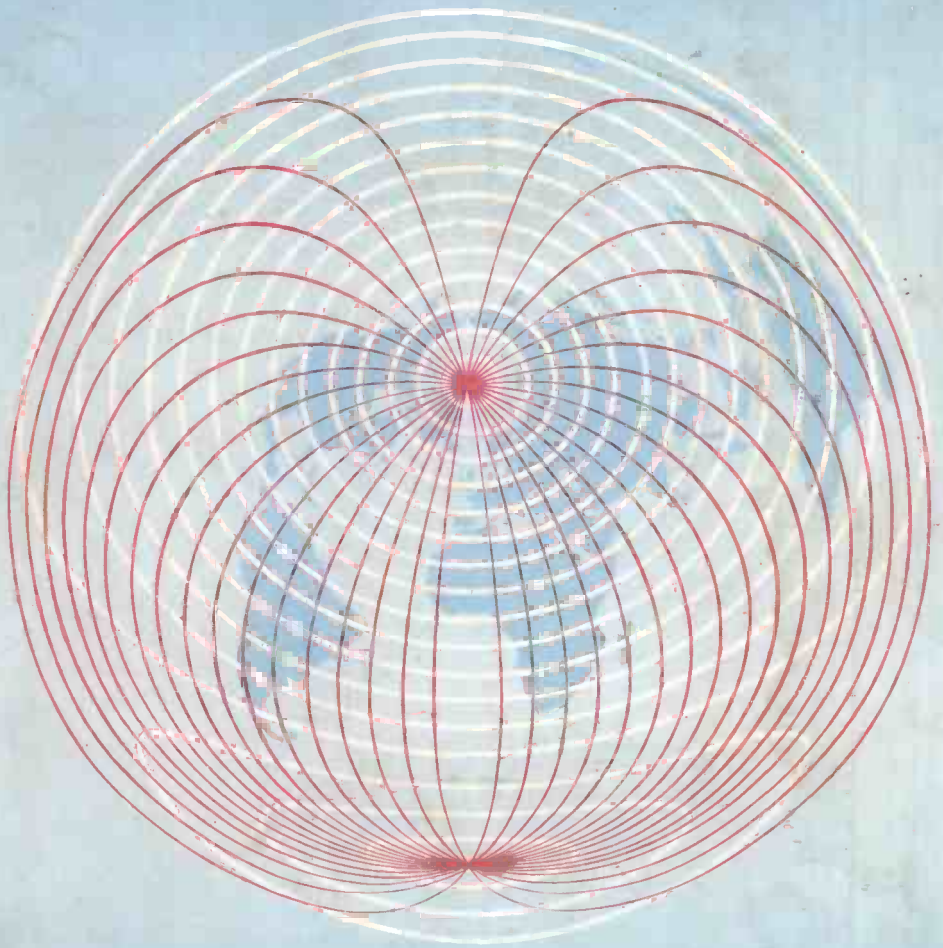
Wireless World

FEBRUARY 1954 · TWO SHILLINGS



RADIO, TELEVISION AND ELECTRONICS

Wireless World

RADIO, TELEVISION AND ELECTRONICS

43rd YEAR OF PUBLICATION

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FEBRUARY 1954

In This Issue

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VALVES, TUBES & CIRCUITS

14. FULL-WAVE RECTIFIER TYPE EZ80

The new Mullard full-wave rectifier, type EZ80, having a maximum output current of 90 mA, is suitable for the power supplies of most small and medium power amplifiers designed for operation from a.c. mains. It is a miniature all-glass valve having a single-ended construction and a B9A (noval) base. With a heater rating of 6.3V, 0.6A, the maximum peak heater-to-cathode voltage of 500 volts is sufficient to permit the heater of the EZ80 to be supplied from the same 6.3-volt winding on the transformer as the other valves in the amplifier.

CHOICE OF RESERVOIR AND SMOOTHING CAPACITORS. When designing an amplifier it is desirable to know the amount of a.c. ripple which may be superimposed on the direct voltage supplied to the valves. For a particular input voltage and output current the values of ripple and direct voltages depend upon the reservoir capacitance and upon the type of smoothing network. Generally the power supply includes a reservoir capacitor (C1), either an inductance (L) having a resistance (R) or a resistance (R) alone, and a smoothing capacitor (C2). The following table shows typical values of ripple and direct voltages across C1 and across C2 for several standard values of components. The input voltage is 2 x 250V r.m.s. and total output currents of 90 and 60 mA are considered.

In general, the value of the ripple voltage across C2 is inversely proportional to the values of both C2 and C1 whereas the ripple across C1 is only inversely proportional to the value of C1 and not dependant upon L, R or C2. To ensure a low ripple voltage at C2 it is necessary to make both C1 and C2 as large as possible. If further smoothing is desired, as with the supplies to a pre-amplifier stage, it is usual to incorporate this in a form of decoupling in order to isolate this stage. If large values of capacitance are used it is possible to economise in the design of the amplifier by replacing the smoothing choke by a resistor with little change in ripple voltage. The output voltage from C2 will then be reduced by an amount depending upon the load current and the value of the resistor. In this case the voltages required for the anodes of the output valves may be taken from C1. With a single valve output stage, the ripple across C1 must then be as low as possible. In push-pull stages, if the two output valves are reasonably similar, quite large amounts of ripple can be tolerated as they will be balanced out.

$V_{a\ (r.m.s.)}$ = 2 x 250V, I_{out} = 90mA.

C1 (μF)	C2 (μF)	L (H)	R (Ω)	Ripple Voltage across C1 ($V_{r.m.s.}$)	Ripple Voltage across C2 ($mV_{r.m.s.}$)	Direct Voltage across C1 (V)	Direct Voltage across C2 (V)
8	8	10	100	21	450	260	251
8	16	10	100	21	210	260	251
16	16	10	100	10.5	110	263	254
50	50	0	500	3.5	225	265	220
50	50	0	1000	3.5	110	265	175

$V_{a\ (r.m.s.)}$ = 2 x 250V, I_{out} = 60mA.

C1 (μF)	C2 (μF)	L (H)	R (Ω)	Ripple Voltage across C1 ($V_{r.m.s.}$)	Ripple Voltage across C2 ($mV_{r.m.s.}$)	Direct Voltage across C1 (V)	Direct Voltage across C2 (V)
8	8	10	100	15	315	283	277
8	16	10	100	15	145	283	277
16	16	10	100	7.5	75	285	279
50	50	0	500	2.5	160	287	257
50	50	0	1000	2.5	80	287	227

From the table it is seen that the conventional network of C1 = 8μF, L = 10H, C2 = 16μF may be replaced by C1 = 50μF, R = 500 Ω, C2 = 50μF with only a slight increase in ripple across C2 from 210 mV to 225 mV and a reduction in the ripple a cross C1 from 21V to 3.5V. The output voltage across C2 is reduced from 251V to 220V but the anodes of the output stage may be connected to C1, across which is a voltage of 265V.

VALVE DATA

HEATER

V_h	6.3	V
I_h	0.6	A

LIMITING VALUES

$V_{a\ (r.m.s.)}$ max.	2 × 350	V
I_{out} max.	90	mA
C max.	50	μF
$v_{h-k(pk)}$ max.	500	V

BASE

B9A

DIMENSIONS

Max. seated height	61	mm.
Max. overall length	67	mm.
Max. bulb diameter	22.2	mm.

TYPICAL OPERATING CONDITIONS

$V_{a\ (r.m.s.)}$	2 × 250	2 × 275	2 × 300	2 × 350 V
C	50	50	50	50 μF
*R_{lim} min.	125	175	215	300 Ω
I_{out}	90	90	90	90 mA
V_{out}	265	285	310	360 V

*Per anode.

Mullard

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MVM 260

Wireless World

FEBRUARY 1954 VOL. 60 No. 2

V.H.F. Very Much at Sea

THE world as a whole seems to have got itself into an almost inextricable tangle over international marine radio-telephone communication on v.h.f. The trouble started with the Atlantic City conference in 1947, where, we can now see clearly, insufficient thought was given to the framing of regulations for this branch of communications. As a result, frequency modulation is used in the Americas while almost everywhere else amplitude modulation has been adopted.

So far as purely local marine services are concerned, the lack of universally accepted standards is not necessarily a serious handicap. But it is a different matter when we come to ocean-going ships, which, to derive the fullest benefit from v.h.f. equipment, should be able to communicate freely with coastal stations, as well as with tugs and possibly other ships, in all parts of the world. For these vessels, universally agreed standards are clearly desirable.

America, as the principal champion of frequency modulation, has suggested that Great Britain should change over to that system, and it has been implied in reply to questions in Parliament that this change has been considered. The Post Office, however, in a memorandum issued as long ago as 1949, showed itself very much in favour of amplitude modulation. Whatever may be the advantages of f.m. for broadcasting and for some other services, it certainly has not been proved that these hold good for marine communication. A strong argument advanced against f.m. for marine applications is that it would prevent intercommunication between ships and a.m.-equipped aircraft in case of accidents.

All these matters are discussed at length in a statement, summarized on another page, recently issued by Rees Mace Marine. For an ultimate solution of the various problems, the company, appreciating the necessity for a completely new international agreement, pleads for the setting up of a truly representative marine international body. For such a highly specialized branch of communications, a body of this kind would appear to be essential, but, inevitably, the framing of new international regulations and their universal acceptance would take years. As a matter of short-term policy, Rees Mace face the inevitable, and suggest that ships sailing to those countries which have adopted f.m. should be fitted with equipment for dual modulation as soon as the other factors involved can be agreed internationally. This proposal does at least provide a realistic solution of an awkward problem.

Safety in the Air

IF we wireless people had our way, ships and aircraft would become merely floating or flying platforms for the carrying of radio equipment. So runs an oft-repeated gibe and, in our more dispassionate moments, we must admit there is a grain of truth in it. We must always bear clearly in mind the fact that the primary function of craft navigating sea or air is to carry passengers and freight as economically as possible. There is, particularly in the air, a distinct upper limit to the amount of space and weight that can be allocated to wireless gear. Then there are the associated problems of operation and maintenance; both of these are mainly economic.

These thoughts are provoked by recent correspondence originating in *The Times*, where it was suggested that passenger aircraft could be made a good deal safer if more extensive use were made of airborne radar for preventing collisions with mountain peaks, other aircraft and dangerous clouds.

All this raises problems that cannot be summarily disposed of, one way or the other. Elsewhere in this issue a contributor who cannot be accused of undue partiality in either direction examines dispassionately some of the problems inherent in the use of airborne radar for civil aviation. Very roughly, his conclusions are that the installation of cloud warning radar may be justified on certain routes at certain times of year, but the practicability of its general application is extremely doubtful.

No doubt, however, there will be considerable technical development in this field. A device combining the functions of radio-altimeter and cloud-warning indicator, with sequential scanning in different planes and simultaneous but independent presentation of the two kinds of information, should not be beyond the bounds of technical practicability.

"Chameleon" Oscillator

Versatile Modified Hartley Circuit Giving High Frequency Stability

By THOMAS RODDAM

ALTHOUGH you might not think so, if you took these columns as a statistical guide, oscillators are our bread and butter: or perhaps our bread, with modulators playing the role of butter. Without these two essential devices the whole of the radio field would be non-existent. It is rather surprising, therefore, how rare it is to see any description of a newish oscillator circuit, while every variant of a variant of an amplifier circuit is described in detail. One reason is that oscillators are fairly easy to build, and, apart from the traditional reversal of the feedback winding, they usually work after a fashion as soon as they are connected. When the oscillator is to work over a frequency range the requirements for stability are normally fairly lax, and any of the textbook circuits will do.

For more advanced work there is always the crystal oscillator, the Meacham bridge circuit,[1] the Gouriet circuit[2] or the Tillman circuit.[3] But these are complicated, or difficult to design, or use a lot of components, or give rather a small output, or don't give a sinusoidal output. There appears to be room for a good middle-class oscillator giving a fairly large sinusoidal output and good stability, and not using too many components.

The oscillator described in this article appears to me to offer all these advantages. The stability against variations in valves and supplies is high, so that the frequency can be trusted to a few parts in 10^4 without supply stabilization, or better than 1 part in 10^5 if the anode supply is stabilized. It uses relatively few components in its basic form, produces all the output the valve can give, and has a very low distortion content. To date it has been tested at frequencies from 500 c/s to 10 Mc/s, using exactly the same design method, and has worked according to plan every time. This last feature, designability, is one which is often ignored in oscillator circuits: my own view is that if you can't design it you can't trust it.

The title I have chosen for this article reveals one difficulty: there are several different ways of approaching the circuit, all equally valid and all stressing different aspects of the operation. Rather than prejudge the issue, I evade it.

The basic circuit of the oscillator is shown in Fig. 1. Apart from the resistance R, it is just a cathode-coupled Hartley circuit, and the addition of R might be regarded as a bit of whimsy intended to make things more complicated. This is not so, however, because the introduction of R ties the whole circuit down to an optimum design. It also enables us to transform the circuit in several different ways: we shall come back to this point later.

Fig. 2 shows the equivalent circuit, with the valve regarded as a cathode follower and the grid connection dotted. The valve becomes a generator $\frac{\mu}{\mu+1} e_g$ with internal impedance $1/g_m$, acting in series with R: the losses in the tuned circuit are represented by the resistance R_2, which is the dynamic impedance of the circuit at anti-resonance.

The design problem is obviously to determine where the tap A should be on the coil, and what value of R should be used. Clearly a large value of R will be advantageous, because R and $1/g_m$ are in series, so that the bigger we make R, the more we swamp $1/g_m$ and the less effect this term will have on the behaviour of the circuit. A high value of R will help to keep the valve out of the circuit.

The coil acts as an auto-transformer, with a ratio $1 : n$, so that at anti-resonance we shall see across AB a resistance of R_2/n^2. The voltage at AB is thus

$$\frac{\mu}{\mu+1} \cdot e_g \left(\frac{R_2}{n^2}\right) \Big/ \left(\frac{R_2}{n^2} + R + \frac{1}{g_m}\right)$$

and as the auto-transformer has a step-up of n times, the voltage across BC is

$$n \cdot \frac{\mu}{\mu+1} \cdot e_g \left(\frac{R_2}{n^2}\right) \Big/ \left(\frac{R_2}{n^2} + R + \frac{1}{g_m}\right)$$

This, of course, is just e_g, so that we must have

$$\frac{n\mu}{\mu+1} \cdot \frac{R_2}{(R_2 + n^2R + n^2/g_m)} = 1$$

For any practical valve, μ is large enough for $\mu/(\mu+1)$ to be taken as unity, within a few per cent.

Fig. 1. Skeleton of the modified Hartley circuit: the lettering is carried over to Fig 2.

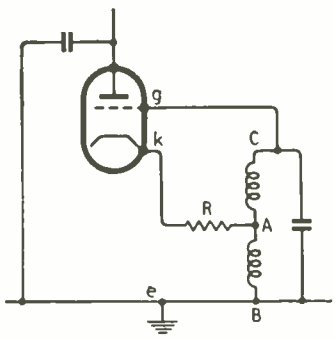
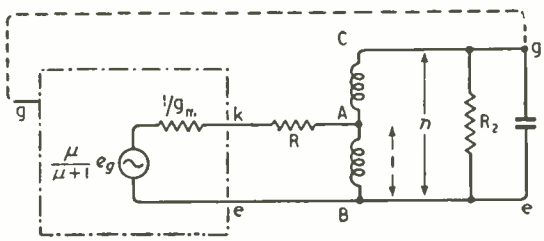


Fig. 2. (below): Equivalent circuit, for calculation purposes. R_2 is the loss in the coil.



[1] *Bell System Technical Journal*, Oct. 1938.
[2] *Wireless Engineer*, April 1950.
[3] *Wireless Engineer*, Dec. 1947.

We intend to have R very much greater than $1/g_m$, to decouple $1/g_m$ from the circuit. A fairly good approximation, therefore, is that

$$\frac{nR_2}{R_2 + n^2R} = 1 \text{ or } R = \frac{n-1}{n^2} R_2$$

In this equation R_2 is fixed, because it is a property of the coil. The maximum value of R is then obtained if $n = 2$, when $R = R_2/4$. You can check by plotting the graph of $(n - 1)/n^2$ that the maximum is a fairly flat one, so that the result is not particularly disturbed by the approximations we have made, and subject to these approximations we find that the centre-tapped coil is the *best* solution.

We are still rather in the air, however, because the design simply says "take one coil." Can we find out anything more? We have seen that across AB we now have a resistance of $R_2/4$, and at the cathode of the valve we shall see $R + \frac{R_2}{4}$, or $R_2/2$. We know that a high μ will help to make $\mu/(\mu + 1)$ more independent of μ, and a high g_m will keep $1/g_m$ small, so that we can choose a valve. The CV455 (ECC81, 12AT7) has a g_m of 5 mA/volt and a μ of about 50 (each section), so that $\mu/(\mu + 1)$ is 0.98 and $1/g_m$ is 200 ohms. A good load for this valve is about 25,000 ohms, which gives a compromise between gain and power output. We must therefore take $R_2 = 50{,}000$ ohms, so that R = 12,500 ohms. Of this, 200 ohms is in the term $1/g\mu$, leaving 12,300 ohms. Even so, we haven't taken account of the $\mu/(\mu + 1)$ term, which would reduce the 12,500 ohms to 12,250 ohms, giving R = 12,000 ohms as a pretty close approximation.

That final dubious piece of arithmetic, with 50 ohms disappearing up my sleeve, is justified by the fact that the coil is yet to be calculated. We know that we want R_2 to be 50,000 ohms. The next step is to choose a coil type, knowing the order of Q to be expected, and from this value of Q and the value of R_2 just determined calculate the inductance. Since $Q = R_2/2\pi fL$ we have

$$L = R_2/2\pi fQ \qquad \text{and} \qquad C = 1/(2\pi f)^2 L$$

Having calculated the coil and constructed it, with its centre-tap, the actual value of Q can be determined, and from this the true values of R_2 and R. That is why the calculation of R above was scamped—the data lacked precision, anyway.

It is, unfortunately, necessary to add some more components, because with 10 kΩ odd in the cathode the valve current will be so small that the mutual conductance will be much lower than we have assumed. The necessary modifications are shown in Fig. 3, and as you can see, they are just a conventional cathode bias resistor R_k, which forms part of the total R, and a grid capacitor and leak resistor. The bias resistor should be the ordinary Class A amplifier bias resistor, chosen to ensure that the value will cut off rather than run into grid current. The grid circuit should be generously proportioned, with $2\pi f C_g R_g \gg 1$ to avoid any phase shift which might alter the operating frequency. And there is the oscillator circuit, all worked out.

A particular design, operating at 1,600 c/s, made use of a dust-iron cored coil with a Q in the region of 50. For this case, assuming still that we want $R_2 = 50{,}000$ ohms, we have $L = R_2/2\pi fQ = 50{,}000/10{,}000 \times 50 = 100$ mH.

When tested, the coil was found to have a Q of 60, making $R_2 = 60{,}000$ ohms and the approximate value of R = 15,000 ohms. No attempt was made to calculate the exact value, but a normal-tolerance 15 kΩ resistor was used and the appropriate value obtained by adding in parallel a resistance box covering the range up to 1 MΩ. A final test showed that 330 kΩ could be used for this position.

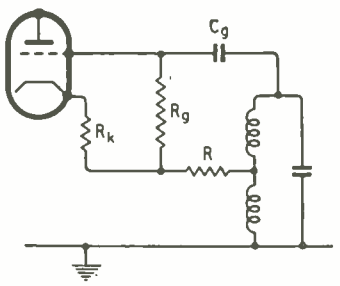


Fig. 3. Adding R_k, R and C_g to get the valve biased to the best point.

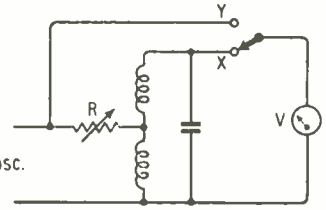


Fig. 4. No Q-meter? You can use this circuit to find the value of R needed in the oscillator. V must be a high-impedance valve voltmeter.

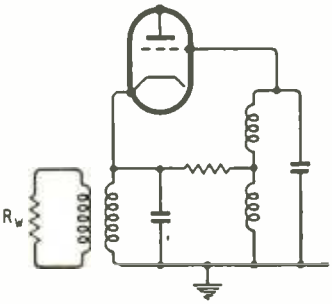


Fig. 5. A transformer in the cathode makes it possible to get the full voltage across the valve: more out, more stable.

Measuring "Q"

The next stage in refinement gives further advantages, but before continuing with this it is worth noticing that a Q-meter is not needed in the design of this circuit. It can perfectly well act as its own Q-meter and, indeed, for some types of core material it is necessary to use this technique. The only apparatus needed is an oscillator, a high-impedance valve voltmeter, and a variable resistance unit. The circuit is shown in Fig. 4. The valve voltmeter is first connected to X, and the oscillator, or the circuit tuning, adjusted until a maximum reading is obtained. The switch is then moved to the position Y, and a convenient deflection obtained on the valve voltmeter. Then switching between X and Y the value of R is adjusted to obtain the same reading at both points. By the mathematics already given, $R = R_2/4$, so that Q can easily be calculated. This circuit is also very useful for studying core materials in which the loss varies with the level, because the value of R_2 for any voltage across the coil is easily, and directly, measured.

The ordinary Q-meter is only useful if the Q does not depend on the signal level.

A disadvantage of the oscillator circuit as it appears in Fig. 3, is that a lot of supply power is wasted in R, and that there is nowhere to connect a load. The other half of the CV455 can be used as a buffer amplifier, of course, but it would be advantageous to find some way of keeping the d.c. out of R, for economy, to avoid changes in R caused by heating and to keep g_m high by passing more current through the valve. With the values discussed above only about one-third of the supply voltage is available between anode and cathode, which is a severe limitation. The circuit shown in Fig. 5 was evolved to deal with this question. The transformer primary is chosen to have a resistance equal to the required bias resistance in low frequency designs, and has an added series resistor, which is not shown, in high frequency designs. A tuning capacitor is provided, but the tuning is extremely coarse, since the valve presents a very low impedance in shunt across the circuit. Power can be taken off in a secondary load R_W, thus avoiding the need for a buffer amplifier.

It was found that even though now loaded directly, the performance of the oscillator was not degraded, owing to the fact that the full supply voltage now appeared across the valve. The problem was then to calculate the cathode transformer. As before, we must choose the load which is to be presented to the valve, and we will usually be free to take some compromise between maximum gain and maximum power, leaning now towards the conditions for maximum power. Let us call this optimum load R_l. If all the power goes into the load, and none into the oscillatory circuit, the oscillator will not be stable: if all the power goes into the oscillatory circuit and none into the load it will not be very useful. As a compromise, let us split the power equally between the load and the oscillator itself. This gives us the conditions indicated in Fig. 6, so that if we know R_W, the actual load, the output transformer must have a ratio of $\sqrt{2R_l/R_W}$. The oscillator circuit must be recalculated, with R now equal to R_l and $R_2 = 4R_l$. This does not make so very much difference, because R_l will be lower than the optimum load for gain alone. In a particular design, the one for which the numerical example above was actually used, the value of R_l for a CV455 was taken as 25,000 ohms, and in the embodiment of this design it was found that a change of supply voltage from 150 V to 300 V produced only about 1 part in 1,000 change in frequency. Small changes of anode voltage had very little effect on the frequency, and quite elaborate equipment was needed to measure the changes.

All the best oscillator designers incorporate a.g.c. in their designs: none is used in this oscillator. The reason why it is not needed here is in the vital inequality $R \gg 1/g_m$. Viewed at the point A in Fig. 1, the negative feedback is very large, and the valve is either operating in the linear region, or it is cut off. Even when the valve is not cut off, the impedance at the grid is very high, because of the cathode-follower action: when the valve is cut off, the impedance is, of course, even higher. As a result, the tank circuit is free to swing for a fraction of a cycle, and driven through a high resistance over the rest of the cycle. There isn't really very much which can upset the frequency.

Having decided that this circuit, which doesn't seem to have been analysed anywhere else, though it is mentioned in "Waveforms" (B. Chance *et alia*, M.I.T. Series, McGraw Hill), is a good one, there remains the problem of why it is quite so good. After staring at the circuit for quite a time it became clear that it can be drawn in the form shown in Fig. 7(a). I do not propose to go through the analysis of what

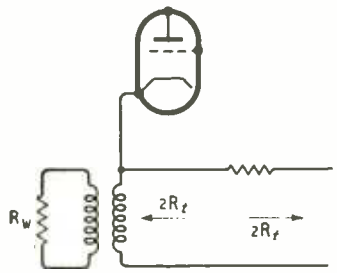
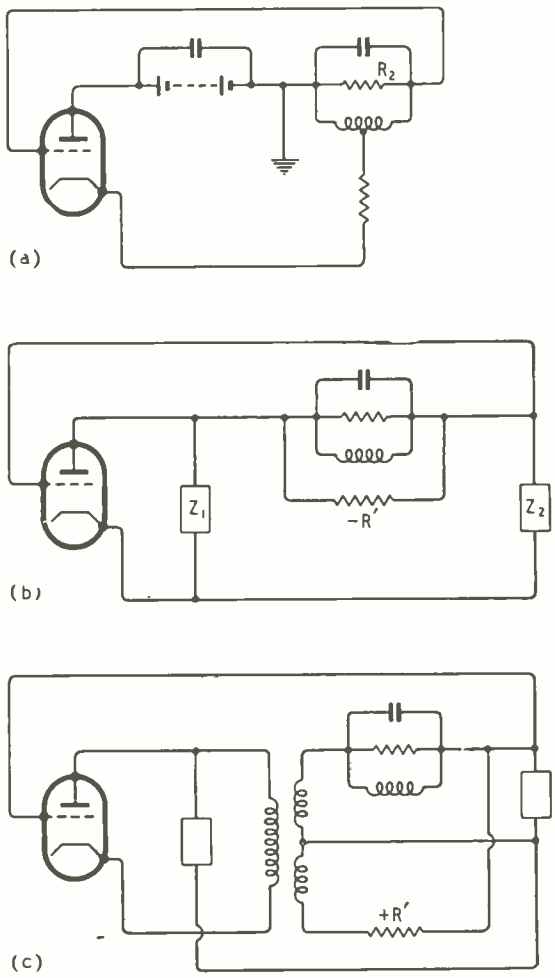


Fig. 6. The bottom of Fig. 5 looks like this as we calculate the cathode transformer.



Right: Fig. 7. Drawn as in (a) the circuit shows the bridged-T form. After the T-π transformation (b), and a further rearrangement (c), the circuit assumes a bridge form.

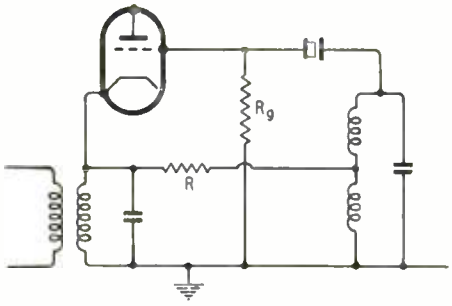


Fig. 8. You want to add a crystal? Just plug it in, and add a grid leak. The value of R needs to be reduced by a few per cent.

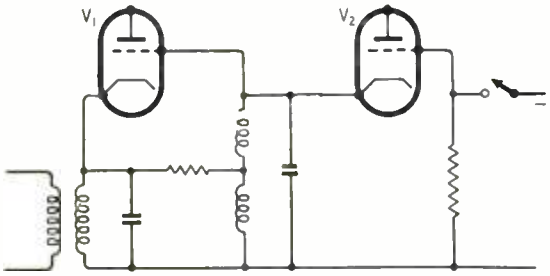


Fig. 9. The triode V_2 can be used to key the oscillator and provide the same starting phase to each pulse.

happens next, but by means of T—π transformation the network can be converted into the form of Fig. 7(b), with the shunt arm R transforming to a negative resistance —R′ this is the method used to obtain an infinite-Q rejection circuit, and it was described in *Wireless World* some years back[4]. A further operation gives us the equivalent circuit shown in Fig. 7(c), with a transformer providing a phase reversal on one side so that a positive R′ can be used.

Now we can see what is happening. The resistance R′ produces positive feedback from anode to grid, but this is offset by the negative feedback through the LCR circuit, except at the anti-resonant frequency of the LCR circuit. At this frequency the negative feedback through R_2 is not quite enough to prevent oscillation: at harmonic frequencies, of course, there is a lot of negative feedback, so that harmonics, and hum, too, are suppressed. Drawn in this way the circuit is obviously a bridge and has all the advantages of a bridge circuit. The reader may wonder why the oscillator does not include a thermistor for amplitude control, thus ensuring completely Class A operation. The answer is simple: thermistors with a suitable characteristic are hard to come by. For the example we have discussed the thermistor, which would replace the resistor R, would need to be about 12,000 ohms with an applied voltage of about 10 volts—a dissipation of the order of 10 mW. Furthermore, the resistance must rise with applied level. If this B-type characteristic were readily available it might be worth reconsidering the design to see if we could apply thermistors.

An interesting extension of the oscillator is to crystal control. It is not, I suppose, one of the very best crystal circuits, but it has a feature of extremely great value: the crystal current is predetermined quite accurately, so that there is no reason why the crystal should be overloaded. The necessary modification for crystal control is shown in Fig. 8. The circuit without the crystal is designed in the way already described, and is set up to give oscillations at the required frequency. The amplitude of oscillation is adjusted by trimming R. Suppose that this amplitude is 20 V, and that the recommended maximum crystal current is 25 μA. By choosing $Rg = 1\ M\Omega$, the crystal current cannot exceed 20 μA, because the grid swing, which is equal to the cathode swing, can only drive this current through the crystal and Rg in series. When the crystal is inserted, of course, the oscillator will probably not oscillate, because R will be just too high. A very small reduction of R will be needed to make up for the loss in the series resistance of the crystal. In this circuit the crystal is operating in its series mode, and I can see no reason why it should not be worked on an overtone, although I have not yet tried this.

One final variant is shown in Fig. 9. This is actually better known than the oscillator itself. It is a method of keying this oscillator to produce a very clean square wave-train which always starts with the same phase. When the key is down, V2 is completely backed off, and the oscillator functions quite normally. When the key is up, the grid of V2 goes to earth, V2 conducts and damps the tank circuit so heavily that the oscillations just stop. Each time the key is operated, therefore, the cathode of V2 drops sharply, brings the grid of V1 down with it, and the circuit is all set at a peak of the sinusoid, free to oscillate. This form is described in "Waveforms," referred to above.

The modified Hartley oscillator described in this article is an extremely simple and good circuit. As we have seen, it can be described as a bridge circuit; and it might also be well described as an over-balanced rejector circuit oscillator.

[4] June 1950, p. 223

Measuring Interference

DIFFICULTIES have for some time been experienced both in Germany and in this country in correlating the data on the measurement of interference from motor vehicles obtained in each country. Tests were, therefore, arranged through the Electrical Research Association and the Fernmeldetechnisches Zentralamt, with the co-operation of Joseph Lucas, Ltd. and the Bosch Co., in order to compare the behaviour of the British and German measuring equipment under identical conditions.

A comparison of the two types of equipment, as a result of tests which were carried out in January last year at the F.T.Z. at Darmstadt, is given in a report published by the E.R.A. This report (M/T123) entitled "Radio Interference from Motor Vehicles," by A. H. Ball and S. F. Pearce, shows that the British interference measuring equipment (Post Office measuring set RI2) will give indications of field strength from an ignition system approximately 20 db lower than that obtainable with the German set.

The results of the tests show why more elaborate suppression was required in Germany to meet the proposed limit of 120 μV/m than has usually been found necessary to conform to the British limit of 50 μV/m. Experience in Germany would be comparable with that in Great Britain if the proposed German limit were increased to 500 μV/m.

The report is obtainable from the British Electrical and Allied Industries Research Association, Thorncroft Manor, Dorking Road, Leatherhead, Surrey, price 10s 9d by post.

The Transistor in

By S. KELLY*

DURING the five years since the introduction of transistors, considerable effort has been expended not only in the development of the transistors themselves but also in circuit techniques and associated components. The prime advantages of the transistor are the ability to work at very low power levels with high efficiency, small size and light weight. The disadvantages of currently available transistors are higher noise level than equivalent vacuum valves, rather bad temperature coefficient, and greater variability of characteristics than vacuum valves. So far as can be seen at present, the first and last of these criticisms are a question of manufacturing techniques and will be overcome as quantity mass production of transistors becomes fact. The question of temperature coefficient appears to be bound up in the nature of the beast and, for the time being at any rate, must be suffered. Variations in transistor characteristics and temperature coefficient can be compensated by circuit design, but are usually wasteful of gain, and with the present high cost of transistors cannot usually be justified on economic grounds for commercial applications.

It is important to appreciate that the transistor behaves almost as the dual of the familiar vacuum valve.[1] Additionally, there is considerable reaction between the input and output circuits coupled to the transistor, which is almost entirely absent in vacuum valve circuits at low frequencies, thus requiring an entirely different approach to circuit design. Unfortunately, junction transistors have not so far been generally available in this country, with the consequence that practical experience, which alone can give familiarity with any technological process, has been denied to the majority of designers.

Apart from specialist uses, such as for military requirements, computors, and the telephone industry, the main outlet for transistors in the domestic field in the next few years would appear to be in hearing aids and miniature "personal" radio receivers, where the high initial cost of the transistor is more than outweighed by the considerable saving in running costs. So far as can be seen, the transistors will all be of the junction type.

An output power of 2.5mW at 10 per cent distortion can be obtained from available junction transistors for a current consumption of 2mA at 3V, or an efficiency of 42 per cent. A modern hearing aid sub-miniature output pentode gives 0.95mW output at 10 per cent distortion for a total battery power consumption of 15.25mW with an efficiency of only 6 per cent. The significance of the transistor will be appreciated by those who have not already had experience of maintaining small battery-operated devices, when it is realized that the cost of "high-tension" power from batteries may cost as much as £5 per kilowatt hour as compared with, say, 1d from the national electricity supply grid.

Because of the low voltages and currents involved, the design of really sub-miniature components becomes a practical proposition, and the reader is referred to the article "Components for Transistors," by G. W. A. Dummer (*Wireless World*, May, 1953). These components, however, have been developed for the Services, and are not yet generally available.

Transistors can be used in various ways: (a) earthed base, (b) earthed emitter, and (c) earthed collector. Fig. 1 shows their approximate equivalent vacuum valve circuits.

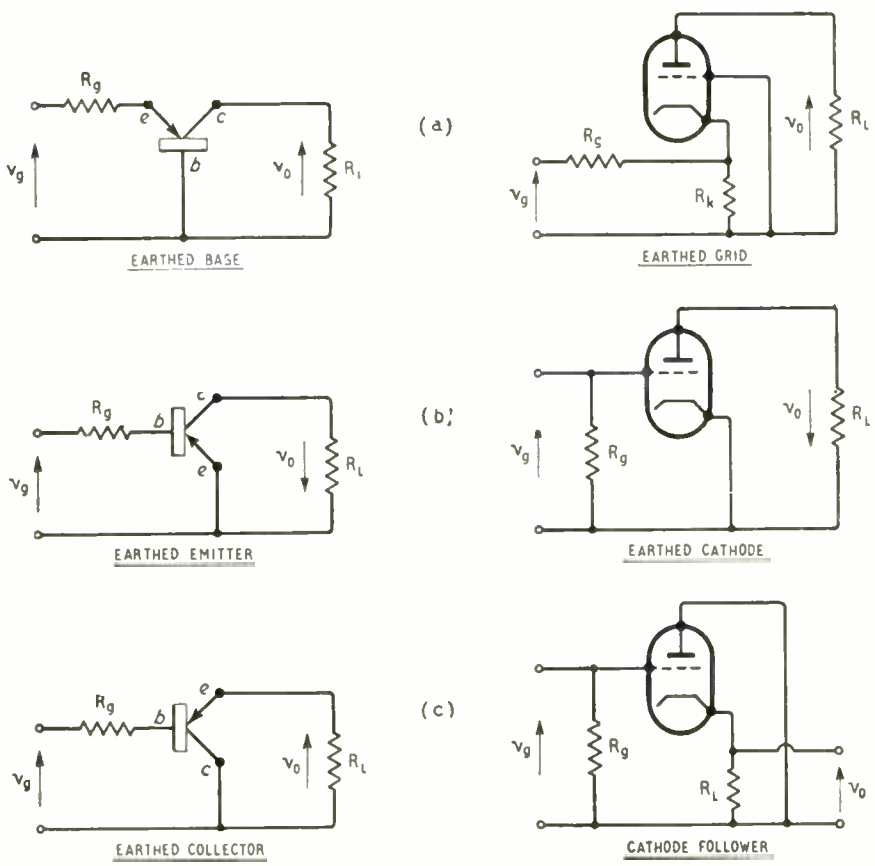


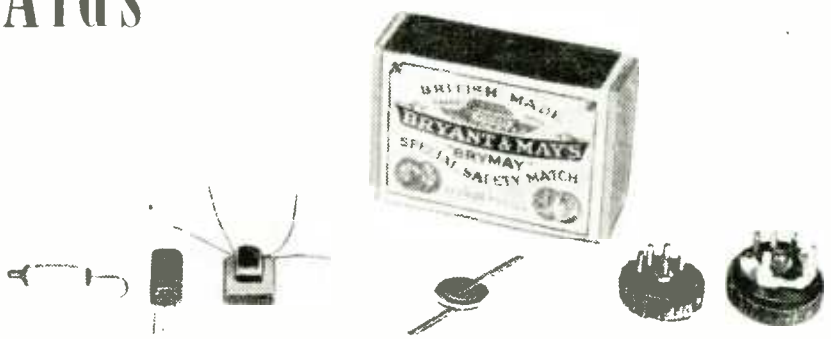
Fig. 1. Transistor circuits and their approximate valve duals.

* Cosmocord, Ltd.

[1] R. L. Wallace and G. Raisbeck. *B.S.T.J.* April. 1951

Hearing Aids

Its Impact on the Design of Components



Some typical transistor hearing aid components. (Left to right) 6μF electrolytic coupling capacitor, junction transistor, coupling transformer, bias cell, on-off switch and low-resistance logarithmic volume control.

It is emphasized that these are approximate only, but they are a good practical working guide. Application of feedback to the equivalent circuits can give an exact correlation,[2] but it is not justified in this dissertation.

When used as an earthed base amplifier, the input resistance lies between 40 and 100Ω and the output resistance between 100kΩ and 300kΩ; the power gain will vary from 10 to 20db for a variation in load impedance of 1,000 to 10,000Ω. As shown in Fig. 1 (a), this form of connection behaves very much the same as an earthed grid triode.

The earthed emitter gives the same general effect as a normally connected triode with the cathode at earth potential. The input resistance is 500 to 1,200Ω, the output 20kΩ to 100kΩ; the power gain is 20 to 30db for a source resistance of 800 to 1,200Ω, and a load resistance of 15kΩ to 25kΩ (Fig. 1 (b)).

When used as an earthed collector, Fig. 1 (c), the cathode follower configuration is approximated. The input resistance will vary from 10kΩ to 200kΩ when the load resistance is varied from 500 to 10,000Ω, the power gain being almost constant at about 10db for a variation in load resistance of 300 to 10,000Ω.

Circuit Design

From the above it is seen that there is considerable interaction between the input and output circuits, and the determination of the operating point, particularly when using a single power source (which is dictated by the ease of battery replacements, servicing, etc.), becomes a complicated affair. However, for the majority of audio-frequency applications, the earthed emitter configuration is used and the circuit designed backwards (i.e., decide power output, determine the best load resistance, then work towards the front end).

As we have seen, the input resistance of the average transistor working as an earthed emitter is of the order of 1,000Ω as against, say, 0.5 to 5MΩ for the grid resistance of a vacuum valve. The output impedance of the transistor will usually be of the order of 20,000Ω, and for maximum power gain the load resistance should approximate this value. In cascade circuits, some form of impedance transformer will therefore be required to couple the stages. Were transistors not so costly, it would be possible to use an earthed collector transistor as the impedance-transforming device between the earthed emitter units. Under present conditions it is more economic to use a transformer.

The transformer shown third from the left in the photograph measures 0.375in × 0.375in × 0.25in. The stack of 0.008in thick Mumetal laminations has a core cross-sectional area of 0.096in × 0.096in and the bobbin is 0.25in cube. The primary is wound with 3,500 turns of 49 s.w.g. and the secondary with 800 turns of the same gauge of wire. The insertion loss of the transformer at 3,000c/s is 2.7db under working conditions, the primary inductance being 6 henrys when measured with 0.1 volt a.c. across it.

The coupling condenser, which is of the electrolytic type, has a value of 5 to 10μF, in order to maintain the bass response with the low value of the load resistance. Compared with the remainder of the components, the electrolytic condenser is somewhat large, and some Continental manufacturers have replaced it with a modified form of bias cell (fourth from left in the photograph). This requires the circuit constants to be slightly rearranged so that a maximum potential difference of 1.2 volt across the cell terminals is not exceeded. Under these circumstances, the bias cell behaves as a capacitance of 30μF at 3,000c/s, the impedance being approximately constant with frequency and the leakage current negligible.

One of the severest headaches encountered to date has been the provision of sub-miniature volume controls with a low resistance value of 5,000Ω and a logarithmic track. These are now available in production quantities and when used between the first and second stages of the amplifier, the noise level is considerably less than that due to associated circuits.

Choice of Microphone

Valve-operated hearing aids almost invariably use piezo-electric microphones, the input resistance of the amplifier is usually of the order of 10 to 30 MΩ, and the design of the microphones is directed to obtain the highest practical open circuit voltage sensitivity. To this end, small crystals using series elements are used, resulting in an output of approximately 3 millivolts with a source capacity of 300 to 500pF. But the transistor has a low input impedance and must be thought of as a power-operated rather than a voltage-operated device.

Crystal microphones can be used successfully with transistors by using an appropriate matching trans-

[2] R. F. Shea, "Transistor Circuits" Chapter 15.

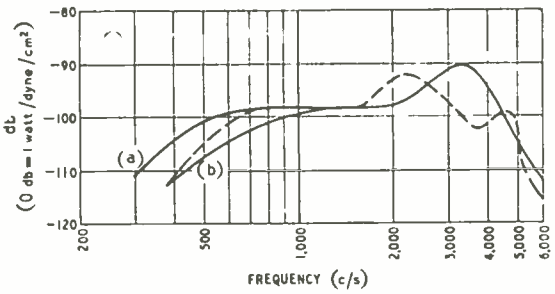


Fig. 2. Response of parallel-connected crystal with transformer working into 1,000-ohm load. Microphone capacitance (a) 4,000pF, (b) 2,000pF. A typical magnetic microphone response is shown dotted.

former. If a normal type of hearing aid microphone is used, the primary inductance of the transformer would need to be between 100 and 200H for adequate bass response. This high value of primary inductance can be reduced to approximately 20H or even less if certain elementary modifications are made to the crystal assembly. It can be shown that if a parallel combination of crystal elements instead of the usual series arrangement is used, the voltage is reduced by half, and the capacitance increased by four times—which, in terms of available *power*, is exactly the same as the first case. If the crystal is further subdivided, into a total of four elements, the capacitance is increased 16 times and the voltage output reduced to a quarter. (These two latter combinations giving between 2,000 and 4,000pF and 10,000 and 20,000pF respectively.)

Coupling Transformers

It thus becomes a practical proposition to design a sub-miniature matching transformer to couple the microphone to the transistor. In the case of the four-element crystal, the transformer previously described functions quite satisfactorily, but the crystal element is a rather costly proposition. The two-element parallel crystal can be used successfully if the primary inductance of the coupling transformer is approximately 20H. The absolute value is arranged to resonate with the microphone crystal capacitance at the low-frequency end of the spectrum (the −3db point). This has been taken as 750c/s for hearing aids, and without any secondary loading there will be a resonant rise in current at this frequency. The turns ratio is adjusted to give the maximum power transfer at 1,000c/s, resulting in a virtually aperiodic system, and a fall of 6db per octave below 750c/s. The actual transformer winding consists of 6,000 turns of 50 s.w.g tapped at 600 turns, and is used as an auto-transformer to conserve space.

The sensitivity of the microphone plus transformer is −100db referred to 1 watt per dyne per cm² at 1,000c/s and can be maintained easily to 6kc/s (Fig. 2). It should be noted that the high-frequency performance of these miniature transformers is extremely good, considering their simple construction, some units being only −1db at 20kc/s referred to the 1-kc/s level.

Magnetic-type microphones, which can be manufactured quite economically for low-impedance working, are quite a practical proposition, the coil being wound to give the correct source impedance for matching the input impedance of the transistor. The majority of present-day magnetic microphones are very similar in construction to the magnetic telephone receiver with the addition of an auxiliary diaphragm. The power sensitivity of these units is the same as the crystal microphone, being approximately −100db referred to 1 watt per dyne per cm.² With one or two notable exceptions, the high-frequency response is not good, there being a rapid cut-off above the main resonant frequency, which is usually about 2,500c/s.

The modern insert magnetic telephone receiver is characterized by high power sensitivity, good low-frequency response, and low distortion; but the high-frequency response could, with advantage, be improved. In most units the peak sensitivity is at about 2kc/s with a very rapid fall-off in sensitivity beyond 2.5 to 3kc/s. They can be wound to any required impedance between about 25 and 10,000Ω and can therefore be connected directly in the transistor collector feed circuit without an isolating transformer. Excellent impedance match can be obtained and they will give an output in excess of +120db referred to 0.0002 dyne per cm² (threshold level) for 2 milliwatts input power. This is usually adequate for most hearing aid and miniature receiver requirements.

Fig. 3 shows a complete hearing aid amplifier circuit which has performed satisfactorily with both American and British junction transistors.

Maximum power output, whilst keeping within the limiting values imposed by the transistor manufacturers, requires rather critical control of the base bias resistor, and it has usually been necessary to vary this resistance for optimum conditions, the value usually lying between 5kΩ and 30kΩ. Once the optimum value has been determined, it can be considered fixed for the life of the transistor, provided that the unit has not

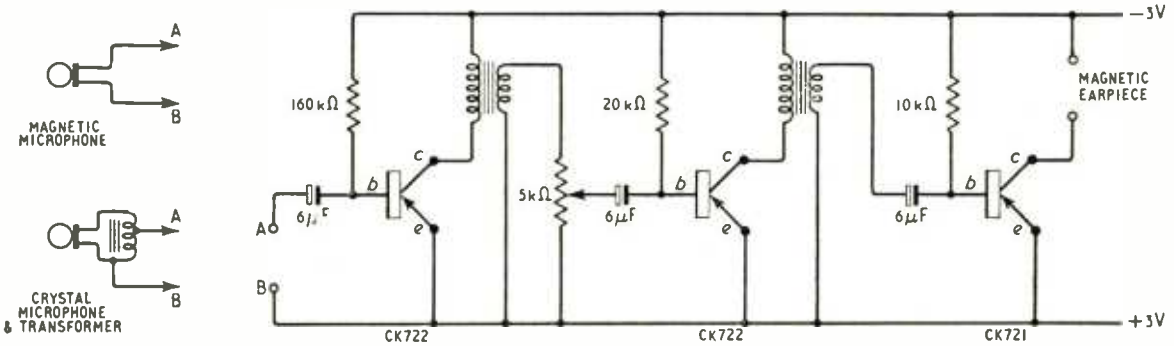


Fig. 3. Hearing aid circuit which gives good results with many makes of junction transistor.

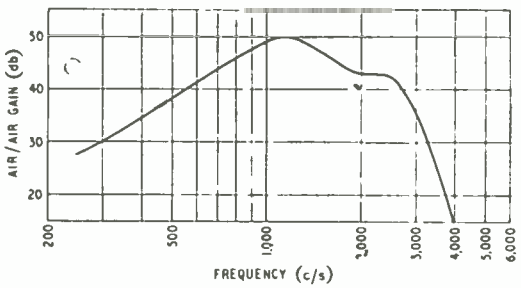


Fig. 4. "Air-to-air" overall gain of the hearing aid whose circuit is given in Fig. 3.

been exposed to temperatures in excess of about 60 deg C. It has been found easier to adjust the resistance until the collector current is of the order of 2 to 2.2mA, although for greater power output it can be adjusted for a maximum of about 4mA. This results in a reduction of the input impedance of the transistor and the coupling transformer turns ratio must be adjusted accordingly.

The second stage is not critical, but the adjustment of the base resistor can vary the overall gain quite considerably. Here, however 20kΩ has proved more satisfactory.

Noise Reduction

Either magnetic or crystal-cum-transformer microphones may be used, and the circuit is generally self-explanatory. There are, however, one or two points which need amplification. Usually the first transistor has to be carefully selected for noise and it has been found expedient to vary the base bias resistor for optimum results—about 160kΩ results in the best compromise between maximum gain and maximum signal-to-noise ratio.

The coupling transformers are the units previously described, and the maximum working gain is of the order of 80 to 85db. It is flat from about 500c/s to 15,000c/s. With care, the noise level can be dropped within 20db of Johnson noise. Transistor noise differs from other common types such as thermal and shot noise in that transistor noise per unit bandwidth varies approximately inversely with frequency,[3] (i.e., each octave of the frequency range contains the same noise power). The representative value of the collector open circuit noise voltage is 5 to 15 microvolts; the emitter open circuit voltage is usually 30 or 40db below this value. The total noise is, however, very dependent upon the operating point. The emitter noise is almost independent of the collector voltage whilst the collector noise depends strongly on it. In addition to this dependence on operating conditions, noise is also very dependent upon operating temperature, and, generally, the increase in noise is such as to detract considerably from the use of transistors in fairly low level circuits for use in temperatures in excess of 40 deg C. Additionally, the transistor parameters vary very considerably with temperature. For example, the collector resistance under a given set of conditions can vary from 100kΩ to 50kΩ over a temperature range of 20 deg to 70 deg C. The latter is considerably above normal ambient temperatures and will not usually be reached with transistors working under low power conditions, but this temperature can certainly be obtained if the transistor is called upon to deliver more than a few milliwatts of power.

Fig. 4 shows the air-to-air response of the complete hearing aid receiver, and before the high-fidelity enthusiasts raise their hands in pious horror, a word of explanation may be offered. The amplifier portion is quite flat in the high-frequency region, and the very rapid fall off with frequencies above the peak is due almost entirely to the insert telephone receiver. The low-frequency cut-off is deliberately engineered in the microphone circuit in order to provide the most desirable frequency response of +12db per octave which, according to the Medical Research Council Report No. 261, results in optimum articulation efficiency for deaf people. The overall performance is by no means ideal, but is comparable with the average two-valve and some of the three-valve hearing aid units being offered to the public today. The high-frequency response could be materially improved with a better high-frequency performance on the part of the telephone receiver. It may be thought possible to compensate for this lack of high-frequency response by altering the frequency characteristic of the amplifier or microphone, and this would be satisfactory if the unit were not required to run at peak power over the whole frequency band. Obviously, if the output transistor is delivering peak output at 1,000c/s and a rise in frequency characteristic is built into the pre-amplifier, it will be grossly overloaded at these higher frequencies although, at lower levels, the measured frequency response may appear superior.

Much remains to be done in component development for use with transistors and, in this country at least, it can be said that generally transistor development is ahead of associated components. But, to revert to the introductory remarks, it is a pity that more transistors were not generally available earlier, because they are delightful little beasts and tend to grow upon one.

[3] H. C. Montgomery. *Bell Lab. Record* Sept., 1949.

PRODUCTION CONTROL

IN the report of the specialist team* on production planning and control which visited the United States in 1951, the use of radio as an aid to production control—in some quarters erroneously called radio control—is strongly recommended to British industry.

One of the first engineering concerns to employ radio communication to co-ordinate the movement of goods in its factories was Davey, Paxman and Company, of Colchester, Essex. Their installation, which includes five mobile units and a control station, was initially installed by Pye two years ago. Operating on 172.2 and 182.2 Mc/s, which are shared with (among others) a London taxi organization, the fixed station can readily be received at Harwich Quay, over 25 miles away. Its main use, however, is for the co-ordination of movement of heavy cranes and fork lifts within the main works and the conveyance of goods between the two factories which are about a mile-and-a-half apart.

With the proposed clearing of Band 3 to make room for an alternative television service, the position of such users is threatened and the recently formed Mobile Radio Users' Association is strongly contesting the users' case.

*Among the 12 members of the team were representatives of Plessey, B.T-H., E.M.I. and Automatic Telephone & Electric Co.

Measuring Non-Linearity

By D. C. PRESSEY, B.Sc. (Lond.)*

DISTORTION arises as a result of non-linearity in the input versus output characteristic of apparatus, and has been the subject of two recent articles in *Wireless World*[1,2]. This article has been written with the object of supplementing them with a method of measuring non-linearity that is simple, and has found numerous applications.

When the input is sinusoidal the output contains harmonics of the input frequency as well as the fundamental, and to measure or examine the distortion the fundamental must be somehow removed.

For the purpose of diagnosis, Wigan[1] has described a rather elaborate method for subtracting the fundamental; it requires both filters and phase-shifters. Tyler[2] uses a fairly simple valve filter to remove the fundamental.

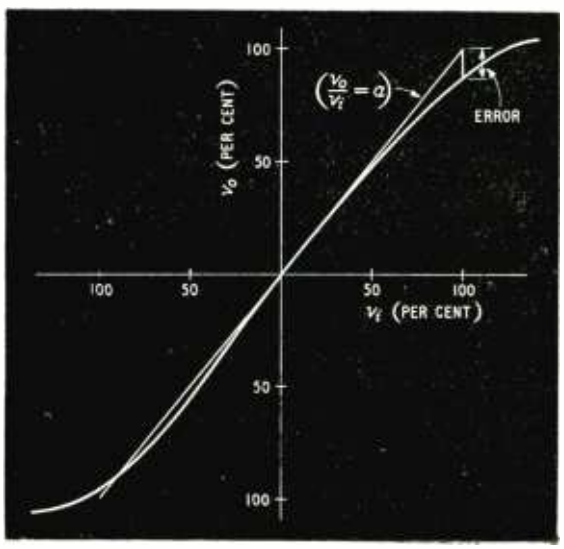
The disadvantages of filters are that they may shift the phase of harmonics, and that they restrict the test frequency to that for which the filters were designed.

In the following method the substraction is carried out by a frequency-insensitive element, so that tests may be carried out from zero-frequency upwards and without the need, in general, of pure sine-wave test signals.

The basic principle is simply that if the apparatus is linear, and of gain A, the output may be cancelled by adding to it a voltage A times the input voltage, but in anti-phase to the output. If the apparatus is non-linear incomplete cancellation results, the difference being exactly equal to the amount of the non-linearity for every value of the input voltage.

* Southern Instruments Ltd., Camberley, Surrey.

Fig. 1. Illustrative input/output characteristic.



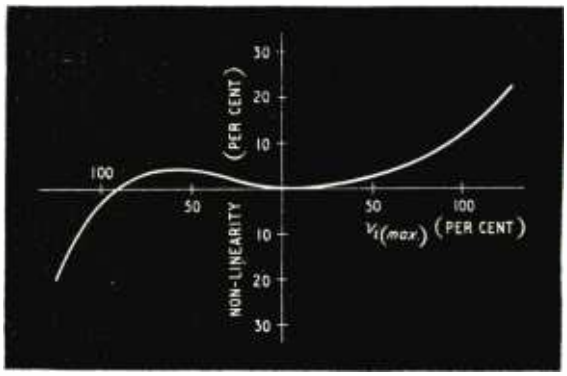


Fig. 2. Here, the non-linearity of the characteristic of Fig. 1 is plotted as a percentage of the nominal maximum output $av_{i(max)}$, against the input v_i. These two figures incidentally illustrate the difficulty of observing non-linearities of below 3% on c.r.t. displays corresponding to Fig. 1.

This method was developed particularly to measure the non-linearity of d.c. computing amplifiers and other units having non-linearities of the order of 1% or less, but it is entirely suitable for less rigorous tests.

The process can be formulated mathematically as follows. The relationship between output and input can be written :—

$$v_o = av_i + bv_i^2 + cv_i^3 + \quad .. \quad .. \quad .. \quad (1)$$

where the coefficient a defines the gain, and b, c, etc., are the coefficients of the non-linear terms. This relationship is depicted in Fig. 1, showing also that a is the slope of the tangent to the curve at the origin. If the apparatus were linear the output would be av_i, and adding $-av_i$ to equation (1) gives :

$$v_o - av_i = v_e = bv_i^2 + cv_i^2 + \quad .. \quad .. \quad (2)$$

Strictly, the percentage non-linearity is given by :

$$N = (v_e/av_i) \times 100\% \quad .. \quad .. \quad .. \quad (3)$$

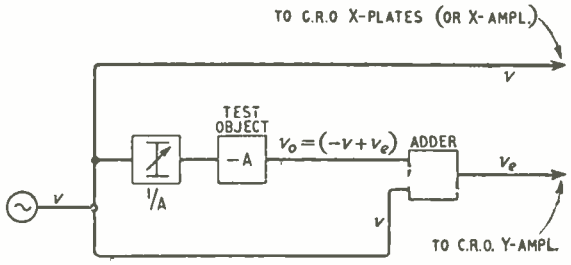


Fig. 3. Suitable experimental arrangement.

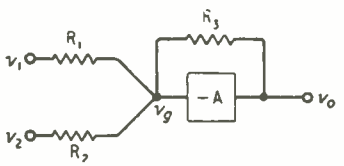


Fig. 4. Amplifier connections to provide an output proportional to the sum of two inputs. Typically $R_1 = R_2 = R_3 = 1M\Omega$.

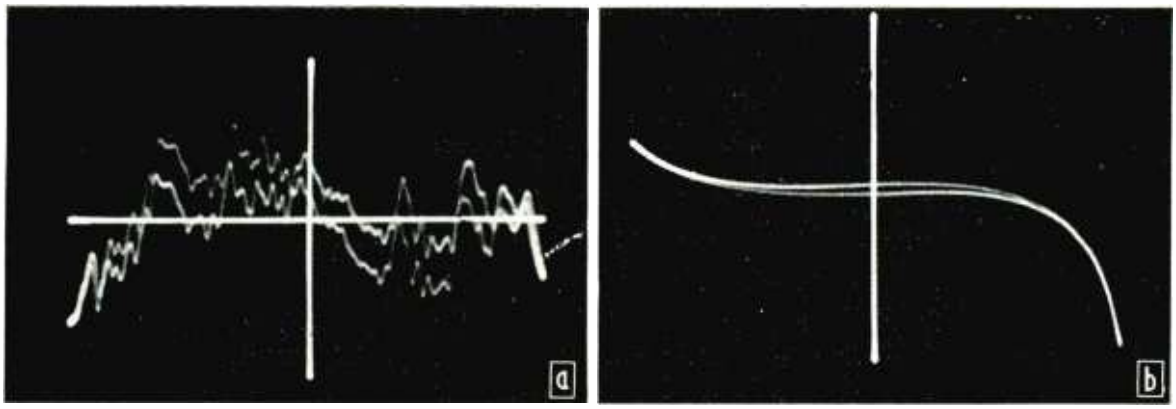


Fig. 5. The trace (a) shows the error in the output of an analogue multiplier. The irregularities are due to a scanned edge, and the separation of the traces is due to hum. The gain has been taken as the value which gives minimum peak-peak value to the error voltage. The amplitude of the calibration line is ± 0.5%. In (b) is shown the error of a paraphase amplifier adapted from the circuit of Fig. 6(a) by applying the input to R_1 and omitting R_2. In this case the error curve is horizontal at the origin. The amplitude of the calibration line is ± 1%.

but it is more convenient, and more usual, to calculate the non-linearity as a percentage of the nominal maximum output; i.e., $av_{i(max)}$ is used in place of the term av_i in equation (3). The non-linearity of the curve in Fig. 1, is plotted on this basis in Fig. 2.

This way of defining the gain leads to the simplest mathematics, and is correct for audio amplifiers and many others. For other applications (e.g., oscilloscope amplifiers) it is more convenient to define the gain as the slope of the best straight line, which, in this case, is that straight line drawn through the origin which gives minimum errors at all points throughout the working range.

In d.c. amplifiers for analogue computers the quantity v_e is frequently called the "error" due to the amplifier, leading to the name "error curve" for the curve of Fig. 2. As it shows the departure from true linearity of the apparatus this term is thought to be more descriptive than "difference diagram," as used by Wigan. Furthermore, the error of a meter is expressed in this way, $av_{i(max)}$ corresponding to full-scale deflection.

Experimental Arrangement. The simplest and most accurate arrangement for testing a phase-reversing amplifier by this method is shown in Fig. 3. If the attenuator is adjusted till the error curve is horizontal at the origin, or till the errors are minimal, depending on the application of the unit, the attenuation is then equal to 1/A, A being the gain of the test object. The value of N is found by calibrating the Y-amplifier by means of a suitable fraction of v. The adding unit is of the type used in analogue computers. For d.c. tests the oscilloscope X and Y amplifiers can be replaced by meters.

Fig. 5 shows some of the results obtained.

The adding unit is a negative-feedback amplifier connected as in Fig. 4. For $R_1 = R_2 = R_3$ and a sufficiently high gain the output approximates to the sum of the inputs, i.e.,

$$v_o \approx (v_1 + v_2) \quad .. \quad .. \quad .. \quad .. \quad (4)$$

For example, for $A = 150$, $v_o \approx 0.98\ (v_1 + v_2)$, which is sufficiently accurate for many purposes. If required, perfect addition may be obtained by making

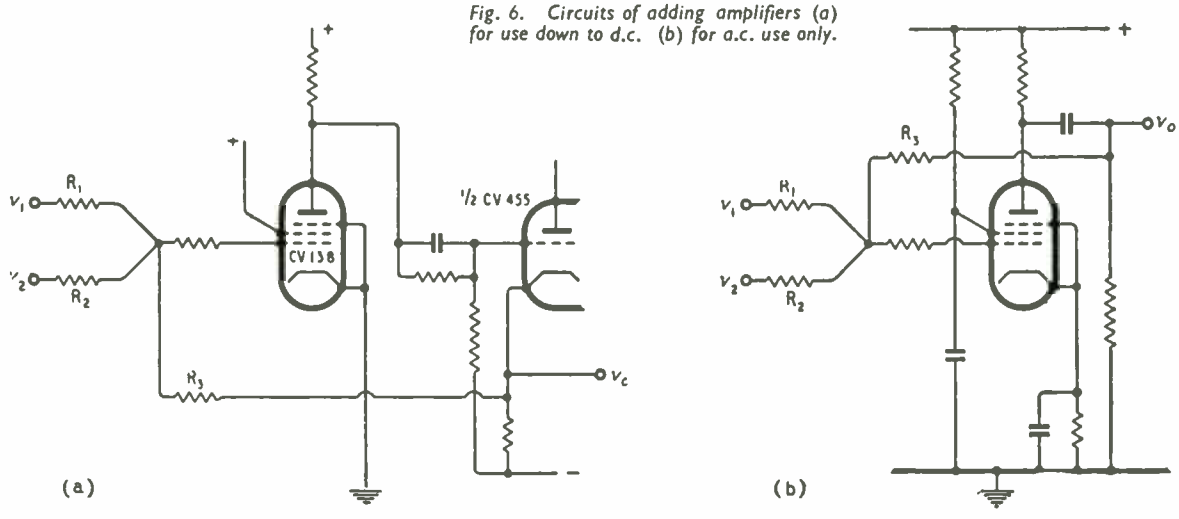
$$R_3 = R(A - 1)/(A + 2) \quad .. \quad .. \quad (5)$$

where $R_1 = R_2 = R$

These formulæ are derived in Appendix 1.

A suitable circuit is shown in Fig. 6 (a). For a.c. use only, the simpler circuit of Fig. 6 (b) can be used.

Fig. 6. Circuits of adding amplifiers (a) for use down to d.c. (b) for a.c. use only.



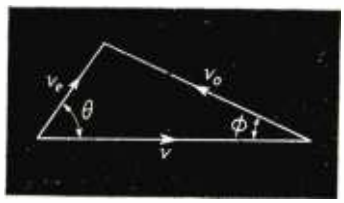


Fig. 7. Vector diagram for the equation $v_e = v + v_o$. The amplitudes and phase angles are shown. If v is taken as the reference phase, then conventionally, both v_o and ϕ are negative for the case shown.

In the computer field such arrangements are known as "adders," or "adding amplifiers."

For the a.c. tests of non-phase-reversing units the problem of phase-reversal is simply solved by the use of a centre-tapped transformer to supply test signals to the adder and the test object in antiphase. For d.c. tests a paraphase amplifier must be inserted between the attenuator and the unit under test, except when this has a gain of less than unity, when it is best to insert it in the lead to the adder, as it then has to handle smaller signals. The non-linearity of this unit has to be added to the measured error; its non-linearity being simply measured by first omitting the test object and attenuator.

The attenuator may be dispensed with when the gain of the unit under test does not differ greatly from unity by adjusting the ratio of (R_1/R_2).

Requirements of Test Apparatus and Precautions.—It is essential for the adder and Y-amplifier (and X-amplifier and attenuator if used) to be free from phase shift at the test frequency. At 50 c/s, or even 1,000 c/s, this presents little difficulty. When testing at mains frequency, it is advisable to observe the c.r.o. trace before applying the test signal to the adder and the test object in order to note any hum. If the test object introduces any phase-shift the error curve will take the form of a loop.

A saw-tooth test signal may be used (e.g., a c.r.o. time-base) *providing that* the frequency response of all units, including the one under test, is flat over the range of frequencies contained in the saw-tooth. This is quite a stringent requirement as harmonics up to twenty times that of the recurrence frequency will normally be present.

Accuracy.—The method is inherently very accurate provided that the adder is carefully adjusted to give no output for equal and opposite inputs. Subsequent errors in measurement of the error voltage are of secondary importance. Thus if a paraphase amplifier giving a nominal 50 volts out has a measured error voltage of 50 millivolts then the non-linearity is 0.1%, but if there is, say, a 10% high error in the measurement of the error voltage the true figure for the non-linearity is 0.09%. If the output had been measured directly, however, and the measuring instrument had given a 10% high figure (i.e., 55.05 volts) the figure for the non-linearity would have appeared to be 10.1% instead of 0.1%.

Measurement of Phase-Shift.—Phase-shift is usually accompanied by a change in the output level. To measure these it is necessary to use a pure sine-wave input and to decrease the input level until the test object is substantially linear. The c.r.o. display will then be elliptical if the phase shift is present. The amplitude and phase angle of the error voltage are then determined[3,4]. If these are v_e and θ then the amplitude error is given by $(v - v_o)$, which may be expressed as a percentage or as a number of decibels in the usual way, where v_o is given by:

$$v_o = \sqrt{(v^2 + v_e^2 - 2vv_e \cos \theta)} \quad .. \quad .. \quad (6)$$

and the phase angle is given by.

$$\phi = \cot^{-1}[(v/v_e) \operatorname{cosec} \theta - \cot \theta] \quad .. \quad (7)$$

The formulæ are derived in Appendix 2.

Further Applications.—It is possible to apply this technique of error measurement to the testing of servo-mechanisms providing that the input and output are, or can be converted into, voltages. It is thought that it may be possible to carry out what have been referred to as two-terminal tests[1] by the provision of a reference signal.

Acknowledgements.—The author wishes to record his indebtedness to his colleagues and to Mr. J. A. Colls for helpful discussions.

APPENDIX 1

The analysis of the circuit of Fig. 4 is as follows. Denoting the gain of the amplifier by $-$ A, we have

$$(v_o + v_g) R_3 = (v_1 - v_g) R_1 + (v_2 - v_g) R_2 \quad (1)$$

and

$$v_g = -Av_o \quad (2)$$

From (1), putting $R_1 = R_2 = R$

$$v_o = [(v_1 + v_2)R_3/R] - v_g(1 + 2R_3/R) \quad .. \quad (3)$$

From (2) and (3)

$$v_o = (v_1 + v_2)(1 - 1/A - 2R_3/AR) \quad .. \quad .. \quad (4)$$

showing that the output is equal to the sum of the inputs multiplied by a constant factor. For $R_3 = R$, this reduces to

$$v_o = (v_1 + v_2)(1 - 3/A) \quad .. \quad .. \quad .. \quad (5)$$

which approaches unity as A approaches infinity. If required, perfect addition is obtained by making the factor exactly unity, and the condition for this is

$$R_3 = R(A - 1)/(A + 2) \quad .. \quad .. \quad .. \quad (6)$$

APPENDIX 2

Relationships between error voltage and output voltage.

Fig. 7 shows the vector relationship of the voltages involved. For the case shown, if v is taken as positive, then v_o and ϕ are negative, ϕ being a phase lag.

Clearly, for v_o we have

$$v_o = \sqrt{(v^2 + v_e^2 - 2vv_e \cos \theta)} \quad .. \quad .. \quad (1)$$

Also

$$v = v_e \cos \theta + v_o \cos \phi \quad .. \quad .. \quad (2)$$

and

$$v_o/\sin \theta = v_e/\sin \phi \quad .. \quad .. \quad .. \quad (3)$$

therefore

$$v_o = v_e \sin \theta/\sin \phi \quad .. \quad .. \quad .. \quad (4)$$

whence

$$v = v_e \cos \theta + v_e \sin \theta \cot \phi \quad .. \quad .. \quad (5)$$

$\therefore$

$$\cot \phi = (v - v_e \cos \theta)/v_e \sin \theta \quad .. \quad (6)$$

or

$$\phi = \cot^{-1}[(v/v_e) \operatorname{cosec} \theta - \cot \theta] \quad .. \quad (7)$$

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3. Scroggie, M. G., "Radio Laboratory Handbook" (5th Edition), p. 247 (Iliffe & Sons Ltd.).
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Centimetre-wave Oscillograph

FREQUENCIES of the order of 9,500 Mc/s can be displayed on an experimental c.r. oscillograph which has recently been built at Manchester. Described in a letter to *Nature* (5th December, 1953) by B. Jackson, D. R. Hardy and R. Feinberg, it uses a special 6-in aluminized c.r. tube with a highly actinic blue phosphor screen. The vertical electrostatic deflection system is formed by a twin-wire transmission line passing through the tube at right angles to its axis. This reduces the transit time of the electron beam in the deflection field and permits correct matching to the signal source. The deflection sensitivity of the tube is about 0.006mm per volt. A single-sweep time base of 1.3 milli-microseconds duration is used, giving a sweep width of about 4cm, and with this the writing speed amounts to approximately 5×10^{11}cm per second. The tube is magnetically focused and its trace is about half a millimetre wide.

The D.C. Component in Television

Video-Stage to C.R. Tube Coupling

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

IN a recent paper[1] D. C. Birkinshaw has stressed the importance of the d.c. component of the television signal to the correct reproduction of pictures and he illustrated his theme by a most convincing series of photographs. He pointed out that although considerable attention is paid to the maintenance of the proper level of the d.c. component in the B.B.C. transmissions it is considerably attenuated in many commercial receivers.

Out of 26 sets tested, only seven reproduced the d.c. component fully. Eight reproduced it with from 15% to 40% attenuation, six with 50%, three with 62% to 70% and two with 100%.

The d.c. component is, of course, the part of the picture signal which governs the mean brightness of the picture. Its absence or appreciable reduction means that the brightness control of the receiver will require re-adjustment whenever the mean brightness of the transmitted scene changes. If such re-adjustment is not carried out some pictures will be too dark, with a lack of detail in their darker parts, and others will not be dark enough and will have washy blacks and visible frame-flyback lines.

In view of this, it seems surprising that deliberate attenuation is often introduced in commercial receivers. As Birkinshaw states, however, it is often done with the aim of reducing aircraft flutter. It is, however, not essential to attenuate the d.c. component to do this; it is possible to reduce flutter in other ways,[2] the use of a.g.c. being probably the best method. In his paper, Birkinshaw did not consider how the d.c. component should be retained; he confined himself to showing the bad effect of attenuating it and he did this most convincingly. However, he did make one statement about circuit performance which is actually incorrect. He is hardly to be blamed for this, because most designers believe the circuit in question to be a satisfactory one and, until quite recently, the writer did also.

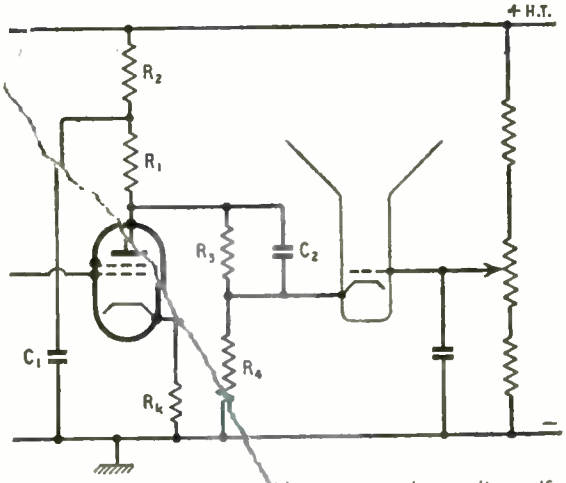


Fig. 1. A commonly-used video-stage to tube coupling. If the tube resistance is very high, the coupling is compensated and gives equal gain at all frequencies. The compensation is spoilt in practice by the input resistance of the tube.

The reference is to the common circuit (Fig. 1) in which the cathode of the c.r. tube is fed from the anode of the video stage through a voltage divider. This is done to keep the heater–cathode voltage of the tube within its rating and it inevitably reduces the d.c. component of the signal below the value existing at the anode of the video valve. To overcome this, the d.c. component is equally over-amplified at the anode of the video valve, usually by a correct choice of value for the anode decoupling resistor.

What has been overlooked in the past, and what makes it impossible to obtain the correct level for the d.c. component with this circuit, is the fact that a c.r. tube which is fed at the cathode has a fairly low input resistance. Moreover, it has an input resistance which varies greatly with the signal voltage.

The circuit in question is the well-known one of Fig. 1. In an a.c./d.c. set, the heater of the tube must usually be at chassis potential and the maximum allowable difference of potential between heater and cathode is usually 150 V; in some of the older tubes it was considerably less. The anode potential of the valve may well be 150–200 V and the voltage divider brings the cathode potential to $R_4(R_3 + R_4)$ of this figure.

At all frequencies within the picture signal, the capacitors are large enough to be short-circuits. The load on the valve is then R_1 in parallel with R_4 and, since R_4 is large compared with R_1, it is virtually R_1 alone. At d.c. the capacitors form open-circuits and the load on the valve is $R_1 + R_2$. The amplification at d.c. is $1 + R_2/R_1$ times as great as at higher frequencies, but only $1/(1 + R_3/R_4)$ of it is passed on to the tube. The d.c. component is fully retained if $R_2/R_1 = R_3/R_4$. In addition, if C_1 and C_2 are related in a certain way the overall amplification is constant at all frequencies. However, by a proper choice of their values, the amplification can be made to fall off at very low frequencies near to d.c. and the circuit can then give proper representation to the d.c. component while also reducing aircraft flutter.

All this is in accordance with the usual circuit theory and supposes that the c.r. tube has an input resistance which is very large compared with R_3

[1] "The Importance of the D.C. Component," *J. Televis. Soc.*, July-September 1953, Vol. 7, No. 3, p. 105.

[2] See "Television Interference by Aircraft," by A. H. Cooper, B.Sc. *Wireless World*, April 1949, Vol. 55, p. 142, for a discussion of the subject. Because of the input impedance of the c.r. tube the particular circuit and component values given in this article are unlikely to permit full retention of the d.c. component.

and R_4 in parallel. Quite normal circuit values would be $R_1 = R_2 = 3.5\ k\Omega$ and $R_3 = R_4 = 100\ k\Omega$.

Tube Input Impedance

Now a cathode-ray tube is exactly analogous to an ordinary valve as far as its electrical characteristics are concerned. Although figures for them are not usually quoted, it has a mutual conductance g_m and an anode a.c. resistance. It is well known that when a valve is used in a cathode input (earthed-grid) circuit it has a low input resistance of the order of $1/g_m$; it is commonly 100–500 Ω. A cathode-ray tube also has an input resistance of $1/g_m$ but, because the mutual conductance is small compared with that of a valve, the input resistance is correspondingly high. It is not often less than 50 kΩ.

The mechanism by which this comes about is quite simple. If the cathode voltage is changed by some small amount in a direction to increase the anode current (that is, cathode voltage changing negatively) this same voltage is operative between grid and cathode where it also acts to increase the anode current, but by μ times as much. The change of current is thus

$$i_a = \frac{e_k}{r_a}(1 + \mu)$$

where r_a and μ are the anode a.c. resistance and amplification factor of the tube. This current flows from the circuit which feeds the tube. An equivalent resistance R_{in} for the tube is one which, if connected to the driving circuit in place of the tube, would draw from it the same current. Therefore

$$R_{in} = \frac{e_k}{i_a} = \frac{r_a}{1+\mu} \approx \frac{1}{g_m}$$

It is possible to obtain figures for g_m from the ordinary tube maker's grid-volts-anode-current characteristics. At an operating voltage corresponding to peak white, the mutual conductance is usually about 0.02 mA/V, which makes $R_{in} = 50\ k\Omega$.

Like those of a valve, the tube characteristics are curved and the mutual conductance falls as the tube is biased back for reduced brightness, consequently the input resistance rises as the brightness decreases. Unlike a valve, however, a cathode-ray tube cannot be operated only over the straight part of its characteristic, for the beam current must be nearly, if not quite, cut off for picture black. As the signal varies the brightness between white and black, therefore, the input resistance must change from a minimum of the order of 50 kΩ to a high value approaching infinity.

In the circuit of Fig. 1, this tube resistance appears in shunt with R_1. At high frequencies, where the capacitors are short circuits, the load on the valve is R_1, R_1 and R_{in} all in parallel. If R_1 is 3.5 kΩ and R_4 is 100 kΩ, the load is $3.5 \times 100/103.5 = 3.38\ k\Omega$ in the dark parts of the picture where R_{in} is very large. At peak white, if R_{in} is 50 kΩ the load falls to $3.38 \times 50/53.38 = 3.17\ k\Omega$. The gain near white is about 94% of that near black. The effect on the tone graduation of the picture is that changes near white are not quite as great as they should be.

The magnitude of this effect is very small, however, and is both smaller and in the opposite sense to that brought about by curvature of the tube characteristics. It is therefore negligible.

At d.c., however, matters are quite different, for the tube is fed from R_3 and R_4 which have values of the same order of magnitude as R_{in}. Near black level R_{in} is large and will have comparatively little effect upon the circuit so that the d.c. component will be present at the tube cathode at very nearly its proper level. At peak white, however, matters are very different. Suppose $R_1 = R_2 = 3.5\ k\Omega$, $R_3 = R_4 = 100\ k\Omega$ and $R_{in} = 50\ k\Omega$. Then R_4 and R_{in} in shunt come to 33.33 kΩ, and the loading of the voltage divider on $R_1 + R_2$ (7 kΩ) is 133.33 kΩ. The load on the valve is $7 \times 133.33/140.33 = 6.65\ k\Omega$. At high frequencies the load is 3.17 kΩ, so the gain to the valve anode is at d.c. $6.65/3.17 = 2.1$ times the gain at high frequencies. The reduction factor to the tube cathode is $33.33/133.33 = 0.25$ and so the d.c. component is $2.1 \times 0.25 = 0.525$ of its proper level.

The result of using this circuit in practice is that if the brightness control is initially adjusted correctly on a rather dark picture, then when a picture of greater mean brightness comes along the brightness does not increase proportionately. The dark parts of the picture are too dark and the detail in them is lost. The brightness control has to be turned up for proper reproduction. Conversely, if the brightness control is initially adjusted on a bright picture then when a dark one is transmitted it will be reproduced too brightly; black will not be black, but dark grey, and the frame flyback lines will show. These effects are quite noticeable in practice.

It will now be clear that with the circuit of Fig. 1 a reduction of the d.c. component to 50% of its proper value is quite likely even when the designer has the intention of retaining it fully. Because of the variable nature of R_{in} it is not possible to compensate for it by any practicable change in the values of the components. Because the resistance is variable, its effect can be made negligible only by feeding the tube from a circuit having a resistance low compared with the lowest value of R_{in}. This is a condition which exists in Fig. 1 only at high frequencies and it is one which must be made to exist at d.c. also.

In the circuit of Fig. 1 this could be done if it were practicable to reduce R_3 and R_4 to about 10 kΩ only. They would then shunt R_1 and R_2 so much that these two resistors would have to be increased in value. The reduction of R_3 and R_4, coupled with the increase of R_1 and R_2, would require an increase of h.t. supply voltage to maintain proper operation of the valve. In an a.c./d.c. set this is usually impossible.

In commercial practice circuits of the form of Fig. 1 are often used but with values deliberately chosen to reduce the d.c. component. Quite often, for instance, R_2 is omitted. Even without the effect of the input resistance of the tube the d.c. component may then be reduced to 50% of its proper value; when the tube resistance is taken into account the reduction may be to 25% of the correct level. As already stated, this reduction is often deliberate and is introduced to alleviate aircraft flutter.

We are not concerned here with the question as to whether or not it is desirable to do this. There is no doubt that where aircraft flutter is not experienced it is desirable to retain the d.c. component fully. There is also very little doubt that it is desirable to remedy aircraft flutter, not by reducing the d.c. component, but by employing a.g.c. Whether or not it is commercially practicable to do so this is quite another matter.

For the present, therefore, we shall consider only how best to retain the d.c. component. It is clear that the use of the circuit of Fig. 1 is inadmissible. Two alternatives present themselves. The first is to utilize the circuit of Fig. 1 but to include a cathode follower between R_3R_4 and the tube. The second is to omit R_3R_4 and to join the cathode of the tube directly to the anode of the valve, adopting some other means of keeping the heater–cathode potential within bounds. The cathode follower is used in at least one commercial set, but mainly for other reasons. The second alternative is used in a good many sets and is applicable wherever it is possible to use a separate winding on a transformer to supply the heater of the tube. It is only in the case of the a.c./d.c. set, where the heater must be at chassis potential, that difficulty may arise with it.

Practical Cathode-Input Circuit

We shall not discuss here the cathode-follower circuit, because the design of the complete video stage plus cathode follower is quite an intricate matter. We shall deal only with the second circuit in detail. Before doing so, however, it may be as well to remark that if the video signal is fed to the grid of the tube instead of to the cathode all these difficulties disappear. A capacitance coupling with a d.c.-restoring diode can be used. Because the video signal must then be of opposite polarity, however, difficulties arise in the sync separator and an extra valve in this circuit would probably be needed to obtain a normal performance. The use of d.c. restoration with cathode input to the tube does not seem practicable because of the low input resistance of the tube. The use of capacitance coupling to the tube cathode with a pulse-operated black-level clamp might, however, be practicable but has not been investigated.

The form of circuit which we shall now consider in detail is shown in Fig. 2. At all but the lowest frequencies and d.c., that is, at what we shall for convenience term high frequencies, the capacitors are all short-circuits and the video stage gives an amplification of

$$A=\frac{g_m R_1}{1+F_k} \quad \ldots\ldots\ldots\ldots \quad (1)$$

where g_m and g_T are respectively the mutual conductance of the valve connected as a pentode and as a triode and $F_k=g_TR_k$. At d.c. the internal resistance of the h.t. supply, shown as R_2, plays a part, for it is common to both screen and anode circuits. The voltage developed across it appears on the cathode of the tube and a fraction $R_5/(R_4+R_5)$ of it is also applied to the grid (via the brightness control) where it acts in opposition; only the fraction $R_4/(R_4+R_5)$ of the voltage across R_2 is, therefore, effective in operating the tube.

The voltage across R_2 and R_k, and also any across R_3, acts on the screen grid where it produces negative feedback tending to reduce the gain. On balance, R_2 tends to increase gain and R_3 to reduce it. It is possible, therefore, by a proper choice of R_3 to make the gain at d.c. the same as at higher frequencies.

It is not difficult to work out the d.c. gain. Between the grid of the valve and the cathode–grid circuit of the tube it is

$$A_{DC}=\frac{g_m R_1+g_T R_2 \alpha}{1+F_s+F_a+F_k} \quad \ldots\ldots\ldots\ldots \quad (2)$$

where

$$\alpha=\frac{R_1}{R_1+R_3}$$

$$F_k=1+g_TR_k$$

$$F_s=\{g_T(R_2+R_3+R_k)-g_mR_3\}/\mu_{12}$$

$$F_a=\{(R_2+R_k)g_T g_m+R_1\}\,r_a$$

r_a = anode a.c. resistance of the valve as a pentode.

μ_{12} = amplification factor of the valve between control and screen grids.

The gain at d.c. relative to that at high frequencies is

$$\frac{A_{dc}}{A}=\frac{1+\dfrac{g_T R_2 \alpha}{g_m R_1}}{1+\dfrac{F_s+F_a}{1+F_k}} \quad \ldots\ldots\ldots\ldots \quad (3)$$

In a pentode r_a is normally very large and the term F_a can usually be neglected. If the gains at a.c. and d.c. are to be equal equation (3) must be unity. Neglecting F_a, the condition for this is

$$R_3=\frac{\dfrac{g_T R_2 \mu_{12} \alpha(1+g_T R_k)}{g_m R_1}-g_T(R_2+R_k)}{g_T-g_m} \quad \ldots\ldots \quad (4)$$

As an example, suppose $R_1=3.5\,k\Omega$, $R_k=220\,\Omega$, $R_2=500\,\Omega$, $\alpha=0.6$, $g_m=6.5\,mA/V$, $g_T=8.5\,mA/V$, and $\mu_{12}=75$. Inserting values, we get $R_3=9\,k\Omega$.

It may or may not be possible to use this value for R_3. It depends on the h.t. voltage and the required screen voltage. If R_3 is zero, the relative gain works

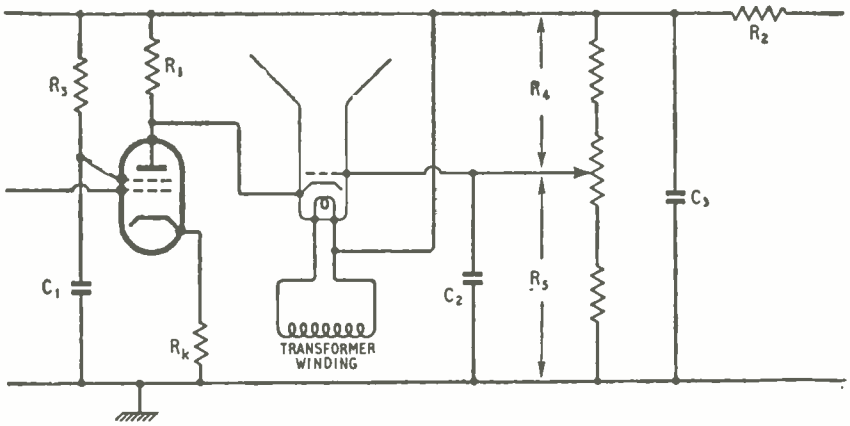


Fig. 2. This circuit can give nearly perfect reproduction of the d.c. component if R_3 is correctly chosen. It is, however, very good even without R_3. The resistance R_2 represents the resistance of the h.t. supply. Care must be taken over the tube-heater supply if the heater-cathode rating is not to be exceeded.

out at 1.08 to slide-rule accuracy. Without any attempt at compensation by choosing a particular value of R_3, therefore, the excess of d.c. component is only about 8%.

The basic tendency with this circuit is for the d.c. component to be slightly over-amplified. The excess, however, is not critically dependent on the values of components or the valve characteristics as long as the two right-hand terms in numerator and denominator of equation (3) are a good deal smaller than unity. Consequently, it is not necessary to employ close-tolerance components. In the circuit of Fig. 1, however, close tolerances, or at least closely matched components are necessary; with normal components errors of 40% in the d.c. component level are possible.

Taking into account both performance and cost, the circuit of Fig. 2 seems to be unquestionably the best one. Generally speaking, it seems to be an unnecessary refinement to choose R_3 in accordance with equation (4) and it is sufficient to choose it only to suit the screen voltage required by the valve. Often this will be the full voltage of the h.t. line and then both C_1 and R_3 can be omitted.

It must be emphasized that the practicability of the circuit of Fig. 2 is often restricted to receivers in which it is possible to supply the heater of the tube from its own private winding on a transformer. The heater can then be joined to any required point on the h.t. supply to minimize the heater–cathode potential difference. As shown in Fig. 2, this will often be positive h.t.

In an a.c./d.c. set, however, the tube heater must usually be at chassis potential. It is safe to use the circuit in such sets, therefore, only when the h.t. supply is of lower voltage than the heater–cathode rating of the tube.

In neither Fig. 1 nor Fig. 2 have the high-frequency compensating components been shown. They are irrelevant to the present discussion but, in practice, R_1 will usually have an inductance in series with it, or there may be one in series with the cathode lead of the tube; sometimes both are used. Then R_k quite often has a small capacitance in shunt with it. All these things have no effect at all at d.c. or at the lower picture frequencies; they play their part at frequencies over 2 Mc/s.

Ionosphere Review: 1953

Short-wave Propagation Changes : Approaching the Sunspot Minimum

By T. W. BENNINGTON*

IT is now nearly ten years since the last sunspot minimum—ten years during which the solar activity has passed through nearly all its changes and is now approaching a minimum again. It was in April, 1944, that the last sunspot minimum values were recorded, after which the activity rapidly increased to a maximum of almost unprecedented intensity in May, 1947. Almost unprecedented, that is, when compared with the intensities of the previous maxima shown in the records available, records which exist on a continuous basis for just over 200 years. In that time 19 sunspot maxima have been recorded, and only one of these was of greater intensity than that of 1947—a fact which may or may not be of significance. Who can say, for what is 200 years in the life of the sun?

Since 1947 the average sunspot activity has been declining towards another minimum and it might be thought, observing that the mean duration of the cycles is about 11.1 years, that the coming minimum is a year away. But there is no certainty about this; the length of the sunspot cycles varies very considerably, ranging for the 17 cycles for which we have complete records from about 9.1 to about 13.6 years. Thus the time of the occurrence of an approaching minimum cannot be foretold on the mere basis of the lapse of time since the preceding minimum, or indeed of that since the last maximum. It is, in fact, impossible to forecast its occurrence with accuracy on any known basis, though, as we shall see later, indications of some value on this point may be obtained from a study of the past cycles. There are also some of greater value directly provided by the sun itself.

Fig. 1 shows the twelve-month running average of the sunspot number for each monthly epoch from Jan./Feb., 1947, to June/July, 1953; the twelve-month running average of the noon critical frequency of the ionospheric F_2 layer and the twelve-month running average of the midnight critical frequency of the layer, for the same periods. The sunspot number is obtained from the observations made at a number of astronomical observatories (or, in the case of the last 12 values, at the Royal Greenwich Observatory alone) and is a measure of the sunspot activity on the sun's visible disc. The critical frequency of the F_2 layer is the highest frequency returned from the layer (which is the principal transmission medium in short-wave communication) when the measuring waves are sent vertically upwards. The two curves are compiled from the measurements made at the Slough station of the D.S.I.R. The

* British Broadcasting Corporation.

object of presenting the curves in the form of twelve-month running averages is that by smoothing out the month-by-month variations in sunspot number and the regular seasonal variations in critical frequency enables the long-period changes in both sunspot number and critical frequency to be more clearly seen. The last available number given by this method is, of course, that for a period six months back from the time of the last observation; *i.e.*, in the present case six months back from December, 1953, to the epoch June/July, 1953. The dotted portion of the curve which carries it forward into 1954 will be referred to later.

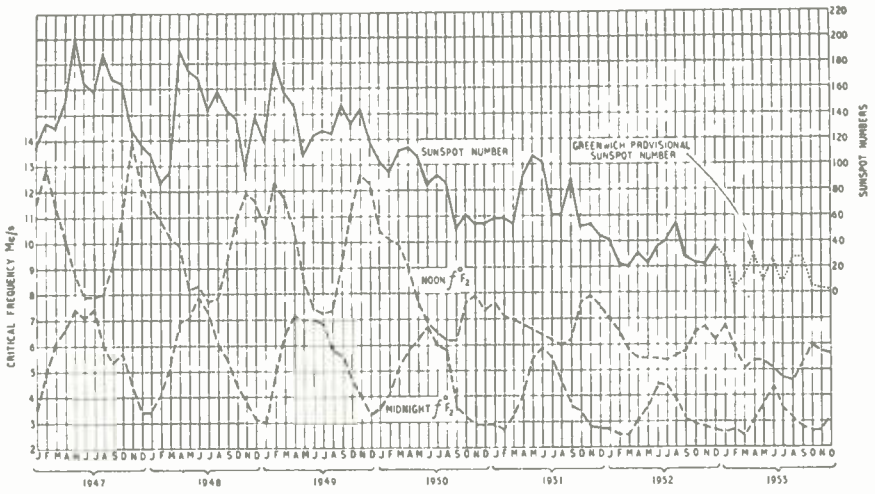


Fig. 1. Twelve-month running averages of sunspot numbers and noon and midnight F_2 critical frequencies since the last sunspot maximum, with possible future values of sunspot number (dotted extension).

It is seen that since the sunspot maximum in 1947 the sunspot number has fallen from about 150 to one of somewhat less than 20, though during the last twelve months it fell only by about 15. During all this time the critical frequency curves have followed the decreasing sunspot activity in a very faithful fashion, decreasing, in the case of the noon curve, from about 10.4 Mc/s to about 5.5 Mc/s and in the case of the midnight curve from about 5.7 Mc/s to about 3.1 Mc/s. It was pointed out, at the end of 1952, that the critical frequency had already attained "quasi minimum" values, and indications were that the noon critical frequency would fall by about 1 Mc/s only between then and the sunspot minimum. As can be seen, during the past year the fall in noon critical frequency is of the order of 0.5 Mc/s only, whilst that in the midnight value was correspondingly smaller. It appears, therefore, that the critical frequencies are likely to undergo only a very small further decrease between now and sunspot minimum.

All of which means, of course, that there is not likely to be much change, due to the sunspot cycle, in the frequencies at present of use for short-wave communication until after the coming minimum. These have decreased very considerably since the 1947 sunspot maximum, and, whilst the actual decrease varies widely for different circuits, with the seasons and with time of day, some idea of the order of things can be obtained from the figures given here. The decrease in noon critical frequency implies that the mean noon m.u.f. for transmission over the longest possible one-hop trajectory, with the ionosphere over Slough as its apex, has decreased since sunspot maximum by about 15 Mc/s, whilst the midnight figures indicate that the mean midnight m.u.f. has fallen by about 8 Mc/s. These large decreases have necessitated drastic alterations in the conduct of all kinds of long-distance services, which are now generally confined to the lowest short-wave frequencies, having regard to season and time of day. But, as has been said, no further appreciable reduction in their working frequencies is likely to be necessary.

For those who may be interested in more details of the changes which have occurred over the past few years the curves of Fig. 2 are given. These show the monthly means of the sunspot number and of the

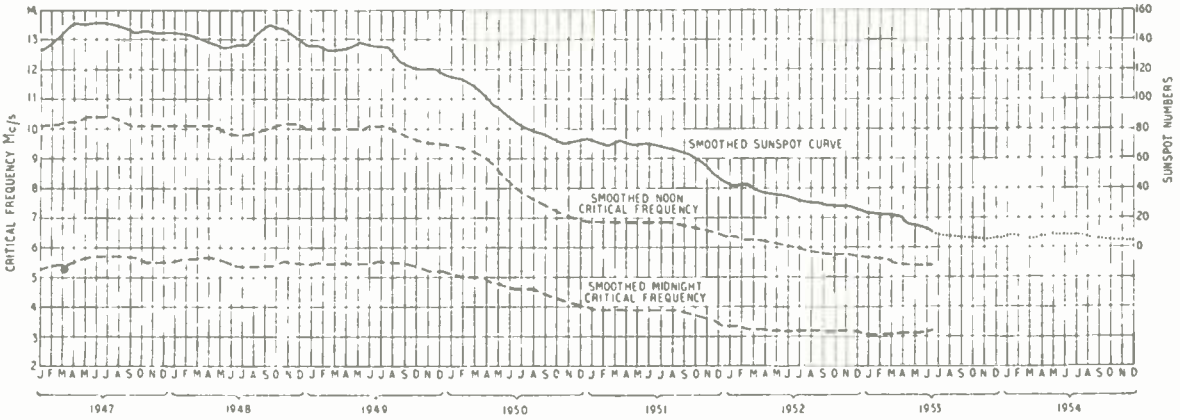


Fig 2. Monthly mean sunspot numbers and noon and midnight F_2 critical frequencies since the last sunspot maximum.

F_2 critical frequencies as measured at Slough. Some of the variations in the latter are rather interesting. For instance the noon critical frequency, which reaches its lowest values during the summer months, and its highest about mid-winter, is seen to have decreased by a very much greater amount since the sunspot maximum during the winter than during the summer. In fact it has decreased by about 8 Mc/s for winter and by about 3 Mc/s for the summer. On the other hand the midnight critical frequency decreased by about 1 Mc/s for the winter and by about 3 Mc/s for the summer. These differences may be ascribed to the differing effects of the sun upon the layer, either in kind or degree, at different times of the day and the year, but the net result on the usable short-wave frequencies is clear. They must vary over the sunspot cycle to the greatest extent during the winter day, to a lesser extent during the summer day and night, and least of all during the winter night. Of course these variations are much modified by the behaviour of the ionosphere in different terrestrial regions, and by the varying conditions over a long transmission path. But broadly speaking the variations in usable frequencies over the sunspot cycle are of the kind described.

Transferring our attention to Fig. 1 again and remembering our conclusion that it is unlikely there will be much further variation in critical frequencies or maximum usable frequencies until after the coming sunspot minimum, we are naturally concerned to know when that event will occur. But, as has already been stated, there is no way of telling this with any real accuracy. However, a classification of the sunspot cycles of which we have record would appear to indicate that the present one belongs to the class with high maximum and medium long duration. By matching it to a "representative" cycle of this class—which is the mean of all previous cycles of the same class—one can extrapolate it towards the minimum, and the result of this is shown in the dotted extension of the curve. This indicates possible future valves of the 12-month running average sunspot number and places the sunspot minimum at November/December, 1954. The curve should, of course, be accepted with reserve.

Signs of the New Cycle

However, some additional and stronger evidence that sunspot minimum may occur within a year or so has now been obtained from observations of the sun itself. Towards the end of a sunspot cycle the sunspots belonging to that cycle all appear in positions relatively near to the solar equator, but when the new cycle commences the spots appear in relatively high solar latitudes. Furthermore the spots of the new cycle have opposite magnetic polarity to those of the old one. These high latitude sunspots (belonging to a new sunspot cycle) usually begin to appear some considerable time before those of the old cycle have ceased, and, in fact, about a year before the sunspot minimum is reached.

According to a report from America† there was observed on August 13th, 1953, a very small sunspot in solar latitude 52° N by members of the staff of the McNath-Hulbert Observatory, Michigan, which it would seem may have been the first spot of the new cycle. It is also reported that magnetic observations of the sun made in Pasadena increase the probability that this sunspot belongs to the new cycle. If this is so the observations would indicate that, on the basis of similar observations made towards the end of past cycles, the sunspot minimum might be expected between about March, 1954, and April, 1955. Therefore, whilst it still is not possible to be precise about the time of the minimum, the implications of the observations do not appear to conflict very much with the dotted part of the curve of Fig. 1.

The frequencies at present of most use for communication over various circuits—such as 17, 15 and 11 Mc/s for daytime broadcasting, 9 Mc/s for summer night-time and 7 and 6 Mc/s for winter night-time use—are thus likely to remain so during 1954. And even after sunspot minimum does occur it would seem unlikely that the sunspot activity will begin rapidly to increase for several months, or perhaps for a year. So it looks as if the present "rock bottom" conditions are likely to remain for a considerable time yet and perhaps, to hazard a guess, till towards the end of 1955.

† *Publications of the Astronomical Society of the Pacific*, Oct., 1953, Vol. 65, No. 386, p. 256.

Transistor and Valve Circuitry

BECAUSE there is a good deal of functional similarity between the transistor and the thermionic valve, people have been tending to think of the process of "transistorization" as little more than pulling out valves and inserting transistors in their place, after making very slight circuit modifications. This impression has been greatly strengthened by various theories about the duality between valves and transistors and how it can be utilized in the design of transistor circuitry. Engineers are now beginning to realize, however, that this duality idea is not a good thing to follow slavishly, as it tends to restrict what can be done with the transistor. The valve automatically becomes the yardstick, and by comparison the transistor sometimes appears as rather a poor substitute. It would be more profitable to take the transistor for what it is, and build an entirely new type of circuit technique around it. For example, it has been suggested that since the transistor operates very efficiently in pulse and trigger circuits we should attempt to transform our existing linear circuits into this type of operation—rather as we can use a.c. techniques for amplifying d.c. fluctuations after making the d.c. discontinuous.

This new outlook was implicit, if not stated in so many words, in a recent I.E.E. discussion meeting "Will Transistors Oust Receiving Valves?" opened by E. H. Cooke Yarborough. One example which was mentioned of a departure from established valve-circuit technique was a new transistor digital computor at Manchester University. As a result of the new approach there were actually fewer transistors in this computor than there would be valves in an equivalent "thermionic" computor doing the same job. It was also pointed out by several speakers that greater flexibility should be possible in transistor circuits because of the reversible functions of the collector and emitter—a feature not possessed by the equivalent electrodes of thermionic valves.

At the same time, of course, the transistor must emulate the valve in some respects and be able to bear comparison with it. The limit on operating frequency is one problem here (resulting from the lower electron transit time in semiconductor materials) and to get comparable results the electrode spacing has to be very much smaller. However, one speaker at the meeting mentioned that an experimental transistor had been made to operate at 80 Mc/s, and there were hints from others that the limit could be pushed to well over 100 Mc/s. The restriction on power output was another difficulty, although it was mentioned that transistors dissipating as much as 20 W were being produced in the U.S.A.

LETTERS TO THE EDITOR

The Editor does not necessarily endorse the opinions expressed by his correspondents

Ignition Interference in U.S.A.

HAVING read the letter from Mr. Morse on ignition interference with TV in this country (your October issue) and your subsequent editorial comments, coupled with those of my friend "Diallist," I feel driven to enter the controversy, if only to keep the record straight.

As an English immigrant to the U.S.A. of less than two years standing, I can claim to have seen TV on both sides of the ocean, and, quite impersonally, would like to make these comments.

There is no doubt that interference does exist in fringe areas, but it is a growing problem to find a fringe area, as new transmitters going into service are a frequent occurrence on the u.h.f. band. Mr. Morse probably speaks as he finds things. In nearly two years of TV, I have yet to see visual interference on my screen derived from auto ignition. Up to two months ago, I lived on an eight-lane super highway, with autos passing four abreast in each direction at the usual thirty-foot intervals, and never had reason to complain of interference. My experience when visiting with friends or in various cities across this country has been the same; no visual signs of ignition interference. As several million TV sets are in constant use, I feel sure, knowing the Americans, that if auto interference was a problem something would be done about it, and we would know.

My feeling is that it must be standard practice for all interference-forming machines to be adequately suppressed by the maker before sale. My car, a cheap one, was suppressed as delivered from the factory. So was my vacuum-cleaner, my washing machine, the clothes drier, the dish-washer, the refrigerator and all the small kitchen power tools. I have heard auto interference myself, particularly when following a pre-war car along open highways, showing as a superimposed crackle on the car radio. However, this has never been heard when following post-war automobiles.

I am not prepared to argue American v. British design, as I have a foot in both camps, but I will back Mr. Morse fully when he says he has never seen auto TV interference, I never have either, nor have any of my friends. So shall we put the matter to bed by saying electrical appliance makers suppress their products adequately before sale, here in the U.S.A.?

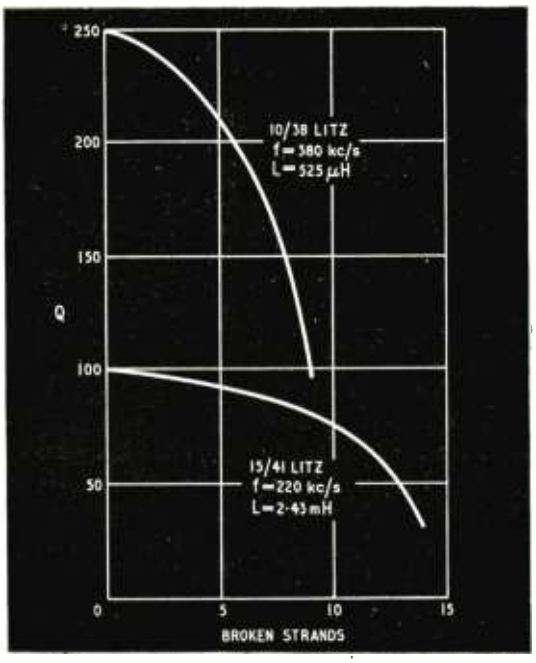
Ferguson, Mo., U.S.A. R. LINCOLN OSTER.

Skin Effect

IN the final paragraph of his article "Skin Effect" (*Wireless World*, November, 1953), "Cathode Ray" observes that the effective resistance of litz wire rises appreciably when some of the strands are broken. While actual values are not stated, the reader is given the impression the resistance will increase in proportion to, or even exceed, the increase in d.c. resistance.

This popular misconception seems to appear periodically in the literature. Theory, however, does not substantiate this argument: in fact, there is ample evidence which disproves it.[1, 2]

The accompanying curves show the effect of broken strands in a universal type coil wound with 10/38 litz, and in a single-layer solenoid wound with 15/41 litz. The frequency in each case was sufficiently low to ensure efficient use of the litz wire.



Curves showing effect of broken strands of litz wire in two different types of coil.

From the curves it is evident that the broken strands are not completely divorced from the circuit. Some current remains in the broken strands owing to the tight coupling between strands.

It is interesting to note the curves are somewhat similar when compared on a percentage basis.

Fairlawn, N.J., U.S.A. R. E. LAFFERTY.

[*"Cathode Ray" writes:* I am much obliged to Mr. Lafferty for correcting me in the matter of the rise in resistance when strands of "litz" wire are broken. It would be interesting to know what was the basis for the common belief that a few broken strands cause a disproportionate increase in r.f. resistance. I have been unable to trace it.—ED.]

Why No Prices?

WHY are so many of your advertisers so cagey about the prices of the goods they are trying to sell? One can, perhaps, understand it where a maker of resistors or condensers offers hundreds of different sizes, types and capacitances and is only interested in attracting makers of radio or electronic equipment; but there are many makers of other types of gear—testing sets, amplifiers, loudspeakers, recording tape, new types of valves and so on, who omit from their advertisements any suggestion of the price. Even the women's magazines now give one an idea of the prices of the creations advertised, "This dinky little model chapeau in *fer blanc*, about nine-and-a-half-guineas," but there isn't even that suggestion in many of your advertisements.

Surely the AVO people, Vortexion, Marconi Instruments and Trix don't expect to sell their products whole-

[1] Hund and De Groot, *Bur. Stds. Tech. Paper* 298, Vol. 19, p. 651, 1925.

[2] Morecroft, J. H., "Principles of Radio Communication," 3rd Ed., p.195.

sale by the gross—or do they? Even if they did, an indication that the retail price is so-and-so would be of interest to many readers, and would still not debar the large user from negotiating other terms.

Cambridge. G. W. IRWIN.

Crystal-Transistor Link?

IT is difficult to disagree with anything that Dr. Armstrong, the distinguished pioneer of regeneration, superregeneration and the superheterodyne principle, says in his letter published in your January issue. "Major" Armstrong (as he will always be to me) helps to get the perspective right. The valve made little impact on the radio art until the introduction of regeneration, which turned it into a receiving device of hitherto undreamed-of sensitivity. The regenerative triode detector was the heart of the radio receiver for many years, and was not finally displaced until the short-lived neutralized triode (which quickly gave way to the screened-grid tetrode) provided us with effective r.f. amplification.

But is Dr. Armstrong right in implying (his penultimate paragraph) that the originators of the transistor obtained no inspiration from the crystal detector? I am inclined to submit that if they did not, there was little excuse for their failure. The oscillating zincite crystal, which aroused some interest in the early 1920s (I cannot confirm the date*) surely served, or should have served, as a fairly obvious connecting link between the humble crystal detector and the transistor.

"RADIOPHARE."

* *Editorial footnote.*—Several articles on oscillating crystals, including one from the Russian originator Lossev, appeared in *Wireless World* during 1924.

Historical Relic

MAY I correct "Free Grid's" dates? The German-made coherer unit which he illustrates on his page in your January issue was certainly on sale in either 1911 or 1912. I became the proud owner of one, with its accompanying spark-coil transmitter, about two years before the outbreak of the first World War. These sets were sold, I believe, by more than one shop dealing in electrical novelties for schoolboys.

The relay fitted to the receiver unit was for actuating the de-coherer, which at the same time rang a bell and so gave a clearly audible signal. I think "Free Grid" is wrong about the morse inker, which was not used with my set.

With careful adjustment of relay and de-coherer, a range of 20 or 30 yards was obtainable.

Manchester. A. M. FISHER.

INTERNATIONAL MARINE V.H.F.

AT the Atlantic City Conference of the International Telecommunication Union in 1947, frequency modulation was made compulsory for marine v.h.f. communication on certain frequencies in Region 2 (the Americas), but not in Regions 1 (Europe) and 3 (Far East). Subsequently, in 1949, it was announced by the Post Office that it had been decided to specify amplitude modulation for all v.h.f. maritime services of the United Kingdom using the international simplex channels (156.8 and 156.6 and 156.3 Mc/s), or the proposed international two-frequency public correspondence channel (157.4 Mc/s mobile and 161.9 Mc/s fixed) and associated national two-frequency public correspondence channels (157.5, 157.6, 157.7 and 157.8 Mc/s mobile and 161.5, 161.6, 161.7 and 161.8 Mc/s fixed), or the group of two-frequency channels reserved in this country for the use of harbour docking and pilotage authorities (158.6 to 159.4 Mc/s mobile and 163.6 to 164.4 Mc/s fixed).

Not only was a.m. adopted by this country, but it was widely recommended by the U.K. to other countries in Regions 1 and 3.

According to facts given in a report issued by Rees Mace Marine these opposing decisions have resulted in a position where some 40 base stations and 330 mobile stations in North America (mostly on the Great Lakes) have been equipped with f.m. gear while over three times as many stations in the rest of the world have been fitted with a.m. equipment.

The Assistant Postmaster-General recently stated in the House, in reply to a question, that "The shipping industry and the radio industry (with the exception of one manufacturer) have agreed that it would be in the national interests to resume discussions internationally with a proposal in favour of standardization on frequency modulation, and there is at last some prospect of reaching agreement and of removing the uncertainty."

The Rees Mace report summarizes the present position and formulates a plan for the solution of the impasse. A truly international decision on a unified system of modulation cannot be arrived at until the next meeting of the I.T.U. which, at the earliest, will not be held until 1957. The view is, therefore, expressed that it would be wrong for changes to be introduced in the interim as these would not be internationally binding; on the other hand, it is pointed out that it would be quite unthinkable to stop fitting v.h.f. gear during this period. There must, therefore, be some co-ordinated interim plan, but, as pointed out by the General Council of British Shipping, such a plan must not only permit the continued growth of the use of v.h.f. but must ensure that any eventual change can be made with a minimum of inconvenience. It is, therefore, suggested that the problem can be solved by the production of dual-modulation equipment. During the interim period it will be necessary for only a small proportion of British ships to install dual-purpose equipment, in fact only those sailing to Region 2.

The report lists some of the problems which have to be solved before international standardization can possibly be achieved. They include (a) frequency allocation (at present only three channels have been internationally allocated); (b) simplex or duplex working; (c) a standardized selective calling system, and (d) transmitter and receiver specifications. Rees Mace consider that it would cause less disruption to British manufacturers to market dual equipment for a.m. and f.m. than it would to adopt American standards. "It is, therefore, at least as important to find out American views on international standards as it is to find out their views on modulation."

It is claimed that the Admiralty will support any plan which will permit British merchant ships to continue fitting v.h.f. and will facilitate v.h.f. inter-communication with ships throughout the world. The plan formulated in the report also leaves the door open for the integration of v.h.f. services for air/sea rescue purposes.

PUBLICATION DATE

In future *Wireless World* will be published on the last Monday (instead of the last Tuesday) of the month preceding that for which it is dated.

RUSSIAN TELEVISION

Some Notes from the U.S.S.R. on Equipment

LITTLE has been published in this country on the development of Soviet television, and it was, therefore, refreshing to find a delegate to this country during the recent British-Soviet Friendship Month who was able to give some factual information.

It is, of course, general knowledge that the U.S.S.R. is employing the "European" standard of 625 lines, 50 frames per second and f.m. sound, but using a bandwidth of 8 Mc/s. Transmissions are horizontally polarized.

It would appear that while there are a considerable number of communal receivers installed in the service areas of each of the four stations (Moscow [2], Leningrad and Kiev) there is a growing demand for domestic receivers. The large majority of sets are for direct viewing, but some projection models are available and both forward and back projection is employed.

In addition to the two transmitting stations, Moscow now has a television theatre which regularly shows the transmitted programmes on a big screen.

Each of the present stations originates its own programmes, but can be linked with other transmitters by radio and cable. Undoubtedly one of the biggest and most important problems for the Soviet broadcasting authorities is the relaying of television programmes in such a vast country. The shortest distance between any two of the present three centres is 500 miles. The same applies to the new stations being constructed in Stalingrad and Sverdlovsk.

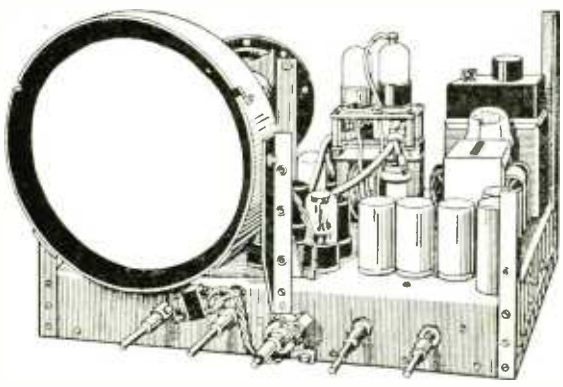
Russian television sets give a certain impression of the earlier American practice. The screens are fairly small—9in being about the average size—and are often made to look even smaller by the large loudspeaker grilles which appear alongside them on the fronts of the cabinets. There are usually four, five or six controls brought out for the viewer to adjust, and apart from the usual brightness, focus and sound volume these often include such things as contrast, frame-hold, wave-change and tone control. Modern sets are still being built with mains transformers and there is no evidence of the a.c./d.c. transformerless technique.

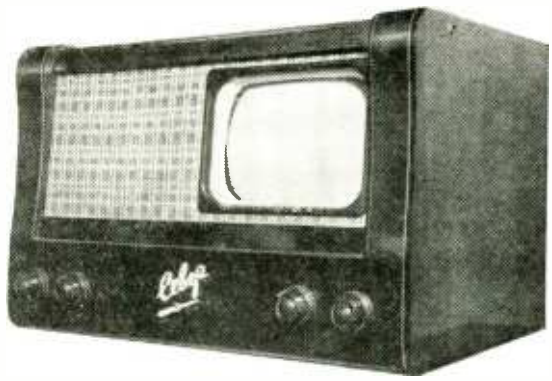
While most of the receivers are superhets, a good many straight sets are still being made for short-range reception. These usually have about ten valves to the superhets' 20. Some models have provision for receiving a.m. and f.m. sound broadcasts as well as the f.m. television sound transmissions. Few, if any, extra valves are needed for this, as some of the sound-channel stages are used for double purposes. One recent prize-winning design, for example, has a valve which acts as a limiter on the f.m. signals and as a diode detector for the a.m. sound broadcasts.

Blocking oscillators are popular for both frame and line time-bases and scanning coils are often directly fed from the anodes of their appropriate output valves. An unusual feature of one fairly typical receiver is the use of an efficiency diode to recover energy, not for the scanning system, but to energize the focus coil. It seems there is no difficulty in getting enough scanning power for the deflector coils since the cathode ray tubes are fairly small with narrow deflection angles.

American-type metal valves with octal bases are widely used in receivers and the 6.3-V heater appears to be standard. Some of the valves have well-known American type numbers and equally familiar characteristics, while others have numbers which are not recognizable but are obviously based on the same system. There are no signs of any miniature valves. Components generally have much the same appearance as ours.

With horizontally polarized transmissions the receiving aerials are naturally T-shaped, as in America. A good many people, however, make use of indoor aerials which are disguised to look something like electric bowl fires. The bowl reflectors are actually used to give a directional effect, so that the aerials can be adjusted to find the best angle for





On the left is a sketch of a recent prize-winning Russian receiver, reproduced from the Soviet journal "Radio," and on the right is a fairly typical table model in its cabinet.

reception. Naturally the directivity is not very great because the reflectors are relatively small compared with the wavelength. In blocks of flats communal aerial systems are used, as the authorities have the same objections to forests of dipoles on the roofs as they have in this country.

Colour television will be starting up soon, apparently on the frame-sequential system, and adaptors with rotating colour filters are being made for use with existing black-and-white receivers.

One type of interference which is not experienced by town dwellers in the U.S.S.R. is flutter caused by aircraft; flying is prohibited over built-up areas.

Gregory Alexandrov, our informant, who was leader of the delegation from the U.S.S.R., is a professor at the Central Film Institute, Moscow, and has directed a large number of Soviet films. He told us, incidentally, that they have experimented with the use of electronics in the production of films, but have abandoned the project.

Television Society's Exhibition

New Circuitry and Devices

HELD in London on 7th-9th January, the annual exhibition of The Television Society included 39 exhibitors. As in previous years, it was noteworthy for the number of demonstrations of an experimental and educational nature.

One of particular interest to sufferers from ignition interference was the "grey spotter" circuit of G.E.C. The circuit is shown in Fig. 1; V_1 is the video stage coupled in the usual way to the cathode of the c.r. tube. The signal from V_1 is also applied to the cathode of V_2 and appears at the anode in the same phase, whence it is passed to the grid of the tube. If the complete signal were passed it would, of course, cancel the cathode signal, but the limiting action of V_2 and V_3 makes the grid signal one of interference only. V_2 is biased to be non-conductive during the video signal proper and to conduct only during noise pulses of amplitude greater than peak white. It then conducts and amplifies and if it were not for the diode V_3 it would be a "black spotter" for, because of the amplification in V_2, the noise pulse applied to the grid of the tube would be greater than that applied to the cathode. V_3, however, is biased to act as a second limiter, this time of the noise pulse amplitude applied to the grid. The result is that the effective level of noise on the tube is held at a level corresponding to grey in the picture and as this is the average level of illumination the contrast between the noise and the picture brightness is reduced. In a demonstration the circuit appeared very effective.

A circuit which enables a direct visual comparison to be made between two aerials was demonstrated by Belling & Lee. It enables the top half of a normal television picture to be reproduced from a signal received on one aerial while the bottom half is provided by a signal received on a second aerial. It has the great merit of enabling a direct comparison of two aerials, particularly as to their susceptibility to interference, to be made under proper viewing conditions.

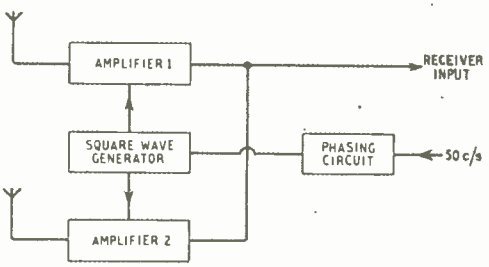
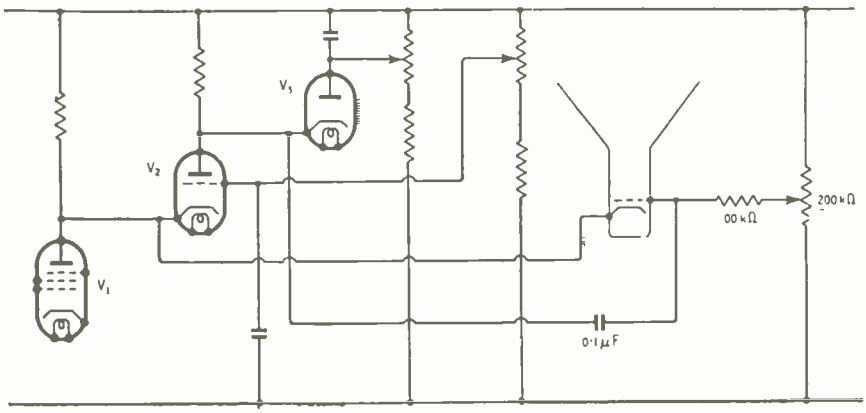


Fig. 2 Belling-Lee electronic switch for aerial comparison.

The arrangement is sketched in Fig. 2. Each aerial feeds an r.f. amplifier the outputs of which are commoned and taken to the input of any television receiver. The two amplifiers are rendered alternatively inoperative by a biasing pulse. A 50-c/s square-wave generator is used for this and is locked at 50 c/s through a phasing circuit which enables the change-over to be adjusted to the required point. One change-over occurs during the frame fly-back, the other half-way through the picture. In the demonstration an artificial source of interference was impressed on the input signal to one amplifier, the input to the other being free of interference. This gave a good idea of the capabilities of the method, which appears to be a valuable one for assessing the practical value of television aerials whenever it is possible to have the two to be compared erected simultaneously.

Fig. 1 Circuit of G.E.C. "grey spotter"



Apart from ignition interference, aircraft flutter is probably a major cause of interference, especially in certain districts. A circuit to reduce its effect on the picture was demonstrated by G.E.C. Under the somewhat artificial conditions of the demonstration, where the signal fluctuations were provided by an input attenuator which was varied regularly at a

slow rate, the circuit made an enormous improvement to the picture, although it did not completely eliminate the effects of the flutter,

The circuit is shown in Fig. 3 and is extremely simple. The video signal is fed back through an RC network comprising a cascade of integrator and differentiator type circuits which form a frequency-selective circuit. Neither picture-frequency signals nor d.c. is passed. Slow variations of the signal in the region of 10 c/s are passed, however, and vary the bias, and hence the gain of the i.f. amplifier, so that as the output increases the gain decreases and vice versa. It is a form of a.g.c.

The care that is needed in television receiver production is brought home by the elaborate apparatus shown by Bush for r.f. amplitude and phase characteristic tests. A combination of step and pulse methods is used. This same firm also showed an experimental recording wobbulator which enables a permanent record of the response curve of a television receiver to be made by means of a pen recorder. A variable-frequency oscillator is used to produce the signal and there are several crystal-controlled marker frequencies.

Bush showed a receiver using a direct-drive line-scanning circuit to show the simplicity resulting from this arrangement and G.E.C. demonstrated a set using an experimental 12-in c.r. tube with a 90° deflection angle. Small external magnets are used to correct for pincushion distortion.

The possible advent of new television stations in Band 3 was reflected at the show by a 12-channel tuner (Cyldon) covering the frequency range 50-220 Mc/s, and two new Mullard valves specifically designed for use in such circuits. These valves were the PCC84 double triode and the PCF80 triode-pentode, both on the B9A base. The PCC84 is intended for use as a cascode low-noise r.f. amplifier with an h.t. voltage of 180V. In the cascode circuit the two triodes are connected in series across the h.t. supply so they get only 90V each, but in spite of this low operating voltage each triode has a slope of 6mA/V and an amplification factor of 24, permitting a gain of about 12 db from the circuit. A difficulty of the cascode circuit is that a high voltage is placed across the heater-cathode insulation of the top earthed-grid valve. This has been catered for in the PCC84, which has a heater-cathode voltage rating of −250V and +90V.

The PCF80 triode-pentode is intended for use as a frequency changer following the PCC84, and in a typical circuit it is claimed to give a conversion gain of 20 db working with an input frequency of 200 Mc/s. The triode and pentode sections are placed side by side instead of one above the other as in earlier Mullard valves.

This combination of PCC84 cascode r.f. amplifier and PCF80 frequency changer is actually used in the Cyldon tuner. The unit is based on the American type of turret tuner and has a rotating drum carrying 12 aerial and 12 r.f. coupling and oscillator coils. These coils are mounted on low-loss Bakelite contact strips which are clipped on to the turret, and rotating the turret brings the desired set into circuit, leaving the others isolated.

Mullard were showing how the difficult and complicated processes of frequency-changer design can be simplified and made more exact by an interesting type of "three-dimensional" display which presents a large number of characteristics of a mixer valve (actually the PCF80) in their correct relationship on a single chart. It is called the "contour line method"

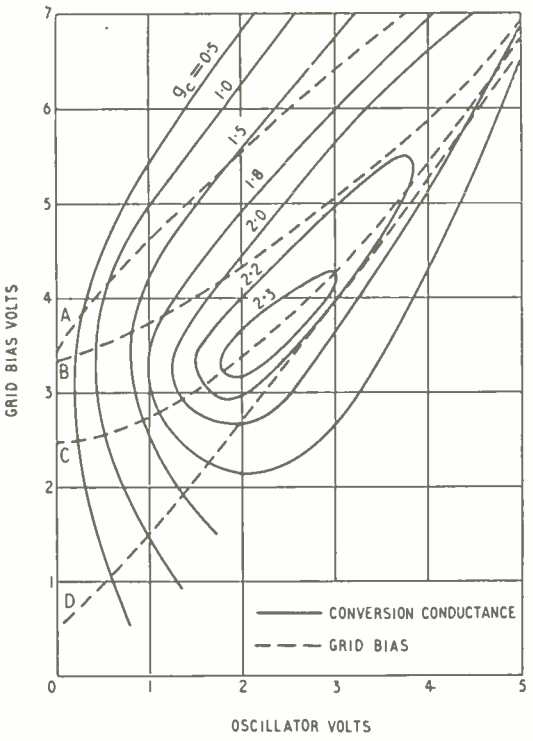
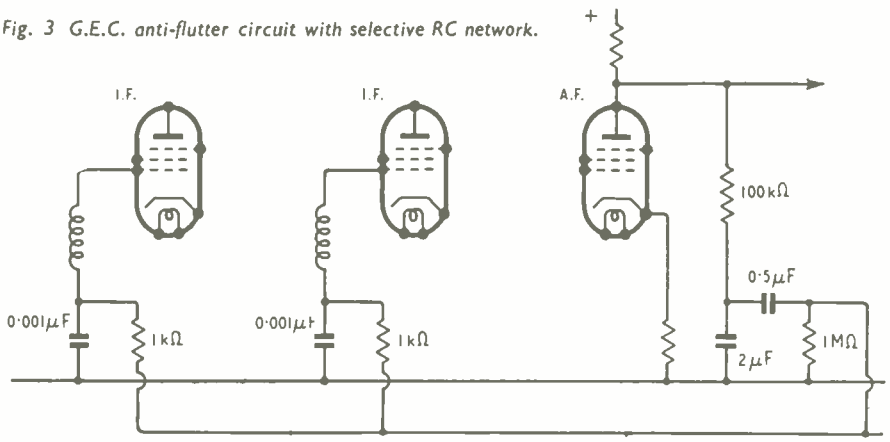


Fig. 4 "Three-dimensional" display of PCF80 characteristics. Control-grid bias of pentode section for different values of cathode resistor and grid resistor (A, B, C, D), plotted against oscillator volts, with superimposed "contour" lines of constant conversion conductance.

because on an ordinary two-dimensional graph are superimposed lines joining points of equal conversion conductance. Looking at Fig. 4 one can, in fact, imagine it as a bird's eye view of a relief map, with a "hill" rising to its summit in the middle at a conversion-conductance "height" of just over 2.3 mA/V. The dotted lines A, B, C, D represent different values of grid leak and cathode resistor. While the maximum conversion conductance lies on curve C, at an oscillator voltage of 2.3 V and a control-grid bias of −3.6 V, its value is affected considerably by changes in oscillator voltage. Optimum conditions are given by curve B, which runs almost parallel to the contours (along the side of the "hill" instead of straight up and down the slope) and is reasonably near the maximum conversion conductance.

Fig. 3 G.E.C. anti-flutter circuit with selective RC network.



Radar in Airliners

Is it a Practicable Aid to Extra Safety in the Air?

THE use of airborne radar as an aid towards safer air travel has recently attracted some attention in the daily Press; but it has been under consideration by the airlines ever since the end of the war, and a lot of work has been done towards developing a suitable set. In general terms, the requirement is to extend the "range of vision" from the aircraft, and to indicate clearly the presence of obstructions to flight. With increasing speeds of transport aircraft—up to 500 m.p.h.—the need for a lot of clear airspace is apparent, because transport aircraft, and their loads, are not normally subjected to violent manœuvres.

The routes which airliners follow are, of course, selected to avoid all dangerous ground, or else to fly over it at a height which provides a large margin of safety against a possibility of partial loss of power. Flying between mountain peaks is not airline business, and following an established route is an everyday exercise in air navigation, presenting neither novelty nor difficulty in normal circumstances. In fact, it is doubtful whether the use of aircraft radar as a form of map-painter will be any advantage, because the information on the radar screen is not detailed and the navigation systems available, such as for instance the Decca system, give precise information about position. In case of doubt, though, radar information can be used as confirmation of orthodox navigation, but it would be rather like using a watch to confirm the Rugby time signals.

Dangerous Cloud Formations

However, there is one particular application which can only be met in a satisfactory way by using radar, and this application is being followed up, with trials taking place at present by the Royal Canadian Air Force in a Comet. This application is the avoidance of obstacles which occur seasonally, and which are not stationary—dangerous clouds.

In and near the tropics at certain seasons the weather conditions produce a type of thundercloud (cumulo-nimbus) which has a core with a high percentage of water in it, and where the vertical currents are very severe, up to 60-80 feet per second. These clouds are avoided by aircraft, because of the very disturbed air around the cloud, which would cause a very rough ride. The interference increases as the aeroplane speeds are raised, and with high-speed jet aircraft it could become very troublesome.

As long as these clouds can be seen, they may readily be avoided, but at night they may be so severe as to cause flying to be suspended. Experiments with radar have shown that the dangerous clouds produce strong echoes on the radar screen (and so do some non-dangerous clouds); so by fitting radar, aircraft may be able to fly by night in areas where "stuffed clouds" are likely to be, with sufficient warning of the presence and locality of the hazards to allow the aircraft to avoid them. This is an appreciable advantage.

A radar set has been developed in England, by Ekco* working with the Ministry of Supply, and it has been extensively tested as it has been developed. It has a maximum range of 40 miles, and has detected clouds, presumed to be dangerous, at maximum range. The equipment needs about 650 VA of power, and its output is 10 kW peak, on a wavelength of 3 cm, with 700 pulses per second, each of 1-microsecond duration.

The strength of the echo from clouds depends on the size of the water drops in the cloud, and on the wavelength of the radar. Experimenters in U.S.A. have found that in some cases a wavelength of about 6 cm produces a much stronger echo than does the 3-cm radar, and they have built an aircraft set to use these longer waves. It has rather more range, for the same power, than the 3-cm radar, but has the great disadvantage that the aerial assembly is so very much bigger. This will make the equipment difficult to accommodate in an airliner, for a very large section of the nose would not only become useless as stowage space, but would have to be encased in Perspex or something similar.

Economic Problems

Space and weight are at a premium on every aeroplane, and the British equipment weighs about 200 lb, installed. This is about the same as the weight of a passenger, so it is clear that even to carry the radar implies a substantial cost to an airline; it must only be carried where it can serve a useful purpose. This would be equivalent to reducing the payload in some localities to cater for weather hazards, as is done in ships which are less deeply laden for winter in the North Atlantic than elsewhere.

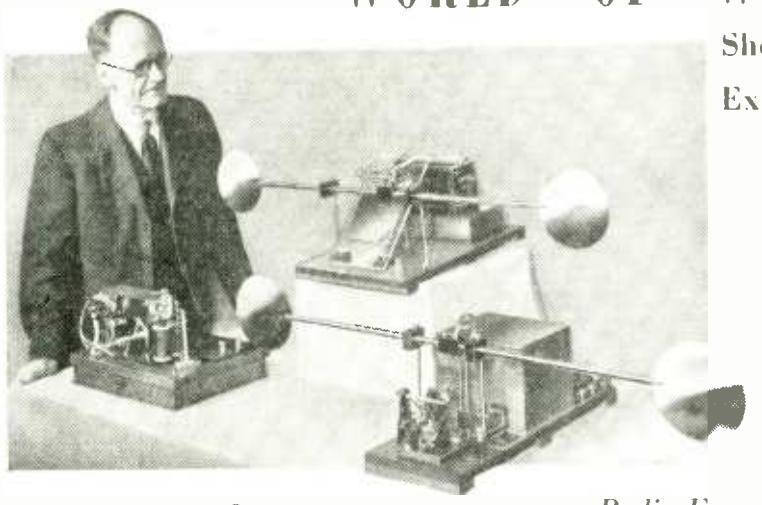
Aircraft radar has occasionally been suggested as a valuable preventer of collisions between aircraft, but the information displayed is not specific enough for collision prevention. However, collision between aircraft is not a serious hazard; there are few localities where air traffic is dense enough to create collision risks, and in all these localities there is an effective and rigid system of air traffic control, using ground radar as one of its principal tools. By means of two-way radio telephony, aircraft are given instructions on route and height, and the only danger would arise from an intrusion by an aircraft without two-way radio telephony. Such an intrusion is forbidden, but is has happened, though radar on aircraft would be of little value in such a case.

I have tried to show that there is a case for aircraft radar, which can be a useful aid in certain circumstances. This is far from recommending that all airliners should be fitted with radar as a permanent fixture, or from suggesting that without radar any operations carried out at present are less safe than they might be. The contrary is the case, and certainly radar will be used where its use is justified. The provision of a suitable equipment is actively being pursued, but the total costs will be so high that the article will have to be very good. J. M.

* "Radar Cloud Detector" *Wireless World*, December 1950

WORLD OF WIRELESS

Show News • Record Radio Exports • V.H.F. Report • TV Pioneer Honoured



MUSEUM-PIECE V.H.F. — A working model of the apparatus used by Marconi in his early experiments has recently been presented by the Marconi Company to the Science Museum, South Kensington, where its operation is being demonstrated to visitors. The apparatus, seen here with its maker, R. W. Piper, of the Marconi Marine Company, comprises a spark transmitter (top) and a coherer receiver (right). Operating frequency is 85 Mc/s

Instruments and Components

ANNUAL London exhibitions of the Radio and Electronic Component Manufacturers' Federation and the Physical Society will overlap by only one day this year. The R.E.C.M.F. components show will be held at Grosvenor House, Park Lane, W.1, from April 6th to 8th. Some 130 exhibitors will be participating in the exhibition. Admission is by invitation, limited to those interested in the industrial, scientific or trade aspect of components. The show will be open on each of the three days at 10.0 and will close at 6.0, 9.0 and 5.0 respectively. Tickets are obtainable from the Federation at 22, Surrey Street, Strand, London, W.C.2.

Tickets for the 38th Physical Society exhibition of scientific instruments and apparatus, which will be held at the Imperial College of Science and Technology, Imperial Institute Road, S.W.7, from April 8th to 13th, will be available from the Society from the beginning of March. As in previous years, tickets will be valid for specific sessions and days. The exhibition will open daily at 10.0 and will close at 8.0 on the 8th, 9th and 12th and at 5.0 on the 10th and 13th. On the opening day admission will be limited to Fellows and the Press from 10.0 until 2.0. The handbook covering the exhibition will be available on March 1st, from the Society, 1, Lowther Gardens, Prince Consort Road, London, S.W.7, price 6s, postage 1s 3d.

V.H.F. Broadcasting

THE LONG-AWAITED report of the Television Advisory Committee on v.h.f. broadcasting has, it is understood, been received by the Postmaster General. It is not known whether the findings of the Committee will be published, as, of course, the report has been prepared solely for the guidance of the Government and is not in itself a statement of Government policy. It is, however, known that the Committee recommends, as was anticipated, the use of frequency modulation, although there is an adverse minority report.

New Zealand Television

BRITISH 405-LINE TELEVISION standards having been recommended by a Government departmental committee for adoption in New Zealand, Pye recently shipped to Wellington complete transmitting equipment and a number of receivers to provide demonstration transmissions during the Wellington Show and Industrial Fair (January 7th-27th).

The Minister in Charge of Broadcasting has, however, stressed that there is no likelihood of the Government taking immediate action to establish a television service.

Radio Exports

ACCOUNTS for November recently issued by the Board of Trade show that the total value of radio exports during the month was £2,677,912, which, for the second successive month, broke previous records. The figure for the eleven months of 1953 (£23,328,347) is within £1.2m of the total for the whole of 1952.

The November figure and the eleven-month total (in £m) for each of the four sections of the industry are:

Transmitting and radio navigational gear	1.245	9.866
Components and sound reproducing equipment ..	0.955	8.222
Domestic receivers	0.276	3.225
Valves and c.r tubes	0.202	2.015

Faraday Medallist

ISAAC SHOENBERG is to receive the 32nd award of the Faraday Medal of the I.E.E. "for his distinguished work in electrical engineering, in particular the outstanding contributions which he has made to the development of high-definition television in this country."

Mr. Shoenberg, who is director of research of Electric and Musical Industries, led the team (including A. D. Blumlein, C. O. Browne, G. E. Condliffe and J. D. McGee), which was responsible for the development of the 405-line television system and ancillary equipment adopted by the B.B.C. in 1936.

Born in Russia in 1880, Mr. Shoenberg was chief engineer of the Russian Wireless Telegraph and Telephone Company, Leningrad, from 1905 until he came to this country in 1914 as consulting engineer to the Marconi Company of which he became joint general manager. He has held his present position since the formation of E.M.I. in 1931 through the amalgamation of the Gramophone Company and the Colombia Graphophone Company of which he had been joint managing director for three years.

European Broadcasting Problems

DURING the meeting of the Technical Committee of the European Broadcasting Union at Monte Carlo in November, E. L. E. Pawley (B.B.C.) chairman of the

Committee, presented a report on the studies of a working party concerned with v.h.f. broadcasting, especially in relation to the Stockholm Plans. In its future studies this working party will consider the problems regarding the securing of the 216-223 Mc/s channel for television (this will extend Band 3 by 7 Mc/s) and the co-ordination of investigations into the use of Bands 4 and 5.

Three new working parties, were set up during the meeting. One will deal with the operational use of magnetic-tape recording, including its applications in television; another with the expansion of the television network in Europe, with special reference to the location and responsibility for standards-converters for international relays; and the third will be responsible for collaboration between the E.B.U. and the C.I.S.P.R.

The report of the Brussels Technical Centre given at the meeting included references to the standard of musical pitch, the choice of i.f.s for television sets, stereophony and the compilation of a bilingual technical glossary.

"*W.W.*" *Index*

COPIES of the index to the 1953 volume of *Wireless World* are now available from our Publishers price 1s (postage 2d). Cloth binding cases are also obtainable with index, price 6s 5d by post. The binding of readers' own issues can be undertaken by our Publishers, the cost, including binding case and index, being 17s 6d plus 1s 4d postage on the bound volume.

NEW YEAR HONOURS

Dr. W. G. Radley, C.B.E., Post Office engineer-in-chief, received a Knighthood in the New Year Honours. He joined the Post Office in 1920, was for five years controller of research and was appointed E.-in-C. in 1951. He is chairman of the Technical Sub-Committee set up by the Television Advisory Committee.

Norman C. Robertson, M.B.E., who recently concluded his two-year term of office as director-general of electronics production at the Ministry of Supply and returned to E. K. Cole, Ltd., where he has been deputy managing director since 1945, has been appointed a Companion of the Order of St. Michael and St. George (C.M.G.).

Rear-Admiral (L) C. P. Clarke, C.B., D.S.O., R.N.(ret.), and **Cdr. S. S. C. Mitchell,** C.B., O.B.E., R.N.(ret.), are created Knights Commanders of the Order of the British Empire (K.C.B.). Commander Mitchell has been controller of guided weapons and electronics (M.o.S.) since 1951 and has been in charge of all research, development and production of guided weapons in this country.

G. J. S. Little, G.M., an assistant engineer-in-chief, Post Office, and **G. Darnley Smith,** managing director of Bush Radio and Cinema Television, are among the new Commanders of the British Empire (C.B.E.). Mr. Darnley Smith is chairman of the Radio Industry Council and is one of the two representatives of the industry on the Television Advisory Committee.

Among the new Officers of the Order of the British Empire (O.B.E.) are **T. H. Baines,** deputy director radio equipment (production), Admiralty, **A. S. Mitson,** assistant director electronics production. M.o.S., and **M. J. L. Pulling,** senior superintendent engineer (television), B.B.C. Mr. Pulling has been in his present position since 1949 and was previously superintendent engineer (recording) for eight years. He recently visited the United States and gave his impressions of American television in our January issue.

New M.B.E.s include **O. H. Barron,** engineer, Planning and Installation Department, B.B.C., **D. J. Bowman,** B.B.C. Monitoring Service, **F. Clark,** Marconi Radio Officer in m.v. *Isipingo*, **W. H. F. Griffiths,** chief engineer, H. W. Sullivan, Ltd., who has contributed articles on standard measuring equipment to both *Wireless World* and *Wireless Engineer*, **H. J. Harbour,** test controller, Radio Division, E. K. Cole, Ltd., and **G. Houghton,** chief technical instructor, Radar Section, Technical Training College, Indian Air Force, Jalahalli.

Recipients of the British Empire Medal include **W. McLaren,** leading technical officer, P.O. Radio Station, Cupar, and **G. Wilkins,** experimental mechanician, McMichael Radio.

PERSONALITIES

Ernest Leete has been elected an Honorary Member of the I.E.E. "for his services as Honorary Treasurer . . . and also for his work on behalf of the Benevolent Fund of the Institution." Mr. Leete joined the London Electric Wire Company and Smiths, Ltd., in 1904 and subsequently became managing director.

H. Faulkner, C.M.G., B.Sc., M.I.E.E., has retired after forty years' service in the Post Office where he has been deputy engineer-in-chief since 1948. He was a member of the team responsible for the design of the Rugby Station and was its first officer-in-charge (1925). Mr. Faulkner was chairman of the recent London meeting of the C.C.I.R. and is a member of the Technical Sub-Committee of the Television Advisory Committee. He has accepted the office of director of the Telecommunication Engineering and Manufacturing Association (see opposite page).

A. H. Mumford, O.B.E., B.Sc.(Eng.), M.I.E.E., succeeds Mr. Faulkner as deputy E.-in-C. at the Post Office, having been an assistant E.-in-C. since 1951. He joined the Post Office Engineering Dept. as a probationary assistant engineer in 1924, and after a short period at Headquarters went to the Dollis Hill laboratory. He took charge of the Radio Branch in 1928. Mr. Mumford is succeeded as assistant E.-in-C. by **C. F. Booth,** O.B.E., who has been deputy director, External Telecommunications Executive, for the past eighteen months. Both Mr. Mumford and Mr. Booth have been chairmen of the I.E.E. Radio Section. (Portrait opposite.)

Rudolph Kompfner, the originator of the travelling-wave valve which he described in the November, 1946, issue of *Wireless World*, is now at the Bell Telephone Laboratories, Murray Hill, New Jersey, U.S.A., where he is working on microwave valves and has recently contributed an article on backward-wave valves in the *Proceedings of the I.R.E.* He came to England from Austria in 1934 and joined the Admiralty as a temporary experimental officer in 1941, undertaking research in the Physics Department of Birmingham University. From 1944 until 1952 he was in the Clarendon Laboratory of Oxford University.

RECIPIENTS OF NEW YEAR HONOURS

DR. W. G. RADLEY
(Knighthood)

NORMAN C. ROBERTSON
(C.M.G.)

M. J. L. PULLING
(O.B.E.)

W. H. F. GRIFFITHS
(M.B.E.)

W. R. Nash, M.Inst.R.E.(Aust.), who has been London manager of Amalgamated Wireless (Australasia), Ltd., for the past seven years, has returned to Sydney as an assistant to the managing director of A.W.A. He is succeeded by **D. Craig,** who joined A.W.A. in 1936 after five years with Raycophone, Ltd. From 1937 to 1946 he was in the company's research laboratory where he was concerned with development work on crystal manufacturing machinery, aircraft equipment and mobile f.m. gear. For the past seven years he has been in the Technical Services Section.

A. H. MUMFORD

D. CRAIG

A. I. Bray, B.Sc.(Eng.), A.C.G.I., A.M.I.E.E., who joined the engineering staff of the B.B.C. in 1935 and was attached to the London Outside Broadcasts Section, has been appointed engineer-in-charge Television Outside Broadcasts (London). During the war he served in the R.A.F., attaining the rank of Squadron Leader, and returned to Television O.B.s in 1946.

L. Evans has been appointed engineer-in-charge of the Isle of Man television transmitter. He joined the B.B.C. in 1941 and has served at a number of the Corporation's sound and television stations, including Sutton Coldfield and Wenvoe.

OUR AUTHORS

S. Kelly, chief engineer of Cosmocord's electro-acoustic division, who writes on components for transistors in this issue, was on radar research at R.A.E., T.R.E. and at the Massachusetts Institute of Technology for the major part of his wartime service in the R.A.F. He was subsequently senior radar officer, Transport Command Development Unit. Before the war Mr. Kelly was in the development laboratories of Standard Telephones & Cables and Philco.

D. C. Pressey, author of the article on page 60, is at present developing analogue computing devices at Southern Instruments, which he joined in 1950. He commenced his radio career in 1944 at R.R.D.E. (now Radar Research Establishment), Malvern, where most of his work was concerned with the radio proximity fuse. Two years later he went to the Nuffield Department of Anæsthetics, Oxford University, where he undertook research on the application of electronics to medical problems, as a result of which an instrument for the recording of respiration rates and volume was developed.

T. W. Bennington, whose annual survey of the ionosphere appears in this issue, was from 1939 until recently in charge of the ionospheric and short-wave propagation work of the Overseas and Engineering Information Department of the B.B.C. He is now engaged on similar work in the Corporation's research department. He helped in 1930 to inaugurate the first long-distance ship-shore radio-telephone service and was in charge of the radio-telephone service in R.M.S. *Majestic.* Mr. Bennington, who joined the B.B.C. in 1934 after a period in the radio industry, is author of the book " Short-wave Radio and the Ionosphere."

H. S. Jewitt, contributor of the article on wideband i.f. amplifiers on page 86, worked on anti-aircraft radar while in the army from 1939 until invalided out in 1942. He then undertook research work on v.h.f. and a.f. until September, 1945, when he went to Queen Mary College, London University. He graduated in 1949 as B.Sc.(Eng.) and joined Ferranti's as development engineer working on pulse circuitry. Since mid-1952 Mr. Jewitt, who is now 31, has been with Decca Radar where he is senior engineer in charge of the receiver design group at the radar research laboratory, Tolworth, Surrey.

IN BRIEF

Receiving Licences.—During November the number of television licences in Great Britain and Northern Ireland increased by 119,157, bringing the total to 2,846,227. The total number of broadcast receiving licences, including sound. vision and 202,676 for car radio, was 13,216,644 at the end of the month.

East Anglian Transmitter.—A new low-power transmitter at Hempstead, near Cromer, was brought into service by the B.B.C. at the end of December. The 2-kW station, which operates on 434 metres (692 kc/s), has been provided with a directional aerial system designed to give a good service in Sheringham, Cromer, North Walsham and Aylsham without affecting reception of the Moorside Edge transmissions in north-west Norfolk and along the Lincolnshire coast.

Farnborough 1954.—The annual flying display and exhibition of the Society of British Aircraft Constructors at Farnborough, which is fast becoming the focal point for aeronautical radio, will this year be held from September 7th to 12th.

The **Daventry Third Programme Transmitter** (647 kc/s), the aerial of which had been undergoing repair for some time, resumed transmission on full power at the end of the year. Further adjustments to the aerial system are being made to reduce the fading which is experienced after dark in the more remote areas.

The Physical Society is organizing a conference on the **Physics of the Ionosphere,** to be held at the Cavendish Laboratory, Cambridge, from September 6th to 9th Details of the Conference, which will be devoted to discussions on the lowest ionosphere, irregularities and movements in the ionosphere, the F2 layer and the mathematics of wave propagation, may be obtained from J. A. Ratcliffe, F.R.S., Cavendish Laboratory, Cambridge.

T.E.M.A.—The Telecommunication Engineering and Manufacturing Association, of which H. Faulkner has been appointed director (see "Personalities"), is concerned mainly with general policy matters in the telecommunication industry. Among the members of the association, which was formed in 1943, are A. T. & E., Creed, Ericsson, G.E.C., Plessey, S.T.C., Siemens and T.M.C. The address of T.E.M.A. is Stafford House, 40-43, Norfolk Street, London, W.C.2.

Magnetic Tape Standards.—A revised British Standard (BS1568:1953) has been issued on "Magnetic Tape Sound Recording and Reproduction for Programme Interchange." Dimensions are now included of an adaptor to permit the use of American N.A.B. spool hubs on machines designed primarily for European standard spools. Copies, price 2s 6d, are obtainable from the British Standards Institution, 2, Park Street, London, W.1.

Amateur Colour Television pictures have been transmitted over a closed circuit by C. G. Dixon, of Ross-on-Wye. The home-built equipment works on the frame-sequential system with rotating colour discs in front of the camera and c.r.t. monitor, and the scanning rate is 100 colour frames per second or 33⅓ complete pictures per second of 150 lines (non-interlaced) each.

Richmond Readers interested in the "technical aspects of the reproduction of music" might like to know that a group of music enthusiasts in the district is holding monthly meetings. Details may be had from B. J. Davis, 18, West Park Avenue, Kew Gardens, Richmond, Surrey.

As already announced, the fourth **Mechanical Handling Exhibition and Convention,** organized by *Mechanical Handling,* will be held at Olympia, London, W.14, from June 9th to 19th.

A booklet on the benefits of **V.H.F. Mobile Radio-telephones** in business and public services has been prepared by the Radio Communication and Electronic Engineering Association. It includes a list of the members of the Association supplying mobile radio equipment.

Amateur Call Book.—The winter edition of the R.S.G.B. Amateur Radio Call Book, which contains the calls, names and addresses of some 7,500 amateurs in the British Isles and Eire, is now available by post from the Society, price 2s 9d.

A new **Mullard Film** dealing with the technicalities of valve design and manufacture is now available for showing to clubs, colleges and schools. The "Manufacture of Radio Valves" as it is called, can be borrowed from Mullard's, Technical Publications Department, Century House, Shaftesbury Avenue, London, W.C.2.

Details of specialized **Higher Technological Courses** in a variety of subjects including electronics, high vacuum techniques, semi-conductors and transistors, which are available

at 26 establishments in London and the Home Counties, are given in a Bulletin issued by the Regional Advisory Council, Tavistock House South, Tavistock Square, London, W.C.1. The price is 1s 6d.

INDUSTRIAL NEWS

Belling & Lee are arranging to give talks to the trade on the reception problems associated with the proposed introduction of an alternative television programme. They will be given in areas in which it is intended to erect transmitters and will cover aerial adaptors, feeders, input arrangements, etc.

Marconi Marine Company has appointed as manager of its Grimsby Depot, J. W. Dalton, who commenced his service with the company as a sea-going operator in 1928. He was manager of the Cape Town Depot of Marconi (South Africa), Ltd., from 1946 to 1953.

An order valued at over £100,000 has been placed with **E.M.I. Factories** by the French Air Ministry for 100 airborne Rebecca Mark IV sets with spares and associated test gear.

A complete **Pye** duplex multi-carrier radio-telephone system has been installed in South Turkey for the police. The installation consists of a 15-watt control station at Adana which controls two 50-watt repeaters installed at points where maximum coverage can be obtained. A further fixed station at the port of Mersin is linked by radio with the police headquarters at Adana 75 km away

A further three complete **Emitron** mobile television microwave radio links have been ordered by the Swiss Post Office from E.M.I.

Ediswan's Glasgow district office is now at 167, St. Vincent Street, Glasgow (Tel.: Central 0687). The cathode-ray tube service depot is at the same address, but its new telephone number is Central 2206 The company has also opened a c.r.t. service depot at 39-41, Jacksons Row, Manchester, 3 (Tel.: Blackfriars 2969).

Wharfedale Wireless Works, of Bradford, Yorks, celebrated in December the 21st anniversary of its formation.

MEETINGS

Institution of Electrical Engineers

London.—Faraday Lecture "Electro-Heat and Prosperity" by O. W. Humphreys, B.Sc., at 6.0 on February 16th at Central Hall, Westminster, S.W.1. (Admission by ticket obtainable from Savoy Place, W.C.2.)

"The Manchester Kirk o'Shotts Television Radio Relay System" by G. Dawson, B.Sc., L. L. Hall, K. G. Hodgson, B.A., R. A. Meers, O.B.E., T.D., and J. H. H. Merriman, on February 4th.

Radio Section.—"Basic Ground-Wave Propagation Characteristics in the 50-800 Mc/s Band" by J. A. Saxton, B.Sc., Ph.D., and "Ground-Wave Field Strength Surveys at 100 and 600 Mc/s" by J. A. Saxton, B.Sc., Ph.D., and B. N. Harden, M.Sc., on February 10th.

Discussion on "Acceptable Standards of Quality in Sound Broadcast Transmission and Reception"; opener, J. K. Webb, M.Sc. (Eng.), B.Sc.Tech.

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

Cambridge Radio Group.—"The Use of Radio in the Ascent of Everest" by G. C. Band, at 6.30 on February 16th at the Cambridgeshire Technical College.

North-Eastern Radio Group.—"Technical Arrangements for the Sound and Television Broadcasts of the Coronation Ceremonies" by W. S. Proctor, M. J. L. Pulling, M.A., and F. Williams, B.Sc., at 6.15, on February 15th, at King's College, Newcastle-upon-Tyne.

North Midland Centre.—"Special Effects for Television Studio Productions" by A. M. Spooner, B.Sc.(Eng.), and T. Worswick, M.Sc., at 6.30, on February 9th at the British Electricity Authority, 1, Whitehall Road, Leeds.

"Ignition Interference with Television Reception" by A. H. Ball and W. Nethercot at 7.15 on February 25th at the Yorkshire Electricity Board, Ferensway, Hull.

North-Western Radio Group.—"The Reproduction of Signals Recorded on Magnetic Tape" by E. D. Daniel, M.A., and P. E. Axon, M.Sc., Ph.D., at 6.30, on February 17th, at the Engineers' Club, Albert Square, Manchester.

South Midland Radio Group.—"What is an Amplifier?" by D. A. Bell, M.A., Ph.D., at 6.0, on February 22nd, at the James Watt Memorial Institute, Great Charles Street, Birmingham.

Rugby Sub-Centre.—"Technical Arrangements for the Sound and Television Broadcasts of the Coronation Ceremonies" by W. S. Proctor, M. J. L. Pulling, M.A., and F. Williams, B.Sc., at 6.30, on February 3rd, at the Rugby College of Technology and Arts.

Southern Centre.—Faraday Lecture "Electro-Heat and Prosperity" by O. W. Humphreys, B.Sc., at 6.30, on February 18th, at the Guild Hall, Southampton.

"Technical Arrangements for the Sound and Television Broadcasts of the Coronation Ceremonies" by W. S. Proctor, M. J. L. Pulling, M.A., and F. Williams, B.Sc., at 7.30, on February 24th, at the R.A.E. Technical College, Farnborough.

Western Centre.—Faraday Lecture "Electro-Heat and Prosperity" by O. W. Humphreys, B.Sc., at 6.30, on February 1st, at Sofia Gardens Pavilion, Cardiff.

"Technical Arrangements for the Sound and Television Broadcasts of the Coronation Ceremonies" by W. S. Proctor, M. J. L. Pulling, M.A., and F. Williams, B.Sc., at 6.0, on February 8th, at the South Wales Institute of Engineers, Park Place, Cardiff.

South-Western Sub-Centre.—"Printed and Potted Electronic Circuits" by G. W. A. Dummer and D. L. Johnston, B.Sc.(Eng.), at 4.30, on February 11th, at Dowlish Ford Mills, Ilminster, Somerset.

British Institution of Radio Engineers

London Section.—"Electronics in Film Making" by W. D. Kemp and B. R. Greenhead (High Definition Films), at 6.30 on February 17th at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

Scottish Section.—"Electronics in Film Making" by W. D. Kemp and B. R. Greenhead (High Definition Films), at 7.0 on February 4th at the Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2.

North-Western Section.—"Police Radio, Its Past, Present, and Future Possibilities" by I. Auchterlonie (Manchester City Police) at 7.0 on February 4th at the Reynold's Hall, College of Technology, Manchester.

North-Eastern Section.—"Some Aspects of Micro-Wave Aerial Design" by J. Bilbrough (Microwave Instruments), at 6.0 on February 10th at the Neville Hall, Westgate Road, Newcastle-upon-Tyne.

Merseyside Section.—"Micro-Wave Test Gear" by J. Bilbrough (Microwave Instruments), at 7.0 on February 4th at the Electricity Service Centre, Whitechapel, Liverpool, 1.

West Midlands Section.—"Applications of Electronic Techniques to the Testing of Magnetic Materials" by J. MacFarlane (Guest, Keen & Nettlefold), at 7.15 on February 23rd at the Wolverhampton & Staffordshire Technical College, Wulfruna Street, Wolverhampton.

British Sound Recording Association

London.—"Stereophonic Sound Reproduction" by J. Moir, at 7.0 on February 19th at the Royal Society of Arts, John Adam Street, London, W.C.2.

Manchester Centre.—"The Problems of Hearing" by J. E. J. John (Manchester University), at 7.30 on February 15th at the Engineers' Club, Albert Square. Manchester.

Television Society

London.—Fleming Memorial Lecture on "Colour Television" by G. G. Gouriet, B.Sc., at 7.0 on February 10th and 24th at the Royal Institution, Albemarle Street, London, W.1.

Leicester Centre.—"Modified Murphy Receiver Using 24-in G.E. Tube" by H. Fairhurst (Murphy Radio), at 7.0 on February 28th at the College of Art and Technology, The Newarkes, Leicester.

Institute of Navigation

"The Requirements for Marine Pilotage" by Commander L. W. Akerman and R. F. Hansford, at 5.0 on February 19th at the Royal Geographical Society, 1, Kensington Gore, London, S.W.7.

Institution of Production Engineers

Wolverhampton.—"Electronics in Production Engineering" by D. R. Whatley, B.Sc. (Eng.), at 7.15 on February 3rd at the Wolverhampton and Staffordshire Technical College, Wulfruna Street, Wolverhampton.

Edinburgh.—"Electronics in Industry" by G. Horsfall, at 7.30 on February 17th at the North British Station Hotel, Edinburgh.

Radar Association

"Some Unsolved Radar Problems" by K. E. Harris (Cossor) at 7.30 on February 10th in the Anatomy Theatre, University College, Gower Street, London, W.1.

Institute of Practical Radio Engineers

Midlands Section.—"Ultra Television Receivers" by H. G. Trapp (Ultra), at 7.30 on February 1st at the Crown Hotel, Broad Street, Birmingham.

Radio Society of Great Britain

London.—"Practical Aspects of Tape Recording" by S. A. Lacey (Murphy Radio), at 6.30 on February 26th at the I.E.E., Savoy Place, London, W.C.2.

Electron Optics

By "CATHODE RAY"

How Electron Paths are Controlled by Electric Fields

WHAT is electron optics? Well, for one thing it is a contradiction in terms. My dictionary says that "optics" is derived from a Greek word meaning "pertaining to sight; visible." Now one of the most obvious things about electrons is that they are *not* visible. You may perhaps have read somewhere that the fluorescent screen in a cathode-ray tube is for rendering the electron stream visible, but of course that is not literally true; it is the effect of their impact that is visible, not the electrons themselves. But "electron optics" does not even mean the technique of rendering effects visible. It is often very closely connected with such technique, notably in the cathode-ray tube, but it is really quite a distinct science. Roughly it could be defined as doing with electrons much the same kinds of things as can be done with light. Such things as focusing and deflecting rays. But I would like to make it clear from the start that "optics" only comes into the title on the strength of an analogy, and what is called electron optics could quite well be practised if there were no such thing as optics or even light. The analogy between optics and electron optics is by no means perfect and can actually mislead. One might almost as well call the subject of ordinary current electricity "electron hydraulics" because there is an analogy between electric currents and water. As we shall see, optics is not the only analogy that can be used in explaining "electron optics." However, that is the name it is known by, for good or ill, so we shall just have to use it.

I suppose we had better begin by establishing the resemblance between electron optics and optics, or electron rays and light rays; and the customary starting place is the Maltese-cross experiment, described by Sir William Crookes (as he later became) in 1879. This experiment, as you probably well know, was performed with a glass vacuum tube (Fig. 1) in which "cathode rays" were produced by applying a high voltage between two electrodes. The glass of the tube fluoresced under the impact of the rays, except where it was protected from them by the anode, which cast a shadow. The anode was in the form of a Maltese cross, but as far as I can see there is no special merit in that shape; it could just as well be a silhouette of Marilyn Monroe, and in fact that would probably ensure closer attention to the demonstration; though, in that comparatively unsophisticated age, the cross seems to have made such a hit that a less picturesque demonstration of the same phenomenon no less than ten years earlier by a man named Hittorf was quite overshadowed. However it did show strikingly that what was coming from the cathode bore some resemblance to light, notably in normally travelling in straight lines and in being stopped by metal. There was, even in 1879, a strong suspicion that these rays consisted of negatively charged particles, which were later (after the suspicion had been confirmed) named electrons.

The study of light had shown that its rays can be bent ("refracted" is the scientific term) by various means, such as lenses; and when it was found that similar things could be done with electron rays (though not by the same means) there was enough of an analogy for people to begin to talk about "electron optics," "electron lenses," and so forth. The tie-up with light was made practically unbreakable by the arrival of the electron microscope, which does the same sort of thing as a light microscope only more so. Some of the vast existing store of knowledge about optics has been used to develop electron optics, but it needs a good deal of adaptation, and much of it cannot be applied at all.

We shall probably be doing well enough if we confine this first view of electron optics to its use in cathode-ray tubes, for that is what interests most of us. In their raw state, the cathode rays would just make a splodge of light on the screen, which would be no use for anything (beyond the childish pastime of throwing electronic shadows). A prime necessity is to focus the rays to a fine point—the very words emphasize the analogy with the "burning glass." But the

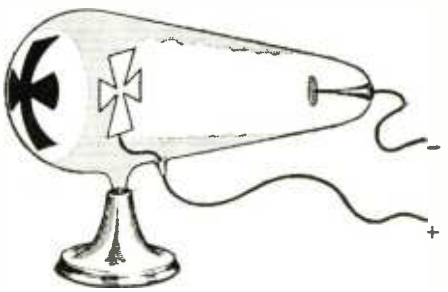


Fig. 1. The celebrated Maltese-cross experiment, by which Crookes demonstrated that cathode rays resemble light in travelling in straight lines and being stopped by metal. The cross casts a shadow on the fluorescent glow caused by the rays.

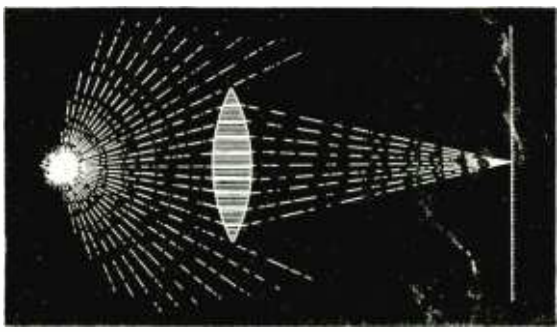


Fig. 2. Light rays can be focused on a screen by means of a glass lens, which bends the rays. Any device that does the same thing for cathode rays is called an electron lens.

resemblance is more in the results than in the means for achieving them. So I think it would be a mistake to spend a lot of time studying optics as a preliminary to electron optics, much though I would enjoy illustrating it in terms of the effects of local boggy ground on the movements of columns of troops. But I don't want to be classed with the lecturer on electricity whose students complained that they learnt a great deal from him about water in pipes but not very much about electricity. All we need, I think, is a passing glance at the probably very familiar diagram, Fig. 2, which shows a lens focusing a diffuse beam of light by bending its rays so that they all converge on the same point. The corresponding kind of electron lens is one that makes electrons do the same thing, and that is the kind we are going to consider.

Bending Electron Paths

The principle used in an optical lens for bending the rays of light is the change in speed of light when it passes from one medium to another, such as from air into glass. How are the paths of electrons bent? There are two means—electric fields and magnetic fields. So here once more we find ourselves confronted with these twin fantasies that seem so elusive and unreal and yet are the basis of everything electrical —and in fact of the whole universe. Our understanding of things electrical—including emphatically electron optics—can be no better than our understanding of fields. Unfortunately, being basic, there is nothing more basic that can be used for describing them, and in the attempt to "unscrew the inscrutable" one is almost bound to make use of imaginary things shown as lines drawn on paper. It must be remembered all the time that such things are no more than artificial aids towards apprehending something whose ultimate nature may be beyond our grasp but about whose behaviour there is no doubt.

However, let's get down to it. Most electrical people have a more or less clear picture of the workings of Ohm's law. And even though it is nearly always applied to circuit elements such as wires, where one does not have to bother much about the sideways distribution of current but only the length, it ought not to be too difficult to visualize what happens in wide conductors. (There is no need to fear another departure into "skin effect"; we shall be considering d.c. only!) Suppose we were to coat a rectangular sheet of plastic with a perfectly uniform layer of carbon, and connect a 100-V battery to opposite ends, using strips of copper to make sure that the whole width was at the same potential (Fig. 3). Then if we were to reckon the lower edge as zero potential, the top edge would be at +100 V, and the potentials in between would be proportional to the height up the strip. If we had a voltmeter that took no current at all we could quite easily check this by applying point probes to the carbon surface. We could, in fact, map out the surface with "equipotential lines," as shown dotted. But in this simple case we can easily fix their positions theoretically by Ohm's law.

We might also draw another kind of dotted line to show the directions in which the current would flow as a result of this potential pattern. The current, of course, consists of free electrons in the carbon, and they take the shortest route towards a more positive potential. Or, more correctly, what appears at the moment to be the shortest route. Like J. H. Newman, they say "I do not ask to see the distant scene; one step enough for me." And what appears to the short-sighted electron to be the shortest route *is always at right angles to the equipotential lines.* Fig. 4 is an enlarged view of a bit of Fig. 3, and it must be obvious that a stationary electron at A will take the shortest route to the higher potential, viz., along AB, and, of course, that shortest route is at right angles to the dotted lines. Any other route would necessitate sideways movement, and that could not take place without a sideways attraction, and if there were any sideways attraction, the potential pattern could not be as shown.

With such a simple set-up as Fig. 3 one could hardly go wrong. The equipotential lines and the lines of electric force (for that is what the electron paths are called) together make a sort of squared-paper pattern. But what happens when the short view and the long view disagree; that is to say, when the equipotential lines are not parallel to one another. Suppose the carbon sheet had the shape shown in Fig 5. A zero-potential electron at A, if it were far-sighted, would see that the nearest maximum-potential point was B and would make straight for it along the chain-dotted line. But this would mean that during the first stage of the journey it would *not* be taking the shortest route between 0 V and +10 V. The electron can only respond to the direction of the attractive force where it actually happens to be at the moment, and that force is beckoning not from the +100-V line, nor the +10-V equipotential line (which is visibly out of parallel with the 0-V "starting grid"), nor even the +1-V line, but from a line so close in front as to be practically parallel to the 0-V line; and so the electron moves off at right angles to that line. But as it progresses the increasing inclination of the equipotentials bends its path around, so that when complete it is the curve leading to B'.

Potential Gradients

Does that mean that there will be just as much current flowing along the outer edge of this wide track as along the shorter inner path? Certainly not, if Ohm's law is true, for the total voltage is the same for every path, whereas the resistance is proportional to the length of the path. So the current density is greatest on the inside and decreases towards the outer edge in the same proportion as the distance increases. (The current density along a surface is the amount of current per small unit of width.) Another way of putting it is to say that the current density increases with the closeness of the equipotential lines. One advantage of this way is that if one knows anything at all about contour maps a very pretty analogy fairly leaps to the mind. Contour lines, of course, are lines

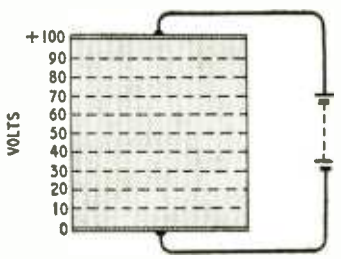


Fig. 3. Equipotential lines (dotted) of electric field along a uniformly conducting strip having a difference of potential between the ends.

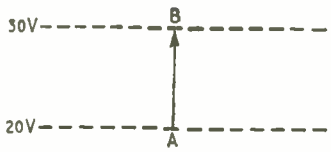


Fig. 4. An electron starting from rest at A tends to take the shortest path to a more positive potential, and in doing so always moves along the line of force and at right angles to the equipotential line passing through its position.

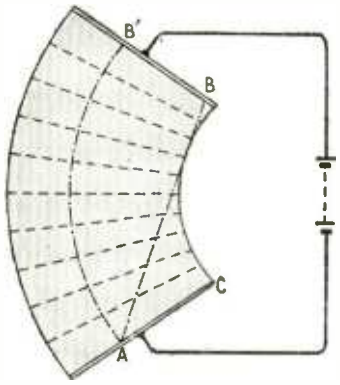


Fig. 5. When the equipotential lines are, as here, not parallel to one another, the electron does not take the shortest route (AB) to the highest potential. It still tends to keep at right angles to its own equipotential line, which means a curved path (AB').

joining all points at the same height above sea level, so they might be called equi-height lines; and since electrical potential is often likened to height the analogy is obvious. A steep gradient is revealed on the map by the contour lines being close together. The steeper the gradient the stronger the pull of gravity along the surface. That pull always acts at right angles to the contour lines; one might say that the lines of gravitational force are at right angles to the equi-height lines. Fig. 5 can now be regarded as a plan diagram of a spiral stairway, except that instead of steps we must imagine a smooth slope, to correspond with the smoothly continuous change of electrical potential along the carbon strip. If the slope is downwards from A, a marble released there does not roll straight to B; it cannot see, so it does not know anything about B, all it knows about is the slope where it actually is, at A, and that slope is at right angles to CA, so it starts off on the AB' curve, just like the electron in the carbon strip. Will it then, like the electron, follow that line all the way to B'?

You have only to try it—or perhaps even imagine it—to realize that it will not. Because the slope is smooth, the marble gains speed, and the direction of its movement is then determined not only by the direction of the slope but also by the direction in which it was moving when it reached that slope. The marble always tends to go straight on, and cannot respond immediately and fully to a change in direction of slope. The faster it is going the less readily it responds.

The electron in the carbon conductor can be likened to a marble rolling down a slope thickly studded with pins, rather like a Corinthian bagatelle board but with no permanent stops. Every time it hits a pin its journey is interrupted and it has to start afresh, so its speed is no greater at the end than at the beginning. Its average speed is so low that its movement is controlled almost entirely by the slope, and when the slope stops the marble stops. Similarly the electron in the carbon is constantly bumping into carbon molecules, and so is kept down to a constant average speed, which as we saw last month is very low. It continues to move only so long as it is on a potential slope. If the strip in Fig. 3 were extended beyond the 100-V terminal into a sort of blind alley, would they go on into it? Not they!

Introducing Free Electrons

But what we are supposed to be studying is the movement of electrons that are *not* hindered by resistance. So our carbon conductor, although it may serve as an introduction to electric field and equipotential lines, is actually a complication. If we throw it out of Fig. 3, leaving only the battery and copper electrodes, the potential pattern remains. The space between the electrodes is still occupied by an electric field, and any free electrons there are attracted along nearly the same lines of force as before. The trouble is that there aren't any free electrons there. So we have to introduce some. A convenient way of doing this is to coat the negative electrode (i.e., the cathode) with a suitable material such as barium oxide, and heat it. Electrons then boil off, but their space trip is complicated by encounters with air molecules, so to give them a clear run it is necessary to put the electrodes in a glass bulb and pump the air out. Then, at last, the electrons can really display their own simple nature, which is (as Newton saw long before electrons were thought of) to remain in a state of rest or uniform motion in a straight line unless acted upon by external forces, and to accelerate in proportion to any acting force. The particular force we are concerned with just now is the electric field.

In the carbon or any other resistance the electron speed is very limited because it gives rise to a kind of frictional force that neutralizes the force of the electric field, and directly it is fast enough to do so exactly there is no net force and the electron continues uniformly at that speed, in accordance with Newton's first law. But in the clear vacuum it continues to gain speed, like the marble, as long as it is falling down a potential gradient.* As we saw last month, the speed it gets up depends only on the voltage it "falls" through, and if that voltage is denoted by V the speed reached from a standing start is $593\sqrt{V}$ kilometres per second, which is $368\sqrt{V}$ miles per second. The analogy with marbles rolling down frictionless slopes holds good, for the speed they acquire in losing height to the extent of h feet is $8\sqrt{h}$ feet per second. regardless of whether the slope is gradual or precipitous; and when they have acquired it they continue at that speed indefinitely on the level. But whereas in practice friction always interferes with rolling balls (otherwise the game of bowls would be unplayable) our electrons in a vacuum really do keep on accelerating so long as the voltage is rising, and in a constant-potential region they keep up the speed and direction with which they entered it. (They are

* It may be necessary to remind ourselves that because an electron is negative a downward gradient to it is one that becomes increasingly positive. Any confusion in the fact that a "rising" potential is (from the electron's point of view) a downward slope is the fault of whoever persuaded everybody to call the electron-attracting end "positive."

so light that the force of gravity on them can be neglected.) The only restriction on their speed is that when they have accelerated through about 10,000 volts (to 59,300 kilometres per second) their increase of mass due to "relativity" begins to become appreciable, and this makes the speed curve flatten off to an absolute limit of 299,792 km/sec, which would be reached if the voltage were infinite. But even in modern high-voltage cathode-ray tubes the relativity correction is quite small, so we shall not bother about it here.

Steering the Electrons

We can sum up our knowledge of electron optics so far by saying that we know how many volts we need to accelerate electrons to any desired speed (up to about 40,000 miles/sec, anyway!), and having got them up to speed can keep them going in a straight line at that speed, simply by arranging for their route to be at a constant potential. Presumably also we can retard them as desired, using a negative voltage; for retardation is just negative acceleration. But all that is not enough to gain us an electron-driver's licence. We must now tackle the much more difficult problem of steering. Unlike electrons in wires, those in space are not "vehicles steered by their own tracks." Nor is it enough to lay down lines of electric force in the required directions (though that may seem difficult enough, seeing they are imaginary!) because there can be no lines of force without change of potential, and change of potential causes change of speed, and the quickness of response to changes in direction of the lines of force depends on the speed. It is no more use expecting a high-speed electron to follow a sharp bend in a line of force than it is to expect a car to get round a sharp corner at 80 m.p.h.

But let us get back to our marbles. Suppose we release a gentle cascade of them from the top of a long straight ridge, AB in Fig. 6. If the contour lines of the slope were parallel to AB all the way down, the lines of gravitational force would run at right angles to AB and parallel to one another, and the cascade of marbles, though gaining speed, would continue to spread thinly over the whole width. But hollowing the slope out, as shown by the curving inwards of the contour lines CD etc., would make the lines of force converge. If the marbles followed these lines exactly (as they would were it not for their momentum) they would take the paths at right angles to the contour lines as shown, and converge into a raging torrent of marbles at P. Note that it would not be necessary to continue the slope all the way to P; provided that the marbles were going in the right directions by the time they reached the line KL the ground from there on could be perfectly flat.

Near the start, before the marbles had time to get up much speed, their actual paths would follow the lines of force fairly closely; but as they gained momentum they would respond less and less to the inward curvature of the slope. So it would seem to be a good idea to do the focusing as near the start as possible; partly because least curvature would be needed, and partly because the marble tracks could be predicted the most accurately from the lines of gravitational force, which can be plotted by means of a simple slope-indicating device or arrived at from the contour lines. But of course one would not really care to leave the matter quite so vague as this; what exactly is the principle determining the actual paths taken by the marbles?

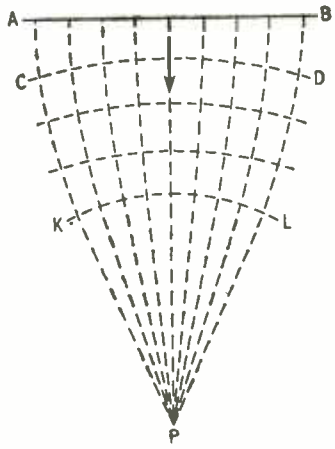


Fig. 6. Contour lines (CD, etc., to KL) of a hollow downward slope that would make marbles released along AB converge towards P. If their directions are correct by the time they reach KL the rest of the run can be flat, as shown by absence of further contour lines.

Well, this is really a matter of mechanics, and if that is a totally unknown subject it is a little late to give a full course on it here and now. But I suppose most *Wireless World* readers are sufficiently knowledgeable to need only an outline, at most. Suppose then that A in Fig. 7 is the position of a marble—or electron—which is travelling with a known velocity in the direction AB. If there were no other influence it would arrive at B after a certain interval of time. But suppose that a certain gravitational—or electric—field is acting in the direction AC. This force can be resolved in the usual way into one force acting along AB and another at right angles to it, along DC. The marble—or electron—is therefore accelerated in both of these directions in proportion to the separate forces. If the length AC represents the combined force the component forces are represented by AD and DC. The acceleration in any direction is equal to the mass of the marble—or electron—multiplied by the force acting in that direction. So the effect of the force here is to increase the velocity along AB so that the position in that direction after the interval of time is not B but E, and the right-angles acceleration has meanwhile carried it a distance EF, so the actual position is F. By plotting the position after different intervals of time, its track can be found—the dotted curve. All this may sound rather complicated, but such tracks are familiar from our earliest youth, for a ball thrown into the air is a body with an initial velocity in an arbitrary direction, combined with a steady acceleration (downwards). The faster the ball is thrown horizontally, the less is its curvature downwards and the longer it takes to come into line with the gravitational lines of force.

Designing the Electrodes

Given a field pattern, the foregoing principles can be used to calculate the track of an electron from any point in it. But that is not quite the problem; usually one is given the desired electron tracks and wants to find the arrangement of electrodes and voltages that will provide the field pattern that will produce those tracks. And that is quite a different matter. It is

usually solved by a combination of calculation, intelligent guesswork, and experiment.

The first stage is to find the field patterns between various electrodes. For a few specified configurations they can be calculated mathematically; some fairly easily, others not so easily. Usually the easier they are to calculate the less likely they are to be directly useful in practical c.r. tube design. It is not very helpful, for example, to have to accept a proviso that the electrodes are infinitely large, or that there is nowhere for connecting the sources of p.d. Even a pair of parallel plates does not provide a simple rectangular field pattern, unless the plates are infinitely large; with finite plates the lines barrel out at the edges, something like Fig. 8. We can easily guess, however, that one way to obtain a converging or diverging pattern is to make one electrode smaller than the other, as in Fig. 9. Note that the potential changes more rapidly where the lines of force are close together. This is what one would expect by analogy with the carbon sheet; if the lower electrode in Fig. 3 were made smaller than the upper, the greater current density near it would cause a greater voltage drop per inch there than near the wider electrode. As we have already noted, one could actually use a uniform carbon sheet to plot field patterns experimentally, by placing electrodes on it—preferably lead, so that they could easily be bent into different shapes—and plotting the potentials with a pointed probe and "infinite-input-impedance" voltmeter; but to simulate infinite space the sheet would have to be much larger than the inter-electrode space. Another and better method is to use a tank of liquid instead of the carbon.

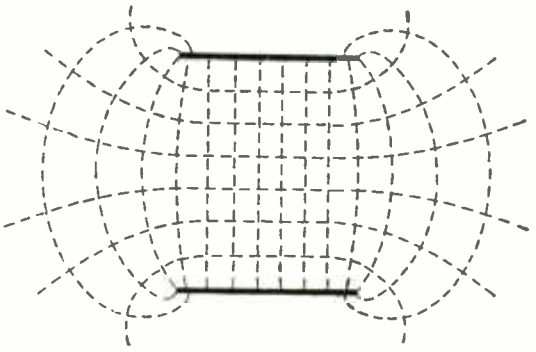


Fig. 8. Pattern of lines of electric force and equipotential lines between and around a pair of parallel charged plates.

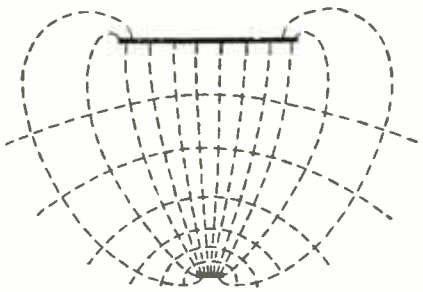


Fig. 9. The pattern when one plate is relatively small.

Final Adjustments

Having found the field pattern around the electrodes being studied, one can make a slope model with contour lines coinciding with the equipotentials, and try rolling marbles down it, or, better still, ball-bearing balls. This shows the tracks of electrons, and gives some idea of how the electrodes should be modified to get nearer the desired result. Alternatively, there are graphical methods of plotting the electron tracks on the field patterns, and even more or less automatic apparatus for plotting them direct from the electrolytic tank.

Fortunately a good focus does not depend on the electrode system having been manufactured dead right in the first place. Electron lenses are, so to speak, flexible, like the little optical lenses forming the fronts of our eyeballs, which change shape without conscious effort when changing our distance of looking. The focus of electric lenses can be varied within considerable limits by adjusting the voltages applied to the electrodes.

Obviously the plate kind of electrode we have been thinking about is not likely to be much good in an electron lens, however useful it may be in a valve; nor is the grid kind, because it stops some of the electrons altogether and on those that get through it imprints a pattern of its mesh. Most of the electrodes forming lenses in electrostatically focused c.r. tubes are hollow cylinders, rings, or disks with holes in the middle.

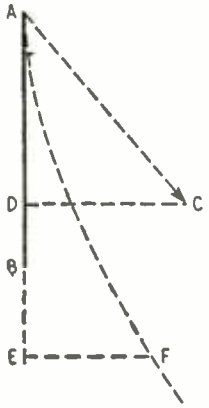


Fig. 7. How to find the net result of constant speed along AB and constant acceleration along AC.

Rolling-Ball Analogy

Time is just about up, and we have not yet looked at any examples of electric lenses, still less the more difficult subject of magnetic focusing. They will have to wait till next month.

In the meantime, to stop anybody writing in to complain that I am deluding the proletariat by giving the impression that the analogy between rolling balls and flying electrons is perfect, I would mention that whereas the electric force on an electron is inversely proportional to the distance between equipotential lines, the gravitational force on a ball is inversely proportional to the distance *along the slope* between the contours, not the horizontal distance shown on the contour plan. But provided the gradient does not exceed 1 in 7 the difference is less than 1%. There is also a discrepancy due to the fact that rolling balls roll and thereby acquire some rotational energy, but this also makes little difference.*

* "Determination of Electron Motion in Two-Dimensional Electrostatic Fields," F. H. J. A. Kleynen, *Philips Technical Review*, 1937, p. 338.

Magnetic Tape Recording

Problems of Standardization : Accidental Printing Phenomena

EXCELLENT as are the results obtained with magnetic tape as a medium for high-quality reproduction of sound, it is nevertheless liable to irregularities and inconsistencies which assume importance when attempts are made to measure and standardize a recording characteristic—which is necessary when tapes have to be exchanged between broadcasting organizations.

A systematic study has been undertaken by the B.B.C. and an outline of some of the results was given in a recent lecture to the British Sound Recording Association, "Problems of Magnetic Tape Reproduction," by P. E. Axon, M.Sc., Ph.D. One of the main difficulties is that the surface intensity of magnetization on the tape can be measured only indirectly, and that the flux is modified by association with the reluctance of the magnetic core used in the normal type of pick-up head. This manifests itself in discrepancies between the slopes of curves taken with short and long gaps—even after allowance has been made for variations of eddy-current losses with frequency.

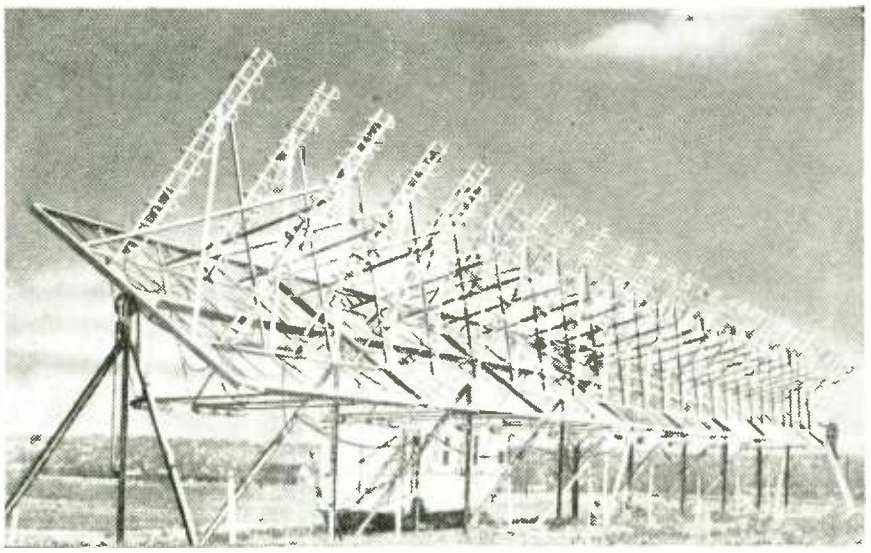
Better agreement is found when a non-magnetic single-turn head is used for calibration. This consists of a thin strip of copper foil between ebonite clamps mounted edge-on to the tape and supplied with thicker soldered leads at the ends. A series of minima appear when the thickness of the conductor equals an integral number of wavelengths, but unlike the magnetic head the "effective" gap is equal to the physical thickness of the conductor, and the frequencies of the minima are all harmonically related.

The virtue of the single-turn head is that with it a tape can be recorded and calibrated with a surface induction rising exactly at the theoretical rate of 6 db/octave, and this standard tape can be used subsequently to calibrate existing iron-cored heads.

Intimate contact between tape and head is of great importance in all calibration work, and both the tape and the head in the region of the gap must have a smooth surface finish if consistent measurements are to be made. It has been calculated that the loss due to separation is about 55 db per wavelength (λ) of the recorded frequency. At 7½in/sec and 7.5 kc/s, λ = 0.001in, and a separation between tape and head of only a tenth of this distance gives a drop in signal strength of nearly 6 db. Under normal recording conditions such irregularities manifest themselves as amplitude modulation noise.

Mr. Axon also discussed the phenomenon of accidental printing, and showed that the print level between adjacent layers could increase nearly 10 db after a rise of temperature of 10 C lasting only 5 minutes. Other factors known to affect printing are external magnetic fields and the physical tension of the tape during spooling.

Fortunately, accidental prints, made without h.f. bias, were less stable than the master signal and showed a tendency to decrease rapidly over a period of minutes from the instant of separation. The stability of the print increases with the duration of contact before separation, and all effects which tend to increase the printing level also increase its stability. Provided that the accidental print is not too deeply established, successful differential erasure between the wanted and unwanted signals is possible, using a weak h.f. field in the erasing head. This may even force the print below the noise level of the system, without reducing the main recording more than a few db. It is always worth while to re-spool immediately before replaying and at intervals during the storage life of the tape.



RADIO TELESCOPE

THIS broadside array of 48 helical beam aerials mounted on a pivoted earth screen has been built by the Ohio State University, U.S.A., for studying celestial radio sources. It has a beam width of only 1.2 degrees at 250 Mc/s. Each helix has 10 turns and is 10ft long by 15in in diameter. Receiving equipment is in the van underneath.

(Photo : Courtesy Electronics)

Megawatt Transmitter

Dependable World-wide Communication on Very Low Frequency

A GIANT radio transmitter which has taken six years to build was recently handed over by the Radio Corporation of America to the United States Navy. It was conceived with the idea of providing dependable communication with U.S. Fleet units in any part of the world at any time of the day or night and under all atmospheric conditions.

This requirement is best fulfilled by a powerful, very low frequency transmitter, as such frequencies are far less dependent on changeable wave propagation conditions than any of the frequencies normally used for long-range communications. If the power is great enough and the wavelength long enough signals will penetrate to arctic and tropical outposts and to submerged submarines, despite magnetic storms and ionospheric disturbances of the worst kind.

Special Valve

This transmitter is designed for operation on frequencies between 14.5 and 35 kc/s and is capable of a maximum power output of 1,200 kW. It consists of two nominal 500-kW units operating in parallel and arranged so that each can be used independently if required. The transmitters were designed around the special RCA Type 5831 high-vacuum transmitting triode. Each of the two r.f. amplifier units employs three of these valves, two in a push-pull circuit with the third as spare. The valves measure 10 in in diameter and 38¾ in high, weigh 135lb and are water cooled. The six-volt filament structure of thoriated tungsten requires 13 kW. Each valve needs 500 watts of grid driving power for 285 watts output at 80% anode efficiency with an anode voltage of 11.5 kV.

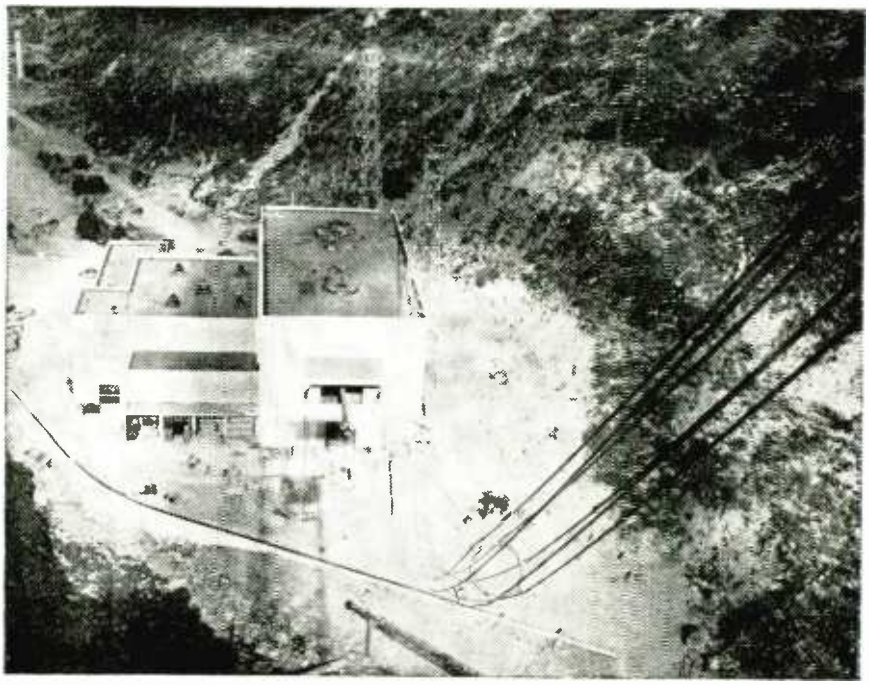
The design and erection of the aerial system constituted a gigantic task. The site chosen was the Jim Creek Valley, situated in rough country some 55 miles north east of Seattle. The station lies in a valley at the foot of twin 3,000-ft mountain peaks from which is suspended an impressive aerial system.

Prior to the erection of the aerial thousands of trees were felled on the valley slopes to facilitate rigging work and eliminate possibilities of forest fires. Most important of all, however, was the necessity to improve the transmitter efficiency as trees tend to absorb large amounts of r.f. energy radiated by nearby aerials.

The actual aerial consists of ten trans-valley spans each over a mile in length and forming a zig-zag pattern high above the floor of the valley. Twelve 200-ft steel towers erected along the crests of the twin mountains support the aerial. Owing to the tapering nature of the valley the spans are of unequal length; the longest measures 8,700 ft and the shortest 5,640 ft.

Like the transmitter, the aerial system is divided into two parts, each independent of, and isolated from, the other. This arrangement makes it possible to operate one-half of the transmitter and one-half of the aerial system in the event of repairs being required to the other halves.

With an aerial at such a great height there is a marked tendency to pick up static electricity from the air and if left unearthed for any time voltages can build up to a point where sparks a foot or so long will jump gaps in the system. As a safety measure the system is kept securely earthed when not employed for transmission. More than 200 miles of copper wires, cables and screens are buried in an intricate pattern across the valley floor to provide an efficient "earth."



Bird's eye view through steel framework of 200-ft summit ridge tower shows transmitter building in a valley between 3,000-ft mountain peaks.

Wide-Band I.F. Amplifiers

Design Technique Using Negative Feedback

By H. S. JEWITT.* B.Sc. (Eng.)

IN many electronic systems using pulses the trend at present is towards the use of shorter pulses, and pulse lengths of 0.1 microsecond and less are now common in the radar field. This development has necessitated the design of intermediate frequency amplifiers of large bandwidths, so that the reproduction of such short pulses will not be degraded. Bandwidths (to the -3db points on the response curve) for amplifiers are now commonly greater than 10 Mc/s, and the problem of achieving wide bandwidth and higher gain, yet producing an amplifier which is an economic possibility to manufacture, is very real and pressing. On the one hand the designer must use a large number of valves and tuned circuits to obtain the required gain and bandwidth; on the other, he is pressed to design his amplifier in such a way that it is easy to manufacture and maintain in service.

There are two methods of obtaining wide bandwidths in common use, one utilizing transformers as the tuned elements and the other frequency-staggered circuits. Both of these give satisfactory results as far as obtaining the necessary gain and bandwidth is concerned, but both tend to give difficulty in manufacture and service. These difficulties arise from one major cause, which is the tolerances to be expected on the parameters of the valves used. The difficulty is that an i.f. amplifier may be aligned with a given set of valves before it leaves the laboratory or factory to be put into service: if a valve fails in service and has to be replaced it is only too probable that the alignment process will then have to be repeated to restore the original bandwidth, as the capacitances of the new valve will differ from those of the old one. Alignment in the field is not easy on wide-band amplifiers: in the transformer-coupled case the difficulty of adjusting the inductances of the two windings and the coupling factor between them is considerable; in the staggered amplifier the frequencies of individual circuits and their damping resistors need adjustment.

In assessing the value of any particular circuit configuration the desirability of "pre-plumbing" must not be overlooked. By this term is meant the manufacture of the amplifier from components of reasonable tolerance without provision for any aligning: the amplifier when fitted with valves from stock should then give the required performance within the permissible limits. Clearly, if this can be achieved valve-changing in service will no longer be a problem.

A means of obtaining wide bandwidths in i.f. amplifiers which has been known for a considerable time, but which appears to have been somewhat neglected in comparison with those noted above, is the application of negative feedback. That the use

* Decca Radar.

TABLE I: COMPONENT VALUES FOR FEEDBACK PAIRS

B = -3 db bandwidth of response curve
C = Total capacitance = $C_{in} + C_{out} + C_{stray}$
g_m = Valve mutual conductance
from which $R_T = \frac{1}{2\pi CB}$ = effective damping required
and $G = g_m R_T$ = approximate gain per stage
K = Shape coefficient

	FIGURE 1		FIGURE 2	
	$R_1 (= R_3)$	R_2	$R_4 (= R_6)$	R_5
General Case $2 > K > -2$	$\frac{4GR_T}{2(\sqrt{2}+K)G-(2-K)}$	$\frac{4GR_T}{2-K}$	$\frac{4GR_T}{2-K+2(\sqrt{2}+K)G}$	$\frac{4GR_T(2-K)}{4G^2(2+K)-(2-K)^2}$
Special Cases $K = 0$ (flat pair)	$\frac{2GR_T}{\sqrt{2}G-1}$	$2GR_T$	$\frac{2GR_T}{1+\sqrt{2}G}$	$\frac{2GR_T}{2G^2-1}$
$K = -1$ (pair in flat triple)	$\frac{4GR_T}{2G-3}$	$\frac{4GR_T}{3}$	$\frac{4GR_T}{3+2G}$	$\frac{12GR_T}{4G^2-9}$
$K = +\sqrt{2}$ (pairs in flat quadruple)	$\frac{4GR_T}{3.7G-0.58}$	$6.9GR_T$	$\frac{4GR_T}{0.58-3.7G}$	$\frac{2.32\,GR_T}{13.7G^2-0.335}$
$K = -\sqrt{2}$	$\frac{4GR_1}{1.52G-3.42}$	$1.17GR_T$	$\frac{4GR_T}{3.42+1.52G}$	$\frac{13.7GR_T}{2.32G^2-11.6}$

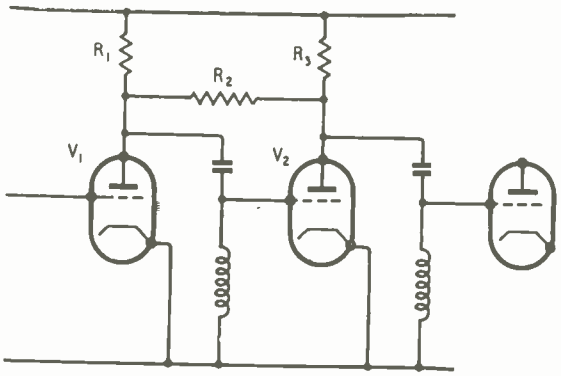


Fig. 1. Simple negative feedback amplifier with feedback applied through R_2.

of negative feedback will broaden the response curve of an amplifier is immediately apparent from consideration of the effect of the feedback. If all stages of the amplifier are tuned to the same frequency (the centre i.f.), then the feedback will be strongest at this frequency. Provided that the feedback circuit is not frequency-sensitive, the feedback will decrease on each side of centre frequency, thus increasing the response at off-centre frequencies. The shape of the resultant response curve depends upon the degree of feedback used: for small amounts of feedback the curve will exhibit one peak at centre-frequency, but as the feedback is increased the curve will become first flat-topped and then double-humped, with humps spaced equally about the centre frequency.

The original conception of this method appears to have been a chain of amplifier stages, over each of which the feedback was applied, but this has been simplified to the application of feedback over alternate stages. Thus the amplifier is divided up into a series of pairs of valves, the first valve of each pair operating without, the second valve with, feedback. It will be seen, then, that this type of amplifier will produce the flat-topped response curve usually associated with the staggered pair or transformer-coupled amplifier. It will be shown that the flatter, steeper-sided curves given by staggered triples, quadruples and so on can also be produced.

The feedback amplifier has been analysed mathematically,† and Table I, which is a simplification of the results of this analysis, gives the required component values for the circuit with a minimum of computation. The expressions are accurate enough for normal design processes. It should be particularly noted that the shape and width of the response curve and the gain of the amplifier are governed solely by the relative values of the resistors whose values are given. In comparison with the two other methods mentioned above, the use of single-tuned circuits eliminates the difficulties of the i.f. transformer, and since these circuits are all tuned to the centre i.f. there are no problems of accurate maintaining of stagger frequencies or different Q-factors in individual circuits.

The simple feedback pair of Fig. 1 shows how the feedback is applied. V_1 and V_2 are the valves forming the pair, R_1 and R_3 being their respective anode loads. The resistor R_2 is for applying feedback across V_2. From the practical point of view this circuit has dis-

† "Vacuum Tube Amplifiers" by Valley and Wallman, Chapter 6. (M.I.T. Radiation Laboratory Series, Vol. 18), McGraw Hill.

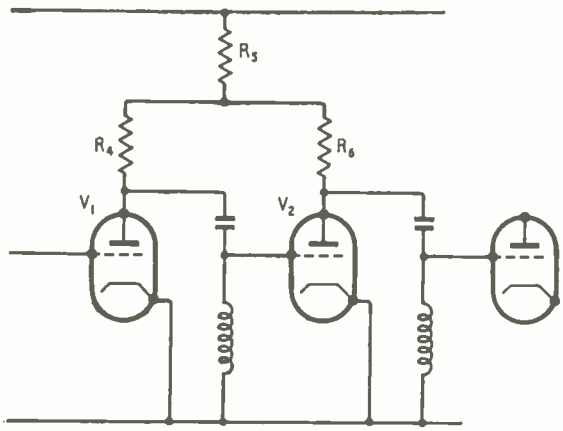


Fig. 2. Modified version of Fig. 1, giving more symmetrical response curve.

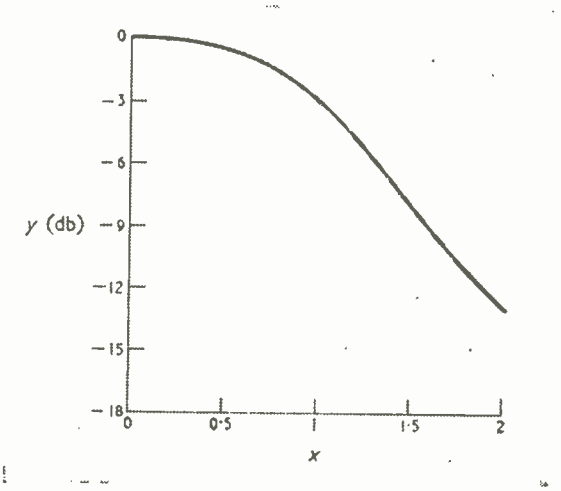


Fig. 3. Flat pair response curve. Only one half is shown as the curve is symmetrical about $x = 0$.

advantages, however. It was noted above that the feedback circuit should not be frequency-sensitive; if this condition does not hold the feedback will be greater on one side of centre frequency than on the other, and the resultant response curve will be tilted instead of being symmetrical about the i.f. Returning to Fig. 1, the resistor R_2 possesses self-capacitance (of the order 0.5 pF) which causes such a tilt; in addition the anode-grid capacitance of V_2 is in parallel with the feedback resistor, which increases the tilt.

The resistor network R_1, R_2, R_3 of Fig. 1 may be replaced by its T-equivalent, producing the circuit of Fig. 2. In this circuit the feedback is produced by the voltage drop across R_5 due to anode current in V_2, R_5 being common to the anode circuits of both valves. Now the effect of capacitance across R_5 will be to reduce its apparent value, and hence the feedback, at higher frequencies, so that the output of the amplifier will increase above centre frequency. The effect of the anode-grid capacitance of V_2 is to reduce the feedback at lower frequencies and increase the response below centre frequency. Thus the effects of these unavoidable but unwanted capacitances tend to cancel each other. Cancellation may be made complete by

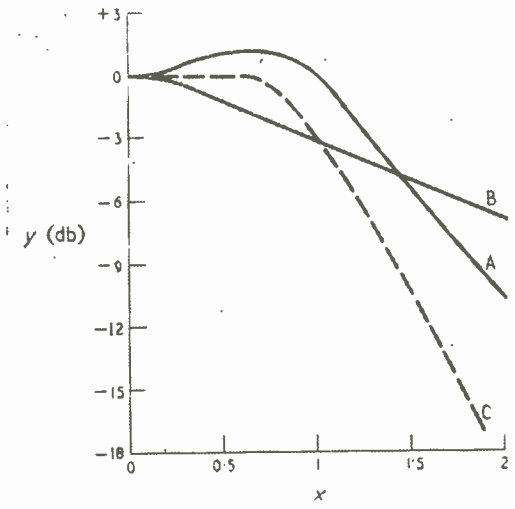


Fig. 4. Synthesis of flat-topped curve (C) associated with staggered or feedback triples.

increasing one or the other capacitance as indicated by the response curve tilt, and a symmetrical response curve may thus be obtained.

It was stated above that a wide variety of response curves can be produced according to the relative values of the resistors. One such curve is the flat-topped curve usually associated with the staggered pair, the mathematical expression of which is

$$y = \frac{1}{\sqrt{1 + x^4}}$$

where x represents frequency difference from centre frequency and y is the relative amplitude at the frequency considered (x). Clearly, $y = 1$ at centre frequency ($x = 0$), and where $x = \pm 1$, $y = \frac{1}{\sqrt{2}}$. In other words, $x = \pm 1$ gives the $-$ 3db points on the response curve and hence the bandwidth. This curve is shown on Fig. 3. The feedback pair to produce it has been found to be very non-critical and may be easily pre-plumbed. Slight staggering of the tuned circuit frequencies (due, for instance, to valve capacitance variation) has little effect on the response curve beyond broadening it.

To produce other curves of the flat-topped form a process of synthesis must be used, as is done with staggered circuits. The difference between the two types of circuit in this respect lies in the fact that a feedback pair, correctly designed, will generate a double-humped response curve with its circuits all tuned to the same frequency, whereas in the staggered system one circuit must be tuned to each side of centre frequency and appropriately damped to produce such a curve. The idea of synthesizing a flat-topped curve from two curves which are not flat-topped may be better understood from Fig. 4. This diagram illustrates the synthesis of the flat-topped curve associated with staggered triples or feedback triples. Three circuits are used (hence "triple"): two, in a feedback pair, give curve A, while the other circuit on its own gives curve B. These circuits are cascaded, and the resultant overall response may therefore be obtained by adding the two curves (a decibel scale being used for relative amplitudes). Curve A is slightly double-humped, the rise each side of centre frequency boosting the falling response of curve B. The result of the addition is the flat-topped curve C, which, if compared with the flat pair curve of Fig. 3, shows flatness over a wider range together with steeper sides. The first characteristic, flatness, is generally the desired one in this application, as several such circuits may have to be cascaded to obtain the necessary overall gain. Each additional circuit added will narrow the overall bandwidth, but the bandwidth narrowing will be less for the curve with the wider flat top. The mathematical expression for the triple curve is

$$y = \frac{1}{\sqrt{1 + x^6}}$$

and $x = \pm 1$ again gives the $-$ 3db bandwidth.

In general, any curve of the form

$$y = \frac{1}{\sqrt{1 + x^{2n}}}$$

may be synthesized, and n indicates the number of stages required in the synthesis. The general expression for the response curve of a feedback pair is

$$y = \frac{1}{\sqrt{1 + Kx^2 + x^4}}$$

in which x and y have significance as before.

The constant K, which may be called the "shape coefficient," determines the form of the response curve obtained. One case already discussed, that of the flat pair, is seen to correspond to $K = 0$ when the above expression reduces to that for the flat pair curve. Other values of K will give different forms of response curve: K can lie between $+ 2$ and $- 2$. The value $K = 2$ corresponds to no feedback. Such a pair is identical with two single-tuned stages on the same frequency and should give the same response curve. Mathematically, this may be checked by substituting $+ 2$ for K and observing that

$$\frac{1}{\sqrt{1 + 2x^2 + x^4}} = \frac{1}{\sqrt{1 + x^2}\sqrt{1 + x^2}}$$

and that $y = \frac{1}{\sqrt{1 + x^2}}$ is the equation describing the single-tuned circuit response curve. Negative values of K give a double-humped curve: positive values give a single-peaked response. The value of shape coefficient for the synthesis of other flat-topped curves may be easily found. The expression for the desired flat-topped curve is first set down, for example

$$y = \frac{1}{\sqrt{1 + x^8}}$$ for a flat quadruple.

Now, the general expression, with shape coefficients K_1, K_2, etc., may be used to build up the desired equation:

$$\frac{1}{\sqrt{1 + x^8}} = \frac{1}{\sqrt{1 + K_1x^2 + x^4}} \times \frac{1}{\sqrt{1 + K_2x^2 + x^4}}$$

In this case only two pairs are needed because the final term of the right side of the equation is x^8, as required on the left side. By multiplying the terms on the right side together, we obtain:

$$1 + x^8 = 1 + (K_1 + K_2)x^2 + (2 + K_1K_2)x^4 + (K_1 + K_2)x^6 + x^8$$

The left side contains no terms in x^2, x^4 and x^6, so

that the coefficients of these terms must be zero, and hence

$$K_1 + K_2 = 0$$
$$2 + K_1K_2 = 0$$

and from these equations $K_1 = +\sqrt{2}$, and $K_2 = -\sqrt{2}$ Therefore a flat-topped quadruple curve will be produced if two pairs are cascaded, one having shape coefficient $+\sqrt{2}$, the other $-\sqrt{2}$. Fig. 5 shows these two curves and the resultant curve. Similarly, curve C of Fig. 4, the curve of a triple, is generated by putting the equation of the triple curve

$$y = \frac{1}{\sqrt{1+x^6}} = \frac{1}{\sqrt{1+K_1x^2+x^4}} \times \frac{1}{\sqrt{1+x^2}}$$

and, following the same process, finding that $K_1 = -1$ so that the triple is built up from a pair with shape coefficient -1 and a single-tuned stage of the desired bandwidth.

Table I gives component values for certain commonly used values of shape coefficient, and enables flat feedback pairs, triples or quadruples to be quickly designed. For other curve shapes, the first line gives the general values of the components in terms of the shape coefficient K. As an example of the use of this table, the design of a typical amplifier may be carried out thus :

Bandwidth (to $-$ 3db) required (B) = 10 Mc/s.

Total parallel capacitance present = $C_{in}(V_2)+C_{out}(V_1) + C_{straus}$ (C) = 15pF.

Valve mutual conductance (g_m) = 7 mA/V.

Curve shape decided to be flat quadruple form, using circuit of Fig. 2.

From the above

$$R_T = \frac{1}{2\pi CB} = \frac{10^6}{2\pi \times 15 \times 10} \text{ ohms}$$
$$= 1060 \text{ ohms}$$

and $G = g_mR_T = 7 \times 1.06 = 7.4 = 17\text{dB}$

Since the curve is to be of flat quadruple shape, $K_1 = +\sqrt{2}$, $K_2 = -\sqrt{2}$.

First Pair ($K_1 = +\sqrt{2}$)

$$R_4 = R_6 = \frac{4GR_T}{0.58 + 3.7G} = 1120 \text{ ohms}$$

$$R_5 = \frac{2.32GR_T}{13.7G^2 - 0.335} = 24 \text{ ohms}$$

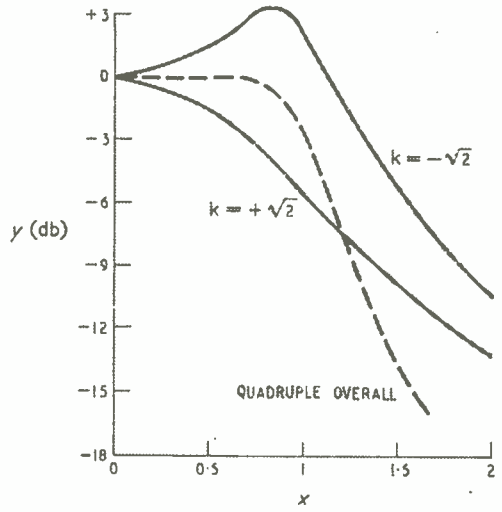


Fig. 5. Synthesis of flat-topped curve from two curves with different shape coefficients.

Second Pair ($K_2 = -\sqrt{2}$)

$$R_4 = R_6 = \frac{4GR_T}{3.42 + 1.526} = 2140 \text{ ohms}$$

$$R_5 = \frac{13.7GR_T}{2.32G^2 - 11.6} = 930 \text{ ohms}$$

and the two pairs are so designed. In practice the nearest standard values of resistors in the 5% range would be used. The complete circuit would be as shown in Fig. 6 ; the inductors (L) of Fig. 6 would be wound to resonate with 15pF at the chosen centre frequency. The overall gain will be approximately 68db (4 × 17db). If gain control is desired, it must be applied to V_1 or V_3 or both.

As is to be expected, the use of negative feedback is accompanied by a loss of gain. Except for extremely wide bandwidths, this loss is very small indeed and is usually within the normal uncertainties of gain computation. The feedback has a slight effect in stabilizing the gain of the amplifier, an effect which increases as bandwidth increases, but this stabilization

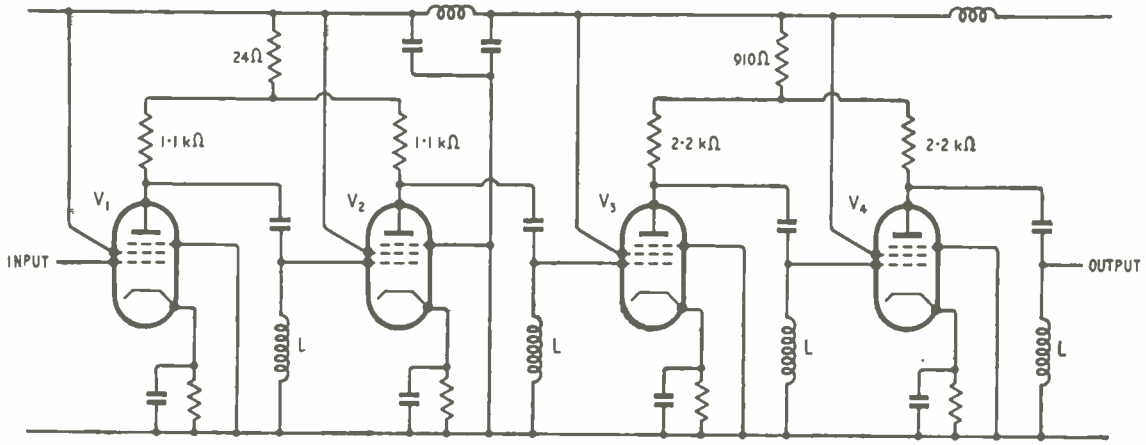


Fig. 6. Complete circuit of an amplifier designed to give a flat quadruple response curve with a bandwidth of 10 Mc/s.

is not enough to compensate for changes of mutual conductance in the valves. An additional disadvantage is that gain control can only be applied to those stages to which feedback is not applied. This is not normally serious as amplifiers of the type for which such circuits are used commonly have many stages, and control of two or three alternate valves gives an adequate gain control range. Application of bias to the feedback stages may, however, be used as a bandwidth control. The use of feedback pairs often results in a saving of decoupling components as stages may be decoupled in pairs. All amplifiers so far built have been found to be exceptionally stable, compared with amplifiers of similar characteristics using other methods of obtaining wide bandwidths.

The original setting-up procedure is very simple. The amplifier is built with resistor values chosen as detailed above. The feedback is removed (short circuiting R_5 in Fig. 2) from each pair in turn and the tuning coils within each pair are adjusted to tune to the centre i.f. In practice, it is found that adjustment of one coil is sufficient, all others then being wound to be identical with the correct coil. If feedback-resistor capacitance or valve anode-grid capacitance effects produce an objectionable tilt in the response curve a small capacitor is added (usually on one or two pairs only) across the appropriate points, and is adjusted until the curve is flat. If the feedback resistor capacitance is the controlling factor in curve tilt, the response is greater on the high frequency side of the centre i.f., as previously stated, and compensation is applied by adding a small capacitance between the anodes of V_1 and V_3 (Fig. 2) to reinforce the anode-grid capacitance of V_2. Similarly, if the inter-electrode capacitance of V_2 is the controlling factor and the tilt is from low- to high-frequency, then capacitance must be added in parallel with the feedback resistor R_5.

A number of amplifiers of various bandwidths have been constructed using this system, and all have been satisfactory. After a long alignment process needed for the previously-used staggered amplifier, the time and effort saved by adopting the feedback system has been most noticeable, as have the excellent response curves obtained. Amplifiers have been built with centre frequencies of 30, 45 and 60 Mc/s, with bandwidths ranging from 5 to over 20 Mc/s. In one particular instance the i.f. amplifier, of twelve stages, had a bandwidth of 20 Mc/s to — 1db at a frequency of 60 Mc/s and used a quadruple curve. The overall gain at i.f. was about 90db. In order to find out whether change of valves affected this amplifier, all twelve valves were changed *en bloc*. Twelve valves of a different make were inserted and the response curve was measured again. This was done for six sets of valves, the final set being a mixture of valves produced by various English and American manufacturers. The worst response curve change was a rise of 1db on one side of centre frequency. When a duplicate amplifier was built, the only adjustment needed was in the tilt-compensating capacitance, a small 5-pF trimmer. In most instances Mullard EF95 valves have been used, but some amplifiers have been built using the EF91.

EDUCATION AND TRAINING

WE are all prone to be insular and this is particularly noticeable in many Londoners, who tend to think of the metropolis as England. It was, therefore, refreshing for *Wireless World*, which so often attends discussions and meetings in London, to hear educationists in the Provinces discuss the question of "Education and Training in the Radio and Electronics Industry." The meeting, which was convened by the Merseyside Section of the British Institution of Radio Engineers, was addressed by representatives of Liverpool's University and Technical College, the Post Office, the Radio and Television Retailers' Association and the Automatic Telephone and Electric Company. There followed a lively discussion during which it was obvious that the speakers had their feet on the ground. It is also true that the speakers did not "pull their punches"; we doubt if we would hear a London graduate forcefully criticize the training scheme of the firm in which he was a student apprentice during a meeting attended by the company's training and education officer.

Both the introductory speakers and those taking part in the general discussion interpreted the title as including education both for and in the industry. We were particularly pleased to see the stress laid upon the need for a pass in English as an essential for apprentices. Technicians should be able to lucidly convey in writing their findings to others.

J. Durnford (Liverpool University) concluded his introductory remarks with these questions: (a) Are the Universities in fact giving the right sort of training? (b) Are there enough graduates being turned out? (c) Does industry in general know how to use its graduates to the best advantage? and (d) Should there be a period of practical training before as well as after a University course?

Some felt that the training was not sufficiently specialized, and to this end students should be encouraged to take part-time vocational training in industry, possibly between the "inter" and degree courses.

The question of technical qualifications, which is now being debated in our correspondence columns, and the confusion which exists regarding professional status in the industry was discussed. In this connection it may not be generally known that the Burnham Committee, which decides teachers' salaries, accepted some time ago associate membership of the Brit.I.R.E. (with certain provisos) as a degree equivalent for teachers in further education establishments.

CLUB NEWS

Cambridge.—The February meetings of the Cambridge University Wireless Society (G6UW), which will be held at St. John's College, include lectures on electron microscopy (1st), electronic organs (8th) and miniaturization (15th). The club plans to visit the Pye radio works on February 17th. Sec.: R. C. Marshall, St. John's College, Cambridge.

Cleckheaton.—At the meeting of the Spen Valley and District Radio and Television Society on February 10th, D. Skirrow (G3GFD) will speak on "Principles of Radar 1945-52." Meetings are held on alternate Wednesdays at 7.30 at the Temperance Hall, Cleckheaton. Sec.: N. Pride, 100, Raikes Lane, Birstall, Nr. Leeds.

Southend.—J. Missen, of the G.E.C. Research Laboratories, who recently described in *Wireless World* a circuit for a push-pull transistor amplifier, is to speak on transistors at the meeting of the Southend and District Radio Society on February 5th. At the meeting on February 19th, H. T. Stott (Bulgin) will speak on "Time Standard Upon NH,." Meetings are held at 7.45 at the Municipal College Laboratories, Queen's Road, Southend. Sec.: J. H. Barrance, 49, Swanage Road, Southend-on-Sea.

Eliminating C.W. Interference

Some Experiments in a Television Fringe Area

By B. L. MORLEY

AMONG the many trials and tribulations of the fringe area viewer is the marring of the picture by continuous wave interference. The radio interference branch of the Post Office is very helpful in these matters, but it has no powers of compulsion and if the owner of the offending apparatus is unhelpful there is very little that can be done to remedy matters.

A case of this kind led to the experiments described in the following paragraphs. In this instance the interference caused bright bands of light, the thickness of one or two lines, to cover the whole of the picture. The lines not only made the scene appear as though it was being viewed through prison bars but it also played havoc with the line synchronization.

Another form of interference which was cured was the appearance of a broad band of light across the screen which was from $\frac{1}{4}$ to $\frac{3}{8}$ in wide. This was intermittent; sometimes on for a few minutes, sometimes on for an hour or more like the first type, but it yielded to the treatment to be described.

The receiving point was located almost at sea level 80 miles from Sutton Coldfield. A Yagi aerial array comprising director, folded dipole and reflector spaced 0.1 and 0.15 wavelength respectively was in use. The array was mounted on a 16-ft mast fitted to the chimney stack; a typical domestic type of installation.

Now the obvious answer to unwanted c.w. is simply a matter of filtering, so the first step was to construct filters of various forms which were inserted in the aerial circuit. The filters completely eliminated the interference—and the picture! It appeared that a circuit with a sufficiently high "Q" could not be obtained. The method was abandoned.

The next approach to the problem was on a different line. It is a well-known fact that each transmission line has a certain propagation velocity which directly affects its electrical length. In the television aerial the incoming signal generates currents and voltages which are carried down the transmission line to the receiver. An interfering signal will also generate in the aerial a current and a voltage which likewise are carried down the transmission line. At the receiving end we may have the position shown in Fig. 1.

The phase relationship between the two signals remains substantially the same throughout the whole length of the line and the time taken for the two to reach the receiver will depend upon the length of the line.

The physical length of a transmission line corresponding to the electrical length is given by:—

$$L = \frac{984V}{f}$$

where,

L = length in feet
V = velocity factor of the line
f = frequency of the signal in Mc/s.

It will be seen, therefore, that the time taken by the signals to traverse the length of the line depends upon the velocity factor of the line and the frequency of the signals.

TV signals occupy a broad band of frequencies but if the interference covers a single or narrow band then matters can be so arranged that the interference is eliminated without detracting too seriously from the quality of the picture; indeed it is generally preferable to sacrifice some quality in order to get rid of the interference.

The method employed was to arrange that the signal plus interference arrived at the receiver on two separate paths, the electrical length of the second path being such that the arrival phase of the interference was 180 deg out of phase with that in the first path (Fig. 2).

In the experiment an "X" aerial's feeder was connected directly to that of the Yagi array at the aerial socket of the receiver. The electrical length of the secondary path was adjusted quite simply by the rather laborious method of cutting one inch from the end of the line, testing, then cutting a further inch and so on until the correct conditions were found.

Eventually a stage was reached where the two signals completely cancelled each other and the picture, though decreased in strength by a small amount, was quite clear. The actual loss of quality was not noticed as the bandwidth of the vision receiver had been adjusted to just under 2 M/cs so as to obtain as much gain as possible. (This reduction in bandwidth is

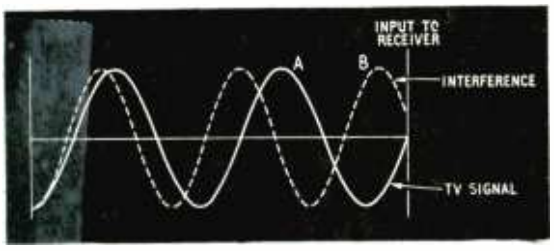


Fig. 1. Wanted (full line) and unwanted (broken line) signal currents flowing along the feeder of a typical television aerial.

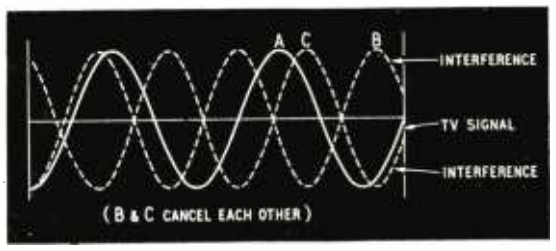


Fig. 2. If a second aerial is used and its feeder cut to the proper length the interfering signals can be cancelled out at the receiver.

not really so serious as it may appear at first sight, as generally the picture quality at extreme ranges leaves much to be desired, except on very rare occasions).

The system worked on both types of interference, the " prison bars " and the broad white band being eliminated from the screen, the single secondary path serving for both.

The word " eliminated " has been used deliberately; the interference was not merely obliterated; picture detail which had been concealed previously by the broad white band was once again visible, and beyond a slight loss in picture brightness (restored by adjustment of the contrast control) there appeared to be no noticeable deterioration in the overall quality of the picture.

For those who would like to try the scheme for themselves it will be found that, during the process, points will be found where (a) the picture is seriously attenuated, (b) the sound is seriously attenuated, (c) both are seriously attenuated, but a point can be reached where the interference alone is attenuated, there being little effect on the sound or the picture.

The writer does not claim that this is an ideal arrangement though it works quite well in practice. There are other methods of producing the necessary reversal of phase between the two signals—there is plenty of scope for the keen experimenter!

"Plug and Socketry"

A Plea for New Standardization of Nomenclature

By C. LISTER

"WHEN is a plug not a plug?" From the evidence to hand at this moment the answer would appear to be, " When it is a socket."

Consider Fig. 1. A is a device equipped with metallic contact pins and intended for attachment to the end of a cable. B is a device equipped with metallic contact-pin receptacles and intended for mounting in some relatively fixed position. C is a device equipped with metallic contact-pin receptacles and intended for attachment to the end of a cable. D is a device equipped with metallic contact pins and intended for mounting in some relatively fixed position.

There appears to be no argument whatever about the nomenclature of A and B: A seems to be universally accepted as a plug, B as a socket. The difference of opinion arises over C and D. Party No. 1 maintain that C is a socket and D is a plug. Party No. 2 maintain that C is a plug and D is a socket. In effect, Party No. 1 see a common factor in the physical appearance of certain constituent parts of the objects, whilst Party No. 2 see a common factor in the function and location of the object as a whole.

The main argument appears to go as follows:—

Party No. 1. The device known in electrical work as a " pin " may be inserted into a receptacle of similar size and shape which it will fill completely. The pin is then by dictionary definition a plug (something fitting into and filling a hole) whilst the receptacle is a socket (a hole for something to fit into). It therefore appears reasonable that the term plug should be applied as a collective noun to any assembly of such pins, whilst the term socket should similarly be applied to any assembly of such receptacles.

Party No. 2. From the dictionary definition just given, X in Fig. 2 is clearly a plug whilst Y is a socket. Whatever arrangement of smaller plugs and sockets we make on the two surfaces 1, 2 and 3, 4 should not alter the names already given to the two devices X and Y. Whichever way the smaller plugs and sockets are moving X will still be plugged into Y, and X will still be attached to the end of a cable whilst Y will still be mounted in some relatively fixed position.

If we accept the recommendations of the first party, then we must find some way of indicating whether we require our plug (or socket) to be " loose " (i.e. cable attached) or " fixed." Each manufacturer appears to devise his own method of effecting this discrimination and their catalogues reveal such descriptions as, " with mounting brackets," " chassis mounting," " flex-mounting," " cable mounting," " panel mounting " etc.

If we accept the recommendations of the second party then we must find some means of indicating whether our plugs (or sockets) are equipped with pins, or pin-receptacles. One method which has been in satisfactory use in some factories for many years utilizes the term " male " to indicate pins and " female " to indicate pin-receptacles. Thus A, B, C, D, (Fig. 1) are described as " male-plug," " female-socket," " female-plug," and " male-socket " respectively.

Support for Party No. 1 is found in the drawings of

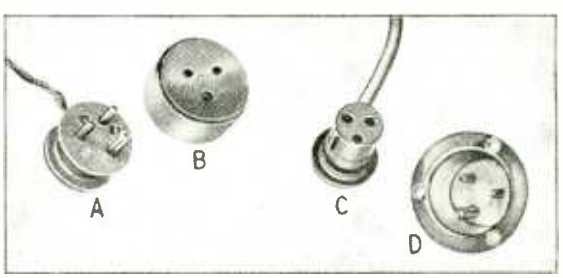


Fig. 1. Some plugs and sockets in common use.

some Government departments and in the catalogues of some manufacturers whilst support for Party No. 2 comes from other Government departments and other manufacturers.

Let us see what the British Standards Institution has to say on the subject. We look up British Standard No. 205 "Glossary of Terms Used in Electrical Engineering." Part 3 (1943) Section 3, Sub-section 37. It looks at first sight as though the issue has been very carefully side-stepped, for reference 3701 reads: "Plug-and-socket. A device consisting of two portions, a plug and a socket, having metallic contacts and arranged to engage with each other, so that it forms a ready means of connecting or disconnecting current-using apparatus to or from a source of supply." However, looking further, we discover the following:—

"3706. Outlet plug-and-socket. A plug-and-socket intended for use at a supply point.
3707. Inlet plug-and-socket. A plug-and-socket intended for use on current-using apparatus.
3708. Outlet socket. One portion of an outlet plug-and-socket, intended for mounting at a supply point and provided with untouchable metallic contact-tubes.
3709. Outlet plug. The other portion of an outlet plug-and-socket, intended for attachment to a cable and provided with metallic contact-pins.
3710. Inlet plug. One portion of an inlet plug-and-socket, intended for attachment to a cable and provided with untouchable metallic contact-tubes.
3711. Inlet socket. The other portion of an inlet plug-and-socket, intended for mounting on current-using apparatus and provided with metallic contact-pins."

Clearly in the light of these definitions the British Standards Institution regards our original C and D (Fig. 1) as plug and socket respectively. In other words it supports Party No. 2. At the same time, however, it introduces these terms "inlet" and "outlet" which, in my personal view, tend to confuse the issue rather than to clarify it.

Consider the two references 3709 and 3711. In each the following words appear "provided with metallic contact-pins" (Similarly in both the references 3708 and 3710, the words "provided with untouchable metallic contact-tubes"). With a common factor in the description we might, therefore, reasonably expect to find a common factor in the accepted titles; instead of which we find "outlet-plug" and "inlet-socket"—two precise opposites.

The trouble arises here, I think, from use of the terms "inlet" and "outlet." I have already suggested that once we accept the arguments of Party No. 2 (as the B.S. clearly does) all that we then need consider is how to indicate which device has the pins and which the pin-receptacles. To my mind the terms "outlet" and "inlet" do not perform this function in a sufficiently clear-cut manner. On the other hand the terms "male" and "female" leave no one in any doubt. Moreover, the argument of "no common factor in the titles" cannot be levelled against "male-plugs" and "male-sockets" (which would be the equivalent of references 3709 and 3711).

What we might term this "physiological system" would appear, at first sight, to be the most logical for standardization. However, further consideration now leads me to the conclusion that we have readily available an even simpler method of differentiation.

Suppose we wish to purchase the device which answers the description of reference 3709. If we belong to Party No. 1, and we stroll up to the counter and ask for "a plug" the assistant will immediately

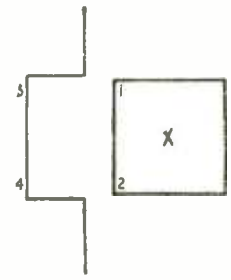


Fig. 2. Illustrating one method of defining a plug and socket.

come back at us with either two or three questions:
(*a*) How many pins?
(*b*) Cable mounting or fixed mounting?
(*c*) (If it is a power plug) What current rating?

If we belong to Party No. 2 and ask for "a male-plug" we shall still be asked question (*a*). If we belong to the B.S.I. section of Party No. 2 and ask for "a outlet-plug" question (*a*) will still be fired at us. Does it not seem reasonable, then, that, whatever party we belong to, our title for the device which we require should contain a term specifying the number of connections that we desire this plug-and-socket to be capable of handling?

"But," it might be objected, "this we already do; we don't ask for things in the vague manner suggested above." Taking "n" as representing any number, if we belong to Party No. 1 we ask for an "n-pin plug"; Party No. 2 "an n-pin male-plug"; and Party No. 2 (B.S.I.), "an n-pin outlet-plug". In reply I should say "I agree with you entirely: that is precisely what we all do; and look at the redundancy that we involve."

Take Party No. 1 member. He asks for an "n-pin plug"; and yet the whole basis of the argument which divides Party No. 1 from their fellows is "that the device with the pins is *always* the plug." He is on an even stickier wicket when he asks for "an n-pin socket," for then redundancy gives place to inconsistency. If he changes from "an n-pin socket" to "an n-hole socket" he is back to redundancy again.

Precisely similar arguments apply to the terms put forward by both sections of Party No. 2. In the expressions "an n-pin male plug" and "an n-pin

Designation	Definition	Equivalent BS205 Number
N-hole socket	One portion of a plug-and-socket, intended for rigid mounting, and having n untouchable contact-tubes.	3708
N-pin plug	The other portion of a plug-and-socket, intended for attachment to a cable, and provided with n metallic contact-pins.	3709
N-hole plug	One portion of a plug-and-socket, intended for attachment to a cable, and having n untouchable contact-tubes.	3710
N-pin socket	The other portion of a plug-and-socket, intended for rigid mounting, and provided with n metallic contact-pins.	3711

outlet plug" neither "male" nor "outlet" contributes one iota to our specification of the device which we require, once we have accepted the main contention of Party No. 2 that the portion of a plug-and-socket which is designed for attachment to a cable is the plug, whilst the portion which is designed for more rigid mounting is the socket.

What sort of definitions, then, do these considerations suggest? Surely something on the lines indicated in the table.

Well, that is my system. Until I meet a simpler system that is how I, as an individual, shall classify these objects within my own mind. If you, dear reader, can produce an even simpler system, good luck to you. I for one shall be only too happy to discard mine and to embrace yours. Meanwhile I think I have written sufficient to indicate that a problem exists and requires attention. If it does not receive attention then it would seem that we are to be faced for ever with the state of affairs in which drawings of plugs and sockets made by one Government department are converted to sockets and plugs by a second Government department, only to be converted back to plugs and sockets again when they are passed on to the manufacturer. Moreover, as the last British Standard on this subject was in 1943, I feel that the time may now be ripe for once again reopening discussion of this matter.

In closing I must hasten to take evasive action against the reader who is even now reaching for his scissors to clip out that extraordinary "plug-and-socket" recently advertised in an American contemporary. I've already seen it, and I suggest that, in the terms of the "physiological" system the most apposite title would appear to be the "hermaphrodite" plug.

Manufacturers' Literature

Switches, lampholders, jacks, knobs, connectors and other chassis fittings listed in a new revised catalogue (No. 192) available from A. F. Bulgin & Co., Bye Pass Road, Barking, Essex; price 1s including postage.

Television Pre-amplifier with gain control, available with any number of coaxial outlets up to eight. Leaflet from the Rainbow Radio Manufacturing Co., Mincing Lane, Blackburn.

Miniature Plug and Jack (approx. 1¼in long) and a B7G plug are amongst new products listed in a catalogue of Ediswan Clix chassis fittings; available from The Edison Swan Electric Company, 155, Charing Cross Road, London, W.C.2.

Television Pattern Generator (40-70 Mc/s) with simple controls, giving patterns of seven horizontal bars and six vertical bars, described in a leaflet from Homelab Instruments, 615-617, High Road, Leyton, E.10. Seven types of test can be carried out.

Circuit-symbol Stamps for rapid printing of circuit diagrams; mounted on transparent blocks so that the user can see where he is placing them. Leaflet describing a complete kit from John Griffin Company, 2157, James Avenue, St. Paul 5, Minn., U.S.A.

Aircraft Intercommunication Equipment consisting of three units weighing 8¾lb (total) capable of operating up to ten headsets. Specification and general description on a leaflet from Airmec, Ltd., High Wycombe, Bucks.

Signal Generator covering 100 kc/s to 100 Mc/s on fundamental frequencies in six ranges, with output variable from 1 μV to 100 mV. Specification on a leaflet from Advance Components, Back Road, Shernhall Street, London, E.17.

Books Received

TV Repair Techniques. Gernsback Library No. 50. Collection of hints by practising servicemen on unusual faults occurring in American television receivers. Pp. 128; Figs. 98. Price $1.50. Gernsback Publications, 25, West Broadway, New York, 7.

Introduction a l'Électronique by P. Gran, L.ès S. Survey of electron tube devices and their applications. Pp. 212; Figs. 205. Price 1,650 Fr. Dunod, 92, Rue Bonaparte, Paris, 6.

Cours Practique de Television by F. Juster. Vol. 1. Design of wide-band r.f. amplifiers for use in television. Pp. 127; Figs. 71. Price 490 Fr. Editions Techniques et Professionelles, 18 bis, Villa Herran, Paris, 16.

Cours sur les Ondes Ultra-Courtes by Y. Place. Elementary theory and practical application of metric, decimetric and centimetric waves. Pp. 186, Figs. 232. Price 1,300 Fr. Edition Eyrolles, 61, Boulevard Saint-Germain, Paris, 5.

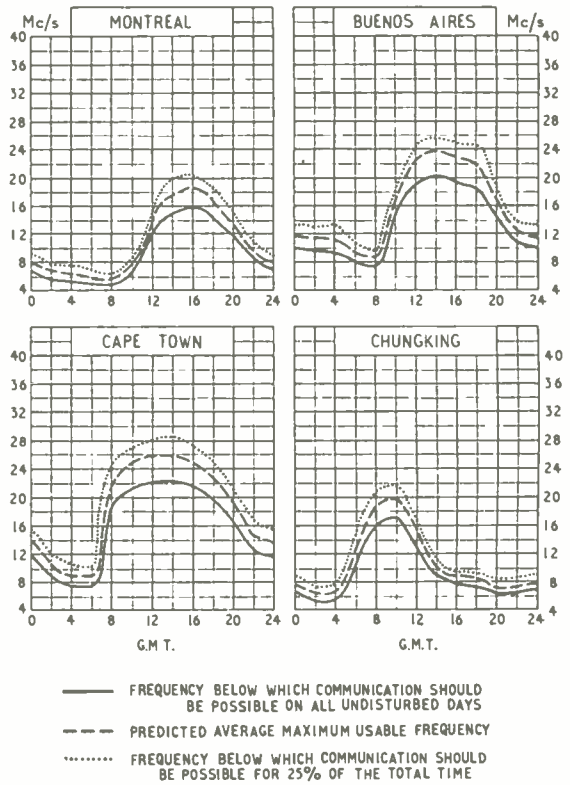
Industrial Electronics, by R. Kretzmann. Survey of vacuum and gas-filled valves, photocells, voltage stabilizers and cathode-ray tubes and their application as relays, counting and control devices, etc., in industrial processes. Sections are devoted to radio-frequency heating of dielectrics and metals. Pp. 236; Figs. 266. Cleaver Hume Press, 31, Wrights Lane, London, W.8. Price 25s.

Short-wave Conditions

Predictions for February

THE full-line curves given here indicate the highest frequencies likely to be usable at any time of the day or night for reliable communications over four long-distance paths from this country during February.

Broken-line curves give the highest frequencies that will sustain a partial service throughout the same period.



Resistances in Parallel

Calculating Effective Values on the Slide Rule

By FRANCIS OAKES,* M.Inst.E.

A NUMBER of methods for rapid calculation of the equation

$$R_{1,2} = \frac{R_1 R_2}{R_1 + R_2}$$

have been published in recent years. Unfortunately these suffer either from considerable inaccuracy (particularly when R_1 and R_2 are of different orders of magnitude) or when they have the drawback of necessitating tiresome intermediate calculations, such as the finding and adding of reciprocals, adding of resistance values, or calculation of auxiliary currents. The method described here suffers from neither of these disadvantages, and lends itself readily to a number of further applications.

To find the numerical solution of the equations above, proceed as follows:

(1) Bring cursor line over R_1 on the stock (Fig. 1, one arrow).

(2) Move the end-mark of the slide (1 or 10 as required) over R_2 on the stock (two arrows).

(3) Read R_1/R_2 on the slide under the cursor line (three arrows) and add 1 to this reading.

(4) Move the slide so as to bring this sum, i.e. $R_1/R_2 + 1$ under the cursor line (four arrows).

(5) Read result $R_{1,2}$ on the stock under the end-mark of the slide (five arrows).

In the example shown in Fig. 1 the following numerical settings are indicated:

$R_1 = 770, R_2 = 124, R_1/R_2 = 6.2, R_1/R_2 + 1 = 7.2$ and the result $R_{1,2} = 107$.

Proof: *1st step*: The section on the slide between the end-mark and R_1/R_2 is equal to the section on th stock between R_1 and R_2. Therefore $\log R_1/R_2 = \log R_1 - \log R_2$.

2nd step: The section on the slide between the end-mark and the new setting $R_1/R_2 + 1$ is equal to the section on the stock between R_1 and $R_{1,2}$, thus

$$\log R_{1,2} = \log R_1 - \log\left(\frac{R_1}{R_2} + 1\right)$$

$$\therefore R_{1,2} = \frac{R_1}{\frac{R_1}{R_2} + 1} = \frac{R_1 R_2}{R_1 + R_2}$$

A series combination of capacitances C_1 and C_2 is equivalent to a capacitance $C_{1,2} = C_1 C_2 (C_1 + C_2)$. It is therefore obvious that the same method can be used also for the solution of series-capacitance problems. An analogous relationship holds good for parallel inductances.

It should be observed that the settings are so arranged that the result appears on the stock. This is of importance when more than two resistances are connected in parallel, or more than two capacitances in series.

If, for example, the parallel equivalent $R_{1,2,3}$ for the three resistances R_1, R_2, R_3 is required, the calculation is started by finding $R_{1,2}$ in the manner described above. To continue, the cursor line is moved over $R_{1,2}$ and the process repeated with $R_{1,2}$ instead of R_1, and with R_3 instead of R_2. In other words, $R_{1,2}$ is considered as one single resistance to be shunted by R_3. The result $R_{1,2,3}$ then appears in the same way as $R_{1,2}$ was found in the original example. In this way any number of resistances in parallel, or capacitances in series, can be worked out.

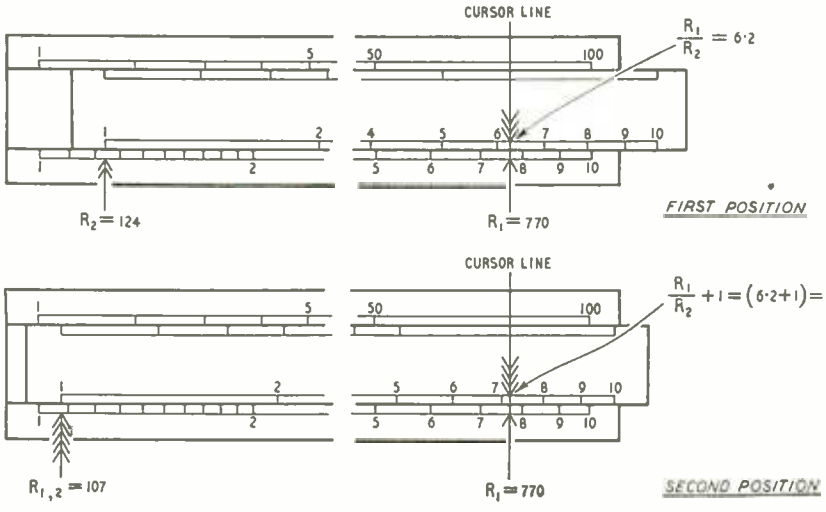
A similar process, with the only difference of subtracting 1 instead of adding, can be used to find the shunt value R_2 required to reduce a resistance R_1 to a desired value $R_{1,2}$. This is illustrated in Fig. 2 on the next page and is carried out as follows:

(1) Bring cursor line over R_1 on the stock (one arrow).

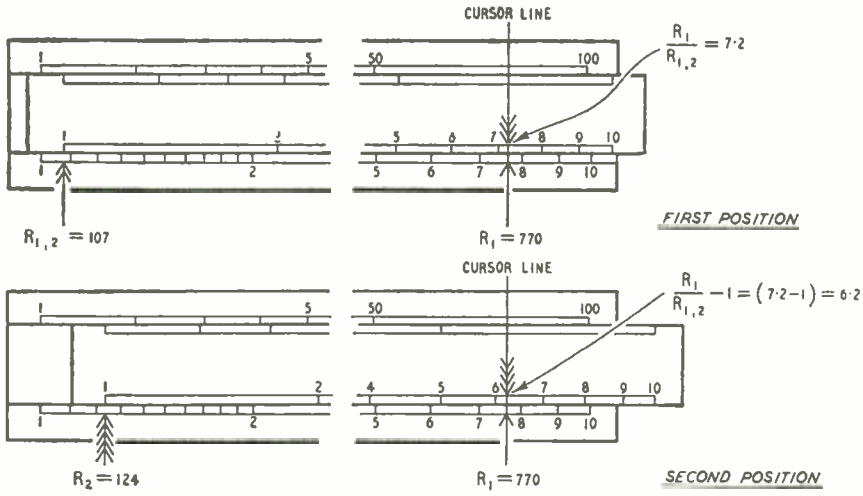
(2) Move the end-mark over $R_{1,2}$ on the stock (two arrows).

(3) Read $R_1/R_{1,2}$ on the slide under the cursor

Fig. 1. Slide rule settings for calculating the effective value of 124 and 770 ohms in parallel. Answer 107 ohms.



* Ferguson Radio Corporation



Complementary problem to that of Fig. 1. What resistance must be connected in parallel with 770 ohms to give an effective value of 107 ohms? Answer 124 ohms.

line (three arrows) and deduct 1 from the reading. (4) Move the slide so as to bring this difference, i.e. $R_1/R_{1,2} - 1$ under the cursor line (four arrows).
(5) Read resulting shunt resistance R_2 under the end-mark of the slide (five arrows).

The proof is quite analogous to the additive operation. Similarly, as the result falls on the stock, it can be used as a starting point for further calculations.

The subtractive method can be used for numerical solution of resonant circuit problems. Since the reactance of a parallel resonant circuit above resonant frequency is a capacitive reactance of magnitude $X_a = X_L X_C/(X_L - X_C)$ and below resonance of the magnitude $X_b = X_C X_L (X_C - X_L)$ inductive reactance, the method described is obviously valid. Other problems of this kind, having the same mathematical formalism, and therefore being solved by the same slide rule operations, are the equivalent admittance of a series resonant circuit off tune, or the equivalent resistance of a positive and a negative resistance in parallel.

Manufacturers' Products

NEW EQUIPMENT AND ACCESSORIES FOR RADIO AND ELECTRONICS

Recording Amplifier

DESIGNED for use with the leading makes of tape recording mechanisms, the "Elpico" Model AC/54 Mark II amplifier is suitable for use with either high- or low-impedance heads, and alternative levels of bias and erasing output are provided. Wide-range tone compensation circuits enable an overall characteristic level from 80 to 8,000 c/s, within ±4 db, to be obtained at a tape speed of 7½ in/sec.

In this redesigned version, the negative feedback has been increased, and precautions have been taken to prevent audio frequencies from getting into the erase head via the bias feed network. A biased neon lamp level recorder is fitted, and calibrated on each individual amplifier.

The makers are Lee Products, 63 Great Eastern Street, London, E.C.2, and the price is £16 16s.

"Elpico" Model AC/54 Mark II tape amplifier

High-quality Record Player

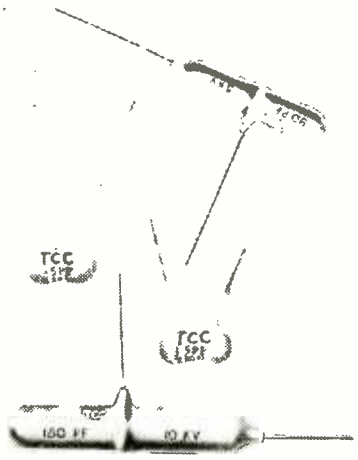
AN unusual disposal of two identical loudspeakers in opposite sides of a ½-inch thick mahogany cabinet is said to give "presence" and the atmosphere of the concert hall in the reproduction from the "Black Box," the latest record player, produced by Pye, Radio Works, Cambridge. A "Monarch" three-speed record changer is incorporated and the push-pull amplifier is provided with tone and volume controls. The record changer will play up to ten 7in, 10in or 12in records mixed at any one of the following speeds: 33⅓, 45 or 78 r.p.m. The price is £40 19s (including tax).

Pye "Black Box" record player.

New Ceramic Capacitors

AMONG the new capacitors introduced recently by the Telegraph Condenser Co., Ltd., Wales Farm Road, North Acton, London, W.3, are two series of ceramic types of unusual interest. One consists of small-capacitance tubulars (Type CC125A) primarily intended for "top-end" coupling in bandpass filters. Capacitances range from 0.5 pF to 5 pF at 500 V d.c. working, the closest tolerance being ±10%, for all except the 0.5-pF model, for which it is ±20%. Overall size is 0.5 in × $\frac{3}{16}$ in (approx) and side exit connecting wires of No. 22 s.w.g. are fitted.

The other series is for high working voltages, such as the e.h.t. positions in television sets and pulse-feed capacitors in radar transmitters and



T.C.C. high-voltage tubular and small capacitance tubular capacitors, both are ceramic types.

receivers. These are tubular ceramics also but with one axial wire and one centrally wrapped connecting wire.

Working voltages range from 1 kV to 10 kV and capacitances from 50 pF to 620 pF according to type and voltage rating. The largest capacitance for 10-kV working is 180 pF and for 1-kV 620 pF. They are quite small considering the high working voltages, a 250-pF, 3.5-kV capacitor, for example, measuring 1 in long and $\frac{5}{16}$ in diameter.

Redesigned Record Changer

WHILE retaining the essentially simple and reliable design of the earlier mechanism, and its quick-changing characteristics, the latest version of the "Monarch" three-speed changer has been given a more attractive appearance. The pickup pivot and corner trip mechanisms are now housed in a single "streamlined" moulding, and an ivory finish is standardized.

More important from the technical point of view, the record release arm has been reshaped and is now made in Perspex instead of metal to give more silent operation. The pickup arm has also been reshaped to give better accessibility to the centralized control knob.

Redesigned "Monarch" three-speed record changer.

The price of the "1954 Monarch" is £16 10s 3d (including tax), and the makers are Birmingham Sound Reproducers, Claremont Street, Old Hill, Staffs.

New Loudspeaker Enclosure

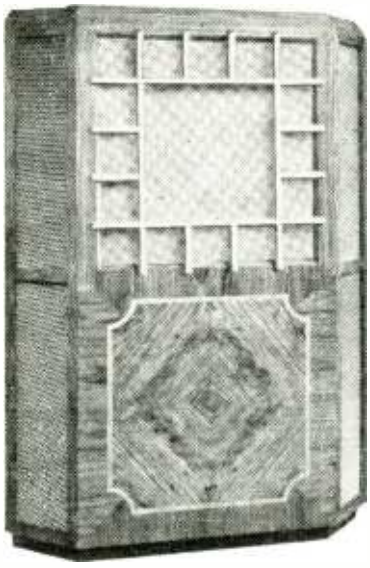
IN order that the full potentialities of the Dual Concentric loudspeaker unit may be realized, Tannoy have recently developed a new enclosure which provides horn loading throughout the frequency range. Hitherto the horn principle has been applied only above 1,000 c/s, but now the front of the large cone is loaded by a short horn with a flare efficient down to 200 c/s, while the back of the diaphragm is coupled to a larger folded horn covering frequencies from 200 c/s downwards. Radiation above 200 c/s from this larger horn is deliberately restricted by absorption at the discontinuities in the direction of the emerging sound.

The result is twofold: there is a noticeably "tight" control of transients and freedom from excitation of cavity resonances, often apparent in vented enclosures; and there is an effect of spaciousness consequent on the increase of source area. Since frequencies above 200 c/s are radiated from the single central source, there is no incongruity when speech or solo voices are being reproduced.

A 15-inch Dual Concentric unit is used, and this has now been redesigned for ease of dismantling and is fitted with a new phenolic-resin impregnated corrugated centring device. Plug-in connections are provided for the cross-over filter unit.

The makers are Tannoy Products, Norwood Road, West Norwood, London, S.E.27.

Tannoy "expanding source" enclosure for the Dual Concentric loudspeaker.



RANDOM RADIATIONS

By "DIALLIST"

Sticking My Neck Out?

A LETTER in a recent issue of the *Wireless Trader* called attention to the inconvenience caused to servicemen by a method of soldering leads to tags used in many—if not most—of our radio and television factories. This consists in securing the wire to the tag by twisting or hooking before the solder is applied. The serviceman's complaint is that it makes the substitution or replacement of components always a slow, and sometimes an exasperating business. One can see, and to some extent sympathize with the manufacturers' point of view. In the absence of that third hand which all solderers would like to possess, the preliminary securing of wires to tags speeds up the work. In most kinds of soldering, too, it is sound practice to make joints mechanically strong before the solder is applied. Manufacturers feel, no doubt, that sets made in this way are more likely than others to stand up to the shocks and bumps that come their way in transit. True; but I couldn't agree less that this kind of soldered joint is the right one to use in *factory-made* apparatus. Why? Well, because it can, and too often does, enable a dry joint to be passed as sound by inspectors applying the usual tests. Sooner or later a dry joint, even though the wire is twisted to the tag, is likely to give rise to one of those horrible intermittent faults which are responsible for the entry of so many black marks in the Recording Angel's notebook.

Alarm and Despondency

TRYING OUT a television set the other day on Test-card C, I was surprised to find it suffering from what appeared to be a markedly jittery frame scan. In particular, the black and white rectangles of the horizontal borders were quite unstable in their height. They just wobbled. A 'phone call to the Alexandra Palace elicited the information that film was being used and that a slight up-and-down movement was to be expected. Now, I don't think that that's quite fair. Test-card C should be something on whose faithful transmission experimenters and servicemen can bank. It should surely be *the* television image whose faultless transmission is guaranteed. Things become pretty difficult if this isn't so.

A Little Learning

THE VAST MAJORITY of radio dealers are first-rate fellows, who know their job and do well by their customers. But there is, more's the pity, nothing to prevent any Tom, Dick or Harry with a small amount of capital from taking a shop and erecting a sign describing himself as an "electrical, electronic, radio and television engineer," even though his knowledge of the very elements of any of these wide fields is of the scantiest and his practical experience *nil*. He can, without let or hindrance, undertake the wiring of houses and the installation and maintenance of electrical equipment of all kinds. The result is too often that electricity, the best and safest servant that Man has yet devised, becomes a menace to life and to property. One evening, long after the shops had closed, a neighbour came, with many apologies, to seek my help: with a child seriously ill in his house, all the lights had "gone"; fuses blew as soon as they were replaced. What I found left me gasping. One of these dabblers had sometime previously put electric light into two rooms. Since then the lighting had been extended by him to the rest of the house simply by tapping off the original cables. *One* fuse-box served not only all the lights, but also numerous 2-pin wall sockets feeding a variety of gadgets, such as a couple of 1-kW heaters and a washing machine. The whole 5-amp wiring system had been "strengthened" by fitting 15-amp fuses in the single fuse-box. . . . .

When it Comes to TV

It is a lamentable fact that up and down the country thousands of non-technical owners of radio and television receivers are completely at the mercy of these black sheep. I can't think why manufacturers don't exercise more care in appointing retailers of their wares; for there is no question that a first-rate make of radio or television set can gain a quite undeserved local reputation for lack of reliability through the misdeeds of one ignorant or unscrupulous dealer. Here are a few cases that have come to my knowledge. (1) The typical horizontal bars of sound-on-vision ascribed to camera faults; (2) Five radio and television sets installed by one dealer in a 230-V area with the mains tappings at 200 volts; (3) A new c.r. tube fitted, at a cost of over £20, to "cure" distorted reproduction of sound; (4) Poor results with an elaborate aerial array found, on investigation by its manufacturer, to

be due to an error of some 40 deg. in its orientation; (5) An H-type array erected with its reflector towards the transmitting station. And I could go on and on.

Battery Operated TV

ONE FIRM of manufacturers of television receivers demonstrated at the Earls Court Radio Show that any of their sets could be operated from a pair of 12-volt car starter accumulators, or from a private lighting plant, if sufficient "juice" could be spared. For all that, I'm not persuaded that a standard television set, with power requirements of the order of 150 watts, is suitable for use in this way. I've put up the idea for a genuine battery-and-converter receiver to several firms without arousing any marked enthusiasm. What I'd like to see is a set equipped mainly with battery miniature valves, whose requirements in the way of power are very small indeed. It would probably be necessary to use specially designed battery valves with high-consumption filaments for most of the functions. I'm told that there wouldn't be a big enough market to make such a set worth while. That I just don't believe. I live in a small country town and I can think right away of over a score of people within a few miles of my home who want television and would have it if reasonably economical battery operation were possible. And that's just one small town. There must be tens of thousands of folk in television service areas—townsmen, villagers and farmers—who would give no uncertain welcome to such a set, if it became available.

Soldering Aids

HERE ARE TWO soldering aids that I've found most useful since I made them a good few years ago. The first is a 230V-12V step-down transformer, mounted on a rectangular switch block. The primary and the core are connected by heavy flex to a 3-pin plug. The secondary connections go to a 2-pin socket, mounted on the same block. Each of my three small 12-V irons has a 2-pin plug at the end of its flex. The second gadget enables one to use the larger irons at some distance from a wall-socket. It is the simplest thing you can imagine. Just a 3-pin socket mounted on a circular switch block, which is itself attached to a plywood disc. To the contacts of the socket a 3-pin plug is connected through four yards of good flex.

UNBIASED

By FREE GRID

Plastic Plumbing

A KINDLY READER has sent me a bunch of cuttings from the local paper at Barnet, where they appear to be having a lot of trouble separating the Light and the Home Service programmes. Apparently the trouble is due to a rectification effect set up by the corroded joints in the guttering and piping and also in the metal window frames of Barnetonian houses. Such corrosion exists in all districts, of course, and doesn't have any serious effect but Barnet is so close to Brookman's Park that the resultant rectification causes the two main B.B.C. programmes to break through on each other in hopeless fashion.

It is astonishing that nobody seems to have thought of any really drastic method of tackling the problem. Irritating palliatives of doubtful efficiency seem to be all that the local experts can suggest. The obvious solution, of course, is to scrap the offending pipes and to substitute plastic plumbing; metal window frames and guttering could be similarly dealt with. The benefit to the nation of the large supplies of scrap metal which my plan would make available would be enormous and would more than justify the Treasury in making a substantial grant towards the cost out of the ill-gotten 15 per cent blood money which it squeezes out of the B.B.C.

Patients' Preference

ON MORE THAN one occasion in these columns I have complained of the inadequacy of hospital radio. In many of the cases brought to my notice the maintenance of the equipment has apparently been nobody's responsibility. When the hospitals were nationalized in 1948 the Government, through the various hospital boards, took over responsibility for all such necessary services as the plumbing and the electric lighting, but not apparently the radio installation—judging by the sorry state in which I have found it in certain cases. In some hospitals the headphones are in a bad state of repair; very often too, the reproduction is far too loud and an individual volume control for each patient is an unheard-of luxury.

It was, therefore, an agreeable surprise recently when I found a new installation being put in at an establishment which I had previously criticized. It is designed to give each patient a separate volume control and the choice of no fewer than four programmes.

I was unable to obtain any official information as to what these programmes were to be, but as the installation was being carried out by a well-known radio relay company I presume that the programmes—which I understood are to be fed to the hospital by landline—will be the usual ones that are "on tap" to subscribers to this particular company.

I cannot help feeling, however, that each of our large hospitals should reserve one of their audio channels for its own internal programme provided by gramophone records chosen by the patients themselves; in other words a "patients' preference" or "sufferers selection" service. The number of patients in even the largest hospital is infinitesimal compared with the B.B.C.'s listeners, and, therefore, each patient would have a certainty of hearing his own favourite record played. There would be little difficulty, I think, in obtaining the services of amateur disc jockeys from the local branches of voluntary organizations like the W.V.S.

I suppose that one day a TV screen will be found at the foot of every hospital bed or on the ceiling above. The expense of installation would be very great, but I do wonder why our cinema magnates do not seize their opportunity to boost business by bringing movies to each patient's bedside by means of a scanning unit in the local cinema and a closed-circuit link to the local hospital. Patients would almost certainly tell all th... visitors to be sure and see such-and-such a film. Maybe commercial TV could be tried out in this way using films and a scanning unit in the hospital.

Baseless Ballyhoo

THE AMERICANS ARE a very likeable people and I number a great many among my readers and my friends—not always the same thing. But certain of them have the irritating habit of thinking that nothing ever happens or has its being outside "God's own country." Incidentally I may remind them that even the use of this expression to describe their homeland is not original. It was first employed by Dick Seddon, a famous premier of New Zealand, to describe that delectable land and is in fact recorded on his tomb in Wellington; it was probably shown to the Queen on her recent visit.

I recall being very irritated on one occasion by an American who had just been on a visit to what he kept on referring to as Cairo, Egypt. Eventually exasperation got the better of my manners and I pointed out that few people were ignorant of the fact that Cairo was in the land of the Pharaohs, but he promptly floored me by blandly explaining that there was another Cairo in the U.S.A., as indeed there is. Needless to say, I gave up.

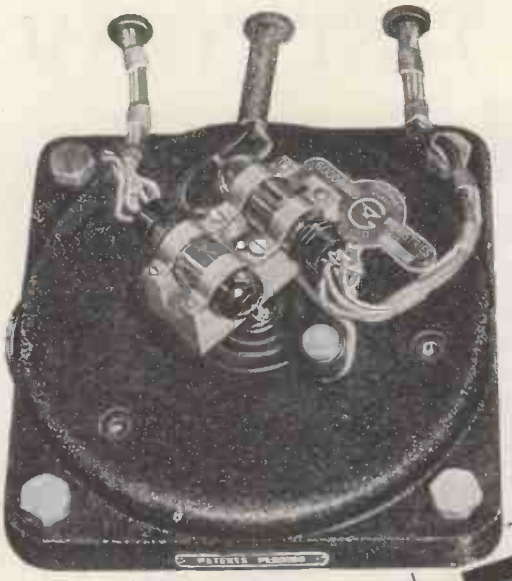
After this incident it scarcely surprised me a few months ago when, at an international radio gathering, a tribute paid by the chairman to Franklin, the pioneer of long-distance beam telegraphy, drew vociferous applause from the Americans present. It was clear that the chairman ought to have said C. S. Franklin of England, as the applauders obviously thought that he meant that gifted American Benjamin Franklin who, in the 18th century, drew sparks from a kite

"They have the irritating habit . . ."

string. Maybe they were not altogether wrong to think of him as, after all, Marconi, when he first used an aerial for wireless purposes, was possibly not unmindful of Franklin's work.

However, it is not about Franklin that I wish to write but of the ballyhoo that is being made in the U.S.A. about the recording of TV programmes on magnetic tape. This is undoubtedly a first-class achievement and is without question "pregnant with possibilities," as one typical writer puts it. I would, however, remind people not only in the U.S.A. but over here also that Baird recorded television on discs some twenty years ago and I think it is axiomatic that what can be recorded on discs can also be done by means of tape, film or any other recording media.

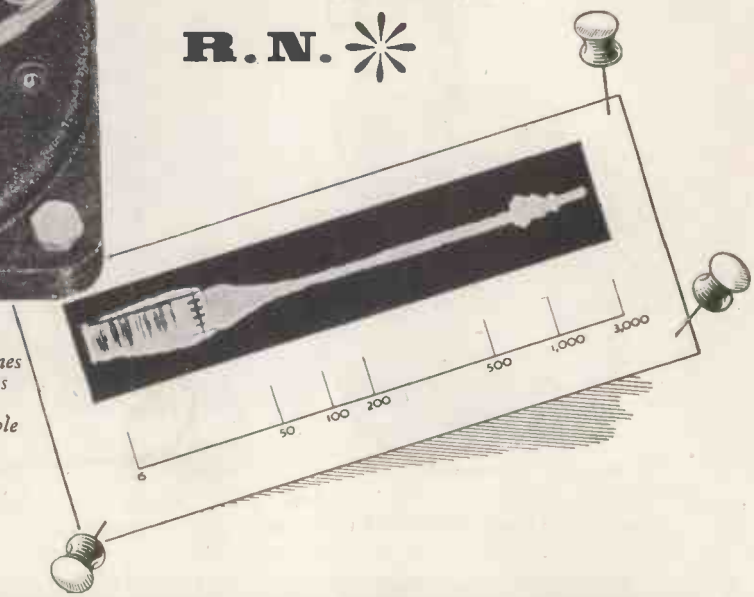
I hope my American readers will not regard my remarks as unmannerly. No doubt they suffer equal irritation at certain of our national habits and are exasperated at instances of our unjustified ballyhoo.



BRIMAR

Pin down

R.N. ✳



Illustrations by courtesy of Standard Telephones and Cables Limited who say, "These vibrators have been chosen as they give a faithful reproduction of the input wave form and enable high accelerations at any frequency to be obtained."

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✳ RESONANCE NOISE describes a particular factor in a valve which can very seriously impair its otherwise good characteristics. Only when "R.N." is negligible can a valve operate strictly according to its published "curve" and data.

Complete investigation of this phenomenon is only possible by subjecting the valve to *controlled* vibration throughout a wide frequency range. If the valve is operated in a Class A circuit, and the A.C. noise voltage appearing at the anode of the valve is presented on an oscilloscope, a resonance diagram against input frequency can be obtained. By this means it is possible to excite the valve in the range of frequencies 20 to 10,000 c/s, and the resonance noise performance checked. By the use of a twin mounting as illustrated, comparisons of valves can be made under identical conditions.

Just another of the wide applications of Goodmans Vibration Generators. Perhaps "controlled vibration" can serve you also.

The range includes models developing a force of ± 300 lbs. to the midget model with a force output of ± 2 lbs. for optical-cell research and hairspring torque testing etc. Full technical data available from "Vibration Division W"

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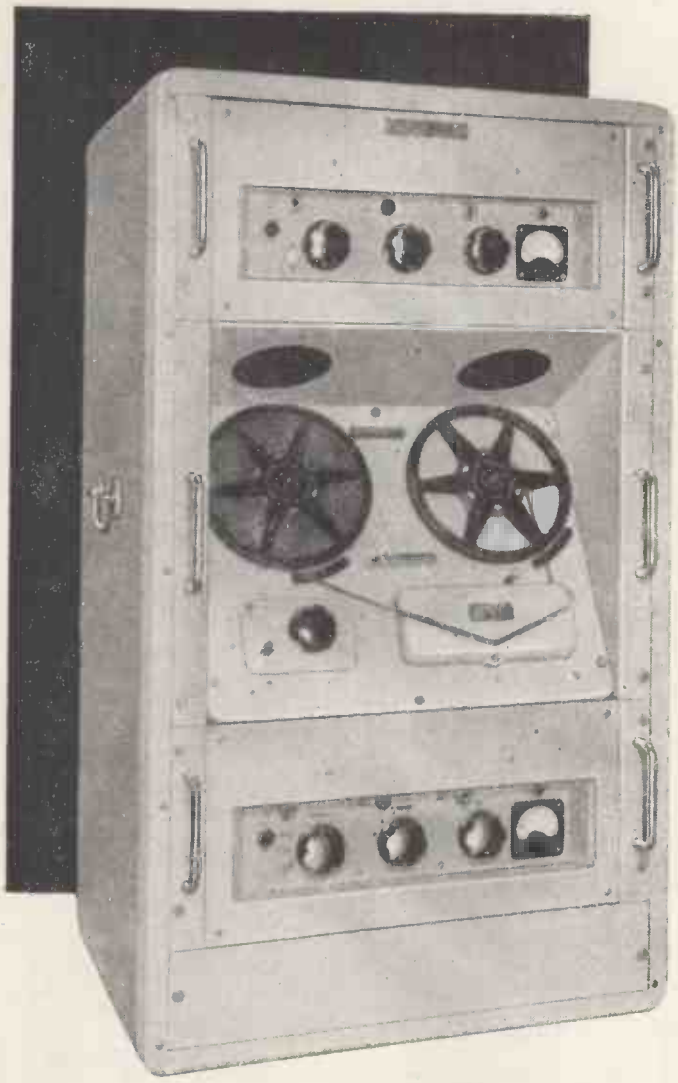


Equipment Type YDC

A simultaneous dual-channel Recorder/Reproducer

. . . offering special facilities to those engaged in analysis problems in the medical, aeronautical and scientific fields.

Besides the fairly normal ability to record time pulses on one track and intelligence on the other, it will become immediately obvious that comparative measurements, stereophonic sound and indeed any two activities capable of translation into electrical phenomena within the frequency and phase shift limitations, can be recorded and replayed simultaneously.

It is also possible easily to convert the equipment for endless loop working so that the last few minutes of any activity are recorded for ultimate continuous replay and analysis.

GENERAL SPECIFICATION

SUPPLY VOLTAGES : 100-120 volts and 200-250 volts A.C. 50 c.p.s. (60 c.p.s. by special pulley).

TAPE SPEEDS : 3¾" and 7½" per sec : Alternatively 7½" and 15" per sec.

SYNCHRONOUS CAPSTAN MOTOR giving long term speed stability of 0.5%.

TRACK WIDTH : 0.1" displaced to one edge.

NUMBER OF TRACKS : 2 accommodated side by side.

RUNNING TIME (50 c.p.s. supply) 30 mins at 7½" per sec, pro rata for other speeds.

REWIND & WIND-ON TIME : Less than 1 min. for full reel.

FREQUENCY RESPONSE : At 7½" p.s., 50-11,000 cycles and correspondingly increased at higher speed.

INPUT IMPEDANCES AND LEVELS : A. *Line Input*—600 ohms. Balanced, by P.O. Gauge B jack via built-in isolating transformer. Minimum signal level 0.07 volt peak.
B. *Microphone Input*—1 megohm unbalanced, or using external plug-in matching transformer, 25 ohms balanced. Minimum signal level .002v at high impedance socket.

OUTPUT IMPEDANCES AND LEVELS : A. *Main Output*—600 ohms Balanced. P.O. Gauge B jacks. 1 watt available into external 600 ohms if necessary. B. *Monitor Loudspeaker*—1 watt to internal 5" speaker. Can be switched out if desired.

SIGNAL TO NOISE RATIO : A. In the range 200-8000 cycles, for 1 watt main output (full depth recording) 50 D.B. approximately. B. Unweighted signal to noise, better than 40 D.B.

DISTORTION : At 1 watt output, 400 c.p.s. less than 5% total.

"WOW" AND FLUTTER (expressed as change in tape velocity) : Less than 0.2% at 7½" p.s.

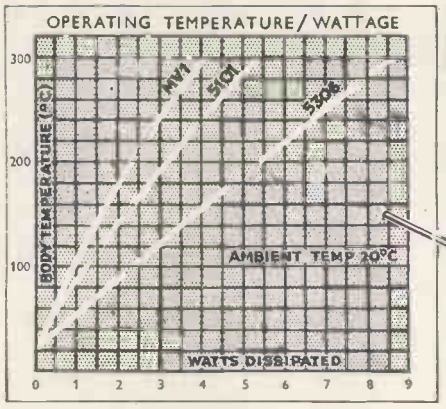
ERASE AND BIAS FREQUENCY : 51 K/cs nominal.

FINISH : Light battleship grey, British Standard Colour 631.

SIZE : 24" x 15" x 36" high.

PAINTON

By Appointment to the Professional Engineer



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DEMAND **MIDGET** RESISTORS

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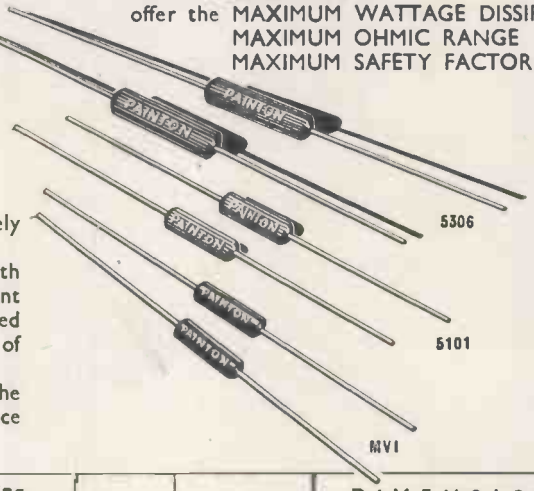

In the Heavy Duty **MIDGET** Range, the extremely high wattage dissipation is achieved by :
(a) the use of a sintered alumina ceramic former, with thermal conductivity approximating steel (Patent 626128), in conjunction with a Painton glaze developed to match the thermal and mechanical properties of sintered alumina,
(b) the exceptional strength and conductivity of the Painton "Intermediate Wire Process" of resistance termination (Patent 575297).

Range	Type	Resistance Range Ohms		Tol.	Rating Watts		Max. Working Temp.	Temperature Coefficient	DIMENSIONS			
		Min.	Max.		Normal 20 °C.	Tropical 70 °C.			Length	Diam.	Lead Length	Lead Material
Standard	MV1	1 10	9.99 4,700	10% 5%	4	3	300 °C.	BELOW 100^— NEGLIGIBLE ABOVE 100^— 0.01% /°C.	15/32"	13/64"	1 1/4"	20 S.W.G. Silver Clad Copper Wire
Heavy Duty	5101	1 10	9.99 4,700	10% 5%	5.5	4	350 °C.	BELOW 100^— NEGLIGIBLE ABOVE 100^— 0.01% /°C.	15/32"	13/64"	1 1/4"	
Heavy Duty	5306	10	15,000	5%	8.5	7	350 °C.	BELOW 200^— NEGLIGIBLE ABOVE 200^— 0.01% /°C.	13/16"	9/32"	1 1/2"	

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Excellent opportunities exist at various levels in all branches of our organisation, and particularly in our Research and Development Laboratories for radar and electronic engineers, mechanical designers and draughtsmen. If you are experienced in these fields or feel you have qualifications which would enable you to make a real contribution to our activities please write to us at once. There is plenty of scope for men of ability to move forward in this progressive company. Your letter which will be treated in the strictest confidence should be addressed to :

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When there's a special recording to be done . . . when there's no chance of a second take, or repeats will send costs soaring — that's when you need the M.S.S. White Label Master Disk.

Out of every hundred recording disks made at M.S.S. most are graded as excellent for direct play-back, but only about *three* meet our stringent demands for master recordings. That will give you an idea what *we* mean by perfection! And that is why so many of the World's recording and broadcasting companies rely upon M.S.S. Disks. There is a range of M.S.S. Disks to suit all types of recording work. May we send you further information?

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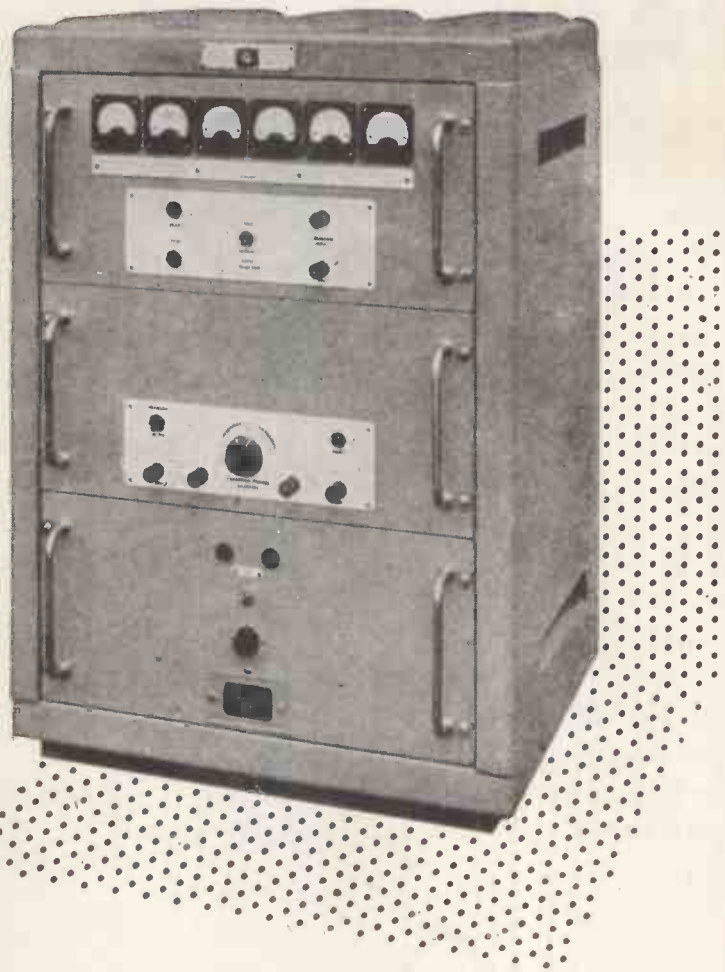

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Designed for the measurement of any frequency in the range 10 c/s to 1 Mc/s with a basic accuracy of ± 0.005% ± 0.1, 1.0, or 10 c/s. Higher accuracies available if required. The unknown frequency is determined by counting the number of cycles that pass through a 'gate' open for a selectable time interval of 0.1, 1.0, or 10 seconds. The result is presented on six panel mounted meters each scaled 0 to 9 and is in decimal notation. Full information available on request.

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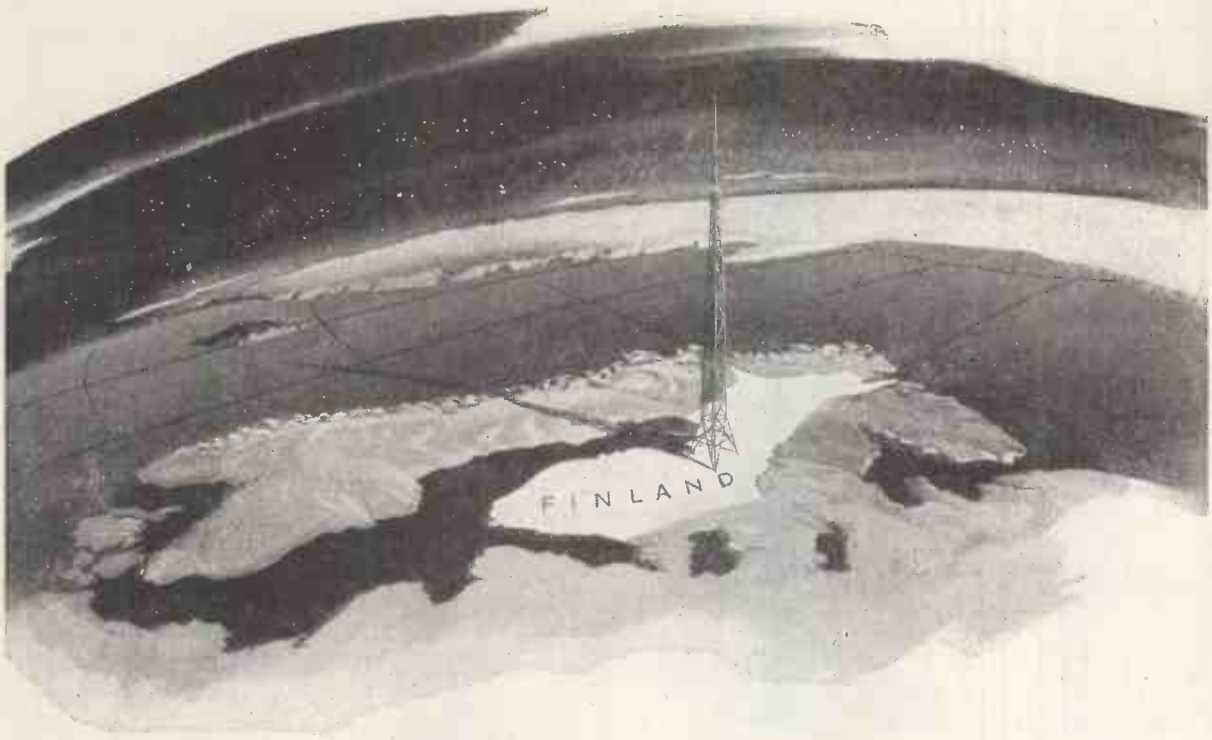

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Frequency Modulation Network Broadcasting aids her people

ONCE AGAIN, Finland's traditional foresight has carried her people forward in the march of progress.

From Lahti—where Finland's new broadcast center is growing toward completion—a *Frequency Modulation* network will reach out to all parts of the land. The network's nineteen RCA FM transmitters will carry the benefits of modern radio to Finnish people from Helsinki on the Gulf of Finland to Utsjoki in the far North.

• • •

The Radio Corporation of America is proud of the opportunity to have cooperated in this significant achievement and joins Havulinna Oy, its distributor in Finland, in saluting the Government of Finland, and the Finnish Broadcasting Company . . . a pioneer in FM networking on the European continent.

RCA INTERNATIONAL DIVISION "Marca Registrada"
RADIO CORPORATION of AMERICA
RCA BUILDING
30 ROCKEFELLER PLAZA, NEW YORK, N.Y., U.S.A.

Designed to obtain the best results from Modern Gramophone Technique

THE BURGOYNE R.G.1.

8 VALVE SUPERHET *Custom Built* RADIOGRAM CHASSIS

We offer this de luxe radiogram chassis made by Tape Recorders (Electronics) Ltd., confident that you will gain the greatest satisfaction from the superior quality of both radio and record reproduction. So sure are we of the R.G.1's reliability that we offer with every chassis a TWO YEAR GUARANTEE (valves subject to the usual makers' guarantee).

SPECIFICATION

- ★ **Illuminated full vision coloured tuning scale 11¼in. x 6¼in.**
- ★ **Negative feedback.**
- ★ **Designed for minimum mains hum.**
- ★ **Bass and Treble controls for cut and lift.**
- ★ **200-250 v. A.C. 50 c/s (110 v. A.C. available for export).**
- ★ **Wavebands 16-50, 190-550, 1,000-2,000 metres.**
- ★ **Magic eye tuning indicator and precision fly-wheel tuning.**
- ★ **8 watts push-pull output.**
- ★ **3 or 15 ohms impedance output to choice.**

We recommend high quality 10in. or 12in. Goodmans, Wharfedale and W.B. speakers for use with this chassis (3 or 15 ohms). All these available from stock.

Price **22** gns.

H.P. Terms and Credit Sale

H.P. Terms : Deposit 154/- with 12 monthly payments of 29/-. **Credit Sale Terms :** No Deposit, 9 monthly payments of 59/-, the first payment being sent with your order.
Carr. & Packing 7/6 extra.

Export

We specialise in speedy shipment to any overseas destination. Our price (exclusive of P.T.) for export buyers is £17/10/- sterling ex works.

HAVE YOU TOLD YOUR FRIENDS about the M.O.S. PERSONAL CREDIT PLAN?

Any type of equipment in our vast range of merchandise may be purchased under this plan which is essentially a personal one, as everyone has different requirements.

★ Two methods of purchase are available :—CREDIT SALE OR HIRE PURCHASE. The first allows you to own your equipment on payment of a first instalment of nine which are spread over 9 months. We quote the first instalment as one-ninth of the total purchase price, but if you so desire the first instalment can be any sum you please (within reasonable limits).

★ The second method secures delivery on payment of one-third of the cash price and the balance plus charges spread over any period up to 18 months. Again, we quote payments spread over 12 months but this may be varied.

★ Our range of electronic equipment is unequalled by any other firm, and can be inspected at your leisure in our spacious modern showrooms.

★ Your enquiries and orders will be dealt with confidentially whether by mail or personal shopping. We have years of experience behind us to advise and help you on your choice of goods. Carriage and packing is extra, all prices quoted being ex warehouse and subject to market fluctuations. Comprehensive lists are available upon request.

★ We specialise in export, and, having a world wide market for our merchandise, we have had to create a special export packing department, which, having had long experience of all types of packing for all markets, will ensure that your order reaches you safely wherever you are.

★ Satisfaction is always guaranteed to our customers, no matter how small the order, it will be valued by us.

M·O·S

Send us your Enquiry or Order Today !

E. & G. **MAIL ORDER**

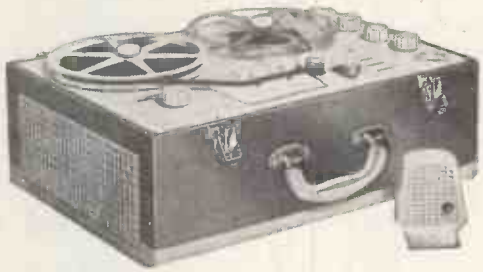
Telephone: MUSeum 6667. *THE RADIO CENTRE.*

Why we recommend the "EDITOR"

start with...

a new lightweight chassis—embracing the latest techniques of recorder construction. It has an output of 4 watts and achieves high quality reproduction with negligible wow and flutter. Precision built, the ingeniously planned circuitry is mounted on a steel frame that is easily removed from the case for inspection and maintenance in 30 seconds.

★ ★ ★ ★ ★ ★ ★



add a case...

only 5in. high of sturdy but lightweight construction with a strong carrying handle. It is available in various combinations of two tone leather-cloth with attractive gilt fittings.

add a lid...

an integral part of the case, secured by neat clips—but is completely detachable. This allows unrestricted access to the easily operated controls. A magic eye ensures balanced recording and listening. High speed rewind motors facilitate ease of playback selection.

★ ★ ★ ★ ★ ★ ★

and you have...

The Editor—the smallest lightweight mains operated fully automatic tape recorder—and only 45 gns! Weighing 33 lbs., the Editor is comfortably portable and can be freely used to capture vital moments of business or of social and domestic events.

Editor
SUITCASE TAPE RECORDER

Made by TAPE RECORDERS (ELECTRONICS) LTD

PRICE ONLY **45** gns.

SPECIFICATION. ★ Tape speed 7½in. per second. ★ Mullard miniature valves. ★ Twin track heads. ★ Three high grade specially designed recording motors give fast forward run and 50 sec. rewind without unlacing tape. ★ Independent Bass and Treble Controls for recording and playback. ★ Overall negative feedback. ★ 1,200ft. reel of tape gives over ONE hour playing time. ★ Amplifier may be used independently for very high quality record reproduction and public address. ★ High fidelity Record head. ★ Special high grade speaker. ★ Provision for external speaker. ★ Speaker muting switch. ★ 4 watts output—brilliant reproduction. ★ Positive servo braking on all functions ★ Size only 16½in. × 12in. × 7in. (with lid). ★ Radio/gram and microphone inputs.

ACCESSORIES. The "Editor" is supplied complete and ready for use with a crystal desk microphone made specially for this equipment by RONETTE. The Coronation microphone can be supplied as an alternative if desired. A 1,200ft. reel of high coercivity specially recommended BURGOYNE tape is also issued with every recorder. Extra reels are available at 35/- per 1,200ft. reel or 21/- per 600ft. reel.

H.P. TERMS. £15.15.0 Deposit, 12 monthly instalments of 60/-. Or 18 monthly instalments of 42/-.

CREDIT TERMS Send only £6 to secure with further monthly payments of £6.

SEE IT—AND HEAR IT—AT THE RADIO CENTRE

M·O·S SUPPLY COMPANY

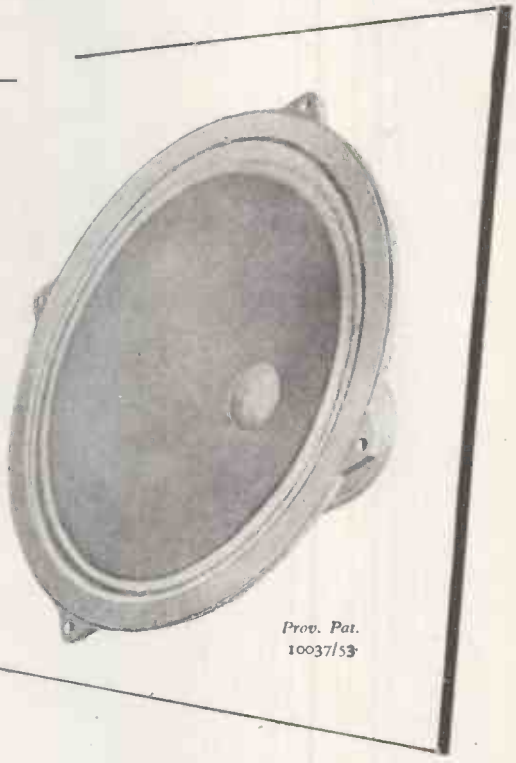
The Radio Centre, 33 Tottenham Court Road, London, W.1. *Telephone MUSeum 6667*

READ WHAT USERS SAY

"May I tender my thanks to you for providing such an excellent job at a price which poor mortals like we can afford. It certainly is a big step towards realism in sound reproduction which until now I considered out of my reach. More power to your elbow".

"I have purchased one of your H.F.1012 speakers, the results from which have astounded me. At the time of purchase I was sorely temped to pay a much higher price for another make of speaker, but fortunately, I was able to try both under varying conditions, good and bad, and then there was no hesitation about the decision. If the H.F.1012 has a good life, and there seems no reason why it should not, then it is a most outstanding achievement in performance and price".

"After reading P. Wilson's report of your new 10" speaker, H.F.1012, in the *Gramophone*, I immediately purchased one. Used in conjunction with a Leak Amplifier and a Leak Pick-up, the results were indeed remarkable. One would be tempted to say that at three times the price it would be exceptional".



Prov. Pat. 10037/53

Stentorian

HIGH FIDELITY UNITS

WITH THE PATENTED CAMBRIC CONE

MODEL H.F.610. 6" Steel unit, incorporating 10,000 gauss magnet. Handling capacity, 3 watts. Frequency response, 60 c.p.s.-12,000 c.p.s. Bass resonance, 70 c.p.s. Price **£2.10.6** (Tax Paid)

MODEL H.F.810. 8" Steel unit, incorporating 10,000 gauss magnet. Handling capacity, 5 watts. Frequency response, 50 c.p.s.-12,000 c.p.s. Bass resonance, 65 c.p.s. Price **£3.0.6** (Tax Paid)

MODEL H.F.912. 9" Die-cast unit, incorporating 12,000 gauss magnet. Handling capacity, 7 watts. Frequency response, 40 c.p.s.-13,000 c.p.s. Bass resonance, 45 c.p.s. Price **£3.7.0** (Tax Paid)

MODEL H.F.1012. 10" Die-cast unit, incorporating 12,000 gauss magnet. Handling capacity, 10 watts. Frequency response, 30 c.p.s.-14,000 c.p.s. Bass resonance, 35 p.c.s. Price **£3.13.6** (Tax Paid)

Transformer available if required
All models available either 3 or 15 ohms.

...and remember what the experts said:

These new speakers have scored a sensational success: even we are amazed at the enthusiasm they have aroused. Hear what the experts say: "A great advance in speaker technique" (F. J. Camm); "A new thrill in high fidelity reproduction" (John Gilbert); "An extension of the bass response which is truly remarkable" (H. J. Barton-Chapple); "The smoothness of response is one of the really remarkable characteristics" (P. Wilson).

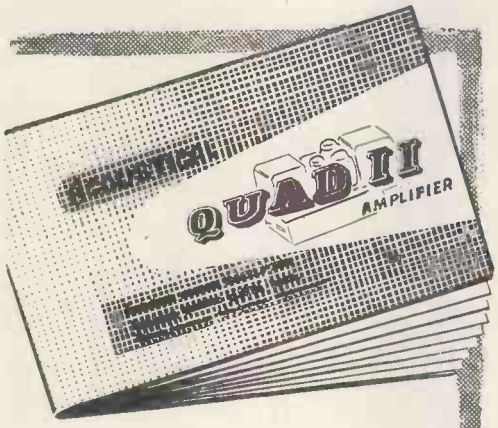
This consensus of opinion proves that the introduction of the cambric cone represents an amazing advance in loudspeaker design and performance. This achievement by W.B. engineers crowns thirty years' experience and progress in sound reproduction.

● *Write for leaflet giving full technical details, or ask your dealer to demonstrate. Alternatively, these speakers may be heard at our London Office, 109 Kingsway, W.C.2, any Saturday between 9 and 12 noon.*

WHITELEY ELECTRICAL RADIO CO. LTD.
MANSFIELD · NOTTS

To start you talking

–and listening



Those who have followed the growth of high quality reproduction in recent years may wonder how it is possible to improve still further the amplifier part of the system. Yet, like its predecessor, the QUAD II introduces entirely new features of importance to the final objective—features anticipating trends in design of both amplifier and associated equipment.

Engineers will readily appreciate among the many salient points of design of this amplifier, the complete stability under all load conditions. They will delight too in the unique low noise pickup matching system and in the new wide range filter developments.

The gramophone enthusiast will be pleased to find that his moving coil pickup no longer requires a transformer; that each of the seven playback characteristics is accurately provided at the touch of a button; that the logical system of filter control gives him low distortion without the sacrifice of correct musical balance.

Above all, the musician will find that the QUAD II gives the closest approach to the original sound. . . . The QUAD II booklet will tell you why.

A booklet describing the **QUAD II** *is available on request from*

ACOUSTICAL MANUFACTURING CO LTD
HUNTINGDON · HUNTS · TEL: 361

PRICE £42.0.0 RETAIL

Modesty forbids...

. . . .that we reproduce all the letters of appreciation we receive. But when one like this turns up what can we do ?

261 Heather Road,
Small Heath,
Birmingham.

Dear Sir,

I do a great deal of record reproducing as a pastime I have already made a corner cabinet for the Audiom 60 and the sound production is simply marvellous, and in my honest opinion I think it is superb.

I have had all different types but never have I found anything to equal the Audiom type of reproducer.

What other loudspeaker could bring forth greater genuine praise ?—except, perhaps, another Goodmans' High Quality reproducer. What immense versatility this high-powered, single cone AUDIOM 60 has ! The secret ?— fine sensitivity plus robust construction. The AUDIOM 60 will work as well from a battery set as it does in an Electronic organ. And as for radio and record reproduction of varied input, it will reduce background noise encountered in the playing of vintage recordings—and more— because of its low harmonic and intermodulation distortion the AUDIOM 60 is extensively used as a bass unit in cross over networks, whilst its success as a P.A. unit is widely acclaimed.

AUDIOM 60

BRIEF SPECIFICATION

Fundamental Resonance	75 c/s
Voice Coil Impedance	15 ohms
Power handling capacity	15 watts peak A.C.
Flux density	14,000 gauss
Net weight	12 lb 3 oz.
Price	**£8 12 6**

(Free of Purchase Tax)

Remember there is a loudspeaker in the Goodmans AXIOM and AUDIOM range for every application and you are invited to write for full details, advice and free dimensioned drawings of specially designed reflex cabinets.

A TRADITION OF EXCELLENCE FIDELITY EFFICIENCY

GOODMANS

GOODMANS INDUSTRIES LIMITED AXIOM WORKS, WEMBLEY, MIDDLESEX, ENGLAND.

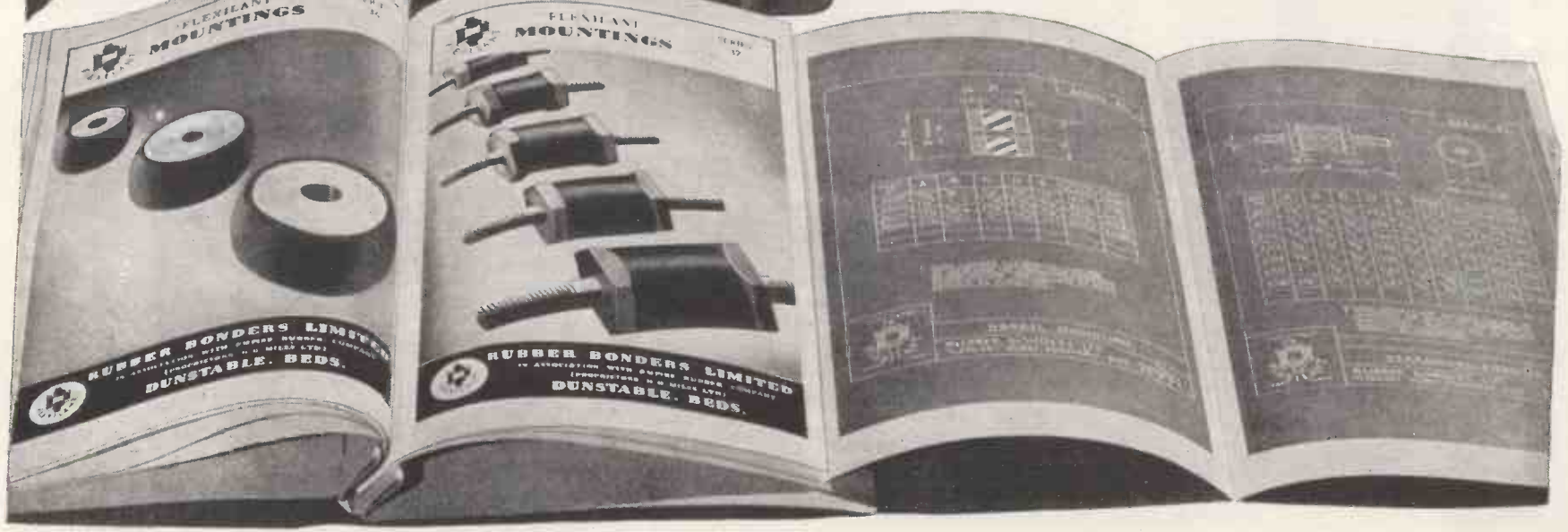
Telephone : WEMbley 1200. Cables : Goodaxiom. Wembley. England.

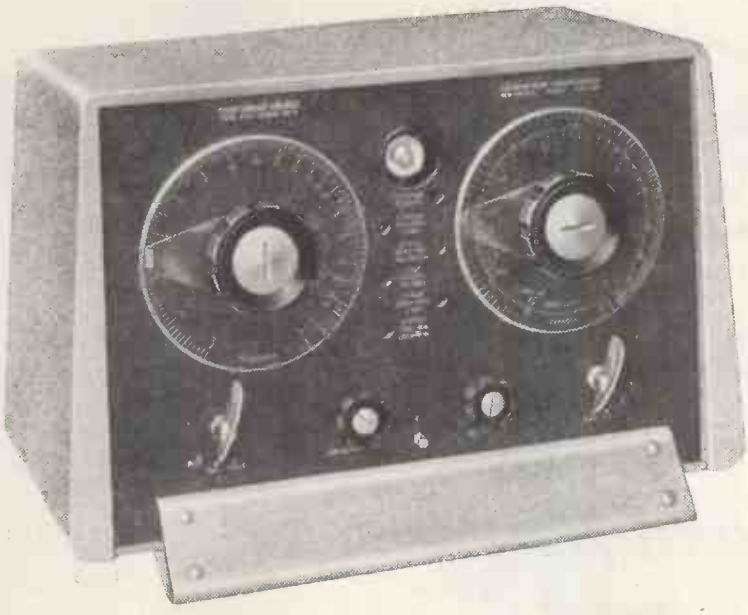
clatter?

To put up with noise and vibration in machinery is as modern as to ride a bone-breaker with solid-rubber tyres. "Clatter" in a factory shatters nerves, paralyses production, raises maintenance costs. Don't stand for it.

TO RUBBER BONDERS LIMITED DUNSTABLE, BEDFORDSHIRE

We will send our new Flexilant catalogue. This illustrates all the recent progress in the science of bonding rubber to metal—thus deadening noise, killing vibration, cushioning shock. We're also glad to advise on special problems.





A New Component Bridge

THE WAYNE KERR MODEL B.121

A MODERATELY PRICED self-contained instrument, capable of a wide range of accurate measurements.

In addition to giving direct readings of resistance, capacitance, and inductance, it will measure the impedance between any pair of terminals in a three-terminal network, and it can also be used for in situ measurements of component values.

Two individually calibrated dials give simultaneous readings of parallel combinations of resistive and reactive components, with independent scale multiplying of R and C values. The mains supply constitutes the source, and a selective amplifier with sensitive "magic eye" is used for null indication.

Specification

RESISTANCE RANGE: *3 ohms to 1,000 megohms, using six ranges and 3 multipliers of 0.1, 1 and 10.*

CAPACITANCE RANGE: *1.0 pF to 1,000 μF, using six ranges and 3 multipliers of 0.1, 1 and 10.*

INDUCTANCE RANGE: *100 mH to 10,000 H in five ranges.*

ACCURACY: *2% on all ranges over the major part of the scale. If higher accuracy is required, the instrument can be supplied hand-calibrated.*

POWER SUPPLY: *110/115 V. or 200/250 V. at 50 c/s —10 W. approx.*

DIMENSIONS: *17¼" × 10½" × 10" high.*

WEIGHT: *15 lb. approximately.*

Wayne Kerr

THE WAYNE KERR LABORATORIES LTD • NEW MALDEN • SURREY • MALDEN 2202

PROBLEM-

145 x 2 x 3

SOLUTION-

The LAB TESTED CONTINUOUS STORAGE UNIT

BRITISH PATENT No. 680632

SAVE your slide rule—the real answer is 870—that's the number of different resistors in the 'T' & 'R' range—145 preferred types in two wattages and three tolerances.

Add to that, the fact that it is necessary to carry stocks of each, it's no wonder the problem of storage is a real headache—unless of course they're LABpak'd.

LABpak continuous storage units solve the whole problem giving positive segregation of ohmic values with finger type selection of card index simplicity. Carded LAB resistors may be added as stocks deplete and are readily obtainable from usual wholesalers. Furthermore, the continuous storage unit is FREE with a small initial order for 180 type 'R' or 240 type 'T' resistors, the values of which YOU can specify.

The scheme's well worth investigating—ask your wholesaler or drop us a line for illustrated list.

RESISTOR SPECIFICATION

Ref.	Type	Loading	Max. Volts	Range	Dimensions
T	½-watt	½-watt	250	10 ohms	⅜" × ⅛"
R	½-watt	1-watt	500	to 10 megohms	⅝" × ¼"

Tolerance available ±20%, ±10%, ±5%

The Lab Continuous Storage Units are available from your normal source of supply, but more detailed information can be obtained on request.

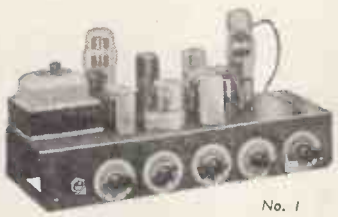
THE RADIO RESISTOR COMPANY LTD.

50 ABBEY GARDENS, LONDON, N.W.8 · Telephone: Maida Vale 5522

REAL HIGH FIDELITY *at modest cost . . .*

• *Manufacturer-to-Consumer policy saves you one-third cost ! !*

You may have already extended your record reproducer to include the now firmly established L.P. Records. You may be considering doing so. In either case, for real high fidelity at modest cost, it will pay you to consult us. Our aim is not just to sell you equipment *but to save you money and to ensure that you get the apparatus most suited to your needs.* **Discuss your problem with our Chief Engineer (available daily including Saturdays 11 a.m. to 6 p.m.). Or write enclosing 2½d. stamp. This Technical Guidance Service will cost you nothing and save you pounds.**
NOTE: Regarding Pick-up heads to take standard or miniature thorns for 78 r.p.m., these can be supplied with any of the single-record Gram Units or Auto-changers sold by us, if desired.



No. 1

No. 1 "SYMPHONY" AMPLIFIER is a 3-channel 5-watt Gram/Radio Amplifier with astonishingly flexible tone-control. You can lift the treble, the bass, or—and here is the unique feature—the middle frequencies to suit your own ear characteristics and the record or radio programme being heard. It is thus possible to arrange the frequency-response of the amplifier to a curve equal and opposite to the resultant curve of the other items in the chain so that what finally registers in the brain is as per original. This flexibility of control is far more important than mere nominal linear response of the amplifier, as the pick-up, speaker, etc., are not linear. Independent Scratch-Cut is also fitted and special negative-feedback circuit employed. The amplifier can accommodate a wide variety of records from old 78's to new L.P.'s. Input is for all types of pick-up of 0.2v. output or more and there is full provision (and power) for Radio Tuner. It is available to match 2/3 or 15 ohms speakers. Price: 10 gns. (carriage 5/-). Fitted in Portable Steel Cabinet 35/- extra.

No. 2

No. 2 "SYMPHONY" AMPLIFIER as No. 1 but with 10-watt Push-Pull triode output and triodes throughout. Woden mains and output transformers and choke. Full provision and power for Tuner. Output tapped 3, 7.5 and 15 ohms. Competes with the most expensive amplifiers on the market yet costs only 15 gns. (carriage 5/-). Fitted in portable Steel Cabinet 2 gns. extra.

"SYMPHONY" AMPLIFIERS with REMOTE CONTROL. Both the above model Amplifiers are available with all controls on a separate Control panel with up to 4 feet flexible cable which simply plugs into the amplifier. Enables the Amplifier proper to be sat in the bottom of a cabinet whilst the controls are mounted conveniently higher up. Extra cost 2 gns.

THE N.R.S. No. 2 PUBLIC ADDRESS AMPLIFIER for 200/250 volts A.C. mains gives output of 15 watts audio. Valve line-up ; 6SL7, 6SN7, input and phase splitters, feeding 2 x 6V6 beam power tetrodes in push-pull, 5Z4 rectifier. Twin inputs with separate volume controls enabling gram. and mike or twin turntables to be faded in and out. Tone control is fitted and output is for 3, 7.5 and 15 ohms. This amplifier is built on the same de luxe hammer-finish chassis as the Symphony No. 2 and incorporates the same robust Woden mains transformer and choke, ensuring extreme reliability and absolute confidence in the instrument on the job. We can highly recommend this instrument as gramophone, microphone and radio amplifier for dances, socials, etc., in halls, clubs, institutes, etc. Price in Kit form £12. Fully built and tested 13 gns. Carriage 5/-. Hammer-finish Steel Cabinet with handles, 2 gns. extra.

GARRARD 3-SPEED GRAM UNIT MODEL "T." With turnover Magnetic Pick-up Head or Turnover Astatic Crystal Head, £10, post and pack., 2/6.

MODEL "TA," as above, but fitted with the latest Radio Show High-Fidelity Acos HGP35 Pick-up Heads (one for Std. and one for L.P.). Price £12/3/9, post and pack. 2/6. Heads only, 43/- each, post 1/-.

Model "TB," as above, but with two separate Decca XMS Heads, £13/7/6, post and pack., 2/6. Or with two separate Acos GP19 Mk. 2 Heads, £12/10/-. Or with Garrard Head for fibres (78) and Acos GP19 Mk. 2 for L.P., £12/5/-, post 2/6.

GARRARD 3-SPEED AUTO-CHANGERS, Model RC80, plays up to ten records 7in., 10in. or 12in. at 78, 45 and 33⅓ r.p.m. Stylus pressure on L.P. 10 grammes (adjustable). New ultra-sensitive auto-trip mechanism and heavy loaded turntable to eliminate "wow." Price £14/2/6 or with Garrard Magnetic or Astatic Crystal Turnover Pick-up Head, £16/2/6. With two separate Acos Hi-fi Heads, £18/2/6. With two separate Decca XMS Heads, £19/7/6. Carriage 5/-. Optional Extras : 45 r.p.m Auto Centre Spindle, 20/9; A.C./D.C. Operation £7/14/-. Fitting in de luxe rexine-covered Portable Cabinet, £5. Pick-up Head to take Fibre Needles, 25/- to 35/-.

GARRARD 3-SPEED AUTO-CHANGERS, MODEL RC90 in de luxe rexine-covered Portable Case, £23/1/-. Or fitted with Garrard Magnetic Turnover Head, £25/3/5. Or fitted with two separate Acos high-fidelity HGP35 Heads, £27/7/-. Carriage in all cases 7/6.

ABOVE GARRARD UNITS are for A.C. Mains but are also available at extra cost as follows : 6v. D.C 90/-; 12v D.C. 90/-; 200-250v. A.C./D.C 153/-.

VIBRATOR POWER UNITS to enable the use of any modern A.C Record Player together with one of our Symphony Amplifiers from D.C. mains £12 post paid.

GARRARD 3-pin plug-in MAGNETIC PICK-UP HEADS for Fibre or Steel Needles fit Garrard and Decca Arms. Prices: Standard 25/-; Miniature high-impedance 35/-; Miniature low impedance 25/-. Postage 1/-. Garrard Arm 35/-; Decca XMS Arm, 23/6. Post 1/- Advice re. matching if required.

COLLARO latest model A.C.3/534 3-SPEED GRAM UNIT with new "STUDIO" Pick-up type "O" or "P," £10/6/1, post 2/6.

COLLARO latest model 3RC531 AUTOCHANGER with "STUDIO" PICK-UP type "O" or "P" £15/3/10, carr. 5/-. DITTO but Mixer (3RC532), £17/9/6.

COLLARO "STUDIO" PICK-UP (Arm and Head) type "O" or "P" 74/8, post 2/-

RECORD PLAYER CASES, rexine-covered with hinged lid and carrying handle and fasteners and uncut motorboard. Standard model to spring-mount any Garrard, Collaro or B.S.R./Decca Gram Unit, 57/6, post 2/6. Ditto autochanger size 90/-, carriage 5/-. As Standard but extra large for Connoisseur Motor and one or two Pickups 67/6, carr, 5,-

TAPE DECKS. We stock and recommend the latest TRUVOX Mark 3. Price 22 gns., carriage free.

ILLUSTRATED CATALOGUE AND SUPPLEMENT. Our new catalogue just published will save all those considering the purchase of radio or record-reproducing equipment much time, trouble and money. Send two 2½d. stamps for your copy now ! Our CHIEF ENGINEER will be pleased to afford TECHNICAL ADVICE where required.

HIRE PURCHASE FACILITIES
NOW AVAILABLE on orders of £15 or over.
Send one-third deposit with order, balance over 6 or 12 monthly instalments. *State which required.*

NORTHERN RADIO SERVICES

16 KINGS COLLEGE RD., ADELAIDE RD., LONDON, N.W.3. *Phone : PRImrose 8314*
Tubes : Swiss Cottage and Chalk Farm.
Buses : 2, 13, 31, 113, 187.

GOODMANS CORNER CABINETS (above) for the AXIOM 150 Mark 2, manufactured by us to Messrs. Goodmans own design. Price: complete kit in plain board with felt, 8 gns. Price ready built, 10 gns. Finished in figured walnut, 16 gns. Other veneers to order. Carriage extra.

" SYMPHONY " BASS REFLEX CABINET KITS. 30in. high, consist of fully-cut ¾in. thick, heavy, inert, non-resonant patent acoustic board, deflector plate, felt, all screws, etc., and full instructions. 8in. speaker model, 85/- ; 10in. speaker model, 97/6; 12in. speaker model, £5/7/6. The design is the final result of extensive research in our own laboratory and is your safeguard of optimum acoustic results. Carriage 7/6. Ready built, 10/6 extra.

CONSOLE AMPLIFIER CABINETS (above), 33in. high, lift-up lid, take Gram Unit or Auto-changer, Amplifier, Pre-amplifier, and Radio Feeder Unit, finished medium walnut veneer. De Luxe version, 10 gns., carriage according to area. Bass Reflex Cabinets to match available. Details 2½d.

LETTER FROM *Brazil*

Rio de Janeiro.
24th November 1953.

Dear Mr. Briggs:

About your books; I have all their editions. Their texts are simple, objective, constructive, immune to a common pest which might be called "scientific demagogy." Further, your informal way of exposing ideas, occasionally adorned by a peculiar sense of modesty and humour, are features which make the reading of your texts an attractive occupation. So, and all values duly praised, I believe that the repeated study of the contents of your books, and the execution of lessons therein given, are, to any person interested in matters of sound reproduction, profitable investments of time and mental energy.

About your loudspeakers: The abundant evidences which, within the last five years, I have had participating in merciless comparative tests, technical tests followed by decisive listening tests, have led me to believe that the qualitative performance of loudspeakers must be less the realisation of technical specifications than the fruit of art. Otherwise, how could I thoroughly understand, for instance, the very superior performance of the Wharfedale loudspeaker model Super 12/CS/AL?

Well, whatever the cause may be, an important effect is that your loudspeakers have fascinated me. Consequently, let me confess, Wharfedale units, models W15/CS, Super 12/CS/AL and 8/CS, have overwhelming preponderance, in terms of quantity and quality, in the two separate groups of loudspeakers which are installed in my home. Incidentally, by the end of the year a Wharfedale 5in. tweeter should enrich my equipment.

Thank you, Mr. Briggs, for your accomplishments concerning the betterment of the reproduction of sound.

Yours sincerely,
ED. VIDAL.

THESE ARE THE FOUR BOOKS REFERRED TO IN OUR LETTER FROM BRAZIL

Sound Reproduction
By G. A. Briggs
Enlarged and revised 3rd Edition. 368 pages, 315 illustrations. Many new chapters; up-to-the minute advice and information.
17/6 (plus **1/-** postage). De Luxe edition **25/-** (plus 1/- for postage).

Loudspeakers
By G. A. Briggs.
3rd Edition. 9th Impression. 88 pages, 36 illustrations.
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Fine art paper. Bound full rexine. 216 pages. 174 illustrations.
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Pianos, Pianists and Sonics
By G. A. Briggs
192 Pages. 162 illustrations.
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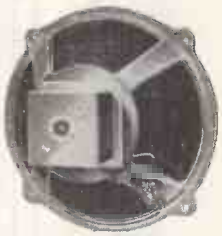

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It is regretted that the price of the Super 12/CS/AL and W15/CS has been increased from the 1st January due to an increase in the cost of the magnets.

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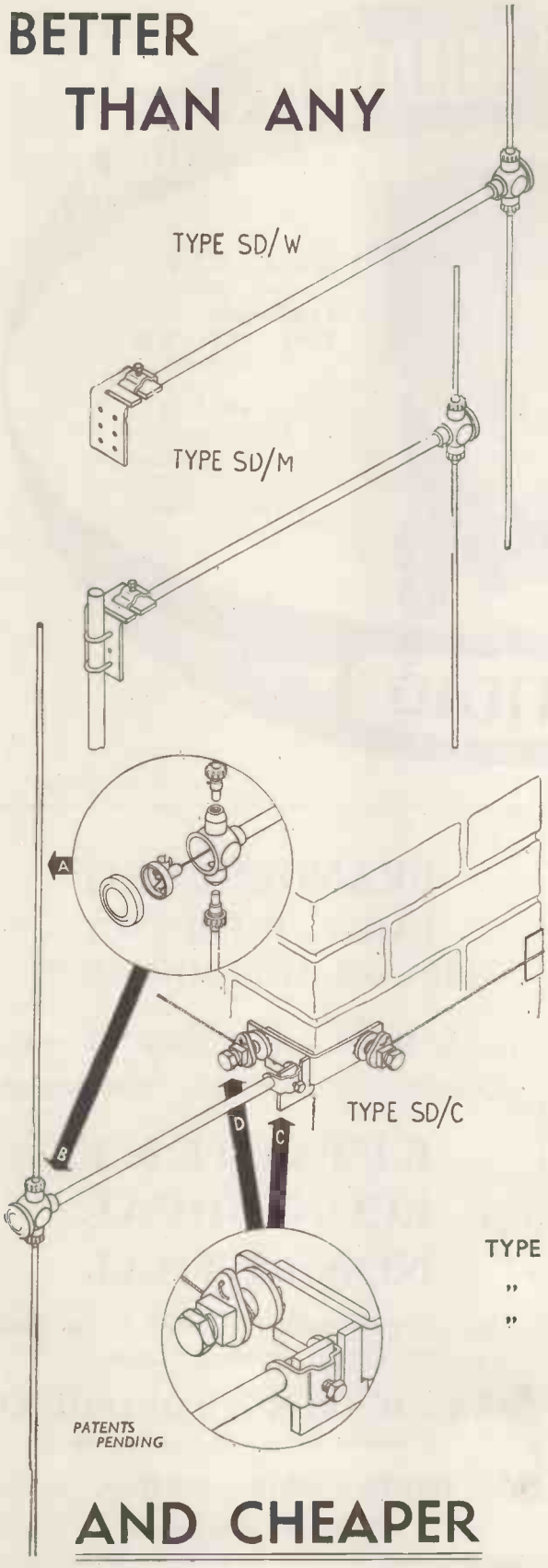

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'VARIAC' infinitely variable voltage-regulating transformers are designed and constructed for many years of trouble-free operation. Not only do they supply perfectly smooth control of voltage from zero, but many types (including 100-R), also furnish output voltages considerably above line voltage while the 100-RM/2B is a dual output type. Illustration left shows Type 100-R, Rating 2,000 va., Input Voltage 230/115. Output Voltage 0-270.

Left—Type 200 C.U.M.

Right—Type 50-B.

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TYPE	LOAD RATING	SPECIFICATIONS				NO-LOAD LOSS	NET + PRICE +
		INPUT VOLTAGE	CURRENT		OUTPUT VOLTAGE		£ s. d.
			RATED	MAXIMUM			
100-K	2000 va.	115	15 a.	17.5 a.	0-115	20 watts	17 17 0
100-KM	2000 va.	115	15 a.	17.5 a.	0-115	20 watts	18 12 0
100-L	2000 va.	230/115	8 a.	9 a.	0-230	25 watts	17 17 0
100-LM	2000 va.	230/115	8 a.	9 a.	0-230	25 watts	18 12 0
100-Q	2000 va.	115	15 a.	17.5 a.	0-135	20 watts	18 9 0
100-QM	2000 va.	115	15 a.	17.5 a.	0-135	20 watts	19 4 0
100-R	2000 va.	230/115	8 a.	9 a.	0-270	30 watts	18 9 0
100-RM	2000 va.	230/115	8 a.	9. a.	0-270	30 watts	19 4 0
100-LH	1200 va.	480/240	2 a.	2.5 a.	0-480	25 watts	21 15 0
500-L *	1450 va.	180	8 a.	9 a.	0-180	25 watts	17 17 0
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Taylor Model 88A multirange universal meter

20,000 o.p.v. D.C. 2,000 o.p.v. A.C.
A portable multirange A.C./D.C. instrument providing wide testing facilities.

Five-inch scale with knife-edge pointer and anti-parallax mirror. Instantaneous overload protection on all ranges. Buzzer for quick continuity testing. Supplied complete with leads, crocodile clips and comprehensive instruction manual.

RANGES

Volts D.C.—0, .1, .25, 1, 2.5, 5, 10, 25, 50, 100, 250, 500, 1,000, 5,000.

Volts A.C.—0, 1, 2.5, 5, 10, 25, 50, 100, 250, 500, 1,000, 5,000.

Milliamperes D.C.—0, .05, .1, .25, 1, 2.5, 5, 10, 25, 50, 100, 250, 500, 1,000.

Milliamperes A.C.—0, .25, 1, 2.5, 5, 10, 25, 50, 100, 500, 1,000.

Amperes D.C.—0, 2.5, 10.

Amperes A.C.—0, 2.5, 10.

Resistance.—1 ohm to 5 megohms in 4 ranges.

Decibels. — −20 to + 69 in 9 ranges. Zero reference level is 6mW into 500 ohms.

Output. —As A.C. volt ranges, except 5,000 volts, via a condenser.

Inductance.—0.2 to 200 henrys in two ranges.*

Capacitance.—1,000 pF to 100 μF in four ranges.*

* External adaptor, Model 313D, required.

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Taylor Model 71A multirange universal meter

Accuracy D.C. ranges 2 per cent. of F.S.D.
A.C. ranges 4 per cent. of F.S.D.

Precision engineered meter with instantaneous overload protection on all ranges. Five-inch easy to read scale with knife-edge pointer. A buzzer is fitted for quick continuity testing. One switch selects both circuit and range. Fitted in moulded black shockproof case.

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Milliamperes D.C.—0, 15, 150, 1,500.

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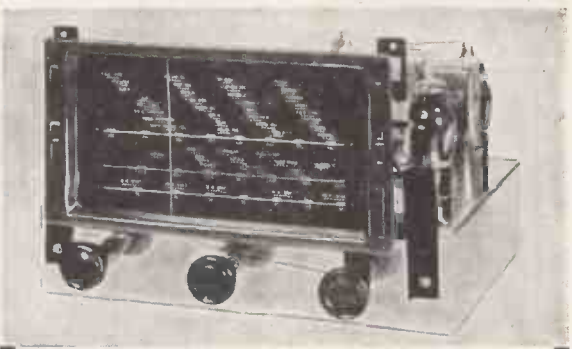

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IT DOESN'T FRAY!

"PERIBRAID" SILVERGLASS SLEEVING is made from close-braided glass fibre filament specially treated to reduce the fraying of cut ends.

It is available in continuous lengths in sizes from 0.5 to 10mm. and has the following characteristics :—

- Maximum flexibility over whole temperature range from 450°C to minus 50°C.
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SEPARATE COILS: A full range is available for all popular wavebands and purposes. Fully descriptive leaflet and connection data available. Just note these "plus points":

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A spotlight on another of the "specials" in the OSMOR "Q" Coil Range

45 K/C Tape Recorder Oscillator Coil

TYPE QT8.

A centre tapped wave-wound coil as illustrated for TRUVOX and similar tape-decks. Single screw fixing. Fitted tags.

7/6 each

TWO for the Price of ONE

The NEW OSMOR CHASSIS CUTTER

An inexpensive but invaluable tool of entirely new design. Cuts two hole sizes with any one reversible punch and die; and can be operated with a spanner or tommy-bar. Blanks easily removed. **For use on steel up to 18 s.w.g. Brass and Dural up to 16 s.w.g. Aluminium and Copper up to 14 s.w.g.**

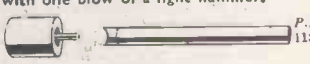
P. Pat. 11325/53

Type	Hole Sizes	
1	1in. x 1¼in.	Illust. price list on request.
2	¾in. x 1¼in.	
3	¾in. x 1¼in.	
4	1¾in. x 2in.	

Tommy-bars available.

The OSMOR "JIFFY PUNCH"

For cutting smaller holes neatly and quickly with one blow of a light hammer.



P. Pat. 11324/53

Type	Hole Size	
A	¼in.	Illust. price list on request.
B	⅜in.	
C	½in.	

For use on Steel up to 20 s.w.g. Brass and Dural up to 18 s.w.g. Aluminium and Copper up to 16 s.w.g.

DIALS

Type A. Glass DIAL ASSEMBLY (as illust.) measuring 7in. x 7in. (9¼in. x 9¼in. overall) mounts in *any* position on or above the chassis and works with any type of drive. Choice of two 3-colour scales—G1 (L.M.S.) or G2 (M.S.S.). Price complete 24/6. P. & P. 1/6. Pulley assembly for right angle drive if required 1/9. Escutcheon 4/-.

METAL DIALS

Overall size 5¼in. sq. Printed area 4in. sq., as illustrated. Cream background, 3-colour.
Type M1, L.M.S. waves.
M2, L. & M. waves.
M3, M. & 2/S. waves.
Price 3/6 each.
Pointer, 1/6.
Drum, Drive, Spring and Cord for use with both types of dial, 3/2.

FREE! Send 5d. (stamps) for fully descriptive literature including "The really efficient 5-valve Superhet Circuit and practical Drawings," 6-valve ditto, 3-valve (plus rectifier) T.R.F. circuit, Battery portable superhet circuit, Coil and Coilpack leaflets, Chassis Cutter leaflet, and full radio and component lists, etc., etc.

We keep stocks of many radio components for use in published circuits, including:—

"WIRELESS WORLD"

"No Compromise" TRF Tuner. "Midget Mains Receiver." Sensitive 2-Valve Receiver. Television Converter (special coils in cans available), etc., etc.

"PRACTICAL WIRELESS"

Coronet Four; Beginners' Superhet; Modern High Power Amplifier 2; Attache Case Portable; R1155 Converter; A.C. Band-Pass 3; Modern 1-Valver; 3-speed Autogram.

Dear Reader,

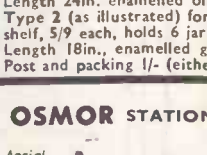
We can't mention all our products here but shall be glad to receive your enquiries for ***Chassis, Tuning Condensers, Switches, Volume Controls and all other Radio Components.*** *If it's top-quality components and a speedy, courteous service you are looking for—try Osmor. We really shall do our best for you.*

Keep those small components—resistors, condensers, etc., neatly stored yet visible by using an

OSMOR "JAR-RACK"

(If you're a generous husband you'll buy one or two for your wife's larder, too—she will appreciate the extra space they make.) Holds any 1 lb. jam jars, with or without lids. Easily removed, cannot fall out. Just the thing for the tidy "HAM" or Radio Dealer.
Type 1 for wall-fixing, 6/9 each, holds 8 jars (Jars are not supplied but are easily obtained.)
Length 24in. enamelled olive green.
Type 2 (as illustrated) for screwing under a shelf, 5/9 each, holds 6 jars.
Length 18in., enamelled green.
Post and packing 1/- (either type).

OSMOR STATION SEPARATOR



TYPE	METRES
1	141-250
2	218-283
3	267-341
4	319-405
5	395-492
6	455-567
7	1450-1550
8	410-550 k/c

This is a device on the well-known "wave-trap" principle, which will reject an undesired signal when inserted in the aerial lead.
The Separator may easily be tuned to eliminate any one Station within the ranges stated and fitting takes only a few seconds. Sharp tuning is effected by adjusting the brass screw provided.
Complete with plug, socket and full instructions—nothing to add.

7/6 POST FREE *Satisfaction guaranteed.*

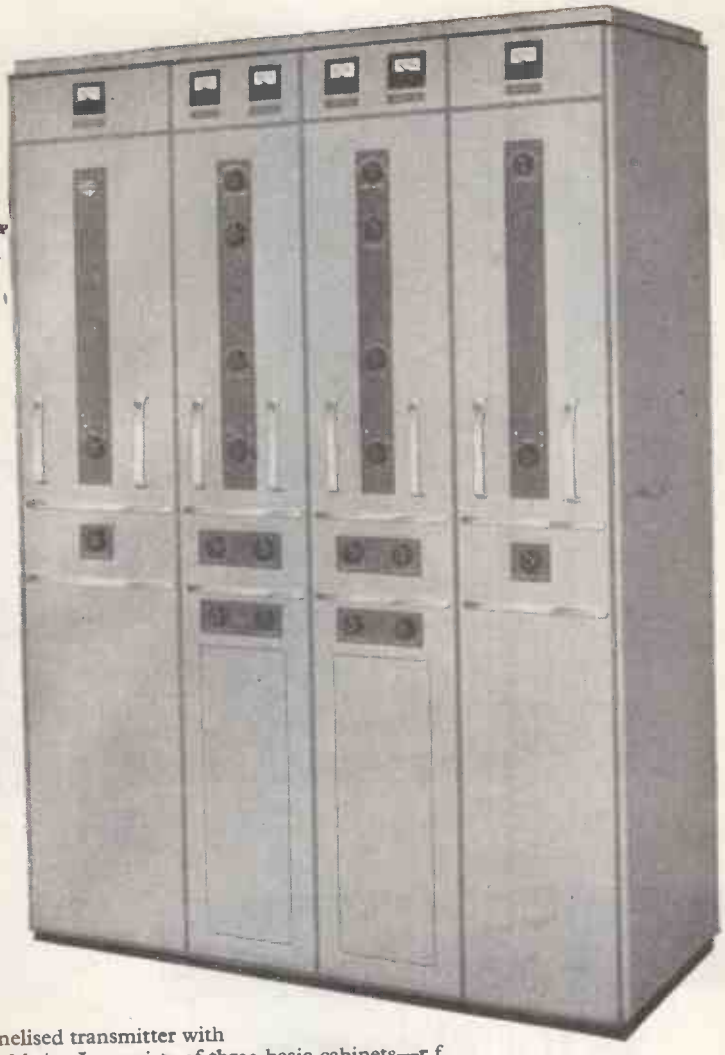
I.F.s. 465 k/c. Permeability-tuned with flying leads. Standard size 1⅜in. x 1⅜in. x 3½in. For use with OSMOR coilpacks and others, 14/6 pair. PREALIGNED, 1/6 extra.

OSMOR radio products ltd.

(Dept. W.50) 418, BRIGHTON ROAD, SOUTH CROYDON, SURREY.
(Trade Enquiries Invited)

Telephone: **Croydon 5148/9**

1 kW Channelised Transmitter



THE GFT.560 is a 1kW channelised transmitter with a frequency range of 1.5—30 Mc/s. It consists of three basic cabinets—r.f. unit, modulator unit, and power supply unit—combinations of which can be used to provide multi-frequency working as well as a number of different types of emission. The wave change facilities of the transmitter are both rapid and reliable—a valuable asset when the operating frequency is changed many times each day.

The GFT.560 is fully tropicalised, and its unit construction facilitates future expansion of the initial installation, should the need arise.

For use in conjunction with the GFT.560 there are ancillary units that enable the transmitter to be remotely controlled over a two wire telephone circuit: operational adjustments are dialled to the transmitter.

The versatility and reliability of this new Mullard transmitter make it particularly suitable for h.f. en-route, ground-to-air services and point-to-point communication networks. A team of Mullard communication engineers is available to advise on the use of the GFT.560 in such applications. They will also assist in planning complete communication systems, if required.

ABRIDGED DATA

Frequency Range *1.5—30 Mc/s*
Frequency Stability *To Atlantic City, 1947, standards*
Power Output *1 kW*
Types of Emission *c.w., m.c.w., telephony, frequency shift, single and independent sideband. (A1, A2, A3, F1, A3a and A3b)*
Output Impedance *600 ohms balanced twin feeder*
Power Supply *400V, 50-60 c/s, 3-phase*

Mullard

SPECIALISED ELECTRONIC EQUIPMENT

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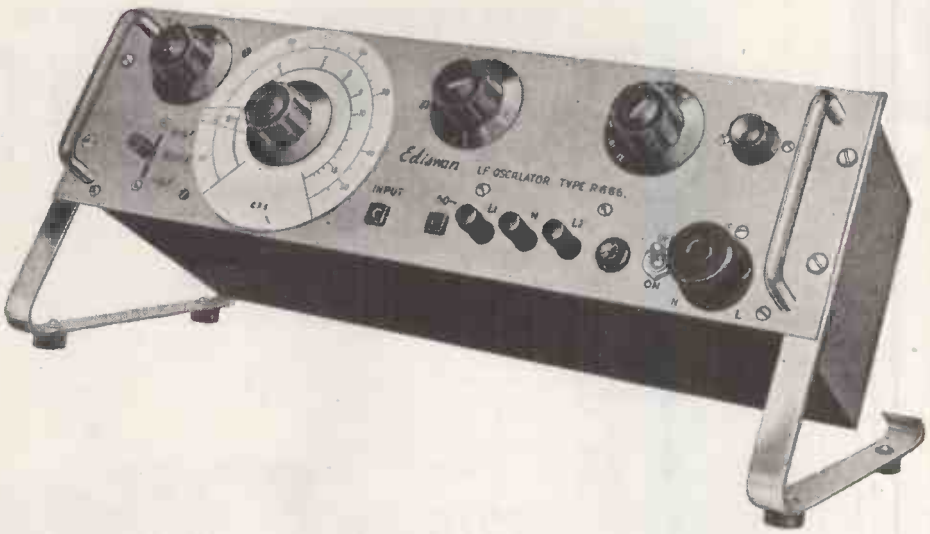
(M1434)

A dependable low-frequency standard



The Ediswan Low Frequency Oscillator type R.666 provides a dependable low frequency standard for testing, calibration and set up of biological amplifiers and recorders, strain and vibration recorders, and low frequency wave analysers.

Production of this Oscillator has been stepped-up to meet the great demand for it and delivery can now be made with little or no delay. Complete the attached coupon or write for further details.

Brief Specification of Ediswan Low Frequency Oscillator type R.666

TYPE. Resistance capacity, with automatic amplitude control effective over the whole frequency range.
FREQUENCY RANGE. 1.15 c.p.s. to 5,500 c.p.s. **INPUT.** 200—250 volts, 40—60 c.p.s.
OUTPUT. Sine wave 50 volts peak to peak, push-pull, with built-in attenuator.
CONSTRUCTION. Standard 19″ rack mounting, but also suitable for bench use. Bench stands available.

NOTES. An incremental switch is fitted. Provision is made for modulation of output.

PRICE £75 nett STANDS £1. 1s. nett

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RADIO DIVISION

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Please send me full details of the Ediswan Low Frequency Oscillator Type R.666.

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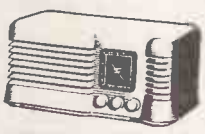
BUILD A PROFESSIONAL LOOKING RADIO AT LESS THAN HALF TODAY'S PRICE

We can supply all the parts to help you.

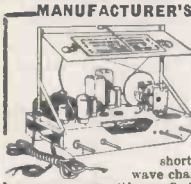
Drum (2¼in. dia.) ..	1/6
Driving head	1/6
Double pointer	4d.
Spring	3d.
Nylon Cord (yard) ..	6d.
Dial Front Plate ..	2/6
Engraved Glass Dial 180-560 and 800-2,200 m. With station names, new wavebands ..	1/6
T.R.F. Coils, 180-550, 800-2,200 metres, pair	5/6
Punched chassis, 3-valve plus rectifier T.R.F.	3/9
Cabinet, Bakelite, in Walnut or Ivory or Wooden in Walnut Finish	17/6
Packing and Insurance	2/6

SEND 1/6 FOR EASY TO FOLLOW POINT-TO-POINT DIAGRAMS AND CIRCUIT DIAGRAM which shows how YOU can build the Receiver illustrated above.

THE COMPLETE KIT to construct a 3-valve plus rectifier T.R.F. Receiver for use on 200/250 v. A.C. mains can be supplied at **£5/15/0**, plus 2/6 packing and carriage. Each Kit is complete in every detail, nothing has to be made or improvised. Easy to follow, point-to-point diagrams are supplied, making construction very simple. The Dial is illuminated, and the Receiver housed in its Cabinet, size 12in. × 5in. × 6in., presents an attractive appearance. The valve line-up is : 717A—HF. Pentode VR116 — Detector. ATP4 — Output, and Metal Rectifier. Waveband coverage for the medium and long bands. Choice of 3 Cabinets: Bakelite in Walnut or Ivory, or Wooden (Walnut finish).



MANUFACTURER'S SURPLUS STOCK



5-VALVE SUPERHET RADIO RECEIVER CHASSIS, built to high standards ensuring quality reception. SPECIFICATION:—VALVE LINE-UP: 7S7, 7B7, 7C6, 7C5, 7Y4, 3 WAVEBANDS Long, medium and short. CONTROLS: Tuning, wave change, volume tone control on/off Gram Position on Switch. Pick-up and Extension Speaker Sockets incorporated. For use on 200/250 v. A.C. mains. DIMENSIONS: Length 14¼in., height 11¼in., width 6¼in. Distance between controls, left to right from edge of chassis: 1in., 3in., 6¼in., 3in. Plus 5/- pkg./carr./Ins. **£7.19.6**

The above Receivers less Speaker and Output Transformer. A suitable 10in. Moving Coil Speaker and Output Transformer can be supplied at 29/- extra.

LIMITED QUANTITY

1132A RECEIVER UNITS

COMPLETE WITH CIRCUIT

11-valve Superhet Receiver, covering 100 to 124 Mc/s., using four VR53, two VR56 and VR66, VR67, VS54 and VR57 valves. Fitted with Tuning Meter, slow motion drive, R.F. and I.F Gain. Control, etc. Circuit: R.F. amp. frequency changer, oscillator and stab., 3-IF. amps., B.F.O. Det., first audio and output. Brand new, with circuit diagram.

Price **59/6** *plus 7/6 carriage.*

POWER PACK for above completely wired and tested, will fit on Receiver chassis. Price 50/-. plus 2/6 pkg. and carr.

2 STAGE QUALITY AMPLIFIER
Complete with 10 in. Energised LOUDSPEAKER

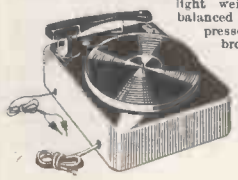
4 watts output. A.C. 110/230 mains.

£6 . 19 . 6

plus 5/- carriage.

DECCA MODEL 33A
DUAL SPEED RECORD PLAYER

Includes crystal pick-up with sapphire stylus and a light weight plastic spring balanced arm. Heavy gauge pressed steel case with brown enamel finish in good quality for operation on A.C. mains 200/250 v. 50 c.p.s. Supplied complete with single head (either standard or long playing). **£4.19.6** Extra Head can be supplied for 19/6. Plus pkg. and carr. 5/-.



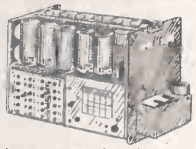
EX-U.S.A. U.H.F. AERIAL

with untuned detector stage, consisting of V.R.92 valve, etc. Brand new, in carton, 5/-.

MAINS NOISE ELIMINATOR KIT

Two specially designed chokes with three smoothing condensers with circuit diagrams. Cuts out all mains noise. Can be assembled inside existing receiver. 5/6 complete.

1124 RECEIVER UNITS



Range 30 to 40 Mc/s. Contains six new Valves 3-9D2, 1-8D2, 1-15D2 (frequency changer), 1-4D1, 24 ceramic trimmers, 6 ceramic valveholders, 6 valve screening cans, 30 resistors, 1-WW Pot. Meter Mica Tubular and Block Condensers, Ceramic coil former. 2 Westector WX6 and 1 Westector WX4, 5-way 4-bank switch with long spindle, I.F. transformers, etc.

17/6 plus 3/6 postage and packing.

1155 RECEIVER UNIT

SLIGHTLY SOILED

In original cases complete with 10 valves. Frequency range 18.5 Mc/s.-75 Kc/s. in 5 wavebands. **£7/19/6.** Plus 10/6 packing and carriage.

POWER SUPPLY UNIT

for above, incorporating output stage. Supplies an output of 250 volts at 80 mA., which is ample for the R1155 with the output stage. Jones plugs for connecting the Power Pack to the Receiver are included. The 6V6 output stage complete with Output Transformer and 6½in. speaker is built into the unit. Price £5/5/-, plus 5/- packing and carriage.

We have a few Brand new R1155 Receivers in original cases, complete with 10 valves. Frequency range 18.5 Mc/s.—75 Kc/s in 5 wave bands. PRICE £11/19/6. Plus 10/6 pkg. and carr.

As a special offer, power supply unit including speaker together with R1155 receiver. PRICE £16.19.6. Plus 15/- pkg. & carr.

R1355 RECEIVER AMPLIFIER

with 5 I.F. Stages for T.V. conversion. Contains 7 VR65's. 1—5U4, 1—VU120, 1—EA50. £1/19/6. Plus pkg. and carriage 10/-.

RF 24 UNITS

Frequencies covered 30-20 Mc/s (10-15 metres). Switched tuning. 5 pre-tuned spot freq. 3/VR65 (SP61) 12/6

RF 25 UNITS

Frequencies covered 40-50 Mc/s (6-7.5 metres), switched tuning. 5 Pre-set positions complete with 3 VR65's. 17/6.

RF 26 UNITS

The ideal short-wave converter for T.V., variable tuning, contains 2—EF54. 1—VR137 37/6.

RF 27 UNITS

Frequencies covered 85-65 Mc/s (3.5-5 metres). Otherwise as RF 26. 37/6.

CORRECT ASPECT WHITE
Rubber Mask—Round or Flat

6in.	8/6	9in.	9/6
12in.	16/11	15in.	27/6

T.V. PRE-AMPLIFIER

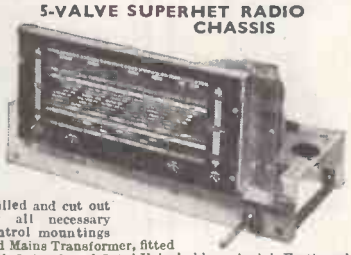
Amplifier Unit Type 208A using 2-VB91 valves suitable for operation on London frequency. Brand new. Plus 1/6 pkg. and carr. **19/6**

ONLY A FEW LEFT—BUY NOW!
THE FAMOUS 'SOBELL' 4-VALVE SUPERHET TABLE RECEIVER
M. & L. WAVEBANDS

Valve line-up: 12J7, 35L6, 1487, 35Z4.
Entirely transportable and unusually sensitive owing to special feed-back circuit employed. Housed in attractive plastic cabinet.
Choice of 2 colours—Brown and Cream.
Carrying handle incorporated in design. For use on 200/250 A.C./D.C. mains.
Plus 5/- Pkg./carr./Ins. **£8.8.0**

Fully covered by Manufacturer's Guarantee

5-VALVE SUPERHET RADIO CHASSIS



Drilled and cut out for all necessary control mountings and Mains Transformer, fitted with 5 Amphenol Octal Valveholders, Aerial, Earth and Gramophone Sockets. 500 pf Tuning Gang Condenser, full vision drive Tuning Assembly consisting of unbreakable Perspex 3-coloured scale for long, medium and short wavebands. Calibrated in metres, kilocycles and station names, price 39/6.

A WORLD-FAMOUS *Manufacturer's Surplus of* RADIO RECEIVER CHASSIS
7-valve RECEIVER

Built to exacting specifications and incorporating features ensuring superlative tonal qualities and world-wide reception. Specification: 8 watts push-pull output using 2 Mazda Pen. 45 valves. Ample negative feedback is applied over all the audio-amplifier. Amplifier Mazda Type HL41DD gives signal Detection A.V.C. and Phase Splitting. Two stages of I.F. amplification 465 Kc/s., using Mazda VP41.
FOUR WAVEBANDS—14 M.-24 M., 24 M.-55 M., 190 M.-600 M., 900 M.-2,000 M.
DIRECT AND VERNIER TUNING. Gram. position on Switch. Provision for external Loudspeaker. For use on 200/250 A.C. Mains. £13/10/-. plus 21/- pkg. and carr.

Famous Manufacturer's Surplus of

ANTI-INTERFERENCE AERIALS
offered at a fraction of original cost

The aerial is designed for reception of long, medium and short waves, with any ordinary or communications receiver, having an input impedance greater than 1,000 ohms long/medium waves and 150 ohms short waves. The installation discriminates against locally generated electrical interference, especially on the short wave bands. The equipment enables the installation of an 8.3 Mc/s flatly-tuned dipole which operates as a "T" aerial on medium and long waves. The aerial and receiver transformers are intended to be interconnected with a 70 ohms co-axial cable.

COMPONENT PARTS

Aluminium Aerial Transformer Assembly. Comprising one each: Aluminium transformer, Transformer clip, Rubber sucker, ¼in. × ¼in. brass screw, 4AB × ¼in. brass bolt, 4BA nut.
Receiver Transformer. Complete with Insulators, clips, etc.; Porcelain Insulators, 2 each, 60ft. Insulated Aerial Wire, 60ft. Screened Co-Axial Down Lead.
Installation instruction leaflet included.
LESS CO-AXIAL CABLE & AERIAL WIRE. 15/-. plus 1/6 pkg. and carr.
COMPLETE **35/-**: plus 1/6 pkg. and carr.

PREMIER RADIO COMPANY

WHY PAY MORE?

WILLIAMSON AMPLIFIER KIT 15gns.
plus 7/6 post, pkg. & Ins.
This kit is absolutely complete and all components are guaranteed exactly to author's specification.

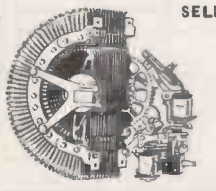
WILLIAMSON OUTPUT TRANSFORMER
(author's spec.), 3.6 ohms. sec. £4.4.0

MAINS TRANSFORMER SP425A (with additional 6.3 v 3 a. and capable of supplying an extra 50 mA. for Pre-amp. or Feeder Unit) £3.7.6

PREMIER MAINS TRANSFORMERS

All primaries are tapped for 200-230-250 v. mains 40-100 cycles. All primaries are screened. All LTs are centre tapped.

SP175B, 175-0-175, 50 mA., 4 v. @ 1 a., 4 v. @ 2-3 a.	25/-
SP350A, 250-0-250, 100 mA., 5 v. @ 2-3 a. 6.3 v. @ 2-3 a.	29/-
SP351, 350-0-350, 150 mA., 4 v. @ 1-2 a. 4 v. @ 2-3 a. 4 v. @ 3-6 a.	36/-
SP352, 350-0-350, 150 mA., 5 v. 2-3 a. 6.3 v. 2-3 a. 6.3 v. 2-3 a.	36/-
SP375A, 375-0-375, 350 mA., 6.3 v. @ 2-3 a. 6.3 v. @ 3-5 a. 5 v. @ 2-3 a.	55/-
SP501, 500-0-500, 150 mA., 4 v. @ 2-3 a. 4 v. @ 2-3 a. 4 v. @ 2-2 a. 4 v. @ 3-5 a.	47/-
SP501A, 500-0-500, 150 mA., 5 v. @ 2-3 a. 6.3 v. @ 2-3 a. 6.3 v. @ 2-3 a.	50/-
SP425A, 425-0-425, 200 mA., 6.3 v. @ 2-3 a. 6.3 v. @ 3-5 a. 5 v. @ 2-5 a.	67/6
250-0-250, 80 mA., 6.3 v. @ 4 a. 5 v. @ 2 a.	19/6
350-0-350, 80 mA., 6.3 v. @ 4 a. 5 v. @ 2 a.	19/6
200-230-250, output 3 v.-30 v. @ 2 a. ..	17/6



SELECTOR SWITCHES

For many uses, including station selection on a Pre-tuned Radio Receiver.

16 way, 53 Position.
24 v. motor driven.

Price **69/6**

Plus 2/6 Pkg. & Carr.

PREMIER VARIABLE IMPEDANCE "MATCHMAKER" M.O.15 OUTPUT TRANSFORMER

Designed to meet the demand for an efficient variable ratio Output Transformer. 11 ratios from 13 : 1 to 80 : 1 all centre tapped and can be used to match any output valves either single- or push-pull. Class "A" "AB1" "AB2" or "B" to any low impedance speech coil or combination thereof. Primary Inductance 60 henries 15 watts audio 100 mA. Price 45/-.

WEYMOUTH MINIATURE I.F. TRANSFORMERS

465 Kc/s., iron cored, permeability tuned, 10/6 pair.

WEYMOUTH MINIATURE COIL PACK

Covering Med./Long/Short wave bands. Iron cored coils, gram position on switch. Dimens.: Height, 1¼in. Length, 3¾in. Width 2¼in. Spindle length 2in. Price 19/6.

MINIATURE TUNING CONDENSERS

2 gang .0005 mfd. with trimmers 6/9

CHARGER TRANSFORMERS

Input 230 v. A.C. Output 12 v. at 1 amp. Completely shrouded. Price 9/11

BATTERY CHARGERS

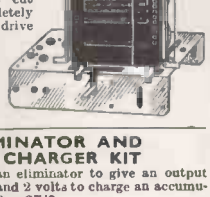
200-250 v. A.C. Will charge 2 v., 6 v. and 12 v. Car Battery at 1 amp. Housed in strong metal casing. Finished in Green hammered enamel. Size: 6in. long, 3¼in. wide, 3¼in. high. Guaranteed 12 mths. The above unit is manufactured by PREMIER and does not contain ex-Govt. components. Plus 2/6 post and pkg. **39/6**

BATTERY CHARGER KITS

All incorporate metal rectifiers. Transformers are suitable for 200/250 v. A.C. cycle mains.
Cat. No.
2002 Charges 6 volt accumulator at 1 amp. Resistance, supplied to charge 2 v. accumulator 21/-
2004 Charges 2, 6 and 12v. accumulators at 1 amp. 24/6

7-VALVE SUPERHET CHASSIS

All control mountings cut out, fitted with completely assembled full vision drive scale, long, medium and short waveband and band spread. Heavy flywheel tuning, 19/6, plus 2/6 pkg. and carr.



H.T. ELIMINATOR AND TRICKLE CHARGER KIT

All parts to construct an eliminator to give an output of 120 volts at 20 mA., and 2 volts to charge an accumulator. Uses metal rectifier, 37/6.

C.R. TUBES

VCR516
9in. Blue picture. Heater volts 4 Anode 4 Kv. In manufacturer's original carton.
£3/19/6. Plus 5/- pkg., carr., Ins.

VCR517C
6½in. picture. This tube is a replacement for the VCR97 and Price 35/-
VCR517. Guaranteed full size picture. Plus 2/6 pkg. carr. ins.

ALL BRAND NEW

AUTO TRANSFORMERS 50 WATTS

Input/Output 0-110-210-220-230-240-250 volts. Plus 1/- P. & P. 7/6

SPECIAL OFFER

THE FAMOUS "CHANCERY" HIGH FIDELITY MICROCELL PICK-UP — TYPE GPX *for Standard and Long Playing*

The Chancery Light Weight GPX Pick-up which has a sapphire stylus which is precision ground and semi-permanent. With two cartridges 1 L.P. and 1 Standard Price 52/6. *Additional L.P. or Standard Cartridges can be supplied from stock at* 19/6 *each.*

★ **QUALITY CRYSTAL PICK-UP ROTHERMEL TYPE U48 26/-**
plus 1/6 Pkg. and Carr.

PORTABLE GRAMOPHONE UNIT

Ready to plug into Radio or Amplifier. Fitted with B.S.R. 2-speed motor 33⅓ and 78 r.p.m. and Chancery high fidelity microcell pick-up type G.P.X. with L.P. and Standard Cartridge. Assembled in rexine covered cabinet. Height 5½"; Length 15½"; Depth 13¾".

Price **£7 . 7 . 0**

plus 5/- Pkg. & Carr.

Cabinets can be obtained separately at 29/6 plus 2/6 Pkg. & Carr. Carrying handle and clips are supplied free.

SPECIAL OFFER—AT ALMOST HALF PRICE PLESSEY GRAMOPHONE UNITS

The Motor, Tone arm, and Magnetic Pick-up is in one Unit, with Automatic stop and start.
For use on 200/250 v. A.C. mains 50 cycles. Limited quantity only. £3/19/6, plus 2/6 packing and carriage.

GARRARD Rim Drive 78 r.p.m., complete with magnetic pick-up and turntable £5.19.6

Packing and carriage on the above units 2/6

THE COLLARO RC3/521 3-SPEED AUTOMATIC RECORD CHANGER

Magnetic Studio head transformer included. Motor suitable for 100/125v. or 200/250 v. Play either 7" or 10" or 7" and 12" not mixed.

Price
£9 . 19 . 6
Plus 5/- Pkg. & Carr.

"MASTERADIO" VIBRATOR PACK

6 v. input. 180 v. 35 mA. output, complete with valve rectifier and leads.
39/6. Plus 5/- pkg., carr.

ACCUMULATORS

Lead Acid Celluloid Non-Spill, 2 v., 7 amps.....	8/6
2 volt 10 amp (by famous maker)	4/11

RECTIFIERS

E.H.T. Pencil Type S.T.C.

Type K3/25	650 v.	1 mA.	4/7
" K3/40	3.2 kV.	1 mA.	6/-
" K3/45	3.6 kV.	1 mA.	8/2
" K3/50	4 kV.	1 mA.	8/8
" N3/160	12 kV.	1 mA.	21/6

H.T. Type S.T.C.

Type RM1	125 v.	60 mA.	4/-
" RM2	125 v.	100 mA.	4/6
" RM3	125 v.	125 mA.	5/6
" RM4	250 v.	250 mA.	18/-

L.T. Type Full Wave

6 v. 1 amp.	4/-
12 v. 1 amp.	8/-
12 v. 2 amp.	10/9
12 v. 4 amp.	15/-

A.C.R.I. C.R. TUBES

5½in. screen. 4 volt Heater. This Electrostatic Tube is recommended as eminently suitable for Television. 15/- plus 2/6 Pkg., carr. and ins. Data sheets supplied.

SUPER QUALITY TELEVISION MAGNIFYING LENS

5in. lens suitable for 6in.	18/6
6in. lens	25/-
10in. lens	£2/10/-
12in. lens	£3/10/-

ALUMINIUM CHASSIS 18 s.w.g.

Substantially made from Bright Aluminium, with four sides

7 × 5½ × 2in. ..	4/-
7 × 3½ × 2in. ..	3/9
9½ × 4½ × 2in. ..	4/3
10 × 8 × 2½in. ..	5/6
12 × 9 × 2½in. ..	7/-
14 × 9 × 2½in. ..	7/6
10 × 9 × 3in. ..	7/-
12 × 10 × 3in. ..	7/9
14 × 10 × 3in. ..	7/11
16 × 10 × 3in. ..	8/3
16 × 8 × 2½in. ..	8/-

ALUMINIUM PANELS 18 s.w.g.

7 × 6in.	1/3	7 × 4in.	1/-
9½ × 6in.	1/8	9½ × 4in./	1/5
10 × 9in.	2/2	10 × 7in./	1/11
12 × 9in.	2/8	12 × 7in.	2/5
14 × 9in.	3/2	14 × 7in.	2/11
16 × 9in.	3/8	16 × 7in./	3/5
20 × 9in.	4/8	20 × 7in.	4/5
22 × 9in.	5/2	22 × 7in.	4/11

LOUDSPEAKERS

ELAC—2½in. dia., Moving Coil, 15 ohms imp.	15/-
PLESSEY—3in. dia., Moving Coil, 3 ohms imp.	9/11
ELAC—3½in. dia., Moving Coil, 3 ohms imp.	15/-
ELAC—5in. dia., Moving Coil, 3 ohms imp...	15/6
ELAC—8in. dia., Moving Coil, 3 ohms imp.	19/6
PLESSEY—8in. dia., Mains Energised, 3 ohms imp. (600 ohms field), with Pentode Transformer	22/6
PLESSEY—8in. dia. Mains Energised, 3 ohms imp. (600 ohms field)	19/6
PLESSEY—10in. dia. Moving Coil, 3 ohms imp.	23/6
GOODMANS—12in. dia., Moving Coil, 15 ohms Plus 5/- packing and carriage.	£8/8
VITAVOX—K12/20 12in. dia., Moving Coil, 15 ohms imp..... Plus 5/- packing and carriage.	£11/11

SPECIAL OFFER

A 12in. TRUVOX P.M. SPEAKER
(2-3 ohm Voice Coil) For only
These are brand new in Maker's Cartons **47/6**
Plus 2/6 *Pkg. and Carr.*

METERS

Large stocks available, a few of which are enumerated below :—

Full Scale Deflection	Scale Length in.	External Dimensions in.	Movement	
25 A	1½	2½ round ..	R.F. Thermo ..	7/6
3.5 A	1½	2½ × 2½	R.F. Thermo ..	7/6
4 A	1½	2½ × 2½	R.F. Thermo ..	7/6
20 A	1½	2½ round ..	M/C	8/6
40 A	1½	2½ round ..	M/C	8/6
1.5 mA ..	1½	2½ round ..	.....	12/6
5 mA ..	2	3½ round ..	.....	7/6
6 mA ..	2	3½ round ..	.....	16/9
50 mA ..	1½	2½ × 2½	M/C	7/6
20 V	2	2½ × 2½	M/C	8/6
40 V	1½	2½ × 2½	M/C	8/6

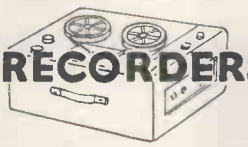
MOVING COIL METER

A super quality Moving Coil Meter basic movement 2 mA Scale dimensions 2½in. Overall dimensions 2½in. dia. 1½in. deep. Bakelite Case projecting type. At present scaled 1 amp. R.F. By removing thermo couple, reversing scale and recalibrating the meter, a high grade test instrument with any range above the basic F.S.D. may be built up. Price 4/9

Germanium Crystal Diodes. G.E.C. wire ended, 2/6 24/- doz.

CLASSIC EXAMPLES of HIGH-FIDELITY EQUIPMENT and COMPONENTS

TAPE RECORDERS ETC



	PRICE £ s. d.	DEPOSIT £ s. d.
COMPLETE INSTRUMENTS		
580/1 Ferrograph Model 2a (as available)	79 10 0	27 0 0
580/2 G.B. Standard	99 10 0	33 5 0
580/A Vortexion with Wearite Deck	84 0 0	28 0 0
581/2 Grundig 2-speed	84 0 0	28 0 0
581/8 R.M.C. with new Lane Tape Desk	47 10 0	16 0 0
TAPE DESKS		
585 Lane Mark IV	17 10 0	6 0 0
586 Truvox, Mark III*	23 2 0	8 2 0
587/1 Wearite, Type 2A*	35 0 0	12 0 0
587/2 Wearite, Type 2B*	40 0 0	14 0 0
588/1 Bradmatic, Type 5 and 5RP*	41 0 0	14 0 0
588/2 Bradmatic, Type 5c*	45 10 0	15 10 0
588/3 Bradmatic, Type 5/6RP*	42 0 0	14 0 0
588/4 Bradmatic, Type 5CL*	47 10 0	16 10 0
588/5 Bradmatic, Type 5D*	50 0 0	17 0 0
Equipped for half-tape recording.		
MICROPHONES		
553 Reslo VMC (Moving-coil)	6 0 0	
554 Reslo R.V. Ribbon	9 0 0	
557 Grampian Moving-coil	5 17 6	
560 Cosmocord Mic/30 Desk Model Crystal	2 10 0	
561 Cosmocord Mic/22-1 Acos Crystal	4 4 0	
563 Cosmocord Mic/16-2 Acos Crystal	12 12 0	
565 Lustraphone C.H.51 Hand Model, Moving-coil	5 15 6	
566 Lustraphone L.X.55 Crystal Model	2 10 0	
Stands of all types available.		
T.R. AMPLIFIERS		
592/1 Lane Amplifier Kit, K-A.-1/R.P.	13 10 0	4 10 0
592/2 Lane Amplifier Assembled	15 10 0	5 5 0
593/1 Elpico Junior Amplifier	16 16 0	6 0 0
593/2 Elpico Senior Amplifier	24 0 0	8 0 0
594 Bradmatic C.I. with Push/Pull O/P	62 0 0	21 0 0
593 C.J.R.C.P./1 with P/P O/P	24 12 0	8 5 0
595/1 C.J.R. Professional Type P.A.I.	94 0 0	32 0 0
MOTORS		
520 Collaro Clock and Anti-clockwise	1 18 6	
521 B.S.R. Model S.R.2	1 5 0	
522 B.S.R. Model S.R.1	1 12 0	
523 B.S.R. Model F.P.10	1 18 0	
T.R. TAPES		
569 Emitape H60/6, 600ft.	1 1 0	
570 Emitape H60/12, 1,200ft.	1 15 0	
570 Emitape H65/12, 1,200ft.	1 15 0	
572 G.E.C. Plastic, 1,200ft.	1 10 0	
573 Gevaert, 1,200ft.	2 0 0	
574 Agfa 1,200ft.	1 17 6	
576 Magnetophon, 1,200ft.	2 0 0	
576 Ferrotape (Wearite), 1,200ft.	2 5 0	
577 Ferrotape (Wearite), 1,750ft., 8½in.	3 3 0	

And our vast and varied range of apparatus and equipment, possibly the largest in the country, is backed by the famous Classic pre-sales test scheme, whereby every piece of apparatus is thoroughly tested before despatch and guaranteed by our own highly skilled technicians, thus enabling us to give a firm guarantee.

The outright purchase of equipment can be a heavy item, but that is no reason why you should not straight away have the best of gear available by Classic H.P. Here are a few examples showing deposits in relation to the full cash purchase price.

DISK EQUIPMENT

	PRICE £ s. d.	DEPOSIT £ s. d.
MOTORS AND PICK-UPS		
CONNOISSEUR		
400 3-speed motor	21 17 3	7 10 0
400/1 3-speed motor with pick-up and one head	27 16 6	9 5 0
GARRARD		
401 Autochanger RC 80 less pick-up heads	15 1 6	5 0 0
401/1H Autochanger RC.75A with 2 Decca XMS heads	18 17 8	6 5 0
COLLARO		
402 Autochanger Model 3RC.531, 3-speed less pick-up head	12 3 1	4 5 0
402/6 A.C. Motor 5/534, 3-speed	6 5 4	2 5 0
DECCA		
403 GU.4C 3-speed motor with crystal turnover pick-up	9 10 0	3 5 0
403/3 Decca transcription motor, 3-speed, Decca XMS pick-up and 2 heads	23 18 2	8 0 0
B.S.R.		
405 M.U.10 3-speed motor	3 18 7	1 5 0
405/2 GU.4 3-speed motor with turnover crystal pick-up	9 9 0	3 5 0
PLESSEY		
406 Plessey 3-speed Autochanger unit, with pick-up. Special price, limited number	10 10 0	3 10 0
E.M.I.		
407 E.M.I., 3-speed, type 2125	17 2 6	5 15 0
AMPLIFIERS, TONE-CONTROLS ETC.		
100 Leak, T.12 Standard	28 7 0	9 10 0
101 Quad, with control unit	35 0 0	11 15 0
103 Goodsell M.A.15	19 10 0	6 10 0
104 Rogers Baby de Luxe	14 0 0	4 15 0
150 Leak "Vari-slope"	12 12 0	4 5 0
151 Goodsell Type U/TC	8 15 0	3 0 0
151/1 Goodsell Type F/U/TC	14 14 0	5 0 0
151/2 Goodsell Type P/FA	18 0 0	6 0 0
152 Rogers Junior de Luxe, Mk. II	9 0 0	3 0 0
153 Lowther Master Control Unit	20 0 0	6 15 0
LOUDSPEAKERS		
WHARFEDALE		
601/2 W.12	9 5 0	3 5 0
601/3 W.12/C8	9 15 0	3 5 0
601/4 Super 12in./CS/AL	16 0 0	5 10 0
GOODMANS		
603/1 Axiom 150/2	10 5 9	3 10 0
603/2 Audiom 80 15in.	22 10 0	7 10 0
603 Audiom 60	8 12 6	3 0 0
TANNOY		
606 Tannoy 12in. Dual Concentric, with built-in crossover network	27 10 0	9 5 0
LOWTHER VOIGT		
607 Lowther Voigt PM/2 Drive unit	35 0 0	12 0 0
VOIGT		
608 Voigt P.M. Pressure Unit	42 0 0	14 0 0

The items shown here represent but a small proportion of our regular stock, which includes radio-feeder units, complete radio units etc.

CLASSIC ELECTRICAL CO LTD

352-364 LOWER ADDISCOMBE ROAD · CROYDON · SURREY TEL · ADDISCOMBE 6061-2

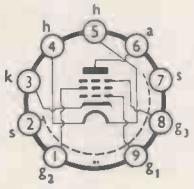
VALVES FOR TAPE RECORDERS

Service in tape recorder amplifiers makes stringent demands on the valves used, particularly in the early stages.

Operation in high gain circuits with a considerable degree of bass boost, and in a confined space in close proximity to a loudspeaker, places a premium on freedom from microphony and hum.

The typical Osram valve line-up shown has proved entirely satisfactory in practice for tape recorder applications. The use of the Z729 low noise pentode, allied with a suitable circuit layout, ensures the virtual elimination of induced hum.

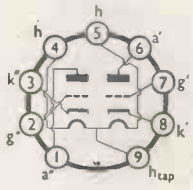
INPUT STAGE
Z729
low noise pentode



V_h	6.3V
I_h	0.2A
V_a	250V
V_{g2}	140V
g_m	1.85m/AV
V_{hum}	1.5μV
$R_{g_1\text{-}k}$	=470kΩ

Base B9A

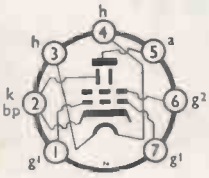
Tone correction and intermediate stages
B309
double triode



V_h	6.3V
I_h	0.6A
V_a	250V
g_m	5.5 mA/V
r_a	10 kΩ

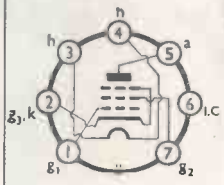
Base B9A

Output and bias oscillator
N727/6AQ5 or N78



V_h	6.3V
I_h	0.45A
V_a	250V
V_{g2}	250V
I_k	50mA
V_{g1}	−12.5V
P_{out}	4.5W

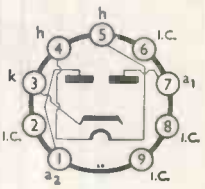
Base B7G



V_h	6.3V
I_h	0.64A
V_a	250V
V_{g2}	250V
I_k	40 mA
V_{g1}	−5V
P_{out}	4W

Base B7G

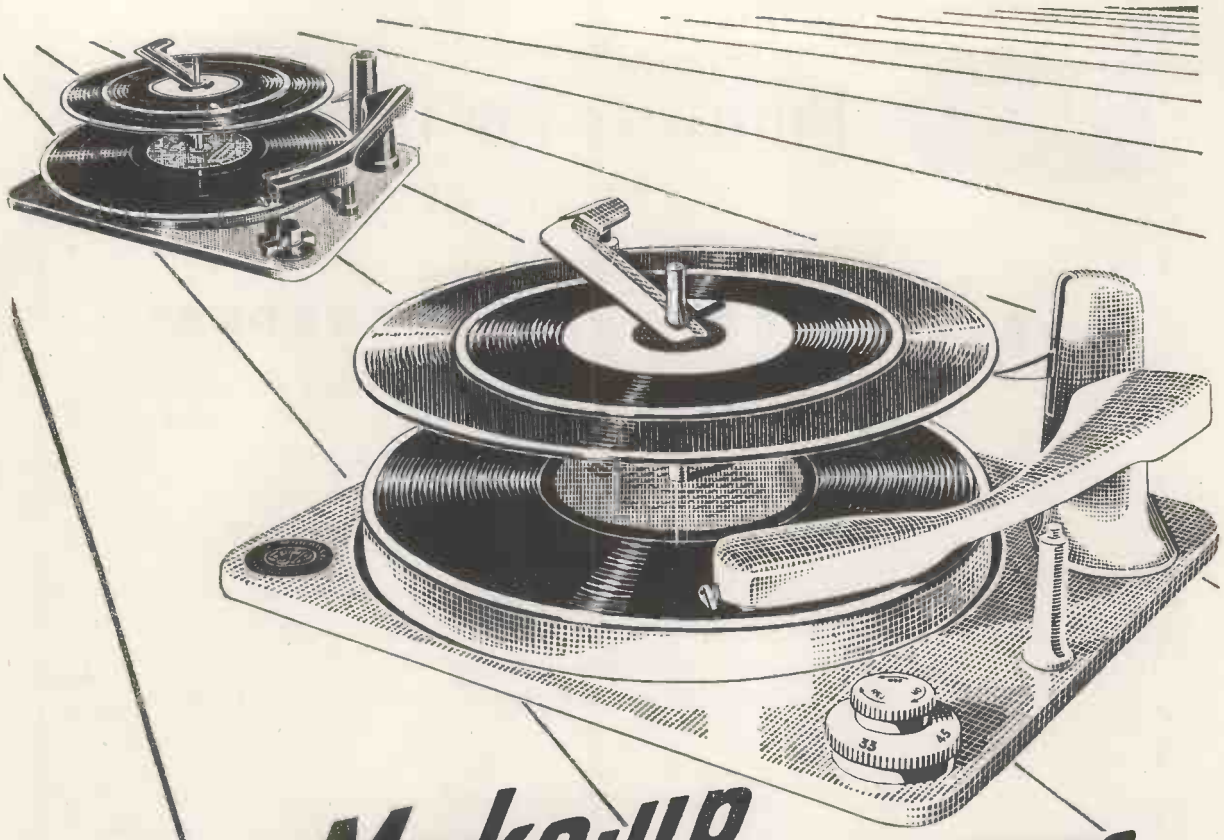
Rectifier
U709
full-wave rectifier



V_h	6.3V
I_h	0.95A
$V_{h\text{-}k}$	450V (max.)
V_{in}	350 rms (max.)
I_{out}	150 mA

Base B9A

The heater-cathode rating of the U709 permits operation from a common 6.3V heater winding



New Make-up for famous features

Everyone knows the Monarch couldn't be better, but the universally acclaimed features have been given a new-look. It's fresher—smoother looking—superfinely finished. In fact it's a new conception that still stars—

★The 'Magidisk'—that exclusive feature of the Monarch that selects any record, any size, in any order.

★The quickest changeover that gives uninterrupted pleasure.

★The hidden music discovered by the BSR dual stylus cartridge.

★The control—so simple—so handy.

That is why it is agreed that the Monarch is the World's Finest and most wanted Auto-changer.

BSR

WORLD'S FINEST AND MOST WANTED AUTOCHANGER

BIRMINGHAM SOUND REPRODUCERS LTD. OLD HILL, STAFFS. ENGLAND

Wireless World

RADIO, TELEVISION AND ELECTRONICS

43rd YEAR OF PUBLICATION

Managing Editor: HUGH S. POCOCK, M.I.E.E.
Editor: H. F. SMITH

FEBRUARY 1954

In This Issue

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VALVES, TUBES & CIRCUITS

14. FULL-WAVE RECTIFIER TYPE EZ80

The new Mullard full-wave rectifier, type EZ80, having a maximum output current of 90 mA, is suitable for the power supplies of most small and medium power amplifiers designed for operation from a.c. mains. It is a miniature all-glass valve having a single-ended construction and a B9A (noval) base. With a heater rating of 6.3V, 0.6A, the maximum peak heater-to-cathode voltage of 500 volts is sufficient to permit the heater of the EZ80 to be supplied from the same 6.3-volt winding on the transformer as the other valves in the amplifier.

CHOICE OF RESERVOIR AND SMOOTHING CAPACITORS. When designing an amplifier it is desirable to know the amount of a.c. ripple which may be superimposed on the direct voltage supplied to the valves. For a particular input voltage and output current the values of ripple and direct voltages depend upon the reservoir capacitance and upon the type of smoothing network. Generally the power supply includes a reservoir capacitor (C1), either an inductance (L) having a resistance (R) or a resistance (R) alone, and a smoothing capacitor (C2). The following table shows typical values of ripple and direct voltages across C1 and across C2 for several standard values of components. The input voltage is 2 x 250V r.m.s. and total output currents of 90 and 60 mA are considered.

In general, the value of the ripple voltage across C2 is inversely proportional to the values of both C2 and C1 whereas the ripple across C1 is only inversely proportional to the value of C1 and not dependant upon L, R or C2. To ensure a low ripple voltage at C2 it is necessary to make both C1 and C2 as large as possible. If further smoothing is desired, as with the supplies to a pre-amplifier stage, it is usual to incorporate this in a form of decoupling in order to isolate this stage.

If large values of capacitance are used it is possible to economise in the design of the amplifier by replacing the smoothing choke by a resistor with little change in ripple voltage. The output voltage from C2 will then be reduced by an amount depending upon the load current and the value of the resistor. In this case the voltages required for the anodes of the output valves may be taken from C1. With a single valve output stage, the ripple across C1 must then be as low as possible. In push-pull stages, if the two output valves are reasonably similar, quite large amounts of ripple can be tolerated as they will be balanced out.

V_a (r.m.s.) = 2 x 250V, I_{out} = 90mA.

C1 (μF)	C2 (μF)	L (H)	R (Ω)	Ripple Voltage across C1 ($V_{r.m.s.}$)	Ripple Voltage across C2 ($mV_{r.m.s.}$)	Direct Voltage across C1 (V)	Direct Voltage across C2 (V)
8	8	10	100	21	450	260	251
8	16	10	100	21	210	260	251
16	16	10	100	10.5	110	263	254
50	50	0	500	3.5	225	265	220
50	50	0	1000	3.5	110	265	175

V_a (r.m.s.) = 2 x 250V, I_{out} = 60mA.

C1 (μF)	C2 (μF)	L (H)	R (Ω)	Ripple Voltage across C1 ($V_{r.m.s.}$)	Ripple Voltage across C2 ($mV_{r.m.s.}$)	Direct Voltage across C1 (V)	Direct Voltage across C2 (V)
8	8	10	100	15	315	283	277
8	16	10	100	15	145	283	277
16	16	10	100	7.5	75	285	279
50	50	0	500	2.5	160	287	257
50	50	0	1000	2.5	80	287	227

From the table it is seen that the conventional network of C1 = 8μF, L = 10H, C2 = 16μF may be replaced by C1 = 50μF, R = 500 Ω, C2 = 50μF with only a slight increase in ripple across C2 from 210 mV to 225 mV and a reduction in the ripple across C1 from 21V to 3.5V. The output voltage across C2 is reduced from 251V to 220V but the anodes of the output stage may be connected to C1, across which is a voltage of 265V.

VALVE DATA

HEATER

V_h	6.3	V
I_h	0.6	A

LIMITING VALUES

$V_{a\ (r.m.s.)}$ max.	2 × 350	V
I_{out} max.	90	mA
C max.	50	μF
$V_{h-k(pk)}$ max.	500	V

BASE

B9A

DIMENSIONS

Max. seated height	61	mm.
Max. overall length	67	mm.
Max. bulb diameter	22.2	mm.

TYPICAL OPERATING CONDITIONS

$V_{a\ (r.m.s.)}$	2 × 250	2 × 275	2 × 300	2 × 350	V
C	50	50	50	50	μF
*R_{lim} min.	125	175	215	300	Ω
I_{out}	90	90	90	90	mA
V_{out}	265	285	310	360	V

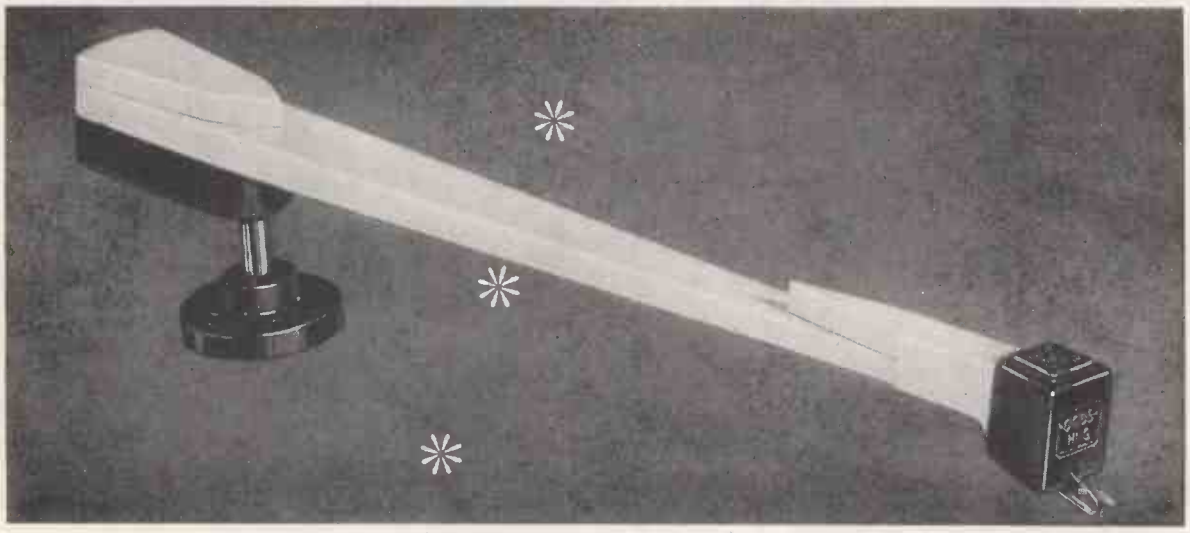
*Per anode.

Reprints of this advertisement, together with additional data, may be obtained free of charge, from the address below

MULLARD LTD., Technical Publications Department, Century House, Shaftesbury Avenue, W.C.2.

MVM 260

Important Announcement



ABOUT acos HGP 40 AND GP 20 PICK-UPS

We will be frank with you. When we evolved the now famous Hi-g pick-up tracking principle, we felt that it called for the introduction of an entirely new pick-up, complete with arm and new style heads. We called this pick-up the HGP 40.

The interest in the HGP 40 has been tremendous, but it is already clear that there are thousands of owners of that most popular of all crystal pick-ups—the GP 20—who wish to bring it up to date by changing the existing head (GP 19 or GP 19LP) for an HGP 40 head (standard or LP). It cannot be done.

However, we bow to public demand. We are discontinuing the HGP 40 as such. Instead, we are now producing the HGP 39-1 (STD. or LP) pick-up head to fit the GP 20 arm. Its response will be substantially the same as the HGP 40 and the sapphire stylus is easily replaceable. Its price is £1 12 0, plus 10/3 Purchase Tax.

always well ahead

Acos devices are protected by patents, patent applications and registered designs in Great Britain and abroad.

TO SUM UP:—

HGP 40 Pick-up is discontinued.
HGP 39-1 (STD or LP) Heads are available to modernise the GP 20.
GP 20 fitted with HGP 39-1 head will in future be known as the GP 20/Hi-G.

COSMOCORD LIMITED · ENFIELD · MIDDLESEX

THE "BELLING-LEE" PAGE

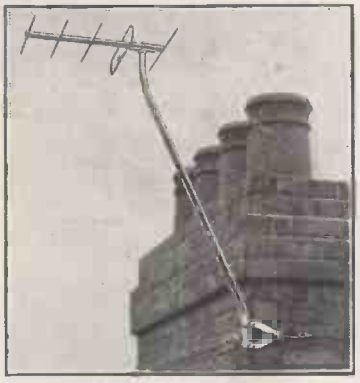
Providing technical information, service and advice in relation to our products and the suppression of electrical interference

Television Developments

Television may or may not develop along the lines with which you agree, but nobody can say that it stands still.

The first alternative programme will be the transmission of "Stills" by the Television Society's experimental transmitter. The aerial was designed by D. N. Corfield, manufactured by "Belling-Lee" and presented to the Society by the company. The range of the transmitter is semi-visual and about 15 miles, covering Central, South and West London. The necessary receiving aerials are available to those who prefer to buy a factory made job rather than make their own.

The Isle of Man Douglas transmitter has brought Christmas cheer to thousands, and one is tempted to enquire as to whether suppressors will be considered a "must" in



next year's Tourist Trophy races on the Island as they are at Goodwood.

A small island is an ideal place on which to launch a suppression campaign, as it is reasonably practical for the organisers to keep a grip on the situation.

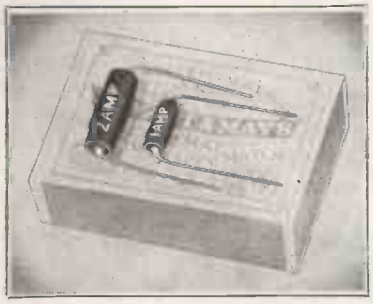
We would like to make it very clear that so far as aerials for the official alternative transmissions are concerned, it is our policy to develop these so that they may be added to an existing aerial in such a way that its good features are retained. Where the normal B.B.C. Television programme is obtainable on an indoor aerial and an outdoor aerial is necessary for the alternative programme, complete installations will be made available. Dimensionally, these new aerials are much smaller, consequently offering less windage, and it will be our aim to design fixings and attachments in such a way as to keep prices at a minimum.

One very important point must be made here. It will be obvious that in designing these additional arrays to be attached to or incorporated in existing aerials, care has been taken to ensure that the addition does not in any way adversely affect the performance or mechanical strength of the aerial to which it is intended to be attached.

It is possible that some viewers will build their own supplementary arrays or attach arrays not manufactured by Belling and Lee Ltd., but such additions if attached to an existing aerial manufactured by Belling and Lee Ltd., will invalidate any guarantee or insurance by Belling and Lee Ltd., which may be in force at the time.

In addition, Belling and Lee Ltd., can accept no responsibility whatever if a supplementary array manufactured by them is attached to an aerial not of their manufacture. Supplementary arrays complete with masts and lashings will be available where a viewer wishes to use one manufactured by Belling and Lee Ltd., although his original aerial may be of another make.

The method of connecting such aerials to receivers or converters has not yet been decided but we are at present discussing this point at Industry level as a very urgent question.



Except for the fact that the alternative stations will probably transmit on band 3, at the time of going to press, no official information is available regarding siting of stations relative to existing B.B.C. transmitters, nor polarisation nor contemplated radiated power.

Suppression of Household Appliances

The ever increasing number of television receivers coming into use emphasises the need for the suppression of household appliances employing fractional horse power motors. It is a fact that the eye is less tolerant than the ear and has a very strong dislike to flashes and distorted pictures.

Suppression of some of the larger pieces of domestic apparatus should be approached with care, as sewing machines, washing machines, refrigerators, etc., may be subject to Hire Purchase agreements which may prohibit their being opened up. The same kind of thing may have to be considered when dealing with appliances where the guarantee might be affected.

Fortunately much may be achieved in many cases without opening up, even in locations famed for bad reception conditions. For example, during a conversation with Mr. Coupland, a service engineer working with Messrs. J. E. Dawson, Bridge Street, Boston, Lincs., he confirmed that sewing machines, etc., are satisfactorily suppressed without tampering with the "innards" by the use of 2 "Belling-Lee" type L.1310 inductors (see illustration) inserted in the mains lead at the motor. These were, in fact, within 2/3 inches of the brushes.

In general, fairly large capacitors are required to suppress interferences on medium and long waves. In the case of a hairdryer or a similar class of appliance, it is often impractical to have these large suppressors either within the appliance housing, or hanging in the lead close to it. In such cases a plug suppressor "Belling-Lee" type L.1308 will probably solve the difficulty. Where both television and medium and long waves have to be considered, and particularly in the case of a "portable" appliance, the flex lead suppressor "Belling-Lee" type L.799 close to the appliance will take care of T.V. suppression, and the plug suppressor L.1308 will protect you on the medium and long waves.

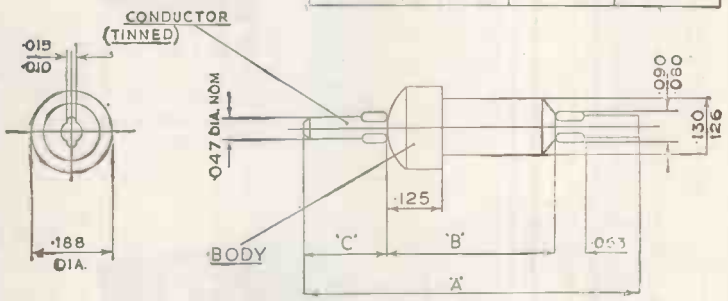
POLYTAGS... lead-through and stand-off insulators

Polytetrafluoroethylene (P.T.F.E.) is an outstanding insulator. It is tough, durable and will not crack or arc. Its dielectric properties are substantially constant over a frequency range of 60 c.p.s. to at least 300 Mc.p.s. and are unaffected by temperature changes between minus 100°C. and plus 288°C. It has zero moisture absorption and is water repellent. It is, therefore, a most suitable material for stand-off and feed-through insulator terminals and has been chosen by Ediswan for this purpose. Ediswan Polytags are available in five types as illustrated below.

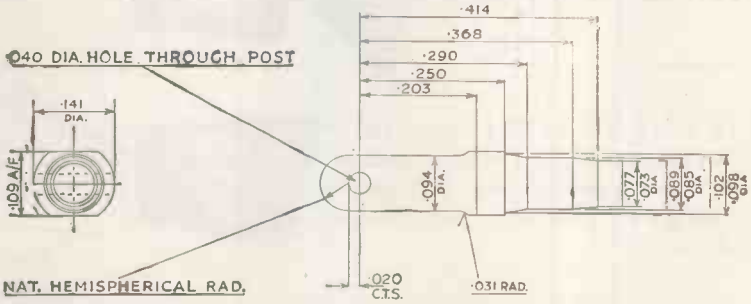
PT 1 & 2. Lead-through

	A	B	C
PT 1	.750	.375	.188
PT 2	.875	.500	.188
PT 3	.563	.375	—
PT 4	.688	.500	—

PT 3 & 4. Stand-off



PT 5. Component mounting



Fixing: Polytags are primarily designed for fixing with a 5 B.A. nut—PT 1—4 or an 8 B.A. nut PT 5. They are self-tapping.

We are equipped to produce components fabricated or moulded in P.T.F.E. to individual specifications and enquiries will be welcomed.

EDISWAN

CLIX

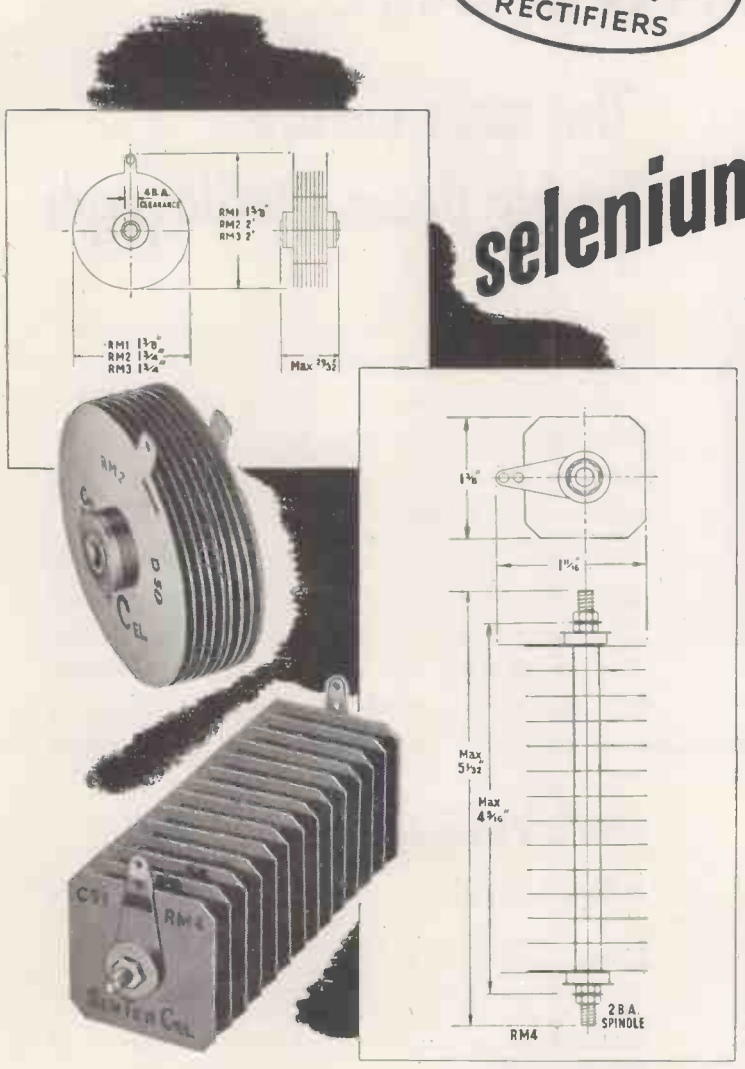
THE EDISON SWAN ELECTRIC CO., LTD.,

Sales Department P.T.F.E.6, 21 Bruton Street, London, W.1. *Telephone: Mayfair 5543* ER24

Head Office: 155 Charing Cross Road, London, W.C.2. *Member of the A.E.I. Group of Companies*

R

10 advantages of SELENIUM SenTerCel RECTIFIERS miniature selenium rectifiers



Compare these outstanding features with those of the rectifiers which at present you are using :—

- **Less wiring**
- **Unlimited instantaneous overload such as the charging current of de-formed electrolytic capacitors.**
- **Far lower heat dissipation.**
- **No "warming-up" period.**
- **No valve-holder.**
- **Practically indestructible in normal service.**
- **No limit to size of electrolytic capacitor.**
- **Saves weight.**
- **Saves space.**
- **Low in cost.**

Study these **RATINGS**

TYPE	RM0	RM1	RM2	RM3	RM4
Maximum ambient temperature	35°C 55°C	35°C 55°C	35°C 55°C	35°C 55°C	35°C 40°C 55°C
Maximum output current (mean)	30mA 15mA	60mA 30 mA	100mA 60mA	120mA 90mA	275mA 250mA 125mA
Maximum input voltage (r.m.s.)	125V	125V	125V	125V	250V
Maximum peak inverse voltage	350V	350V	350V	350V	700V
Max. instantaneous peak current	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
Weight	0.82 oz.	1 oz.	1.4 oz.	2 oz.	4.5 oz.

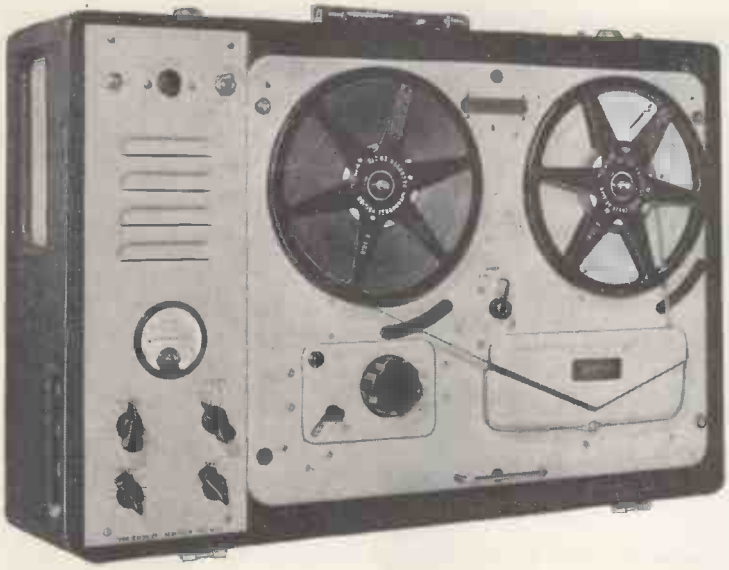
SELENIUM SenTerCel RECTIFIERS

Standard Telephones and Cables Limited

(Registered Office : Connaught House, Aldwych, W.C.2)

RECTIFIER DIVISION: Warwick Road, Boreham Wood, Hertfordshire.
Telephone : Elstree 2401 Telegrams: Sentercel, Borehamwood

VORTEXION TAPE RECORDER



The amplifier, speaker and case, with detachable lid, measures 8¼in. x 22½in. x 15¾in. and weighs 30 lb.

PRICE, complete with WEARITE TAPE DECK £84 0 0

★ The noise level is extremely low and audibly the hum level and Johnson noise of the amplifier and deck are approximately equal. Only 25% of this small amount of hum is given by the amplifier alone.

★ Extremely low distortion and background noise, with a frequency response of 50 c/s.—10 Kc/s., plus or minus 1.5 db. A meter is fitted for the measurement of signal level and bias level.

★ Sufficient power is available for recording on disc, either direct or from the tape, without additional amplifiers.

★ A heavy mu-metal shielded microphone transformer is built in for 15-30 ohms balanced and screened line, and requires only 7 micro-volts approximately to fully load.

★ The .5 megohm input is fully loaded by 18 millivolts and is suitable for crystal P.U.s, microphone or radio inputs.

★ A power plug is provided for a radio feeder unit, etc. Variable bass and treble controls are fitted for control of the play back signal.

★ The power output is 3.5 watts heavily damped by negative feedback and an oval internal speaker is built in for monitoring purposes.

★ Facilities are provided for using the amplifier alone and using power output or headphones while recording or to drive additional amplifiers.

★ The unit may be left running on record or play back even with 1,750 ft. reels with the lid closed.

POWER SUPPLY UNIT to work from 12 volt Battery with an output of 230 v., 120 watts, 50 cycles within 1%. Suppressed for use with Tape Recorder. **PRICE £18 0 0.**

3-WAY MIXER AND PEAK PROGRAMME METER

FOR RECORDING AND LARGE SOUND INSTALLATIONS. ETC.

One milliwatt output on 600 ohm line (.775V) for an input of 30 micro-volts on 7.5-30 ohm balanced input.
Output balanced or unbalanced by internal switch. The meter reading is obtained by a valve voltmeter with 1 second time constant, which reads programme level, and responds to transient peaks.
Calibration in 2 db steps, to plus 12 db and minus 20 db referred to zero level. Special low field internal power pack supplies 8 valves including stabilising and selenium rectifier, consumption 23 watts.

Manufactured by

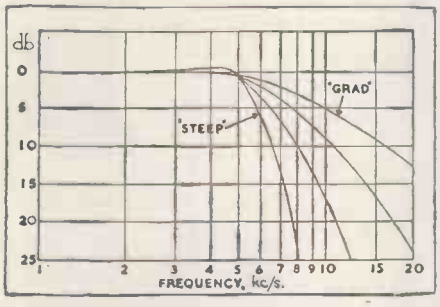
VORTEXION LIMITED, 257-263, The Broadway, Wimbledon, London, S.W.19

Telephones: LIBerty 2814 and 6242-3 Telegrams: "Vortexion, Wimble, London."

LEAK *equipment is* ***unique***—

It is acceptable to professional communications engineers for recording and broadcasting. The B.B.C. use several hundreds of the TL/12 Amplifier, and 1,000 are used by other Broadcasting Corporations.

The Vari-Slope



Frequency amplitude curves for the "TREBLE-3" position (5 kc/s turn-over). Curves of the same slopes are obtained on the other two positions turning over at 7Kc/s and 9Kc/s ("—2" and "—1" positions).

Representing a unique feedback circuit development, the "Vari-Slope" pre-amplifier gives audibly better reproduction. This advance consists of variable slope "electronic" low-pass filters operating on negative voltage feedback principles. No Inductors ("Chokes") are used, and their disadvantages are completely eliminated. The turnover frequencies are 5kc/s, 7kc/s, and 9kc/s, and the slopes of attenuation are continuously variable over the range 5db to 50db per octave.

The filters consist essentially of Twin-T resistor-capacity networks inserted in the return circuit of a single-loop feedback amplifier. The more obvious advantages of this electronic feedback method over conventional choke filters include :—

(a) Improved transient response characteristics (due to absence of chokes having self-capacitance) and the consequent reduction of "ringing."
(b) Extremely low harmonic and intermodulation distortion due to negative voltage feedback action.
(c) No discontinuities in the rates of slope when the slope control is operated, and no change in signal level at frequencies below turnover (Both these faults occur in variable-slope choke filters due to the slope control altering the terminating impedance and the insertion loss.)
(d) No chokes to cause magnetic hum pickup.
(e) Smaller size, lighter weight, greater uniformity in production.

LIST PRICE IN BRITAIN **12 Gns.**

Point-One TL/12

Triple Loop Feedback Amplifier

Used with the "Vari-Slope" pre-amplifier and the best available complementary equipment, the TL/12 power amplifier gives to the music-lover a quality of reproduction unsurpassed by any equipment at any price.

For laboratory use as a stabilised-gain audio frequency power amplifier. For the highest possible standard of disc recording. For the highest possible quality of reproduction from Pickup, Radio, Microphone, Film and Magnetic Tape. For use as a driver amplifier in the speech modulator chain of broadcast transmitters.

27 Gns.

The "Point-One" TL/12 Amplifier is built to a tropical specification and used throughout the world, including:

The British Broadcasting Corporation.
The South African Broadcasting Corporation.
The Swedish Broadcasting Corporation.
The Swiss Broadcasting Corporation.
The Italian Broadcasting Corporation.

Steep-Cutting Filter

For use with the TL/12 power amplifier and pre-amplifiers preceding the Vari-Slope. This filter unit is of particular interest to the record enthusiast.

£5. 10s.

Write for fully descriptive literature.

H. J. LEAK & CO., LTD., BRUNEL ROAD. WESTWAY FACTORY ESTATE, ACTON, W.3

Phone : SHEpherds Bush 1173/4. Telegrams : Sinusoidal, Ealux, London. Cables : Sinusoidal, London.

ELECTRONIC PRECISION EQUIPMENT LTD.

ENAMELLED WIRE
(On wooden reels)

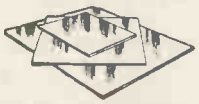
S.W.G.	2 oz. Reel	4 oz. Reel
16	1/4	2/-
18	1/4	2/2
20	1/5	2/4
22	1/6	2/6
24	1/7	2/8
26	1/8	2/10
27	1/9	3/-
28	1/8	2/10
30	1/9	3/-
31	1/10	3/1
32	1/10	3/2
33	1/11	3/3
34	1/11	3/4
36	2/-	3/6
38	2/2	3/10
40	2/4	4/2

TINNED COPPER WIRE

16	1/4	2/-
18	1/4	2/2
20	1/5	2/4
22	1/6	2/6

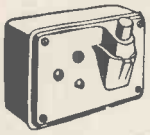
DOUBLE SILK COVERED WIRE

16	1/3	1/10
18	1/3	1/11
19	1/5	2/3
20	1/6	2/6
22	1/8	2/10
23	1/9	3/-
24	1/9	3/-
26	1/11	3/4
27	2/-	3/6
28	2/1	3/8
29	2/2	3/10
30	2/3	4/-
31	2/4	4/2
32	2/6	4/6
33	2/9	5/-
34	2/10	5/2
35	3/-	5/6
36	3/2	5/10
38	3/6	6/6
39	3/9	—
40	4/-	7/6
41	2/3	—
42	2/6	—



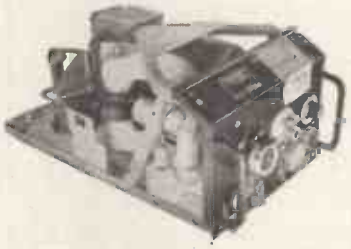
SHEET PAXOLIN
Invaluable for when you are experimenting. Size 6in. × 6in., 1/-. Size 12in. × 8in., 2/-. Size 12in. × 12in., 3/6. Size 24in. × 12in., 6/-.

CLIX 15-AMP. FOOT SWITCH PLUG



Made to B.S.S. specification, shuttered in moulded bakelite, case, 8/6 each.

CHARGING SWITCHBOARD
Feed this Switchboard through a Mains Transformer and Rectifier giving 24 volt D.C. up to 50 amps. and you have an excellent multi-circuit charger for simultaneously charging several batteries at different currents. This is an ex. Government switchboard rated at 550 watts 18 volts fitted into steel cases with doors. It contains three reversed current relays, one voltmeter, one main ammeter, two secondary ammeters and three variable resistors for controlling circuits. These are brand new, in original cases. Price £4/10/-, carriage 10/-.
We can supply a 12 volt, 50 amp. Mains Transformer at £4/5/-, plus 5/- carriage.



COMPLETE 10 C.M. TRANSMITTER RECEIVERS

Type numbers available include T.R. 3548, T.R.3191, T.R.3151. All are priced at £15 each, and contain blower motor, I.F. Unit, suppressor unit etc.

MAGNETRONS
Precision made for RADAR type Nos. CV. 186 and CV.64. Unused, guaranteed. Any not functioning correctly will be replaced. Price £7/10/-. Post and insurance 10/-.

MAGNETRON MAGNET
The correct one for using with the above magnetrons can be used for many other purposes, one such purpose being the making of a magnetic chuck. Price 30/- each, carriage 7/6.

THIS MONTH'S SNIP

This month our special snip is quite a small item but undoubtedly of use to every radio electrical experimenter. It is a wire-wound variable slider resistance which can be locked at any point along its length. The Type Number is CLR.810. Its value is 1,000 ohms but other gauges of wire can be wound on it to make a variable resistor to your special requirements. Price only 1/6, or 6 for 8/-.

SURPLUS BARGAIN CABINETS

For Tape Recorders, Televisors, Radios, Radiograms, etc., are always on show at our branches, Fleet Street, Finsbury Park or Ruislip Manor. The one illustrated we call The Regina. This is a television Consol cabinet, cut out for a 12in. tube, but not drilled. It has an adjustable platform. It is extremely well-finished, walnut veneer and satin polish. Ideal for many constructor sets, View Master, Teleking, etc. Price £7/17/6, carriage 10/-.

This other one is our portable Tape Recorder Cabinet. A Superior cabinet covered with best quality rexine and complete with carrying handle and fasteners. Price is £3, carriage and packing 10/- extra.

GREATLY REDUCED CATHODE RAY TUBES

VCR97. Brand new and unused, ideal for 'scope, etc. Price 12/6. Carriage and insurance 5/- extra.

VCR517. 6½in. guaranteed full picture. 29/6 plus 5/- carriage and insurance.

VCR139A. 2½in., 32/6 plus 2/6 carriage, etc.

VCR138. 3½in. electrostatic short persistence, suitable for T.V. and ideal for 'scope work, 37/6 plus 3/6 carriage, etc.

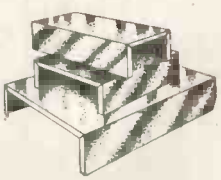
VCR112. 5in. electrostatic, persistence not known, 15/- each plus 5/- carriage, etc.

CV996. 6in. electrostatic, persistence not known, 15/- each plus 5/- carriage, etc.

CV1140, CV1590, CV1546. All 12in. magnetic long persistence £4/10/- plus 10/- carriage.

CHASSIS ASSEMBLY
3 colour, 3 waveband scale covering standard Long, Medium, and short wavebands, scale pan, chassis punched for standard 5 valve superhet, pulley driving head, springs, etc., to suit. Scale size 14½in. × 3½in. Chassis size, 15in. × 5in. × 2in. deep. Price 15/-, plus 1/6 post.
Note: This is the one that fits our £7/10/- Radiogram cabinet and our 37/6 table cabinet.

Complete kit comprises Hi-craft 40 watt control unit starter lamp lamp holders, clips and wiring diagram. Price, less tube, 22/6, plus 1/6 post. With tube, 30/-, plus 3/6 P.P. Tubes 7/6 each, carr. free, minimum quantity 6.



BLANK CHASSIS
18 S.W.G. Aluminium

7 × 3½ × 2	3/9
9½ × 4½ × 2½	5/-
10 × 8 × 2½	5/6
10 × 5¾ × 2½	5/-
10 × 9 × 3	7/-
12 × 9 × 2½	7/-
14 × 9 × 2½	7/6
14 × 10 × 3	7/9
16 × 10 × 3	8/3
16 × 8 × 3	7/9
11½ × 10 × 3	7/6
16 × 12 × 3	8/8
19½ × 9 × 2½	8/3
20 × 10 × 3	10/-
21½ × 9⅛ × 2½	10/6

GARLAND BROS, Ltd.

The "Unitelex Prima" Tape Recorder

57 GNS. OR ON HIRE PURCHASE

(£19/19/- Deposit. Balance by 6 monthly instalments of £7/3/- or 12 monthly instalments of £3/13/2.)

TAPE DECK : Truvox Mk. III. 3-motor Twin Track Two Speed (3¾in. per second and 7½in. per second). **AMPLIFIER** : Unitelex PR3A. Valves EF40, 12AX7, EL41, EL41, EM34. Separate power pack with full-wave metal rectifier system for robustness and instantaneous brake operation. **CONTROLS** : Bass control (boost) operative on both record and playback ; treble control (boost and cut) operative on playback ; volume control. **INPUTS** : Low Gain 20mv. across 1 megohm, used for recording from Radio, Television and Gramophone. High Gain 100μV across 2 megohm, used for recording from microphone. **FREQUENCY RESPONSE** : 50 Cycles—10 Kc/s ± 3 db on recording. 30 Cycles—14 Kc/s ± 1 db on direct playback. **OUTPUT** : 4 watts. **L/SPEAKER** : High—Flux 10in. elliptical speaker—provision for feeding up to 2 extension speakers ; switch for muting internal speaker if desired. **RECORD LEVEL INDICATION** : Magic eye. Direct Playback available for playing records from Gramophone unit or as direct microphone amplifier. A.C. Mains only, 200/250, 50 cycles. Supplied complete with microphone and tape. Weight 35 lbs Dimensions : Height 18¼in., Width 17¼in., Maximum Depth 10in. Send 2½d. stamp for illustrated brochure.

TAMSA TYPE 100 TAPE RECORDING HEADS. As used by the leading commercial tape recorder manufacturers. Housed in chromium plated brass case on adjustable mounting. Record/playback heads have ¼-thou. gaps and erase heads have 2.5 thou. gaps. These heads are of high impedance. Price 45/- each.

"HERALD" TAPE RECORDER. 8in. Speaker, 2 Inputs with mixing controls, Lane Tape Table, Single tape speed twin track recording. Fast rewind and forward speeds. 48 Gns. or on H.P. Send 2½d. stamp for brochure.

MAGNETIC TAPE. Now available, the new Scotch Boy High Coercivity Tape MC2-111, with higher output and signal-to-noise ratio. Price 35/- per 1,200ft. reel. Still available : Scotch Boy MCI-III : 1,200ft., 33/- ; 600ft., 21/- ; 300ft., 12/3. Spare 7in. spools, 4/3. Ferrovoice, the new kraft-based medium coercivity tape : 1,200ft., 22/6. Spare 7in. spools, 4/6. Magnetophon Tape : £2 per 1,200ft. reel.

BRENETTE MICROPHONES. Large sales of these popular microphones have enabled us to make substantial reductions in the prices. The following range is available : **Type 9ND** : Multi-directional ball-type, in black and chrome, £2/2/-, post 2/-. **Type 7D** : Directional type, for instrumental or vocal use ; black and chrome, £3/15/-, post 2/6. **Type 11A** : A wide-frequency-response microphone, in brown cast case with chrome grille, £5/5/-, post 2/6. **Type 13U** : A highly sensitive studio microphone with outstanding frequency characteristics. Flexible mounting enables it to be used directionally or not as required. Black and chrome finish, £6/6/-, post 3/6.

EXAMPLES OF OUR "EASY PAYMENTS" TERMS

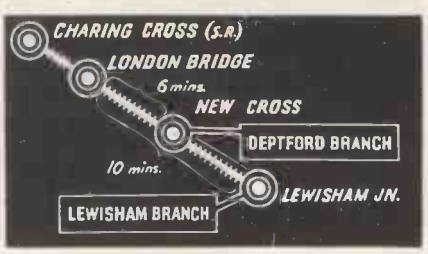
ARTICLE	Cash Price	Deposit	6 monthly payments	12 monthly payments
T.V. Enlargers. 9in.	£2 10 0	16 8	6 2	—
T.V. Enlargers. 12in.	£3 10 0	£1 3 4	8 8	—
De Luxe T.V. Enlargers. 12in.	£3 15 0	£1 5 0	9 2	—
Bremi Microphone 7D	£3 15 0	£1 5 0	9 2	—
Tamsa R/P & Erase Head	£4 10 0	£1 10 0	10 9	—
Amplion Testmeter. 10 ranges A.C.-D.C.	£5 0 0	£1 13 4	12 3	—
Bremi Microphones 11A	£5 5 0	£1 15 0	12 10	—
Three 1,200ft. reels Scotch Boy Tape	£5 5 0	£1 15 0	12 10	—
Black & Decker ¼in. Universal Drill	£6 5 0	£2 1 8	14 11	7 8
Collaro AC514	£6 5 11	£2 2 0	15 1	7 10
Bremi Microphone 13U	£6 6 0	£2 2 0	15 1	7 10
Goodmans Axiom 101. 8in. L/Spkr.	£6 12 1	£2 4 1	15 9	8 1
Garland Amplifier AC11A	£6 12 6	£2 4 2	15 9	8 1
Collaro AC47	£6 13 4	£2 4 6	15 11	8 2
Wharfedale Golden CBS. 10in. Speaker	£8 6 7	£2 15 7	19 11	10 2
Goodmans Audiom 60 Speaker	£8 12 6	£2 17 6	£1 0 8	10 7
B.S.R. 3-speed single player. GU4	£9 5 0	£3 1 8	£1 2 2	11 4
Connoisseur Pick Up, 2 heads	£9 5 6	£3 1 10	£1 2 2	11 4
Leak Pre-amplifier	£9 9 0	£3 3 0	£1 2 7	11 7
Wharfedale W12/cs. 12in.	£9 15 0	£3 5 0	£1 3 4	11 11
Goodmans Axiom 150, Mk. II	£10 5 6	£3 8 6	£1 4 7	12 7
Leak "Varislope" Pre-amplifier	£12 12 0	£4 4 0	£1 10 2	15 6
Garrard 3-speed Auto-changer. R.C.75A	£15 8 1	£5 2 8	£1 16 10	18 10
Garland Amplifier AC IV	£15 15 0	£5 5 0	£1 17 8	19 3
B.S.R. "Monarch" 3-speed Auto-change	£16 10 3	£5 10 1	£1 19 6	£1 0 3
Garrard 3-speed Auto-change. R.C.80	£17 1 3	£5 13 9	£2 0 10	£1 0 11
Lane Tape Desk, Mk. IV	£17 10 0	£5 16 8	£2 1 10	£1 1 5
"Unitelex" Record/Playback Amplifier. PR3A	£20 0 0	£6 13 4	£2 7 10	£1 4 6
Connoisseur 3-speed unit	£21 17 3	£7 5 9	£2 12 3	£1 6 9
Truvox Tape Deck, Mk. III	£23 2 0	£7 14 0	£2 15 3	£1 8 3
Leak "Point One" Amplifier	£28 7 0	£9 9 0	£3 7 9	£1 14 8
Q.U.A.D. Amplifier with pre-amplifier	£35 0 0	£11 13 4	£4 3 8	£2 2 9
Herald Tape Recorder	£50 8 0	£16 16 0	£5 17 8	£3 1 8
Unitelex "Prima" Tape Recorder. (Described above)	£59 17 6	£19 19 0	£7 3 0	£3 13 2

This list is not exhaustive—if your requirements are not here, ask us for H.P. quotation.

ALL GOODS NEW AND UNUSED (except where otherwise stated).

PLEASE ADD POST OR CARRIAGE ON ALL ITEMS. KINDLY PRINT NAME AND ADDRESS. POST ORDERS TO OUR DEPTFORD ADDRESS. EARLY CLOSING THURSDAY. OPEN ALL DAY SATURDAY.

SHOP HOURS: *Mon: Tues: Wed: and Sat: 9 a.m.—6 p.m. Thurs: 9 o m.—1 p.m. Fri: 9 a.m —7 p.m.*



GARLAND BROS. LTD.

CHESHAM HOUSE, DEPTFORD BROADWAY, S.E.8. TEL : TIDEWAY 4412/3

5 OBELISK PARADE, LEWISHAM, S.E.13. TEL LEE GREEN 4038

GARRARD RECORD PLAYERS

For 6 and 12 v. operation, complete with magnetic pick-up and volume control. In metal cabinet size: 17in. × 14in. × 11in. Very limited quantity.

LASKY'S PRICE **£5.19.6**

Carriage 10/- extra.

¼ H.P. ELECTRIC MOTORS

By Famous British Manufacturer. 230/250v. 50 c.p.s. Single phase. 1425 r.p.m. Self starting, standard spindle. Dims:- 8 × 6½ × 6in.

LASKY'S PRICE **99/6**

Brand New and Unused. Carr. 7/6.

HEARING AIDS

By well-known Manufacturer. In metal case, size: 2¼in. × 4½in. × 1in. Complete with batteries and 3 sub-miniature valves, earpiece and cord. Only two controls; volume and on/off. Fitted with internal crystal microphone.

MADE TO SELL FOR 22 GNS.

LASKY'S PRICE **99/6**

Postage 3/6 extra.

Ready for use. Perfect working order. Slightly soiled but new and unused.

TANNOY PRESSURE UNITS

10 watts. 7.5 ohms impedance. Last few only. **PRICE** **59/6**

Carriage 4/6 extra.

R.F. OSC. E.H.T. KIT

Consisting of R.F. oscillator E.H.T. coil with EY51 heater winding, EY51 rectifier, 6V6 valve and base. All necessary condensers and resistances, including .0005mfd. 12.5Kv. smoothing condensers.

LASKY'S PRICE **53/6**

GRAM MOTORS Shaded Pole

Rim drive, synchronous. For 200-250v. 50 c.p.s. Many uses. 9/6.

METAL RECTIFIERS

6 and 12 volt F.W. Bridge.

0.6a.	4/6
2a.	9/-
3a.	9/11
4a.	12/-
6a.	17/6

6 volt Centre Tapped Bridge.

0.75a.	3/9
1a.	3/11

HUGE PURCHASE OF STAINLESS STEEL RECORDING WIRE. ON STANDARD REELS. (By B. & H.)

15 mins.	7/6
30 mins.	12/6
60 mins.	25/-

PORTABLE TAPE RECORDER

Brand new and unused. Perfect working order. Twin track recording, with fast rewind. Valve line up:—2-6V6, 2-6J7, 5Z4 and 6J5. In attractive carrying case, with hinged lid, handle and locks. Size:—17 × 12 × 7in. Supplied with hand microphone, spool of tape and empty take up spool. For 200-250 volt A.C. mains. Circuit available.

LASKY'S PRICE **£34.19.6**

Carriage 15/- extra.

SOLON SOLDERING IRONS

220-250 volts

Latest model instrument iron	19/8
Standard model	19/-

ALL WAVE RADIO INTERFERENCE SUPPRESSOR UNITS, 5/6 each.

R.1155 RECEIVERS

BRAND NEW AERIAL TESTED BEFORE DESPATCH

These well-known ex-Air Ministry Receivers need no further introduction. Supplied complete with 10 valves, and full circuit data.

LASKY'S PRICE **£11.19.6**

USED MODELS **£7.19.6**

A Few Only. Model R1155.N. Covering the shipping band of 1.5-3.0 Mc/s. Price £17.

Carriage 12/6 per unit extra, including 10/- returnable on packing case. 10s. 0d. rebate will be given on power packs for the R.1155 when purchased with the receiver.

Fully Assembled Power Pack and Output Stage, for R1155 Receiver For use on 200-250 volts A.C. mains.

LASKY'S PRICE **79/6**

Carriage 5/- extra.

MUIRHEAD SLOW MOTION DRIVES 8/6

CRYSTAL DIODES

Germanium 1/6 each, post free.

12 VOLT D.C. MOTOR GENERATORS

Output 300 volts at 150 m/A. D.C. 7,500 r.p.m. Size: 2½in. diam. 6in. long.

LASKY'S PRICE **17/6**

I.F. TRANSFORMERS

465 Kc/s Iron dust cores in cans, midget type. Size 1½in. x 1in. x 2½in. By Plessey. Price 8/6 per pair.

WEARITE TYPE 550. 445-520 Kc/s. 8/6 per pair.

WEARITE TYPE 500. 450-470 Kc/s. 8/6 per pair.

TOGGLE SWITCHES. BULGIN

S.P.S.T.	1/6
D.P.S.T.	2/6
D.P. Change over	3/6

TRIPLEX DARK SCREEN FILTERS

14 × 12½ × ⅛in.	7/6
15½ × 13½ × ⅛in.	9/6

Postage and packing 5/- per piece extra. (This charge is necessary owing to extra packing required.)

BRANDENBERG R.F. E.H.T. UNITS

Complete with valves.

6-9 Kv.	£6	6	0
13-16 Kv.	£9	9	0

BAFFLE RADIO CABINETS

Pleasing design, complete with knobs, drilled chassis, dial, drum drive and back. Finish in satin mahogany veneer, natural colour polish. Outside dimensions: 17½in. wide 11½in. high, 5in. deep.

LASKY'S PRICE

36/6

Carriage 2/- extra.

A LASKY'S RADIO ADVERTISEMENT. SEE OVER.

THE SOUNDMASTER

You can now build your own **HIGH FIDELITY TAPE RECORDER** (both tape desk and amplifier) **AT HOME.** Uses precision machined parts and standard radio components. Easily wired and assembled without previous experience.

SEND NOW for 26 page booklet giving full data to build in 6 easy stages, with full size wiring diagrams. All the latest developments in home recording. Lifelike reproduction of voice, music and events. 3 speeds, twin track recording at 3¾in., 7½in. and 15in. per second. Fast forward and fast rewind using 3 motors.

POST FREE **6/6**

BY THE CREATORS OF THE VIEWMASTER

All components in stock. Write for list. Wearite, Bulgin, T.C.C., Collaro, etc.

PRESS BUTTON COIL PACKS

5 Preset stations—3 M.W. and 2 L.W. For use in superhet circuit, with 460 Kc/s. I.F. Size: 3½in. × 5½in. 2½in. Deep. By Famous Manufacturer, complete with circuit, and knobs.

LASKY'S PRICE 21/-.

Postage 2/6.

SENTERCEL RECTIFIERS

RM1	3/10
RM2	4/3
RM3	6/-
RM4	18/-

WESTINGHOUSE RECTIFIERS

250 v. R.M.S.

14A976. 80 m/a 8/6.

14A86. 200 m/a. 20/4.

14A100. 270 v. R.M.S. 200 m/a. 21/6.

CONDENSERS. Electrolytics.

Cans		Tubular	
16 mfd. 500 v.w.	3/6	1 mfd. 200 v.w.	1/-
24 mfd. 450 v.w.	3/11	1 mfd. 250 v.w.	9d.
32 mfd. 500 v.w.	5/11	2 mfd. 150 v.w.	1/-
60 mfd. 350 v.w.	3/6	2 mfd. 350 v.w.	1/6
64 mfd. 450 v.w.	4/11	4 mfd. 350 v.w.	1/3
8+8 mfd. 450 v.w.	3/11	4 mfd. 450 v.w.	1/6
8+16 mfd. 450 v.w.	3/11	8 mfd. 150 v.w.	1/6
8+32 mfd. 475 v.w.	3/11	8 mfd. 350 v.w.	2/-
16+8 mfd. 500 v.w.	4/6	8 mfd. 450 v.w.	1/9
16+16 mfd. 500 v.w.	4/6	15 mfd. 200 v.w.	2/-
16+32 mfd. 450 v.w.	4/9	16 mfd. 350 v.w.	2/3
20+20 mfd. 275 v.w.	2/-	16 mfd. 450 v.w.	2/9
32+32 mfd. 500 v.w.	4/11	16 mfd. 500 v.w.	3/3
32+32 mfd. 350 v.w.	3/11	32 mfd. 350 v.w.	3/6
60+100 mfd. 350 v.w.	7/6	32 mfd. 450 v.w.	4/9
250 mfd. 350 v.w.	4/11	50 mfd. 350 v.w.	4/6
8000 mfd. 3 v.w.	6/11	250 mfd. 12 v.w.	2/-
		8+8 mfd. 350 v.w.	3/-
		8+8 mfd. 450 v.w.	3/11
		12+12 mfd. 350 v.w.	2/6

MANY OTHER TYPES IN STOCK

SPECIAL T.V. CONDENSERS

32 + 100 mfd. 450 v.w. 7/6 .04 mfd. 12.5 Kv. 7/6

Bias

10 mfd. 25 v.w.	1/3
12 mfd. 50 v.w.	1/3
25 mfd. 25 v.w.	1/6
25 mfd. 50 v.w.	1/6
50 mfd. 12 v.w.	1/3
50 mfd. 25 v.w.	1/6
50 mfd. 50 v.w.	1/9
75 mfd. 12 v.w.	1/-
100 mfd. 25 v.w.	2/-
100 mfd. 50 v.w.	2/6

Tubular Waxed

500 v.w., .01, .02, .05, .001, .002, .005, etc. From 6d. each, 5/- doz. .1 mfd. 9d. each.

Miniature Mica

100, 200, 300, 500 PF., 5d. each, 4/- doz.

High Voltage

.1 mfd. 10 Kv.	12/6
.25 mfd. 2.5 Kv.	5/6
.1+.1 mfd. 3.5 Kv.	5/11

T.C.C. VISCONOL HIGH VOLTAGE CONDENSERS

(Cathodray)

.001 mfd. 12.5 kV.	7/6
.001 mfd. 15 kV.	10/-
.001 mfd. 25 kV.	18/-
.0005 mfd. 25 kV.	18/-
.0005 mfd. 12.5 kV.	10/-

Plastic case, single bolt fixing. Other h.v. types.

.1 mfd. 7 kV.	15/-
.04 mfd. 12.5 kV.	7/6

We have a large range of ceramic tube condensers now available.

R.1132.A RECEIVERS

Supplied in maker's original wood transit case. Frequency coverage 100-124 Mc/s. 11 valves: 1 VR65, 1 VR66, 4 VR53, 2 VR54, 1 6J5, 1 VS70, 1 VR57. Large tuning scale with slow motion drive. 0-5 mA. tuning meter. R.F. and L.F. gain controls, jack sockets for line and 'phone. Totally enclosed in metal case, grey enamelled with plated handles. Size: 18 × 10 × 11in. Supplied with all valves, also circuit and calibration chart.

GRADE 1. Brand New 79/6. **GRADE 2.** Soiled 49/6 **GRADE 3.** Secondhand 39/6. Carriage 10/- per unit extra.

TWO-GANG TUNING CONDENSERS .0005MFD.

No. 1. Miniature. With trimmers. Size: 2½in. × 1½in. × 1½in., ½in. spindle. **LASKY'S PRICE, 7/6**

No. 2. Midget. With trimmers. Size: 2½in. × 1⅞in. × 1⅞in., ¼in. spindle. **LASKY'S PRICE 8/6.**

No. 3. Midget. Less trimmers. Size: 2in. × 1⅞in. × 1½in., ¼in. sp ndle. **LASKY'S PRICE 6/6.**

No. 4. Standard type. Size: 2½in. × 2⅜in. × 1⅞in., ¼in. spindle. **LASKY'S PRICE 6/6.**

THREE GANG .0005mfd. Less trimmers. Size: 3½ × 2⅜ × 1⅞in. **LASKY'S PRICE 7/6.**

THE TELE-KING

A practical 5-channel

SUPERHET TELEVISION RECEIVER

16" 17"

Using the new 16 and 17 inch cathode ray tubes and wide angle components for the home constructor.

Complete instructions, wiring diagrams and 32-page descriptive booklet.

6/- POST FREE

ALL COMPONENTS IN STOCK
WRITE FOR LIST

ALLEN WIDE ANGLE COMPONENTS

D.C. 300 latest type Ferroxcube Coils 39/6
GL. 16 Coil 7/6
GL. 18 Coil 7/6
Focus Coil 31/-
FO.305 trans. 21/-
Frame B.O. transformer 15/-
Line EHT. transformer 40/-

CHASSIS

Power pack Sound-vision and Scan chassis. PRICE 11/- each. All other metal work available from stock.

CONDENSERS

All condensers as specified. Manufacturers' surplus £3/16/-.

COILS 13 all exactly as specified. Price 44/6.

RESISTANCES. 72 Resistances, all exactly as specified, 18/-.

CABINET

Walnut veneer, £8/10/-, plus carriage 12/6 extra. As illustrated here.

WIDE ANGLE CATHODE RAY TUBES

14in. MW36–22 ..	£19	9	3
14in. C14B	£20	10	1
16in. MW41–1	£22	4	10
16in. T901	£22	4	10
17in. MW43–64 ..	£23	12	8
17in. C17BM	£24	13	0

Carriage and insurance extra.

OUTPUT TRANSFORMERS

40 mA Multi ratio 4/11
80 mA Multi ratio 14/11
80 mA Pentode 12/6
60 mA Plessey, 6,000 ohms.. 5/11
Standard Pentode 4/11
Pentode 3/6
Midget Pentode 3/6
Miniature Pentode, 3S4, 1S4 3/6
PX4 Intervalve 8/6
5 : 1 Intervalve..... 5/11

R.F. E.H.T. OSCILLATOR COILS. 6-18 Kv. output. Heater winding for EY51. Circuit and full data supplied.

LASKY'S PRICE 25/-.

P.M. LOUDSPEAKERS

All with 3 ohm speech coil

2½in. 15/- 4in. 9/6 6½in. 15/-
3in. 14/6 5in. 14/6 8in. 15/-
10in. 17/6

NEW AVAILABLE 12-inch Goodmans heavy duty speaker. Capacity 15 watts, 15 ohms speech coil impedance.

LASKY'S PRICE £5/19/6. Car 3/6 ex. All loudsprs. offered are first grade and of highest quality construction. Many other types in stock. Send us your reqts. Special offer. 12in. Truvox, 3 ohms. **LASKY'S PRICE 49/6.**

LASKY'S T.V. CONSTRUCTORS' PARCELS

No. 1. All brand new components by Igranic. Comprises E.H.T. flyback line transformer, 7-10Kv. with Ferroxcube core and rectifier heater winding; scanning coils; frame output transformer; Elac focus unit with vernier adjuster, U37 E.H.T. rectifier and brand new 12-inch cathode ray tube with ion trap, mask and glass. **LASKY'S PRICE FOR THE COMPLETE PARCEL, £15/19/6.** Carriage and insurance 15/- extra.

No. 2. The Constructors' Parcel as above, but less the cathode ray tube and ion trap. **LASKY'S PRICE 79/6.** Carr. 3/6 extra.

No. 3. Condenser Parcel. 1 of each :—.04mfd. 12.5Kv.; 32+32mfd. 350 v.w.; 32+100mfd. 450 v.w. AND 24 1,000pf. ceramic tubes; 6 .1mfd. 500 v.w.; .01mfd. 500 v.w. ALSO 12 assorted "pf" condensers of your own choice. **PRICE 45/-.** POST FREE.

No. 4. Complete set of metalwork, as illustrated here. Unassembled. Comprising main chassis, tube supports and valveholders. (Less sound-vision chassis.) **PRICE 25/-.** Carriage 3/6 extra.

No. 5. RESISTANCES. ½ Watt. 85 resistances your choice. **PRICE 18/-.** POST FREE.

No. 6. One of each of the following :—Ion tap IT6; Duodecal tube holder; low impedance line and frame scanning coils. **PRICE 15/-.** Postage 1/6 extra.

Alexandra Palace, Sutton Coldfield, Holme Moss, Wenvoe, Pontop Pike, Belfast, Kirk o'Shotts.

SPEAKER FRET

Expanded Metal. Silver Finish.
12in. × 12in. 3/11
12in. × 18in. 5/11
Plastic White, 12in. × 5in... 2/-
Wire. Bronze, 11in. × 8in... 2/-

SMOOTHING CHOKES

20 mA. 40 H 3/6
40 mA. 8 H..... 3/6
40 mA. 10 H 4/3
100 mA. 10-20 H 7/3
250 mA. 10 H..... 18/6

LASKY'S RADIO

NOTICE TO ALL PURCHASERS OF THE ENGLISH ELECTRIC 16 inch C.R.T. TYPE T.901

The first and only reconditioning service. By English Electric. A reconditioned 16in. metal tube costs £12 and carries maker's full guarantee. Write for further details.

MAINS TRANSFORMERS

All 200-250 v. 50 c.p.s. primary. Finest quality, fully guaranteed.

M.B.A./3. 350-0-350 v. 80 mA., 6.3 v. 4 a., 5 v. 2 a. Both filaments tapped at 4 volts. An ideal replacement trans. Price 18/-.

MBA/6. 325-0-325 v. 100 mA. 6.3 v. 3 a., 5 v. 2 a. With mains tapping board. Price 22/6.

MBA/7. 250-0-250 v. 80 mA., 6.3 v. 3 a., 5 v. 2 a. Both filaments tapped at 4 volts. Price 18/-.

MBA/8. 235-0-235 v. 60 mA., and 6.3 v. 3 a. Price 12/6.

AT/3. Auto transformer. 0-10-120, 200-230-240 volts 100 watt. Price 17/6.

J/RA/3 AMPLIFIER

6 VALVES. 12-15 WATTS OUTPUT. Originally made for talkie film projectors. In carrying case. Chassis size: 14½×10×4 ins. For use on 200-250 volts A.C. mains. Grey crackle finish. Fitted with volume and tone controls. Resistance capacity coupled circuit. Output 2 KT66 in push-pull.

High quality components used throughout. In black rexine covered wood case, size 15½ × 13½ × 9½ ins. giving plenty of room for speaker, etc. Circuit diagram available. Complete with 6 valves, fully assembled and wired.

LASKY'S PRICE £9.19.6 COMPLETE

Carriage 15/- extra.

No. 7. One of each T.V. Mains auto-transformers (type AT/9), 60+100mfd. 350 v.w. condenser; 5H 250 mA. choke; 14A100 rectifier. **PRICE 60/-.** Carriage 2/6 extra.

FILAMENT TRANSFORMERS

6.3 v. 1.5 a., 5/9. 6.3 v. 3 a., 9/6. 6.3 v. tapped at 4 v. 2 amps., 7/9.

Special Transformer. 2 amps. with the following tappings: 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24 and 30 volts. Price 17/6.

COIL PACKS

Medium and 2 short wave bands. Price 16/-. Long. medium and short wave bands. 29/6.

RF25 UNITS. New, with valves. 19/11. Carriage 2/6.

LASKY'S RADIO

Lasky's (Harrow Road) Ltd.,

370 HARROW ROAD, PADDINGTON, LONDON, W.9

(Opposite Paddington Hospital)

MAIL ORDER AND DESPATCH DEPARTMENTS, 485/487 HARROW ROAD, PADDINGTON, LONDON, W.10

Telephones : CUNningham 1979 and 7214. ALL DEPTS. Hours : Mon. to Sat. 9.30 a.m. to 6 p.m. Thurs. half day 1 p.m.

TERMS : Pro forma, Cash With Order or C.O.D. on post items only. Postage and packing on orders value £1—1/- extra £5—2/- extra ; £10—3/6 extra. Over £10 carriage free, unless specifically stated otherwise.

AMPLIFIERS !

TWO COMPLETE KITS OF PARTS

A 4-VALVE QUALITY "PUSH-PULL" 6-8 watt AMPLIFIER for A.C. mains. Incorporating Negative Feedback. Filter Input Circuit and employing 6V6's in Push-Pull. A simple arrangement is provided to enable either a magnetic-crystal or lightweight pick-up to be used, and is suitable for use with Standard or long-playing records. A tone control is incorporated, and the 10-watt output transformer is designed to match 2 to 15 ohm speakers.

The overall size of the assembled chassis is 10in. × 8in. × 7½in. high, and full practical) diagrams are supplied. Price, including drilled chassis and valves, of complete kit, £6/17/6. Price of assembled chassis, supplied ready for use. £8/12/6. Plus 5/- Carr. & Ins. Full descriptive leaflets are available separately for 1/-.

A 12-watt HIGH FIDELITY "PUSH-PULL" AMPLIFIER designed for A.C. mains 200 to 250 volts, employs 6 valves plus rectifier with negative feedback, and comprises a main amplifier chassis and a remote controlled Preamplifier and Tone Control Unit, incorporating four controls—bass, treble, main volume or mixing control, and a radio, gram, microphone, selector switch. This control unit measures only 7 × 4 × 2in. The measured frequency range of the amplifier with this unit shows an excellent response from 14,000 cycles down to 20 cycles, the bass and treble controls allowing independent control of gain at both ends of the frequency range from zero to a gain of 50. It can be seen, therefore that ample correction is provided to suit any type of pick-up with any type of recording. Input voltage for maximum output is 70 mV. 6.3 volts at 2 amps, and 30 mA. H.T. is provided for tuning unit, etc. Price of complete kit, including drilled chassis and valves, £14. Complete specification and layout, 2/-. We can also supply completely assembled and ready for use at £17. Plus 7/6 Carr. and Ins.

THIS AMPLIFIER COMPARES WELL WITH THE WILLIAMSON AND SIMILAR DESIGNS AT A FRACTION OF THEIR COST.

MODERNISE YOUR OLD RADIOGRAM

WITH THE VERY LATEST EQUIPMENT FOR **£25**

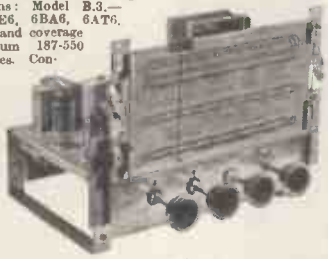
Half the price of comparable commercial 3 speed Auto Radiogram.

THREE COMPLETELY ASSEMBLED ALL-WAVE SUPERHET CHASSIS

- Model B.3. A 5-valve 3-waveband Receiver.
- Model B.3.P.P A 6-valve 3-waveband Receiver with PUSH-PULL OUTPUT.
- Model B.3.P.P./R.F. A 7-valve 3-waveband Receiver incorporating an R.F. stage with PUSH-PULL OUTPUT.

The three Receivers are for operation on A.C. mains 100/200 volts and 200/250 volts, and employ the very latest miniature valves. They are designed to the most modern specification, great attention having been given to the quality of reproduction which gives excellent clarity of speech and music on both gram. and radio, making them the ideal replacement chassis for that "old Radiogram," etc.

Brief specifications: Model B.3.—Valve line-up, 6BE6, 6BA6, 6AT6. 6BW6, 6X4—waveband coverage short 16-50 metres, medium 187-550 metres, long 900-2,000 metres. Controls: (1) volume with on/off; (2) tuning (flywheel type); (3) wave-change and gram.; (4) tone (3-position switch operative on gram and radio). Negative feedback is employed over the entire audio stages. Chassis size: 11 × 7½ × 8½in. high. Dia. size 9½in. × 4½in.



Price complete and READY FOR USE, excluding speaker, £12/12/- (carr. and Ins. 7/6 extra).

Model B.3. P.P. This model is the B.3 Receiver but incorporates two 6BW6 VALVES in PUSH-PULL, resulting in really excellent quality reproduction up to approximately 6 watts. Price £15/15/- (plus 7/6 carr. and Ins.).

Model B.3. P.P./R.F. This model is similar in appearance and has same waveband coverage as the Model B.3, but in addition it incorporates an R.F. STAGE together with PUSH-PULL OUTPUT, employing a total of 7 valves with two type 6BW6 in Push-Pull. This makes for a really sensitive receiver with genuine quality reproduction. Price £18/18/- (plus 7/6 carr. and ins.).

This AUTOCHANGE UNIT by a Famous Manufacturer is offered for £11/14/6

We will supply this 3 speed Autochanger and the Model B.3 Chassis on the left together with a 10in. (or 8in.) PM Speaker for £25 or with the B.3. P.P. for £28/7/6 or with the Model B.3 P.P. / R.F. for £31/5/-. Carr. and Ins. 10/-.

(Plus 7/6 Carr. and Ins.). (Normal price is £16/10/-).

- These units will autochange on all three speeds, 7in., 10in. and 12in.
- They play MIXED 7in. 10in. and 12in. records.
- They have separate sapphires for L.P. and 78 r.p.m., which are moved into position by a simple switch.
- Minimum baseboard size required 16in. × 12½in. with height above 5½in. and height below baseboard 2½in. A bulk purchase enables us to offer these BRAND NEW UNITS at this exceptional price.

The COLLARO 3RC/521 3 Speed AUTO CHANGE UNIT £9/17/6

We will supply this 3 speed Autochanger and the Model B.3 Chassis on the left together with a 10in. (or 8in.) P.M. speaker for £23 or with the B3.P.P. for £26/5/-, or with the Model B.3.P./R.F for £29. Carr. and Ins. 7/6 extra.

(Including Carr. and Ins.) (Normal price is £18/10/-.)

- With separate crystal heads for standard and L.P. records.
- Incorporating pick-up weight adjustment.
- Will autochange on 7in. 10in. and 12in. records not intermixed.
- Minimum Base plate size 15in. × 12½in., with height above 4½in. and below baseplate 3in.

● Brand new in Makers Cartons, complete with Mounting instruction.

The COLLARO 3RC/514 3 Speed Non-Auto Change Unit

£6/19/6

We will supply this 3 speed Record Player and the Model B.3 Chassis on the left together with a 10in. (or 8in.) P.M. speaker for £20, or with the B.3.P.P. for £23/5/-, or with the Model B.3.P.P./R.F. for £26 Carr. and Ins. 7/6 extra.

(Plus 5/- Carr. & Ins.) (Normal price £12/7/6.)

- With the New Autodynamic Hi-Fi Magnetic head and matching transformer.
- Incorporating separate alloy stylii for L.P. and standard records which are moved into position by a simple switch together with pick-up weight adjustment.
- These units are quite new and contained in the makers original cartons complete with Mounting Template.

A COMPLETE KIT OF PARTS TO BUILD A 3-4 WATT HIGH GAIN AMPLIFIER

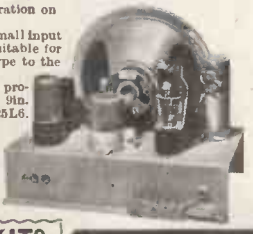
For operation on A.C. or D.C. Mains, 200-250 volts.

This amplifier will give 3 watts output for the small input voltage of only 75 millivolts, and is therefore suitable for use with any type of pick-up from the crystal type to the miniature H/F Magnetic type.

A tone control is incorporated and the quality produced is excellent. The overall size of chassis is 9in. × 5in. × 7in. and valve line-up 25Y5-6sH7-25L6. Price of complete kit, including drilled chassis and valves, £4/2/9, plus 6½in. P.M. (which fits on chassis), 16/-, or 8in. P.M., 18/9.

Price of fully assembled chassis ready for use. £5/5/- (plus cost of speaker).

Copy of assembly instructions and components price list available for 1/3.



The "REGENT" Crystal Hand Microphone 25/6

Plus 1/- Carr. & Ins. Complete with screened lead List Price £2/2/-.

The COLLARO Model A.C. 514 Record Player

£3/19/6

(Plus 5/- carr. and ins.) RIM DRIVE 78 r.p.m. complete with the COLLARO Plug in type MAGNETIC HEAD and 10 inch TURNTABLE. These are COMPLETE BRAND NEW UNITS for A.C. Mains 200-250 Volts.

HALF-WAVE H.T. RECTIFIERS

250 Volts 150 m/a 12/9 ; 250 Volts 250 m/a. 16/9.

The DENCO M.T.O.I. Modulated Test Oscillator £3/15/-

(Plus 2/- carr. and ins.). Has Frequency range continuously variable from 170-475 Kc/s and 550-1,600 Kc/s. Battery operated and thereby completely self contained.

BATTERY CHARGER KITS

All Kits are for A.C. Mains 200-250 Volts. They comprise of a Metal Rectifier and Transformer, tapped for 6 or 12 volt charging, and a tapped Resistor, with Selector Switch, to enable the charging rate to be varied.

For 6 or 12 volt batteries at max. 1 amp.	£1/17/6
For 6 or 12 volt batteries at max. 2½ amp.	£2/5/3
For 6 an 12 volt batteries at max. 4 amp.	£3/2/6

An easily followed Wiring Diagram is included with Each Kit.

VARLEY HEATER TRANSFORMER

Input 200-250 volts. Output 4 volts (centre tapped) 5 amps **14/9** (1/- postage).

When submitting orders, please include post and packing.

STERN RADIO Ltd.

109 & 115, FLEET STREET, E.C.4

Tel.: CENTRAL 5812-3-4

R.S.C. MAINS AND OUTPUT TRANSFORMERS

Fully Guaranteed, Interleaved and Impregnated

FILAMENT TRANSFORMERS
Primaries 200-250 v. 50 c/cs.

6.3 v. 1.5 a.	5/9
6.3 v. 2 a.	7/6
6.3 v. 3 a.	9/6
0-4-6.3 v. 2 a.	7/9
12 v. 1 a.	7/11
6.3 v. 6 a.	17/6
0-2-4-5-6.3 v. 4 a.	16/9
12 v. 3 a. or 24 v. 1.5 a.	17/6

CHARGER TRANSFORMERS
All with 200-230-250 v. 50 c/s. Primaries: 0-9-15 v. 1.5 a., **14/9** ; 0-9-15 v. 3 a., **16/9** ; 0-9-15 v. 6 a., **22/9** ; 0-4-9-15-24 v. 3 a., **22/9** ; 0-9-15-30 v. 3 a., **23/9**. 0-22-23-24 v. 5 a., **19/6**.

TOP SHROUDED DROP THROUGH TYPE
Primaries 200-230-250 v. 50 c/s.

250-0-250 v. 70 mA., 6.3 v. 2.5 a.	12/11
260-0-260 v. 70 mA., 6.3 v. 3 a., 5 v. 2 a.	14/11
350-0-350 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a.	16/9
350-0-350 v. 80 mA., 6.3 v. 3 a., 4 v. 2.5 a.	14/11
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9
300-0-300 v. 100 mA., 6.3 v.-4 v., 4 a., c.t., 0-4-5 v. 3 a.	23/9
350-0-350 v. 100 mA., 6.3 v.-4 v. 4 a., c.t. 0-4-5 v. 3 a.	23/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	29/11
350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a.	29/11

E.H.T. TRANSFORMERS. 2,500 v. 5 mA., 2-0-2 v., 1.1 a., 2-0-2v. 1.1 a., for VCR97, VCR517 or ACR2X 35/-
5,000 v. 5 mA. 2 v. 2 a. 39/6

Primaries 200-230-250 v. 50 c/cs.

FULLY SHROUDED UPRIGHT MOUNTING

250-0-250 v. 60 mA., 6.3 v. 2 a., 5 v. 2 a., Midget type 2½-3-3in.	16/9
350-0-350 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a.	18/9
300-0-300 v. 60 mA., 12 v. 1.5 a., c.t.	18/11
250-0-250 v. 100 mA., 6.3 v.-4 v. 4 a. c.t., 0-4-5 v. 3 a.	25/9
250-0-250 v. 100 mA., 6.3 v. 6 a., 5 v. 3 a., for R1355 conversion	29/9
300-0-300 v. 100 mA., 6.3 v.-4 v. 4 a. c.t., 0-4-5 v. 3 a.	25/9
350-0-350 v. 100 mA., 6.3 v.-4 v. 4 a. c.t., 0-4-5 v. 3 a.	25/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	33/9
350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a.	33/9
350-0-350 v. 160 mA., 6.3 v. 6 a., 6.3 v. 3 a., 5 v. 3 a.	45/9
350-0-350 v. 250 mA., 6.3 v. 6 a., 4 v. 8 a., 0-2-6 v. 2 a., 4 v. 3 a., for Electronic Eng. Televisor	67/6
425-0-425 v. 200 mA., 6.3 v.-4 v. 4 a., c.t., 6.3-4 v. 4 a., c.t., 0-4-5 v. 3 a., suitable Williamson Amplifier, etc.	49/9
425-0-425 v. 250 mA., 6.3 v. 6 a., 6.3 v. 6 a., 5 v. 3 a.	65/6

EX-GOVT. E.H.T. SMOOTHING CONDENSERS

.02 mfd. 5,000 v. Bakelite Tubulars	1/6
.02 mfd. 8,000 v. Cans	1/11
.1 mfd. 2,500 v. Cans	3/6
.1 mfd. plus .1 mfd. 8,000 v., large blocks (common negative isolated)	9/6

SMOOTHING CHOKES

250 mA., 7-10 H. 200 ohms Shrouded	16/9
250 mA., 3 H. 50 ohms	11/9
100 mA., 15 H. 350 ohms	7/6
80 mA., 10 H. 350 ohms	5/6
60 mA., 10 H. 400 ohms	4/11
50 mA., 40 H. 1,000 ohms Potted	10/9

ELIMINATOR TRANSFORMERS

Primaries 200-250 v. 50 c/s. 120 v. 40 mA.	7/11
90 v. 10 mA., 8-0-8 v. 250 mA.	9/11

OUTPUT TRANSFORMERS

Midget Battery Pentode 66 : 1 for 3S4, etc.	3/6
Small Pentode, 5,000Ω to 3Ω	3/9
Standard Pentode, 5,000Ω to 3Ω	4/9
Standard Pentode, 8,000Ω to 3Ω	4/9
Standard Pentode, 10,000 ohms to 3 ohms	4/9
Multi-ratio 40 mA. 30 : 1, 45 : 1, 60 : 1, 90 : 1, Class B Push-Pull	5/6
Push-Pull 10-12 Watts 6V6 to 3Ω or 15Ω	15/9
Push-Pull 10-12 Watts to match 6V6 to 3-5-8 or 15Ω	16/9
Push-Pull 15-18 Watts to match 6L6, etc., to 3Ω or 15Ω Speaker	22/9
Push-Pull 20 Watts high-quality sectionally wound, 6L6, KT66, etc., to 3 or 15Ω	47/9
Williamson type, exact to author's specification	85/-

MICROPHONE TRANSFORMERS

100 : 1	5/9

SILVER MICA CONDENSERS. 5, 10, 15, 20, 25, 30, 35, 50, 100, 120, 150, 180, 200, 230, 300, 330, 400, 470, 500, 1,000pfd. (.001μF), .002 mfd. (2,000 pfd.). All at 5d. each ; 3/9 dozen one type.

DIAL BULBS, M.E.S., 8 v. 0.15 a., 6/9 doz. 6.5 v., 0.15 a., 6/9 doz.

VOLUME CONTROLS with long spindles, all values less switch, 2/9 ; with S.P. switch, 3/9.

WIRE WOUND POTS : 20 ohms, 30 ohms, 1,000 ohms, 5K, 50K (medium length spindles), 2/9. 220 ohms, 2K, 10K, 20K, 50K Preset type, 1/9 ea.
AMMETERS. Moving coil. G.E.C. 0—5 amps., 2in. scale, 11/9.

ELECTROLYTICS (Current production. NOT ex-Govt.).

Tubular Types		Can Types	
8μF 450 v.	1/11	16μF 450 v.	2/9
8μF 500 v.	2/9	24μF 350 v.	2/11
16μF 350 v.	2/3	32μF 350 v.	2/11
16μF 450 v.	2/9	32 mfd. 450 v.	4/9
16μF 500 v.	3/9	40μF 450 v.	4/9
24μF 350 v.	3/3	64 mfd. 450 v.	4/9
32μF 350 v.	3/9	8-8μF 350 v.	3/9
32 mfd. 500 v.	5/9	8-8μF 450 v.	3/11
8-16μF 500 v.	4/11	8-16μF 450 v.	4/6
25μF 25 v.	1/3	16-16μF 450 v.	4/11
50μF 12 v.	1/3	16-16 mfd. 500 v.	5/9
50μF 50 v.	2/3	16-32μF 350 v.	4/9
Can Types		32-32μF 350 v.	4/9
8 mfd. 450 v.	2/3	32-32μF 450 v.	5/11
8 mfd. 500 v.	2/11	64-120 mfd. 350 v.	7/6
16 mfd. 350 v.	1/11		

MISCELLANEOUS EX-GOVT. ITEMS
Slydelock Fuses, 15 amp., 1/9. Bulgin panel mounting Fuseholders (ex-equipt.), 11d. Bulgin octal type moulded Bakelite, 5-pin or 7-pin Plugs and Sockets, 1/11 pr. Earphones (Single), low resistance, 1/3.

EX-GOVT. ACCUMULATORS with non-spill vents. Unused and guaranteed. 2 v. 16 A.H. Size in wood carrying case 9—7—5in., 14/9, plus 2/6 Carr.

P.M. SPEAKERS. All 2-3 ohms. 3½in. Goodmans (Ex New Units) 10/9, 6½in. Elac., 14/11, 6½in. Plessey with Pentode Trans., 14/11, 8in. Plessey, 15/9, 8in. R.A. Heavy duty, 18/9, 10in. Goodmans, 31/-, 10in. Plessey, 18/6, 10in. Rola with Trans., 29/6, 12in. Truvox, 49/9.

M.E. SPEAKERS. All 2-3 ohms, 6½in. Rola field 700 ohms, 11/9, 10in. R.A. field 600 ohms, 23/9. 10in. R.A. field 1,500 ohms, 23/9. 10in. R.A. Field 1,000 ohms, 23/9.

BAKELITE AND WALNUT VENEERED CABINETS

Size approximately 12in. × 6½in. × 5in. Bakelite type available in Brown or Cream. Price of Cabinets, 17/6 ea., carr. 2/6.

Suitable fully punched T.R.F. 3-valve and rectifier chassis	3/9
Suitable fully punched superhet chassis (4 valves and rect.)	4/9
Dial Scales, 2 colour, 2 waveband, station named, glass	1/6
Dial Scales, 3 colour, 3 waveband, station named, glass	1/9
Suitable coloured Metal Backplates	1/3
Pointers, Double ended	4d.
T.R.F. Coils, 2 waveband with circuit	6/9
Drum Drives, complete	2/6

THE SKY CHIEF T.R.F. RECEIVER
A design of a 4 stage, 3 valve 200-250 v. A.C. Mains receiver with selenium rectifier. For inclusion in any of cabinets illustrated above. It consists of a variable Mu high gain H.F. stage followed by a low distortion grid detector triode. The next stage is a further triode amplifier with tone correction by negative feedback. Finally comes the output stage consisting of a parallel connected double triode giving ample output at an extraordinary low level of distortion. Point to point wiring diagrams, instructions, and parts list, 2/6. This receiver can be built for a maximum of £4/16/- including cabinet.

SELENIUM RECTIFIERS

L.T. Types		H.T. Types H.W.	
2/6 v. ½ a.h.w.	1/9	70 v. 20 mA.	2/11
F.W. Bridge Types		90 v. 20 mA.	3/6
6/12 v. 1 a	5/9	120 v. 40 mA.	3/11
6/12 v. 2 a.	9/9	250 v. 50 mA.	5/9
6/12 v. 4 a.	14/9	350 v. 50 mA.	7/9
6/12 v. 6 a.	19/9	250/350 v. 80 mA.	8/9

EX-GOVT. AUTO TRANSFORMERS 50c/cs

15-10-5-0-215-235 v. 200 watts	25/9
Double wound 10-0-200-220-240 v. input, 10-0-270-290-310 v. output 200 watts	27/9

EX-GOVT. MAINS TRANSFORMERS.

All 230 v. 50 c/cs input. 48 v. 1 a. output	9/6
Outputs 250-0-250 v. 40 mA., 6.3 v. 2 a., 5 v. 2 a.	10/9
350-0-350 v. 150 mA. 5 v. 3 a.	17/6

VALVE SCREENING CANS. International Octal 3 piece, 10/6 doz., 1/3 each.

EX-GOVT. SMOOTHING CHOKES

250 mA., 10 H. 50 ohms.	14/9
250 mA. 20 H. 250 ohms. Tropicalised	13/9
250 mA. 10 H. 100 ohms	14/9
250 mA. 3 H. 50 ohms Potted	7/6
150 mA. 10 H. 50 ohms	10/11
100 mA. 10 H. 100 ohms. Tropicalised	6/9
100 mA. 5 H. 100 ohms. Tropicalised	4/6
90/100 mA. 10 H. 100 ohms. Potted	8/9
50 mA. 50 H. 1,250 ohms. Potted type	8/11
70 mA. 5-10 H.	3/9
50 mA. 5-10 H.	2/9

EX-GOVT. T.V. TYPE TRANSFORMERS. All 230 v. 50 c/s input.

1250-0-1250 v. 250 mA. 4v. 3a.	25/-
6.3 v. 6 a., 6.3 v. 6 a., 5 v. 3 a., 5 v. 3 a., 4 v. 3 a.	22/6
278-0-278 v. 80 mA.	7/9
400 v. C.T. 150 mA. 4 v. 6 a., 6.3 v. 6 a., 6.3 v. 0-6 a., 4 v. 6 a., 4 v. 3 a., 4 v. 3 a., 4 v. 3 a., 5 v. 2 a.	22/9

EX-GOVT. BLOCK PAPER CONDENSERS

4 mfd. 500 v.	2/9	4 mfd. 1500 v.	4/9
4 mfd. 750 v.	3/3	10 mfd. 1500 v.	7/9
10 mfd. 500 v.	6/9		

EX-GOVT. CATHODE RAY TUBES
VCR517 (guaranteed full picture) (carr. 5/-) 29/6 ea.
ACR2X (guaranteed full picture) (carr. 5/-) 12/6 ea.

SPECIAL OFFERS. Germanium Crystal Diodes 1/11. Midget Mains Transformers (size approx. 2½ × 3 × 2½in.). Screened Primary 220/240 v. 50 c/s Output, 250-0-250 v. 60 mA, 6.3 v. 2.5 a. Only 11/9.

CO-AXIAL CABLE. 75 ohms ½in., 8d. yard.

EX-GOVT. CATHODE ISOLATING FILAMENT TRANSFORMERS. 6.3 v. to 6.3 v. c.t., 3/9 ea.

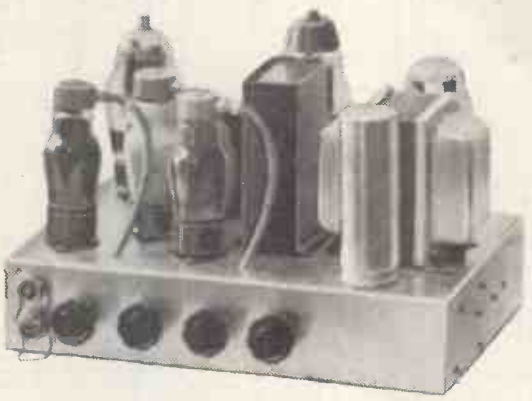
SPECIAL PURPOSE EX-GOVT. VALVES (GUARANTEED)
VR91, 5/9, SP61 (VR65) 2/9, VR56 3/11, 807 6/11, 6J6 10/6, 6SH7Met 6/11, 12SC7GT 6/11, VU120A 2/9, VS110 1/9.

R.S.C. 25 WATT "PUSH PULL" AMPLIFIER

Now firmly established and proving extremely popular, our A11 Quality Amplifier we consider to be the best value in amplifiers offered to-day. The volume of its high fidelity reproduction is completely controllable, from the sound of a quiet intimate conversation to the full glorious volume of a great orchestra. Its sensitivity is so high that in areas of fair signal strength it can be operated straight from a crystal receiver. Entirely suitable for standard or long playing records in small homes or in large auditoriums. For electronic organ or guitar or for garden parties or dance bands.

The kit is complete to the last detail, and includes easy to follow point-to-point wiring diagrams.

Twin volume controls with twin input sockets allow SIMULTANEOUS INPUTS for BOTH MICROPHONE and GRAM, or TAPE and RADIO. SEPARATE BASS and TREBLE CONTROLS giving both LIFT and CUT. FOUR NEGATIVE FEEDBACK LOOPS with 15 db in the main loop from output transformer to voltage amplifier. Frequency response ± 3 db. 50-20,000 c.p.s. Hum and distortion LESS THAN 0.5 per cent. measured at 10 watts. This is comparable with some of the highest priced amplifiers. Six B.V.A. valves, Marconi/Osram KT series output valves. A.C. only, 200-230-250 v. 50 c/cs. input. 420 v. H.T. LINE. Paper reservoir condenser. Compact chassis. Matched components. OVERALL SIZE 14-10-9in. approx. Output impedances for 3 and 15 ohms speakers.



Available in kit form at the amazingly low price of **9 gns.** Plus carriage 5/-

Or ready for use 50/- extra.

R.S.C. MASTER INTERCOMM. UNIT, with provision for up to 4 "Listen—Talk Back Units" individually switched. A high gain amplifier enables speech and other sounds emanating from the rooms containing remote control units to be heard at the master control. The unit is in kit form and point-to-point wiring diagrams are supplied. A walnut veneered wood or Brown Bakelite cabinet is included. Mains input is 200-250 v. 50 c/s. H.T. line 300 v. CHASSIS IS NOT "ALIVE." Ideal also for use as "Baby Alarm." Sound amplification 4 watts. Price only **£5/19/6.** "Listen—Talk Back Unit" as illustration can be supplied at **30/-** each. Full descriptive leaflet 10d.

The Master Unit can be supplied assembled and tested for **30/-** extra.

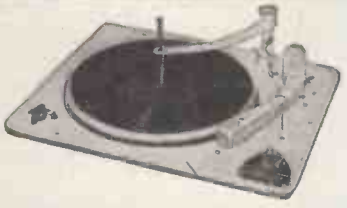
R.S.C. BATTERY CHARGER KITS. For mains input 200-250 v. 50 c/s. To charge 6 v. accumulator at 2 amps., **25/9.**

To charge 6 v. or 12 v. accumulator at 2 amps., **31/6.**

To charge 6 v. or 12 v. accumulator at 4 amps. **49/9.**

ABOVE KITS CONSIST OF BLACK CRACKLE STEEL CASE, MAINS TRANSFORMER, FULL WAVE METAL RECTIFIER, FUSES, FUSEHOLDERS AND CIRCUIT. Due to careful design the use of resistors for regulation of charge has been obviated. The mean charging rates are as indicated above, and complete safety is ensured by fusing of both input and output. Chargers supplied assembled and tested for 6/9 extra.

A PUSH-PULL 3-4 WATT HIGH-GAIN AMPLIFIER FOR £3/12/6, plus carr. 2/6. For mains input 200-250 v. 50 c/s. Complete kit of parts including point-to-point wiring diagrams and instructions. Amplifier can be used with any type of feeder unit or pick-up. Output is for 2-3 ohm speaker. (We can supply a very suitable 10in. unit by Goodmans at **31/-**). The amplifier can be supplied ready for use for **25/-** extra. Full descriptive leaflet 7d.



COLLARO 3-SPEED AUTOMATIC RECORD CHANGERS (brand new), type RC3/521, complete with 2 plug-in Crystal P.U. heads for long playing or standard records 7, 10 or 12in. Not intermixed. Mains input 200-250 v. Limited number available at only **£9/15/-,** plus carr. 5/-.

COLLARO 3-SPEED RECORD PLAYER UNIT. Type RC3/514, complete with Orthodynamic Pick-up, and matching transformer. Separate Stylii for long playing or standard records are moved into position by a switch which also makes necessary weight adjustment. Mains input 200-250 v. A.C. Brand new in Makers cartons, **£6/19/6,** plus 5/- carr.

COLLARO RECORD PLAYER UNIT. Type AC/514. Standard 10in. turntable. Speed normal 78 r.p.m. Crystal pick-up. Mains input 200-250 v. A.C. Brand new cartoned **£3/19/6,** plus 5/- carr.

COLLARO GRAM MOTORS, TYPE AC37. Governor controlled at 78 r.p.m. Mains input 110-200-230-250 v. Shaded pole type, **35/-.**

COLLARO TAPE DESK MOTORS. Shaded pole type. Clockwise or anti-clockwise. Mains input 110-200-250 v., **31/6.**

R.S.C. TONE CONTROL-PRE-AMP. UNIT. A complete set of parts for the construction of a very efficient but simple pre-amplifier and tone control unit. Suitable for use with any amplifier and pick-up. Fil. supply is self-contained. Overall size is 7½-5-5½in. approx. Full descriptive leaflet **9d.** Price including wiring diagrams **37/6.**

Or ready for use **15/-** extra.

CHASSIS

18 s.w.g. undrilled aluminium amplifier type (4 sided)	
12in. × 9in. × 2½in.	6/11
14in. × 9in. × 2½in.	6/11
14in. × 10in. × 3in.	7/11
16in. × 10in. × 3in.	8/3
18 s.w.g. aluminium, receiver type. 6in. × 3½in. × 1½in.	1/11
7½in. × 4½in. × 2in.	2/9
10in. × 5½in. × 2in.	3/3
11in. × 6in. × 2½in.	3/11
16 s.w.g. aluminium, receiver type, 12 × 8 × 2½in.	5/3
16in. × 8in. × 2½in.	7/6
20in. × 8in. × 2½in.	8/11
16 s.w.g. aluminium, amplifier type, 4 sided.	
12in. × 8in. × 2½in.	7/11
16in. × 8in. × 2½in.	10/11
20in. × 8in. × 2½in.	13/6
14in. × 10in. × 3in.	13/6

PERSONAL SET BATTERY SUPERSEDER KIT. All parts for an "All Dry" Battery Eliminator

Complete with case. Supplies 90 v. 10 mA. and 1.4 v. 250 mA. fully smoothed, from normal 200-250 v. 50 c/s. mains. For 4-valve superhet receivers. Price with circuit **35/9.** Or ready for use **42/6.** Size of unit 5½-4-1½in.

BATTERY SET CONVERTER KITS. All parts for converting any type of battery receiver to all mains. A.C. 200-250 v. 50 c/s. Kit will supply fully smoothed H.T. of 120 v. 90 v. or 60 v. at up to 40 mA., and fully smoothed L.T. of 2 v. at 0.4 a. to 1 a. Price complete with circuit and instructions only **48/9.** Supplied ready for use for **7/9** extra.

H.T. ELIMINATOR AND TRICKLE CHARGER KIT. Consists of h.t. and l.t. transformer, h.t. and l.t. rectifiers, smoothing electrolytic choke, and steel case. For mains input of 200-250 v. Output 120 v. 40 mA. and 2 v. ½ a. Price with circuit **29/6.**

Or in working order, **37/6.**

RADIO SUPPLY CO. (LEEDS) LTD.

32 THE CALLS, LEEDS 2

Terms C.W.O. or C.O.D. No C.O.D. under £1. Postage 1/1 extra under £1, 1/9 extra under £3. Full Price List 6d. Trade List 5d.

Open to Callers: 9 a.m. to 5.30 p.m. Saturdays until 1 p.m.

MAINS TRANSFORMERS

Primary, 200-250 v. P. & P. 2/-. 300-0-300 100 mA., 6 volt 3 amp., 5 volt 2 amp., 22/6.

Drop thro' 350-0-350 v. 70 mA., 6 v. 2.5 amp., 5 v. 2 amp., 14/6.

Drop thro' 250-0-250 v. 80 mA., 6 v. 3 amp., 5 v. 2 amp., 14/6.

Drop thro' 110-110 60 mA., 6 v. 0.5 amp., 8/6.

280-0-280, drop through, 80 mA., 6 v. 3 amp., 5 v. 2 amp., 14/6.

250-0-250 80 mA., 6 v. 4 amp., 14/-.

Pri. 230 v. Sec. 200-0-200 35 mA., 6 v. 1 amp., 8/6.

Pri. 200/250 v., secondary 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24 and 30 volt at 2 amps., 13/-.

Drop thro' 280-0-280, 200 mA., 6 v. 5 amps., 5 v. 3 amps., 27/6.

Drop thro' 270-0-270 80 mA., 6 v. 3 amp., 4 v. 1.5 amp., 13/6.

Drop thro' 270-0-270 60 mA., 6 v. 3 amp., 11/6.

Heater Transformer. Pri. 230-250 v. 6 v. 1½ amp., 6/-; 2 v. 2½ amps., 5/-. 2, 4 or 6 v. at 2 amps., 7/6; 2 v. 2½ amp. and 6 v. 0.6 amp. E.H.T. insulated, 8/6. P. & P. each 1/-.

Input 200/250 sec., v. 6.3, 6 amp., 4 v. 4 amp., 2 v., 2 amp., 14/6. P. & P. 1/6. 1000-0-1000 v. 250 mA. 4 v. 3 amp. 37/6. P. & P. 5/-.

P.M. SPEAKERS (closed field)

	with trans.	less trans.
2½in.	—	15/6
3½in.	—	13/6
5in.	16/6	12/6
6½in.	16/6	12/6
8in.	18/6	15/-

P. & P. on the above 1/- each. 10in. less trans., 19/6. P. & P. 1/6.

5in. M.E. field coil 750 ohms with O.P. trans., 17/6. P. & P. 1/-.

Truvox BX11. 12in. P.M. 3 ohm speech coil, 45/-. P. & P. 3/6.

6½in. M.E. Speaker, 1,000 ohm field 15/-. P. & P. 1/6.

R. & A. T.V. Energised 6½in. speaker with O.P. trans., 6V6 matching, field coil 175 ohms. Requires a minimum 150 mA. to energise, maximum current 250 mA. 15/-. P. & P. 2/-.

Extension Speaker Cabinet, in contrasting walnut veneer, size 15×10½in. Will take 6½ or 8in. speaker 17/6. P. & P. 2/-.

Volume Controls, Long spindle less switch, 50K, 500K, 1 meg., 2/6 each. P. & P. 3d. each.

Volume Controls. Long spindle and switch ½, ¼, 1 and 2 meg., 4/- each: 10K. & 50K., 3/6 each. ½ and 1 meg., long spindle double pole switch, miniature, 5/-. P. & P. 3d. each.

Trimmers, 5-40 pf., 5d.; 10-110, 10-250, 10-450 pf., 10d.

Twin-gang .0005 Tuning Condenser, 5/-. With trimmers, 7/6. P. & P. 1/-.

Line Cord, 2-way 0.3 amp., 60 ohms, per foot, 1/3 per yard.

Twin-Gang .0005 with feet, size 3½×3×1½in., 6/6.

3-gang .0005, with feet, size 4½×3×1½in 7/6.

Hoover Variable Speed 600-1,200 revs. Tape Recording Motor. Silent running, 200/250 v. A.C. Shaded pole with fixing. Weight 5 lb., 27/6. Plus P. & P. 2/6.

PERSONAL SHOPPERS ONLY. 9in. Enlarger 17/6, 12in., 27/6.

Germanium Crystal Diode, 2/3 post paid.

Television Masks. White Rubber 9in. with glass, 7/6. Cream Rubber, 12in., with armour-plate glass, 15/-, 15in. Cream, 17/6 plus 1/6 P. & P.

T.V. Width Controls, 3/6.

T.V. Sub Assembly, all-chassis, 12in. × 3½in. with frame osc., line osc., 12 mfd. 275 wkg., Metrosil, 8 condensers, 4 resistors and tag panel 15/-, p. & p. 1/6.

CRYSTAL PICK-UP by famous manufacturer complete with sapphire trailer needle and volume control 23/-. P. & P. on each 1/-.

Amplifier case, black rexine covered leather carrying handle, chrome plated corners, rubber feet, felt lined, detachable lid. External dimensions, 13½×13½×9½in., £1. P. & P. 2/6.

Mains Droppers. 0.3 amp., 460 ohms, tapped 280 and 410, 1/6; 0.2 amp., 717 ohms, tapped at 100 ohms, vitreous, 1/6; 0.3 amps., 950 ohms, tapped 700 and 825, 2/6; 0.2 amp., 1,000 ohms, vitreous, tapped, 2/6; Vitreous .3 amp. 700 tapped 080, 640, 600, 3/6. P. & P. on each 3d.

D. COHEN

RADIO AND TELEVISION COMPONENTS

Terms of Business: Cash with order. Despatch of goods within 3 days from receipt of order. Where post and packing charge is not stated please add 1/- up to 10/-, 1/6 up to £1, and 2/- up to £2. All enquires and lists, S.A.E.

SPECIAL NOTE: NO GOODS SENT WHERE CUSTOMS DECLARATION IS APPLICABLE.

23 HIGH STREET (Uxbridge Road)

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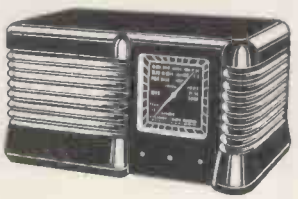
Hours of Business:
Saturday 9—6 p.m. Wednesday 9—1 p.m. Other days 9—4.30 p.m.

HIGH-IMPEDANCE PLASTIC RECORDING TAPE, by famous manufacturer, 1200 ft., on aluminium spool. 17/6, post and pkg. 1/6.



CABINET, as illustrated, 11½×6½×5½in., in walnut or cream complete with TRF chassis, 2 waveband scale, station names, new waveband, backplate, drum pointer, spring, drive spindle, 3 knobs and back, 22/6. P. & P. 3/6.
AS ABOVE, with superhet chassis, 23/6. P. & P. 3/6.
AS ABOVE, complete with new speaker to fit, and O.P.trans., 35/-. P. & P. 3/6, with superhet chassis, 36/-. P. & P. 3/6.
Used metal rectifier, 230 v. 50 mA., 4/6; gang with trimmers, 6/6; M. & L. TRF coils, 5/-; 3 obsolete ex-Govt. valves, 3 v/h and circuit, 6/6; heater trans., 6/-; volume control with switch, 3/6; wavechange switch, 2/-; 32×32 mfd., 4/-; bias condenser, 1/-; resistor kit, 2/-; condenser kit, 4/-.

M. & L. Superhet Coils with circuit, 6/6; Iron cored 465 IF's, 7/6; min. gang, 5/6; volume control with switch, 4/-; wave-change switch, 2/6; heater trans., 7/6; 4 v/h, 1/6; 4 obsolete ex-Govt. valves, metal rectifier and Xtal diode with circuit, 14/6; 25×25 mfd., 1/-; 16×16 mfd., 3/3; condenser kit (17), 7/6; resistor kit (14), 3/6.

USED 4-VALVE PLUS METAL REC. A.C. MAINS 230/250 SUPERHET. Valve line-up: 6K8, 6K7, 6Q7 and 6F6. Medium wave, in mahogany cabinet, size 14½×9×7½in. These have been checked and are in first-class working order, and first-class performance. 6½in. P.M. speaker, £3/19/6. P. & P. 5/-.

USED 5-VALVE A.C. MAINS 200/250 3 WAVEBAND SUPERHET. Complete in outstanding walnut cabinet, size 22×14×10½in. Valve line-up: 6K8, 6K7, 6B8G, 6F6, and U50 rec., 8in. P.M. speaker. In first-class working order. £7/19/6. P. & P. 12/6. We have a few of these in A.C./D.C., price as above, or £2/10/- dep., 6 monthly payments of £1/1/-.

T.V. POWER SUPPLY CHASSIS, size 13×5½in. A.C. mains 200/250 v. Complete with smoothing choke, mains transformer, 40 mfd. 350 wkg., 3.16 mfd., 450 wkg., 32 mfd. 450 wkg., 5U4G, twin mains fuse, 11 pin output socket and mains lead. Smoothed output 350 v. 200 mA. heaters 6.3 v. 7 amp., 70/-. P. & P. 5/-.

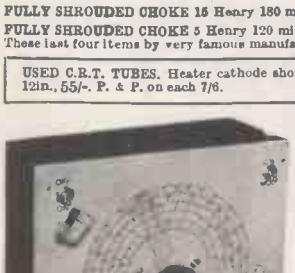
FULLY SHROUDED MAINS TRANSFORMER, input 110/250, sec. 350-0-350 175 mills 6.3 v. 7 amp., 5 v. 3 amp. 35/-. P. & P. 3/-.

FULLY SHROUDED PUSH-PULL TRANS. Pri. 6,000 ohms, sec. 15 ohms (2 L66's in push-pull) £1. P. & P. 2/-.

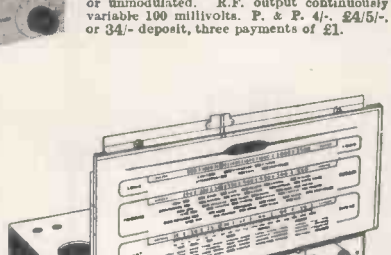
FULLY SHROUDED CHOKE 15 Henry 180 mills, 15/-. P. & P. 2/-.

FULLY SHROUDED CHOKE 5 Henry 120 mills, 8/6. P. & P. 2/-.
These last four items by very famous manufacturer.

USED C.R.T. TUBES. Heater cathode short 9in., 45/-. 12in. 75/-. Ion burn 9in., 35/- 12in., 55/-. P. & P. on each 7/6.



COMPLETELY BUILT SIGNAL GENERATOR. Coverage 110 Kc/s.-320 Kc/s., 300 Kc/s.-900 Kc/s., 900 Kc/s.-2.75 Mc/s., 2.75 Mc/s.-8.5 Mc/s., 8.5 Mc/s.-25 Mc/s., 17 Mc/s.-50 Mc/s., 25.5 Mc/s.-75 Mc/s. Metal case 10×6½×4½in. Size of scale 6½×3½in., 2 valves and rectifier. A.C. mains 230/250 v. Internal modulation 400 c.p.s. to a depth of 30 per cent., modulated or unmodulated. R.F. output continuously variable 100 millivolts. P. & P. 4/-. £4/5/-. or 34/- deposit, three payments of £1.



CONSTRUCTOR'S PARCEL comprising chassis 12½×8×2in., cad. plated 18 gauge, v/h., IF and trans. cut-outs, backplate, 2 supporting brackets, 3 waveband scales, new wavelength station names. Size of scale 11½×4½in., drive spindle drum, 2 pulleys, pointer, 2 bulb holders, 5 paxolin international octal valve holders, 4 knobs and pair of 465 IFs. 16/6. P. & P. 1/9.
AS ABOVE, but complete with 16+16 mfd. 350 wkg. and semi-shrouded drop thro' 250-0-250 60 mA. 5 v. 3 amp. Pri. 200-250, and twin-gang, 31/6. P. & P. 3/-.

BATTERY CHARGER KIT comprising metal case 4½×5×4½in., transformer 230/250 v., and metal rectifier. Will charge 6 or 12 v. battery 1½ amp. 19/6. P. & P. 2/6.

PERSONAL PORTABLE CABINET. In cream-coloured plastic: size 7×4½×3in. Complete 4-valve chassis. Scale and 3 knobs. Takes miniature 90 v. and 7½ v. batteries 9/-. post and pkg. 1/6.
3in. P.M. Speaker to fit above, 10/-. Miniature output transformer, 5/-. Miniature wavechange switch, 1/6. Miniature 1-pole 4-way used as Volume and Off, 1/6. 4B7G valve holders, 2/4. Midget twin gang ½in. dia., ½in. long and pair medium and longwave TRF coils ½in. long × ½in. wide; complete with 4-valve all-dry mains and battery circuit 8/6. Condenser Kit, comprising 11 miniature condensers, 3/6. Resistor Kit comprising 16 miniature resistors 4/-. The above receiver (less valve and batteries) could be built for approximately 51/-. All valves to suit above available. Point to Point Wiring Diagram 1/-.

R.I. MAINS TRANSFORMERS, chassis mounting, feet and voltage panel Primaries 200/250.

300-0-300 60 mA. 6.3 v. 1 a., tapped at 4 v. 6.3 v. 2 a. tap 4 v., 13/6.

350-0-350 75 mA. 6.3 v. 3 a. tap 4 v. 6.3 v. 1 a., 13/6.

350-0-350 70 mA. 4 v. 5 a. 4 v. 2.5 a. C.T., 18/6. P. & P. on the above transformers, 2/-.

500-0-500 125 mA. 6.3 v. C.T. 4 a. 6.3 v. C.T. 2 a. 5 v. C.T. 2 a., 27/6.

500-0-500 125 mA. 4 v. C.T. 4 a. 4 v. C.T. 4 a. 4 v. C.T. 2.5 a., 27/6.

500-0-500 250 mA. 4 v. C.T. 5 a. 4 v. C.T. 5 a. 4 v. C.T. 4 a., 39/6.

P. & P. on the above transformers 3/-.

Line and E.H.T. transformer 9KVA, using ferrocart core complete with built-in line and width control. Mounted on small all-chassis. Overall size 4½×1½in., EY51 rec. winding. 27/6. P. & P. 2/6.

Valve Holders, moulded octal Mazda. and loctal, 7d. each. Paxolin, octal, Mazda and loctal, 4d. each. Moulded B7G, B8A, and B9A, 7d. each. B7G moulded with screening can, 1/6 each.

32 mfd., 350 wkg.	2/-
16×24 350 wkg.	4/-
4 mfd., 200 wkg.	1/3
40 mfd., 450 wkg.	3/6
16×8 mfd., 500 wkg.	4/6
16×16 mfd., 500 wkg.	5/9
16×16 mfd., 450 wkg.	3/9
32×32 mfd., 350 wkg.	4/-
32×32 mfd., 350 wkg. and 25 mfd., 25 wkg.	6/6
25 mfd., 25 wkg.	11d.
250 mfd., 12 v. wkg.	1/-
16 mfd. 500 wkg., wire ends	3/3
8 mfd., 500 v. wkg., wire ends..	2/6
8 mfd., 350 v. wkg., tag ends..	1/6
50 mfd., 25 v. wkg., wire ends..	1/9
100 mfd. 350 wkg.	4/-
100+200 mfd., 350 wkg.	9/6
16+16 mfd. 350 wkg.	3/3
Ex-Govt. 8 mfd., 500 v. wkg., size 3½×1½, 2 for	2/6
16×32 mfd., 250 wkg.	6/-
50 mfd., 180 wkg.	1/9
65 mfd., 220 wkg.	1/6
8 mfd., 150 wkg.	1/6
60+100 mfd., 280 wkg.	7/6
50 mfd., 12 wkg.	11d.
32+32 mfd., min., 275 wkg.	4/-
50 mfd., 50 wkg.	1/9
Miniature wire ends moulded, 100 pf., 500 pf., and .001 ea..	7d.

Combined 12in. mask and escutcheon in lightly tinted perspex. New aspect, edged in brown. Fits on front of cabinet, 17/6. P & P. 2/-

Frame Oscillator Blocking Trans., 4/6. Tube Mounting Bracket, size 9½×4½in., 12in. tube clamps, 2/-.

Smoothing Choke, 2 henry 150 mA., 3/6. 250 mA. 3 henry, 5/-; 250 mA., 10 henry, 10/6; 5 henry 250 mA., 60 ohms, 8/6.

P.M. Focus Unit for any 9 or 12in. tube except Mazda 12in., with Vernier adjustment, 15/-. P. & P. 1/6.
P.M. Focus Unit for Mazda, 12in., with Vernier adjustment 17/6. P. & P. 1/6.
Wide Angle P.M. Focus Units, Vernier adj., state tube, 25/-. P. & P. 2/-.
Energised Focus Coil, low resistance mounting bracket, 17/6 plus 2/- P. & P.
Scan Coils, low line low impedance frame, complete with O.P. transformer. 17/6. P. & P. 2/-.

Ion Traps for Mullard or English Electric tubes, 5/- post paid.

465 kc. I.F.s, size 2½ × 1½in. Q.110 removed from American equipment. 5/- per pair. Standard 465 Kc. Iron-cored IFs. 4 × 1½ × 1½in., per pr. 7/6. Wearite standard Iron-cored 465 Kc. IFs, 3½ × 1½ × 1½in., per pr., 9/6.

Iron-cored 465 Kc. Whistle filter, 2/6.

OUTPUT TRANSFORMERS. Standard type 5,000 ohms imp., 4/9. 42-1 with extra feed-back windings, 4/3. Miniature 42-1, 3/3. Multi-ratio 3,500, 7,000 and 14,000, 5/6. 10-watt push-pull, 6V6 matching 7/-. 90-1 3 ohm speech coil, 6/6.

PUSH-BACK CONNECTING WIRE. Doz. yds., 1/6, post paid.

STANDARD WAVE-CHANGE SWITCHES, 4-pole 3-way, 1/9; 5-pole 3-way, 1/9; 3-pole 3-way, 1/9; 9-pole 3-way, 3/6; Miniature type, long spindle 3-pole 4-way, 4-pole 3-way and 4-pole 2-way, 2/6 each. P. & P. 3d.

465 KC. MIDGET I.F.s. Q.120, size 1½in. long, 1in. wide, ½in. deep by very famous manufacturer. Pre-aligned adjustable iron-dust cores, per pair, 12/6.

Prices slashed at Clydesdale

F24 AIRCRAFT CAMERA in Transit Case.

Full Details:
Lens 5in. f/4 with internal iris diaphragm stops to f/11, fixed focus set at infinity, screw-in housing projects 5¼in. Focal plane shutter, speeds 1/60th to 1/1,000th of a second and time, fitted in film magazine designed for 5¾in. wide film, picture size 5½ x 5¼in. Shutter release and rewind spindle for standard spanner. Hand operated as it stands. Nett. weight 17lb. Packed in fitted transit case 42lb. Dimensions: body 6½ x 9 x 9½in., overall including lens housing 11½ x 9 x 9½in. Provision for external motor drive (not supplied). Lens housing grooved for fitting to aircraft camera port. A precision Air Survey Camera, could be adapted for Laboratory, Industrial or Portraiture use.

ASK FOR X/H302 — **£4.19.6** each — CARRIAGE PAID

F24 AIRCRAFT CAMERA in Transit Case. With 8in. f/2.9 lens, otherwise as H.302.

ASK FOR X/H300 — **£9.19.6** each — CARRIAGE PAID

14in. f/5.6 LENS FOR F/24 CAMERA
Complete with Iris, Filter, Mount and Extension. In Transit case.

ASK FOR X/H563 — **£6.19.6** each — CARRIAGE PAID

CAMERA CONTROL ELECTRICAL, type 35 No. 20, Ref.: 14A/3208, Input 24 volts D.C. Time interval selection switch 15-51 second, calibrated in height, thousands of feet. Suitable as the basis of an enlarger timer or many other timing uses. Dim.: 8 x 3¾ x 4¼in. overall including controls. In Transit Case.

ASK FOR X/H962 — **15/-** each — POST 1/6 EXTRA

RECORDER MK. II 24 VOLTS
As previously described, Used. Good condition, in Transit Case.

ASK FOR X/H883 — **27/-** each — POST PAID

ONLY AVAILABLE with Recorder Mk. II. Film Cassette, 25ft. Capacity.

ASK FOR X/H960 — **10/-** each — POST PAID

We are unable to supply external fittings or films for these units at present.

GLASS DOME INSULATOR, with Threaded Terminal Top and Metal Lead-through Rod. Dome dim.: 2½ x 1¾in. high, lead-through projects 6½in. Overall length 9¾in.

ASK FOR X/H54 — **2/-** each — POST 3d. EXTRA

CERAMIC AERIAL SPREADER individually boxed.
Length overall 11in., between centres 9½in.

ASK FOR X/H718 — **1/-** per pair — POST 3d. EXTRA

BLACK PLASTIC CHAIN AERIAL INSULATORS
Comprising 3 links, 3½in. long, 1¾in. wide, each link. Total length 7½in. A.M. ref. 10A/1275.

ASK FOR X/H525 — **9d.** per pair — POST 3d. EXTRA

BC-456 SPEECH MODULATOR UNITS.
Part of SCR-274-N. "Command Equipment." (U.S.A. made)
Complete with valves 1625, 1215 and VR150/30, transformers, relays, etc., less dynamotor. Overall dim.: 10¼ x 7¼ x 4¼in. Loose stored.

ASK FOR X/E42 — **17/6** each — CARRIAGE PAID

Also available. BC-456 as above, in original carton.

ASK FOR X/E42A — **27/6** each — CARRIAGE PAID
Circuit 1/3

FOR EXPORT ONLY
WIRELESS SET NO. 38, Mk. II
Range 7.7-9 Mc/s., 5 valves and all accessories. Complete (less batteries) and unused in original wood case. 4 complete units per case.

ASK FOR X/H519/4 — **£20.0.0** F.O.B. GLASGOW — PER CASE OF 4 SETS

ROTARY CONVERTER TYPE 195
Input 24 v. D.C. 5 A. Output 230 v. A.C. 50 c/s. 100 w. Complete in metal case. Dim.: 13 x 11 x 8in. with carrying strap.

ASK FOR X/H914 — **£5.19.6** each — CARRIAGE PAID

RECEIVER UNIT TYPE 25
Ref.: 10P/1L
Part of TR1196, Range 4.3-6.7 Mc/s. with valves 2/VR53 (EF39), 2/VR56 (EF36), VR55 (EBC33), VR57 (EK32), 2/I.F.T. 460 kc/s, etc., in metal case 8¼ x 6½ x 6¼in.

ASK FOR X/H299 — **35/-** each — POST PAID

TRANSMITTER TUNING UNITS

Each having Vernier tuning dial, Variable Capacitor, Tank Coil unit on ceramic former, Ceramic Switch, etc., etc. In metal cabinet 17¼x 7¼ x 8in. Finish black. Unused, but externally soiled, scratched and dented, due to being Loose Stored.

TU.7B Range 4,500-6,200 Kc/s. Ask for X/H29.
TU.8B Range 6,200-7,700 Kc/s. Ask for X/H30.
TU.9B Range 7,000-10,000 Kc/s. Ask for X/H467.

EITHER UNIT — **10/-** each — CARRIAGE 2/- EXTRA

I.F. RECEIVER R3108. Ref.: 10DB/505
Contains Motor Generator Input 12 v. 3.8 A. Output 480 v. .04 A. D.C. with a gearbox operating a switching mechanism to detune the receiver at time intervals. Data available for converting to 250 v. 50 c/s use as motor.
Plus: 4/VR65A (SP.41), 2/VR92 (EA50), 2/CV6 (Det. 20) Valves, etc., etc.
Metal case: Dim. 12 x 12 x 8in. Wgt. 24lb.

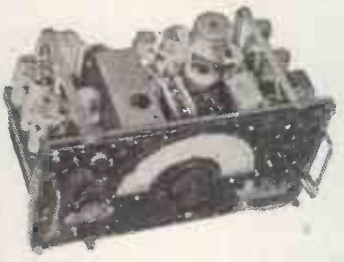
ASK FOR X/H961 — **19/6** each — CARRIAGE PAID

26 WATT OUTPUT TRANSFORMER
Parmeko type AF5084/1A (Mfg. Surplus).
Primary: 6,600 ohms. C.T. Sec's. 3.5, 5, 7.5 or 10 ohms. Dim.: 3⅜ x 2¾ x 3⅛in. Fully shrouded. Wgt. 3lb.

ASK FOR X/H565 — **19/6** each — POST PAID

WAVE FORM GENERATOR TYPE 26
With valves VR55, 2/VR54, VR116, 3/VR56, 6/VR65, 2 relays, plus cond., etc. Input 80 v. 2,000 c/s A.C. In metal-case: 12 x 7½ x 11½in.

ASK FOR X/H884 — **21/-** each — CARRIAGE 2/6 EXTRA



R1155 RECEIVER UNIT
Communications, D.F. and "ham," 20, 40, 80, 5 ranges 18-7.5 Mc/s., 7.5-3 Mc/s., 1,500-600 Kc/s., 500-200 kc/s. and 200-75 kc/s. Complete with 10 valves. S.M. drive, M.E. tuning, B.F.O., etc. In metal case 16½ x 9 x 9in. External Power Supply required. Used, good condition. In Transit Case.

ASK FOR X/H916 — **£8.19.6** — CARRIAGE PAID

ALSO AVAILABLE
R1155, as above, but loose stored.

ASK FOR X/H898 — **£5.19.6** — CARRIAGE 7/6 EXTRA

VISUAL INDICATOR TYPE 1, Ref. 100/2
Dual reading left/right D.F. meter for R1155, 2¾in. Scale overall dim.: 3¼in. x 2¼in. In used condition.
Ask for X/H862A

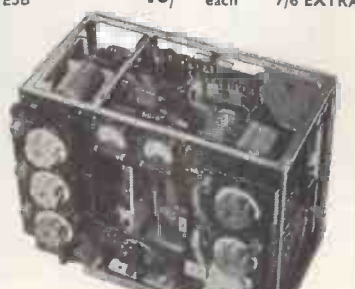
12/6 each
Post Paid.

T1154 TRANSMITTER UNIT
Medium/high powered for C.W.-M.C.W. R/T, 3 ranges 10-5.5 Mc/s. 5.5-3 Mc/s. 500-200 kc/s. Complete with 4 valves, etc., in metal case 14in. x 16½in. x 8¼in. External Power Supply required.

ASK FOR X/E5A — **39/6** each — CARRIAGE 7/6 EXTRA

ALSO AVAILABLE
T1154 as above, but less valves.

ASK FOR X/E5B — **15/-** each — CARRIAGE 7/6 EXTRA



POWER UNITS FOR T1154/R1155 UNITS
Each a Motor Generator Unit, smoothed, etc., in metal case 16in. x 7½in. x 6in.
LOOSE STORED.
Types 33 or 33B. Input 24 v. D.C. 16A. Output 1,200 v. D.C. 200 mA.

ASK FOR X/E7A — **42/6** each — CARRIAGE PAID

Type 35A. Input 18 v. D.C. 12 A. Outputs 7.2 v. D.C. 13 A. and 225 v. D.C. 110 mA.

ASK FOR X/E8A — **£1.0.0** each — CARRIAGE PAID

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50 MICRO-AMP. METER. 2½in. barrel, 3½in. flange, panel mounting. Scaled 0-100 in 50 equal divisions. Price **ONLY £3/10/-** each.

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SKY CHAMPION S20R. This super Hallicrafter receiver covers 550 kc/s to 45 Mc/s (550 to 6½ metres) without gaps. Has bandspread tuning. R.F. stage, two I.F. stages, etc. Built-in power-pack for 200/250-volts 50 cycles A.C. mains operation. Complete with all nine valves, built-in speaker and ready for operation. Each set tested prior to despatch and demonstrated to callers. In case size 18in. x 8½in. x 10in. Price **£21**, plus 10/- carriage and packing.

SKY RIDER DEFIANT SX24 is similar to above but includes crystal I.F. filter and S meter, etc. Complete with valves and crystal for **£27/10/-**, plus 10/- carriage and packing. For further details send S.A.E.

COMMUNICATION RECEIVER R1155 for world-wide reception. Can be heard at any time during shop hours. Air tested prior to despatch. Brand new at £11/19/6. A few slightly used at £7/19/6.

TRAWLER BAND. R1155N, with super slow motion drive, available at **£17/19/6. Carriage in original transit cases 10/6 extra on all models. Send 1/3 for full details and circuit.**

A.C. MAINS POWER PACK OUTPUT STAGE enables the R1155 to be used to operate speaker from 200/250 volts A.C. without ANY MODIFICATIONS WHATEVER. **All our Power Packs** have heavy duty transformers, are complete with leads and Jones plugs and are **guaranteed for 6 months.**

Type A. In neat black box, size 8½in. x 4½in. x 6½in. Less speaker. Price **£4/10/-**, plus 3/6 carriage.

Type B. With built-in 5in. speaker in black case, size 13½in. x 5½in. x 7½in. Price **£5/5/-**, plus 3/6 carriage.

Type C. With 8in. R.C.A. speaker, built in R.C.A. speaker cabinet as described below. Price **£6/10/-**, plus 3/6 carriage.

SAVE £££££'s Deduct 10/- when purchasing any R1155 and power pack together.

VISUAL INDICATOR TYPE 1 Ref. 10Q/2—the cross-over Left/Right indicator for D.F. operation and Loop Aerials Type 4, ref. 10B/420. Both Brand new and boxed. We have these items in stock and those interested in complete D.F. installations should contact us for quotations.

R.C.A. SPEAKER. 8in. P.M. unit in beautiful black crackle cabinet. Size 11½in. x 10½in. x 6in. A de Luxe job. **Brand new at 45/-**, plus 2/6 carr.

U.S.A. DYNOMOTOR. 12 volts D.C. input, 250 volts 60 mA. output. Weight 2¾ lbs. Size 4½in. x 3in. diameter. Ideal for car radio, mobile amplifiers, small transmitters, etc. All tested prior to despatch. **ONLY 22/6**, post paid.

POLICE, FIRE, WROTHAM

THE R1132A receiver covers 100-124 Mc/s with variable tuning. Very easily altered to other frequencies. Complete with all 11 valves. Requires only 250 volts and 6.3 volts when it is ready to operate. Complete circuit supplied. Only 45/-, plus 7/6 carriage. BRAND NEW. Will operate from our standard R1155 power pack using special lead, price 10/- extra.

POWER PACK NO. 3. Standard 19in. rack-mounted power packs for 200/250 volts mains operation. Paper smoothing, two heavy duty chokes, VU39 rectifier. Output 250 volts D.C. 100 mA., 6.3 volts 4 amps. Two types : Mark I, with H.T. current meter at £4/4/- ; Mark II with H.T. current and voltmeters at £4/10/-, carriage 5/-. Suitable for use with P48, R1132, R1481, R1392, R1155, etc. Lead for any specified set with Jones plugs, 10/- extra. All power packs guaranteed in working order.

TRANSFORMER BARGAINS. 350-5-350 volts at 180 mA., 6.3 v. 5 Amps and 5 v. 3 Amps. Standard 200/250 volt 50 cycle screened primary. Size 4in. x 4in. x 5in. Brand new and unused 29/6 plus 2/6 post. Filament Transformers—Standard tapped primary, two types—Type "A" 12 volts 1½ Amps., 6.3 volts 1½ Amps. Type "B" 12 volts 1½ Amps., 4 volts 1½ Amps. Either type 7/6 each.

H.R.O. 6 VOLT VIBRATOR PACK gives 165 volts 80 mA. smoothed D.C. Uses Mallory vibrator, 6X5, heavy duty smoothing choke, etc. In black crackle cabinet size 7in. x 7in. x 6in. Brand new only 29/6, plus 2/6 postage.

GROUNDED GRID TRIODES TYPE CV82—A few of these in stock.

C.R. TUBES for G.E.C. "Miniscope" price 35/- each. New and Boxed.

VARIACS. semi-variable. Rated .8 kVA, oil filled. Adjustable for 30 volts above and below the mains input. Price £5.

METER BARGAINS

UNIVERSAL AVOMETERS MODEL 40—very little used, thoroughly checked and tested. First-class multi-range test meter for ONLY **£9/19/6.**

1 Milli-amp. 2½in. square panel mtg., 15/-.
5 Milli-amp. M/c. 2½in. square panel mtg., 7/6
200 Milli-amp. M/c. 2½in. diameter flush panel mtg., 10/6.
20 Amps. 2½in. diameter M/coil, 7/6.
20 Volts 2in. square panel mtg., M/coil, 7/6.
500 Milli-amps. Thermo-couple 2in. square panel mtg., 5/-.
All the above meters are brand new and boxed.

G.E.C. 1 mA. METER RECTIFIERS, BRAND NEW AT ONLY 11/6.

BLOCK CONDENSERS

4 mfd. at 1,000 volts. Size, 4½in. x 4in. x 1½in., 5/-. New and boxed.

10 mfd. at 1,000 volts D.C. test, will work at 600 volts. Size, 2in. x 3in. x 3in. New and boxed. SPECIAL PRICE at 3 for 10/6. .25 mfd. at 1,500 volts. Size, 2½in. x 2in. x 1¾in. Price, 3 for 4/6, post paid. All the above are metal cased with paper insulation and fixing feet. .04 mfd. 12.5 kV. ONLY 6/- each.

BATTERY CHARGERS. Contained in black crackle case, size 6in. x 7in. x 12in., includes a heavy duty transformer, metal rectifier, 0-5 ammeter, on/off mains switch and 2 Slydlock fuses. 230 volts 50 cycles input ; output 4 amp., 6 or 12 volt battery. The transformer, etc., is conservatively rated and the whole unit is of sturdy construction and super quality. Made to a very stringent specification, this equipment is well worth the price of £4/19/6, plus 5/- carriage and packing. **In brand new unused condition.**

METAL RECTIFIERS

Selenium 230 volts 60 mA. at 5/- ; 300 volts 100 mA. at 7/6 ; RM2 at 4/3 or two for 8/- ; RM4 at 17/- ; Selenium Full Wave Bridge 6 or 12 volts— 1 Amp. at 7/6 ; 2 Amp. at 11/3 ; 3 Amp. at 12/6 ; 4 amp. at 15/-. Heavy duty selenium rectifier, square fins, size 8½in. x 4in. x 4in. Two units in full wave bridge give 48 volts 10 Amps. D.C. Brand new at £4 per pair.

COLLARO THREE SPEED AUTO CHANGER 3RC521 complete with two separate crystal heads. BRAND NEW AND BOXED. Only £9/19/6.

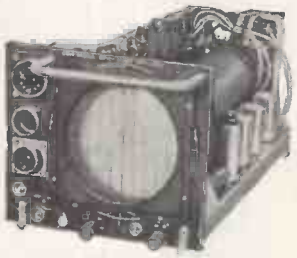
GOODMANS AND B.T.H. 12in. 15 watt 15 ohm heavy duty speakers in stock. Brand new and boxed at bargain prices for callers.

PUSH PULL OUTPUT TRANSFORMERS 15 watts, push-pull 6V6's to 15 ohms. A bargain for ONLY 7/6 each.

HEAVY DUTY CHOKES 5Hy 300 mA. 500 ohm, size 3in. x 4in. x 4½in. high. Potted type, chassis mounting. A beautiful job, brand new and boxed, 12/6. 30Hy 150 mA. 300 ohms, universal mounting size 4in. x 3in. x 2½in. Price 10/6.

INDICATOR UNIT 182A

contains 3 EF50, 1 5U4G, 4 SP61 and a 6½in. C.R.T. type VCR517. This tube will replace the VCR97 without any alteration, is completely free from cut-off and has a more pleasant tube colour. Contains in addition a very large assortment of pots, resistors, condensers, etc. Tubes demonstrated. Supplied BRAND NEW (less relay) for only **67/6**, plus 7/6 carriage in original transit cases. **Original circuit** supplied FREE with each order, or 1/6 separately.



NOTE PRICE REDUCTION

45 Mc/s PYE STRIP. Vision unit for London frequency, complete with 6 EF50 and 1 EA50. Circuit provided. Price **£3/10/-**, plus 2/6 carriage.

TV PRE-AMP. Uses 2 EF50's and tunes to 45 Mc/s. Easily altered to other frequencies. With valves, **19/6**, less valves, **10/-**, post 1/- extra.

E.H.T. TRANSFORMER for the VCR97, etc. Mains input. Output 2,500 volts, 4 volts 2 amps. 2-0-2 volts 2 amps. Fully guaranteed at **35/-** each, plus 1/- post.

CO-AXIAL CABLE. Brand new 70/80 ohm. with STRANDED inner conductor. Not ex-Govt. Price **9d.** per yard. Minimum per post, **7/6** per doz. yards.

HEAVY DUTY twin circular polythene cable, weatherproof, suitable for extension mains lead, etc. Price **9d.** per yard. Minimum per post **8/6** per doz. yards. SPECIAL OFFER of 100 yard coil for **50/-**, plus 3/6 carriage.

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COIL PACKS. We have a bargain line in S. M. and L. wave packs for 465 kc. I.F. Single hole fixing. Price **14/6**, BUT regret **CALLERS ONLY** this item.

I.F. TRANSFORMERS iron dust core, 465 kc/s., brand new, manufacturer's surplus, **ONLY 6/9** per pair.

TYPE 12 TRANSMITTER. Mains operated transmitter covering 1.2-17.5 Mc/s in four bands, crystal or V.F.O. Size 24in. x 12½in. x 17½in., weight 134 lbs. Complete with all valves, ready for operation. In first class condition and tested before despatch, with circuit and instructions **ONLY £16/16/-**, plus 14/- carr. A few, soiled, for callers only at bargain prices.

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Transformers of current manufacture. Two types, both standard tapped primaries. Universal mounting. (1) 350-0-350 volts 80 mA., 0-4-6.3 volts 4 amps., 0-4-5 volts 2 amps. (2) 250-0-250 volts 80 mA., 0-4-6.3 volts 4 amps., 0-4-5 volts 2 amps. Both these transformers are new and boxed, fully guaranteed at 18/- each, post paid.

30 VOLT TRANSFORMER standard primary. Secondary 30 volts 2 amps., tapped to give 3, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24 volts. Has countless uses. Price **17/6.**

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HALLICRAFTERS SX28, S27, S41, S38, etc. All in perfect condition.
AR88LF, AR88D, CR100, from stock. **R1155 RECEIVERS,** new.
A.C./D.C. MOTORS, suitable for sewing machines, **47/6** each.
A.C./D.C. 12 v.-15 v. MOTORS, long spindle for models, **15/-** each.
20 WATT P.A. RACK MOUNTING AMPLIFIERS, complete with power pack, 200/250 v. A.C., less valves, **£6/10/-.** Valves—2 type PX25, 1 MH4 and 1 MU14, **£2/15/-** per set.
NEW M/C MICROPHONES, hand type, with 12 yds. heavy duty screened cable, **£3/15/-** each.
B.C.221 FREQUENCY METER, from stock Many items of American equipment available.
TEST EQUIPMENT. We hold a comprehensive stock. Multi-range meters at 1,000 and 20,000 o.p.v., valve testers, signal genes.
4,000Ω EARPHONES, 11/6 pr.
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EDDYSTONE 640 RECEIVER. Perfect, at **£22.**
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H.R.O. COILS. .46-.96 Mc/s., etc., at **£2/5/-** per coil.
LARGE STOCKS OF MOTORS. A.C./D.C. and A.C., 1/16, 1/12, ¼, ½ h.p
EDDYSTONE "750," as new, **£45/10/-.**
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WARNING

Readers are warned that Government surplus components and valves which may be offered for sale through our columns carry no manufacturers' guarantee: Many of these Items will have been designed for special purposes making them unsuitable for civilian use, or may have deteriorated as a result of the conditions under which they have been stored. We cannot undertake to deal with any complaints regarding any such items purchased.

NEW RECEIVERS AND AMPLIFIERS

ALL types of audio equipment designed and built to order.—Bernard J. Brown, 33, Goldhawk Rd., London, W.12. [0024

QUALITY amplifiers, bass and treble controls; s.a.e. list.—Parker, 22, Tybenham Rd., Merton Park, S.W.19. [2316

12-watt high quality amplifiers, bass and treble boost; £12/15; lists.—Broadcast & Acoustic Equipment Co., Ltd., Tombland, Norwich. [0065

REAL bargain clearance, all new goods, e.g., 4v L.M.S. wave s/het, £3/10, incl. valves, coil pack, etc.; A.F. oscillator sine/sq atten., o/p 20-20kc/s only, £4/10; 10w quality high gain ampfr., perfect, £4; tape recorder ampfr., osc., offers over £7; numerous other smaller items; s.a.e. for list in confidence.—J. A. Vanstone, "Cleland," Agates Lane, Ashtead, Surrey. [2328

RECEIVERS, AMPLIFIERS—SURPLUS AND SECONDHAND

EXC. cond. 750, £45 o.n.o.; working 12in TV kit.—Box 2608. [2327

ACOUSTICAL quad amplifier for sale, perfect; best offer over £25.—Box 2487. [2270

FOR sale, large screen (4ftX3ft) Valradio TV projector, under maker's guarantee; good price to dealers, what offers?—Box 2563.

HRO Rx's and coils in stock, also AR88, BC348R, CR100, etc.—Requirements please to R. T. & I. Service, 254, Grove Green Rd., London, E.11. Ley. 4986. [0053

LOUDSPEAKERS—SURPLUS AND SECONDHAND

EDDYSTONE 740 plus speaker, little used; £30, nearest offer.—Box 2565. [2304

LOUDSPEAKERS WANTED

WANTED, 72in circular metal horns, price, particulars.—Radiovox, Ltd., 5, Oxford Place, Leeds, 1. [2261

NEW DYNAMOS, MOTORS, ETC.

ALL types of rotating electrical machinery up to 20kva available, including rotary converters, rotary transformers, motors, petrol and diesel-engined generating plants, alternators and d.c. generators. We are also in a position to quote for power transformers; as actual manufacturers we will be glad to quote for any quantity for home or export.
DIESEL Electric generating plants, 3kva, 230v, with push-button remote control, starting equipment ready for use; £225.
CHAS. F. WARD, Lordscroft Works, Haverhill, Suffolk. Tel. 253. [0039

THE Pearce new model diesel alternator plant, on welded steel frame 230/1/50 3kva plus 32v 15a d.c., Petters latest AVA1, air-cooled diesel engine, alternator, self-energised automatic-voltage control by winding arm stator d.c. output charges lighting and starter battery up to 15amps, 24v lighting is used when plant is not in use, remote control push-buttons, complete with main switch and fuses, battery cables; £255.
SEND p.c. for full description and photographs. ALSO above plant fitted Lister slow-speed water-cooled diesel and electric flywheels.
ALTERNATORS, 230/1/50, 400VA, self-energised, 3,000rpm, ball bearing, £23/15 del. also special television model same price; voltage regulator 30/- extra.
J.A.P. No. 2A 1.2hp petrol engine, air-cooled, 4-stroke, starting rope, tools; £17/10 delivered for above alternators.
SPECIAL rotary converters, guaranteed interference free, fitted radio and television filters, wt. 60lb, d.c. input 12v 200va, out, 24v, 32v, 50v, 110v, 230v d.c. to 230v, out, 250va, £28/10 del.: also converters for radiogram and general use, inputs, outputs and prices as above; the above also supplied without smoothing, £25 del, immediate despatch; trade supplied.
AT a purchaser's home 60 m.s. S.W. of Sutton Coldfield a 24v.
TELEVISION converter was tested on Ekco television, 12in tube, stated consumption 135 watts d.c. current from battery only 9½amps, picture and sound were perfect and completely free of interference or flutter.
THE above are the latest products of British manufacture, and are guaranteed for one year fullest details of plant, alternators or 400VA alt. or rotary converters, by return post; state which required: terms c.w.o., pro forma invoice c.o.d (post goods only).
T. W. PEARCE, 66, Great Percy St., W.C.1 (near Angel). [0013

The Boffin and the Partridge...

The habits of the boffin are a commonplace in contemporary research. In the small back room which tradition demands he shall occupy, you will find none but the finest equipment. Not for him the makeshifts of his predecessors, the frustration of failures through unreliable components. For example when he requires a transformer it is fundamental that he specifies a Partridge.

P 3064—the latest development in Audio Transformers. Technical data sheet No. 5 on request.

PARTRIDGE
TRANSFORMERS LTD
TOLWORTH SURREY

NEW DYNAMOS, MOTORS, ETC.

BATTERY chargers, 4 models, 2-6-12v, 1-2-4 amp D.C. any mains voltage; also larger types special transformers, chokes, test gear, interior car heaters, etc.—The Banner Electric Co., Ltd., Hoddesdon, Herts. [0112

DYNAMOS, MOTORS, ETC.—SURPLUS AND SECONDHAND

VALRADIO 230/200 A convertor, 50 c.p.s., used 10 hrs.; £7/10.—Wallis, University College, Oxford. [2308

TEST EQUIPMENT—SURPLUS AND SECONDHAND

UNUSED Homelab signal generator; £8.—Davis, 1, Orchard Way, Rickmansworth, Herts. [2329

MODEL 1035 Cossor double-beam oscillograph, as new (cost £110); our price £60.—R.T.S., 23, Pelham St., London, S.W.7. Tel. Ken. 0586. [2181

339 'scope £25, 343 ganging osc. £20, both £40; Garrard RC67A's and RC72A, at £12 and £13/10 each; as new; send for list.—Meek, 17, Haydock Rd., Wallasey, Cheshire. [2318

SIGNAL generators, oscilloscopes, output meters, valve voltmeters, frequency meters, multi-range meters in stock; your enquiries are invited.—Requirements to R.T. & I. Service, 254, Grove Green Rd., London, E.11. Ley. 4986. [0056

NEW GRAMOPHONE AND SOUND EQUIPMENT

FERROGRAPH magnetic tape recorder, models 2A and 2B now available, from 76gns.
WEARITE tape decks and component parts.
DISC recording machines and blank discs.
MAGNETIC tape—Ferrograph, Scotch-boy, etc.
RESLO ribbon microphones and stands.
EVERYTHING for the professional recording studio.
SOUND DISCS (SUPPLIES), Ltd., 178, Bispham Rd., Southport, Lancs. Tel. 88153. [2314

RAESOUND home audio, HI-FI amplier and T/C unit; £24/10; send for details.—R.A.E., 377, High Rd., London, N.2. [0213

SWITCHED vol. controls, 3DBS steps, silent operation, 110K, 250K, 500K, 9/6 post free.—Johns, 20, Park Rd., E.12 [2322

F.M. hear the ultimate in transmitted quality without background noises, on V.H.F.—Ring Arc. 5078 for demonstration. Bel, Marlborough Yard, N.19. [0185

C.J.R. ELECTRICAL & ELECTRONIC DEVELOPMENT, Ltd., manufacturers of high quality portable and console magnetic tape recorders for professional and amateur use; full details on application.
BICKFORD Rd., Witton, Birmingham, 6. East 0822. [2056

PRE-AMP/RECORD units for use with Leak, Q.U.A.D., etc., with meter level ind. to suit Bradmatic, Truvox, etc., now £16; to suit Wearite, 17gns; this unit gives you first-class recording with playback via your Hi.-Fi. amp.
AMPS. to suit Wearite 2A (EL84), 5 watts output, 21gns, and £32 for 12 watts P.P. with meter and Partridge out. trans.
MOTEK amp. to spec., £11; others for Truvox, etc., 12 watts P.P., £21.
HARDING ELECTRONICS, 120a, Mora Rd., London, N.W.2. [1858

CINE-VOX disc recording equipments, type C7J for high-quality recordings from existing microphone equipment; price from 28gns; also available as a complete channel inclusive of mic., amplifier and playback equipment, at 70gns; type C7, for highest quality professional requirements—recorder mechanism at 49gns, or complete channel at 110gns; demonstrations arranged in London.
PLEASE write for details to K.T.S., Ltd., 60, Aylward Rd., London, S.W.20 (Liberty 2426). Callers by appointment only. [0209

MAGNETIC recorders, all types, new and secondhand for sale; hire service in greater London area only; mechanical and electronic repairs carried out by specialists; "Magnegraph" limpet telephone pick-ups, suitable for all types of recorders, 25/-; tape storage racks for 12 reels, 37/6; B. & H. recording wire, new and used, from 15/- reel; tape accessories, etc.; full details s.a.e.—The Magnegraph Recording Co., Ltd., 1, Hanway Place, W.1. Tel. Langham 2156. [0236

GRAMOPHONE AND SOUND EQUIPMENT —SURPLUS AND SECONDHAND

GRUNDIG tape recorder, latest model, unused, in sealed carton, unwanted present; £12/10 below list price.—Frank V. Carlshausen, 28, Charlton Kings Rd., London, N.W.5. Tel. Gul. 2083. [2295

FOR SALE AND WANTED ADVERTISEMENT FORM
TURN TO PAGE NO. 149

GRAMOPHONE AND SOUND EQUIPMENT —SURPLUS AND SECONDHAND

LOWTHER pick-up with Diamond and P.M. 2 unit; no reasonable offer refused.—Box 2564. [2300

FERROGRAPH tape recorder, latest 2A model November, 1953, £69; would exchange for disc recorder, late model and perfect, or would purchase same for cash.—Box 2587. c/o W.W. [2313

BOOSEY & HAWKES type wire recorder combined with record player, excellent condition; £28.—Burgess, Lane & Co., Block J, Sunleigh Wks., Sunleigh Rd., Wembley. Wem. 2378. [2135

ANY of you tape types building your own? Although we deal primarily in sub-standard cine equipment, it's quite possible that our "Bits and Pieces" list might be useful; s.a.e. please. We also wish to buy tape desks, recorder components, etc.—Burgess Lane & Co., Block J, Sunleigh Works, Sunleigh Rd., Wembley. Tel. Wem 2378 [0253

YOUR tapes to disk (78 & L.P. Microgroove, genuine), tape, disks, accessories; trade terms on above; E.M.I. & Ferrograph Recorders; 2 BSR disk recorders, condition excellent; reasonable; studio and mobile service, professional standards, "Eroica" Recording Services (Regd. 1949), Peel St., Eccles, Manchester, Eccles 1624, Musical Director Thurlow Smith, A.R.M.C.M. [0121

NEW COMPONENTS

CRYSTAL microphone inserts (Cosmocord Mic-6), guaranteed brand new; 15/6, post free.—Radio-Aid, Ltd. (Retail Dept.), 29, Market St., Watford. [0036

TRANSFORMERS.—Single phase 230 volts to 12 volts; output 15/17 amps, 15/9; cash with order; post free U.K.—Barleymow Engineering, Ltd., Betchworth, Surrey. [2309

2.5KV ringing choke, with EY51 mountings, 12/6; EY51 fitted, 35/-; two models, negative or positive output, first-class job, tested and guaranteed .001mfd 4 kv 3/6.—Cretton, 349, Copnor Rd., Portsmouth. [2194

V.H.F. Hi-Fi, F.M. receivers, complete parts kit, with valves, wound coils, chassis, £7/5; aerials and alignment service available; or as 144 M/cs Rx with mods., collsets, F.M., TV, coilformers, canned ¾in×1⅝in, 2/3.—Bel Sound Products Co., Marlborough Yard, N.19. [0186

FOR really good results you can do no better than use Osmor coils and coilpacks, ask anyone of experience! Send 5d (stamps) today for beautifully-drawn free circuits, our new coil-data leaflets, and latest lists of matched radio components. A speedy mail order department is at your service, and remember, all Osmor lines are guaranteed. (Trade enquiries invited.) Dept. C.W.1.
OSMOR RADIO PRODUCTS, Ltd., Bridge View Works, Borough Hill, Croydon. Tel. Croydon 5148-9. [0046

FLUORESCENT 80 watt 230v complete ballast unit, 39/6; 80w brick choke and starter lamp, 14/6; 40 watt complete ballast 230v, 28/9; complete fluorescent fittings from 45/-; metal rectifiers, 12v 4amp f/w bridge, 13/9; suitable charger transformer, 16/6; 0-4 ampmeter, 8/6; brand new small radio cabinets, 16/6; multi-ratio output transformers, Goodmans, 7/6; Diamond H switches, 4/6; 4-pole cooker switches, 5/-; charge your dry cell batteries with our special charger from mains, complete unit, 14/9; new G.E.C. ½hp electric motors, 230v S/p, £4/16.—Malden Transformer Supplies, Rear of 5, Coombe Rd., New Malden, Surrey. Mal. 2655 (Longside of Malden S.R. Station). [0038

COMPONENTS—SURPLUS AND SECONDHAND

SUPREME RADIO, 746B, Romford Rd., Manor Park, London, E.12. Tel. Ilf. 1260. Est. 17 years.
1954 bargains.
AMAZING bargains in vol/controls, small size, with long spindle and S/P switch, 1meg, ½meg or ¼meg, our price, 2/6 ea.; also ½meg vol/controls, less switch, 1/6 ea.; 2meg standard size vol/controls, long spindle, less switch, 1/6 ea.
LOOK! Crystal sets in brown bakelite case, 3¼in×2¾in×1⅝in, wired ready for use, amazing bargain value at 7/6 ea.; this crystal set uses a crystal diode.
NEW stocks electrolytics, metal can, small, 16mfd 350v, 1/11 ea.; 16+16mfd 350v, 2/3 ea.; 16+24mfd 350v, 2/6 ea.; 32mfd 350v, 2/6 ea.; 32+32+16mfd 350v, 3/6 ea.; large can types, special bargains, 32+32mfd 450v, 550v, surge, our price 4/11 ea.; 60+150mfd 275v d.c. wkg., 4/11 ea.
TUB-CARD wend types, 8mfd 450v, 1/11 ea.; also T.C.C. type 8mfd 450v, 550v surge, 2/9 ea.; 4mfd 150v drylitic type, 10d ea.
STILL a super winner, mains trans., by Parmeko, universal fixing, primary tapped, 0-200-220-240v, sec. 290-0-290v 80 m.a., 6.3v 3amp, and 6.3v tapped at 4v 2amp, with screen, our price 15/11 ea., inc. p/post.
ANOTHER good buy, small mains trans., with vol/panel, tapped 200-210v, 220-230v, 240-250v, primary; secondary, 250-0-250v, 60m.a. with 6.3v tapped at 5v, our price 11/9, inc. p/post.
FILAMENT trans., primary, 0-250v, sec. 6.3v at 1.5amp, 5/11 ea.; or 3amp type 8/11 ea.
DUAL range Litz wound T.R.F. coils, 5/11 per pr., with circuit, for 200-2,000mtrs.
OUR new season radio-television list now ready.
TERMS: c.w.o., no c.o.d.; send 9d extra for postage orders under £5; 2½d s.a.e. all enquiries and list. [0021

COMPONENTS—SURPLUS AND SECONDHAND

RADIO CLEARANCE, Ltd., 27, Tottenham Court Rd., London, W.1. Tel. Museum 9188. ELECTROLYTICS, capacity, voltage, size, type of mounting, price post paid: 400, 6v, 1×2in, lug, 1/9; 250+250, 6v, 1×2in, lug, 2/-; 500+500, 6v, 1×3, lug, 2/6; 40+40, 150v, 1⅛×2, clip, 2/9; 40, 150v, 1×2, clip, 2/6; 20+20, 275v, 1×2, lug, 3/3; 16+32, 275v, 1×2, lug, 3/3; 16+16, 275v, 1×2, clip, 3/3; 32+32, 275v+50mf 25v, 1×3, lug, 3/6; 60+100, 275v, 1⅛×3, lug, 4/6; 100, 275/350v, 1⅛×3, clip, 3/6; 32+12, 350v, 1⅛×2, clip, 4/-; 16+16+16, 350v, 1⅛×2, clip, 1⅛×2, 4/9; 16, 350v, ¾×2, lug, 1/9; 40+40, 300v, 1×3, lug, 3/6; 10, 450v, ¾×2, lug, 1/6; 16, 450, ⅞×2, tag, 2/9; 20, 450v, 1×2, lug, 2/3; 32, 450/525v, 1⅛×2, clip, 3/9; 32+32, 450v, 1⅛×3, clip, 5/6; 30+30, 450v+20mf 25v, 1⅛×3, lug, 5/-; 15+15, 450v+20mf 25v, 1⅛×3, lug, 4/6; 200, 6v, ⅝×1¾, clip, 1/6; 100, 12v, ⅝×1¾, clip, 1/9; 8, 450v, 1×2, clip, 2/-; 50, 12v, ⅞×1⅛, tag, 1/6; 150, 25v, ¾×1¾, clip, 2/-; 250, 12v, ¾×1¾, wire, 2/3; 350, 25v, 1×2¼, clip, 2/6; 16+16, 450v, 1⅛×2, clip, 4/-; 40+40, 275v, 1⅛×2, clip, 3/3; 16+32, 450/525v, 1⅛×2, clip, 5/-; 24+24+16, 350/425v, 1⅛×2, clip, 4/9; 60+200, 275/350v, 1¾×4½, clip, 6/6; 4, 150v, ⅝×1¾, clip, 1/1; 500, 12v, 1⅛×2¾, clip, 2/-; 8, 350v, ¾×2, clip, 1/9; 100+200, 275/350v, 1½×4½, clip, 6/6; 100+175, 275/350v, 1⅛×4½, clip, 6/6; 32+32, 350/425v, 1⅛×2, clip, 5/-; 8+16, 450/525v, 1×2, clip, 4/-; 2, 450/525v, ¾×1¾, tag, 1/6; 2, 350v, ¾×1¾, tag, 1/3; 1,000, 6v, 1×2¾, clip, 2/9; 8, 450v, ¾×2, clip, 1/9; 6,000, 6v, 1⅛×3, clip, 4/9; all all cans, some with sleeves all voltages. WKG. surge where marked new stock, guaranteed. [0015

TELEVISION! Set of 3 components, comprising line output trans., with E.H.T. winding to give 7kV, using EY51 (heater winding for EY51 also included), and fitted with width control scanning coils, low impedance line and frame, focus coil (res, 10,000Ω, current approx. 20 mA); the set of 3 for 42/-, plus 2/- post, diagram of line trans. supplied.

PERSONAL receivers, 3 valve T.R.F. using 1T4s, contained in handsome bakelite case with lift-up lid, size 7×6½×5in with lid closed, plastic carrying handle, fram. AE in lid, these receivers cover the medium waveband and operate from self-contained dry batts., standard types, W1435 and U2, output to a pair of lightweight 'phones (H.R.), controls, SM tuning and reaction, opening lid switches on, supplied brand new, with valves, batteries, 'phones, an ideal set for invalids hos, patients, etc., these receivers are not Govt. surplus and are offered ready to play; carr. paid £4/10.

UNIVERSAL amplifiers, 8-valve 20watt A.C./D.C., black crackle chassis, and black and chrome cover, overall size 15½in×7½in×7in. First-class components (Partridge O.P.T., and driver, Gardner choke, A.E.E. Mu-Metal input trans. for mike). Valves, 2×EF37, 4×CL33, 2×UR3C. Switched input for high or low imp., top cut and bass cut switches, V.C., mains switch, mains plug and socket, 220-250v, isolated chassis, 15Ω output. Wired and tested, ready for use, with valves, brand new, £10/19/6, carr. paid.

5 mA meters, moving coil, Bakelite case, 2in square, flush mounting, new, boxed; 8/- post paid.

RADIO CLEARANCE, Ltd., 27, Tottenham Court Rd., London, W.1. Tel. Museum 9188. [0015

SOUTHERN RADIO SUPPLY, Ltd., 11, Little Newport Street, London, W.C.2. See our displayed advertisement, page 132. [0016

T.V. tubes, £1 9in, 30/- 12in, work perfect, but have ion burns, ideal for testing or standby; post and insurance 15/6 extra.—Duke & Co., 621, Romford Rd., Manor Park, E.12. [2317

WANTED, EXCHANGE, ETC.

VHF test equipment.

TS47AP, TS174, TS175/U, TS148 or TSX-4SE; analysers; BC221 freq. meters, TS69, and any U.S.A. test gear; Klysrons type 723/AB, 2K33 2K39 2K41; receiver, APR4 and units TN16 17-18-19; RCA AR88D, S27 and SX28s and S27CA; microwave equipment; highest offers given by return.—Ger. 8410. Universal Electronics, 27, Lisle St., Leicester Square, London, W.C.2. [0229

WANTED, Wilcox Gay V.F.O. units in new or modified condition.
McELROY-ADAMS MFG. GROUP, Ltd., 46, Greyhound Rd., London, W.6. Tel. Fulham 1138/9 [0194

WANTED, receivers A.P.R.4. also T.N. 16, 17, 18, 19, etc., and any radio test gear.
LESLIE DIXON & Co., 214, Queenstown Rd., Battersea, S.W.8. Macaulay 2159. [0176

WANTED, R.C.A. transmitters, all types or any R.C.A components, including chassis and metal work.
McELROY-ADAMS MFG. GROUP, Ltd., 46, Greyhound Rd., London, W.6. Tel. Fulham 1138/9 [0196

A COLLINS 75A receiver wanted.—Parvin, 19, Fellbrook Ave., Acomb, York. Tel. 78283. [2323

WANTED, set manufacturers' or ex-Government radio equipment, large or small quantities of valves, electrolytics, speakers, meters, also components.
LOWE BROS., 5, Fitzroy St., London, W.1. Tel Museum 4389 [9745

WANTED, HRO coils, Rxs, etc., A.R.88s, BC348s, S27s, etc.—Details to R.T. & I. Service, 254, Grove Green Rd., London, E.11. Ley. 4986. [0163

WANTED, EXCHANGE, ETC.

WANTED, TCS/6 or TCS/12 transmitters in mint condition; also control boxes for same.—McELROY-ADAMS MFG. GROUP, Ltd., 46, Greyhound Rd., London, W.6. Tel. Fulham 1138/9. [0195

WANTED, platinum and mercury for spot cash.—A. Hamburger & Sons, Ltd., 57, Lower Tower Street, Birmingham, 19. Tel.: Aston Cross 1548-9. [1977

NO. 10 headsets or No. 13 microphones, large or small quantities required top prices paid.—Industrial Suppliers (Cambridge), Ltd., 15a-17, Brecknock Rd., London, N.7. Gulliver 5891. [2018

WANTED, R.C.A. speech amplifiers, type MI-11220 J. or K and Ariel tuning units BC939a; offers stating quantity and price to—P.C.A. Radio, Office and Works, Beavor Lane, Hammersmith, W.6. Tel. Riv. 8006. [0079

WANTED, BC-610 Hallicrafters, R.C.A.-4336 transmitters SX-28, AR-88, S-27 H.R.O. receivers and spare parts for above; best prices.—P.C.A. Radio, Office and Works, Beavor Lane, Hammersmith, W.6. Tel. Riv. 8006. [0080

ALTHAM RADIO Co. pay highest prices in the trade for all American equipment, including test sets, transmitters, receivers, teleprinting gear, etc.—Jersey House, Jersey St., Manchester, 4. Tel. Central 7834-6. [0228

WANTED, AN/APR-4 receiver, any units; any other good quality U.S. surplus radio and radar tubes, test sets; laboratory equipments, etc.; give condition and price in first letter.—Engineering Associates, 434, Patterson Rd., Dayton, 9, Ohio, U.S.A. [0234

WANTED, good quality communication rxs., domestic radios, test equipment, etc.; top prices paid, established since 1937.—Miller's Radio, 38a, Newport Court, 1 min. from Leicester Sq. Tube. Tel. Ger. 4638. Call, write or send. Hours of business 10-6 p.m. Open all day Saturday. [0199

WANTED, signal generators types 30, 31, 51, 53, 54, 56 and 101; also any American test equipment with prefix TS or BC. American receivers types AR88, APR4 or similar.—Send price and details to Hatfield Instruments, Ltd., 175, Uxbridge Rd., Hanwell, W.7. Tel. Ealing 0779/9857. [0037

WANTED: we will pay 10% more for the following American equipment; test sets with TS prefix, BC221, APR4 receivers, APR4 tuning units, BC342, BC312, power units No. 15 and PE98, teleprinter equipment.—Altham Radio Co., Jersey House, Jersey St., Manchester, 4. Tel. Central 7834-5-6. [0227

WILL buy ART/13-T47A or T47 type transmitter; R5/ARN7 radio compass receiver; BC348 receiver; ARC3 radio complete; R77 receiver; EC312 and BC342 receivers; APN9 Loran transceiver; R89B Glidepath; 788C altimeter receiver; IEI52C scope; RA20 power units; T17 microphones; TS67 test sets.—Write H. J. Burke Co., 49, Washington Avenue, Little Ferry, N.J. [2310

VALVES WANTED

VALVES urgently wanted for export, types 813, 723A/B, 250TH, 833, any quantity; highest prices paid.—Write Pype-Hayes Radio, 606, Kingsbury Rd., Birmingham, 24 (Erdington 4942.) [2016

45/- paid for 813 valves, 60/- 723 A/B; also wanted, 805, 803, 807, 2J32, 2K33, TZ40, 808, etc.; any quantity; write.—Pype Hayes Radio, 606, Kingsbury Rd., Birmingham, 24. (Erdington 4942.) [1861

BATTERIES

JUST released by the Ministry.—All-dry H.T./L.T. batteries, 72 volt H.T.+1.5v L.T., layer type size, 6in×5in×2in; also 60v H.T.+1.5 L.T., ideal for deaf aids, personnel sets, models, etc., size 4in×3½in×1⅝in, all tested and guaranteed full voltages before despatch; our special price 4/6 each, post and packing 1/3 or two for 8/-, post and packing 1/6.—Walton's Wireless Stores, 48, Stafford St., Wolverhampton. [0061

CABINETS

LEWIS RADIO have the best selection and finest finish.—See page 142. [0224

WALNUT radiogram cabinets; details.—Cabinetware, 1a, Heyes St., Blackburn.

TELEVISION, radio, radiogram and tape-recording cabinets.—157, Bromsgrove St., B'ham. Mid. 1054. [2133

CABINETS made to order; send details for quotations. BASS REFLEX CABINETS, finished in period or contemporary styles. See display advertisement, page No. 138. Open till 5.30 Saturdays.—A. Davies & Co. (Cabinet Makers), Hampstead. Gulliver 5775. [2319

REPAIRS AND SERVICE

MAINS transformers rewound, new transformers to any specification.
MOTOR rewinds and complete overhauls; first-class workmanship; fully guaranteed.
F.M. ELECTRIC Co., Ltd., Potters Bldgs., Warser Gate, Nottingham. Est. 1917. Tel. 47898. [0113

TRANSFORMER rewind service, mains, E.H.T. transformers and chokes, prompt delivery, range of replacement types ex stock or manufactured to your specification.
METROPOLITAN RADIO SERVICE Co., 75, Kilburn Lane, London, W.10. Ladbroke 2296. [0200

REPAIRS AND SERVICE

ELECTRIC blankets and clocks repaired: efficient service. ELECTRONIC, 157, Tullibardine Rd., Sheffield. [1994

MAINS transformers, E.H.T. line outputs, chokes and field coils, etc., promptly and efficiently rewound or manufactured to any specification; 12 months' guarantee. LADBROKE REWIND SERVICE, Ltd., 820a, Harrow Rd., Kensal Rise, N.W.10. Lad. 0914. [0222

REPAIRS.—Mains, EHT or OP transformers, field coils and chokes; also armatures and motors. New transformers designed to specification. All items fully vacuum impregnated. TRANSFORMER SERVICE Co., 2a, Frithville Gardens, Shepherd's Bush, W.12. Tel. Shepherd's Bush 5819. [0075

ELECTRICAL test instruments repaired and standardized, all types British or American, ammeters, voltmeters, ohmmeters DC/AC multi-range meters, etc.; meters converted to specification. THE ELECTRICAL INSTRUMENT REPAIR SERVICE, 329, Kilburn Lane, London, W.9. Tel. Lad. 4168. [2011

AUDIO equipment repaired, rebuilt, modified, disk or tape recorders, amplifiers, tone control units, sound projectors; quotations without obligation.—Bernard J. Brown, 33, Goldhawk Rd., London, W.12. [0025

REWINDS and conversions to mains and output trans, pick-ups, fields, clock coils, etc., from 4/6; PP equipment a speciality; all work guaranteed.—N.L. Rewinds, 173, High Rd., Willesden Green, N.W.10. Tel. Wordsworth 7791. [2306

24-HOUR service, 6 months' guarantee, any transformer; rewind, mains outputs and i.f.s., etc.; all types of new trans., etc., supplied to specification; business heading or service card for trade prices.—Majestic Winding Co., 180, Windham Rd. Bournemouth. [6520

ALWAYS at your service, high quality transformers made to suit your requirements or rewound to the original specifications. Woodrow Transformers, Ltd., now removed to larger premises, thus enabling the employment of more labour and a quicker turn round of orders.—New Address, 7, Dudden Hill Lane, Willesden, N.W.10. All work fully guaranteed. [2243

ARMATURE rewinding service to the trade, vacuums, drills, grinders, hood dryers, dental motors, vacuum cleaner armatures replaced from stock, 24 hours service; every job guaranteed; we also specialise in complete overhauls and rebuilds of vacuum cleaners; all vacuum cleaner parts, hoses, bearings, fans, brushes, for any make in stock.—Regam Electric, 95, Park Lane, Leeds, 1. [2253

PAINTS, CELLULOSE, ETC.

PAINT spraying handbook, 3/6 post free, cellulose and synthetic paints and all spraying requisites supplied; catalogues free.—Leonard Brooks, 53, Harold Wood, Romford. [0207

BUSINESS OPPORTUNITIES

OLD-ESTABLISHED firm of exporters in the electronic field, invite manufacturers seeking overseas sales, to communicate Box 0239.

WORK WANTED

ASSEMBLY, wiring of all types of electronic eqpt., control panels, switchboards, etc.—R.A.E., 377, High Rd., London, N.2. [0219

ASSEMBLY and wiring of electronic equipment to G.P.O. standards, high-quality work at competitive rates.—Write, Medley Radio, 48, Battersby Rd., Catford, S.E.6. [2251

LABELS, panels, engraved, quantities hot press process, keen prices, prompt deliveries.—Plastic and Metal Engraving Co., 26, Lower Richmond Rd., Putney 8930. [2264

POLYSTERENE machined, electro-mechanical and miniaturised work undertaken; precise toroidal and resistor winding; pulsed power supplies at 20kV, to order.—Bel Sound Products Co., Genl. Electronic Mfgrs., A.I.D. approved contractors, Marlborough Yard, London, Archway, N.19. [0183

CAPACITY AVAILABLE

CAPACITY available; manufacturer of transformers up to 3 k.v.a. to R.C.S. 214, chokes, solenoids, etc.; have capacity available and invite enquiries from manufacturers; small runs of electronic assembly also undertaken; 1/6th h.p. induction motor in production, good delivery.—Avis & Baggs, Ltd., 11, Gosbrook Rd., Caversham, Reading. Tel. 71763. [2076

MISCELLANEOUS

SALE TV/radio service sheets, 2/- each, s.a.e.; list available, 1/-; s.a.e.—"Ratel," 171, Norris St., Preston, Lancs. [2301

METALWORK, all types cabinets, chassis, racks, etc., to your own specifications; capacity available for small milling and capstan work up to 1in bar. PHILPOTT'S METAL WORKS, Ltd. (G4B1), Chapman St., Loughborough. [0208

TAPE recordings transferred to disc, very reasonable prices, guaranteed satisfaction; write.—"Personaldiscs," 50a, Powney Rd., Maidenhead, Berks. [2092

EX-GOVERNMENT steel instrument cases, copper plated and finished grey, size 23in long, 10in high and 7in deep; 10/-, plus 2/6 carriage.—Weatherhead's, Bletchley, Bucks. [2088

MISCELLANEOUS

A HIGH vacuum impregnation unit or single or batch coil impregnation service to R.I.C. specification 214 or individual requirements.—Blickvac, 505, Lordship Lane, S.E.22. Tel. Forest Hill 7089. [0310

YOUR own tape recording transferred to disc. —Write, call or 'phone Queensway Private Recording Studios, 123, Queensway, W.2. Tel. Bay. 4992. Studio recordings, tape recording service. [2187

ENGRAVING amateurs and trade could take the opportunity of engraving problems in the future by getting in touch with A.G. Engraving, 19a, Windmill Rd., London, S.W.18. Bat. 5793. Brass, bronze, erinoid, Perspex dials; one knob or repetition equally entertained. [0034

COPPER wires enamelled, tinned, Litz, cotton, silk covered, all gauges; B.A. screws, nuts, washers, soldering tags, eyelets, ebonite and laminated bakelite panels, tubes, coil formers: Tufnol rod; headphones flexes, etc.; latest radio publications, full range available; list, s.a.e.; trade supplied.—Post Radio Supplies, 33, Bourne Gardens, London, E.4. [0138

PATENTS

THE proprietor of British Patent No. 573313, entitled "Multiple section electronic tube and method of making it," offers same for license or otherwise to ensure practical working in Great Britain.—Inquiries to Singer, Stern & Carlberg, 14, East Jackson Boulevard, Chicago 4, Illinois, U.S.A. [2191

SITUATIONS VACANT

The engagement of persons answering these advertisements must be made through the local office of the Ministry of Labour and National Service, etc., if the applicant is a man aged 18-64 *or a woman aged* 18-59 *inclusive, unless he or she or the employer is excepted from the provisions of The Notification of Vacancies Order* 1952.

ELECTRONIC engineers.

ENGINEERS interested in radar as a career, are invited to apply to Decca Radar, Ltd., to join the Company on its development programme, covering a wide field of radar and associated techniques. Applicants must have H.N.C. and a thorough knowledge of basic circuitry; British nationality essential; there are good starting salaries and prospects of rapid advancement with this expanding company.—Write quoting ref. RLA/11, Decca Radar, Ltd., Research Laboratory, 2, Tolworth Rise, Surbiton, Surrey. [0257

ELECTRICAL engineers.

WAYMOUTH GAUGES & INSTRUMENTS, Ltd., a subsidiary company of Smiths Aircraft Instruments, Ltd. have vacancies in their Aircraft Fuel Gauge Laboratory for Assistant Engineer, required for development of electronic fuel gauging equipment; they should have an engineering degree or Higher National Certificate. Technical Assistants are also required for experimental work in electrical measurements; preference will be given to applicants holding a technical qualification.—Apply in writing to the Chief Development Engineer, Waymouth Gauges & Instruments, Ltd., Station Road, Godalming, Surrey. [2293

TELEVISION.—Careers for young men.

LIMITED vacancies exist upon work which is an introduction to checking and adjusting of electronic circuits on TV receivers; specialized knowledge not necessary, as suitable applicants will receive training.—Apply in writing to Personnel Manager, Pye, Ltd., St. Andrews Rd., Cambridge. [2273

ELECTRONIC engineers are required by

THE ENGLISH ELECTRIC Co., Ltd., Luton, for work on a high priority defence project. Applicants will be required to undertake the engineering of circuitry already developed, which involves close liaison with, and the progressing of work through, the drawing office and production department. Applicants with experience of the engineering of radar and/or aircraft electronics for production will be especially welcome. The posts are permanent and progressive and a staff pension scheme is in operation. Applications to Dept. C.P.S., 336-7, Strand, W.C.2. quoting ref. 1211. [2114

VACANCIES in Government Department.

DRAUGHTSMEN are required, with experience in the layout of telecommunication and electronic equipment, involving detailed mechanical design, preparation of all mechanical drawings, sub-assemblies and final assembly, circuits, specifications, and stock-lists; suitable for prototype and batch production manufacture.

PRACTICAL workshop experience, and knowledge of modern methods an asset but not essential.

SALARY.

FOR a week of 44 hours: £374 per annum at age 21, rising by annual increments of £20 to £597 per annum.

AN extra duty allowance of 3% will also be paid for working 45½ hours each week.

APPLY in writing:—

PERSONNEL Officer, G.C.H.Q., 53, Clarence St., Cheltenham. [2311

RADIO/television service engineer required, salary from £600 per year.—Tel. Pri. 1161. [2294

SITUATIONS VACANT

SENIOR microwave engineers are required by:—

THE ENGLISH ELECTRIC Co., Ltd., at Luton, for work on a high priority defence project. Applicants should have a good theoretical background to degree standard and experience of design or engineering of microwave equipment for development work on aerial and receiving systems. This work includes investigations of new methods of construction with a view to miniaturisation and weight reduction, the design of new components and engineering to the production stage. Successful applicants will be required to take charge of a group and to be responsible for one or more aspects of the system. The posts are permanent and progressive and a staff pension scheme is in operation. Applications to Dept. C.P.S., 336-7, Strand, W.C.2, quoting ref. 1160B. [2115

MARCONI INSTRUMENT Co., Ltd., St. Albans.
VACANCIES exist for both Senior and Junior Electronic Engineers with this well-known company. The vacancies which arise from an expansion of the company's business, cover a large field. Applications are particularly welcomed from young graduate engineers who have had some industrial experience. For the junior vacancies the minimum technical qualifications required is the City and Guilds Final Certificate in telecommunications. The posts are both pensionable and permanent.
APPLICATIONS, which will be treated with the strictest confidence, should be sent to Dept. C.P.S., 336-7, Strand, London, W.C.2, quoting Ref. No. S.A.34A. [2211

THE STEEL COMPANY OF WALES, Ltd. (Tinplate Division), Trostre Works.
ELECTRONIC technicians required for maintenance of various types of industrial electronic control consideration will be given to applicants without experience in the above, but with at least five years' experience in the radio industry on maintenance; excellent wages and working conditions in modern cold reduction plant.—Applications, giving details of age, qualifications and experience, should be submitted to:
THE Supt. Labour and Wages, The Steel Company of Wales, Ltd. (Tinplate Division), Carmarthen Rd., Swansea. [2225

TECHNICAL Instructor (Broadcasting) required by the
NIGERIAN Government on contract for two tours of 12-15 months; possibilities of permanency; salary, etc., according to experience in scale £1,170 rising to £1,269 a year; outfit allowance £60; free passages for officer and wife and assistance towards cost of children's passages or grant up to £150 annually for their maintenance in this country; liberal leave on full salary; candidates must have been employed at the B.B.C. Technical Training School at Evesham and have reached Grade C minus or above.
WRITE to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/30305/WF. [2266

METROPOLITAN Ear, Nose and Throat Hospital, 14-16, Granville Place, London, W.1. (A HOSPITAL of the Fulham and Kensington Group.)
HEARING Aid Technician required immediately. (Temporary post in first instance.) National salary scales and conditions.
APPLICATIONS, giving full particulars, should be made to the Administrative Officer (WW156) immediately. [2258

APPLICATIONS are invited from Senior Development Engineers with experience in any of the following fields:—
1. V.H.F./U.A.F., including tuners, for television and for communications equipment.
2. TELEVISION receiver design.
3. VARIABLE capacitors.
4. RELAYS and switches for special circuit applications.
APPLICANTS should possess an engineering degree or equivalent qualification and have experience in industry or one of the technical establishments engaged on this type of work. Initial salaries will be in accordance with qualifications, experience and age. The appointments are of a permanent and progressive nature and a company pension scheme is in operation.
APPLICATIONS, which will be treated in strictest confidence, should be addressed, quoting reference WW/844, to Box 2347. [2249

FERRANTI, Ltd. (Computor Dept.), Moston, Manchester, have vacancies for the following:—
(1) ELECTRICAL Engineers possessing at least a good Honours Degree for development work on large-scale electronic digital computers. Ref.: DCD.
(2) ELECTRICAL Engineers of approximately graduate status to be trained for the maintenance of the Ferranti computers. Experience in the servicing of large electronic equipments such as radar systems would be an advantage. Successful applicants would be based on the Moston factory but should be free to travel in the normal course of their work as maintenance engineers.
THE work might also be regarded for some candidates as post-graduate training in electronic equipment prior to joining the development sections of the department. Ref.: DCM.
PERMANENT staff appointments with pension benefits. Application forms on request from Mr. R. J. Hebbert, Staff Manager, Ferranti, Ltd., Hollinwood, Lancs. [2095

SITUATIONS VACANT

ELECTRONICS Division of Murphy Radio have vacancies in their design unit at Ruislip for:—
1. PHYSICS or electrical engineering graduates preferably with experience of electronic design.
2. DRAUGHTSMEN with experience in this field.
APPLICATIONS should give full details of experience and qualifications and may be addressed in confidence to Personnel Department. Murphy Radio Limited, Welwyn Garden City when arrangements will be made for suitable applicants to be interviewed at the Ruislip Works. [2288

RADIO testers required, some V.H.F. experience desirable together with some servicing knowledge on domestic or service equipment. MODERN factory; pleasant working conditions; single board available.
APPLY in writing, with full details of past experience, to Personnel Manager, Pye Telecommunications, Ltd., Ditton Works, Cambridge. [2280

TELEVISION and radio engineer required, good appearance, conversant with all makes and able to drive.—Write Maurice Richards, Ltd., Radio House, Leatherhead, Surrey. [2305

KELVIN & HUGHES, Ltd., Barkingside, Essex have vacancies for research engineers for experimental work relating to underwater sound apparatus.
APPLICANTS should be of degree standard and should have a sound knowledge of communications, in particular electronics.
APPLICATIONS, stating salary required, should be addressed to the Personnel Manager, Kelvin & Hughes, Ltd., New North Rd., Barkingside, Essex. [2278

RADIO and Radar Engineers required for work in test department, preference will be given to radio engineers with experience of testing communication receivers, or
RADAR Engineers with experience on H²S aircraft equipment.
SUCCESSFUL applicants will be employed as testers, and must be capable of working with a minimum of supervision
ATTRACTIVE conditions and rates to successful applicants.
APPLY in writing, or phone to Airtech, Ltd., Aylesbury and Thame Airport, Haddenham, Bucks (Tel. Aylesbury 1163). [2325

SALES Manager required, electronic equipment for services and industry, engineering background essential; London; exceptional opportunity for young man.—Box 2426. [2263

TV service engineer wanted Heston, Middlesex; good salary, permanency; must drive, good appearance and ability; inside and outside work; progressive situation.—W. A. Fowler, 331, Vicarage Farm Rd., Heston. [2247

TELEVISION engineer required, fully experienced, able to drive; permanent, progressive position; £600 p.a.—Full particulars to Central Radio, Ltd., 15, Langley Rd., Eastbourne. [2303

TELEVISION—RADIO service engineer required, used to all makes of TVs; clean licence; flat available if required.—Write, stating experience, wages, Paynes, 11, Ford St., Coventry. [2274

FIRST-CLASS car radio mechanic required by Rootes Group distributors, good salary and prospects, permanent position; apply in writing in first instance with copies of references.—Kirbys, Ltd., 45, Duke St., Liverpool. [2284

TELEVISION—RADIO, 1st engineer required to take charge of service, ability to drive an advantage; old-established firm London, N.W.3; salary in accordance with abilities; permanency.—Box 2496. [2281

ELECTRONIC engineers required for research and development work on the application of electronic digital computing techniques to business accounting machines; there are vacancies for the following:—
(i) UNIVERSITY graduates with Honours Degree in Physics or Electrical Engineering; 1 or 2 years' experience in electronic research and development field an advantage but not essential.
(ii) ENGINEERS holding Higher National Cert., Ordinary National Cert., or similar qualifications, and with practical experience of electronic equipment.
APPLICANTS without academic qualifications would be considered if they have had experience of electronic equipment, preferably of pulse techniques as used in digital computing, radar, etc.; salaries will be based on qualifications, experience and age.—Applications, stating age, qualifications, experience, etc., to Personnel Office, British Tabulating Machine Co., Letchworth, Herts. [2142

SENIOR position in servo analysis group (A) working on guided weapon control systems; applicants should hold honours mathematics degree, have some experience in servo mechanism systems or electrical engineering; age 28 to 32 approximately.
ELECTRONIC engineer (B) with desire to produce instructional literature on new product; engineering background, diplomatic approach and command of words more important than knowledge of printing; will ultimately function as technical editor in charge of section of publications department.
PLEASE write in detail quoting reference of post sought to Personnel Manager, de Havilland Propellers, Ltd., Hatfield, Herts. [2151

SHORT WAVE RECEIVERS R103a. For use on 100/110 volts 230/250 volts A. and 12 volt battery. Comprising six valves and built in vibrator unit Covering 1.7 mc/s. to 7.5 mc/s. Brand new In perfect working order £9/15/- plus 5/- carriage.

BRAND NEW AND BOXED METERS AS UNDER.
0/3500 volt meters D.C. Moving Coil 3In. scale 4in. stand off 20/- each.
0/6 amp. Thermo Couple 2½in. flush, 7/6 each.
0/30 M/a Moving Coil D.C., 10/- each.
0/15 Volt A.C. Moving Iron 2½in. Flush 15/- each.
0/300 M/a. Moving Coil D.C. 2½In. Flush, 10/- each.
0/200 M/a. Moving Coil D.C. 2½in. Flush, 10/- each.
0/1 M/a. Moving Coil 2in. square, 15/- each. Postage 9d. extra on all meters.

LOUDSPEAKING TELEPHONE UNITS. These units are complete with I Large Press Button TRUVOX Carbon Mike and C.L.R. Headphones. Working off 12 volt battery they can be used to speak to four positions at the same time. Brand new in cases at only £1/15/-, carr. free.

BUZZER VALVE UNITS Type 2. Can be used as Morse Training Aids with facilities for Interference input. Less valves (2) 7/6 each, carr. free.

SIGNALLING TORCHES. Still a few available at 3/9 each, post 9d.

CUT-OUTS. 12 and 24 volt 60 amp., as previously advertised, 10/- each, post 9d.

0/50 A.C. MOVING IRON 4in. PANEL MOUNTING METERS. Last few now offered at the knock-out price of 17/6 each, post 1/-.

TELEPHONE OPERATOR HEAD AND BREAST SETS. Twin Phones No. 2, 12/6 each, post 1/-.

TAPE DECK CABINETS. Finished in Imitation Lizard Skin. Colours Green, Red, Grey, Blue, Brand New, with space for amplifier, £3/12/6 each, Carriage 2/-. Please state alternative colour.

SOLDER. 1lb. reels of 40/60, 5/- per reel, post 1/-.

EARPHONES. 60 Ohm. C.L.R., 5/- pair, and 4,000 Ohm, 17/6 pair, post 1/-.

JONES PLUGS. 8-way chassis mounting, 7/6 doz. 8-way with covers, 9/- doz., 4-way chassis mounting, 6/-, post 9d. doz.

JONES SOCKETS. 8-way chassis mounting, 7/6 doz. 8-way with covers, 9/- doz. Post 9d. doz.

JONES PLUGS AND SOCKETS, MIDGET. 12-way plug shrouded, 2/6 pair, post 3d.

BRAND NEW. 50 mfd. Motor Capacitors. 10/6 each, post 9d.

Manufacturers of Standard Post Office relays to your own specification.

Quotations by return—prompt delivery.

UNIVERSAL ENGINEERING CO.
Havelock Works, Havelock Place, Harrow, Middlesex. Harrow 1432.

TELETRON SUPER INDUCTOR COILS

Miniature Dust Core Types.

Type HAX.R.F. Transformer, Triple wound for Germanium Xtal Diodes. ● Q 100 ● Gain 33 Times ● No overlap. Unique performance. Each 3/-.

DUAL WAVE TRF. COILS

Type TRF.A/HF. or TRF.A/D. Tuned anode with reaction. Ae. Primary windings designed with rising characteristic to balance fall in ckt. Q." Matched pairs. Pr. 7/-. S/het. range for S., M and L.W. Pr. 6/-. I.F. Transformers, Filters, etc. Stamp for circuits and data.

THE TELETRON CO.,
266, Nightingale Road, London, N.9.
Trade enquiries to sole distributor: **SAM MOZER, 95, Kendal Avenue, N.18.** Edm. 7707.

SITUATIONS VACANT

RADIO service mechanics required by Smiths (Radiomobile). Ltd., for all parts of the country.—Write details of experience and qualifications to Personnel Officer, Goodwood Works, North Circular Rd., London, N.W.2. [0342

McMICHAEL RADIO, Ltd., require experienced radio technicians for the inspection, testing and servicing of Government radio and electronic equipment.—Apply to Personnel Manager, Wexham Rd., Slough, Bucks. [2129

ARE you seeking a well paid permanent situation, with congenial conditions of employment? We have vacancies for television and radio engineers at our Service Dept.—Apply Janes & Adams, Ltd., 1064, High Rd., Whetstone, N.20. Hillside 5555. [2315

DRAUGHTSMAN required immediately for light electrical engineering factory, Stockport district; must be experienced in electronic instruments and test gear; 5-day week, canteen facilities; write stating salary required and qualifications.—Box 2603. [2326

FIRST-CLASS public address engineers required by leading company for London and Home Counties; good remuneration to right men; own car an advantage.—Apply Tannoy Products, Ltd., West Norwood. Gipsy Hill 1131. [2298

RADIO and television engineer required for old-established firm, high wages and permanent position for suitable applicant; all applications considered.—Apply A. Hartill & Sons, Ltd., 8-12, Mount Pleasant, Bilston, Staffordshire. [2152

RADAR engineering.—Two important vacancies exist on the permanent staff of an influential company concerned with high priority production and installation in Huntingdonshire of radar systems, much of which involves American equipment.
BOTH positions are progressive, pensionable and well salaried.
THE first is for a production controller (Ref. P.C.), who should already have had first-class experience of a similar nature and be thoroughly conversant with radar and/or radio engineering production of a high order; he will be a competent executive who knows assembly line production, can handle production layouts, in fact all aspects of this highly important function.
THE second vacancy concerns a production engineer (Ref. P.E.), who has already established his abilities in an efficient, well organized production unit, and who has an intimate knowledge of detailed engineering production in the radio/radar field.
APPLY, quoting above references, in strict confidence, to Box 2488. [2271

YOUNG graduate engineers are invited to apply for interesting positions with The English Electric Valve Co., Ltd., at Chelmsford; experience of microwave work whilst desirable is not essential.—Write, quoting ref. 419K, to Dept. C.P.S., 336-7, Strand, W.C.2. [2256

TECHNICAL Representative required in London area to deal with electronic instruments for marine purposes (not navigational or radio equipment); basic knowledge of physics and electronics essential; degree an advantage.—Box 2420. [2262

ACOUSTICAL vibration general engineers for new acoustic and physical laboratories; experienced men wishing to specialise in either or both subjects, please apply stating qualifications, age, salary required.—Goodmans Industries, Ltd., Axiom Works, Wembley. [2265

EXPERIENCED radio testers and inspectors required for production of communication and radio apparatus, also instrument makers, wirers and assemblers, for factory test apparatus.—Apply Personnel Manager, E. K. Cole, Ltd., Ekco Works, Malmesbury, Wilts. [0238

DRAUGHTSMEN, experienced, required by Decca Radar, Ltd., for permanent posts in the expanding field of radar engineering; excellent opportunities for advancement exist, the salary ranges being well beyond A.E.S.D. rates; staff pension scheme; British nationality essential.
POSTS are to be filled in the following grades: Senior section leader, checker draughtsman and senior design draughtsman; intermediate draughtsman; circuit draughtsman; installation draughtsman.—Apply ref. R.D.J., Decca Radar, Ltd., Radar Research Laboratory, 2, Tolworth Rise, Surbiton, Surrey. [2050

ELECTRONIC engineers with practical factory experience and technical training, preferably up to H.N.C. standard, required for liaison and development work on radar and allied equipment; staff and pensionable positions.—Apply to Personnel Dept. (CE/18), E.M.I. Factories, Ltd., Hayes, Middx. [2252

RADIO and radar testers, first-class men required for work on V.H.F. communication gear and Government contracts for radio and radar equipment by Midland manufacturers.—Men with wide experience of fault finding in any of the fields mentioned should write, giving full details, to Box 1562. [2046

APPLICATIONS are invited from craftsmen for radio and television service in areas within Herefordshire and Shropshire; applicants must be fully experienced in the repair and maintenance of all types of radio and television receivers; rate of pay at present 3/8 per hour, N.J.I.C. conditions.—Apply in writing to Sub-Area Manager, Midlands Electricity Board, Ditherington, Shrewsbury. [2307

W. B. STENTORIAN HF1012

No loudspeaker has gained such popularity within so short a time as this new 10in. unit.

The unique cone construction puts bass resonance as low as 35 c.p.s. and output is well maintained to the higher frequencies. A powerful magnet of 12,000 gauss is employed, and the speaker will handle up to 10W. 3 or 15 ohm.

High fidelity speakers have until now been priced considerably higher, and the performance of this speaker at only 73/6 has been a revelation to all who have heard it.

Also 9" 67/-d., 8" 60/6d., 6" 50/6d.

Special Offers . . .

10in. loudspeakers, famous make, cast chassis, 12,000 gauss, 15 ohm. *Usually 69/- reduced to* **52/6.** Bass Reflex Console Cabinets, 30in. high, for 10in. speakers, heavy ply built, polished walnut veneer. *Usually £9/5/- reduced to* **£7/18/6.**

"The Gramophone" AMPLIFIER

Performance vies with the most expensive models, yet inherent simplicity makes it much lower in cost. We offer it either ready built or in kit form

Amplifier 17 gns. *Complete with valves, tested.*
Pre-Amplifier for magnetic p.u., 5 gns.
Control Unit for crystal p.u., 45/-.

Extended Payment Terms
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£7/14/- and 12 monthly payments of £1/8/3.
Amplifier and Control Unit
£6/14/- and 12 monthly payments of £1/4/6.

9 w. output, 20 dB. feedback, only 0.1 per cent harmonic at 5 w., 20-20,000 c.p.s., latest Mullard valves, 3/15 ohm output, 200-250 v. A.C. mains.

Home Construction details 1/9 post free.

Decca 'H' L.P. Pickup

This smaller, lighter head attracted much interest at Earls Court. Interchangeable with earlier type with 3-pin fitting. Less record wear and better quality. Head only with sapphire 55/-. With diamond £6/18/-. Complete pickup with two heads, £6/9/6.

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GULliver 1131.

Order by Mail. Demonstrations by Appointment.

SITUATIONS VACANT

EXPERIENCED fault-finders wanted by Midland manufacturers of radio equipment; permanent posts located in the Midlands are offered to men with experience of radar, radio control, V.H.F. equipment.—Write, stating fully experience and salary required, to Personnel Manager, Box 1565 [2047

DEVELOPMENT engineers required by Short Brothers & Harland, Ltd., Belfast, for work on Guided Weapons and other interesting projects; ideal conditions in new laboratories for applicants with a degree or equivalent, and good practical experience in one of the following fields:—
(1) ELECTRONICS, preferably D.C. Amplifiers, Electronic Computation, Pulse Techniques or Miniature Equipment.
(2) SMALL Electro-Mechanical Devices, Servos or Instruments.
(3) PRECISION Mechanical Engineering, including Hydraulic or Pneumatic Servos, Medium/Light Mechanisms or Instruments.
GOOD salaries and prospects for men with initiative.
PENSION scheme, assistance with housing.
SEND full particulars of age, qualifications and experience, with salary required, to Short Brothers & Harland, Ltd., Precision Engineering Division, Castlereagh, Belfast, quoting Ref. No. E.3. [2071

A TECHNICAL sales engineer possessing the ability to interpret electronic circuits is required by a large radio and electronic component manufacturing firm; this post offers excellent opportunities to a man of the right calibre. —Applicants, who should be over 30 years of age, please reply to Box 2207. [2189

ACOUSTICAL MANUFACTURING Co., Ltd., Huntingdon, require an electronic engineer for building A.F. equipment up to 1 K.W.; technical knowledge and experience essential, including some knowledge of sheet metal work involved; permanent position for suitable applicant. [2302

EXPERIENCED radar, radio, or electrical control equipment mechanics required for Maintenance of Anti-Aircraft equipment in South Wales, Midlands and North West, wages £7/7 to £8/9, minimum age 21 years.—Application forms from O/C, 4 A.A. Group Workshops, R.E.M.E., Deysbrook Lane, Liverpool, 12. [2320

TELEVISION production engineer is required by a large company on Merseyside, knowledge of radio and experience in manufacturing techniques with particular reference to the production of television receivers is essential.—Reply stating age, experience and qualifications to Box 2549, quoting ref. ABAD. [2289

A PRODUCTION manager who has considerable experience in the production of all types of paper dielectric capacitors is required by a large and well-known firm; this position carries high remuneration, and only men of proved ability should apply.—Applicants reply, in confidence, to Box 2206. [2188

YOUNG electronic engineer required for development of equipment for the measurement of stress and vibration in rotary and fixed-wing aircraft. Degree desirable. Applications, with details of training and experience, should be made to the Personnel Manager, The Fairey Aviation Co., Ltd., Hayes, Middx., quoting reference TO/1. [2108

THE M.S.S. Recording Co., Ltd., Poyle Close, Colnbrook, Bucks, have a vacancy for a technical assistant required for electronic development work on magnetic recording equipment; practical experience or knowledge of mechanical design an advantage.—Apply in writing, stating age, qualifications and experience to the above address. [2192

SALES office manager, age 30-40, required to run small sales office, part of a large established business in Wiltshire, must be capable of handling customer's telephone enquiries, etc.; knowledge of radio an advantage; good prospects and opportunities; write stating age, past experience and salary required to—Box 2495 [2282

LARGE firm of telecommunication engineers (East London) require a junior capacitor engineer; successful candidate will be trained in the design of capacitors for a wide variety of applications; ordinary National Certificate or Inter. B.Sc. in physics or engineering essential; salary according to age and experience.—Write, giving full details, to Box 2372. [2255

ELECTRONIC engineer B.Sc. or H.N.C. for laboratory development work on miniature equipment using transistors; work in Slough/Marlow area; 5-day week; canteen; pension scheme; wide scope for energetic, versatile man with progressive ideas.—Full details of age, experience, salary required to Box M.1069, Haddens, Salisbury Sq., E.C.4. [2254

THE Brown's Lane division of the G.E.C. Stanmore laboratories urgently require a man for work in connection with radar development; a suitable applicant should have a knowledge of service procedure and a general, rather than specialized, knowledge of electronics; a degree or equivalent qualification is desirable, but a well-experienced man would be considered.
APPLICATIONS should be made in writing to the Staff Manager (Ref. R/BSP/AMMV), G.E.C. Stanmore Laboratories, Brown's Lane Division, The Grove, Stanmore Common, Stanmore, Middlesex, stating age, qualifications and experience. [2279

SITUATIONS VACANT

SERVICE engineers required for installation, flight testing, and servicing of aircraft navigational and auto-pilot equipment; applicants must be prepared to travel; essential to have sound knowledge of radio and electronic principles and practice, preferably to C. and G. Radio III standard; good conditions, pension scheme.
APPLY, with full details and salary required, quoting No. 1439. to Personnel Manager, Sperry Gyroscope Co., Ltd., Great West Road, Brentford, Middx. [2259

PHYSICIST required to take charge of a development group on valve manufacture in London area; applicant should have some engineering background and a pronounced ability in administering a development group, age 30-35; salary £800-£1,000 to commence; give full details of qualifications and experience.—Apply Box 2458. [2268

DRAUGHTSMEN required. Electronic instrument, or radio experience. Salary according to qualifications. Saturday interview if required. Opportunity to broaden experience with reputable firm. Near City centre and all amenities. Within easy access of London.—Marconi Instruments, Ltd., Longacres, Hatfield Rd., St. Albans. [2209

ENGINEERS required for (a) maintenance and design of electronic test equipment, and (b) for quality control and investigational work on radio valves and other electronic devices; Inter B.Sc. or Higher National Certificate standard.—Write, giving experience and salary required, to Personnel Superintendent, The Edison Swan Electric Co., Ltd., Cosmos Works, Brimsdown, Enfield. Middlesex. [1966

ELECTRO-ENCEPHALOGRAPHY recordist, Grade II, is required at Royal Edinburgh Hospital for Mental and Nervous Disorders, Morningside, Edinburgh; qualifications necessary and salary to be paid will be as laid down by Whitley Council.—Applications, with references, should be sent now to the Physician Superintendent, stating age and details of previous experience. [2297

FIRST-CLASS television field and workshop engineers required, fully experienced on all popular current models, in the following areas: York, Leeds, Leicester, Banbury, Stratford, Slough, Southampton; attractive salary and congenial working conditions are offered to top grade men.—Apply to Personnel Manager, Belcher (Radio Services), Ltd., 59, Windsor Rd., Slough, Bucks. [2324

MITCHAM WORKS, Ltd., require a graduate for development work in radio and television; applicants should have 3 years' experience in similar work; salary according to qualifications and experience but not less than £650 p.a.—Applications, in writing, should be addressed to the Personnel Officer, Mitcham Works, Ltd., New Rd., Mitcham Junction, Surrey, quoting reference R.2. [2296

RADIO and television service engineer required for work on domestic receivers by a progressive organization with central service depot in Bedford; vacancies also at branches in Hitchin, Northampton, Kettering and Luton; good working conditions; financial compensation by salary, and bonus scheme for energy and initiative; housing assistance provided for suitable applicant.
APPLY Service Manager, David Robinson, Ltd., 47, St. Peter's Street, Bedford. Tel. 61375. [2260

SENIOR and junior engineers required for responsible work in radio and television laboratories, applicants for senior position should be able to undertake development work with minimum supervision; excellent conditions and salary available for applicants who are accepted.—Apply in first case to Personnel Manager (Dept. R.D.), McMichael Radio, Ltd., Wexham Rd., Slough. Applicants must be of British nationality. [2021

THE ENGLISH ELECTRIC Co., Ltd., Luton, have a vacancy for a designer of low power (up to 1kw) low frequency transformers and chokes; previous experience very desirable and applicant should be thoroughly familiar with winding and impregnation processes; varied interesting work, involving development of a number of designs for small quantities.—Applications to Dept. C.P.S., 336-7, Strand, W.C.2, quoting Ref. 1137A. [2064

ELECTRONIC INSTRUMENTS, Ltd., of Richmond, Surrey, has vacancy for Chief Inspector; applicants must have sound practical experience in testing mechanical and electronic apparatus, together with administrative ability; a key post in expanding firm; application in first instance by letter giving full details of experience and salary; junior posts also available for electronic engineers, aged 23 upwards, having H.N.C. or equivalent qualification. [2269

CHIEF Engineer, microwave link development; Decca Radar Limited is creating an appointment at the rank of chief engineer, to lead a growing division engaged in the development and exploitation of microwave link systems; the successful applicant must have had, in either this or closely allied fields, considerable industrial experience at a senior level; this experience must provide evidence of a faculty for leadership, organising ability, and a capacity for drive; British nationality is essential; a starting salary commensurate with the level of the appointment will be paid.—Replies, which will be treated as strictly confidential, should be addressed to the Research Director, 2 Tolworth Rise, Surbiton, Surrey. [0450

SITUATIONS VACANT

ELECTRONIC Engineer for responsible position on advanced applications development work in London area; applicant should hold a degree and have a thorough background of current circuit practice as used in radio, television and electronic control, etc.; an experimental flair essential; age limits 25-35; salary over £1,000 to commence; give full particulars of qualifications and experience quoting "E.E." —Apply, Box 2457. [2267

MURPHY Radio require an engineer for the design and development of specialised electronic apparatus making use of the latest developments in circuit technique; the salary of £650 p.a. and upwards will be paid to one having the necessary qualifications.—Applications, giving full details of experience, etc., may be forwarded, in confidence, to Personnel Dept., (A2), Murphy Radio, Ltd., Welwyn Garden City, Herts. [2286

METHODS engineers required for senior positions in expanding manufacturers, S.E. London; principal duties concern radio and TV line layout; preference given to those with job study experience; to right applicants these will prove permanent and progressive posts with commensurate salaries.—Write in confidence with full particulars and salary required, Box D B.2221. A.K. Advg., 212a, Shaftesbury Ave., London, W.C.2. [2285

SERVICE engineers required by cinema sound equipment company for duties in London area; applicants must have practical ability and good general knowledge principles of electricity and audio amplifiers; clean driving licence and reliable telephone contact essential; salary to scale £400-£500 plus car allowance and expenses; state age, education, experience and whether car and telephone available.—Box 2497. [2283

LABORATORY technician (male), age 20-23 years, required for physics; commencing salary up to £360 per annum, according to age and qualifications; the post is a temporary one, but if a person suitably qualified in radio maintenance should prove satisfactory, there is a possibility of permanence at a later date on a higher salary.—Written applications should be addressed to Head of Department of Physics, Chelsea Polytechnic, Manresa Rd., S.W.3. [2276

BRITISH Relay Wireless and Television Group of Companies have vacancies for television and radio engineers in grades offering wage rates between £7/15 and £10 per week. Applicants should consider their appointment a stepping-stone in a career offering excellent opportunities. Superannuation scheme and active sports and social club. Apply in writing, stating age, experience and qualifications, to British Relay Wireless and Television, Ltd., 397, Albany Rd., S.E.5. [2312

McMICHAEL RADIO, Ltd., require senior and junior engineers in their equipment division laboratory at Slough; training and experience in the field of applied electronics (including communications) and experience of working with Government Departments are the chief qualifications required.—Write, stating age and full details of training, qualifications and experience, to the Chief Engineer, Equipment Division, McMichael Radio, Ltd., Slough, Bucks [0198

FILTER design group of Automatic Telephone & Electric Co., Ltd., Liverpool, has vacancy for engineer to deal with the problems associated with quantity production of electrical wave filters; previous experience in this or similar work is essential, and a degree in engineering or physics is desirable; permanent staff position with contributory pension fund and usual staff conditions.—Write to Personnel Manager, Automatic Telephone & Electric Co., Ltd., Edge Lane, Liverpool 7, giving full details of experience, qualifications and age. [2150

SALES representative, young, London resident, conversant with design and manufacture of Fixed Capacitors, required by manufacturers with London Head Office; preference given to man with established connections in the radio and electronics industries and who has had actual production experience of all stages of fixed capacitor manufacture, must have a clean driving licence, car owner preferred.—Write fully stating age, experience, married or single and salary required to Box 2551. [2292

MURPHY RADIO, Ltd., have vacancies in their Electronics Division Laboratories at Welwyn Garden City for qualified Engineers to develop V.H.F. communication equipment and instruments. salary £600-£1,000 p.a. depending on experience. Further posts available with salary £350-£750 p.a. for Technical Assistants.—Applications should give age, full details of qualifications, experience and salary required and may be forwarded in confidence to P.D. (EDL), Murphy Radio, Ltd., Welwyn Garden City, Herts. [2290

ELECTRONIC Engineers are invited to apply for senior posts of exceptional interest and opportunity with Decca Radar, Ltd., to work in their laboratories on an extensive and expanding programme of link and radar development. Applicants must have had responsible development experience in the electronic field. Posts are permanent and pensionable. Good starting salaries and considerable prospects of advancement.—Write, quoting Ref. RLA/6, The Research Director, Decca Radar, Ltd., Research Laboratories, 2, Tolworth Rise, Surbiton, Surrey. [0256

SITUATIONS VACANT

KELVIN & HUGHES, Ltd., Barkingside, Essex, require immediately a senior research engineer, directly responsible to the division head, to take charge of a team engaged in the development of ultrasonic apparatus; applicants should possess an honours degree in physics or engineering, and have a sound mathematical background; good practical experience of electronics is essential and some knowledge of metallurgy would be an advantage.
THE salary would be in accordance with the responsibilities of the post.
APPLICATIONS should be addressed to the Personnel Manager, Kelvin & Hughes, Ltd., New North Rd., Barkingside, Essex. [2277

TELEVISION trouble shooters are offered an opportunity to train as maintenance and development engineers of electronic test gear with a large manufacturer in East London; the posts, which are permanent and pensionable, will provide experience on all types of test gear connected with radio, television and radar equipment and there are exceptional prospects of promotion; the company works a 5-day, 40-hour week, and has excellent canteen and sports facilities.—Write, quoting reference WW/843, giving full particulars of previous experience, to Box 2348. [2250

THE GENERAL ELECTRIC Co., Ltd., Brown's Lane, Coventry, requires senior and junior electronic development engineers for work on guided weapons and like projects, particularly in the field of microwave and pulse applications; mechanical development engineers, designer draughtsmen and draughtsmen, preferably with experience of radar-type equipments, also required for the above projects; salary according to age, qualifications and experience.—Apply by letter, stating age and experience, to the Personnel Manager (ref. R.G.). [0259

MURPHY RADIO have the following vacancies in their Electronics Drawing Office: (1) Senior Designer-Draughtsman, applicants must be of H.N.C. standard, fully experienced and capable of leading a design team. (2) Senior Draughtsman who must have considerable experience of Electronic Equipment and Ministry Contract procedure to work as Drawing Office checker. (3) Senior Draughtsman experienced in Ministry Contract procedure of Electronic Equipment as a modification draughtsman. Applications should include full details of experience and qualifications, age and salary required and may be forwarded in confidence to P.D. (EEDO), Murphy Radio, Ltd., Welwyn Garden City. [2291

SPECIFICATION engineers are required by Marconi's Wireless Telegraph Company, Ltd., Chelmsford; these engineers will be expected to consult heads of design and production units and reflect their requirements in purchasing and user specifications based on B.S. or other national codes of practice; men with sound experience of this type of work are needed but additionally, consideration will be given to young candidates possessing some design or production engineering experience, together with qualifications up to H.N.C. or degree standard; the appointments are permanent and offer scope for advancement; pension scheme; good salaries will be offered dependent upon qualifications and experience.—Please apply, giving full details and quoting reference 881A, to Dept. C.P.S., 336-7, Strand, W.C.2. [2257

VACANCIES for engineers and draughtsmen of senior and intermediate grades exist at the Ilford works of The Plessey Company for development work on components and mechanisms for radio, television and communications equipment; these vacancies occur as a result of the enlargement of the laboratories to permit a substantially increased interest in the design of circuits and components for specific applications; all positions are permanent and pensionable and the expansion now in progress offers good prospects of advancement; salaries are progressive and attractive initial salaries are offered to men who are qualified by reason of educational attainment or practical experience.—All applications will be dealt with in confidence and should be addressed, quoting reference WW/845, in the first instance, for the attention of the Personnel Manager. [2248

ADMIRALTY—Royal Naval Scientific Service. Engineers and Physicists (particularly with electronics) required for appointments in Experimental Officer and Assistant Experimental Officer grades in Experimental Establishments in London, Portsmouth, Weymouth and Gloucestershire Areas and Scotland. Candidates, British Subjects, must possess one of the following qualifications: University degree in Science, Engineering or Maths., Graduate Membership of appropriate professional institute, Higher National Certificate, Final Certificate or five-year grouped course in relevant subjects at City and Guilds of London Institute or comparable institution, Higher School Certificate, General Certificate of Education, Scottish Leaving Certificate, Scottish Universities Preliminary Examination, Northern Ireland Senior Certificate (all in appropriate subjects and at appropriate levels). London salary inclusive of pay addition (men) E.O.s £681-£838, A.E.O.s (according to age) £274-£607. All appointments unestablished, but with some opportunities to compete for established posts.—Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King St., London, S.W.1, quoting A 247/52/A. [2321

SITUATIONS VACANT

SENIOR radio receiver designer required; several years' experience of similar work essential.—Applications, which should include full details of qualifications and experience, may be addressed in confidence to Personnel Department (S.R.D.), Murphy Radio, Ltd., Welwyn Garden City. [2330

ELECTRONIC engineers with several years research or development experience are invited to apply for posts with a well-established company engaged primarily on the development of precision electronic laboratory instruments; applicants should preferably possess an honours degree or equivalent qualifications in physics or light electrical engineering, although this is not essential as considerable practical experience is equally acceptable; the appointments are of a permanent nature for engineers able to undertake the responsibility for the development of new projects to the prototype stage, and they offer scope for the exercise of individual initiative; furthermore, the work covers a wide range of electronic instruments and similar devices; salaries are commensurate with qualifications and experience; applications should be made in writing, stating full details, to—Chief Engineer, Furzehill Laboratories, Ltd., Boreham Wood, Herts. [0030

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