-making equipment, resulting from the fact that each section automatically shuts itself down until supplied with work, are particularly topical virtues.



High-speed surface milling unit with panel emerging to left of feed roller.

The present maximum rate of output is three panels per minute.

Quite apart from economic considerations, moulded circuit units have many technical advantages, e.g., in reducing flash-over in aircraft radio apparatus at high altitudes, ease of "tropicalization," compactness and low weight.

A detailed description of E.C.M.E. will appear in the *Journal Brit. I.R.E.*

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INTERLACING

Television Frame Synchronizing

By W. T. COCKING, M.I.E.E.

ONE of the most difficult problems confronting the designer of a television receiver is that of securing satisfactory interlacing. Superficially, it is a simple problem; practically, it is often hard to make a receiver give any approach to interlacing, let alone give good interlacing.

In theory interlacing is secured automatically by ensuring that the line and frame time bases are triggered regularly by the line and frame sync pulses in the transmission. There are 50 frame pulses and 405 line pulses a second and interlacing is secured because 405 is not a multiple of 50.

In odd frames, that is, in the first, third, and so on, the leading edge of the frame sync pulse does not coincide with a line pulse but occurs about half-way through a line. In even frames—the second, fourth and so on—the frame sync pulse does coincide with a line pulse. In each complete picture of two frames the synchronizing waveform as a whole is the same. It is the same in alternate frames, but not in successive frames.

The synchronizing waveform as transmitted, and as it appears in the output of the receiver sync separator, takes the familiar form shown in Fig. 1 (a). The line sync pulses proper are of 9.88μsec duration and occur regularly every 98.77 μsec. The frame pulses are broken at similar intervals to ensure that effective synchronizing of the line time base is continued during the frame flyback.

This breaking of the frame pulse gives a different form to the line pulses during this period, but this is normally unimportant. It is usual to differentiate the line pulses and then only their leading edges are important. It is true to say that the leading edges of the line sync pulses occur regularly at all times, including the periods devoted to frame synchronizing.

While Fig. 1 (a) shows the waveform correctly it is apt to give the impression that the intervals between the onset of successive frame pulses are different in alternate frames. It does this because the two waveforms are lined up for comparison on the line pulses. It is equally correct to line them up on the leading edges of the frame pulses as in Fig. 1 (b) and it is clearer to do so when dealing with frame synchronizing problems. The interval between successive leading edges is 20 msec, and the duration of each segment of a frame pulse is 39.52 μsec and the interval between successive segments is 9.88 μsec.

The line time base runs regularly at 10,125 c/s, and there is rarely any difficulty in achieving this with sufficient accuracy. For perfect interlace the frame time base must run regularly at 50 c/s and deliver an output waveform *which is exactly the same in every cycle.*

Now in practice perfect timing and perfect identity of successive cycles are not possible and it is consequently important to know what variations from perfection are tolerable. Let us first of all consider timing, assuming that successive cycles are otherwise the same.

In the first place consider that the even frames are all started regularly at times coincident with the proper line pulses. All even frames are then perfectly superimposed. Consider, too, that all odd frames are started regularly, so that successive odd frames are superimposed, but at a time interval t_1 different from the correct time of 20 msec after an even frame (49.39 μsec after a line pulse).

If this timing error t_1 is $\pm 49.39\,\mu$sec, then clearly the frame time base will be triggered coincident with the line pulses and the scanning lines of all frames will be superimposed. There will be no interlace at all.

The accuracy of timing must be considered in relation to the frame period, so that when the error reaches $\pm 4939/20{,}000 = \pm 0.247$ per cent the interlace is completely destroyed.

The error in positioning of successive frames is proportional to the timing error and it is probable that a variation of ± 20 per cent of the line spacing is permissible. This is a timing error of $\pm 49.39/5 = \pm 9.88\,\mu$sec, so that the permissible error of the frame scan timing becomes $\pm 988/20{,}000 = \pm 0.0499$ per cent—say ± 0.05 per cent.

Now let us consider that the timing is perfect but that for some reason only alternate saw-teeth are of the same amplitude, and that successive ones differ as shown in Fig. 2 (*a*). Two successive cycles are shown superim-

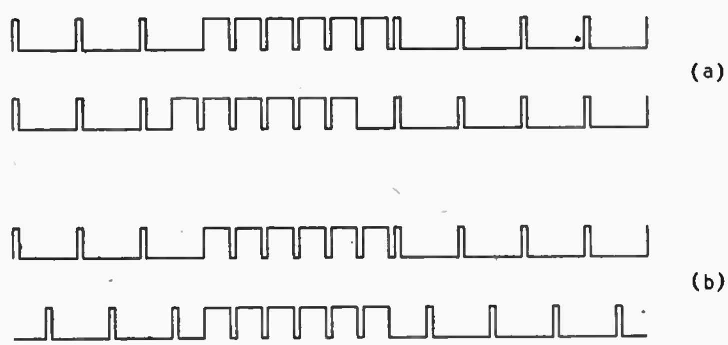


Fig. 1. The frame sync pulses for odd and even frames are shown lined up for comparison on line pulses at (*a*) and on frame pulses at (*b*).

Interlacing—
posed, for clarity, in Fig. 2 (*b*).

Such a waveform will obviously result in perfect interlacing at the top of the picture and a progressive deterioration to a maximum error at the bottom. There are 385 active lines in a picture, or 192.5 active lines in each frame. A difference of amplitude of 0.5/192.5 between successive frames will destroy the interlace at the bottom, since it needs a change of amplitude equivalent to that normally occurring in one-half the scanning time of one line to superimpose the lines. If an error of spacing of ± 20 per cent is permissible, the percentage accuracy of amplitude must be within $\pm 50/192.5 \times 5 = \pm 0.052$ per cent or, say, ± 0.05 per cent.

A waveform like Fig. 2 is not one which is often found in practice. What can occur is a combination of timing and amplitude errors. Normally, the frame sync pulse terminates each frame scan at the correct intervals. Fly-back must occur before the start of the next scan stroke. The fly-back time, and hence, the scan-start time, depends on the circuit constants, including the voltages, so that the avoidance of variations in the timing of the start of the scan depends upon keeping the circuit "constants" sufficiently constant in successive frames. If, for any reason, fly-back is accomplished more quickly in the case of the even frames than with the odd ones, then the odd-frame scans will start a little earlier in relative time than the even. The effective scan will then be slightly longer and so the amplitude will also be greater.

This is illustrated in Fig. 3 in which two successive cycles having different fly-back times are shown at (*a*) and superimposed for clarity at (*b*).

It is now pertinent to enquire in what form the interlacing errors usually occur in practice. Sometimes the error is an obstinate refusal to interlace at all, successive frames being almost exactly superimposed. Sometimes there is a more or less regular pairing of lines, indicating a more or less constant error which, however, is less than in the superimposed case. Frequently, there is weaving. This means that the error is varying, at a rate corresponding to a few cycles per second or less. Sometimes the interlacing condition is fairly steady over periods of minutes or hours, but suddenly changes for no obvious reason. Usually, with this the interlace is very good or very bad and it jumps from one condition to the other erratically.

Fig. 2. Alternate saw-teeth are of different amplitude here (*a*); this is more easily seen in (*b*) where two cycles are superimposed.

It is very rare indeed for the interlace to vary over the picture. The condition illustrated in Fig. 2, for instance, is not often found in practice. The fact that the errors are the same at top and bottom of the picture indicates that the slope of the scanning waveform does not change appreciably in successive cycles.

The synchronizing pulses in the transmission control only the start of fly-back. They trip the time base at the end of each frame scan. For good interlacing three things are necessary; first, the sync pulses must trip the time base at as regular intervals as possible; secondly, all fly-backs must be as alike as possible in duration and amplitude; and thirdly, all scans must be as nearly as possible the same.

A good interlace is not possible if the first requirement is not met and this depends very largely upon the method adopted for separating the frame and line synchronizing pulses. The waveform in the output of the main sync separator, which removes the picture signal, is like Fig. 4 (*a*) and (*b*) for odd and even frames. It is necessary to remove the line pulses for otherwise the frame time base would almost certainly be tripped by one of the line pulses occurring a little before the frame pulse.

The usual way of doing this is by an integrator and limiter. Sometimes the limiter is dispensed with, but the circuit adjustments are then more critical. The output of the integrator has the form shown in Fig. 4 (*c*) and (*d*) and after limiting it becomes like (*e*) and (*f*).

The precise waveform depends on the time constant of the integrator, but in general it approximates to the form sketched here. The important thing to notice is that the sharp leading edges of the pulses are destroyed. Because of this any variation of amplitude of the pulses affects the times at which the time base is tripped. The outputs on alternate frames are not identical, because the interval between the last line pulse and the first frame pulse is different in successive frames with the result that the capacitor of the integrator has discharged to differing degrees at the onset of the frame pulses. This inevitably results in some variation in the timing of the frame time base. Theoretically, perfect interlacing is not possible with an integrator type of pulse separator.

In practice, however, the errors can be made quite small and it is capable of giving good enough interlace for practical needs. There is, however, an alternative which is more nearly perfect. If the pulse signal (*a*) and (*b*) of Fig. 4 is passed through a differentiator-type circuit of time constant equal to the duration of one frame pulse, some 40 μsec, the output wave has the form of (*g*) and (*h*), and subsequent limiting brings it to (*i*) and (*j*).

Fig. 3. Regularly recurring waves of different fly-back time are illustrated at (*a*). Two cycles are superimposed (*b*).

The important thing is that the sharp edges of the pulses are retained, so that theoretically timing errors are eliminated. The leading edges of the pulses in (*i*) and (*j*) are really the trailing edges of the pulses in (*a*) and (*b*), so that synchronization really base. In Fig. 4 no account has been taken of any reversals of phase caused by the limiters.

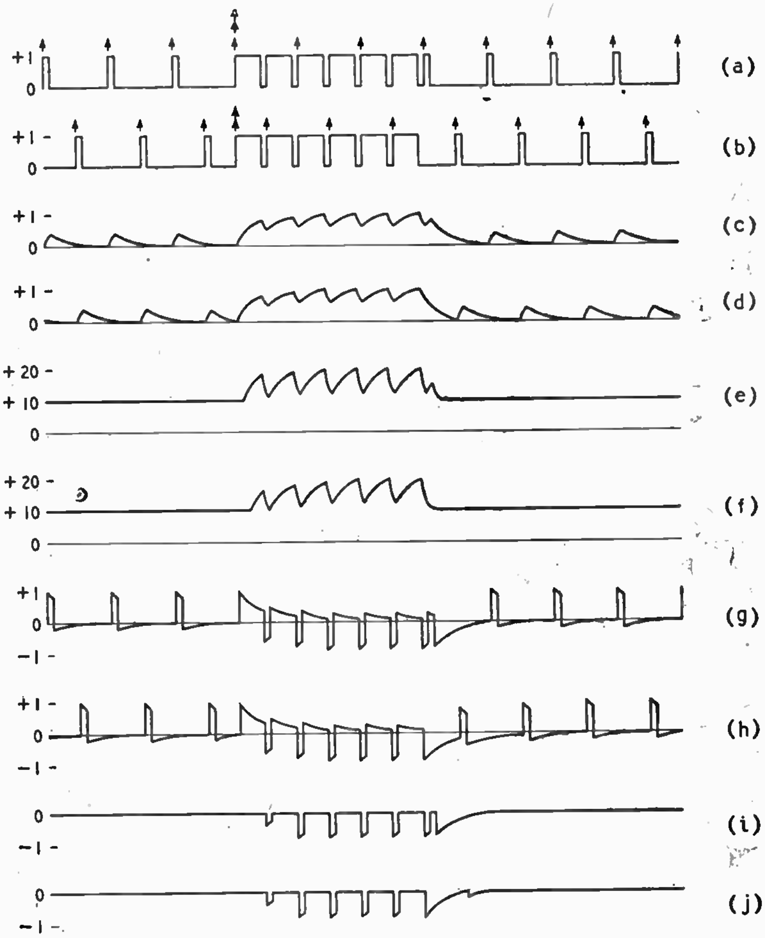


Fig. 4. (*a*) and (*b*) show the waveforms of even and odd frame pulses respectively, while (*c*) and (*d*) indicate the effect of an integrator. Subsequent limiting and amplification produce (*e*) and (*f*). The effect of a differentiator on (*a*) and (*b*) is shown at (*g*) and (*h*) and subsequent limiting at (*i*) and (*j*).

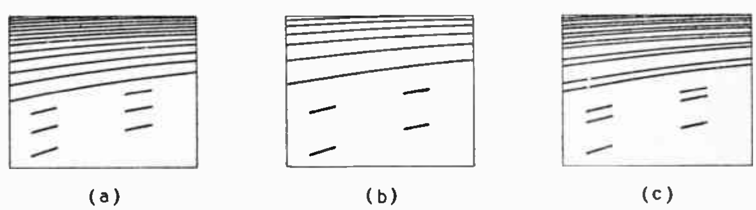


Fig. 5. (Below) When the brightness control is turned up, the frame fly-back lines show as at (*a*) when the interlace is correct, but like (*b*) when there is no interlace. Pairing of lines gives a picture like (*c*).

takes place 40 μsec late. As it is the same for all frames this is unimportant and merely reduces slightly the total time available for fly-back.

The waveforms at the beginning of the separated pulses are identical for all frames, but there is a difference at the ends. This is occasioned by the fact that the first line pulse after the frame pulses is close to them in one case and some distance away in the other. This is not usually important, but might be with some kinds of time base.

It will be observed that in Fig. 4 (*i*) and (*j*) the first separated pulse is of smaller amplitude than the others. This is not important provided that it is of sufficient amplitude reliably to trip the time base.

Such reversals may or may not occur depending on whether diode or multi-electrode limiters are used.

Now even the differentiator type separator is no guarantee of perfect interlacing. It can and does ensure that the start of every frame fly-back is correctly timed. It does nothing to ensure that successive fly-backs and scans are themselves identical. Normally one expects that they will be and accordingly one expects that the use of such a pulse separator will result in good interlacing.

The writer's experience is that this is not the case and that more frequently than not the scanning lines of successive frames are superimposed rather than interlaced. He has investigated in some detail a typical case of this type. Careful inspection of the fly-back waveform with an oscilloscope having a greatly expanded time scale showed that the time-base was actually being tripped regularly by the sync pulses. By turning up the brightness control of the C.R. tube so that the fly-back became visible on the raster, it could be observed that an interlaced fly-back was being obtained. The correct picture is shown in Fig. 5 (*a*); with no interlace on the fly-back half the fly-back disappears (*b*), and with pairing the fly-back lines are unequally spaced (*c*). In spite of the interlace during fly-back, there was none on the scan and all lines were almost exactly superimposed. This is a condition which can result only from a regular irregularity in successive frames.

From these observed facts it is possible to deduce several characteristics of the scanning waveform. Because successive scans lie on one another, all scans must have the same slope, but be displaced in amplitude. Because

Interlacing—

the fly-backs interlace, the waveforms on successive fly-backs must be identical over the major part of their durations, but not necessarily over the whole of them. This last proviso is made because it was possible to observe the fly-back over part of its time only.

Now ideally successive saw-tooth waves are identical and if drawn graphically or observed on an oscilloscope they superimpose perfectly. The symptoms observed above lead to the conclusion that if one wave has the form sketched by the full line A in Fig. 6 the scan part of the next must lie along BC or DE and the fly-back must lie within FG and HI.

This is shown more accurately in Fig. 7.

Scan Waveform

Since the scans are displaced and the timing is the same, the amplitudes at the end of the scan and at the start of fly-back must be different. In Fig. 7 the amplitude of A is point (2) at the end of the scan and that of the next cycle must be either (1) or (3). The start of fly-back which joins A at (7) must be at (4) if it starts at (1) or at (5) if it starts at (3). The start of fly-back for this cycle BC or DE must be at the level of (2) on A; that is, at the point (6).

If BC is the correct scan curve, the path of two cycles must be 7268147, while if DE is correct it must be 7269357.

For simplicity the fly-backs are shown as linear. In practice they are exponential, which means that the lines in Fig. 7 indicating them are more nearly vertical at the start of the scan. Also, the ratio of scan to fly-back times shown is 5:1 instead of the actual 20:1. On the drawing it can be seen that for the path 7268147 there is a

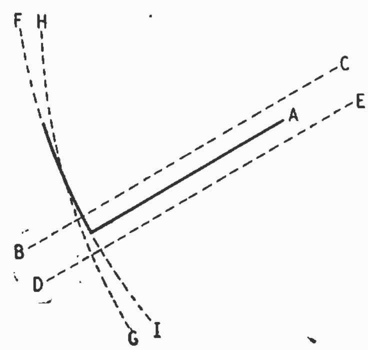


Fig. 6. When the fly-back appears to interlace but not the scan, if one wave is like A, the next must lie along BC or CD with the fly-back between FG and HI.

displacement of 0.2 on the fly-back for a horizontal timing displacement of 1 on the scan. In the real case of a 20:1 fly-back ratio this would be one quarter, or 0.05.

It is probable that this would be undetectable on the fly-back observed on the raster. This is especially so as the fly-back is actually exponential and therefore still more rapid initially, and it is only the initial part that can clearly be seen.

With the alternative path 7269357 the fly-backs actually cross, which means that the displacement errors are much smaller and almost certainly unobservable.

There is no doubt at all that waveforms varying in this general fashion do occur. Unfortunately it is quite difficult to track down precisely how and why they are produced. The variations between successive cycles are much too small to be observable on any normal oscilloscope.

The writer first noticed the effect when using a Transitron-Miller-integrator type of saw-tooth oscillator. In this there are two trigger actions in each cycle. The first is initiated by the sync pulse and starts the fly-back, while the second occurs in its own time and starts the scan. Since the second is uncontrolled it is liable to be started by any spurious voltages in the circuit. It was at first thought that this second trigger was being initiated by interference voltages from the line time-base, but no amount of screening or de-coupling had the slightest effect on the interlace.

It was then thought that it might be caused by a difference between the ends of the frame sync pulses in successive frames, brought about by the different intervals between the last frame pulse proper and the first line pulse. Means were adopted substantially to avoid this difference, again without any improvement.

A change was then made to an entirely different kind of saw-tooth generator—the well-known form of blocking oscillator shown in Fig. 8. In this, the grid, screen and cathode form a triode block-

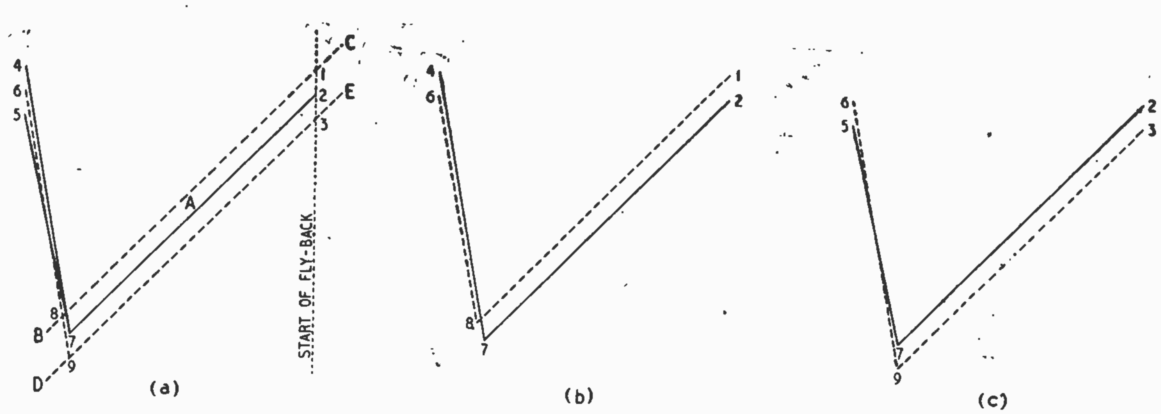


Fig. 7. Two dissimilar cycles are superimposed at (*a*), the operating paths must be 7268147 or 7269357 and these are shown by themselves in (*b*) and (*c*) for clarity.

ing oscillator and the anode-cathode path of the valve acts to discharge C_1 on fly-back. The results, however, were no better than with the Transitron.

The next step was to simplify the circuit further by utilizing the saw-tooth voltage across C instead of that across C_1. Again there was no change in the interlacing. It was then noticed that in making the change R_1C_1 had inadvertently been left connected to the anode. When these components were disconnected, however, good interlacing was at once secured.

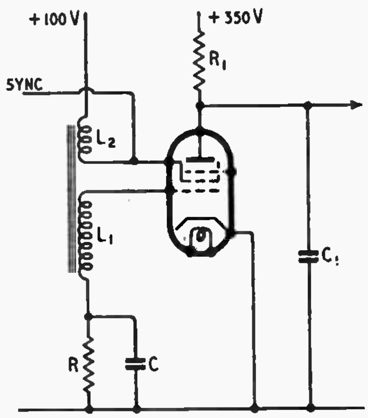


Fig. 8. Typical blocking oscillator saw-tooth generator in which C_1 is discharged by the anode-cathode path of the valve.

Further extensive tests showed the simple triode blocking oscillator to give reliable interlacing; also another circuit in which the blocking oscillator is used to control another entirely separate valve operating to discharge a capacitor proved satisfactory. The circuit of Fig. 8 in which a separate electrode of the same value was used for discharge could not be made to perform satisfactorily.

The reason for this is not known, but it seems clear that it must be due to interaction between the anode and screen currents.

The conclusion to be drawn from all this is that while careful design of the sync separator circuits is necessary for good interlacing, that alone is not sufficient. It is also necessary to pay particular attention to the saw-tooth generator.

MAGNETOPHON RECORDERS

Processes Involved in Manufacturing the Tape

THE principles underlying the German system of magnetic tape recording, using plastic tape impregnated with iron oxide powders, were described in an article in the June, 1946, issue of this journal. Since then a comprehensive report "The Magnetophon Sound Recording and Reproducing System" has been published by the British Intelligence Objectives Sub-Committee and is obtainable from H.M. Stationery Office, price 10s.

The report presents the findings of a team of investigators—M. J. L. Pulling (B.B.C.), E. M. Payne (Electrical and Musical Industries) and H. E. Parker (Ministry of Supply)—and includes circuit diagrams with component values, recording characteristics with and without correction and detailed descriptions with photographs of the tape-winding mechanism in the principal types of machine.

The methods of manufacturing the various types of tape are given in an appendix with descriptions of the chemical materials used. The latest type "LG" tape used in high-quality recorders consists of a backing of polyvinyl chloride coated with a layer of ferric oxide powder. The P.V.C. is mixed with titanium white and is rolled into sheets 0.05 mm thick, 60 cm wide and 400 metres long. It is then drawn under tension over electrically heated rollers until it is 0.04 mm thick, 32.5 cm wide and 1 kilometre long, which gives an appreciable increase of tensile strength in a longitudinal direction.

The ferric oxide powder is prepared by precipitating black Fe_3O_4 oxide from ferrous sulphate with ammonia and then heating the black oxide at 280-300° C to form red-brown Fe_2O_3. After milling, the powder is air-blown through a sieve to a particle size of 0.2 to 1 micron and is then mixed with an equal quantity of P.V.C. powder and a small quantity of plasticiser and solvent to form lumps $\frac{1}{8}$ to $\frac{1}{4}$in diameter for easy handling.

At the coating factory the lumps are milled and made up into a fluid paste with 10 parts benzole and 15 parts tetrahydrofuran to 40 parts iron-oxide mixture. The paste is spread on the film base from a hopper fitted with a mixing paddle, and a bridge piece keeps the layer at the optimum thickness of 0.015 mm. It is found that thicker deposits give a shorter magnetic working range, while a thinner layer results in inadequate magnetization. After coating, the tape is dried in a tunnel through which air at 25° C is drawn, and then in a large drying chamber in which it is wound in a spiral on rollers. The tape takes about 6 minutes to pass through the drying tunnel and chamber.

The coated tape is then slit simultaneously into strips 6.5 mm wide by rotary knives, and after visual inspection electrical tests are made for low background noise and for modulation range at 1,000, 5,000 and 8,000 c/s, the waveform being reproduced on an oscilloscope. The tape can be easily joined, after removing the oxide layer, by the use of cyclohexanone as a solvent adhesive.

The report is a mine of information on this highly developed system of recording and contains a bibliography and also a list of relevant patents. There can be no doubt that the use of high-frequency biasing in conjunction with an iron-oxide dispersion as the recording medium is a notable advance in sound recording of which more is likely to be heard in the near future.

SURPLUS SCIENTIFIC GEAR

UNDER a scheme introduced by the Ministry of Supply some months ago, research centres, universities and educational authorities in this country and also the devastated countries abroad may purchase ex-Service scientific equipment.

Over one hundred research bodies and some 200 educational authorities regularly receive the Ministry's schedules of available equipment, which include radio and electronic gear. Whilst there is an abundance of some radio equipment such as meters and valves, there is only sufficient of the more valuable test equipment to meet a small part of the demand.

Stuck for a 12A7? – then ★BRIMARIZE!

12A7

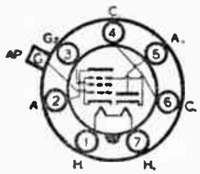
Any of the valve types listed below together with a metal rectifier makes a good substitution for the 12A7.

TYPE 18 *One of the U.X. types which can often be obtained. Its characteristics at low voltages are identical with those of the 12A7 pentode section. The rectifier section is conveniently replaced by a small SenTerCel selenium rectifier which is easily fixed to chassis or cabinet.*

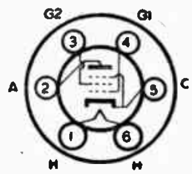
TYPE 43 *Another U.X. type which is still being made and whose characteristics, if self bias is employed, are similar to those of the 18. It is advisable to make a small adjustment to the line cord when using type 43.*

TYPE 25A6G *The International Octal version of the 43, but more readily available at the moment.*

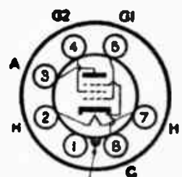
←— PUNCH HOLES HERE —→



KEY.
TYPE 12A7



TYPE 18 & 43



TYPE 25A6G
LOCATING KEY

TYPE	Change Socket From	To	Change Connections From Old Socket	To New Socket	Other Work Necessary	Rectifier
18	U X 7 pin	U X 6 pin	Pin No. 1 " " 2 " " 3 " " 4 " " 5 " " 6 " " 7 Top Cap	Pin No. 1 " " 2 " " 3 Rect. + ve Rect. — ve Pin No. 5 " " 6 " " 4	NIL	SenTerCel miniature Selenium Rectifier Type H18/12/1/B2 (2½" x ⅞" overall) may be fitted to chassis or cabinet in all three cases. Supplies are obtainable from :—
43	U X 7 pin	U X 6 pin	AS A	BOVE	Reduce line cord by 40 ohms SEE NOTE	
25A6G	U X 7 pin	Int. Octal	Pin No. 1 " " 2 " " 3 " " 4 " " 5 " " 6 " " 7 Top Cap	Pin No. 2 " " 3 " " 4 Rect. + ve Rect. — ve Pin No. 8 " " 7 " " 5	Reduce line cord by 40 ohms SEE NOTE	S. T. & C. Ltd. Rectifier Division, Oakleigh Rd., New Southgate, N. 11. PRICE 7/10 List.

NOTE—When fixed Bias is used in the receiver it is necessary to insert a 33,000 ohm ½ watt resistor in series with the lead to the screen grid (Pin 3 of type 43 or Pin 4 of type 25A6G) together with a 2 mfd 150 V.W. condenser from screen grid to chassis.

BRIMAR
RADIO VALVES

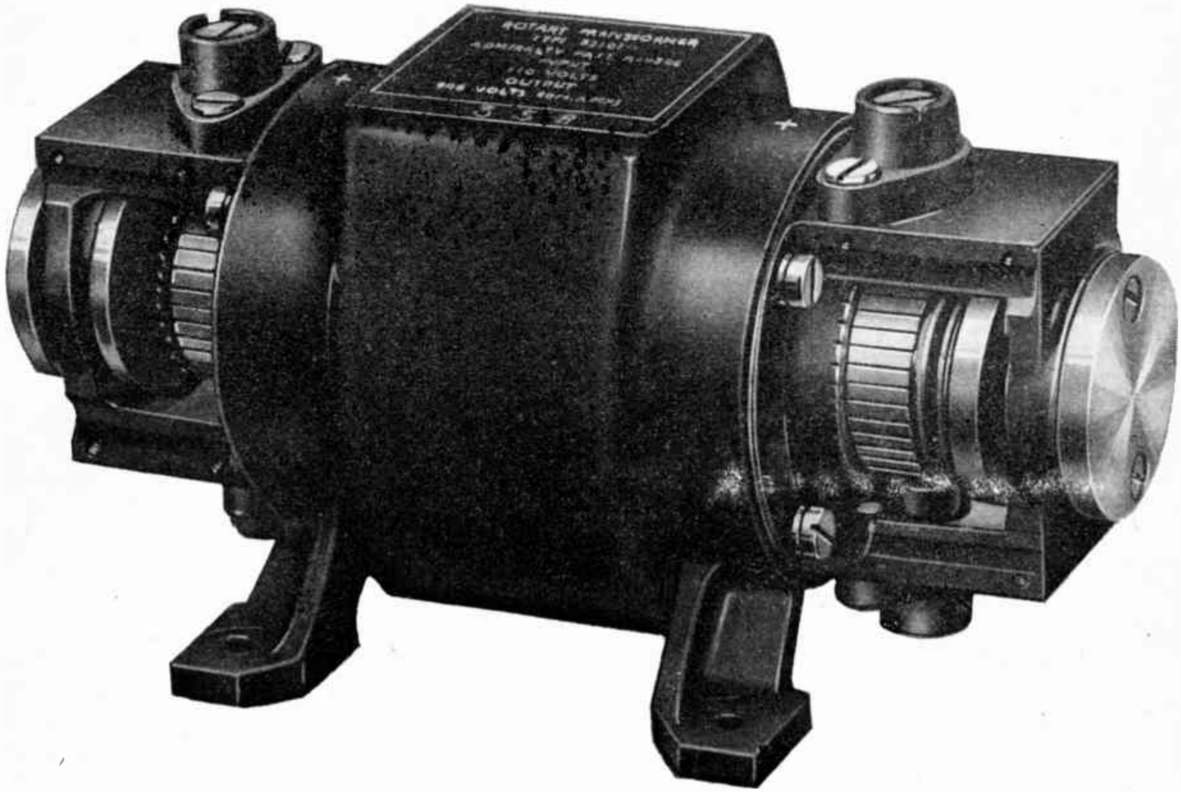
★ *BRIMARIZE—verb transitive. Employed by knowing radio dealers in reference to a BRIMAR process by which a new lease of life can be given to sets with obsolete, obsolescent or otherwise unobtainable valves.*

STANDARD TELEPHONES AND CABLES LIMITED, FOOTSCRAY, SIDCUP, KENT.

INSTRUCTIONS: Punch holes where indicated and cut away this portion. Cut out and file them in the order in which they appear. This column will then give you a quick reference index.

1

Special circumstances compel us to repeat this issue of the Series. The next issue will deal with Type 25A7G



ROTARY TRANSFORMERS. Rotax offer the Radio Industry a range of Rotary transformers, invertors and convertors, from 5 to 250 watts output, D.C. to D.C. or D.C. to A.C. A series of 400 cycle machines is also available, capable of outputs up to 500 V.A. We invite you to discuss the applications of these machines with us.

ROTAX

ROTAX LIMITED · · LONDON, N.W.10 · · ENGLAND

CIRCUIT CONVENTIONS

The Valve "Equivalent Generator"

By "CATHODE RAY"

SOME time ago[1] I mentioned a number of the things that give rise to confusion in talking about circuits—questions of in which direction current flows, whether a condenser is being charged or discharged, which is series and which parallel, and so on. Among them I mentioned the controversy that had been raging about the valve "equivalent generator," but on this particular ground I refused to come out into the open. Now that the big guns have been silent for some time it may be safe to do so. I have a feeling that many readers must have decided that any matter disputed by such eminent authorities must be too involved and uncertain for them even to attempt to understand. And yet it is constantly coming up in technical books and articles, so it is perhaps worth another attempt to get it clear. In case this sounds rather presumptuous on my part, I would say right away that I have nothing new to contribute beyond an attempt to show why I think the viewpoint of D. A. Bell in this country and F. E. Terman in U.S.A. is the most helpful for students to take.

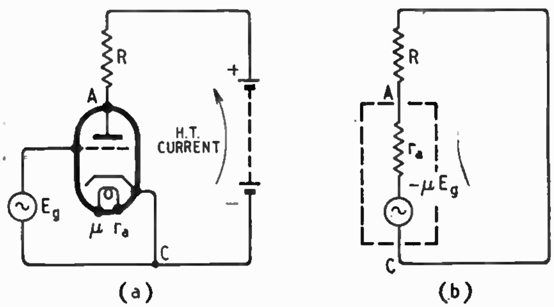


Fig. 1. (*a*) shows the essentials of a triode amplifier circuit, and (*b*) the equivalent generator circuit. A and C mark anode and cathode points respectively.

The valve "equivalent generator" or "equivalent circuit" principle, of course, is an idea for simplifying the theory of valve amplifiers by replacing (on paper) the driven valve (Fig. 1*a*) by an imaginary generator (Fig. 1*b*), giving a voltage μE_g and having an internal resistance r_a. The arguing starts when one draws arrows or + and − signs to show the directions of the voltages and currents.

[1] *Wireless World*, Sept., 1946, p. 299.

These questions are not really matters of absolute right or wrong, any more than the question of driving to right or left of a road. The authorities can decide on either. But once it has been decided failure to conform is likely to lead to collisions and disputes. Seeing that the valve equivalent is a device intended to help the mind, it is a great advantage if the convention adopted fits the facts and also fits other, already accepted, conventions. That is why there were protests when one authority showed two equal signal currents flowing in opposite directions, and another reversed the usual convention by reckoning the cathode voltage relative to the anode, so that (contrary to what is generally understood) anode and grid signal voltages were in phase.

But why should there be any difficulty or dispute? The answer is quite simple; it is the H.T. supply. Conscious that this is really the ultimate source from which any power obtained from the valve comes, people feel they have to acknowledge the debt by using the H.T. as the standard of current and voltage direction. And to do so they may have to stand on their heads or perform other unnatural mental gymnastics. All this is quite unnecessary, and the whole thing is easy, clear, and altogether in line with the rest of simple circuit theory if we don't try to mix Fig. 1*b* with Fig. 1*a*.

You will see I have left out the H.T.B. from Fig. 1*b*. I have done so because it has nothing to do with the imaginary generator. Its purpose is to feed the valve shown in Fig. 1*a*. To decide directions of voltages and currents in Fig. 1*b* according to the direction of the H.T. voltage and current in Fig. 1*a* is like a bricklayer wanting to start at the top of a building and work downwards because that is the way his breakfast went.

A much more relevant and fundamental convention than that is to reckon voltages with respect to the earthy side. In a valve circuit of the general type under discussion, anode and grid voltages are by general acceptance reckoned with respect to their common point, the cathode, which is usually earthed. Anybody who, for the sake of appeasing the H.T. supply, throws over this convention, is more likely to confuse than help. It is an undisputed fact that when the grid of a resistance-coupled or resonant amplifier is made relatively posi-

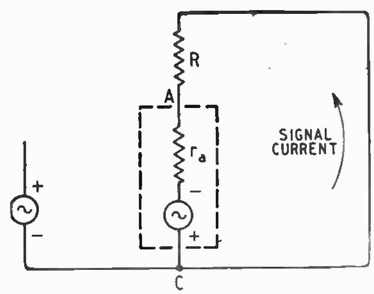


Fig. 2. When the grid signal voltage is positive (relative to C) the result in the anode circuit can be attributed to a positive (in-phase) generator voltage relative to A or a negative (180° out-of-phase) voltage relative to C. The latter way of putting it is preferable because the accepted custom is to specify both anode and grid voltages relative to C, and to reverse this custom with one of them is to invite confusion.

Circuit Conventions—

tive the anode goes relatively negative. That fixes the phase or direction of the output voltage. At such a moment the generator polarity must be as shown in Fig. 2, and the direction of the current (using the classical convention, which is opposite to the electron flow) must be as shown by the arrow, all of which agrees with experimental fact.

So what is all the argument about? Well, it seems to worry

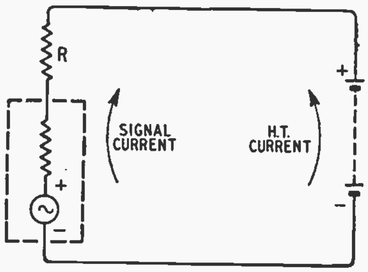


Fig. 3. When the imaginary generator is on its positive half-cycle, it opposes the H.T. source and reduces the steady current.

some people to have a *negative* voltage ($-\mu E_g$), causing a current which from the point of view of the H.T. source is *positive*. But why drag in the H.T. source? It is merely a device for keeping the valve in working condition, and when (for purposes of theoretical calculation) we have replaced the valve, and its H.T. supply unit, and its socket, and the maker's name on the glass, and everything else appertaining to the valve, by a generator inside a dotted line, which (within assumed limits) produces the same external effects, why display this irrational concern for the views of the H.T.?

When considering the signal voltages in an amplifier, it would be very tiresome if we had to be always thinking of the steady H.T. and G.B. voltages that happen to be necessary for the happy domestic life of the valve. The sort and quantity of food one eats admittedly has a lot to do with the efficiency of one's work, but it would be a distraction and waste of time to keep on about it throughout the working day. Similarly, in a signal voltage diagram or discussion it clarifies matters to leave steady voltages out of it. This is so generally accepted that when a statement is made that the effect of a certain signal is to drive the anode of a valve negative it is not considered necessary to explain that the anode is not really absolutely negative, but only relative to its potential in the absence of the signal.

In this valve equivalent affair the mixing of domestic and business matters is bound to cause confusion. In Fig. 1*a* the source of power is a battery, and the direction of the power flow from it is right to left, and positive is anti-clockwise. In Fig. 1*b* the source of power is a generator, the direction of power left to right, and positive is clockwise. So, if the equivalent generator and H.T. battery are shown in the same diagram, as in Fig. 3, a positive generator voltage is seen to be in opposition to the battery. It is therefore perfectly natural for a *negative* generator voltage (corresponding to a positive half-cycle on the grid) to *assist* the battery and increase the anode current—as we know in fact it does.

The only room for question I can see is why the voltage of the fictitious generator should be assumed to be $-\mu E_g$—apart, that is, from a not unnatural desire to make it fit the observed facts. D. A. Bell has given[2] a logical derivation on a basis of accepted conventions, although even he—quite unnecessarily, as it turns out—includes the steady current among his *Wireless Engineer* basic conditions.

He points out that the valve (unlike the imaginary generator) is a passive device; it has no voltage source inside it, and any changes of anode current are caused by varying the voltages applied, from outside it, to grid and anode. In the circuit in question the only variation in anode voltage is due to the drop in the anode load, and this voltage opposes the grid voltage changes, which is how the minus sign comes in.

Any real valve is non-linear; that is to say, the changes of anode current are not exactly proportional to the changes in applied voltage. But if the changes are small compared with the steady anode current, there is not a very serious difference between the real valve and an ideal valve in which the anode current changes are proportional to the voltage changes. It is this ideal valve that is imitated by the fictitious generator. So one mustn't expect too much of the generator idea if the signal voltage is so large that there is appreciable distortion. But until it is necessary to take account of distortion in the valve, the simple equivalent generator does help a lot—so long as one is quite clear about it.

Just one more point. For simplicity these arguments are concentrated on a circuit with a purely resistive anode load. But the generator substitute gives the right answer with any sort of load, and, in fact, it is with reactive loads that its help is most valuable.

[2] *Wireless Engineer*, Nov., 1945, p. 532, and *Electronic Engineering*, Feb., 1946, p. 56.

ROBOT PHONE RECORDER

A SOUND recording device of considerable novelty has recently been invented and is being mass-produced in Switzerland. Known as the Ipsophone, this instrument, which employs a magnetic steel wire, is designed for use as an automatic message recorder on telephone circuits. On a number being called, in the subscriber's absence, this device answers the telephone in the following manner: "Here is Mr. Brown's Ipsophone. Your message is being automatically recorded. Go ahead."

This application is, of course, not new but the ingenious feature of the equipment is the safety code number. The subscriber, before leaving his home, sets one of 1,023 possible combinations of numbers. If when absent he rings his own number to hear any messages recorded, the machine counts from zero to nine three times, and the subscriber has to repeat with it the figures forming his code number. This actuates a circuit and starts the play-back mechanism.

If he desires to record his answer to the message for the advice of his secretary he has to say two words, e.g., "Hello, hello," and then dictate his remarks. If, however, he wishes to eliminate the recorded message, he merely speaks another code word and the wire is demagnetized.

Design Data (12)

R.C. COUPLING

Response at Low-Frequencies

THE method of determining the value of a coupling capacitor in a resistance-capacitance coupled stage is quite well known for the usual case of a signal of sine waveform, but the method to be applied in the case of pulse and saw-tooth waves is not so generally understood.

The usual circuit is shown in Fig. 1 and its equivalent in Fig. 2. Here R_a is the A.C. resistance of the valve modified, if necessary, by any feedback. The impedance of the H.T. supply is assumed to be negligible. It is also assumed that the frequencies or the rates of change of current and voltage are low enough for the stray capacitance to have a negligible effect.

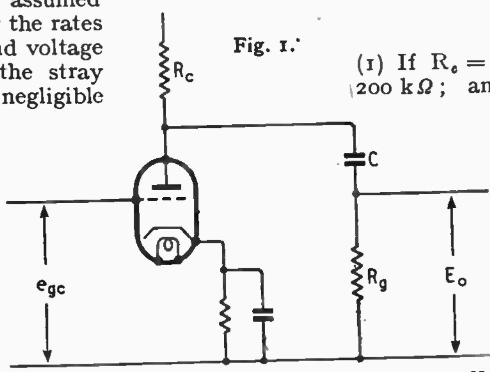


Fig. 1.

There are certain facts concealed in the formulæ which are well expressed as useful rules. They are:

1. For not more than 2 per cent distortion of a pulse or saw-tooth repetitive waveform the time constant must not be less than 50 times the pulse or saw-tooth duration. Time and time constant are to be in the same units; i.e., sec and F-Ω, msec and μF-kΩ, or μsec and pF-MΩ.

2. For a differentiating circuit the time constant should not exceed one-quarter of the pulse duration.

3. For a sine-wave input, the loss is 3 db when $T = 159/f$ (T in μF-kΩ, f in c/s).

Symbols

μ = amplification factor of valve		
R_a = A.C. resistance of valve	(kΩ)
R_c = coupling resistance	(kΩ)
R_g = grid leak of following valve	(kΩ)
C = coupling capacitance	(μF)
$g_m = \mu/R_a$ = mutual conductance of valve	(mA/V)
T = circuit time constant = $C(R + R_g)$	(msec = μF − kΩ)
$R = R_cR_a/(R_c + R_a)$	(kΩ)
t = time	(msec)
f = frequency	(c/s)
$A = E_0/e_{gc}$ = voltage amplification.	

Formulæ

$$A = \frac{g_m R R_g}{R + R_g} x \qquad (1)$$

$$x = 1/\sqrt{[1 + (159/fT)^2]} \qquad (2)$$

for a sine-wave input

$$x = \epsilon^{-t/T} \qquad (3)$$

for a unit impulse input.

For a given response at a given frequency

$$T = \frac{159}{f} \cdot \frac{x}{\sqrt{1 - x^2}} \qquad (4)$$

For a given response at a given time after the application of a pulse

$$T = t/(2.3 \log_{10} 1/x) \qquad (5)$$

and for values of x not less than 0.95

$$T = t/(1 - x) \qquad (5a)$$

Examples

(1) If $R_c = 20$ kΩ; $R_a = 10$ kΩ; $\mu = 20$; $R_g = 200$ kΩ; and a response of −1 db at 50 c/s is required, what coupling capacitance must be used, and what is the amplification at relatively high frequencies where C has a negligible effect?

We have $g_m = 2$ mA/V; $R = 10 \times 20/30 = 6.6$ kΩ, so from (1)

$$A = \frac{2 \times 6.6 \times 200}{206.6} = 12.9.$$

Then from (4)

$$T = \frac{159}{50} \cdot \frac{0.89}{\sqrt{1 - 0.795}} = \frac{159 \times 0.89}{50 \times 0.456} = 6.22$$

since for a response of −1 db $x = 0.89$.

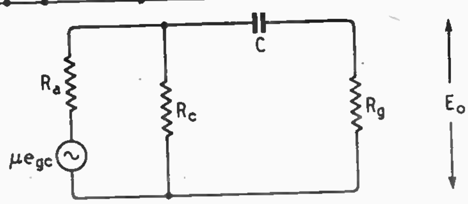


Fig. 2.

Since $R_g + R = 206.6$ kΩ, $C = 6.22/206.6 = 0.03$ μF.

(2) The same amplifier is to be used for a saw-tooth wave of 50-c/s recurrence frequency, and it is necessary that the drop in output should not exceed 2 per cent. What value of C must be used? For a 2 per cent drop, $x = 0.98$ and, ignoring the fly-back time, the duration of the saw-tooth wave is $1/50 = 0.02$ sec, so $t = 20$ msec. We use (5a) since $x > 0.98$ and have $T = 20/0.02 = 1000$ for $R + R_g = 206.6$ kΩ, $C = 1000/206.6 = 4.82$ μF.

The enormously greater time constant needed for low distortion of a pulse or saw-tooth wave is apparent.

(3) With the same amplifier, a pulse of duration 10 μsec is applied, and it is desired that at the end of the pulse there should be substantially no output; that is, the circuit shall act as a differentiator. What value of C is now needed?

This is most easily solved from (3), and it is necessary to assume some arbitrary small value for x—say about 0.02. A table of exponentials gives $t/T = 4$ (about) for $\epsilon^{-t/T} = 0.02$. Therefore, $T = t/4 = 10/4 = 2.5$ μsec $= 0.0025$ msec, and $C = 0.0025/206.6 = 0.0000121$ μF $= 121$ pF.

World of Wireless

STANDARD FREQUENCY BROADCASTS

IMPROVEMENTS in the services broadcast by WWV are announced by the Central Radio Propagation Laboratory of the American National Bureau of Standards. Transmissions, now radiated on four additional frequencies (20, 25, 30 and 35 Mc/s), bringing the total to eight, include regular warnings of radio propagation disturbances.

To ensure reliable coverage of the United States and to extend the coverage in other parts of the world, seven or more transmitters are radiating throughout the twenty-four hours. The services provided are standard radio frequencies—listed below—time announcements (E.S.T.) in code each five minutes, standard time intervals, standard audio frequencies and radio propagation disturbance warnings.

The transmission schedule is:—

Radio Frequency (Mc/s)	Time (G.M.T.)	Power (kW)	Audio Frequency (c/s)
2.5	0000–1400	1	
5	0000–1200	10	440
5	1200–0000	10	
10		10	
15		10	440 and 4000
20		0.1	
25	continuously	0.1	
30		0.1	
35		0.1	440

The station's call letters WWV and other 'phone announcements are given each hour and half hour.

On each carrier frequency, the accuracy of which is now better than one in fifty million, a pulse of 0.005 second duration occurs at intervals of precisely one second. It consists of five cycles, each of 0.001 second duration, and is heard as a faint tick. The pulse is omitted on the 59th second of every minute.

A warning of radio propagation conditions is broadcast in code on each of the carrier frequencies at twenty and fifty minutes past the hour. If a warning is in effect, a series of "W's" (in morse) follows the time announcement; if no warning is in effect, a series of "N's" (in morse) follows the time announcement.

A warning means that radio propagation disturbance is anticipated within 12 hours, or is in progress, with its most severe effects on radio transmission paths crossing the North Atlantic; i.e., those paths for which the control points of transmission lie in or near the northern auroral zone. Disturbance is characterized by low intensities, accompanied by flutter or rapid fading on the normal frequencies used at the different times of the day, or by complete blackout of signals.

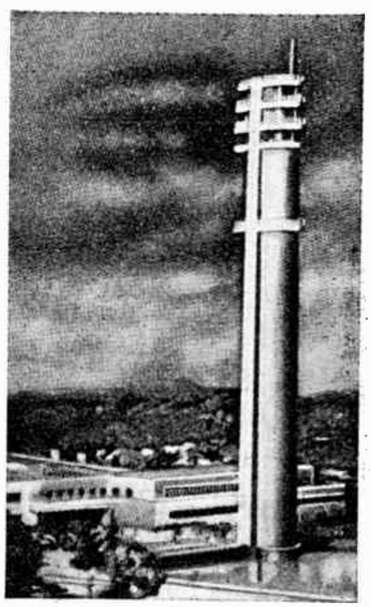
The warnings do not apply to sudden ionospheric disturbances which are unpredictable.

The Bureau welcomes reports on reception—particularly on the new frequencies—which should be sent to the Central Radio Propagation Laboratory, National Bureau of Standards, Washington, 25, D.C.

SERVICEMEN IN INDUSTRY

IT is announced by the Air Ministry that agreement has been reached whereby airmen who received wartime training in certain trades and completed five years' service in their trade are eligible for admission as skilled men in certain engineering trades and allied civilian occupations.

Airmen in the following trades who were not in the electrical industry before the war may now join the Resettlement Section of the Electrical Trades Union if they enter the industry on release: Radar Mechanic (Air or Ground), Wireless and Electrical Mechanic, Wireless Mechanic and Wireless Operator Mechanic (Air or Ground).



MICRO-WAVE TOWER. A reproduction of the architect's model of the Federal Telecommunications Laboratories, New Jersey, showing the 300-foot tower which will be used for U.H.F. research.

PURCHASE TAX ON KITS

WE have been asked by the Commissioners of Customs and Excise to draw attention to the fact that the sale in parts of a receiver of the domestic or portable type does not affect its liability to Purchase Tax.

Constructors' kits of components for the building of sets (including loudspeaker or cabinet supplied therewith) are accordingly chargeable with tax at the rate of 33⅓ per cent of the wholesale value.

AUSTRALIAN AMATEURS

A NUMBER of new frequencies having recently been allocated to Australian amateurs, the most notable being an extension of the 20- and 40-metre bands, we give below a list of the bands now available.

3.5- 3.8 Mc/s	166- 170 Mc/s
7.0- 7.2 ,,	1345- 1425 ,,
14.0-14.4 ,,	2500- 2700 ,,
28.0-30.0 ,,	5250- 5650 ,,
50.0-54.0 ,,	10000-10500 ,,

AUXILIARY AIR FORCE

FORMER members of the R.A.F., particularly those with wartime experience of raid reporting and fighter control methods, may now volunteer to join new Auxiliary Air Force units being set up in nine counties—Hampshire, Kent, Middlesex, Norfolk, Northampton, Nottingham, Suffolk, Sussex and East Riding. These units will be required to man Fighter Command and Fighter Group operations rooms, and radar reporting stations. Their work will be operational rather than technical.

Training will take place during the evenings, at week ends, and during 15 days' camp or exercises annually. There are allowances for training expenses and travelling and an annual bounty for airmen and a retainer for officers. Former members of the W.A.A.F. will be recruited later.

CANADIAN AMATEURS

A CHAIN of emergency amateur radio stations, for use in case of civil emergency or disaster, was recently set up across Canada. Sponsored by the Royal Canadian Air Force, the Air Force Amateur Radio System, as it is called, is open to any Canadian citizen. It does not demand Reserve or Service attachments, and places no obligation on its members to enlist in a Fighting Service at any time. Among the aims of the organization is to provide additional channels of radio communication throughout Canada that may be used to augment or replace telephone and telegraph services in time of civil emergency or disaster and to give Canadian amateurs a knowledge of Service communication procedures and equipment.

RADAR TRAINING

ACCORDING to the latest figures given by the Radio Officers' Union, some 60 radio officers have taken the examination held at the end of each of the six-weeks' technical courses in radar arranged by the Admiralty for the Merchant Navy. In addition to the technical course there is a short radar observer course for navigation officers.

Since the introduction in December, 1945, of the scheme for instructing Merchant Navy Officers in Admiralty establishments the courses have been given in H.M.S. Collingwood, but it is expected this school will soon be closed to Merchant seamen. A Radar Training Committee of the Ministry of Transport is at present investigating the whole question of training.

PERSONALITIES

Lord Trefgarne is the title adopted by G. M. Garro-Jones, chairman of the Television Advisory Board, who was created a Baron in the New Year Honours (not a Knight as stated in the February issue).

Major Edwin H. Armstrong has received the American Medal for Merit for his contributions to military communications especially in the field of frequency modulation. The citation states that he was "instrumental in influencing the Army to adopt F.M. for its mobile communications."

IN BRIEF

Amateurs' Examination.—The report on the City and Guilds examination for amateur transmitters held last November shows that 150 of the 216 candidates passed. The percentage of failures was 30.5 as compared with 22.2 at the previous examination. The only examination this year will be held on May 14th.

T.E.M.A.—As part of the celebrations to commemorate the centenary of the birth of Dr. Alexander Graham Bell, the Telecommunication Engineering and Manufacturing Association held a dinner at which Lord Listowel, the Postmaster-General, was a guest. Among the founder members of T.E.M.A., formed in 1943, are Marconi's, G.E.C., Plessey, Siemens and S.T.C.

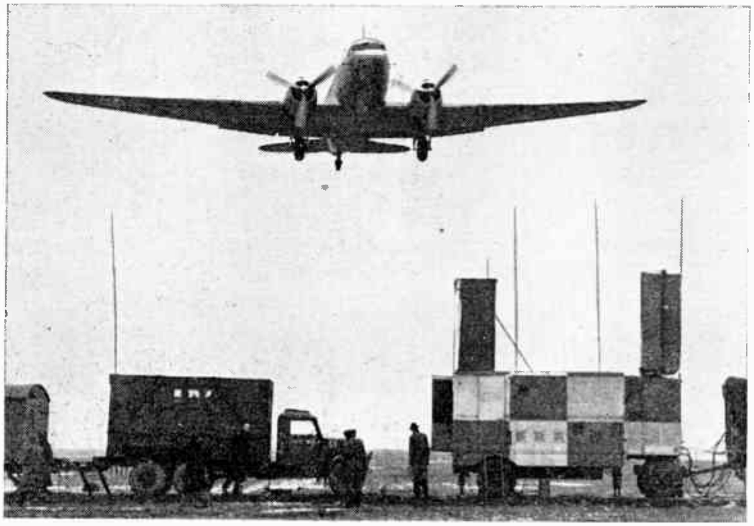
The Freeze-up.—Some idea of the load imposed on the aerials of the Cable and Wireless transmitting station at Dorchester, where at one time all the arrays were on the ground, will be gained by the fact that No. 16 gauge wire was built up with ice to a circumference of 5 inches. No damage was done to the sixteen 300ft masts because the balance weights which keep the arrays taut tripped off without failure. Six 100ft masts were, however, damaged.

Chinese Telecommunications.—A contract covering the supply of twelve telegraph/telephone transmitters—varying in power from 5 to 25 kW—30 triple-diversity high-speed receiving equipments and 150 commercial receivers to the Chinese government has been secured by Marconi's. Valued at nearly £300,000, the equipment is for the extension of China's overseas telecommunication services. Some months ago Marconi's received a similar order for the country's internal services.

station. The provision of a station in Europe and one to serve Eastern Asia and the Pacific is also included.

U.S. 'Phone Bands.—Because of the imminence of the world telecommunications conference the American Radio Relay League has withdrawn its year-old application to the U.S. Federal Communications Commission for the allocation of a 7-Mc/s 'phone band and the widening of the 14.2-14.3-Mc/s 'phone band. It will now await the result of the conference before making further application.

Athlone's new short-wave transmitter, which is now not expected to be operating until the end of the year, is to be supplied by Marconi's W.T. Co.



G.C.A.—Ground Controlled Approach—the radar system for "talking down" aircraft, was brought into operational use at London Airport on February 27th. Initially it is available on one runway only and from 0900 to 1700 daily. The channel normally to be used will be 118.1 Mc/s (2.54 m) but the equipment provides for two-way R/T communication on any one of twelve V.H.F. and 30 H.F. channels. G.C.A. employs two centimetre radar systems —one for marshalling the aircraft and the other for the runway approach. The only equipment necessary in the aircraft is a H.F. or V.H.F. receiver. The mobile G.C.A. gear is shown in use at London Airport.

"**F.M. is now established** on a sound, permanent post-war basis. In all, we at the F.C.C. expect some two thousand of these F.M. stations in the next few years—nearly twice as many as the present number of A.M. stations. . . . If I were buying a new radio today, I would certainly not buy one that did not include F.M."—E. K. Jett, U.S. Federal Communications Commissioner.

"**Nation Shall Speak Peace. . . .**"—Plans have been laid before the General Assembly of the United Nations Organization for the establishment of an international broadcasting and telecommunications system. This plan, which will be considered at the next meeting of the Assembly in September, provides for the expenditure of six million dollars for the equipment. It is recommended that half this amount should be spent on the headquarters

Exeter's Transmitter.—A low-power station at Exeter was added to the existing group of synchronized transmitters working on 1,474 kc/s on February 26th, when the B.B.C.'s Third Programme was resumed after the interruption during the fuel crisis.

A Decrease.—The 10,691,900 broadcast receiving licences in force at the end of January is a decrease of over 86,000 compared with the figure at the end of the year. The January total included 11,200 television licences.

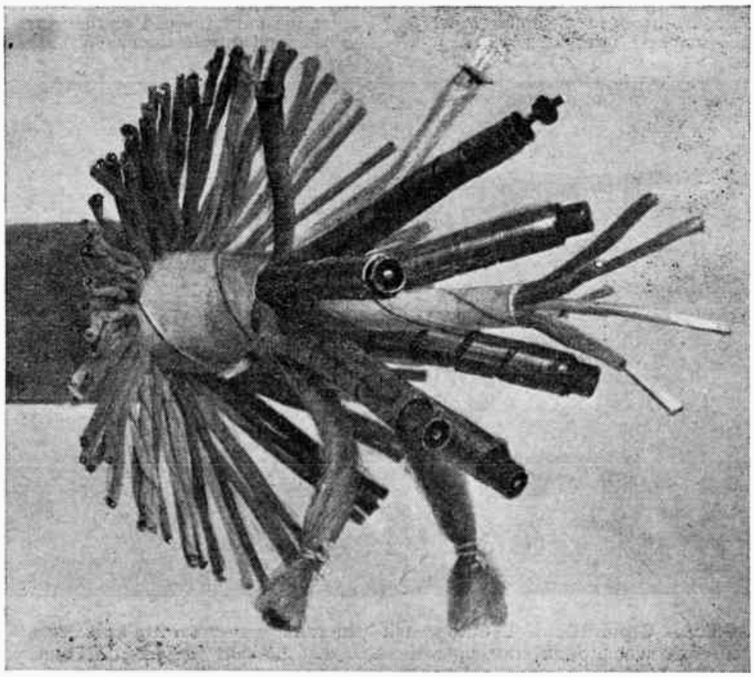
Cable and Wireless, Limited, will remain in being as a Government-owned company and will continue to own the assets and to operate the telecommunication services outside the United Kingdom, apart from those to be owned and operated by the respective national bodies in the Dominions, India and Southern Rhodesia as decided at

World of Wireless—
the recent Commonwealth Telecommunications Conference. All the assets in the United Kingdom will be transferred to the Post Office and the services integrated with those of the Post Office. The P.M.G. has taken over Ministerial responsibility for Cable and Wireless.

R.S.G.B. Council.—At the annual general meeting of the Radio Society of Great Britain, S. K. Lewer, G6LJ, was elected president, and V. M. Desmond, G5VM, vice-president.

Australia's overseas radio and cable services, which in the past were operated and controlled by Amalgamated Wireless (Australasia), have been taken over by the Australian Communications Commission which was set up in conformity with the Empire policy to place the communications services under government control.

Frequency Modulation is to be used experimentally in Australia. Two stations are being erected in Sydney and Melbourne and will soon be in operation. Transmission will be in the 88-108 Mc/s band.



THE WASHINGTON—NEW YORK R.F. CABLE, shown here in section, includes six R.F. lines for television relaying, multi-channel telephony, etc., as well as a number of ordinary conductors.

"A Rose, by any other name. . . ."—To meet the criticism that there are no details of medium-wave stations outside the European zone in our booklet, "Broadcasting Stations of the World," the second edition, which will be published in a few weeks, will be called "Guide to Broadcasting Stations." It has been revised and includes details of some 130 new stations—bringing the total to over 1,200. Frequency and geographical lists of some 300 long- and medium-wave European stations and some 900 short-wave stations of the world are given in the booklet, which is priced at 1s. (postage 1d.).

High Power.—The proposal has been made to the F.C.C. that twenty stations in the United States should be given exclusive frequencies and permitted to operate with a power of 750 kW. The plan is that five of these stations should be operated by each of the four major networks, giving a nation-wide coverage.

Television Bibliography. — Some 275 technical papers on television and closely related subjects, written by members of the Radio Corporation of America and published between 1929 and 1946 in some 30 different American journals, are listed in a booklet "Television: A Bibliography of Technical Papers," issued by *RCA Review*, R.C.A. Laboratories Division, Princeton, N.J., U.S.A.

"Trader Year Book."—The 1947 edition of this valuable trade reference book will be ready this month. New features included in this edition are:—complete receiver specifications, mains voltage directory and a country-wide analysis of receiving licence figures. The usual directories of manufacturers, wholesalers, trade names and buyers' guide have been revised. Copies are obtainable from Dorset House, Stamford Street, S.E.1, price 7s 6d to subscribers to *Wireless & Electrical Trader* and 10s 6d to non-subscribers.

A "Radio Paging" Service is planned by a New Yorker, who, according to *Radio News*, has been granted a construction permit by the F.C.C. for the erection of an experimental station. Clients of the service will carry a "vest pocket" pre-tuned receiver; on hearing their code number they will have to 'phone the headquarters of the service to receive the message addressed to them.

Radar Association.—The first reunion of the Radar Association was held in January, when some 300 ex-R.A.F. and ex-W.A.A.F. members of radar commands met. Founded in 1946, the association, of which A.V-M. D. C. T. Bennett and Sir Edward Appleton are vice-presidents, aims at preserving "the comradeship founded in the radar commands regardless of trade or rank." The secretary is C. W. Knight, 31, Currey Road, Greenford, Middx.

INDUSTRIAL NEWS

Imports from U.S.—According to our New York contemporary, *Tele-Tech*, the Federation of Anglo-American Importers is negotiating for the inclusion of American broadcast receivers in the list of Token Imports permitted by the Board of Trade. The Federation has secured licences for some 34 importers to purchase American valves.

R.C.E.E.A. Officers.—The council of the Radio Communication and Electronic Engineering Association—one of the constituent bodies of the Radio Industry Council—has re-elected C. O. Stanley, C.B.E. (Pye), as chairman and elected L. T. Hinton, B.Sc. (S.T.C.), as vice-chairman.

G.E.C. photo-cell equipment has been installed in H.M.S. *Vanguard* to give automatic indication of smoke density in the funnels.

Exide and Drydex.—A new sales depot has been opened by the Chloride Electrical Storage Co., at 89, Albion Street, Leeds, 1.

Wearite.—The whole of the production side of Wright and Weaire has been transferred to the company's new works at Simonside Works, South Shields, Durham. The London office is now at 2, Lord North Street, S.W.1. Tel. ABB 2126.

B.I. Callender's Cables has adopted a five-day working week. Although all the company's works will be closed on Saturdays, the head offices and branch offices will be open for urgent business.

Marconi's announce that they are to supply the 25-kW F.M. transmitter ordered by the B.B.C., to which reference was made last month.

Sperry Gyroscope Co. has been given the contract to install the shore radar system at Liverpool docks, which it is planned will be in operation in the spring of 1948.

John Factor, Ltd., is the new name of Stanley Cattell, Ltd., of 9-11, East Street, Torquay.

Sussex Industries Exhibition.—The second exhibition to be promoted by the Sussex Engineers' and Manufacturers' Association will be held in the Dome and Corn Exchange, Brighton, from September 17th-27th. Information is obtainable from the exhibition organizer, Lt. Col. C. Hedley Briggs, O.B.E., 3, Marlborough Place, Brighton, 1, Sussex.

Exports.—The policy of the Radio Manufacturers' Association War Export Group, through which production quotas and raw materials were allocated to manufacturers, was recently criticized by the Electronic Manufacturers' Association. It is announced by E.M.A. that a company may now deal direct with the Ministry of Supply.

B.E.T.R.O.—The British Export Trade Research Organization recently completed its first year of full active work, during which it has handled some 600 overseas enquiries and research commissions. It is learned that a considerable number of enquiries have been received from the radio industry.

Birmingham office of G.W.B. Electric Furnaces, Ltd., is now at 21, Steelhouse Lane. Tel.: Central 6372.

CLUBS

Bradford.—Particulars of the Bradford Short-Wave Club, which meets each week at its headquarters, 1374a, Leeds Road, Bradford, are obtainable from V. W. Sowen, G2BYC, Rushwood, Grange Park Drive, Cottingley, Bingley, Yorks.

Crayford.—The recently formed North Kent Radio Society meets on alternate Wednesdays at 7.30, in the Lecture Room of Crayford Library. The next meeting will be on April 2nd. Sec.: H. L. Overton, G4CW, 6, Lower Station Road, Crayford, Kent.

Cornwall.—Meetings of the West Cornwall Radio Club are held alternately in Penzance, on the first Thursday in each month at 7.30 at the Railway Hotel, and in Falmouth, on the third Thursday. Secretary, R. V. A. Allbright, G2JL, Greenacre, Lidden, Penzance, Cornwall.

Exeter.—Membership of the recently formed Exeter and District Amateur Short-Wave Radio Society is now 20. Meetings are held on Thursdays at 7.0 in the Mount Pleasant Chapel Schoolroom, Thurlow Road. Sec.: E. G. Wheatcroft, 7, Mount Pleasant Road, Exeter, Devon.

Manchester.—Re-formed in May last year, the Manchester and District Radio Society now has a membership of 100. The next meeting will be held on April 22nd at the School of Technology, Whitworth Street, Manchester, at 7.30. Sec.: H. Marshall, G4ND, 14, Greenway Close, Sale, Cheshire.

Manchester.—The next meeting of the Radio-Controlled Models Society on March 29th at 3.0 at the Y.M.C.A., Peter Street, Manchester, will be addressed by Peter Hunt, Technical Editor of the Model Aeronautical Press. Sec.: J. C. Hogg, 24, Springfield Road, Sale, Manchester.

Reading.—The next meeting of the Reading and District Amateur Radio Society will be held on March 29th at 6.30 at Palmer Hall, West Street, Reading. Sec.: L. A. Hensford, B.E.M. (G2BHS), 30, Boston Avenue, Reading, Berks.

Southampton.—The new secretary of the Southampton Radio Club, which meets each Wednesday, is J. H. Sillence, 80, The Drove, Coxford, Southampton, from whom details of membership are available.

Wellington.—The name of the Wrekin Amateur Radio Society has been amended to Wrekin and Y.M.C.A. Amateur Radio Society. Meetings are held on Mondays, Thursdays and Fridays at the Y.M.C.A., Wellington, where the club has a private room. Sec.: T. L. Stevens, G3XV, Sunny Cottage, Donnington Wood, Wellington, Salop.

MEETINGS

Institution of Electrical Engineers

Radio Section. — Discussion on "Does Standardization Conflict with Progress," opener J. W. Dalgleish, B.Sc., on April 15th.

"New Possibilities in Speech Transmission," by D. Gabor, Dr. Ing., on April 23rd.

The above meetings will be held at 5.30 at the I.E.E., Savoy Place, London, W.C.2.

Cambridge Radio Group. — "The Pulse Testing of Wide-Band Networks," by D. C. Espley, D.Eng., E. C. Cherry, M.Sc., and M. M. Levy, on April 1st, at 6.30, at the Cavendish Laboratory.

"Dielectric Phenomena at High Radio Frequencies," by Professor Willis Jackson, D.Sc., D.Phil., on April 22nd, at 6.0, at the Cambridgeshire Technical College.

North-Western Radio Group.—"The Design of High-Fidelity Disc-Recording Equipment," by H. Davies, M.Eng., on April 10th, at 6.0, at the Engineers' Club, Albert Square, Manchester.

British Institution of Radio Engineers

Scottish Section. — Discussion on "Television Development in Scotland," opener A. Bogie, on April 10th, at 6.45, at the Institution of Engineers and Shipbuilders in Scotland, Elmbank Crescent, Glasgow, C.2.

North-Eastern Section.—"The Technique of Radio Design," by D. R. Parsons, on April 9th, at 6.0, at Neville Hall, Westgate Road, Newcastle-on-Tyne.

Institute of Physics

Electronics Group.—"Electron Multipliers," by S. Rodda, on April 22nd, at 5.30, at the Royal Society, Burlington House, London, W.1.

Radio Society of Great Britain

"The Design and Construction of Short-wave Amateur Transmitters," by W. H. Allen, M.B.E. (G2UJ) on April 11th, at 6.30, at the I.E.E., Savoy Place, London, W.C.2.

British Sound Recording Association

"Modern Direct Disc Recording," by A. H. Watts, on April 25th, at 7.0, at the Royal Society of Arts, John Adam Street, Strand, London, W.C.2.

BRITISH INDUSTRIES FAIR

ALTHOUGH the floor space to be occupied by the B.I.F. in London and Birmingham is slightly less than that of the last Fair (1939), the area allocated to the radio and music section at Olympia is more than twice as much—17,140 sq. ft. Sixty per cent of the exhibitors in this section are in the radio industry—their names are listed below. In addition, a number of radio manufacturers are exhibiting in the scientific and optical section.

The Radio Industry Council is represented on the B.I.F. Advisory Committee of sixty-four members by W. M. York, G. J. Freshwater and H. J. Dyer.

Admission to the Fair, which will be open from May 5th to 16th will be restricted to home and overseas buyers until 4.30 each day, when the public will be admitted, except Saturday, May 10th, when it will be open all day to the public.

Radio and Music Section.

AIRMEC International.
Allander Industries.
Amplion.
Associated Electronic Engineers.

BELLING & Lee.
Birmingham Sound Reproducers.
British Electronic Products.
British Rola.

CELESTION.
Central Rediffusion Services.
Cossor, A. C.

DALLAS, John E.
Dubilier.
Du Bois.

EASTICK, J. J.

GARRARD.
Grampian Reproducers.

LABGEAR.
Leyland Instruments.

MARCONI'S.
Masteradio.
Mullard.
Multicore.
Multitone.

PHILIPS.
Pye.

RADIO Instruments.
Rediffusion.
Rees Mace.

SOBEL.

TAYLOR Electrical Instruments.
Telegraph Construction & Maintenance.
Telsen.
Thorn Electrical Industries.
Trix Electrical.

ULTRA.

VITAVOX.

WEGO Condenser.
Westinghouse.
Woden Transformer.

Scientific and Optical Section

ALLEN & Hanburys.
Amplivox.
Ardente.

BAIRD & Tatlock.
Baldwin Instrument.
British Physical Labs.

CAMBRIDGE Instrument.
Cinema-Television.

DAWE Instruments.

FURZEHILL Laboratories.

GAMBRELL.

HILGER, Adam.

MULLARD.
Multitone.

PARK Royal Scientific Instruments.

SALFORD Electrical Instruments.
Scophony.
Sperry Gyroscope.

TAYLOR, Taylor & Hobson.

UNBIASED

By FREE GRID

The Turn and the Bar

SOONER or later radar was bound to be blamed for the vagaries of the weather, and the only thing that surprises me is that it has not happened before. I fully expected that it would be made the scapegoat for the great deluge of waters that assailed us last summer. But it remained for the great February freeze-up of this year to supply the necessary inspiration for one of our amateur meteorologists to take up his pen and write to a Sunday newspaper with a strong indictment of radar as the cause of our faces being as blank and dismal as the screens of our television sets.

"Poor and uncultured relations."

I must say that the gentleman in question dealt with his subject with great thoroughness. After pointing out that the winter following the establishment of the pioneer radar station in 1935 was marked by weather of unusual severity, he stressed the fact that the great impetus given to radar by the outbreak of war was followed by very severe wintry weather. The almost unprecedented low temperatures of January, 1940, were scarcely exceeded even in the recent cold spell, which he naïvely puts down to the increasing use of radar in a civilian capacity.

Now, as I have pointed out in these columns, we heard all this sort of thing in the early days of broadcasting from amateur weather wiseacres, who forgot that the radio waves which they blamed had been used for over a quarter of a century earlier in the pre-broadcasting era of wireless. This time it is "radar waves" which are the scapegoat, and it is obvious that the writer thinks that they are altogether different from ordinary radio waves.

I am not really worried about the opinion of amateur meteorologists. They and their opinions will pass into oblivion like those of earlier generations of their kind who have invariably attributed the vagaries of the weather to each new application of science.

What I *am* worried about, however, is the thoroughly unprofessional and technically slipshod way in which certain leading lights of the electrical industry described the public's habits of using electric fires in the days of the great freeze-up. After all, it must be remembered that the electrical industry is a poor and rather uncultured relation of our own radio industry, and any discredit its members bring upon themselves is a reflection also upon us. When, therefore, a prominent member of the electrical world publicly announces that the electric fire consumption was "up by many thousands of bars in each locality," it is time we asked ourselves whether "the bar" as a new electrical unit threatens to oust the old-fashioned kilowatt-hour in the same manner as "the turn" at one time threatened to rival the "micro-henry" in the radio world.

How They Do It

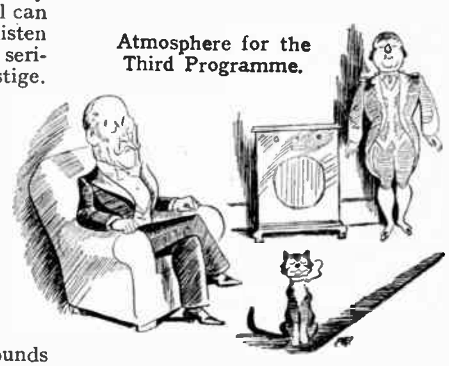
IT goes almost without saying that the Third Programme is the only one which readers of this journal can afford to have it known they listen to unless they wish to suffer a serious loss of intellectual prestige. This programme is, after all, the only one which is at all commensurate with the more rarefied atmosphere to which *Wireless World* readers have become accustomed.

At the same time it is within my knowledge that there is a considerable number of the weaker brethren among the glittering galaxy of technical talent which surrounds the Editorial throne who listen to the Home Service and even to the Light Programme. This they do without loss of prestige by the simple expedient of using headphones and a personal portable disguised as a hearing aid while the domestic loudspeaker drones out the Third Programme unheeded.

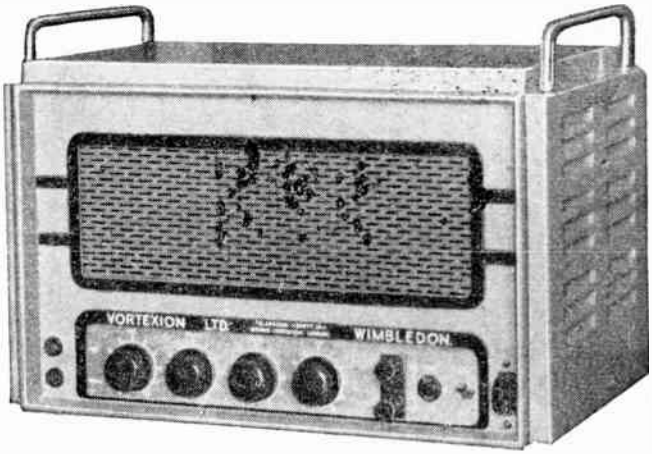
These weaker brethren at any rate will be as familiar as I am with the fact that nearly all comedians, so-called and real, make a special feature of raising a laugh by imitating and caricaturing the efforts of other performers. In these efforts they show themselves to be so familiar with recent broadcasts of a wide variety of other performers that I have often wondered how they manage to find the necessary time to listen to them all, let alone mark, learn and inwardly digest them. Recently I put the question direct to a well-known comedian of my acquaintance. He would only let me know the secret on condition that I refrained from disclosing his identity, as he said that if there was one thing more than another that he liked to avoid it was publicity.

I gave my promise and, picking up the telephone, he dialled a certain number and requested some half-dozen recordings of recent broadcasts by certain fellow artistes. This done he promptly placed the 'phone receiver in a special rest so constructed that the earpiece fed its output into a microphone coupled *via* a suitable amplifier to a loudspeaker, thus legitimately dodging the P.M.G.'s regulations about making any direct attachment to the telephone.

It appeared from subsequent explanations that there is in existence a company which makes a recording of everything broadcast by the B.B.C., and as promoters of the company are not at all sure about their legal position, both with regard to recording rights and also the various copyright acts, to say nothing of the B.B.C., they are compelled to remain underground and operate in this manner. Their telephone number is disclosed to would-be clients only after the most elaborate enquiries as to their trustworthiness.


Atmosphere for the Third Programme.

Vortexion "SUPER FIFTY WATT" AMPLIFIER



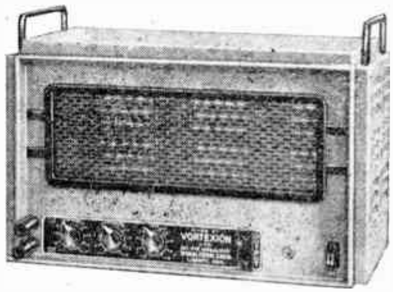
This **AMPLIFIER** has a response of 30 cps. to 25,000 cps., within ½ db, under 2 per cent. distortion at 40 watts and 1 per cent. at 15 watts, including noise and distortion of pre-amplifier and microphone transformer. Electronic mixing for microphone and gramophone of either high or low impedance with top and bass controls. Output for 15/250 ohms with generous voice coil feedback to minimise speaker distortion. New style easy access steel case gives recessed controls, making transport safe and easy. Exceedingly well ventilated for long life. Amplifier complete in steel case, with built-in 15 ohm mu-metal shielded microphone transformer, tropical finish.

As illustrated. Price **36½ Gns.**

C.P.20A. 15 WATT AMPLIFIER

for 12 volt battery and A.C. Mains operation. This improved version has switch change-over from A. C. to D.C. and "stand by" positions and only consumes 5½ amperes from 12 volt battery. Fitted mu-metal shielded microphone transformer for 15 ohm microphone, and provision for crystal or moving iron pick-up with tone control for bass and top and outputs for 7.5 and 15 ohms. Complete in steel case with valves.

As illustrated. Price **£28 0 0**



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This is a development of the A.C.20 amplifier with special attention to low noise level, good response (30—18,000 cps.) and low harmonic distortion (1 per cent. at 10 watts). Suitable for any type of pick-up with switch for record compensation, double negative feedback circuit to minimise distortion generated by speaker. Has fitted plug to supply 6.3 v. 3 amp. L.T. and 300 v. 30 m/A. H.T. to a mixer or feeder unit. Price **£21 0 0**

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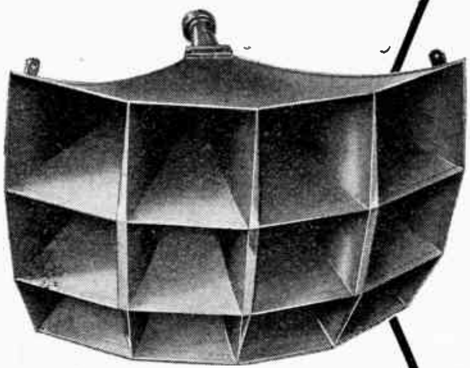

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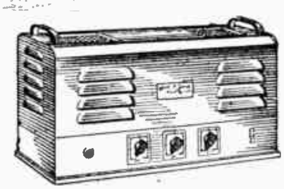
"Audioscope"—maybe we have invented a new word, but the meaning, when applied to WODEN AMPLIFIERS, is that their "audioscope" embraces not only perfected reproduction of any sound but such excellent amplification that it will reach the widest audience in hall or open space without the loss of the slightest undertone or the distortion of music's highest C. Designed for a long life of trouble-free service and built in the WODEN belief that Finest Materials + Expert Craftsmanship must = Quality. Now it's up to you to send us your name and address for further particulars . . . why not do so TO-DAY ?



60 WATT "CLASSIC" AMPLIFIER
Mains supply 200-250 v. A.C. 50 cps. Transformer tapped at 0, 8, 15 and 200 ohms. Response 50-10,000 cycles ± 2 db. Undistorted output of 60 watts. Finished in Light Grey Stove Enamel and Chromium. Retail Price £47 . 10 . 0.

20 WATT "JUNIOR" AMPLIFIER
Undistorted output of 20 watts. Transformer tapped at 0, 8 and 15 ohms. Flat from 50-10,000 cycles ± 1 db. Controls consist of Mic. and Gram. Feeders and Tone. Finished in Light Grey Stove Enamel and Chromium. Retail Price £27 . 10 . 0.

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COMPONENTS FOR 1947

The R.C.M.F. Exhibition

NEARLY 100 manufacturers of components, accessories, test gear and materials had stands at this year's annual private exhibition of the Radio Component Manufacturers' Federation, held March 10-13 in London. A classified list containing a selection of the principal groups of products on show is given below. The full titles of the firms appear in the list of exhibitors which follows.

A review of the exhibition will appear in our next issue.

LIST OF EXHIBITS

Aerial Equipment. Aerialite; Antiference; Belling-Lee; Labgear; Ripaults; Telegraph Construction.

Attenuators. Painton.

Bobbins. Associated Electronic Engineers; McMurdo Instrument.

Cabinets. Imhof; Stratton; Weymouth Radio.

Cables and Wires. Aerialite; Associated Technical Manufacturers; B.I.-Callenders; Duratube; Reliance Electrical Wire; Ripaults; Standard Telephones; Telegraph Construction; Suflex.

Capacitors, Fixed. Bulgin; British Electrolytic Condenser; B.I.-Callenders; British N.S.F.; Daly; Dubilier; Erie; Ferranti; Hunt; London Elect. Mfg.; Plessey; Static Condenser; T.C.C.; T.M.C.; United Insulator; Wego.

Capacitors, Variable and Pre-set. Sydney Bird; Bulgin; Dubilier; Hunt; Jackson; Labgear; Mullard; Plessey; Stratton; Walter Instruments; Wingrove & Rogers.

Ceramics. Geo. Bray; Bullers; Johnson Matthey; Steatite & Porcelain Prod.; Taylor, Tunnicliffe; United Insulator.

Chassis. Imhof; Stratton; J. & H. Walter.

Chokes. Advance Components; Associated Electronic Engineers; Automatic Coil Winder & Elec. Equip.; Bulgin; Electro Acoustic Industries; Ferranti; Goldsman; Labgear; Parmeko; Partridge Transformers; Plessey; Radio Instruments; Stratton; Teledicator; Varley; Weymouth Radio Mfg.; Woden Transformer.

Coils, Tuning. Advance Components; Automatic Coil Winder and Elec. Equip.; Labgear; Plessey; Radio Instruments; Stratton; Weymouth Radio Mfg.; Wright & Weaire.

Connectors. Belling-Lee; B.I.-Callenders; British Mechanical Prod.; Bulgin; Carr Fastener; Plessey; Standard Telephones; Telegraph Construction.

Crystals, Quartz. Salford Elec. Instruments; Standard Telephones.

Dust Cores. Magnetic & Electrical Alloys; Plessey; Salford Elec. Instruments; T.M.C.

Fuses and Fuseholders. Belling-Lee; British Mechanical Prod.; Bulgin; Carr Fastener.

Gramophone Pick-ups. Cosmocord; Garrard; Plessey.

Gramophone Units, Record Changers. Garrard; Plessey.

Instruments, Measuring and Test. Advance Components; Automatic Coil Winder & Elec. Equip.; Dawe Instruments; Ferranti; Labgear; Plessey; Salford Elec. Instruments; Sifam; Taylor.

Insulators. Geo. Bray; Bullers; Steatite & Porcelain Prod.; Stratton; Taylor, Tunnicliffe; United Insulator.

Insulating Materials and Sleeving. Associated Technical Mfrs.; Duratube and Wire; Hellermann Elec.; Long & Hambly; Micanite & Insulators; Spicers; H. D. Symons; Telegraph Construction.

Interference Suppressors. Antiference; Belling-Lee; Dubilier; Erie; Ferranti; Morgan Crucible; Wego.

Laminations. Magnetic and Electrical Alloys; Geo. L. Scott; Telegraph Construction.

Loudspeakers. Acoustic Products; British Rola; Celestion; Electro Acoustic Industries; Film Industries; Goodmans; Plessey; Reslo; Tannoy; Teledictor; Vitavox; Woden Transformer.

Magnetic Alloys. Magnetic and Electrical Alloys; Telegraph Construction.

Microphones. Cosmocord; Film Industries;; Goodmans Industries; Reslo; Vitavox.

Mouldings, Plastic. British Mechanical Productions; Cosmocord; Shipton; Standard Telephones; Telegraph Construction.

Mouldings, Rubber. Long and Hambly.

Plugs and Sockets. Antiference; Belling-Lee; British Mechanical Productions; Bulgin; Carr Fastener; Long & Hambly; Painton; Plessey; Stratton; Telegraph Construction; T.M.C.

Potentiometers. British Elec. Resistance; Bulgin; Colvern; Dubilier; Erg; Erie; Morgan Crucible; Painton; Plessey; Reliance; Taylor Elec. Instruments.

Rectifiers, Metal. Standard Telephones; Westinghouse.

Relays. Plessey; T.M.C.; Varley.

Resistors, Fixed. Automatic Coil Winder and Elec. Equip.; British Electric Resistance; British N.S.F.; Bulgin; Dubilier; Erg; Erie; J. L. Goldsman; Morgan Crucible; Mullard; Painton; Varley, Welwyn Electrical Labs.

Seals, Hermetic (Ceramic). Geo. Bray; Bullers; Steatite and Porcelain Products; Taylor, Tunnicliffe; United Insulator.

Signal Generators. Advance Components; Taylor Electrical Instruments.

Solder, Flux Cored. B.I.-Callenders; Du Bois; H. J. Enthoven; Multicore.

Switches. A. B. Metal Products; British N.S.F.; British Electric Resistance; Bulgin; Labgear; Painton; Plessey; E. Shipton; T.M.C.; Varley; Walter Instruments; Wright & Weaire.

Transformers. Acoustic Products; Advance Components; Associated Electronic Engineers; Automatic Coil Winder and Elec. Equip.; Bulgin; British Electric Resistance; British Rola; Celestion; Electro Acoustic Industries; Ferranti; J. L. Goldsman; Goodmans; Labgear; Parmeko; Partridge; Plessey; Radio Instruments; Salford; Stratton; Tannoy; Teledictor; Varley; Vitavox; Weymouth; Woden; Wright & Weaire.

Valve Holders. Belling-Lee; British Mechanical Prod.; Bulgin; Carr Fastener; McMurdo Instrument; Plessey; Radio Instruments; E. Shipton.

Valve Retainers. Electrothermal Engineering; Long & Hambly.

Vibrators. Plessey; Wimbledon Engineering; Wright & Weaire.

LIST OF EXHIBITORS

A.B. METAL Products, Ltd., Hatton Works, Feltham, Middx.

Acousic Products, Ltd., 50-58, Britannia Walk, City Road, London, N.1.

Advance Components, Ltd., Back Road, Shornhall Street, London, E.17.

Aerialite, Ltd., Castle Works, Stalybridge, Cheshire.

Antiference, Ltd., Plender Place, Plender Street, London, N.W.1.

Associated Electronic Engineers, Ltd., Dalston Gdns., Stanmore, Middx.

Associated Technical Mfrs., Ltd., Vincent Works, New Islington, Manchester, 4, Lancs.

Automatic Coil Winder & Electrical Equipment Co., Ltd., Winder House, Douglas Street, London, S.W.1.

BELLING & Lee, Ltd., Cambridge Arterial Road, Enfield, Middx.

Bird, Sidney S., & Sons, Ltd., Cambridge Arterial Road, Enfield, Middx.

Bray, Geo., & Co., Ltd., Leicester Place, Blackmans Lane, Leeds, 2, Yorkshire.

British Electrical Resistance Co., Ltd., Queensway, Ponders End, Middx.

British Electrolytic Condenser Co., Ltd., 52, Vicarage Lane, Ilford, Essex.

British Insulated Callender's Cables, Ltd., Surrey House, Embankment, London, W.C.2; and Prescot, Lancs.

British Mechanical Productions, Ltd., 21, Bruton Street, London, W.1.

British N.S.F. Co., Ltd., Dalton Mill, Dalton Lane, Keighley, Yorkshire.

British Rola, Ltd., Georgian House, Bury Street, London, S.W.1.

Bulgin, A. F., & Co., Ltd., By-Pass Road, Barking, Essex.

Bullers, Ltd., 6, Laurence Pountney Hill, Cannon Street, London, E.C.4.

CARR Fastener Co., Ltd., Nottingham Road, Stapleford, Notts; and Brantwood Works, Tariff Road, London, N.17.

Celestion, Ltd., London Road, Kingston, Surrey.

Colvern, Ltd., Mawneys Road, Romford, Essex.

Cosmocord, Ltd., 700, Gt. Cambridge Road, Enfield, Middx.

DALY (Condensers), Ltd., West Lodge Works, The Green, Ealing, W.5.

Dawe Instruments, Ltd., Harlequin Avenue, Great West Road, Brentford, Middx.

Dubilier Condenser Co. (1925), Ltd., Ducon Works, Victoria Road, North Acton, London, W.3.

Du Bois Co., Ltd., 15, Britannia Street, King's Cross, London, W.C.1.

Duratube & Wire, Ltd., Faggs Road, Feltham, Middx.

ELECTRO Acoustic Industries, Ltd., Stamford Works, Broad Lane, Tottenham, London, N.15.

Electrothermal Engineering Co., Ltd., 270, Neville Road, London, E.17.

Enthoven, H. J., & Sons, Ltd., Croydon Works, 230, Thornton Road, West Croydon, Surrey.

ERG Industrial Corporation, Ltd., 1021a, Finchley Road, London, N.W.11.
Erie Resistor, Ltd., Carlisle Road, The Hyde, Hendon, London, N.W.9.

FERRANTI, Ltd., 36, Kingsway, London, W.C.2; and Hollinwood, Lancashire.
Film Industries, Ltd., 60, Paddington Street, London, W.1.

GARRARD Engineering & Mfg. Co., Ltd., Newcastle Street, Swindon, Wilts.
Goldsman, J. L., Ltd., 5, Torrens Street, City Road, London, E.C.1.
Goodmans Industries, Ltd., Lancelot Road, Wembley, Middx.

HELLERMANN Electric Co., Ltd., Goodtric Works, Brewer Street, Oxford.
Hunt, A. H., & Co., Ltd., Bendon Valley, Garratt Lane, London, S.W.18.

IMHOF, Alfred, Ltd., 112-6, New Oxford Street, London, W.C.1.

JACKSON Bros., Ltd. (London), Kingsway, Waddon, Surrey.
Johnson, Matthey & Co., Ltd., 78-83, Hatton Garden, London, E.C.1.

LABGEAR, Ltd., Willow Place, Fair Street, Cambridge.
London Electrical Manufacturing Co., Ltd., 459, Fulham Road, London, S.W.6.
Long & Hambly, Ltd., Empire Works, Slater Street, High Wycombe, Bucks.

MAGNETIC & Electrical Alloys, Ltd., 101-103, Baker Street, London, N.W.1.
McMurdo Instrument Co., Ltd., Ashtead, Surrey.
Micanite & Insulators, Ltd., Empire Works, Blackhorse Lane, London, E.17.
Morgan Crucible Co., Ltd., Battersea Church Road, London, S.W.11.
Mullard Wireless Service Co., Ltd., Century House, Shaftesbury Avenue, London, W.C.2.
Multicore Solders, Ltd., Mellier House, Albemarle Street, London, W.1.

PAINTON & Co., Ltd., Kingsthorpe, Northampton.
Parmeko, Ltd., Percy Road, Aylestone Park, Leicester.
Partridge Transformers, Ltd., 76-8, Petty France, London, S.W.1.
Plessey Company, Ltd., Vicarage Lane, Ilford, Essex.

RADIO Instruments, Ltd., Purley Way, Croydon, Surrey.
Reliance Electrical Wire Co., Ltd., Staffa Road, Leyton, London, E.10.
Reliance Manufacturing Co. (Southwark), Ltd., Sutherland Road, Highams Hill, London, E.17.
Resiosound, Ltd., 359, City Road, London, E.C.1.
Ripaults, Ltd., Southbury Road, Enfield, Middx.

SALFORD Electrical Instruments, Ltd., Peel Works, Silk Street, Salford, 3, Lancashire.
Scott, Geo. L., & Co., Ltd., Cromwell Road, Ellesmere Port, Cheshire.
Shipton, E., & Co., Ltd., Ferndown, Northwood Hills, Middx.
Sifam Electrical Instruments Co., Ltd., Leigh Court, Hr. Lincombe Road, Torquay, Devon.
Spicers, Ltd., 19, New Bridge Street, London, E.C.4.
Standard Telephones & Cables, Ltd., Connaught House, Aldwych, London, W.C.2.
Static Condenser Co., Ltd., Toutley Works, Wokingham, Berkshire.
Steatite & Porcelain Products, Ltd., Stourport-on-Severn, Worcestershire.
Stratton & Co., Ltd., 2-5, Station Street, Birmingham, 5, Warwicks.
Suflex, Ltd., Aintree Road, Perivale, Greenford, Middx.
Symons, H. D., & Co., Ltd., Park Works, Kingston Hill, Surrey.

TANNOY Products (Guy R. Fountain), Ltd., Canterbury Grove, London, S.E.27.
Taylor Electrical Instruments, Ltd., 419-424, Montrose Avenue, Slough, Bucks.
Taylor, Tunnicliffe & Co., Ltd., 125, High Holborn, London, W.C.1.
Teledictor, Ltd., 214, Birmingham Road, Dudley.
Telegraph Condenser Co., Ltd., Wales Farm Road, North Acton, W.3.
Telegraph Construction & Maintenance Co., Ltd., 22, Old Broad Street, London, E.C.2.
Telephone Manufacturing Co., Ltd., Hollingsworth Works, West Dulwich, S.E.21.

UNITED Insulator Co., Ltd., Oakcroft Road, Tolworth, Surbiton, Surrey.

VARLEY (Oliver Pell Control), Ltd., Cambridge Row, Woolwich, S.E.18.
Vitavox, Ltd., Westmoreland Road, London, N.W.9.

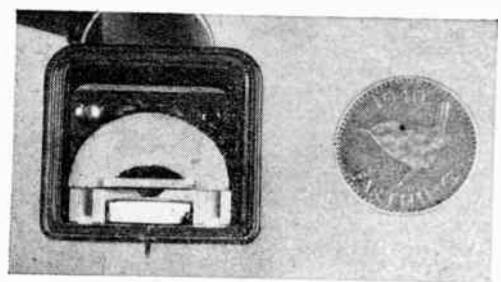
WALTER Instruments, Ltd., Garth Road, Lower Borden, Surrey.
Walter, J. & H., Ltd., 2, Caxton Street, London, S.W.1.
Wego Condenser Co., Ltd., Bideford Avenue, Perivale, Middx.
Welwyn Electrical Laboratories, Ltd., 70, Bridge Road East, Welwyn Garden City, Herts.
Westinghouse Brake & Signal Co., Ltd., 82, York Way, King's Cross, London, N.1.
Weymouth Radio Manufacturing Co., Ltd., Crescent Street, Weymouth, Dorset.
Wimbledon Engineering Co., Ltd., Garth Road, Lower Morden, Surrey.
Wingrove & Rogers, Ltd., Broadway Court, Broadway, London, S.W.1; and Polar Works, Old Swan, Liverpool, Lancs.
Woden Transformer Co., Ltd., Moxley Road, Bilston, Staffs.

Wright & Weaire, Ltd., 740, High Road, Tottenham, N.17.

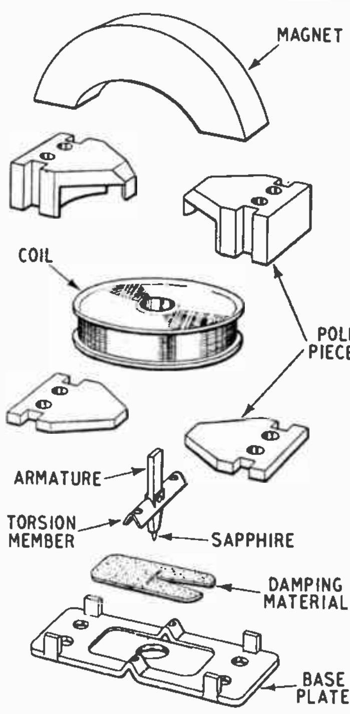
GARRARD HIGH-FIDELITY PICKUP

FURTHER details are now available of the new high-fidelity pick-up which is being fitted to Garrard record changers. A miniature moving iron movement is employed, and the coil is of the high-impedance type giving an output of the order of 0.35 volt, so that the pick-up can be connected to the input of the average amplifier without the additional expense of a transformer.

The armature measures approximately $\frac{1}{32}$in × $\frac{1}{16}$in × $\frac{1}{4}$in and is mounted on a V-section channel cut away to give torsional flexibility in the required direction of movement, limited vertical movement and high resistance to longitudinal stresses. Damping is



Comparison with a farthing gives some idea of the size of the latest Garrard pick-up.



(Left) Component parts of the Garrard high-fidelity moving iron pick-up.

applied as a thin sheet lying under the torsion member, but is not relied upon to supply the restoring force necessary to keep the armature central in the gap.

The pole pieces are machined from the solid and provided with interlocking grooves and spigots which ensure accurate assembly.

No needle is employed, and the sapphire stylus is fixed directly into the armature assembly. The volume of magnetic material in the armature ensures a good output, but its mass is not sufficient to cause appreciable record wear.

According to the maker's curve, the output is level from 50 to 1,000 c/s, then falls 3 db from 1,000 to 10,000 c/s. It is recommended that the coil should be shunted with 0.25 MΩ with 0.0005 μF in parallel. The D.C. resistance is 4,000 ohms, and the impedance at 1,000 c/s 6,500 ohms.

TROPICAL BROADCASTING

Notes on Proposed Use of Metre Waves

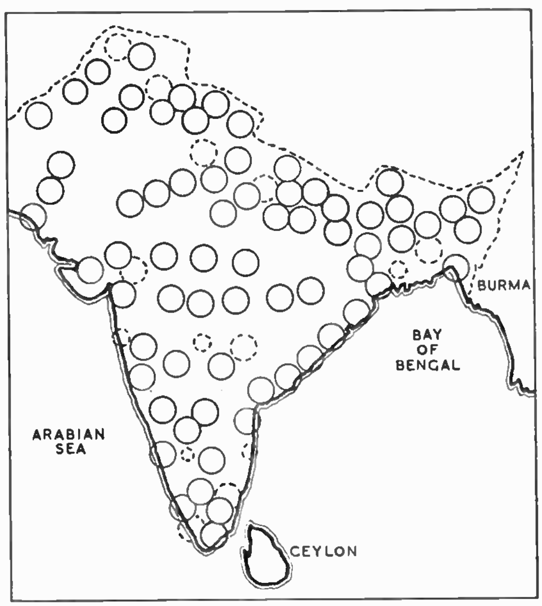
By "RADIATOR"

THE problem of providing internal broadcast services in countries situated within or near the tropics, where the coverage attainable on medium waves is often reduced to uneconomical proportions because of the high prevailing noise level, is one which has exercised the minds of broadcast engineers for some long time past, and seems likely to continue to do so in the future.

In India—and in some of the other countries involved—the main internal coverage has, apart from that of a few of the larger towns, been given on "long - short" waves, where some allocations of wavelengths were made for this express purpose. But this is admittedly only a second-grade service, for, since the waves have first to be reflected from the ionosphere, the received signal is subject to all the deficiencies inherent in such an indirect-ray service. Some of the problems of broadcasting on the "tropical" wavelengths of 60-120 metres were discussed in *Wireless World* for June, 1945.

In a recent address to the Electrical Engineering Society, Indian Institute of Science,* Professor S. P. Chakravarti proposed that a first-grade service should be given in India on the very short, rather than on the medium waves. After pointing out the advantages attending the use of very short waves—chief of which is that, provided the right wavelengths are employed, it should be possible to give reliable first-grade coverage at all times of the year up to 35 miles from a transmitter of only $\frac{3}{4}$kW radiated power—he went on to consider the problems involved.

Postulating that the frequencies to be used should be from 60 to 150Mc/s he states that those higher than 60Mc/s "are never known to be returned by the F2 region," presumably at most oblique incidence. This is true, though it is not true that they are not returned from the ionosphere at all, as it frequently happens that the M.U.F. for Sporadic E is greater than this. Above 150Mc/s other disadvantages—such as multi-path transmission—are likely to arise. In the band proposed the atmospheric noise is negligible and that due to electrical machinery hardly appreciable.



Courtesy "Electrotechnics."

Map showing distribution of proposed U.S.W. stations (full circles) in India. Service areas of existing M.W. stations shown by dotted circles.

A radiated power of $\frac{3}{4}$kW in this frequency range from an aerial 100 ft high should give reliable coverage up to 30 miles, provided the receiving aerials are at least 30ft high. The field strength should be more or less the same at this distance for either vertically or horizontally polarized waves, but since the electrical interference would be vertically polarized, a better signal/noise ratio would result if the transmissions were horizontally polarized. The type of the transmitting aerial is most important and, in order to secure a good circular pattern, the use, at a height of 100ft, of two half-wave horizontal radiators crossed at right angles and fed 90° out of phase is proposed. A second similar type of aerial is proposed if wide-band transmission to accommodate two programmes is undertaken. This would be a great advantage in India for, as is shown, the areas served by the transmitters are generally inhabited by people speaking two different languages, so it is proposed to transmit two programmes simultaneously from each transmitter.

The modulation preferred is A.M. rather than F.M. for the following reasons: (1) F.M. equipment is the more expensive. (2) F.M. is inconvenient for the transmission of two programmes. (3) The improved signal/noise ratio with F.M. is not sufficient on these frequencies to justify its use. (4) The bandwidth required for two programmes with F.M. is too great. (5) Reception difficulties exist with F.M. which are not present with A.M. Altogether a strong case seems to have been made out for the use of A.M.

Coming to the economics of the proposed service the use of no fewer than 70 very short-wave transmitters is proposed—in addition to the existing medium-wave stations—and even these appear to leave an enormous part of the country uncovered. A comparison is made between the approximate cost of erecting and operating very short-wave stations and medium-wave stations, with much

* See *Electrotechnics* (Bangalore), December, 1946, pp. 5-18.

advantage to the former system. But no comparison is made between the cost of providing a first-grade service by very-short-waves and a second-grade service by short-waves, and it would appear that the substitution of a first-grade for the present second-grade service over a large part of India would in any case be somewhat expensive. However, if it is to be done, the very-short rather than the medium waves certainly seem to offer the best solution to a problem that is arising in other tropical countries besides India.

SHORT-WAVE CONDITIONS

Expectations for April

By T. W. BENNINGTON (Engineering Division, B.B.C.)

DURING February maximum usable frequencies for this latitude increased considerably during daytime and very considerably during night-time as compared with those of January. These variations are the normal seasonal ones, but they were accentuated by the increasing sunspot activity. Long-distance communication on exceptionally high frequencies was often possible during daytime, a particularly good day being the 6th, when several U.S.A. stations on frequencies above 40 Mc/s were well received in this country and one U.S.A. harmonic on 50 Mc/s was heard.

Conditions were not unduly disturbed at any time during the month, though ionosphere storms did occur during the periods 8th-10th, 12th-14th and 16th 20th.

Forecast.—During April daytime M.U.F.s in the Northern Hemisphere are expected to begin their seasonal decrease towards the midsummer minimum, and the decrease during the month should be quite considerable. Night-time M.U.F.s, on the other hand, should continue their seasonal increase towards the midsummer maximum. Modifying these effects on most transmission paths is the fact that, since daylight will last longer, moderately high frequencies can remain in use for considerably longer periods. The net result is that during April working frequencies for most transmission paths will be somewhat lower than in March during the full daylight period, somewhat higher during the morning and evening periods, and considerably higher during the full darkness period.

Daytime communication on exceptionally high frequencies (like the 28-Mc/s band), though often still possible, is likely to be somewhat less so than of late. Over many circuits frequencies as high as 17 Mc/s should remain regularly workable till after midnight, and frequencies lower than about 11 Mc/s will seldom be required at any time during the night.

For transmission over distances between about 600 and 1,000 miles the E layer will often control transmission during the daytime, leading to somewhat higher working frequencies than could otherwise be possible. Sporadic E, though it should begin to increase, is not likely to be very prevalent during the month.

Below are given, in terms of the broadcast bands, the working frequencies which should be regularly usable during April for four long-distance circuits running in different directions from this country. In addition a figure in brackets is given for the use of those whose primary interest is the exploitation of certain frequency bands, and this indicates the highest frequency likely to be usable for about 25 per cent of the time during the month for communication by way of the regular layers:—

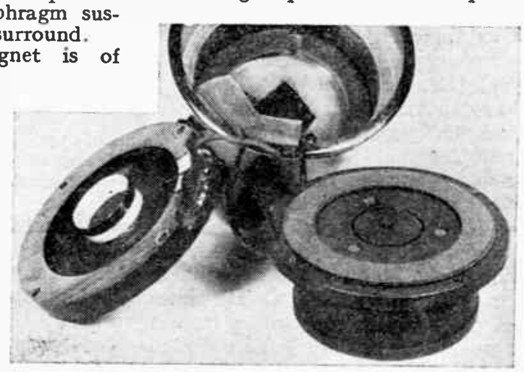
Montreal:	0000	15 Mc/s	(21 Mc/s)
	0100	11 ,,	(17 ,,)
	0900	15 ,,	(21 ,,)
	1100	17 ,,	(25 ,,)
	1400	21 ,,	(29 ,,)
	1900	17 ,,	(25 ,,)
	2300	15 ,,	(22 ,,)
Buenos Aires:	0000	17 ,,	(23 ,,)
	0100	15 ,,	(21 ,,)
	0400	11 ,,	(19 ,,)
	0700	15 ,,	(21 ,,)
	0900	21 ,,	(28 ,,)
	1100	26 ,,	(35 ,,)
	1900	21 ,,	(28 ,,)
	2100	17 ,,	(24 ,,)
Cape Town:	0000	17 ,,	(25 ,,)
	0200	15 ,,	(21 ,,)
	0500	17 ,,	(24 ,,
	0600	21 ,,	(29 ,,)
	0800	26 ,,	(40 ,,)
	1900	21 ,,	(30 ,,)
	2200	17 ,,	(26 ,,)
Chungking:	0000	11 ,,	(16 ,,)
	0400	15 ,,	(21 ,,)
	0600	17 ,,	(24 ,,)
	1000	21 ,,	(28 ,,)
	1600	17 ,,	(23 ,,)
	1900	15 ,,	(21 ,,)
	2100	11 ,,	(17 ,,)

During April a moderate amount of ionosphere storminess is usual. At the time of writing it would appear that ionosphere storms are more likely to occur during the periods 4th-6th, 12th-16th and 27th, than on the other days of the month.

NEW MOVING COIL MICROPHONE

THE new Type C46A Lustraphone microphone is a modification of the standard type and incorporates a corrugated cone diaphragm suspended on a fine gauze surround.

The permanent magnet is of generous proportions and gives a flux density of 8,000 lines/cm². A speech coil impedance of approximately 20 ohms is used and a 1:100 ratio matching transformer in a Mumetal box can be supplied.



Lustraphone Type c46A microphone partly dismantled.

The makers state that over the range 50 to 8,000 c/s the deviation from level output does not exceed ±6db while the sensitivity is −75db referred to a level of 1V/dyne/cm².

A standard ½in brass thread bush mounting is provided and adaptors are available for $\frac{5}{16}$in B.S.F., etc. The price is £6 16s 6d and the makers are Lustraphone, 84, Belsize Lane, London, N.W.3.

WHISTLING METEORS

Audible Radio Reflections from Shooting Stars

SHOOTING stars, or, to give them their more scientific name, meteors, have held a fascination for mankind from the earliest times and although they are no longer regarded with superstition, they still form a subject of absorbing interest. They even have their uses, for it is now known that while the ionization in the upper atmosphere which makes long-distance radio communication possible, is maintained during the daytime by ultra-violet light from the sun, it is the continuous arrival of countless millions of microscopic meteors, travelling at enormous velocities, which maintains the level of ionization throughout the hours of darkness. Meteors are thus far more than a subject of scientific curiosity.

For several years radar methods have been used for the observation of meteors, and their transient echoes will be familiar to many radar operators. With the recent discovery, however, by two engineers of All India Radio, Messrs. Chamanlal and Venkataraman, that under suitable conditions, meteors can also be "heard" on an ordinary communication receiver, a new line of research has been opened up.

Variable-pitch Whistles

The transmitters of All India Radio at Delhi are situated about 10 miles from the Receiving Centre, and while monitoring the high-power short-wave transmitters it was noticed that feeble heterodyne whistles of an unusual nature could often be heard but they could not be explained by any of the known causes. The whistles were invariably of short duration, never lasting for longer than 1½-2 seconds; they commenced as a high-pitched note of about 2-3,000 cycles, fell rapidly in pitch and usually died away before reaching zero frequency. Only in rare cases did the whistle pass through zero and reappear as an ascending note before dying away. The whistles were most frequent between 2.0 and 6.0 a.m. and were only rarely heard during the hours of daylight.

Searching to explain these unusual characteristics, Chamanlal and Venkataraman concluded that they could only be explained as a Doppler effect arising from the interference of the direct ground waves from the nearby transmitter with the waves reflected from some rapidly moving reflecting surface. Calculations showed that if this was the true explanation, the reflecting surface would have to have the initial velocity of the order of 50-80 kilometres per second. Such velocities could only be associated with meteors entering the earth's upper atmosphere, and visual observation soon confirmed this theory by establishing a direct correlation between the arrival of a visible meteor and the occurrence of the audible whistle.

By

G. R. M. GARRATT,

M.A., A.M.I.E.E.

Although a visible meteor invariable produces a whistle of considerable intensity, a far greater number can be heard but not seen. In fact, at certain times of the year, the number arriving is so great as to make it impossible to maintain an accurate count.

Meteors can be broadly divided into two classes—the first being those which enter the earth's atmosphere from random directions, and the second those which are travelling in definite orbits comparable with those of a comet. From the point of view of radio communication those arriving from random directions are by far the most important since it is these which are now known to maintain the ionization in the upper atmosphere during the night. The number of such meteors is literally astronomic and it has been computed that at least a thousand million encounter the atmosphere every 24 hours.

The vast majority of these meteors are of only microscopic size, but their very high velocities and their great number result in steady ionization of the atmosphere at high altitudes and give rise to the familiar reflecting layer. It is, of course, only the larger meteors which produce sufficient ionization to give an individual echo, and it must be a very large one to become visible to the naked eye as a "shooting star." "Large" and "small" are comparative terms, however, so it may be as well to remark that although estimates vary, a "small" meteor can be regarded as being about the size of a grain of sand while a "large" one, visible as a bright shooting star, is no larger than the top of a black-headed pin and has a mass which seldom exceeds 10-15 milligrams!

Although less important from the point of view of radio communication, those meteors which travel in regular orbits are by far the most spectacular since they give rise at times to brilliant "showers" during which very large numbers may be seen. Such meteors are probably the remains of disintegrated comets which continue to travel in the original orbit. The fragments tend to be spread out more or less along the whole length of the orbit, and if the earth should happen to pass through the track at the time when the main bulk is passing, a most brilliant display of shooting stars may be seen by the naked eye. There are nine principal meteoric showers during the year, but really brilliant displays are of rare occurrence.

Conditions for Whistles

In order to detect the arrival of a meteor on a normal radio receiver there are a number of special conditions which must be fulfilled if success is to be achieved. First, it is necessary to have a powerful transmitter—at least 10kW and

Whistling Meteors—

preferably about 50kW, radiating an unmodulated signal on a frequency of the order of 5-15 megacycles. The receiver requires to be situated about 8-15 miles from the transmitter so that it is within the skip distance but so that only a very weak ground wave is received. It is essential that the ground wave received should be a weak one since the reflected echoes may have a strength as low as only 1 millivolt or even less, and if a strong ground wave is received, the normal A.V.C. action of the receiver will so reduce the amplification as to make the feeble echoes entirely inaudible.

It will be appreciated that a highly sensitive receiver is required for these observations. A communication receiver with two R.F. stages before the mixer is most suitable although under good conditions a few of the stronger echoes can be picked up on a high-quality broadcast receiver.

Night-time Phenomenon

A somewhat inconvenient habit of these meteors is that, like the skylark, their peak period of whistling is during the hours just before dawn. A few can be heard from midnight onwards, but a far greater number will be audible about 4 a.m. and it is rare to hear one during the hours of daylight or during the evening. The reason for this state of affairs is easily understood if we recall some of our schoolboy astronomy and remember that besides rotating on its axis once every twenty-four hours, the earth makes a journey round the sun once every year. The earth travels round its elliptical path with an average velocity of 29 kilometres per second and it is obvious that as the earth rotates on its axis there is only one part which is "facing forwards" and where the highest relative velocities will be encountered between the earth and any meteors which it happens to meet. The area facing forwards will actually lie at some point within the tropics and at any moment will be on the longitude where the solar time is 6 hours before noon, i.e., 6 a.m. local time. Various other factors combine to place the peak period rather earlier than this and in practice the highest number of meteors are encountered around 4 or 4.30 a.m.

Doppler Effect

As was mentioned earlier, the "whistle" is due to a Doppler effect produced by the beating between the ground waves and those reflected from the local area of ionization caused by the passage of the meteor through the atmosphere. The apparent frequency shift of the reflected waves is due to the component of the velocity of the reflecting surface towards the observer and it will be clear that if this velocity was constant, a whistle of constant frequency would be heard. In practice, this velocity is not constant for two reasons—first the meteor is retarded very rapidly in the earth's atmosphere, and secondly the component of velocity towards the observer clearly varies with the instantaneous position of the meteor in its track in relation to the observer. For example, suppose that a meteor was travelling at a constant velocity on a horizontal course which passed directly over the head of the observer. Such a meteor would have a component of velocity which would first be directed towards the observer but which would fall to zero as it passed overhead and then increase in the opposite direction as it receded. Such a meteor would cause a whistle which would first fall in pitch, pass through zero frequency and then increase again before dying away at 1-2,000 cycles.

A very small proportion of such whistles can in fact be heard but they are invariably very feeble since the meteors causing them are at extreme altitudes where the retardation of the earth's atmosphere has not entirely arrested their progress before they reach the point where the velocity towards the observer is zero.

Since the beat note is dependent on the direction of the meteor as well as its velocity, it is not possible to calculate the true velocity without simultaneous observations of its position and track. It is easy, however, to calculate the component velocity towards the observer. For example, assume that a beat note of 3 kc/s is heard using a transmission frequency of 6 Mc/s. Then the velocity v of the reflecting surface towards the observer is given by

$$v = \frac{Nc}{2f}$$

where N is the whistle frequency, c is the velocity of electromagnetic waves and f is the transmission frequency. In the example quoted,

$$v = \frac{3{,}000 \times 3 \times 10^{10}}{2 \times 6 \times 10^{6}} \text{ cms/sec}$$
$$= 75 \text{ km/sec.}$$

Although this figure is only a component, it gives some idea of the order of the velocity which may be possessed by a meteor and it is estimated that the real velocity may range from 20-180 km/sec. It should not be difficult to develop a technique employing two receiving stations making simultaneous observations of whistle frequency from which the real velocity could readily be ascertained. In fact, it seems likely that further research on meteors will be carried out on these lines.

Acknowledgment is made to Mr. Cecil Goyder, C.B.E., lately Chief Engineer of All India Radio, by whose courtesy the writer was enabled recently to pay several visits to the transmitters and receiving centre in New Delhi and to experience a first-hand demonstration of the phenomenon described above and which, so far as is known, has not been previously reported.

LOCAL BROADCASTING

A SECTION of the report recently issued by the New Towns Committee, appointed by the Minister of Town and Country Planning, under the chairmanship of Lord Reith, deals with the facilities which it considers should be available in every new town for the reception of broadcasting.

The value of a local broadcasting service is weighed and suggestions for the conduct of the service are put forward.

Ultra-short-wave broadcasting is proposed as the best means of transmission and the report adds "if the new towns in this country were to have their own stations they might well be anticipating a national development whereby the number of available programmes increased."

BELLING-LEE QUIZ (No. 10)

Answers to questions we are often asked by letter and telephone

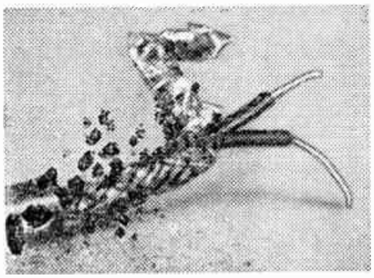
Q. 38. *What is the purpose of the metallised paper wrapping under the wire screen of the Belling-Lee twin feeder (Cat. No. L.1221), and is it necessary to earth this to the screen at either or both ends? (by A. G. F., Highbury, who correctly answered the question in his letter).*

A. 38. (1) The purpose of the metallised paper wrapping is to maintain the characteristic impedance and attenuation loss constant over the life of the cable. It has been found that without this metallic paper the braided tinned copper shielding ultimately oxidises, causing an increased resistance at the points of intersection of the wires comprising the braid which has the effect of increasing both the characteristic impedance and the attenuation loss.

(2) There is no need to bond the metallised paper wrapping to the shield, as its capacity thereto may be regarded as the electrical connection at high radio frequencies.

This metallised paper feature is covered by a patent of Messrs. Telegraph Construction and Maintenance Co. (U.K. patent No. 559518).

The illustration above shows Belling-Lee (Catalogue No. L.1221) screened twin 70 ohms feeder discussed above and recommended as a suitable feeder for the "Eliminoise" *3 and "Skyrod" *4 anti-



interference aerials. It is sometimes used as a balanced feeder for a television dipole, but is in our opinion unnecessarily extravagant used in this way, as the much cheaper L.336 *2 unscreened balanced feeder gives results so nearly comparable that a television user could not see (nor hear) the difference.

Q. 39. *How can a balanced feeder remain balanced when run in a house? Is it not affected by the presence of other conductors such as water pipes, gutters, conduits, etc.?*

A. 39. Theoretically there will be small changes in the characteristic impedance at various points along the line. These changes will be related to its proximity to various earthed objects, but at television frequencies the changes are so insignificant that they are immeasureable by any ordinary means. In the case of a feeder with a characteristic impedance of the order of 400 ohms and typified by a spacing of a few inches between conductors, the presence of other incidental conductors closer to the feeder than this, would result in appreciable attenuation.

In L.336 the spacing between conductor centres is nominally 0.057". Therefore it is unlikely that outside conductors would have any practicable influence on the line characteristic.

*1. **L.1221,** Screened twin feeder per yard **1/9**

*2. **L.336,** Balanced twin feeder per yard **7½d.**

*3. **ELIMINOISE (Reg. Trade Mark).**

L.308/K. Complete aerial kit, comprising Aerial and Receiver end transformers, 60ft. Aerial wire, 50ft. of L.1221 screened feeder, earth wire, insulators and lightning arrester **£6 6 0**

***4 Skyrod (Reg. Trade Mark).**

Type **L.355/CK.** 12ft. collector, downlead, 2 transformers, pole clamps and earth wire **£7 7 0**

Chimney lashings and brackets can be supplied at additional cost.

All prices quoted are subject to alteration without notice.

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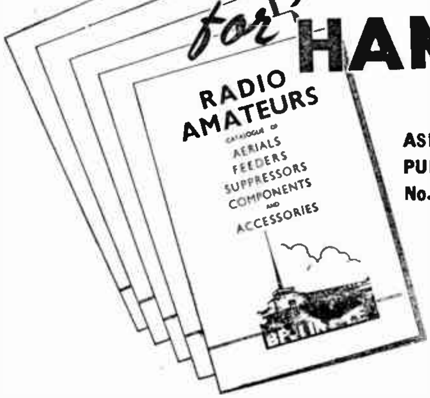

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DESIGNING AN F.M. RECEIVER

1.—General Considerations

By THOMAS RODDAM

I HAVE already explained in the columns of *Wireless World* my objections to frequency modulation: for better or worse it is, however, on its way. The B.B.C. have been conducting experimental transmissions for some time, and some police authorities are using F.M. for routine communication purposes. The writer, who earns a precarious and wholly inadequate living by doing this sort of thing, has already had to construct part of an F.M. receiver. In the course of this work it became apparent that there are quite a number of things, which do not appear in the theoretical papers, which can provide some difficulties in practice. I must explain at the beginning that the receiver already constructed was for experimental work with very wide deviations at 60 Mc/s. In consequence all that this article will seek to do is to discuss the principles of design. This will not do any harm, for it is not advisable to start on an F.M. receiver unless you have a reasonable amount of measuring equipment and other facilities and can really make a job of it.

Frequency modulation, as all readers of *Wireless World* know, is a system of transmission in which the carrier level is kept constant and the carrier frequency wobbled about in accordance with the modulation. The maximum amount of wobble for sound broadcasting is usually 75 kc/s, so that with a nominal carrier frequency of 90 Mc/s the instantaneous frequency on the peaks of a 100 per cent modulated wave will be 90.075 Mc/s and on the troughs 89.925 Mc/s. I am not sure, here, whether pedants will not object to the terminology, but it is convenient to use the ideas already familiar in amplitude modulation. Although the deviation is only ±75 kc/s, a spacing between stations of 400 kc/s is being adopted in America, and in order to get a linear phase response, and also to allow for tuning drift and mistuning, a receiver bandwidth of 200 kc/s is normal practice. In England it will probably be some time before there are enough stations working to make selectivity a problem, and it is wise to err on the side of excessive bandwidth rather than to risk the distortion produced by the non-linear phase characteristic near the edge of the response curve.

These basic principles are quite well known, which is why they are discussed so briefly. The important features of F.M. which must constantly be kept in mind are (1) the bandwidth, and (2) the constancy of carrier level. It is these two features which result in the very low noise level obtained in the service area, and which provide almost perfect A.V.C. without any awkward time constants.

Essentially an F.M. receiver is an ordinary V.H.F. receiver with a wide-band response and a sort of detector circuit. If you already have a V.H.F. receiver for amplitude modulation it should be possible to modify it to receive F.M. The modifications will reduce its sensitivity and involve the widening of the response and the addition of a limiter and discriminator to replace the detector. The A.V.C. is not wanted, but some designs of V.H.F. receiver already include a switch for fixed gain operation. The audio-frequency circuit will also need some modification, to provide de-emphasis on the one hand, and also to give a really high-fidelity performance free from hum so that full advantage can be taken of the virtues of F.M.

The heart of an F.M. receiver is the limiter and discriminator section. The job of the limiter is to provide at its output a signal which is absolutely constant in amplitude in spite of its variation in frequency. The receiver carrier level will not be absolutely constant, because there is likely to be some fading. Most discriminator circuits are sensitive to amplitude modulation, and if the limiter does not fix the level absolutely constant the changes in level will be detected. This is a bad thing. The second cause of changes in level is noise. In Fig. 1(a) there is a sketch of a frequency-modulated carrier with noise on it. The resultant carrier level is clearly modulated by the noise, and the discriminator would detect this, and allow the noise to come through. The limiter alters the shape to that of Fig. 1(b), giving an apparently constant carrier level. Noise still has some effect, for if we try to determine the instantaneous frequency by measuring the time between an up-swing and a down-swing (Fig. 1(c)) we cannot be certain whether to take t_1 or t_2, and this

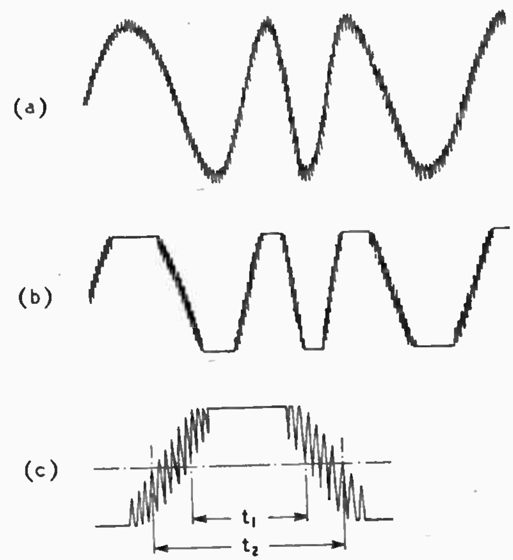


Fig. 1. (a) F.M. signal and noise, (b) effect of limiter, (c) uncertainty of instantaneous frequency resulting from noise.

Designing an F.M. Receiver—

"uncertainty" represents a noise which appears in the output. It is, however, very much less than the noise which would be produced by amplitude modulation of the peaks. This reduction of noise when the limiter is operating is most striking, and is one of the most attractive features of F.M.

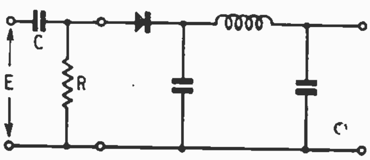


Fig. 2. Elementary discriminator circuit.

The job of discriminator is to turn the frequency-modulated signal into a variable voltage. One way of doing this, which is quite attractive at low frequencies, is to build a network having attenuation which is a function of frequency. In Fig. 2, for example, the voltage appearing across R is, neglecting the circuit to the right of R,

$$V = \frac{R}{R + 1/j\omega C} \cdot E$$

$$= \frac{j\omega CR}{1 + j\omega CR} \cdot E$$

In this expression, so long as CR is small, we can write

$$V = j\omega CR.E,$$

so that the output voltage for constant carrier level E, is proportional to the frequency term $\omega (= 2\pi f)$. If we rectify and allow only the modulation frequency components to pass by means of a low-pass filter, this circuit can be used as a discriminator, and in fact it has been so used. The trouble with it is that C must be very small, and R must be very small, and so the output is microscopic. It does, however, illustrate the principle very well. The usual circuit is that known as the Foster-Seeley circuit, and this will be described in the second part of this article.

Let us now look at the receiver requirements. The limiter grid should receive about 10 volts drive under normal conditions, although less could be allowed at a pinch. For design purposes we shall take 10 volts as the level required. The input level to the receiver is very dependent on where it is to be used. Within 10 miles of Alexandra Palace the B.B.C. 1 kW test transmitter produces field strengths of more than 1 mV/metre, the provisional second class rural service is based on a field strength of 100μV/m. The actual voltage developed at the first grid of the receiver will be very dependent on the aerial used and on the distance from the transmitter, and is a matter for individual determination. Here we shall assume that we can get 1 millivolt: the gain before the limiter grid must therefore be 10,000. If valves having mutual conductance of 5mA/volt are used, a stage gain of 50 can be obtained at an intermediate frequency of 10Mc/s. The gain of the stage before the limiter will be rather lower than this, because of the effect of the limiter grid circuit. A mixer gain of 10 is a reasonable allowance, giving $10 \times 40 \times (n \times 50)$ for a mixer and $(n+1)$ stages I.F. amplification. For two stages this is 20,000, which is more than we asked for so that there is some safety margin. The basic design will therefore be a mixer, two I.F. stages, followed by a limiter, discriminator and audio-frequency amplifier. If an additional factor of about 6-8 is required, an R.F. stage should be added, as it is much easier to make the system stable when the gain is distributed between two different frequencies: stable multi-stage I.F. amplifiers can be built, as anyone who has seen a radar receiver will know, but they require very careful layout and screening.

A stage gain of 50 implies an anode load resistance of 10,000 ohms with a valve having a mutual conductance of 5 mA/volt. The EF50 has been very widely used for this sort of job and it, or its successor the EF54, is an obvious choice here. The total capacity of the EF50 is about 16 pF, and with an allowance for wiring and valveholder capacity will probably be about 30 pF: the reactance of this at an intermediate frequency of 10 Mc/s will be 500 ohms, so that without added capacity the circuit "Q" will be about 20. The bandwidth at 3 db down will then be 500 kc/s. This is definitely too wide, and the circuit capacity must be increased to about 75 pF for a 200 kc/s band. The additional capacity will help to hold down any changes of valve capacity. To tune to 10 Mc/s, an inductance of 3.3 μH is needed.

The design takes more form now. The I.F. stages have EF50 (or EF54) valves, with 10,000 ohms anode load, and a capacity of 75 pF tuning 3.3 μH coils. For a first model, simple tuned circuits between stages are recommended. It is true that they do not give such good adjacent channel selectivity as tuned transformers, but

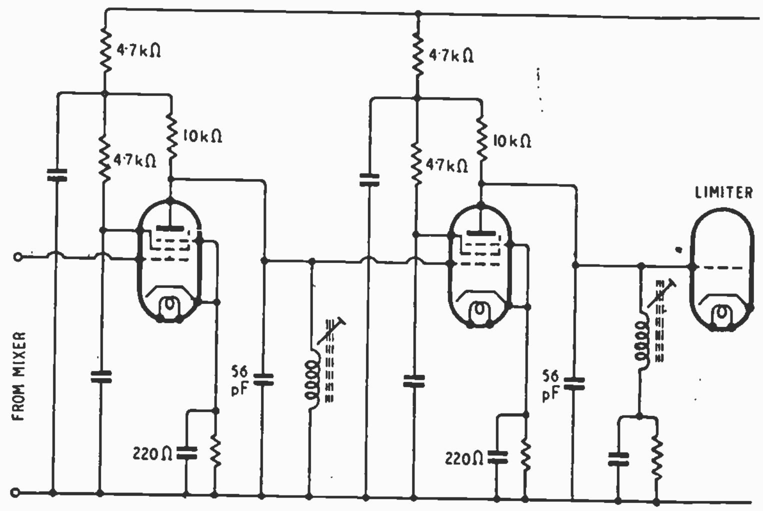


Fig. 3. I.F. stages for an F.M. receiver. Fixed capacitances are all 0.001 μF and the bias resistors are for use with EF50 valves.

they are easier to construct and there probably will not be any adjacent channel to get rid of. The circuit of the I.F. section becomes that shown in Fig. 3. The choice of putting the coils in grids or anodes is largely one of convenience: in the form shown, there is no D.C. applied to the coils, and with some constructions this is an advantage; it does, however, require a higher H.T. supply voltage. Decoupling condensers should be 0.001 μF, and each stage should be built as a unit: that is, all the earth connections should be brought back to a com-

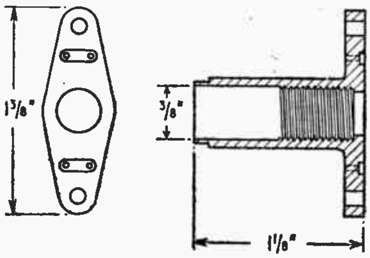


Fig. 4. Drawing of coil former used for I.F. coils.

mon point, preferably the chassis near the cathode pin of the valve.

I have shown fixed tuning capacities of 56 pF on the assumption that dust-cored coils with adjustable slugs will be used. One suitable former is that drawn in Fig. 4, and on this core about 16 turns of 26 S.W.G. wire wound as a single layer with turns touching will give the required inductance. The core can be screwed in and out for tuning, and the winding should begin right at the bottom to allow a maximum range of adjustment. With this pattern of coil an inductance variation of about 20% is obtained by screwing in the core, and this should be sufficient to allow for variations in stray capacitance: it will be enough to enable the circuit to be tuned up, for even if the capacities are too small or too large, the change of gain as the circuit is tuned will show whether turns should be added or removed. If coupled circuits are used, they should be adjusted for "maximal flatness" and not for a wide double-humped response. The reason is that the phase characteristic is more important than the amplitude characteristic in F.M. circuits, and a gently drooping amplitude characteristic is usually associated with a good phase characteristic.

It is my personal view that care should be taken to prevent any limiting action in the I.F. amplifier proper. The reason is that the grid-current flow is accompanied by a detuning of the coupling stage, so that the overall frequency response is affected. The exact effect of this is rather difficult to predict but it seems likely to result in a lowering of the noise-reducing effect or in increased distortion.

It is preferable in building an experimental receiver to make use of a separate oscillator for the mixer circuit. A Colpitts circuit, with an EF50 valve, operating on 40 Mc/s may be used provided that the input circuit provides sufficient selectivity against 30 Mc/s. An EF50 may also be used as mixer. Whether a separate oscillator is used or whether a combined oscillator and mixer valve, the use of harmonic mixing is advisable in order that the tuning capacity of the oscillator circuit shall be mainly outside the valve. Stabilization of an 80 Mc/s oscillator is much more difficult. There would seem to be some advantage in adopting third harmonic operation, with the oscillator working on 26.7 Mc/s. The details of the mixer and input circuit are normal in V.H.F. receiver design and will not be discussed here.

There are other details which it is assumed only need recalling to the reader. Care in separating the circuits, short leads, especially for decoupling condensers, attention to the grouping of earth connections, decoupling circuits for the heater supplies; all these are points "well known in the art," and certainly this is no place to give a full description of them.

In the mention above of the audio-frequency amplifier, nothing was said about the de-emphasis circuits. At the transmitter, pre-emphasis is used, giving an increase in the effective modulation of 14db at 16 kc/s over the modulation produced by an equal level of 1 kc/s signal. Pre-emphasis is just a highbrow way of saying top-boost. The reason for doing this is to counteract the "triangular noise distribution" associated with F.M. I am not going to explain this in more detail, but readers who understand the difference between phase and frequency modulation will realize that noise produces uniform phase modulation, and when detected as frequency modulation the noise output is proportional to frequency. By using pre-emphasis at the transmitter it is possible to use de-emphasis at the receiver; "top cut" to you, and thus avoid the high-pitched hiss effect. The amount of de-emphasis is usually given as the time constant in microseconds of a circuit having the required characteristic. Thus the proposed British standard is 50 microseconds. This is given by a resistance of 50,000 ohms in parallel with 0.001 μF, or 100,000 ohms in parallel with 0.0005 μF. The time-constant circuit can be used as load resistance in one stage of the audio-frequency amplifier, and the response should be 4db down at 4,000 c/s, 10db down at 10,000 c/s and 14db down at 16 kc/s. As other parts of the audio-frequency amplifier will probably make some contribution to the required response it will usually not be desirable to put a 50-microsecond circuit in by itself, but rather to put a smaller top-cut capacitance to supply what is needed.

So much for the conventional parts of a frequency-modulation receiver; as you see, they are midway between the sound and vision channels of a television receiver. In the second part of the article the design of the limiter and discriminator will be described.

OUR COVER

FEEDER LINES, switching tower and terminating rings at the B.B.C.'s short-wave station on Rampisham Down, Dorset, form the subject for our cover illustration this month. The outputs from the four 100-kW transmitters are taken to the switching tower whence they are fed to the appropiate aerial arrays. The station was originally brought into service in 1941.

SAFETY IN THE AIR

A User's Views on Radio Aids

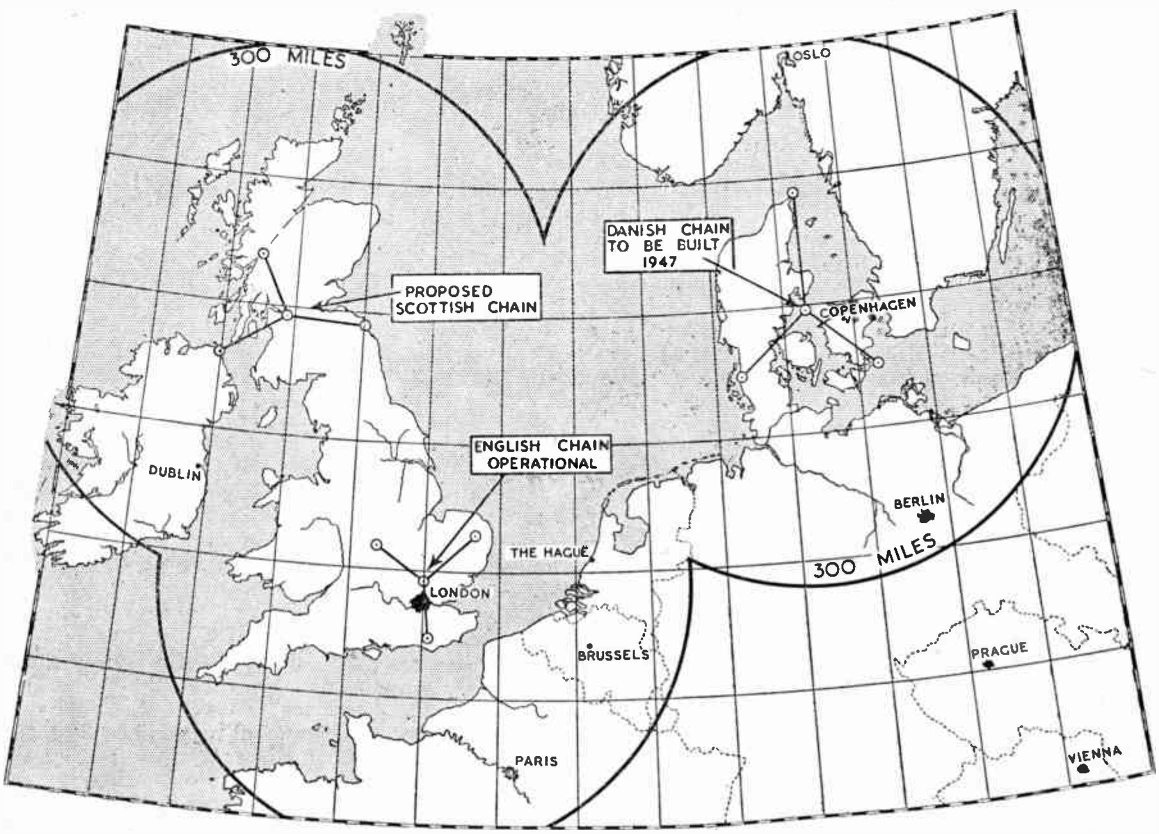
By J. A. McGILLIVRAY

NEARLY two years after the end of the European war, no agreement has been reached, even between the principal European governments concerning a standard air navigation system. Inter-continental airways are in an equally unsatisfactory position.

Several conferences on civil aviation have already been held, professedly in an effort to secure agreement on standardized aids. The various parties concerned at these conferences have usually agreed on the obvious, but elected to disagree on points that really require co-operation. To an onlooker, it appears that the conferences are convened not in an effort to decide upon the most suitable system for a specific purpose, but more to force acceptance of sponsored systems.

During the past eight years very considerable advances have been made in knowledge and application of radio and radar equipment. Much of the knowledge so gained is available for application to civil aviation, yet, in spite of this, the most generally used navigation aid is the airborne medium frequency direction finder, using a rotatable loop aerial—a device at least 25 years old. Since 1938, an automatic version has been available in the U.S.A. and this is generally fitted to American aircraft. The need for such a device for British aircraft has long been obvious, and has been stressed. As long ago as February, 1939, there appeared in *Wireless World* a description of a similar automatic aid to air navigation, which produced no response from the industry. But information now is that at least three British companies are developing an automatic direction finder, and may be in production this year.

With more modern devices—radar and the like—the case is that mental indigestion has prevented any general acceptance of systems. The trouble is embarrassment of riches; too many variants are available. One or other of the variants is fitted to



DANISH DECCA CHAIN. The Danish Government has authorized the Decca Navigator Company to erect a chain of stations in Denmark. The Danish system, which is expected to be in operation by the end of the year, is here shown in relationship to the existing English chain and the proposed Scottish chain—plans for which are being prepared for the consideration of the Ministry of Transport.

most transport aircraft—in some cases more than one system is necessary owing to lack of international standardization. The un-economics of carrying several heavy boxes around the world in an aircraft are obvious, and the un-economics are not confined to aircraft. In order completely to equip a first-class airport, it is necessary to cater for all potential users. At London Airport there are already four different bad-weather landing systems, and four separate short-range aids to navigation, with two more under construction. All this at the taxpayers' expense.

Most of the variants offer something useful and, almost invariably each is backed by either a big organization or a big name, tending to over-awe potential customers and then to overcome their sales resistance. Potential users, potential providers, and disinterested technicians (who always have something better just round the corner) cannot agree on users' requirements. Even the users cannot agree amongst themselves. So, an analysis of the pros and cons of the various alternatives, without too much detail, may be of interest. The problem is in three parts:—

(1) A long-range aid to navigation.

(2) A short-range aid to navigation, with a completely reliable range of 200 miles, under any conditions commonly to be encountered.

(3) A radio aid to runway approach, for use in bad visibility, as an aid to safe landing.

It would appear obvious that any system which provides a satisfactory answer to more than one part of the problem is better than a system which satisfactorily answers one part only. Satisfactorily to answer all three would be better still. Further desiderata common to all aircraft equipment are simplicity, complete reliability, minimum of weight, minimum of volume, and provision for remote control. The manner in which the required information is presented to the crew is important. Interpretation should be patently, glaringly, obvious; something like a compass or a watch.

In order to achieve a high order of accuracy, it is usually necessary to sacrifice some simplicity. Generally speaking, simplicity and reliability are closely related. Or, if you like it this way, if a very accurate result is needed, a spare set should be carried, because when the very accurate device breaks down, it's a specialist's job to mend it. Not like the loop aerial, which is as simple as can be, and reliable, within its accepted limits. That's why it is still in use, after all these years.

The systems to be analysed are put in alphabetical order (to give equal offence to everyone!). All systems to be considered are available, and all have been tried out. All have their supporters and their detractors.

Long-range Aids.—There are three long-range radio aids which are worth consideration. All three are available, and all three are in use at present. For economy's sake, let us make up our minds and concentrate on one, and say that we are going to fit it wherever we have jurisdiction.

Any long-range aid must automatically use a medium or low frequency in order to provide adequate ground-wave cover. All are subject to the well-known factors which adversely affect medium and low frequency transmission, but all are not affected to the same extent.

CONSOL is a system which uses directional transmission, described in *Wireless World* for July, 1946. The equipment required on the aircraft is nothing beyond the normal M/F communications receiver. The process of obtaining a position line is very simple; the whole process may take a minute —sometimes only thirty seconds. Then, either by simple interpolation or by use of a special chart, the observer identifies his bearing from the transmitter. Sector ambiguity is possible with this system, but should any doubt arise as to sector, a series of observations would soon resolve the ambiguity. The greater drawback to the extended use of the system is the interference to be expected from atmospherics. An accuracy of within 2 degrees is normally obtainable by day and night, and accuracy of within one degree, at day ranges of 800 miles, is regularly obtained. The sys-

Safety in the Air—tem is exceedingly simple to use, is economical in airborne equipment, and is generally sufficiently serviceable and accurate for its purpose. The Atlantic seaboard of Europe already has Consol cover. Cost is low.

In the **DECCA** system, position fixing (as distinct from line-of-position finding) is carried out continuously and automatically, by a special receiver, which works in conjunction with specific transmitters. (See *Wireless World*, March, 1946.) Results are presented on three meters and no skilled interpretation is needed. Decca transmitters already exist in England and are being built on the Continent and round New York. Day coverage is up to one thousand miles, and error-free night coverage is three hundred miles. The system is equally accurate at long and short distances, and can be used for homing and airdrome approach. The makers claim that the system will operate satisfactorily through interference up to twice the strength of the Decca carrier.

LORAN is a pulse system requiring, like Decca, special ground and airborne equipment. The transmitters radiate pulses and the receiver is used to measure the differences in the transit times. The measurement is done on a cathode-ray tube, and the results are plotted on a chart which is overprinted with Loran position lines, as with Decca.

Loran is extremely accurate for long-range working, but less so for short-range. The fact that the actual pulses can be observed on the tube screen makes the elimination of interference less difficult, and errors due to night effect and other reflections can be similarly observed and discounted. A certain limited training is necessary in order to use the equipment and interpret the results correctly. The Atlantic seaboard of North America has complete Loran cover, which is effective up to halfway across the Atlantic. Loran could be satisfactorily operated in conditions of bad atmospheric interference when use of the cheaper Consol would be impossible. Loran cover is more expensive than the others.

Short-range Systems.—As with long-range aids, so with the short-range counterparts there are again three immediate possibles — Decca, Gee and O.R.B.

DECCA has already been dealt with as a long-range aid, but merits equal consideration for short-range uses.

GEE is the short-range equivalent of Loran. The basis of the system is pulse transmission on a frequency of between 20 and 30 megacycles, with interpretation on a cathode-ray tube. (See *Wireless World*, January, 1946).

Gee transmitters are already in operation in Southern England, and complete cover for the whole of Europe is projected. There is available an adequate supply of aircraft Gee receivers, and enough transmitters can be made available to provide the required cover. The governments of the European countries concerned are not overly enthusiastic about installing and maintaining the necessary Gee stations, and although an offer of free aircraft receivers has been made, it has not received a widespread welcome. There can be no doubt about the accuracy of Gee. The equipment is not affected by reflections nor atmospherics. In its present form presentation has very little appeal, but this drawback should be fully overcome in models projected for production this year.

O.R.B. (omni-directional radio beacon) is the short-range aid which has the approval of P.I.C.A.O. It is a V.H.F. beacon with simultaneous radiation of two signals. One signal, used as reference, produces in the receiver an alternating voltage, the phase of which is independent of direction. The second signal produces an alternating voltage of the same frequency, but with phase dependent on direction and with complete phase rotation in 360° of azimuth. Determination of bearing from the beacon is determined by turning a 360° scale until the needle indicator registers zero, the scale reading then being the bearing of the receiver from the beacon.

The system has been comprehensively tested, and is very effective. It is extremely simple to use, and gives its information in a direct manner, although unless some care is taken with siting, the result may well be the bearing of a reflected signal. O.R.B. can for completeness be used in conjunction with a responder beacon, to give indication of distance as well as bearing, the two together providing a specific indication of position. The responder is essentially a V.H.F. pulse transmitter which can be triggered-off from the aircraft.

The exponents of O.R.B. plus responder have proved to their own satisfaction that it is the most accurate system possible, and provides the required coverage at the lowest cost. But it should be put on record that the exponents of Gee have proved a similar case for their favourite. O.R.B.-plus is not immediately available but has been internationally preferred because of its form of presentation.

Approach and Landing Aids.—Again there are three systems which must be considered.

B.A.B.S. (Beam Approach Beacon System) is a mobile system, developed during the war. It is a special type of low-power responder beacon, operating only when correctly triggered. Then it radiates directional pulses, alternately of long and short duration. The short pulses are directed to the right of the runway and the longer pulses are directed to the left. When the receiving aircraft is approaching from the correct direction, the pulses are observed to be of equal intensity, although not of equal duration. Observation is on a cathode-ray tube, which shows distance as well as direction.

B.A.B.S., for good results, requires team work. The navigator observes the C.R.T., interprets the results, and cons the pilot on the intercom.

The ground equipment, at present in short supply, is not excessively costly, and may be mounted in a 10-cwt van for complete mobility. The system operates only in conjunction with the appropriate transmitter-receiver on the aircraft, and, operating on about 200 Mc/s, requires rather careful siting to prevent reflection interference.

S.B.A. (Standard Beam Approach) is no newcomer. It was developed originally by Lorenz in Germany for use on about 36 Mc/s and installed in this country at

Heston in pre-war days. The transmitter radiates a narrow equi-signal path along the line of the main runway. The equi-signal is produced by the merging of two overlapping, interlocking morse signals. Along the line of approach, a steady note is heard, and deviation from the correct approach path causes the distinctive letter to be heard in the pilot's headphones. Distance from the airdrome boundary is indicated by short over-riding signals from marker beacons, which have a specific character according to the distance from the beginning of the runway. The system is well-proven, and very reliable. It has been installed extensively all over Western Europe and it is very simple to use.

I.L.S. (Instrument Landing System) which has been given the approval stamp of P.I.C.A.O. was developed in U.S.A. during the war, when it was known as S.C.S.51. It is very similar in principle to S.B.A., but works on a higher frequency band (about 110 Mc/s) and the result is shown on a meter, instead of being presented through headphones.

The equi-signal path is produced by the overlap of two radiated signals, on the same radio-frequency, but distinctively modulated. Movement of the indicator needle is to left or right, according to which signal is more strongly received, and the needle is centrally vertical when the aircraft is approaching from the correct direction. Within the same meter casing is a second, similar movement, but with the needle horizontally disposed. This second movement is used to indicate the correct approach path in the vertical plane—the "glide path indicator."

The glide path indication is from a second transmitter, similar to the approach path transmitter, but operating on a frequency of about 140 Mc/s. This transmission is modulated by two frequencies as in the approach path transmission, and deflection of the needle is similarly obtained. Distance indication is by marker beacons on 75 Mc/s.

Excellent results have been obtained from this system, in conditions of very bad visibility, but the glide path is apt to be affected by changes in soil conductivity, due to change of weather. Equipment is in very short supply.

Many pilots object to visual presentation for a landing aid. Their eyes are already fully occupied, but their ears are spare.

Having selected the above nine from the surfeit of possibilities, we are faced with the choice of three complete systems, each to provide radio aid for navigation from airport to airport.

System one—the all-pulse system—is Loran plus Gee plus B.A.B.S. Loran plus Gee, as a composite aid, using separate receivers and a common indicator, has already been proposed. It is the obvious answer to a requirement (if one exists) for comprehensive coverage of large areas by pulse transmissions.

Secondly, there emerges Consol plus O.R.B. plus I.L.S. The two latter items carry the stamp of approval of P.I.C.A.O., the international organization which has been convened to consider such things. The fact must be borne in mind that neither of them is readily available.

System three is Decca plus S.B.A. Both are easy to use, and are in general use in Europe.

All the above, and many more, have been demonstrated individually. The demonstrations generally show that the equipment can do its job, but I submit that instead of showing how several items of equipment can each do the same job and leaving the choice to the bemused spectator, we demonstrate how one set of equipment can repeatedly and satisfactorily do its job, and impress on the prospective customer how good is the system of our choice.

The use of aircraft as a transport medium is extending very rapidly all over the world. For safe operation, radio aids to navigation are essential. In many of the countries concerned there is almost a radio vacuum, and for all-weather operation the vacuum must be at least partially filled.

Geographical proximity to the U.S.A. does not necessarily imply acceptance of U.S. systems. If we can demonstrate, by regular use, that we have something better for sale—immediately—we may find a ready market.

LETTERS TO THE EDITOR

In Defence of B.B.C. Recordings ✦ Derivation of "-tron"

B.B.C. Quality and Recordings

WITH regard to recent correspondence on the above subject, I should like to point out that the quality of a programme is not entirely a matter of frequency response and distortion. The artistic content is of infinitely greater importance, and in this respect recorded programmes must inevitably excel "live" broadcasts; production can be carried out at leisure, and the programme can be polished before actual transmission. Also, artists can be recorded when available and with no regard to time of transmission. The Third Programme probably provides the supreme example of the intelligent use of recording.

With regard to relative quality of various transmitters, an interesting phenomenon occurs in the "Monday Night at Eight" programme, which includes rapid relays from three regions outside London. Listening to the London transmitter, the technical quality of the material originating in other regions (especially Bristol) is often better than that coming from the studio nearest the transmitter.

The B.B.C. should be congratulated on its new London aerial (recently illustrated in *Wireless World*), which has effectively transferred the whole of Lincolnshire from the North to the London region.

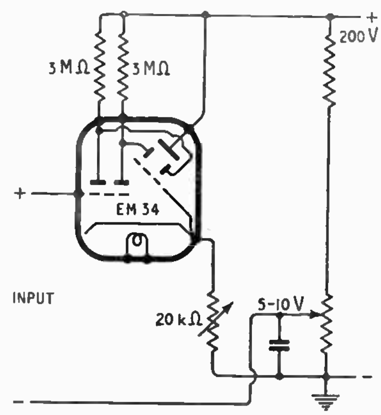
F. DUERDEN.
Cranwell, Lincs.

"Magic Eye" as Null Indicator

YOUR contributors, Messrs. Thacker and Walker, in their article on "Magic Eye Indicators" in the January issue of the *Wireless World*, raise a number of points with regard to the EM1 and EM34 valves. The position regarding these valves should perhaps be clarified.

It would appear that the pre-war EM1 was quite suitable for use in the positive feed-back circuit under discussion, but restrictions on the production of valves for civilian use during the war necessitated certain modifications to the structure. These modifications did not in any way impair its efficiency as a tuning indicator, the grid base remaining substantially unchanged, but the V_g-I_t characteristic of the war-time EM1 rendered it unsuitable for use in high-sensitivity circuits using positive feed-back.

The EM1 is now listed as a "maintenance" type and has been virtually superseded by the EM34. We have, therefore, carried out some experiments with the EM34 with a view to ascertaining its performance in sensitive null indicators.



The accompanying basic circuit gives a sensitivity approximately the same as that of the pre-war EM1, i.e., 5mV for a visible shadow deflection.

This improvement on the results obtained by your contributors is due to the use of higher values for the anode loads and cathode resistor. The alteration in the cathode resistor increases the positive feed-back but necessitates the grid return lead being taken to a point which is slightly positive with respect to the earth line..

It should be possible to make this modification and to substitute the EM34 in any of the circuits mentioned in connection with the EM1 while still maintaining the sensitivity of the apparatus.

D. A. WARD,
The Mullard Wireless Service Co., Ltd.
Technical Service Department.

The -tron Family

IN your issue for February, 1947, your contributor "Free Grid" discusses the ending -tron which appears so frequently in the literature of electronic technique.

Reference to a Greek Lexicon will show that -tron (-τρον) is an ending which means, roughly, "the instrument by which."

Examples which have English derivatives are:—

θεατρον (theatron) "a place for seeing": *a theatre* from θεαομαι (theao-mai) "I gaze at." φιλτρον (philtron) "a spell to produce love"; *a philtre* from φιλεω (phileo) "I love."

These examples show that there is a respectable tradition for the use of the ending.

A writer in *Electronic Industries*, January, 1946, collected about eighty words ending in -tron ranging from Alphatron to Zyklotron. This list does *not* include recent terms such as phantastron or sanatron.

L. H. BAINBRIDGE-BELL.
Witley, Surrey.

The New Standard Valves

TO avoid damage valves sometimes need to be eased out of their sockets with a screwdriver. How is this possible with the new type holder?

In the present economic state of the country the set manufacturer with the largest export trade will be able to offer the best value on the home market. It is hardly likely that he will upset production making types using different valves. I think it will be the set manufacturer, plus economics, and not the B.V.A., that will decide the future valves.

Buyers are becoming more discriminating, and many are holding off. They remember having to lay up their sets during the war, while the neighbours' sets that could use Lend-Lease and similar valves played merrily on.

Paisley. W. GALBRAITH.

UNAVOIDABLE DELAYS

Development of the television receiver that is being described month by month in *Wireless World* has been delayed by electricity "cuts" and suspension of transmissions. This month's instalment must therefore be held over.

Publication of the concluding instalment of the article on "Noise Factor" must unavoidably be postponed till next month.

CAREERS IN RADIO

Advice on Technical Training

Open Letter to Would-be Engineers

Dear Jackson,

THANKS for your long letter. It is always pleasant to hear from past students, especially when they can give so many interesting details of life with the B.A.O.R. Congratulations on your appointment as an education officer to the troops in your area. I know your keen interest in training and fitting the chaps for "Civvy Street," and I am sure you will enjoy the work.

You ask if I can help in advising your men on fitting themselves for a career in radio engineering when they are demobilized. This is a big question not easy to answer, but I will try my best. Before I begin with what they should do on leaving the Army, may I suggest that you can get the keen ones started immediately by encouraging them to prepare for the City and Guilds examinations in Telecommunications Engineering. Probably none can be made ready for the examinations this year—they always take place in May—but don't allow this to be a reason for delay. Procrastination is the greatest enemy of success in study. The syllabuses have been remodelled recently to cover post-war needs, and the course, which specializes in Telegraphy, Telephony or Radio Communication, extends over five years. It has been stiffened by including mathematics as well as by extension with Radio IV and Telecommunications Principles III, IV and V. I am delighted to see mathematics as a subject because I have always held that too many radio engineers neglect this most powerful and useful tool. An Intermediate, Final and Full Technological Certificate is issued on the successful completion of the second, third and fifth year's work respectively, and there are still the usual single-subject certificates.

You can obtain full details of the new course, which will, I believe, be fully operative by 1948, by writing to the City and Guilds, Department of Technology, 31, Brechin Place, South Kensington, London, S.W.7. Since there may be some delay before you get this information where you are it might help if I indicated the broad outline of the syllabuses. Mathematics I covers algebra, trigonometry and mechanics in an elementary manner, Mathematics II is a more advanced edition of I and also includes elementary calculus and complex quantities. Mathematics III deals mostly with the Binomial Theorem, more advanced calculus, and hyperbolic functions. Mathematics IV advances on III and includes differential equations, there is no City and Guilds examination in this nor in Mathematics V, which suggests a number of subjects for study. Telecommunications Principles I concerns itself with elementary electrical theory and would seem to call mainly for descriptive treatment. Principles II introduces the valve and shows the first hint of a radio bias. Magnetic circuits, calculations on A.C. problems, resonance, modulation, detection, propagation of electromagnetic waves along lines, etc., are some of the many subjects included in Principles III. Radio frequency transmission, reception and measuring instruments are covered by Principles IV, whilst Principles V introduces telephone communication theory, pulse, frequency and phase modulation.

You may be a little surprised that the radio student should be required to take Elementary Telecommunications Practice in his first year, for it is almost entirely given over to a descriptive treatment of telephone and telegraph communication, but it should not be a difficult paper and will compel the student to obtain a good grounding in communication practice. Radio I, a second-year subject, requires an elementary, broad knowledge of general principles in radio- and audio-frequency engineering. Radio II is a more advanced treatment of Radio I subjects, covering valves, transmitters, receivers and their

Careers in Radio—

component parts. Propagation, aerials, power rectifiers, as well as more advanced work on transmitters and receivers are treated in Radio III. In his fifth year Radio IV requires the student to deal with short-wave propagation and reception problems, radio frequency power amplifiers, oscillator frequency stability, radio terminal equipment and measurements.

I think you would be fully competent to coach for these exams, but if you prefer not to do so there are several good correspondence courses available from England. You raise your eyebrows? Oh, I know that I have expressed disapproval of tuition by correspondence, and I still think it is a poor substitute for direct teaching, but half a loaf is better than none.

And now for the main problem; the advice to give to men returning to England and wanting to prepare for a career in radio.

I suppose broadly they will fall into four categories:—

(1) Those who have graduated at a university or have obtained a Higher National Certificate but have had little or no practical training.

(2) Those who might qualify for a university course.

(3) Those who will have to earn a living at the same time as studying, and

(4) Those who have a practical bent and need some form of specialized knowledge or training.

Largely at the instigation of the Institution of Electrical Engineers, the Ministry of Labour is now prepared to consider grants to help the first type to gain practical training in industry. The period of training may last two years, a year, or six months, according to the practical experience already gained by the applicant. The six-month course is intended simply as a refresher, whilst the two-year period is for those who have had practically no experience. A letter addressed to the Regional Appointments Officer through the local Labour Exchange should bring full details and advice to anyone who is interested in this scheme.

Now for the second type of would-be radio engineers, the potential undergraduate. There are altogether eleven universities in England, four in Scotland, one in Wales and one in Northern Ireland, but none can offer a degree course specifically in radio engineering, though most provide one in Electrical Engineering or Physics, which can form a good foundation training for radio. A few do, however, specialize in Electrical Engineering with a bias to Communications, notably the City and Guilds College London, Victoria University Manchester, and Liverpool University. Personally I think there is scope for a school of radio engineering, as distinct from electrical engineering, to consist of a combination of electrical engineering, physics and mathematics in almost equal proportions. It is naturally difficult to suggest for which university the returning soldier should try; so much depends on personal circumstances and I think the best I can do is to examine the particular features of the universities as I know them. I shall try to be as unbiased as possible but you will know that this is not easy. Just one point of practical importance before I go on; see that your student puts in an application early in the year during which he is to be demobbed. Many universities require the form to be returned by May if the applicant hopes to start in October.

The universities can roughly be divided into the older residential ones likes Oxford and Cambridge and the newer almost non-residential ones. London is a halfway house between these two. With all due deference to Bruce Truscot (I expect you have read his stimulating "Redbrick University") I would unhesitatingly advise a potential undergraduate to try for Oxford or Cambridge *at the present moment* if he can afford to spend about £300 for the 24 weeks' course per year. Costs at most other universities vary from £50 to £80 per year for tuition and incidental fees so that, with board and lodging, expenses for a 30-week year are likely to be about £200. I underline "at the present moment" because I think Redbrick University is likely to change to residential and seriously challenge the present ascendancy of Oxbridge, which is due partly to its residential character and partly to the emphasis laid on reaching one's own conclusions and not accepting ready-made ones. The position may be summed up by saying that the Oxbridge graduate is generally socially superior but technically inferior to his Redbrick brother.

It may be that your student has a bias to a certain branch of radio. If he is clearly interested in audio-frequency telephonic problems with a view to a Post Office engineering career, City and Guilds College, London, would be an excellent choice. They also give a good general training in radio and this would fit a man for work in the research, development or production department of a radio manufacturer. If he is interested in valves and high-vacuum technique, Manchester University Electrotechnics Department covers this side. Apart from Liverpool most of the other university Engineering Departments give a broad general course biased to the machine and power side. As a recruiting and training officer for a company exclusively concerned with the manufacture of radio equipment, I received engineering graduates (who subsequently became satisfactory radio engineers) from Oxford, Cambridge, London (City and Guilds, University, King's and Queen Mary Colleges), Birmingham, Durham (King's College, Newcastle), Edinburgh (Heriot Watt College), Glasgow, Liverpool, Manchester (Victoria University and College of Technology), Sheffield, and physics graduates from Bristol, and Wales (Cardiff University College).

To sum up I would advise Oxford or Cambridge from an educational point of view, and City and Guilds College, Manchester or Liverpool on technical grounds, but I would stress that a degree in Electrical Engineering or Physics at other universities does not preclude a man from making a success in radio.

There are also the University Colleges of Hull and Nottingham, and one must not forget the London Polytechnics, Woolwich, Northampton, Battersea and Regent Street and also provincial

Careers in Radio—

technical colleges like Brighton.

For the less academic, more practically minded student I would recommend that he should consider one of the full-time Higher National Certificate Courses, lasting for 9 months. These cover Electrical Engineering principles and practice very thoroughly and exempt from the graduate examination of the Institution of Electrical Engineers; I believe that eleven colleges are operating the courses at the present time, and application for grants is made to the Ministry of Labour. To anticipate your question: there are no Higher National Certificate Courses in Radio or Communication Engineering. There should be.

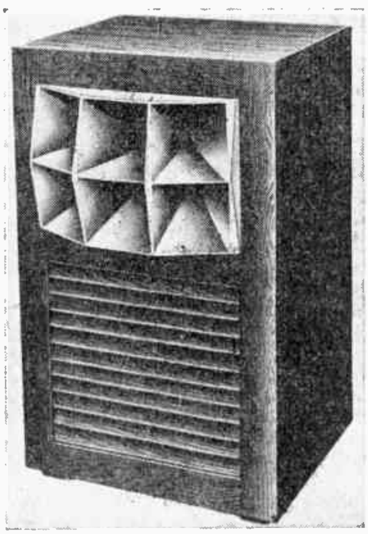
And now for the third class of student who must earn a living while he is training. He will probably take up a post in a radio factory and is likely to have a technical college near at hand. Besides running Ordinary and Higher National Certificate courses in Electrical Engineering, these colleges are often operating classes specifically adapted to the needs of the locality and there is likely to be a course for the 5-year City and Guilds examination I mentioned early on in the letter. Success in this examination carries considerable weight with most employers concerned with communications equipment. If there is no technical college in his area, remind him of the correspondence course, which caters for the graduate examination of the I.E.E. as well as the City and Guilds Exam.

The fourth class of would-be radio technician should be advised to take suitable Craft courses at his nearest technical college in the evenings. One can only offer a general recommendation that he should select the most suitable practical electrical course or if there is not one try to persuade sufficient of his associates to combine to form a class. Principals of technical colleges and Local Education Authorities are generally prepared to give every assistance when a genuine need for particular instruction is shown. Those of your men who carry out radio service work can try for the City and Guilds examination in "Radio Service Work," which has the backing of the Radio Manufacturers' Association. There is also a City and Guilds examination in "Electrical Installation Work," which would be quite valuable to the practical man.

This is, I am afraid, a long screed but you wanted rather a lot of information! Possibly there may be some further questions you would like to ask, and in any case I should be delighted to hear how your work progresses.

Yours sincerely,
A. U. Thor.

"BITONE" REPRODUCER



THIS is the name which has been given to the new wide-range loudspeaker made by Vitavox, Ltd., Westmoreland Road, London, N.W.9. A 12-inch cone loudspeaker working in a vented enclosure operates in conjunction with a multi-cellular horn driven by a pressure unit with duralumin diaphragm.

The units are connected through a dividing network with a cross-over frequency of 1,000 c/s and the terminal impedance is 7.5 ohms. It is stated that the frequency range is approximately 50-12,000 c/s.

Two types will be available, with power-handling capacities of 10 watts and 20 watts. Both will be housed in cabinets measuring 32in high, 20in wide and 21in deep.

Vitavox "Bitone" wide-range loudspeaker.

RANDOM RADIATIONS

By "DIALLIST"

Temper-saving Screws

DO you know the recess-head screw? I was presented recently with a supply of 4BAs and 6BAs and I have been blessing them daily ever since. Instead of a single nick the head bears what looks like a + sign. This is the top of a tapered recess of cruciform section. The driver bit is exactly the same, only just the opposite, if you see what I mean! It has a +-shaped protrusion at its business end, also tapered. If you want to start a screw in an awkward corner you need perform none of those manual gymnastics which the ordinary screw calls for in such circumstances—nor use any of the naughty words provoked by its usual refusal to play. Simply press your recess-head screw on to the screwdriver bit and it stays put in any position. You start it and turn it home without any fuss or bother. And when it's home the bit pulls out as easy as easy. Another joy is that the screwdriver simply cannot slip out of the nick. Now, I reckon that I can use an ordinary screwdriver with anyone. I don't bruise nicks in the ordinary way and only once in a blue moon, when I am thinking of something else, does the screwdriver slip out of the nick. But that blue moon and that fatal skid when they do occur usually happen as a screw is being driven into a piece of work whose surface has been finished with painstaking care. It is *not* funny to have a job of which you were going to be rather proud made into an eyesore by a cut from the blade of a slipping screwdriver. With recess-head screws that just can't happen: the bit stays in its proper place until you remove it by a gentle pull.

□ □ □

Over-Standardized?

RADIO manufacturers kicked heartily (and quite understandably) when the idea of the "utility" (or was it "austerity"? I always forget) receiver was first mooted. As each of them had been turning out up to the outbreak of war, the only set which furnished (with four valves plus rectifier!) "complete fidelity in reproduction," "world-wide sensitivity" (with four valves plus rectifier!!) and "the highest attainable selectivity" (with four valves plus rectifier!!!) it was in no way surprising that every manufacturer should be reluctant to submerge his individual genius in the mass-production of a receiver for which no particular claims were made, though examination disclosed that it consisted of four valves plus rectifier. Some while ago the day of emancipation dawned: every maker was free to strike out his own unfettered line. And strike it almost each and almost every one did by giving to the world his own proudly acclaimed version of its finest fifteen-guinea set—with four valves plus rectifier! What is even more noteworthy is that you can draw with fair exactness the circuits of far too many of those sets without bothering overmuch to investigate what is within the cabinets. Rough in your guess: triode-hexode frequency-changer, vari-mu I.F., D.D.T. and pentode output. Two-gang tuning condenser; usual wave-change and A.V.C. arrangements. Pick-up and extension L.S. terminals and there you are, except that slight variations are to be found in the frequency-distorter, generally termed euphemistically the tone-control. I'm all for standardization in the right places; but I'm all against the over-standardized and uninspired medium-priced receiver of to-day.

□ □ □

Meteors and the E-Layer

SIR EDWARD APPLETON threw new light on an old radio problem in the course of a recent lecture to the Physical Society. Why the E-layer should continue to act as a reflector to wireless waves all through the hours of darkness and should not cease to exist soon after sunset, owing to recombination of its ionized atoms, has long been something of a puzzle. The calculated recombination rate shows that the process would normally be completed very quickly when ultraviolet rays from the sun had ceased to arrive. Something must happen to keep ionization going; but what? From the evidence collected by four different teams of investigators there is good reason to believe that the E-layer is kept in working order by the arrival of meteors and meteoric dust. It has been known for some time that a meteor leaves behind it as it passes through the upper atmosphere a trail of ionized gases from which radar echoes can be obtained. Visible trails usually occur some miles below the average after-dark height of the E-layer; but it is believed that the reflecting efficiency of this layer is maintained throughout the night by the arrival of countless small specks of meteoric dust. These do not penetrate so far as meteors into the atmosphere and they are too minute to produce visible trails or individual radar echoes.

Further Evidence

If meteors and meteoric dust are the shattered fragments of much larger bodies which have been broken up in celestial cataclysms, it is to be expected that the mass of the dust specks will vastly exceed that of the bigger chunks of matter which give rise to the visible shooting-star trails. It appears that mathematical analysis shows that meteor dust should produce exactly the observed effects on entering the atmosphere. One particularly interesting point is the "settling down" of the E-layer after midnight, which every medium-wave D.X. fan must have observed time and again. Some of us, no doubt, attributed the much better reception of North and South American stations obtainable in the small hours to the closing down of European stations. But that is not the whole story. After midnight, wherever you may be, you are on the forward side of the Earth as it rolls along in its orbit. If you walk rapidly through heavy rain, the front of your macintosh (always supposing that you had the coupons to buy one and the forethought to take it with you) becomes much wetter than the back. Similarly the forward side of the Earth, advancing into the clouds of meteors and and meteor dust, receives by far the greater number of meteors and meteor dust specks. Hence between midnight and dawn the E-layer over this part of the Earth is kept in a specially efficient condition as a reflector of wireless waves.

□ □ □

Who was Kipp?

READERS who have to do with radar must have come across the Kipp relay, which forms part of the timebase generator circuit of some equipments. It's a lopsided multi-vibrator, whose mission in life is to generate a long negative pulse when triggered off by the arrival of a short negative sync pulse. The two valves which it contains are interconnected by criss-cross resistor and capacitor arrangements. Normally, V_2 conducts and V_1 is biased back beyond cut-off. The sync pulse closes down V_2 with a bang, and this causes the sudden opening of V_1. The latter valve is held open for a period depending on time constants in the resistor-capacitor criss-cross. Then it slams shut. The result is the generation of a long negative pulse at the anode of V_1. Ingenious, though nothing to make a song about. What has always puzzled me—or rather had puzzled me till recently—about this relay is its name. Kipp was always spelt with a capital K, so presumably this was the name of the circuit's inventor. Who was he? A back-room boy? A research worker whose achievements were commemorated by the name of this one circuit? Searches high and low failed to disclose any book, paper or article from the pen of Kipp. No one seemed ever to have heard of him.

The Mystery Solved

The truth about Kipp is that "there never was no sich person," at any rate not in the ranks of radar researchers. The mystery was cleared up the other day by O. S. Puckle, the Timebase King, when I consulted him in my quest for information. The term Kipp relay was imported from Germany, probably by a translator who, not knowing what it meant and deceived by the capital K, took Kipp for a personal name. The word in German is *Kipprelais*, a mongrel combination, for the *relais* part is French, meaning (as you may have devined) relay. Being a noun "*Kipprelais*" is spelt with an initial capital, as all nouns are in German. The Kipp part is from the verb *kippen*, meaning to topple over. Hence the proper English translation of the term is the familiar "flip-flop." Kipp, I fear, must take his place in the galaxy of radio and radar talent beside Professor Eddy, discoverer of eddy currents and Herr Doktor Litz, inventor of litzendraht wire.

□ □ □

Tailpiece

DESCRIPTION of electricity heard during the Great Switch-off: "Nice stuff, if you can get it!"

BOOKS RECEIVED

Service Valve Equivalents. Lists of British Service and U.S. Signal Corps valves and their commercial equivalents, including names of manufacturers where available. Valves with ratings over 150 watts, and obsolete types have been omitted. A section is devoted to the coding of Continental valves and base connections are given for representative types. Published by the Incorporated Radio Society of Gt. Britain, New Ruskin House, Little Russell Street, London, W.C.1. Pp. 25. Price, 9d, postage paid.

RECENT INVENTIONS

A Selection of the More Interesting Radio Developments

VELOCITY MODULATION

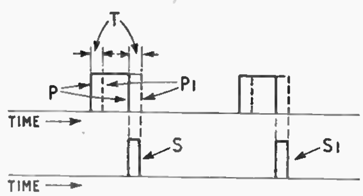
WHEN a discharge tube embodying a hollow resonator is used for amplifying or mixing ultra-short waves, the signal-to-noise ratio is largely determined by the fact that the noise power is proportional to the impedance of the input circuit, whilst the signal modulation applied to the electron beam varies as the square root of the input impedance.

According to the invention, the tube is operated so that the impedance of the input, as presented to the electron beam, is substantially equal to the reciprocal of the mutual conductance of the tube. A mathematical analysis of the working conditions is given in the specification to establish the underlying theory.

C. S. Bull. Application date, April 11th, 1941. *No.* 577168.

RADAR

THE duration of each exploring-pulse P is sufficient to overlap a part of the resulting echo-signal P1. As the receiver is blocked for the period



Measurement of short radar ranges.

of each transmission, it can only respond to the residual part T of the echo, which, as will be seen from the diagram, represents the go-and-return time, and therefore the distance to be measured. The output from the receiver is passed through a limiter-rectifier to form a series of pulses S, S_1, of constant amplitude, which can be integrated in a simple form of indicator such as a milliammeter. Accuracy is not affected by casual variations in the duration of individual pulses, provided an equal number of pulses are transmitted each second.

In systems using waves of continuously variable frequency, the normal beat frequency is utilized to derive a second difference frequency, which can readily be filtered out and integrated in a calibrated ammeter.

Standard Telephones and Cables, Ltd. (communicated by International Standard Electric Corp.). Application date December 26th, 1941. *No.* 577854.

SHORT-WAVE AERIALS

FOR radiating centimetre waves over a restricted service area, a dipole is set at the focus of an upwardly directed parabolic reflector, a second reflector in the shape of an inverted cone being mounted vertically above the dipole. Energy from the aerial is first directed upwards, along the axis of the paraboloid, and is then broadcast outwards, and substantially downwards, from the inclined surface of the cone.

Both reflectors may be fixed near the top of an elevated mast, though by arranging the paraboloid near the base, the use of a long wave guide or feeder is avoided. The absence of any high-angle radiation prevents the type of interference that is caused by reflection from aircraft.

D. I. Lawson; D. Weighton; and Pye, Ltd. Application date April 8th, 1943. No. 578018.

CRYSTAL MIXERS

A SMALL amount of aluminium or beryllium, or of both these metals, is added to pure silicon by melting a mixture of the powdered ingredients in a crucible lined with beryllia, in an atmosphere of hydrogen or helium, or in vacuo. A plane surface of the cooled "melt" is polished, oxidized by exposure to air at a temperature of 1,050 deg C, and then treated with hydrofluoric acid. The metal contact is a tungsten wire 0.2 mm in diameter, sheared off to a point at 45 deg to the axis of the wire.

The resulting combination is stated to give a constant and optimum ratio of forward to reverse impedance at all points on the crystal surface. It deteriorates little with use, even when handling high voltages, and is particularly adapted for use as a mixer in ultra-short wave reception.

The General Electric Co., Ltd.; D. E. Jones; C. E. Ransley; J. W. Ryde; and S. V. Williams. Application dates August 20th and October 18th, 1941. *No.* 577181.

STAND-BY RECEIVERS

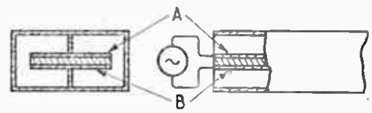
MOBILE receivers, such as those used on police cars and aircraft, are maintained under stand-by or no-signal conditions for long periods during which current is being consumed. To cut down this waste, the noise voltages that are constantly present in the set are applied, in the absence of a signal, to develop a control bias which automatically reduces the anode current of the A.F. amplifier.

The circuit includes a limiting valve which allows the "outward peaks" of the noise-voltage to pass through to a squelching valve, where they are built-up into a cut-off bias for the A.F. amplifier, thus reducing the drain on the storage battery. As soon as a signal comes in, the level of amplification rises so that the noise voltages are swamped in the limiter, whereupon reception is restored to normal. Simultaneously a noise-suppressing circuit of known type automatically comes into action to free the speech channel from interference.

The British Thomson-Houston Co., Ltd. Convention date (U.S.A.), Jan. 22nd, 1943. *No.* 578201.

WAVE GUIDES

WAVES of the transverse electric type are transmitted through a hollow guide, provided the wavelength does not exceed that to which the cross-section of the guide is resonant. In the case of a rectangular guide filled with air, the maximum wave is approximately twice the length of the wider side.



Wide-band wave guide.

As shown in the diagram two internal plates A, B are supported by centre ribs from the wider walls so as to lie, parallel with each other, on opposite sides of the axial plane of the guide; the space between them may be filled with dielectric. This subdivision of the interior increases the effective electrical distance between the walls, and so allows a longer wave to be transmitted by a guide of given external dimensions. The space between the plates A, B is a critical factor, and by making it variable the guide can be adapted to accept a wide range of wavelengths, or, alternatively, to serve as a high-pass filter.

The British Thomson-Houston Co., Ltd. Convention date (U.S.A.), Aug. 16th, 1943. *No.* 578466.

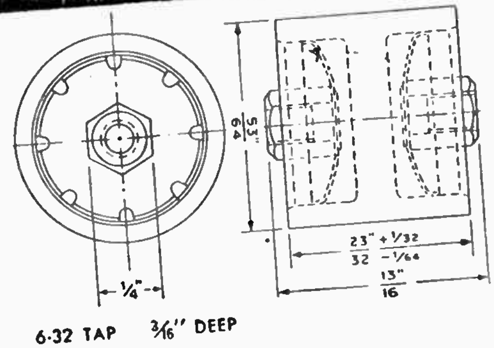
TELEVISION RECEIVERS

TO allow the picture to be seen more clearly in daylight, or under bright artificial illumination, a glass plate of the same monochromatic colour, say yellow, as the fluorescent image is mounted between the observer and the viewing-screen. Extraneous light passing through the coloured glass is deprived of all but the yellow rays, and so is reduced in overall intensity before reaching the viewing screen. Any yellow light that is reflected back will also be reduced in strength, because of its double passage, as compared with the fluorescent rays from the picture, which only pass through the filter once.

The plate is preferably mounted, inside the usual hood, at an angle to the line of vision, the adjacent surface of the hood being blackened to prevent glare.

J. L. Baird. Application date April 25th, 1944. *No.* 578108.

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.



ERIE
DOUBLE-CUP CERAMICONS

The ERIE Double-Cup Ceramicon, the first of a range of new products scheduled for production in 1947, is the result of the need for a high voltage ceramic condenser that will carry appreciable current at high voltage and will retain the advantage of being a compact, single-piece unit.

As the cross sectional drawing shows, the ceramic dielectric has a centre web which is integral with the tubular casing, providing the required long creepage path. The silver plates are fired on to the ceramic on each side of the web and carried without interruption to the rim of each cup, thus greatly increasing the voltage at which corona occurs. Electrical connections are made by means of electro-silver plated metal terminals soldered to the electrodes.

This design has the necessary basic features for high voltage applications at high frequencies. The web section is sufficiently thick to prevent breakdown of the dielectric, and the design described provides adequate protection against flash-over at the rated voltage. Heavy metal terminals serve to dissipate internal heat and provide a 360° contact for the current to fan out to the electrodes. Rating is 5 KVA.

The ceramic dielectric employed is made of the same titanium dioxide series as the well-known temperature compensating tubular Ceramicons. This material plus careful control of processing operations assures stability with respect to temperature, excellent retrace, and high Q factor.

RANGE AND CHARACTERISTICS

TYPE 741A

Standard Capacities	Temperature Coefficient	Peak Wkg. Volts DC at Sea Level
20 MMF	P100	10,000
30 MMF	P100	6,500
39 MMF	P100	5,000
61 MMF	N750	10,000
75 MMF	N750	7,500
100 MMF	N750	5,500

Test Voltage: 50 cycle RMS equal to peak working voltage.
Temperature Coefficient:
P100 = plus 100 ± 30 parts/million/°C.
N750 = minus 750 ± 120 parts/million/°C.

Watch this page for release date and for advance information on other new products.

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NEW RECEIVERS AND AMPLIFIERS

5-VALVE, 8 stage all-wave superhet radiogram chassis, precision built, £12/17/6, plus tax.—Below.

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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.

AMPLIFIERS, 6 watts push-pull output, complete with 10in speaker, for use on ac mains, good quality job, tone control, etc.; call and hear one or send for descriptive leaflet "W."

CHARLES BRITAIN (RADIO), Ltd., 2, Wilson St., London, E.C.2. [6835

AMPLIFIERS; new 1947 model Hi-Fi units, with triple tone controls, built to customer's specification.—Broadcast & Acoustic Equipment Co., Ltd., Broadcast House, Tombland, Norwich 26970. [6433

DORIC Trutone 5-valve A.C.-D.C., 3 waveband superhet, 16-50, 200-550, 1,000-2,000 metres, complete in attractive oak grained polished wood cabinet, size 13in×8in×6in; price £13/6/8 incl. tax.—Doric Radio Co., Lowson St., Darlington. [6947

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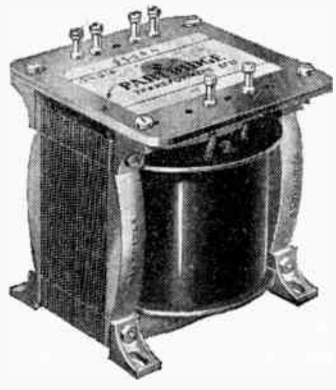
BRIERLEY "Ribbon" and "Armature" pick-ups. Please write your name and address in block letters and include 3d. for booklet containing illustrations, responsive curves, technical details, delivery and prices. These booklets explain aspects of pick-up design, developments, including the "floating element" design leading to the use of ¼ and ⅛ oz downward pressures; the importance of adequate and constant point pressure and its practical achievement; correct point shape; the relation of pick-up weight, point pressure and vertical motion, etc., etc.—J. H. Brierley, Ltd., 46, Tithebarn St., Liverpool, 2. [5701

CHARLES AMPLIFIERS.—Announcing a new version of their famous HFA1 amplifier—the HFA3 incorporating a pre-amplifier to enable the use of moving coil pick-ups direct; this amplifier in conjunction with the Lexington moving coil pick-up and the B.A.E.C. twin cone speaker provides the highest obtainable fidelity of reproduction; the complete range now comprises amplifier HFA1 7watt cathode follower output for crystal pick-ups; HFA2 single-ended for crystal pick-up; the HFA3 for moving coil pick-ups; tuner unit TU2 combination superhet t.r.f. feeder unit; full constructional blueprints 2/6 each; full kits or separate components available or supplied ready assembled; stamp for comprehensive catalogue.—Charles Amplifiers, 1e, Palace Gate, Kensington, W.8.

Partridge News



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CIRCUIT BREAKERS. N.C.S., 7½ amps A.C. enclosed type, 21/-. Ellison make mounted on sub-base, D.P.O/L 200/230 v. A.C. single phase, 200 amps 15in. x 13in. x 12in., weight approx. 50 lbs., ditto 300 amps 17½in. x 14in. x 15in., weight approx. 89 lbs, 220 volts, 1,000 amps, S.P 50 cy. D.P. with no volt hold-on coil, loose handle, switchboard mounting oil switches by Ferguson & Palin. All offered at very low prices to clear.

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Telephone: *MACaulay* 2159

ONLY £10; Emmerson midget receiver in light beech cabinet, 5-valve superhet, all new valves and electrolytics; s.a.e. for lists of other bargains.—Brown, 63, Salisbury Av., Farnham Rd., Slough, Bucks. [7108

TEST EQUIPMENT

GANGING oscillator, Cossor 3343, unused, perfect.—Box 6860. [7122

COSSOR oscilloscope 3332; £18 or near offer. Burley, 60, Balaclava Rd., Derby. [7002

TEST gear in kit form.—List from MacLachlan & Co., 16, Thistle St., Stirling. [7177

TAYLORMETER 90a, new, Pifco 8-range; £16/10.—48, Brecks Cres., Rotherham.

AVO model 40 Universal test meter, as new; £13.—Renfree, 337, Charminster Rd., Bournemouth. [7179

MULLARD GM3152 'scope, £50 or offer; E669 meter, £6; E665 valve voltmeter, £15.—Box 6861. [7124

EVERETT Edgcumbe portable R.F. voltmeter, 0-150v; sell, exchange analyser, oscillator.—Box 6692. [7047

MARCONI valve voltmeter for sale, list price £50, as new; £40.—Dixon, 68, Sitwell St., Spondon, Derbyshire. [7184

MULLARD C.R.T. unit, type B100, with 3in tube, unused, as new; £9/10.—Packer, Rock Hill, Bromsgrove. [6936

WESTON analyser, new, 20,000 o.p.v., £20; R.C.A. Junior Voltohmyst, electronic voltohmmeter, new, £20.—Box 5629.

AVO oscillators, new, mains £13, battery £12; a few available only, please write first.—R. Massey, 58, Wakefield Ave., Hull. [7146

PHILLIPS oscilloscope single beam time base, 2-150,000 c/s, amplification ×1,600; what offers.—Tel. Amherst 2937 after 7 p.m. for appt. to view. [7053

COSSOR 33 and D-B oscillograph, A.C.-D.C. Avo minor, no case, record 500v insulation tester in case all perfect; enquiries/offers to: BM/ANLL, London, W.C.1. [7181

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THANKS for waiting.—The Roberts portable combined valve and circuit analyser ready for distribution (in rotation) in March. —Particulars and price from Sole Distributors, Messrs. Kerry's (Great Britain), Ltd., Warton Rd., Stratford, London, E.15.

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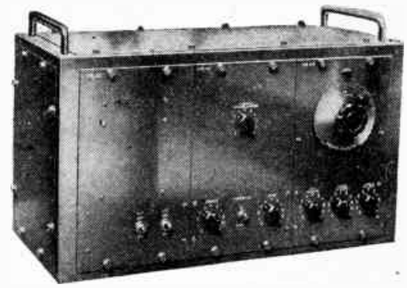

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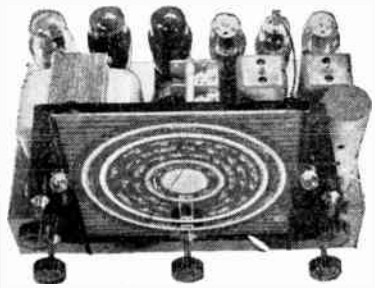

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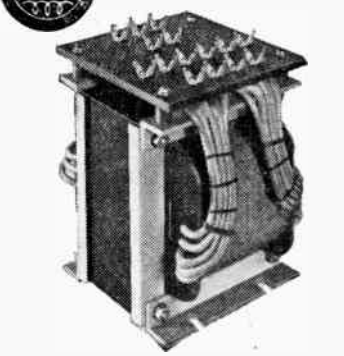

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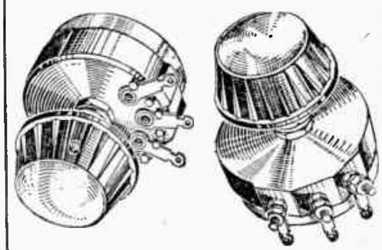

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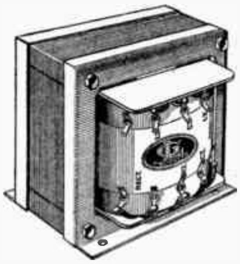

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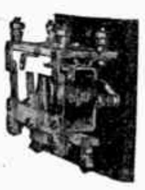

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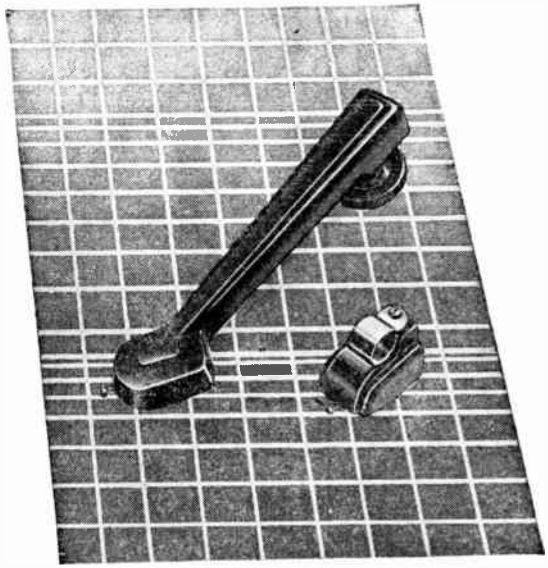

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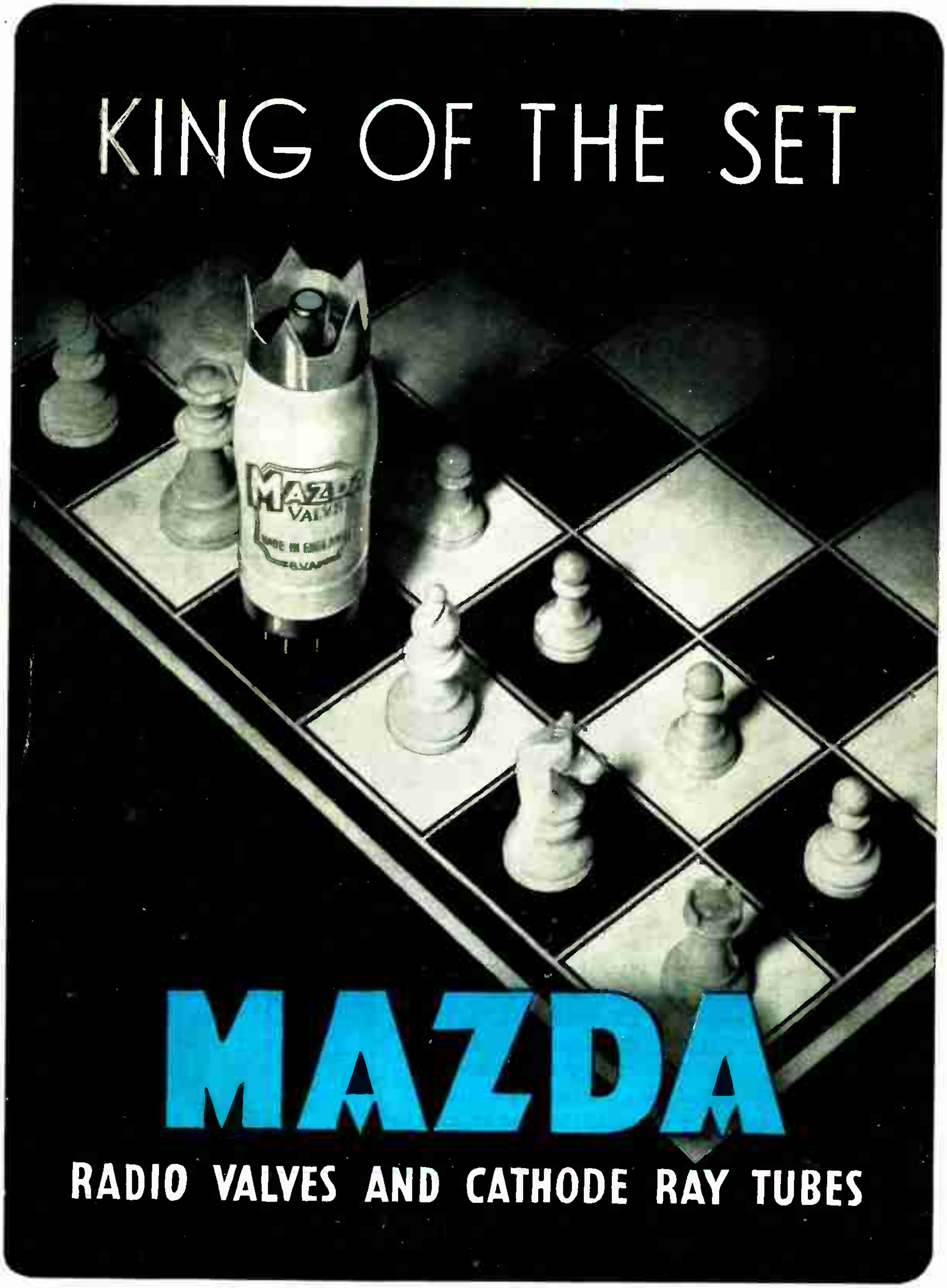
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