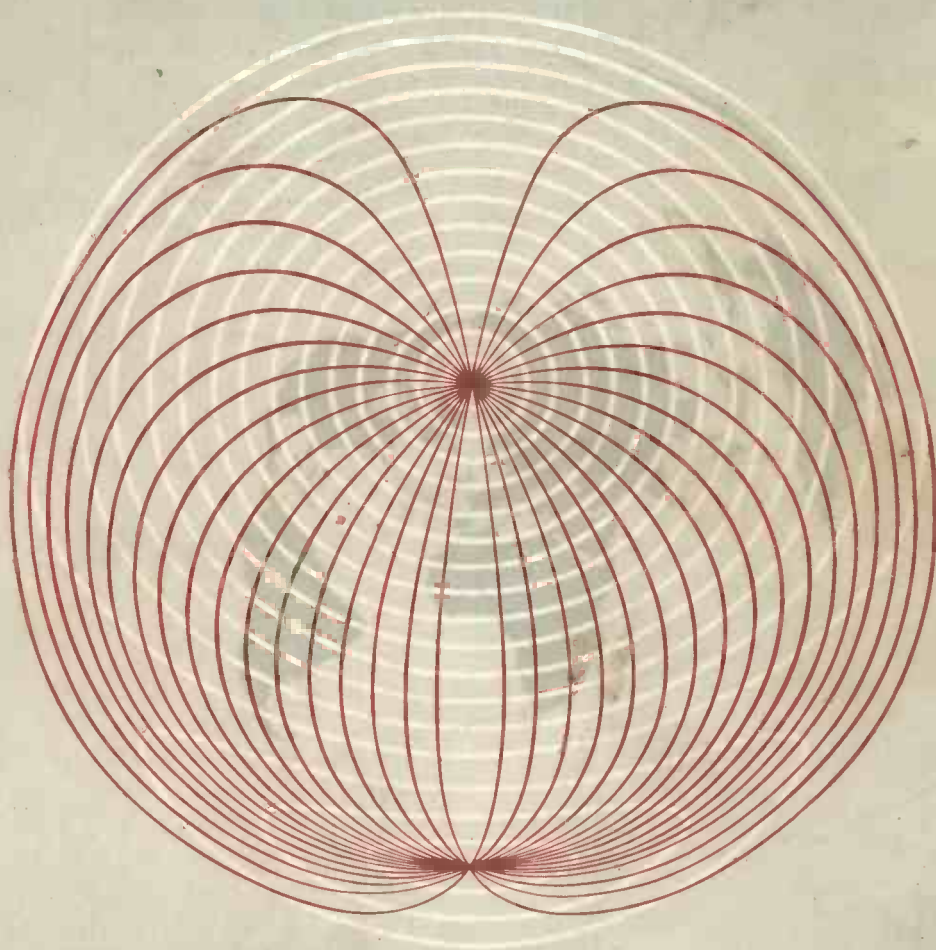


# Wireless World

OCTOBER 1953

TWO SHILLINGS



RADIO, TELEVISION AND ELECTRONICS

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# Wireless World

RADIO, TELEVISION  
AND ELECTRONICS

43rd YEAR OF PUBLICATION

Managing Editor: HUGH S. POCOCK, M.I.E.E.

Editor: H. F. SMITH

OCTOBER 1953

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## ***Domestic Radio, 1953***

**S**TEADY, though perhaps not spectacular, progress in all branches of domestic radio is recorded in our survey, printed in this issue, of current trends in design. As was expected, the greatest technical interest at the 20th National Radio Exhibition was concentrated on television receivers. Here it will be clear from our report that nothing approaching a standardized set with stereotyped circuitry has yet emerged. True, most receivers have a great deal in common, but there are endless variations in matters of detail—and in quite important details at that.

At this stage of development few would wish to see greater uniformity, though the wide diversity of size in cathode-ray tubes in popular demand must be an embarrassment to the manufacturers of those vital components. Up to the present there is no sign that fear of high replacement cost is curbing the public liking for still bigger tubes. The introduction of a tube reconditioning service is of economic rather than technical importance, but it may have a significant effect on the viewer when he comes to choose the tube size of his receiver.

Growing public interest in sound reproduction was well reflected at the Show. The magnetic tape recorder has, in a very few years, established itself firmly as a tool for the more serious uses and is well on the way to becoming established as a piece of domestic equipment for purposes of entertainment. There is, of course, still no sign that the tape will rival the disc record for home reproduction, and the makers of appliances for discs have ingeniously overcome the complications brought about by the recent introduction of varying speeds of rotation.

Sound receivers, though remaining the backbone of the broadcast receiving industry, have not greatly changed. Most of the developments are concerned with production.

## ***Frequency Allocation Secrecy***

**D**ISCUSSIONS over frequencies for alternative television services have brought into the limelight one of the worst features of our system of allocating radio

channels. Everything is done behind closed doors, and, as a rule, those concerned with one branch of communications have little idea of what has been done in another; still less do they know what is proposed to be done. Rational planning ahead is thus impossible. All this tends to incline our sympathies towards the system prevailing in America, where the deliberations of the Federal Communications Commission are conducted under the fiercest light of publicity.

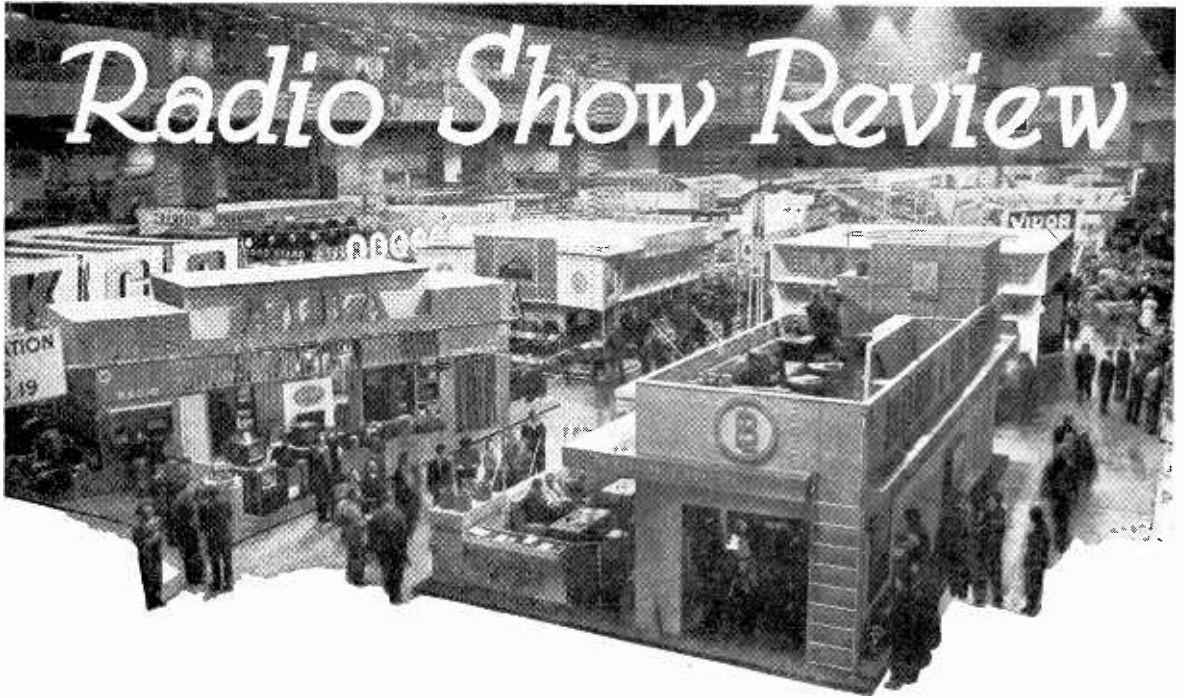
The convenient word "security" is often invoked, though without proper justification, as an excuse for holding back publication of information on frequencies. A case in point is touched upon in a letter in our correspondence columns. The operating frequency of the air-sea rescue device there referred to was at first officially withheld. No "security" could have been involved, and we can only think this reticence was due to the fact that the frequency chosen for this new device fell within the debatable ground of television Band 3.

## ***Television Interference Suppression***

**A** CORRESPONDENT in the U.S.A., whose letter is printed on another page in this issue, seems to paint an over-rosy picture of the state of the ether in his country. The statement that ignition interference is unknown there is contradicted by reference to the American literature, where mentions of it are not hard to find.

Of course, the American system of negative modulation in television tends to reduce the annoyance value of ignition interference. And, although the American car owner may take no precautions against the radiation of television interference, is it not a fact that the use of car radio is widespread, and so most vehicles are effectively suppressed?

We cannot agree with our correspondent's implication that the remedy is in the hands of the television receiver designer. Most British receivers have built-in suppression, but there is a point beyond which it is uneconomic, undesirable and indeed impossible to go in this direction.



## *This Year's Trend in Television Receiver Design—and Some Highlights*

In the following pages the technical staff of *Wireless World* report on tendencies in design in those branches of radio best represented at the National Radio Exhibition. This year technical interest at the Show was dominated by television. A survey follows of aviation radio equipment shown at the Farnborough Exhibition.

**A**LTHOUGH there is, as yet, no real uniformity among the television receivers produced by the various British manufacturers, the sets have a great deal in common and the variations are much more in matters of detail than in basic form. The straight t.r.f. set is now very rare, having fallen out of favour because of the difficulty of making it suitable for the reception of more than one signal channel.

To-day, the superheterodyne is supreme and the typical television receiver has one signal-frequency amplifier, a frequency changer, two vision i.f. stages and one or two sound-channel i.f. stages. Diode detectors and diode noise limiters are used in both channels, there is a single pentode video stage feeding directly to the cathode of the c.r. tube and one pentode develops the power needed for operating the loud-speaker. The sync separator usually has two valves—a pentode to remove the picture content and a diode to separate the frame from the line pulses. Both line and frame time-bases commonly have two valves each, apart from the efficiency diode in the line circuit. The c.h.t. is taken from the line-flyback pulse, using a valve rectifier, and the low-voltage h.t. supply from the mains, using a valve or metal rectifier in a half-wave circuit.

Within this broad framework there is endless varia-

tion of detail but certain particular forms of circuit do find greater popularity than others. The two main divisions into which nearly all sets fall are formed by the power supply. One group has series valve heaters and no form of mains-supply transformer; sets in this group are true a.c./d.c. types and will function on either supply. Sets in the other group may, or may not, have series heaters, but they have mains transformers. There are often auto-transformers for the h.t. supply and a main chain of heaters but with separate windings for one or two heaters. The technique is largely that of the a.c./d.c. sets, but this group is for a.c. only. In the true a.c./d.c. types, the h.t. supply is usually limited to 190 V, but in the second group the auto-transformer permits a higher voltage to be obtained and a 250-V line is not unusual.

An example of the a.c.-only set is the Ultra V814, shown in Fig. 1. Most of the valves are grouped in two series chains, one being fed across BF and the other across DF. The efficiency diode has its heater directly across CD and a thyatron is fed from a tapping EF. The c.r. tube has a separate winding for its heater. A, B and C form the taps for the mains-voltage adjustment and the h.t. rectifier is fed from the highest-voltage point A.

The advantage of this arrangement is not only the

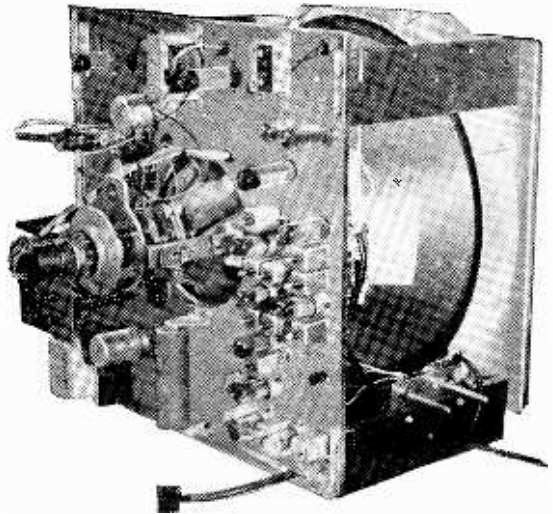
higher h.t. voltage obtainable. In addition, no special precautions have to be taken in the heater circuit. In the a.c./d.c. set, the heater of the c.r. tube must necessarily be in series with the valve heaters and its characteristics are by no means the same. In order to safeguard it during the warming-up period, it is necessary to have some current-control device in circuit. This often takes the form of a thermistor in series with the chain of heaters. In the G.E.C. BT5147, however, a barretter is used as well. The barretter was quite common in the early days of a.c./d.c. sets but fell into disuse and its revival in television is quite interesting.

With the low h.t. voltages available, especially in a.c./d.c. types, little voltage drop in the smoothing circuits can be allowed. A single choke of rather low inductance is usual with very large values of capacitance. The reservoir capacitance may be 100 F and  $\mu$  the smoothing capacitance 200  $\mu$ F. On a d.c. supply, the voltage at the output of the rectifier is lower than on an a.c. supply of the same voltage. The rectifier, however, is no longer necessary. Arrangements are sometimes made, therefore, so that it can be short-circuited on d.c. supplies.

A result of a.c./d.c. technique is that the chassis is in direct connection with the supply mains. In addition to the usual precautions against accidental contact with it, particular attention must be paid to the aerial circuit to avoid any possibility of the aerial, or its feeder, becoming live. Capacitors in both feeder leads are sometimes used; in other cases, there is a capacitor in the earthy lead only and the input coupling transformer is relied upon for isolation. There is a trend towards fitting an earth terminal so that the outer of the coaxial cable can be joined directly to local earth.

The use of one r.f. stage before the frequency changer is general and tuned couplings are employed between the two and between the aerial feeder and the r.f. valve. The number of tuned circuits, however, varies from two to four. The Philips TG1437U is an example of the use of four circuits and the basic arrangement is shown in Fig. 2. The screened twin feeder passes the signal to the coupling coil  $L_1$ , through the RC network, the purpose of which is to give an earthy centre point to the circuit, enable the aerial and feeder to be in direct connection with the local earth and to keep them isolated from the supply mains. An attenuator (not shown) can be included.

The coils of the input coupled pair are  $L_2$  and  $L_3$  and, in the intervalve circuit, the coupled pair is formed



Chassis of English Electric set with metal-cone c.r. tube.

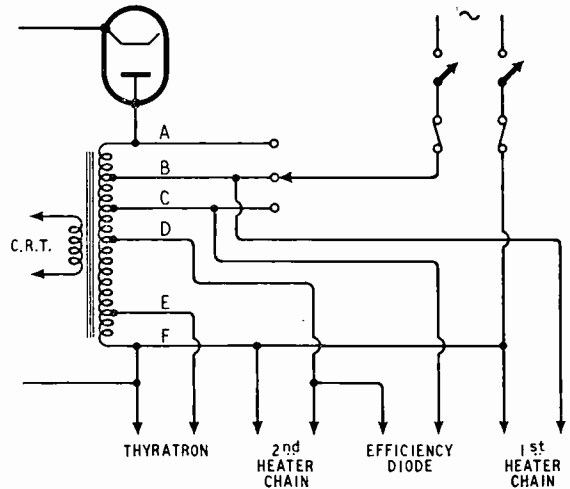


Fig. 1. Heater-supply circuit of the Ultra V814.

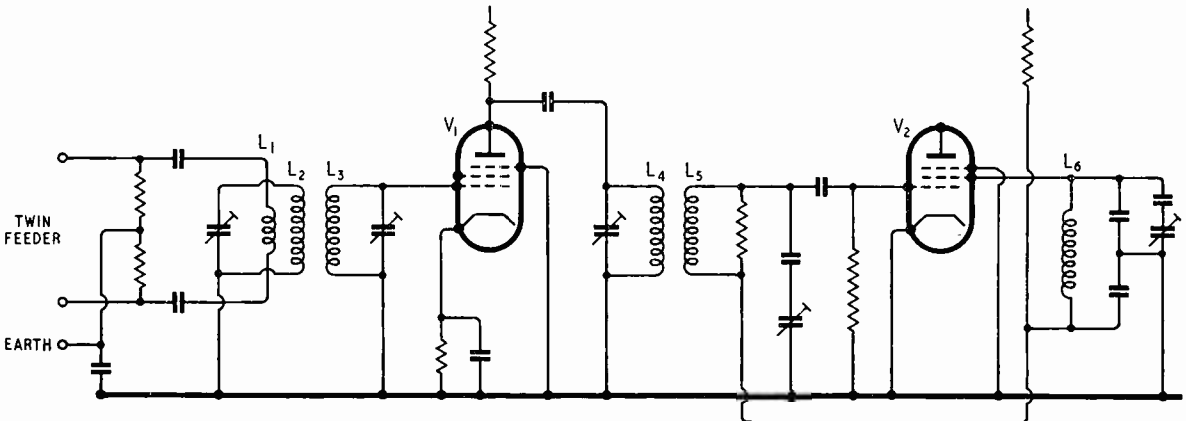


Fig. 2. Signal and frequency-changer circuits of the Philips TG1437U.

by  $L_4$  and  $L_5$ .  $V_2$  is the frequency changer. Apart from the number of signal circuits there are two other unusual features. One is the use of capacitance trimmers, the other is the adoption of plug-in coils.  $L_1$ ,  $L_2$  and  $L_3$  form one plug-in assembly,  $L_4$  and  $L_5$  another and  $L_6$  a third.

The use of four signal circuits is probably intimately connected with this plug-in system, for it is hardly more difficult to change four coils than two. With continuous tuning, however, the complications increase rapidly with the number of circuits.

An example of a more normal kind of r.f. end is shown in Fig. 3. It is of the G.E.C. BT5147 receiver and has continuous tuning for channel selection. A coaxial cable is used and coupled by  $L_1$  to the first tuned circuit, which comprises  $L_2$  and stray capacitance. Another tuned circuit  $L_3$  couples the r.f. valve to the frequency changer  $V_2$ ;  $L_4$  is a fixed coil, not adjustable. The feeder is isolated from the receiver by a capacitor and can be earthed directly.

There are endless variations of detail on the r.f. side, but the general tendency seems to be to use coaxial feeder and two or three continuously tuned circuits. The tuning is usually carried out by movable cores in the coils. Sometimes these are ganged, but more often they are not. It is becoming increasingly common for the controls to be accessible from the rear of the set but in some cases they are still fitted internally. Station selection is then a matter for the dealer to carry out.

The commonest form of frequency changer is undoubtedly an r.f. pentode as a combined mixer-oscillator. The control and screen grids are used as the oscillator electrodes in a Colpitts or Hartley circuit and the signal is applied to the control grid. There are various ways of doing this. In Fig. 2, the oscillator coil  $L_6$  is connected to the grid through the signal coil  $L_5$ . In Fig. 3, a shunt feed is used. Quite often, as in the Vidor CN4217 (Fig. 4), the signal is applied to the null point of the oscillator circuit. Save that the tap is on the inductance rather than on the capacitance, this is a technique which has been used for some years by Bush and is retained in their new models.

Murphy, however, have adopted an r.f. pentode mixer with a triode oscillator, the two valves being in a common envelope. They are also unusual in em-

ploying two r.f. stages and five signal circuits. The triode-pentode frequency changer is to-day more often used than in the past and it will be interesting to see whether it will oust the single-valve type now so common. A variant of the same form of circuit, but with a double triode, is used by Ferguson in the 998T.

In the vision i.f. amplifier two stages are common. The form of the couplings varies considerably, however. Three coupled pairs of circuits is quite a usual arrangement but some sets have one, or even two, of the couplings by single-tuned circuits only. Wave-traps are used to improve the sound-channel rejection, both of the wanted channel and of the adjacent channel. The Murphy V216C has four cathode traps but it is unusual to have as many as this. Probably most sets have two traps, some have one only and a few have three. In the sound channel there are two i.f. stages in most sets, but quite a large proportion have only one. In most cases there are three tuned circuits, but a few sets have four.

As already mentioned, the variations on the detector, video and audio sides are relatively small. The detectors and noise limiters are nearly always diodes, although sometimes of the germanium type. The video stage is nearly always a pentode and usually has an inductance-compensated anode load. Some extra cathode compensation is often used in the form of a small capacitance in shunt with the bias resistor. In one case, Murphy V216C, the cathode circuit is

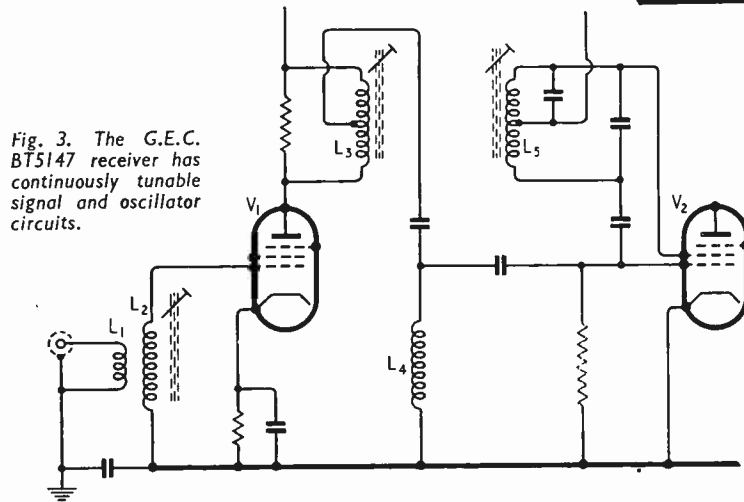


Fig. 3. The G.E.C. BT5147 receiver has continuously tunable signal and oscillator circuits.

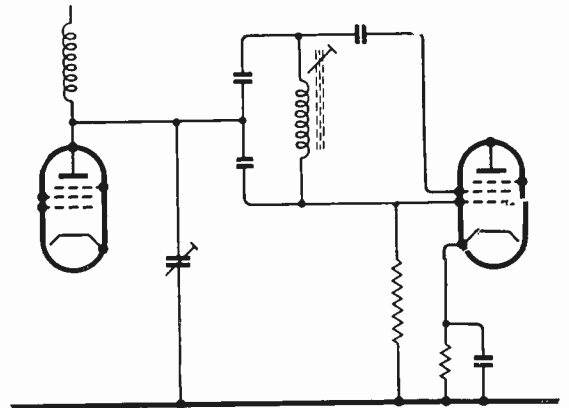


Fig. 4. Frequency-changer circuit of the Vidor CN4217.

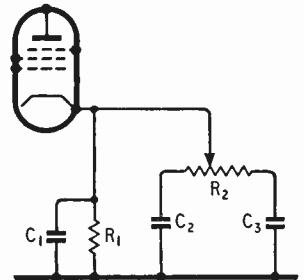


Fig. 5. 'Quality Control' circuit of the Murphy V216C.



adjustable to form a control of picture quality. The arrangement is shown in Fig. 5;  $R_1$  is the bias resistor and  $C_1$  is the usual small compensating capacitor. The capacitors  $C_2$  and  $C_3$  form with  $R_2$  the quality control and operate by giving a variable response to the stage at the higher video frequencies.

Direct coupling between the anode of the video stage and the cathode of the c.r. tube is almost invariable, the few exceptions being rather special cases. The sync separator is fed from the video output and is, without exception, a pentode with low anode and screen voltages and d.c. restoration at the grid. The line time-base is usually fed from it through a differentiator and the frame through an integrator with a diode of some kind to separate the line pulses from the frame. Here, however, there is a good deal of variation in detail and it is fairly obvious that no one has yet found the ideal frame pulse separator.

There are certain cases where special methods of synchronizing are adopted in an endeavour to render it less susceptible to noise and interference. These are of two basic kinds. In the first, pulse triggering of the time-bases is retained and the effect of noise is reduced by exceptional limiting. This is adopted in the Philips and Stella receivers in which four valves (two triode-pentodes) are used for sync separation, no fewer than three being in the line circuit. In Fig. 6,  $V_1$  is the main sync separator and is of normal type. The separated pulses are applied to  $V_2$  which is operated to have a grid base small compared with the pulse

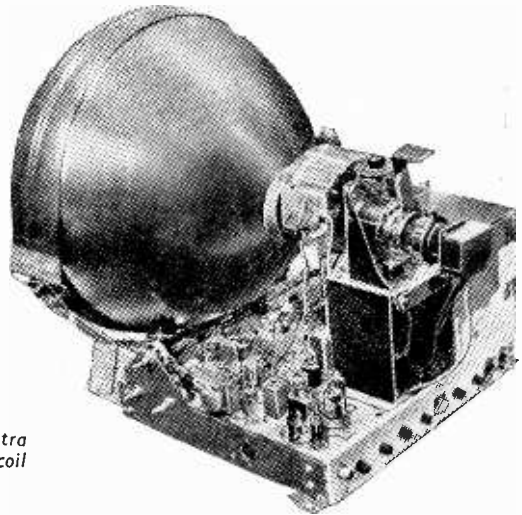
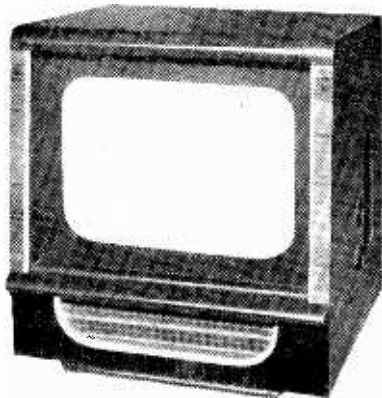
amplitude. It thus selects and amplifies a slice out of the pulses and only the noise on the pulse edges can get through. Its output is differentiated by  $C_1R_1$  and applied to a further limiter  $V_3$  which cuts off the negative-going (input) spikes of the waveform and delivers a negative pulse to the blocking-oscillator saw-tooth generator.

The pulses at the output of  $V_1$  are also integrated by the double integrator  $R_2C_2R_3C_3$  and applied to  $V_4$ . This valve is normally held in grid current but is cut off by the integrated frame pulses to provide pulses of anode current which, after some further integration, lock the frame blocking oscillator via the coupling coil  $L$ .

The whole essence of this method of noise reduction is, in effect, to select only a very narrow slice of the sync pulse. The circuit is unresponsive to noise except during the very short intervals of time when the pulses pass between the slicing limits.

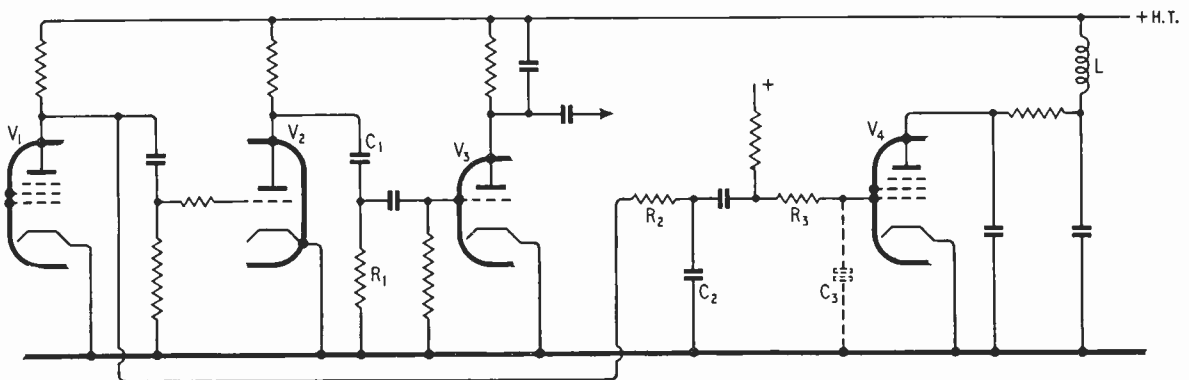
The second method of attacking noise in synchronization is by what is called flywheel sync. The essence of this method is to make the synchronizing depend, not on individual sync pulses, but on the cumulative effect of a very large number. Although it is practically universal in the U.S.A. and a few examples of it were exhibited last year, it is still the exception rather than the rule. Only a few firms have adopted it as a standard part of all sets and a few more utilize it in their "fringe area" models.

Pye retain the form which they introduced last



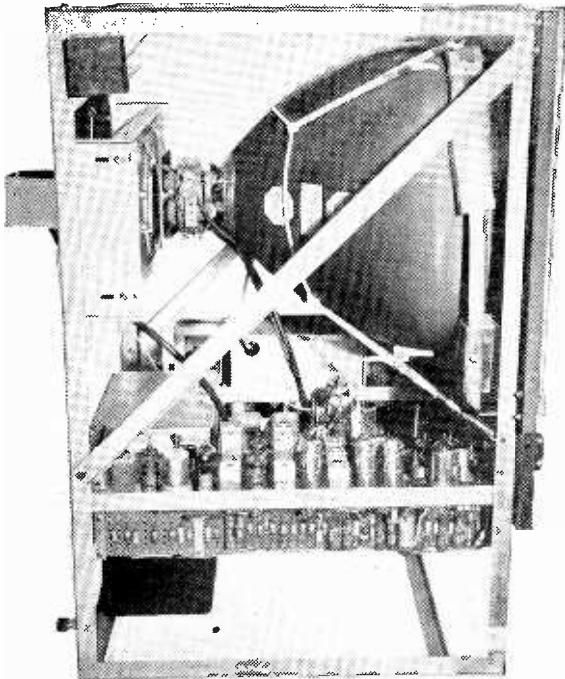
McMichael TM317 table model with a 17-in tube, and (right) Ultra television receiver with metal shroud around the deflector-coil assembly.

Below: Fig. 6. Simplified sync-separator circuit of the Stella ST8314U.



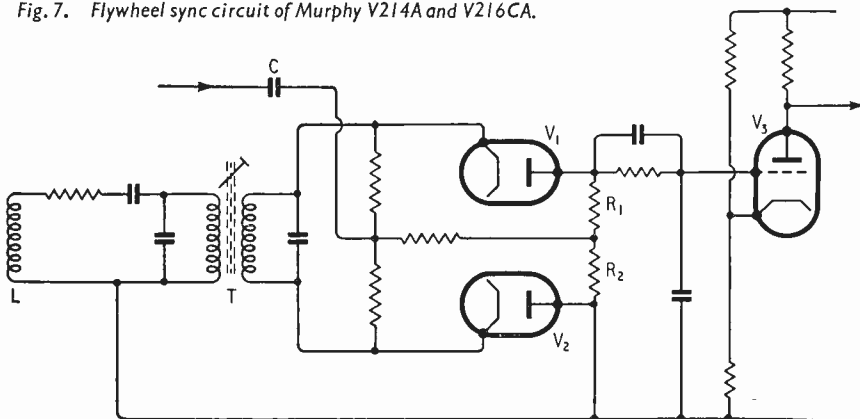
year<sup>1</sup>. Ferguson have retained a model (991T) which they brought out last year but, in a new model 998T, they have reverted to the conventional methods. The new model, however, is not a fringe-area type. English Electric have used a third form of flywheel sync for some years but, again, only for fringe areas. Murphy have now adopted flywheel sync for fringe areas only. It is fitted to the V214A and V216CA models. The arrangement used is somewhat different from the others and so deserves explanation. Referring to Fig. 7, L is a winding on the line output transformer and the transformer T selects the fundamental component of the scanning waveform to develop substantially a sine wave on its secondary. The diodes  $V_1$  and  $V_2$  conduct on alternate half-cycles of this wave

<sup>1</sup> *Wireless World*, October, 1952, p. 385.



Chassis of Dynatron TV27B; the tube is mounted on the framework independently of the receiver.

Fig. 7. Flywheel sync circuit of Murphy V214A and V216CA.



and develop equal mean voltages across the equal load resistors  $R_1$ ,  $R_2$ . These are connected to be in series opposition as regards the output circuit and so the total output is zero.

Negative-going sync pulses are applied through C to both diode cathodes. If they coincide in time with an instant when the sine wave is passing through zero, both diodes conduct equally and the output is again zero. At any other instant, however, one diode has an effective positive bias and the other an equal negative bias from the sine wave and they conduct unequally when the sync pulse arrives. A net output voltage then appears and it has a polarity dependent on whether the sync pulses lead or lag in time on the sine wave and a magnitude dependent on the amount of lead or lag. The output is applied to a d.c. amplifier  $V_3$  and thence to the time-base.

The present trend in flywheel sync is clear. It is to use it only for fringe area reception. Another refinement which is finding its way into television is vision-channel automatic gain control. It is far from common, although sound-channel a.g.c. is widely used. Again, there are several systems and they fall into two categories, those which are black-level operated and which tend to keep the black level constant and those which are picture-operated and which tend to keep the mean brightness constant. The latter are usually a good deal simpler.

Pye adopt a black-level control. The method has been previously described<sup>2</sup> and is quite complex. In essence, the video signal from a cathode follower is applied as bias to a d.c. restorer. Pulses are derived from the line time-base and delayed so that they occur during the back porch—the short period of black following each sync pulse. They are applied to the d.c. restorer and are d.c. restored to black level. Rectification and integration produce a bias voltage for an i.f. stage which is dependent on the black level of the signal. This automatic picture control, as Pye call it, tends to keep the black level of the picture constant.

The scheme adopted by Ekco is much simpler. It is shown in Fig. 8.  $V_1$  is the main sync separator and is fed with the video signal through  $R_1C_1$  in the usual way. The grid leak is formed by  $R_2R_3$  and d.c. restoration occurs in the usual way. The mean grid potential of  $V_1$  is negative to cathode by an amount which depends on both signal strength and picture content. The fraction of this voltage which appears across  $R_3$  is applied in series with the steady voltage across  $R_5$  to the integrator  $R_1C_2$ . The voltage across  $C_2$  is applied to an i.f. valve as bias. It is a steady voltage, the value of which depends on the strength of the signal, the mean brightness of the picture and the voltage across  $R_5$ . This last resistance is variable as a manual gain control (contrast).

The diode  $V_2$  is only to prevent the a.g.c. line from becoming positive to earth. If the signal is small and  $R_5$  is set to develop any considerable voltage, the

<sup>2</sup> "Vision A.G.C.," *Wireless World*, April, 1953.

a.g.c. line tends to go positive.  $V_2$  then conducts and clamps it to earth.

This simple system depends for its success upon the mean brightness of the picture being more or less constant. In fact, this is usually the case and it is only on the comparatively rare occasions when the producer calls for a near black or near white picture that his artistic effects may be marred.

Turning now to the time-bases, it is general for the line output circuit to be a pentode with an efficiency diode and auto-transformer coupling. H.T. boost and fly-back e.h.t. are practically universal. A boost of about 220 V is quite often obtained and e.h.t. supplies of 10-17 kV using a single-valve rectifier. The voltage used varies very roughly with the tube size and is of the order of 1 kV per inch!

The auto-transformer usually has a low-loss core and the magnetic circuit of the deflector coils is closed through a similar material. The so-called "castellated" yoke, which is derived from an earlier design using motor-stator laminations, is becoming more common. Higher efficiency is obtained because the magnetic material can be brought closer to the neck of the tube and a more uniform product results because the windings are definitely located in slots.

The only common variations in the output circuit of the line time-base are in the form of drive for the valve and in the linearity circuit. The use of a saturated coil, which was introduced two years' ago, is increasing in popularity, but many sets retain the resonant transformer. Sets are about evenly divided between saw-tooth and pulse drives for the output valve.

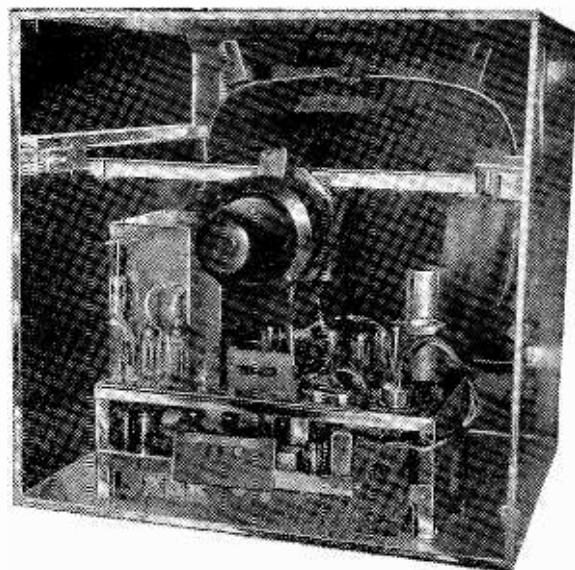
The single-valve self-oscillating line output stage, which a few years back was quite popular, is now comparatively rare. It is used by Ferguson in the new 998T, however, in the form of a pentode which is pulse driven on the control grid, the pulse being derived from a winding on the anode circuit transformer. This pulse drive is actually quite widely used but it is more usual to develop it with the aid of another valve, the two forming a multivibrator. Where a saw-tooth drive is used, the blocking oscillator is the favourite generator.

An exception to this general form of line time-base is to be found in the Bush TV22A and TV24A receivers, the new 9-in and 12-in models. A pentode is used, self-oscillating between the control and screen grids, and with directly fed deflector coils.<sup>3</sup> The necessary loading inductance is an auto-transformer for e.h.t.

In the frame circuit, transformer feed to the deflector coils is usual. Cossor use an auto-transformer, but this is an exception rather than the rule, and Ultra use an RC feed to a high-inductance coil. The Blumlein linearity circuit, or some variation of it, is still common, but there is an increasing tendency to use valve curvature for linearity correction and the linearity control is then merely a bias control on the output valve.

The frame saw-tooth generator is either a blocking oscillator or a multivibrator, but usually the former. Last year, the blocking oscillator seemed to be dropping out of favour and it is noteworthy that it is staging a come-back.

Focusing is nearly always by permanent magnet, but a few people retain the electromagnet, notably Kolster-



Cossor television receiver with rectangular tube.

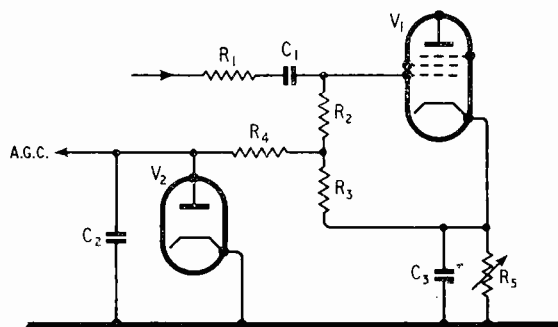


Fig. 8. Simple A.G.C. circuit of the Ekco T207.

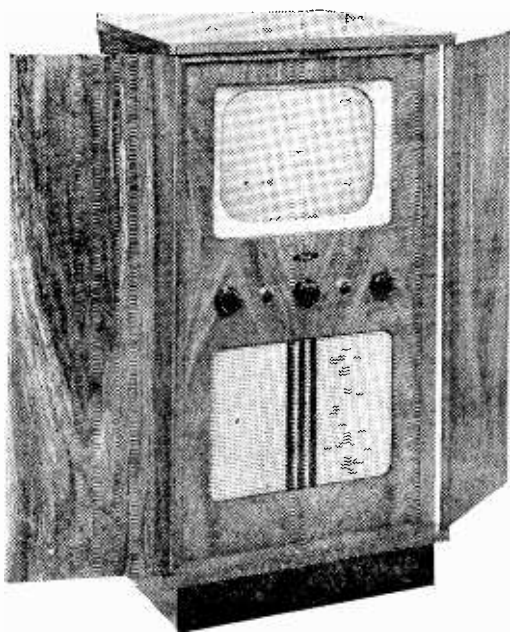
Brandes and Philips. The use of centring magnets instead of tilting the focus magnet is increasing and has much to commend it, since it is not only theoretically superior but is practically easier to adjust. Tubes now usually have ion traps and so ion-trap magnets are fitted.

The size of television pictures is definitely on the increase. The 9-in tube is now comparatively rare and even the 12-in is beginning to look small. The 14-in and 17-in are now the more popular sizes and are commonly rectangular-faced tubes of some 70° deflection angle. Partly because of the reduction of size brought about by these two factors and partly because of the general use of miniature valves, the 14-in and 17-in tubes are widely used in table-model sets. This is quite an achievement, for it is not many years since a 12-in table model was rather a novelty.

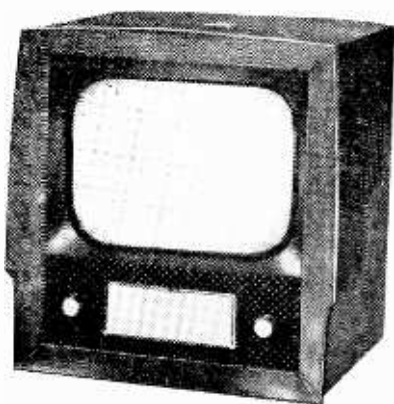
The 17-in tube is the largest in common use, but there are considerably larger ones. H.M.V. showed the 21-in model which they introduced some time ago and Pye had a set with a 27-in tube! This has a deflection range of no less than 90° and is operated at 16.5 kV.

The grey viewing filter is now so widespread that the white faces of sets without them look a little strange. The white-face tube with tinted safety-glass,

<sup>3</sup> "Simple Line-Scan Circuit," by W. T. Cocking, M.I.E.E., *Wireless World*, August, 1952.



*Bush TUG34A with 14-in rectangular tube.*



*H.M.V. Model 1824 with 14-in tube. A black-spotter is used in the interference-suppression circuit.*

however, shows signs of disappearing. The tendency now is for the end of the tube itself to be made of grey glass.

A new trend this year is for the tube to be mounted so that the screen is leaning forward very slightly instead of being vertical or leaning back. The amount of tilt often appears more than it is, since the safety-glass sometimes leans forward more than the tube face and the effect is often exaggerated by the lines of the cabinet. The tilt is introduced in order to reduce room reflections. The room lighting, which produces most of them, is usually above the level of the tube screen and by tilting the screen forward the reflection is brought below eye level.

Considerable attention is now being paid to picture presentation, of which the tilted screen is but one example. Ferguson have introduced an illuminated surround for the picture which they term Halolight.

Fluorescent lamps are fitted so that the surround is lit by an adjustable amount. This is a technique borrowed from the cinema where it has been used experimentally for some time. Another refinement is spot-wobble, which has been fitted to some Ekco sets for the last two years. It is still used in their new model but is to be found in very few other sets.

Projection television is still employed for pictures larger than a 17-in diagonal. Ferranti, Decca and White-Ibbotson, among others, showed sets of this type. The domestic types are basically unchanged from previous years, but are improved in detail. Possibly because of the advent of the 17-in tube, projection television receivers appeared to form a smaller section of this year's exhibition.

### Television Aerials and Accessories

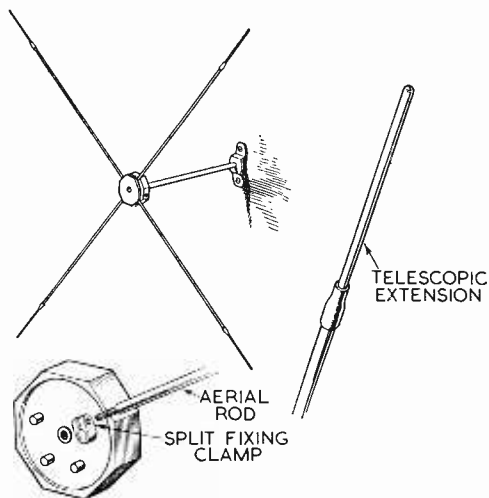
There are faint, but definite, indications that much wider use will shortly be made of indoor television aerials; for, as the chain of medium- and low-power stations nears completion, more and more viewers will be brought within the strong signal service area.

Random lengths of wire will hardly ever be satisfactory as television aerials, although they may satisfy many sound broadcast requirements; and an aerial of the correct length for the nearest station will have to be used. However, some liberties can be taken with the shape, and the rods, or their equivalent, may be bent or set at various angles in order to accommodate the aerial in the somewhat confined spaces available indoors.

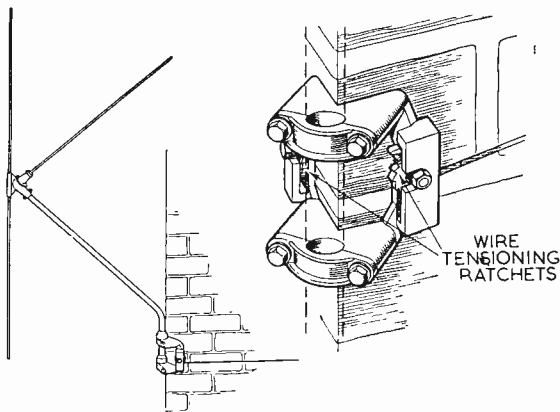
Makers of television aerials are well aware of the almost certain growing demand for less conspicuous types and give greater prominence to them at this year's show.

Considerable ingenuity has been displayed in the design of some of these new indoor models in order to make them as versatile as possible, and the Antiference "Univex" is a case in point. It has an octagonal centre insulator supporting four equi-spaced contact studs on which either two or four aerial rods are assembled. These are telescopic and readily adjusted in length to suit any of the five existing television channels. They can be secured in any position by simple split clamps which grip the studs when the elements are screwed in tight. Provision is made for horizontal or vertical mounting and a wide variety of aerial shapes such as "L," "T," "K," "X," etc., is possible.

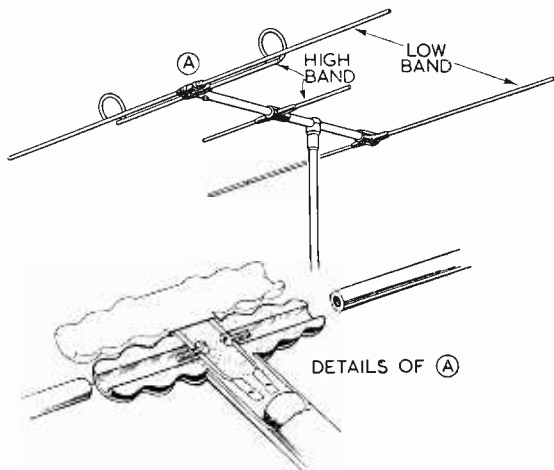
Pre-assembly of television aerials at the factory is a new departure, adopted by several firms as part of a general policy to facilitate assembly and erection as far as possible. The Belling-Lee contribution towards simplification is a new chimney-stack bracket having two ratchet-type wire tensioners for the harness, and these seem very much easier to handle than most other types of wire strainers. This bracket is used for the new Belling-Lee "Kayrod" aerial, which is intended for use in areas of moderate signal strength. It gives a performance about midway between a simple dipole and an "H." The straight arm of the "K" functions as a director, its length being very critical for best results owing to the proximity of the dipole element. The upper arm of the "K" is insulated and forms the top half of the aerial dipole and to this is joined the centre conductor of the co-axial downlead. The lower leg of the "K" behaves as a sleeved dipole



Antiference "Univex" versatile indoor aerial.



Belling-Lee "Kayrod" aerial and new ratchet chimney bracket.



Two-band television aerial developed by Telerection and arrangement of the centre insulators.

element and into it passes the feeder. It is electrically bonded to the director, but an insulator is used where it joins the ratchet chimney clamp.

The re-designed "Antex" by Antiference is an example of an outdoor aerial pre-assembled at the factory and despatched with all its elements secured in position, but folded flat. To open it to the familiar "X" form the elements are swivelled so that they drop into the grooves proved in the centre housing. A turn or two of the spring-loaded captive nuts firmly secures them. When swivelled into position the rods rest in short metal saddles, and, as rods and saddles are insulated, a capacitance of about 350pF is provided at each rod end. This capacitor is the only connection between aerial rod and feeder, but it is large enough to have negligible reactance at television frequencies. It is said that atmospheric corrosion of the ends of the elements will have negligible effect on the aerial, since its performance does not depend on good electrical contact between rods and fittings.

A new form of crossed dipoles in which both are driven elements, to use a transmitting term, has been developed by Aerialite. It is known as the "Unex," and both elements are electrically continuous and insulated from each other. They are assembled as four separate rods, one screwing into the other in each case, and in so doing make contact with an annular ring moulded into the centre housing. These rings form the connections for the feeder.

The two feeder conductors (inner and outer of co-axial type) are each joined to one of the dipoles, and as this forms an anti-phase arrangement the aerial would be bi-directional in the plane of the dipoles or "end-fire" as it is often called. If the top rod of one and the bottom rod of the other are fore-shortened the aerial becomes uni-directional, accepting signals from the side of the shorter rods.

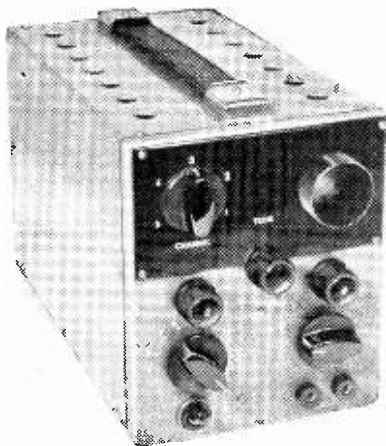
By fitting two fore-shortened rods in the upper positions of both dipoles (a vertical aerial is assumed here) a figure-of-eight response is obtained in the plane of the aerial with two well-defined nulls on either side and one below.

It is apparent from this brief description that quite a large number of polar diagrams can be produced merely by changing the element lengths. Actually what is occurring is that the phasing of the aerial is being modified, and this in turn changes the response characteristics of the aerial. A different set of characteristics can be produced by horizontal mounting.

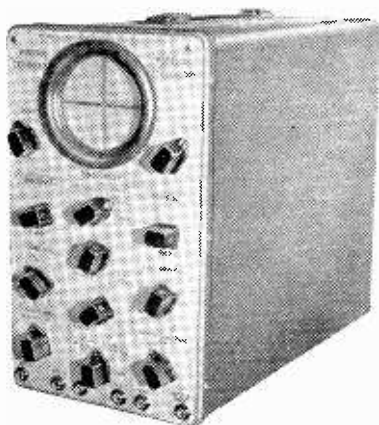
It was interesting to observe that quite a large number of polar diagrams of the new aerials were shown this year. It is apparent that considerable research has been carried out into the behaviour of television aerials, and the user can select the design best suited to his particular requirements, whether it be for best front-to-back ratio or best forward gain.

Should we have to consider television reception in more than one band what type of aerial will be required? One answer to this question is given by Telerection, who have developed some two-band aerials for overseas use. The general form is a 2-element horizontal "H" arranged as dipole and reflector for the lower frequency band. Just behind the dipole is a short reflector for the higher frequency band. On each half of the dipole is a stub which has negligible effect on the performance at the lower frequency, but behaves in such a way that it electrically fore-shortens the dipole at the higher frequency.

Three forms of this aerial have been evolved, one



Television field-strength measuring set made by Telequipment.



Taylor oscilloscope Type 31A suitable for television testing.

with stubs made of sections of rod with the ends joined by a loop, another in the form of "T"-match with an inductance loop (shown in the illustration) where it joins the dipole elements, while the third has short stubs set at an angle to the dipoles.

Apart from a few new aerial plugs, sockets, connections and distribution boxes the miscellaneous class of television accessories seems much as last year. One item that did attract attention was a small television field-strength meter developed by Telequipment. Basically it is a 5-channel television receiver consisting of an r.f. stage, mixer and 2 i.fs and the signal output is taken to a 1-in diameter cathode-ray tube. The actual picture content is not shown and the tube displays the maximum signal amplitude, or peak white.

The method of use is to plug in an aerial—a temporary one or even a short length of wire will often suffice—and adjust the gain controls so that the carrier just fills the defined space. The volume controls are calibrated in microvolts and by noting their readings the actual signal-strength level is obtained and with a little previous testing locally it is possible to predict with reasonable certainty the best type of aerial for good reception in any part of the district. This is but one of several applications for the test set, another is an interference level indicator, as a good idea of the signal/noise ratio is provided by the amount of "grass" accompanying the signal pattern as shown on the tube.

Another item of test gear intended primarily for

television servicing is the Type 31A oscilloscope just introduced by Taylor Electrical. It is a versatile scope fitted with a hard valve linear time-base covering 10 c/s to 500 kc/s nominal and an "X"-amplifier giving a linear amplification up to as much as some 10 screen diameters.

A push pull "Y"-(work) amplifier is included and this gives the equivalent of 5 screen diameters and a sensibly flat response from 10 c/s to 6 Mc/s. The oscilloscope is a.c.-operated, measures  $1\frac{1}{2} \times 7\frac{1}{4} \times 15$  in and weighs 26 lb.

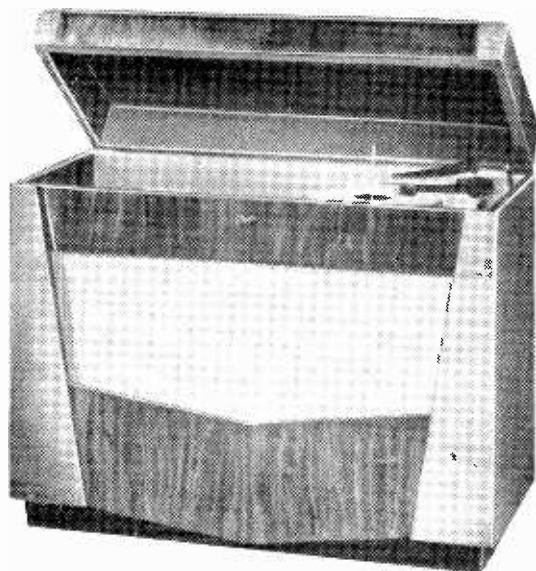
Although having no television label the 25-kV multipliers developed by Avo for the d.c. voltage ranges in their multi-range meters of suitably low consumption qualify for inclusion here as they are for measuring e.h.t. voltages in television sets.

## SOUND RECEIVERS

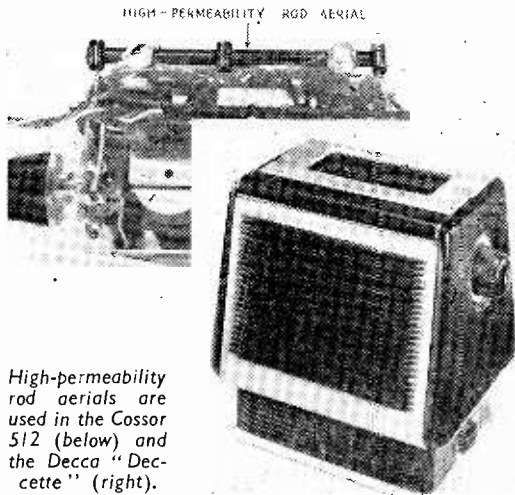
**T**HE stability of the table model superheterodyne (4 stages, plus rectifier) as the basic receiver for sound broadcasting remains undisturbed by any startlingly new development. So far as the number of types available is concerned, however, it is being challenged by the console-type radio-gramophone, largely due to the introduction by a number of firms of inexpensive models in the price range £48-£58. Typical examples are the Ambassador "Coronet," Champion 808, G.E.C. BC9440, Marconiphone ARG33A and Regentone Multi 99.

Two new portable radio-gramophones have made their appearance; the Pamphonic 902 and HMV 1507. Both are fitted with 3-speed turntables and the HMV model is notable for the fact that the latest type of ceramic piezoelectric elements are used in the cantilever, turnover pickup.

A minor trend is the increased use of elliptical loudspeaker diaphragms, which have been consistently favoured by E.M.I. in all sizes, and are now used by other firms in solving a variety of layout problems where space is limited. In the Sobell Type 514TAG table

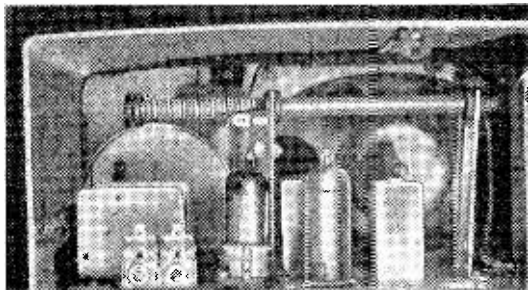


Marconiphone ARG33A radio-gramophone.



HIGH-PERMEABILITY ROD AERIAL

High-permeability rod aerials are used in the Cossor 512 (below) and the Decca "Deccette" (right).

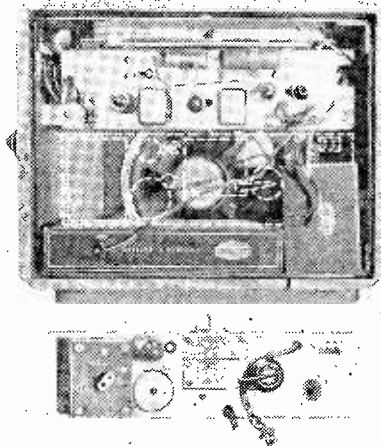
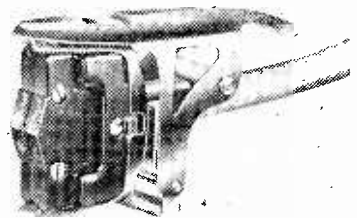


radio-gramophone, for instance, the loudspeaker is fitted into the front edge of the cabinet lid.

Probably the most interesting development is in portable receivers, two of which (the Cossor 512 and the Decca "Deccette") are fitted with internal aerials consisting of a ferromagnetic rod core, and windings no greater in diameter than a conventional tuning coil. The r.f. pick-up of this arrangement is comparable with that of a frame aerial of the size which can be accommodated in a small cabinet, and it exhibits similar directional properties. Inevitably, the introduction of a core brings with it losses which are not associated with an air-cored loop, but most portable frame aerials would be better described as "receiving-set-cored." The decision as to which method will give the best results will depend on the circumstances of layout, dictated by the external form which the receiver is to take, and it should not be implied that a manufacturer is out of date because he uses the conventional frame. In Germany the *ferritstab* aerial was used in most small portables a year ago, but there are signs that designers there are having second thoughts about what was at that time a slavishly followed fashion. If earlier extravagant claims have been modified, there can be no doubt that properly handled—and it is by no means simple to design—the rod aerial can increase the flexibility of portable set design.

Another trend in small portables is to make them primarily as battery receivers, and to provide a mains supply unit as an accessory. This policy has been followed in the Bush BAC31 in which the power

Ceramic (barium titanate) elements are used in the latest H.M.V. pickup (right).



Bush battery/mains portable Model BAC31.

unit can be purchased later and takes the form of an additional chassis strip, which can be fitted internally by the user, with the aid of simple instructions and a screwdriver. In the Decca "Deccette" the mains supply unit is housed in a separate moulding and forms a plinth for the receiver.

The Philips 523UB mains/battery portable provides facilities for re-activating the dry batteries, to extend their life.

## SOUND REPRODUCTION

THE growing interest in magnetic recording is reflected in the wide range of equipment now available for domestic and professional use. E.M.I. make all types from broadcast studio equipment (Model BTR/2) to a small battery-operated portable (Model L/2) in which the tape driving motor is energized from dry cells in parallel. In the Boosey and Hawkes portable "Reporter," the tape mechanism is driven by a clockwork motor.

Most tape recorders have two tape speeds,  $7\frac{1}{2}$  and  $3\frac{3}{4}$  in./sec, but in the Rudman-Darlington "Reflectograph" a novel continuously-variable capstan drive is now used which gives a speed range of  $3\frac{3}{4}$  to 8 in./sec. Not only does this permit exact adjustment of pitch, to compensate for daily variations in mains voltage, but speeds can be chosen to fit programmes of different duration into spools of standard tape length.

Instead of the conventional cylindrical friction drive

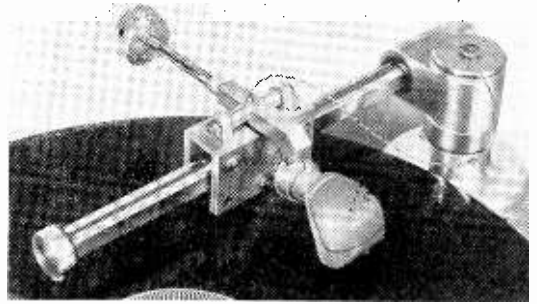
between motor and flywheel, a ball drive is used. The photograph and sketch, reproduced below, show that the motor frame can be tilted by a calibrated screw adjustment, so that the circle traced on the ball by its point of contact with the flywheel face can vary in diameter from zero (when the motor shaft is perpendicular to the flywheel face) to the full diameter of the ball when the shaft is parallel with the face. In practice, of course, the shaft does not reach the vertical position; an additional precaution against permanent depression of the Neoprene surface is provided by an auxiliary mounting bracket which automatically lifts the motor clear when it is switched off. As the tilting axis of the motor coincides with the centre of the ball, only a single line of contact of constant diameter is made on the flywheel. Industrial as well as domestic versions of this machine are available and, in one of these, four hours' playing time is obtained with excellent speech quality at 1in/sec using a 1200-ft reel.

Simon Sound have introduced a very professional looking twin-channel monitoring recorder for airports, using magnetic tape and giving four hours' duration on 2400-ft reels. By an ingenious system of overlapped mounting for the spools, the equipment is accommodated on standard 19-inch instrument panels.

Baird, who were early in the market with a portable tape recorder, have now entered the industrial field and make an industrial model (Type TRS1) for vibration study and other applications.

On the disc reproducing side, there has been plenty of activity, and Collaro are now at the production stage with a "transcription" motor, with a turntable weighing 8½lb. All their 3-speed turntables are now fitted with an ingenious spring-loaded centring device for the large-hole 45-r.p.m. discs. This is automatically depressed below the turntable level when using 78 and 33½ r.p.m. records, and, unlike the separate centring-spiders often used, cannot be detached and lost.

Garrard's latest record changers extend their already wide range with a high-quality unit (Type RC90) which is finding ready sales abroad, and an



Radial-tracking pickup arm (Classic Electrical).

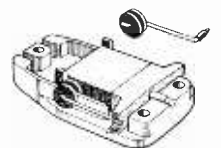
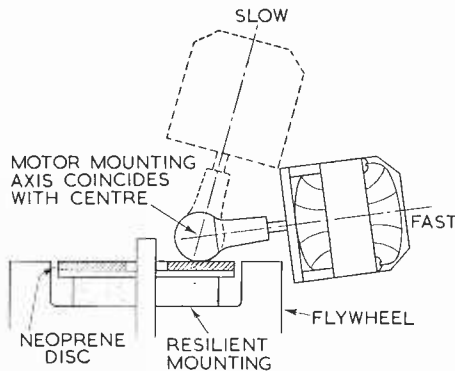
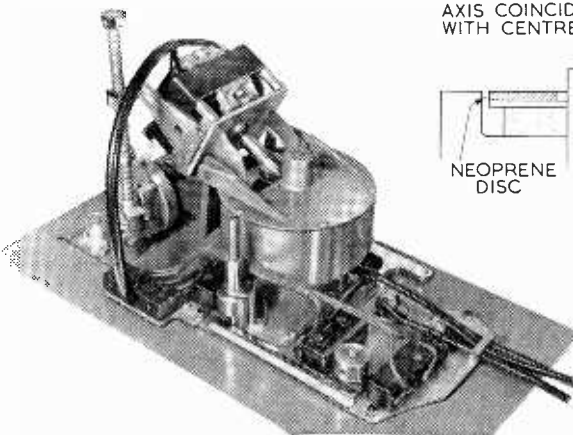
inexpensive unit (Type RC110) which has enabled many manufacturers to reduce considerably the price of radio-gramophones for the home market (as reported in another section of this review).

The Philips "Featherweight" 3-speed record changer, which has hitherto been obtainable only in radio-gramophones or record players, is now to be sold as a separate component (Type AG1000).

Some interesting new pickups have made their appearance. The ceramic cantilever piezoelectric pickup, as used in the Model 2126 record player and Model 1507 radio-gramophone, is a new departure for H.M.V., who have hitherto favoured the magnetic type. It is, we believe, the first commercial appearance in pickups in this country of the barium titanate type of element, with its advantages of thermal stability and resistance to the effects of moisture. This substance is, however, fragile and requires careful mounting; in the H.M.V. pickup a pivoted guard affords protection from gross mishandling.

The Acos "Hi-G" pickups which are designed to track the severest accelerations (of the order of 2000 times the acceleration due to gravity) which can be recorded on discs, and which have hitherto been sold only to manufacturers, will now be more generally available. In the HGP37 series the makers have

Under-side of the "Reflectograph" tape recorder, and (on right) details of the continuously variable ball drive.



Acos Type HGP37 cantilever crystal pickup.

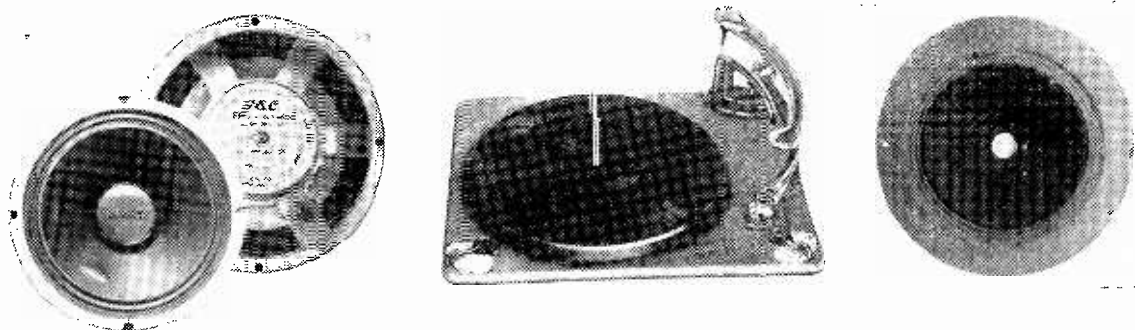


Goodmans Z33 moving-coil microphone.



Left: Double - element crystal microphone, Type Mic 35 (Acos).



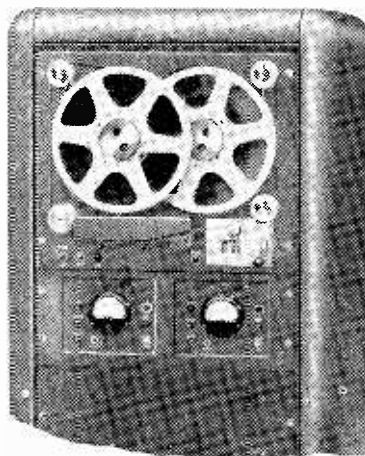


Left: Production-model "FR" metal-cone loudspeaker (G.E.C.). Centre: Garrard Type RC110 3-speed record changer. Right: Composite cambric diaphragm used in Whiteley Electrical Type HF loudspeakers.

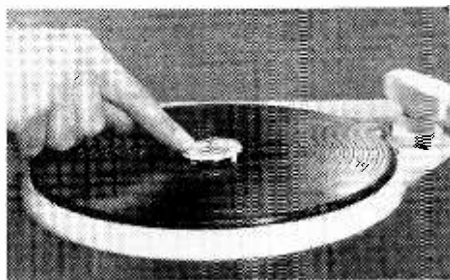
returned to cantilever mounting for the stylus, which drives the crystal element through the compliance of a specially graded plastic moulding. The cantilever anchorage is of simple design and can be easily replaced. The system is said to be truly aperiodic throughout the frequency range, the effective mass at the point is 7 milligrams and the compliance  $3.5$  to  $4.0 \times 10^{-6}$  cm/dyne.

A beautifully made radial tracking arm is under development by Classic Electrical to overcome distortions due to tracking errors. Less than 3 grams is required to propel the carriage, and to reduce friction to this extent knife-edge rollers running, on miniature ball races, in a hardened and ground groove have been used.

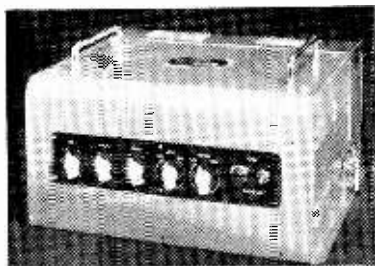
Two new microphones have made their debut. The Goodmans Z33 is of the moving-coil type and is mounted on a "wire" base formed for equal convenience as a desk stand or pocket attachment; a tapped hole is also provided for stand mounting. The Acos Mic 35 is an ingenious double-element design in which two diaphragm-driven crystals are connected in parallel, and in phase in the sound field. It is claimed that in addition to enabling characteristics of two different elements to be combined to give a smooth overall response at low cost, the arrange-



Twin-channel monitoring recorder, Type LDT7 (Simon).



Spring-loaded 45 r.p.m. centring device (Collaro).



Type 635 30-watt gramophone amplifier (Trix).

ment gives some measure of noise suppression when used as a close-talking microphone.

An inexpensive loudspeaker with quality of reproduction above the average has been produced by Whiteley Electrical. The diaphragm is a pressing of open-mesh cambric backed by a light felting over the active area of the cone, the whole being cured together after pressing. The effect is to give a freely suspended movement of low mass which gives very effective reproduction of transients.

Comprehensive demonstrations of high-quality reproduction were once again staged by Goodmans and G.E.C., the latter with the production models of their metal-cone loudspeaker, which was shown in the experimental stage last year.

One of the oldest firms in the loudspeaker business, Baker Selhurst, made a welcome reappearance at the Show and demonstrated a special unit for low frequencies as well as their wide-range "de luxe" units in which a domed metal apex to a paper cone with two rates of curvature combine to cover frequencies from 18 to 17,000c/s.

Two new amplifiers for high-quality enthusiasts have been added to the already wide range of Trix products. The T635 is a 30-watt amplifier with inputs for two ribbon or moving-coil microphones and a gramophone pickup. It has independent bass and treble controls and can be switched to work from a 6-volt external battery or (normally) from a.c. mains. The T102 has been designed for use by gramophone

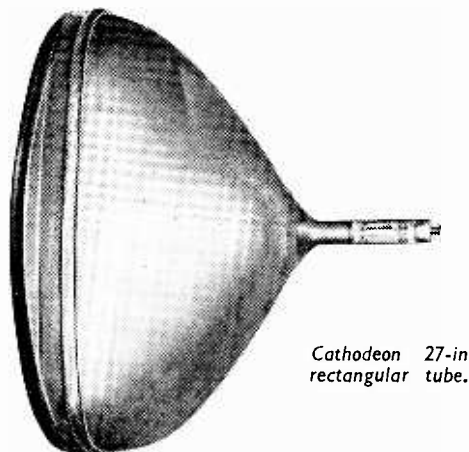
societies and is compact and easily carried. It has an output of 12 watts, and is fitted with wide-range base and treble controls.

## VALVES AND CATHODE RAY TUBES

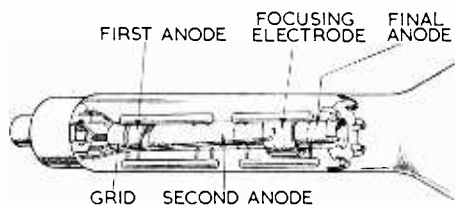
**M**OST television set makers are now featuring the 17-in rectangular tube in their latest models, so there is no doubt that this size of tube has come to stay. Although there is some talk of a reversion towards the 9-in size (perhaps because owners of big-tube receivers are finding it difficult to pay for tube replacements), it seems fairly certain that the future trend of design will be towards even larger screen diameters. Cathodeon, for example, have just brought out a mammoth rectangular tube with a 27-in screen and a deflection angle of about 90 degrees. It has a tetrode gun and the anode voltage is about 18 kV. E.M.I. are still producing the 21-in metal tube that they introduced two years ago, and we understand that one or two other manufacturers may be coming out with new tubes of this size.

A rather more down-to-earth design trend has been the reshaping of existing sizes of tubes so that they take up less space in the cabinet. More and more types are being made with wider deflection angles and consequently shorter lengths. Usually the wide deflection angle is about 70 degrees, but in one experimental 12-in tube made by G.E.C. the reshaping process has been taken even further to give an angle of 90 degrees and a reduction in length of over 5 inches. The deflector coils have to be specially designed for such wide angle scanning, of course, but existing types of output valves can apparently be used in the time bases.

Rectangular tubes are another way of saving space



*Cathodeon 27-in rectangular tube.*



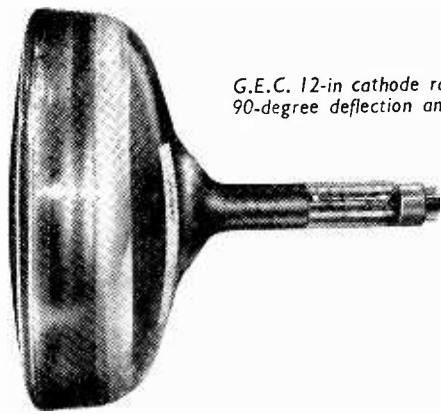
*Electron-gun construction of Brimar electrostatically focused c.r. tubes.*

in the cabinet—although Ediswan have pointed out that their new 14-in round tube CRM141 actually gives a picture of greater area than that of a 14-in rectangular. The secret is, of course, a little judicious corner-cutting. On the other hand, G.E.C. take an entirely new line in introducing their 17-in rectangular tube, 7401A, by pointing out that it can be arranged to give a picture with nice square corners, like that of a projection receiver! Incidentally, the Ediswan CRM141 has an improved type of ion-trapping tetrode gun which not only stops the negative ions from getting to the fluorescent screen but also prevents the positive ones from bombarding the cathode and poisoning it. The secret of this is a slanting electrostatic lens formed between the first and final anodes.

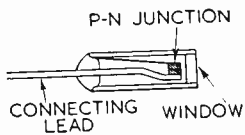
Other manufacturers seem to be showing some interest in electrostatic methods of focusing the beam. Indeed, two recent tubes made by Brimar, the C14GM and C17GM, are entirely focused by electrostatic means—a reversion to the early days when all tubes were of this type. They use an extra electrode at near cathode potential inserted between the penultimate and final anodes. The main advantages of this system are its simplicity and avoidance of external focus magnets. Usually, the fineness of electrostatic focusing is about the same as magnetic focusing, but Brimar claim that their electrostatic tubes are actually better. They also say that the focus does not change so much with variations of final anode voltage. A similar electron optical principle is used by Mullard in one of their recent magnetically-focused tubes, the MW43-64, and here the object is to improve the uniformity of focusing over the whole screen. The pre-focusing action of the electrostatic lens formed by the extra electrode makes the beam narrower than in an ordinary tetrode, so there is less deflection defocusing at the outer edges of the picture. Judging from recent American experience, however, it is questionable whether there will be a complete swing-over to electrostatic focusing. For one thing, the electrode structures of the tubes are rather more difficult and costly to manufacture than those of ordinary tubes.

It seems, too, that manufacturing problems are really at the heart of the old triode-versus-tetrode controversy, which has recently flared up again. Some firms have adopted the tetrode exclusively, while others insist that it is not really any better and continue to produce their latest tubes with triode guns. The main advantage of the tetrode would seem to be that the tube characteristics are not affected by variations in the final anode voltage, so that the picture brightness remains more constant. On the other hand, the triode is supposed to give a spot that is less prone to astigmatism, so that the definition of the picture may be somewhat better. It is often stated that because the electron beam of the tetrode is narrower than that of the triode it requires less focusing power and is not so liable to deflection defocusing. Defenders of the triode, however, reply that there is no reason why its beam should not be made equally narrow. They also say that there is nothing to prevent ion traps from being fitted to triodes—although apparently this is not quite so easy to do as in tetrodes. The fact that the Americans use the tetrode exclusively is not particularly significant—they just didn't happen to think of the triode first.

With the cost of replacing cathode-ray tubes as high as it is at the moment, many people will be interested in a new English Electric scheme for recon-



G.E.C. 12-in cathode ray tube with 90-degree deflection angle.



Construction of S.T.C. germanium junction photocell.



Right: Mullard EF86 low-noise pentode.

ditioning their 16-in metal tubes, which normally cost over £22. When a tube fails (beyond the 6 months guarantee period) it can be exchanged for a reconditioned one, carrying a new guarantee, for £12. The reconditioning process consists of cutting off the neck of the tube, fitting a new gun and renewing the fluorescent screen.

Developments in valves this year have not been very spectacular, but there have been some steady improvements in design, particularly in mechanical construction. It is said, in fact, that the technique of reliable valve production is having such a beneficial effect on ordinary valves that there will soon be no need to distinguish between the two kinds. One rather interesting example is to be found in the Osram television booster diode U329. A high heater-to-cathode resistance is needed for this type of valve, so the makers use a thin layer of vacuum—in other words, they space the two electrodes apart. The arrangement is claimed to be much more reliable than the usual insulating ceramics, which are rather prone to electrolytic action.

On the score of electrical efficiency the latest range of Mullard B7G battery valves are a notable achievement, for they have a filament consumption of only 25mA. This firm also have a new B9A pentode, the EF86, intended for a.f. voltage amplifying stages, which replaces their EF37A or EF40. Its mechanical construction has been designed to avoid microphonic tendencies, and the bi-filar heater reduces hum to a minimum. A similar valve from another manufacturer is the Osram Z729, notable for its low hum-level of 1.5  $\mu$ V.

Osram have also produced two high-slope B9A valves, primarily for television applications. The Z309 is a short-base r.f. pentode intended as a video

amplifier and has a slope of 15 mA/V; while the Z719, designed as an r.f. or i.f. amplifier, has a slope of 7.4 mA/V. In the Z719 two cathode connections are provided to reduce input circuit damping, while the low anode voltage of 170 V makes the valve particularly suitable for transformerless receivers. For stabilizing the series heater current in these receivers against mains fluctuations, and thereby prolonging the life of the valves and tubes, this firm have introduced a barretter, type 305. With a control range of 40-90 V, it maintains the current within  $\pm 5$  per cent of the nominal value.

Turning now to the topical subject of crystal valves, Mullard have entered the germanium field with two crystal diodes, OA60 and OA61, and two point transistors, OC50 and OC51. The OC50 transistor is a general purpose type, while the OC51 is intended for switching, gating and computing circuits. The G.E.C. type GET1, which has already become well known as an experimental transistor, is now in production and is available to manufacturers in sufficient quantities for experimental work. The current gain is greater than 2, the "knee" voltage is less than 3 and the collector current at -30 V for zero emitter bias is less than 2 mA.

Apart from transistors, the most interesting germanium device to come on the market recently is the germanium junction photo-electric cell. Made by S.T.C., it consists of a p-n junction mounted in a metal cylinder of about  $\frac{1}{4}$  in diameter, with a glass window at one end and a connecting wire at the other. If the junction is biased at about 50 V in the reverse direction it passes a saturation current which is practically independent of the applied voltage, and when it is illuminated this current increases in direct proportion to the light intensity. The current varies between about 250  $\mu$ A and 2.5 mA so the cell can be used for direct operation of a relay. S.T.C. have also introduced a power rectifier using a p-n junction. With a resistive load the maximum input voltage is 100 V, the peak inverse voltage is 140 V and the maximum mean d.c. output current is 100 mA. The germanium element is hermetically sealed with glass-to-metal seals and the complete assembly is about the size of a halfpenny.

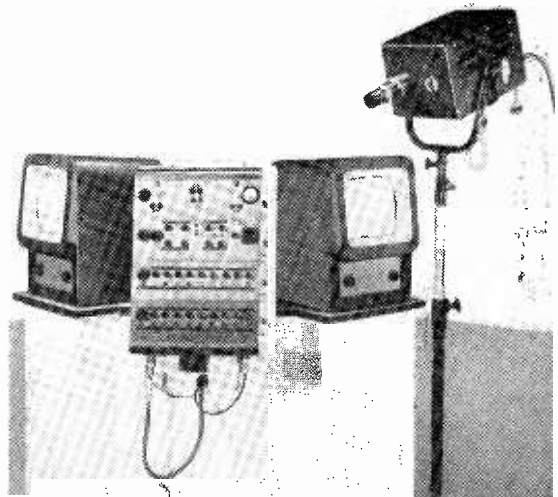
## OTHER EXHIBITS

AMONG the electronic exhibits arranged by the Radio Industry Council was an unusual type of machine for separating discoloured peas or beans from good ones. Instead of a mechanical system to do the final sorting it used electrostatic deflection. The beans are fed from a hopper on to a moving belt and then shot through an illumination chamber, where they are viewed by two photocells from opposite sides. A discoloured bean causes the photocells to produce a signal, which is amplified and applied as a negative cut-off voltage to the grid of a large valve. As a result the anode voltage of the valve rises momentarily to about 25 kV, and this high potential is applied to a point electrode so that the discoloured bean receives an electrostatic charge in mid-flight. After leaving the photocells the beans fall in a stream between two deflecting plates which carry a charge of about 25 kV, and the discoloured ones are attracted to one side out of the normal trajectory so that they fall into a separate container. The apparatus was

designed by the machinery department of R. W. Gunson, the seed merchants.

The increasing use of radio heaters in industry is exemplified by a new Redifon dielectric heating equipment for welding plastic sheet. Its main feature is that the welding electrodes are in the form of a pair of "tongs," which can be taken to the work on the end of a coaxial cable, instead of being incorporated in the main body of the equipment. With varying thicknesses of plastic to be welded, the impedance of the capacitor formed by the two electrodes may be anything from about  $2\Omega$  to  $60\Omega$ , so an impedance-matching device has been incorporated to ensure that the maximum r.f. power is applied. It consists of a coaxial stub and has to be adjusted according to the thickness of the dielectric. The single-valve oscillator used in the equipment has an output power of 450 watts at 35 Mc/s.

One of the very latest electronic aids to industry is, of course, the closed-circuit television system, and there are now two firms making the apparatus in this country. The E.M.I. equipment consists of a camera, a control panel and a television receiver. The camera, which weighs 28 lb, uses a miniature C.P.S. Emitron pick-up tube and can be adjusted to cover a highlight brightness range of 10 to 100,000 ft-lamberts. There is also an electronic system for magnifying the picture up to twice the normal size for close inspection. If necessary the optical focusing and lens selection can be done remotely from the control panel. The Pye equipment is an improvement on their previous design in that the entire picture-generating apparatus, including the power supply, is contained in the camera itself—excepting, of course, the monitor on which the pictures are remotely displayed. Both equipments work on the British television standards, and their pictures can be displayed on domestic receivers—the Pye one having an r.f.



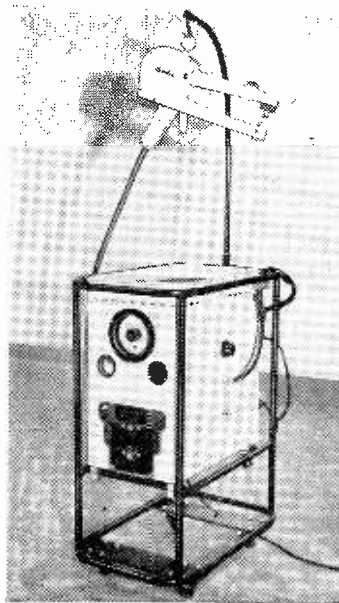
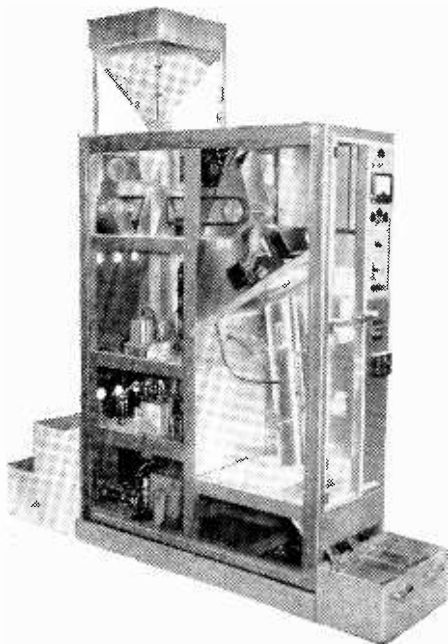
output which can be tuned over all the B.B.C. channels.

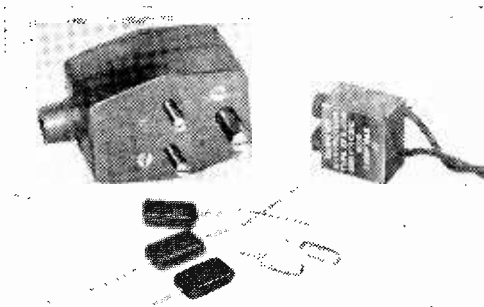
Another electronic system for transmitting visual information was the Creed "Desk-Fax", a small phototelegraphy equipment designed for sending written or typed messages over telephone lines. It operates on well-known principles and the received message is reproduced by a stylus on voltage-sensitive Teledeltos paper. The scanning is done at 100 lines to the inch, and a typewritten message of 150 words, occupying an area of approximately 15 square inches, takes about two minutes to transmit. The same machine is used as both transmitter and receiver.

Among the latest test equipment is a new valve tester made by Avo. Known as the Type 160 it tells a little more than usual about a valve and covers such tests as cathode-heater insulation, inter-electrode insulation, mutual conductance up to 20 mA/V, amplification factor and a.c. resistance. It is a.c.-operated, weighs 22lb and accommodates almost every type of valve in current use.

Electrical interference is still a serious nuisance to broadcast and television reception and while the technique of suppression is well known, convenient forms of suppressors for use in the home and on domestic electrical equipment have been scarce. Dubilier has introduced a series of suppressed plugs in 5-A, 13-A and 15-A types; the 13-A model includes a fuse. Suppressor capacitors of 0.1 and  $0.05\ \mu\text{F}$  are embodied in the plug. These are made of hard rubber and should be very durable. Alone, these plugs are effective on the medium and long wave-bands only and not at television frequencies. For this there is a

*Machine for sorting peas or beans, using electrostatic deflection method of separation, and (right) radio heater made by Redifon for plastic welding.*

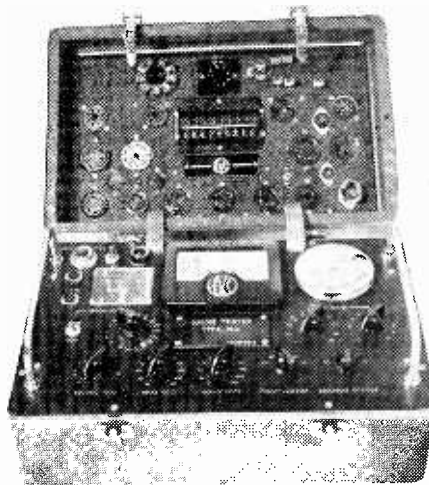




Above: Dubilier interference suppression components for sound radio and television.

Right: Avo valve tester Type 160 for comprehensive tests on all modern valves.

Left: Industrial television equipment made by E.M.I.



range of Dubilier suppressors embodying chokes as well as capacitors and a kit of components for use on the actual offending appliance. A 3-pin, 5-A plug made of bakelite and containing suppressor capacitors is made also by Belling-Lee. The capacitors used in this model are 0.05  $\mu$ F.

People who make capacitors are obviously in a good position to say how they should be measured and tested. Hunt's have introduced a capacitor tester comprising an orthodox Wien bridge, with a few

refinements. An unusually large, high-grade potentiometer is used for the adjustable ratio arms and to obviate multiplicity of scales the multipliers are in steps of 100. The coverage is 20 pF to 500  $\mu$ F in three ranges and power factor and leakage are also measured. The bridge also serves for resistance and insulation measurements so three resistance ranges are included, covering 5  $\Omega$  to 100 M $\Omega$ . Insulation testing is provided for but not actual measurement of leakage resistance.

## AVIATION RADIO

*Trend in Development as Seen at the S.B.A.C  
Flying Display at Farnborough*

**W**HILE the radio show at Earls Court was in progress another exhibition of radio and radar equipment was staged at Farnborough, where the Society of British Aircraft Constructors were holding their annual flying display. A wide range of equipment was shown, including aircraft communication sets, navigational aids, ground station installations and various electronic apparatus connected in one way or another with flying.

If doubt has even existed that the higher frequencies covering the band 2 to 20 Mc/s have no future in aviation radio the newest of the communications equipments should finally dispel such opinions. There is a definite demand for this type of apparatus but in a different form to that used in the past. Hitherto the designs assumed one member of the crew would be a radio operator with telegraphy the primary means of communication, but radio-telephony facilities were included for short-distance working.

It seems now that telephony is becoming the primary system for all purposes with telegraphy taking second place and remote control is provided for operating the radio equipment from the pilot's cockpit. Direct operation is still a requirement so that the new sets

have the dual facilities and provision is made for m.c.w. as well as c.w. transmission.

This requirement has led to considerable change in the design of h.f. aircraft equipment as more power output from the transmitter is needed to ensure satisfactory telephony communication over long distances and since frequent changing of frequency may be called for when working different ground stations and to enable the optimum frequency for the time of day and path to be selected a comprehensive remote control system must be included. Also the control unit must not be too bulky since space is at a premium in the pilot's cockpit.

In order to meet this growing demand Standard Telephones have produced a new version of their STR18B high-power h.f. telegraph-telephone aircraft communications equipment and in its modified form it is known as the STR18C. The main modification is the combining for general servicing purposes and convenience of the transmitter driver section and the receiver in a single unit. Some circuit modifications have been made also.

The STR18C allows for instant operation and selec-

tion from the remote control point of 100 channels in the band 2.8 to 18.1 Mc/s. All the channels are crystal controlled by separate crystals and each crystal is used for the receiver as well as for the transmitter which leads to some economy in crystals and space. The transmitter gives not less than 100 watts output on telephony throughout the band covered and provision is made for use of all orthodox wire or suppressed aerial.

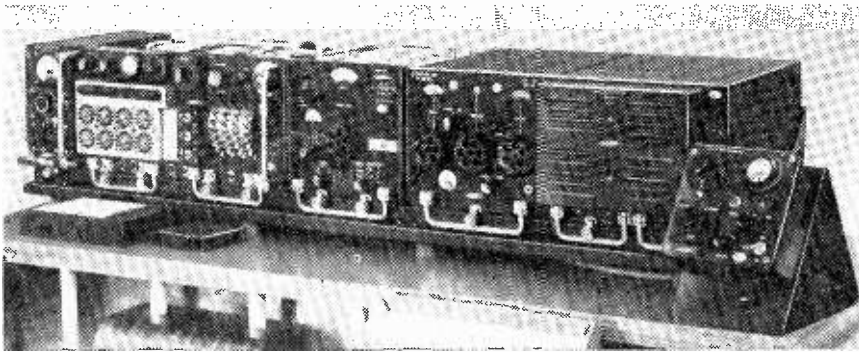
Another high-power h.f. radio-telephone for aircraft with provision also for telegraphy operation on c.w. or m.c.w. is the Marconi AD107B. Full remote operation is possible and some 110 to 130 watts output is available on telephony for an open wire or suppressed aerial. Instant operation on any one of 20 pre-selected channels is possible and a new set of channels can easily and quickly be set up in flight should the necessity arise.

Whilst remote control may have certain advantages for aircraft operation it has undoubtedly added enormously to the complexity of the equipment. Admittedly the channels are precisely fixed by the use of crystals but the associated circuits in the transmitter and the receiver have to be tuned accurately on every

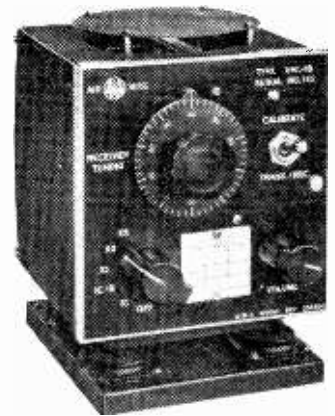
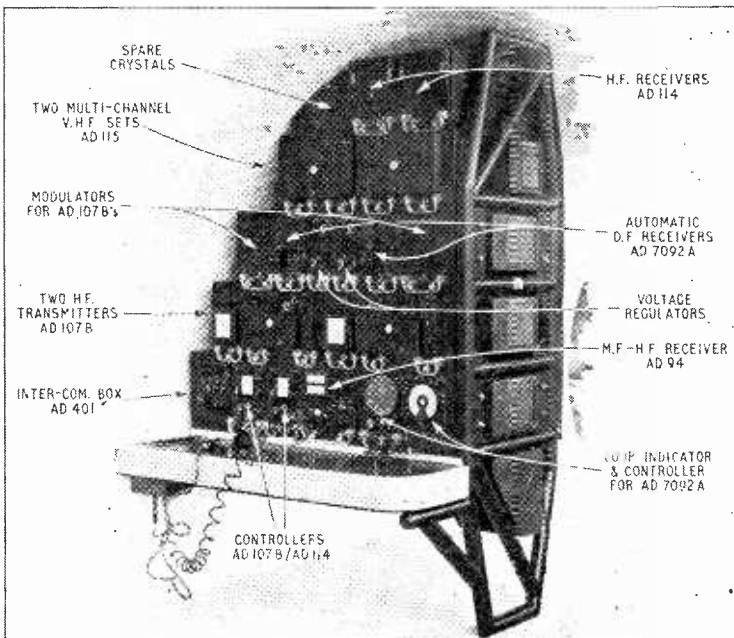
change in frequency. Very small tolerances only are acceptable on the h.f. bands where receiver bandwidths must necessarily be restricted in order to avoid adjacent channel interference so that high precision in the whole of the remote control mechanism is absolutely essential.

### Anti-Static Aerials

Prolonged tests have shown that with the new high-power h.f. radio-telephones ranges of 2,000 to 3,000 miles are normally attainable unless conditions are extremely bad. Atmospheric static especially in tropical regions is the main difficulty to long-range telephony operation on the high frequencies, but even this is apparently being overcome to a large extent by the use of the latest suppressed aerial systems. Apart from reducing drag and impeding the speed of the aircraft, which is one of the objections to exposed wire aerials, the suppressed or buried aerial appears to have a marked discrimination between static and signal with the result that when telephony is quite unintelligible on a trailing wire aerial it has often been perfectly understandable on the suppressed aerial. No adequate



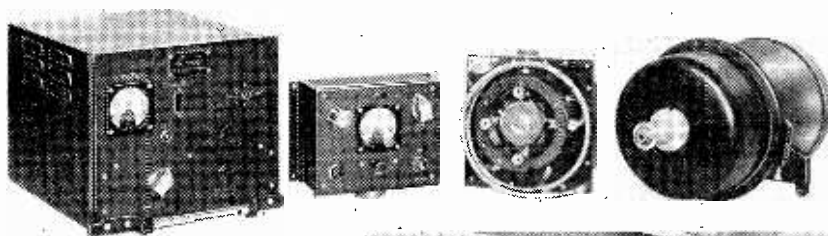
Among other equipment is shown the Standard Telephones STR18C high-power radio-telephone for remote control on the h.f. band.



Amalgamated Wireless (Australia) "Air-Mite" v.h.f. aircraft equipment.

Complete Marconi radio installation for a modern air liner. Some equipments are duplicated to ensure no interruption in service in the event of a failure.

The various units comprising the suppressed aerial equipment made by Ekco.



explanation for this seems forthcoming but the system is still very new and few civil airliners have as yet been fitted. But some of the newer types will have it, the new Britannia being a case in point. So far the Royal Air Force have been the principal users.

The new h.f. equipments have somewhat obscured the developments in the v.h.f. part of the spectrum of which there have been a few although nothing of great consequence. The principal change is brought about by the likelihood that very shortly civil airliners will be required to operate on more than the former number of channels in the 118- to 132-Mc/s band.

It is expected that a minimum of 34 will be needed and to meet this possible demand Murphy has introduced a new remote controller for their TR41 v.h.f. aircraft sets giving instant selection of up to 36 crystal-controlled channels.

Compact, lightweight v.h.f. radio telephone sets find many applications in the smaller type of aircraft but in the majority of cases operation is required only on a very few channels. Murphy have control units for their sets giving a choice of few as well as many channels but one of the smallest sets for the facilities that it provides must surely be the Amalgamated Wireless of Australia "Air-Mite." This company is associated with the English Marconi Company.

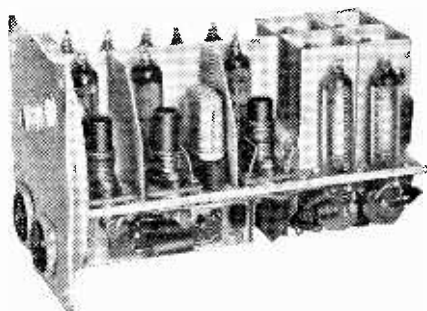
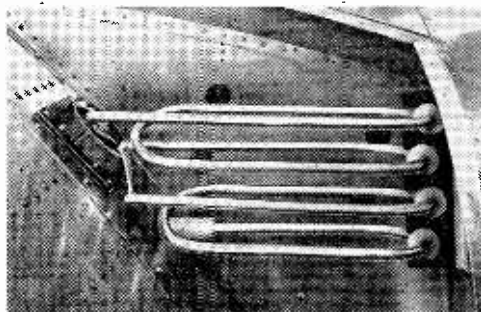
The "Air-Mite" measures  $6\frac{1}{4} \times 4\frac{1}{2} \times 6$  in overall, weighs 12 lb and in its present form allows for operation on 3 crystal-controlled channels in the v.h.f. band and also provides intercom facilities between pilot and passenger. Its main usefulness is apparently found in aircraft employed on such prosaic functions as crop spraying, pipeline patrols in remote, sparsely populated country and also by flying clubs and private individuals. It now gives about twice the r.f. output than hitherto and ranges of 50 to 60 miles are said to be regularly obtainable at the usual flying heights of these aircraft.

## Nav aids

Among the new navigational aids is a simplified airfield approach radar working in the 3-cm band and produced by Decca from experience gained with marine radar on the same wavelength. Much of the marine technique and circuitry is embodied in the equipment which is known as the Decca Airfield Control Radar Type 424.

Its primary function is to speed up the landing of modern high-speed jet fighter aircraft but it needs only the addition of a v.h.f. radio telephone to convert it into a most useful small-scale GCA (Ground Control Approach) installation for airports where a full-scale GCA would not be justified.

Another equipment of a somewhat similar kind is made by E. K. Cole and details have already been given<sup>1</sup> of this Ekco Airfield Approach Aid, as it is



Murphy receiver used for radio control of model and target aircraft.

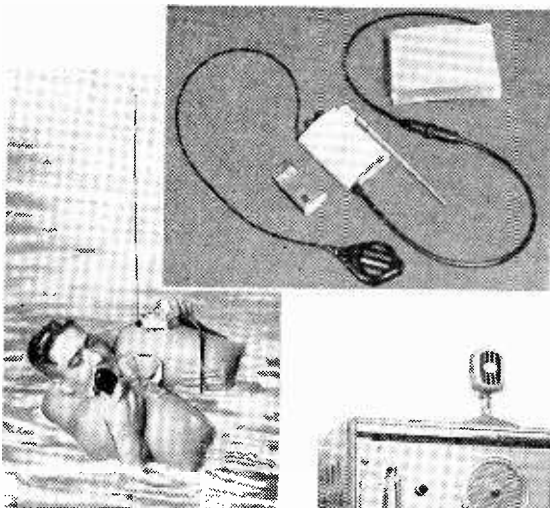


Scanner and radar head of the Decca Airfield Radar Type 424.

called, in *Wireless World*. It has since been greatly improved in layout and in convenience in operation but basically remains the same.

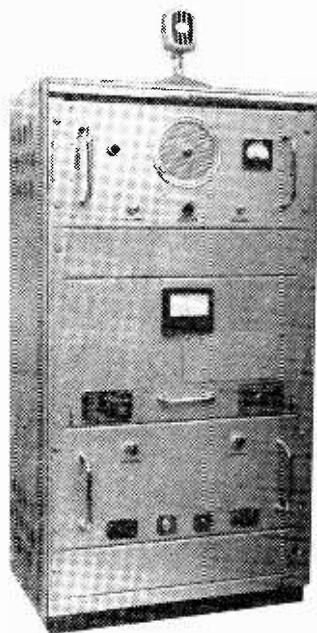
Radio equipment designed to hasten the rescue of survivors of aircraft wrecked in the sea has been receiving some attention lately. The subject has not been ignored by any means in the past but this year two entirely new sets, both in conception and make up,

<sup>1</sup> "Simplified Aerodrome Approach Aid," *Wireless World*, April, 1952, p. 162.



Burndept "Talbe" life-saving radio beacon with two-way R/T its size can be judged from the box of matches.

Pye 50-watt v.h.f. transmitter-receiver (right).



make their appearance. One, the Ultra "Sarah," has already been described in some detail,<sup>2</sup> but the other, which is made by Burndept, made its debut at Farnborough this year.

Known as "Talbe" it is a combined automatic radio beacon and short-range radio telephone set highly miniaturized and so designed that it can be stowed away conveniently in the standard type of life-saving jacket, familiarly known as a "Mae West."

With the aerial extended it automatically transmits a distress signal on 121.5 Mc/s using c.w. with a 1,000-c/s modulation pip once every 2 sec for identification. Location of the beacon in the sea is effected by the normal D/F technique adopted by Service aircraft which can pick up the beacon at about 50 miles when flying at 5,000 ft and the R/T has a range of approximately 20 miles. Small batteries weighing 2 lb suffice to operate the beacon for six hours continuously and give also an additional 30 minutes two-way telephony working.

Burndept has also developed a miniature life-saving beacon transmitter for use in collapsible dinghys on similar lines to "Talbe" but without the R/T facility. Having a larger battery, since weight restriction is not so vital, it has a duration of 24 hours continuous operation.

Radio control of models is not new, but it is likely to play quite an important part in the early design stages of new jet aircraft. Full-size prototypes of the larger swept-back wing or delta-wing aircraft are costly, whereas a study of the behaviour of a new design in model form with radio control is far less

expensive and renders much valuable information.

Radio equipment based on the system described some time ago in *Wireless World*<sup>3</sup> is now being made by Murphy. It operates on 27 Mc/s but the same system is equally applicable to the 80-Mc/s band. Sub-carriers are used for each of the control functions required and the amount of movement in each case is determined by variations in the mark/space ratio. These are applied to the v.h.f. carrier by frequency modulation and servo mechanisms in the aircraft translate the radio intelligence into mechanical movement of the control surfaces.

Frequency modulation is used also in the radio-control equipment fitted to the target model aircraft made by M. L. Aviation. The system is to employ an auto-pilot and use the radio messages to over-ride the auto-pilot. Two-tone modulation conveys the control intelligence.

V.H.F. ground station equipment shows few basic changes but some new transmitters have appeared. Pye has one giving 50 watts output on any spot frequency in the band 60 to 184 Mc/s. Two models are made, one covers 60 to 100 Mc/s (PTC750), the other 100 to 184 Mc/s (PTC751). This firm has recently completed a mobile radio installation for a mobile GCI and operations room for the South African Air Force. It provides several different channels of operation with facilities for easy and rapid change in frequencies when required.

Many and diverse are the applications of tape recorders, but a novel one must surely be the Westinghouse Automatic Announcer. The basis of the equipment is a bank of small "cassettes," each containing a small spool of magnetic tape, another to wind it on and a three-purpose magnetic head for recording, erase and playback as required. Designed in the first place for train announcements, it is now being extended to announcing the arrival and departure of aircraft. Any number of small "cassettes" can be included in a single installation and each runs for

45 sec, but longer working times can be arranged if necessary.

<sup>3</sup> "Radio Controlled Jet Plane," *Wireless World*, December, 1952, p. 489.

#### RADIO EXHIBITORS AT THE S.B.A.C. SHOW

- Amalgamated Wireless (Australia), Ltd., General Buildings, 99, Aldwych, London, W.C.2.
- Burndept, Ltd., West St., Erith, Kent.
- Ekco Electronics, Ltd., Southend-on-Sea, Essex.
- Cossor Radar, Ltd., Highbury Grove, London, N.5.
- Decca Navigator Co., Ltd., 1-3, Brixton Rd., London, S.W.9.
- Elliott Bros. (London), Ltd., Century Works, Lewisham, London, S.E.13.
- English Electric Co., Ltd., Queens House, Kingsway, London, W.C.2.
- Ferranti, Ltd., Ferry Road, Crewe Toll, Edinburgh.
- General Electric Co., Ltd., Magnet House, Kingsway, London, W.C.2.
- Marconi's Wireless Telegraph Co., Ltd., Chelmsford, Essex.
- McMichael Radio, Ltd., Wexham Rd., Slough, Bucks.
- M. L. Aviation Co., Ltd., White Waltham Aerodrome, Maidenhead, Bucks.
- Mullard, Ltd., Shaftesbury Ave., London, W.C.2.
- Murphy Radio, Ltd., Welwyn Garden City, Herts.
- Plessey Co., Ltd., Vicarage Lane, Ilford, Essex.
- Pye, Ltd., Cambridge.
- Redifon, Ltd., Broomhill Rd., London, S.W.18.
- Salford Electrical Instruments, Ltd., Silk St., Salford, Lines.
- Sangamo Weston, Ltd., 22-26, Oxford St., London, W.C.1.
- Standard Telephones & Cables, Ltd., Connaught House, Aldwych, London, W.C.2.
- Ultra Electric, Ltd., Western Avenue, Acton, London, W.3.
- Westinghouse Brake & Signal Co., Ltd., 82, York Way, King's Cross, London, N.1.

<sup>2</sup> "Radio Rescue Beacon," *Wireless World*, August, 1953, p. 381.



# LETTERS TO THE EDITOR

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

## *Allocation of Frequencies*

YOUR August Editorial rightly expresses misgivings on the subject of v.h.f. frequency allocations in this country, particularly on the potential clash of television on the one hand, and Government and mobile services on the other. I should like to comment on a particular aspect of this problem.

Your issue also contained a description of the newly developed air-sea rescue equipment SARAH, and indicated that it operated just over 200 Mc/s. I have nothing but support for efforts made towards introducing satisfactory air-sea rescue communication, but for this particular equipment to be of value the following conditions will have to be met:

(1) It will have to operate on a frequency above Band 3 (216 Mc/s) and the upward extension of it being planned in Europe. If it does not, the airborne receiver will be jammed at very great ranges by television transmitters, British or Continental, or both.

(2) The frequency band allotted to it will have to be available eventually for both civil and military users.

(3) At least a measure of international agreement will have to be obtained on the channels to be used, and upon the rules covering its operation.

I hope some reassurance on these points will be forthcoming, otherwise the designers of the equipment may suffer in the way your Editorial foreshadows. If clear public statements of intention were made by the Government on frequency allocation, this kind of situation need not arise.

My view is that there is an urgent need for v.h.f. air-sea rescue arrangements and that these could be most easily made on the international air distress frequency in the 120-Mc/s band, or on the international marine frequency of 156.8 Mc/s, or on some nearby channel. On these frequencies a minimum of new equipment will be required.

Rees Mace Marine, Ltd. R. I. T. FALKNER.

## *Exhibitions and Catalogues*

THE excessive number of exhibitions of electronic equipment means that the same manufacturers re-exhibit the same products on every occasion; thus their stands are overwhelmed with equipment which is already much too familiar.

An exhibition stand should focus the attention on one or two new exhibits only, and these should be accurately described in the technical leaflets available.

These leaflets and also the exhibition catalogue are all too often so written that they are of little value. A visitor wishes to know the technical details of the exhibits in terms he can understand; a bald statement of the name of the equipment is useless. The leaflets supplied are often couched in the florid terms of a press handout.

A catalogue should enable a visitor to decide in advance which stands he wishes to visit and later to refresh his memory on the technical details of the equipment seen. But, unfortunately, this is not often the case. In a recent catalogue, out of a total of 142 pages only 43 are given to the description of the exhibits and 15 to a classified index; the description of the products of three manufacturers is crammed into a single page and this allows only the name of each exhibit to be given. Although this is not the worst example which I have seen, it cannot be said to perform the required functions as described above.

Surely, it is not asking too much of manufacturers and stand designers to give prominence to really new equipment and to provide an accurate technical description of

it. If, therefore, manufacturers, stand designers and exhibition organizers would collaborate now, next year's exhibitions may prove to be of a higher standard.

Hayes, Middx. S. PEARCE.

## *Ignition Interference in U.S.A.*

FOR many years I have been reading the random writings of "Diallist" with interest and some amusement, but I fear that I really must protest against his proposal to penalize millions of motorists in order to permit British manufacturers to continue to turn out poorly designed television sets that are subject to interference from automobile ignition. Here in the U.S.A. our television sets operate in the midst of millions of motor cars, all un-suppressed, yet never have I seen a case of ignition interference or even heard of anyone troubled by it.

Rockville, Md., U.S.A. MALCOLM S. MORSE.

## *Dry Cells*

I WOULD like the opportunity of dispelling some of the doubts as to the reliability of the present type of dry cell which may have been aroused by R. W. Hallows' article in your June issue.

In the first place the idea of using cumbersome designs by which the electrodes are reversed is by no means new as a study of the patent and technological literature will show. These ideas have not received wide acceptance, as the present design of using the zinc can as both container and electrode is fundamentally correct and lends itself to very fast and economic processing.

Ways and means of overcoming zinc corrosion and early perforation have been studied extensively by battery technologists, particularly during the last war when the demand for primary cells and batteries capable of storage and operation under varied climatic conditions was of extreme importance. A fair measure of success has been achieved by chemical methods and careful, controlled processing. It is fair to say that, nowadays, commercial types of h.t. batteries will store for 12 months, and most torch type cells for 2 years, without undue loss in capacity or reliability.

Major Hallows' conception of the electrode reactions is also somewhat off the beam, and this to some extent leads him to be a too earnest advocate of the "inside-out cell." The reduction in size of the zinc electrode can be carried too far, with the result that it can suffer from lack of electrolyte at high current densities—this factor alone restricts the application of this type of cell. Furthermore, the mere placing of the electrode inside the cell does not overcome the consumption of electrolyte, whilst the cell is idle, at the electrode face, and the consequent inefficiency due to deposition of water-insoluble compounds.

His view that, by extending the carbon area, the efficiency of the manganese dioxide electrode is increased is also not true. He has been led into this belief through his conception that carbon is the electrode and the manganese dioxide is packed around it to keep it clear of hydrogen. In fact, it is the manganese dioxide which is the electrode, and the oxidation of hydrogen takes place at the oxide surface. The oxide is intimately mixed with some form of carbon, and this, with the carbon rod, acts mainly as a conductor. One can see, therefore, that the carbon area is already quite large. The main point in disposing this electrode around a cylinder should be to lessen its thickness so that the conductivity of the electrode is not unduly lessened by the end products of the electrode reaction; i.e., lower oxides of manganese and

zinc amino compounds. The design suggested does not do this.

Battery technologists are not unmindful of the present deficiencies in the current design of cell, nor of the necessity of saving zinc, and constant research is in progress to find a substitute (e.g., magnesium), as well as to prevent wasteful corrosion of zinc itself.

R. W. LEWIS  
(Chief Chemist, Vidor, Ltd.).

South Shields, Co. Durham.

R. W. HALLOWS writes: My friend R. W. Lewis is so knowledgeable about dry cells that I should hesitate to cross swords with him, had he not made a lunge at me.

Despite what he writes, the "inside-out" cell has proved successful in the United States and I understand that it is shortly to make its appearance here.

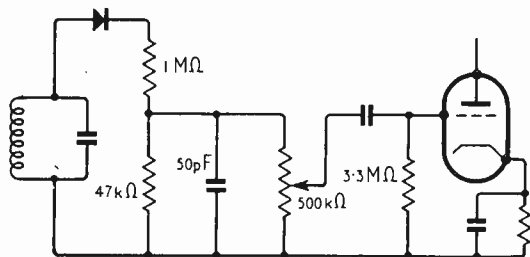
I did not suggest that the shelf-life of our cells is poor; what I did (and do) complain of is that too many of them perorate while in use when their e.m.f.s are considerably above 0.9 V. One cell which passes out in this way can render the other 79 of a 120-V h.t.b. useless.

Pace Mr. Lewis, I really do know that the cathode of a Leclanché cell is not the carbon rod, but what I called in these articles the manganese-dioxide element. I agree that during discharge oxidation of hydrogen occurs mainly at the oxide surface; in this way hydrogen is prevented from collecting as densely as otherwise it would on the particles of carbon in the depolariser mix and on the central conducting rod.

No known depolariser, however, is sufficiently active to prevent entirely the accumulation of hydrogen. Some does collect, with the result that internal resistance rises and e.m.f. falls.

### Broadcast Transmitter Distortion

IN reply to J. D. Herring (September issue) the detector circuit of my receiver is as shown. The figure I gave was calculated for 5,000 c/s. Admittedly, I ignored both stray capacitances and component tolerances. But does this matter? I chiefly meant to convey that the ratio is



about as near to unity as one can, in practice, reach. In fact, it is doubtful whether high-level modulation will occur at a frequency of 5,000 c/s. This detector circuit, and others more modest, give complete satisfaction on a good transmission, even where the dynamic range covered is extremely wide.

London, N.10. IAN LESLIE.

Correction.—In the letter from J. D. Herring on p. 416 of our September issue the lower of the two resistors forming the diode load should have been marked 47 kΩ.

### Technical Qualifications

I RECENTLY attended a post-graduate course in electronics at the English university (special honours degree standard) and, in general, found that holders of the City and Guilds Full Technological Certificate in Telecommunications tended to be weak in mathematics.

To qualify for the Final and Full Technological Certi-

ificate the standard of mathematics is approximately Inter. B.Sc. level. Endorsements in mathematics can be obtained by taking Grades 4 and 5 and the standard then approaches that of a general degree, but at present such endorsements are optional.

The present City and Guilds syllabus places too great an emphasis on telecommunications as understood by Post Office engineers.

The electronic industry of to-day calls for engineers with a knowledge of pulse techniques (radar, television and computers) and microwave circuitry.

My main criticism of the City and Guilds examinations is that there are too many "talkie-talkie" examination questions and too few simple practical design problems. No engineer worthy of his name can afford to be without a working knowledge of elementary physics, some mechanics and drawing.

The letter from "Personnel Manager" (September issue) prompts me to ask why membership of the Brit.I.R.E. is considered inadequate as a condition for enrolment by the Technical and Scientific Register. Apparently a radio engineer can only obtain "official" recognition if he is first trained as an electrical engineer! Surely if public corporations, such as the B.B.C., accept Brit.I.R.E. membership as a means of obtaining engineer status, the Technical and Scientific Register should give similar recognition.

Ruislip Manor, Middx.

M. L. BARTON.

THE City and Guilds of London Institute Full Technological Certificate in Telecommunications is a qualification recognized by the Admiralty Scientific Service and the Ministry of Supply for the post of Experimental Officer. The Ministry of Education regard its holders as qualified teachers of that subject. Also the B.B.C. advertise that those who possess it are eligible for posts as Grade C engineers. Industry probably fails to appreciate its worth because of the incomprehensible attitude of the Technical and Scientific Register which, whilst recognizing a Higher National Certificate, regards those persons who hold City and Guilds qualifications as being of craftsmen status only. This attitude is deplored by most responsible educationalists, but it must affect the attitude of industry towards this qualification.

Sully, S. Wales.

TERENCE L. SQUIRES.

### "Wireless Fifty Years Ago"

MAURICE CHILD'S notes in your August issue evoke many pleasant memories—some of them of Maurice Child. They also move me to make some comments which may have some interest even if they are not very relevant. For example, his reference to the early Marconi aerial, supported by a nearly vertical bamboo sprit, makes me wonder why the present sail arrangement of most American—and maybe British—yachts is called "Marconi Rig," for that rig employs no sprit or gaff.

I am sure that, had space permitted, Mr. Child would have liked to have said much more of those early days, otherwise he would have mentioned the ever-kindly and courteous Commander Loring, who personally inspected all new wireless installations. When I fitted a ship I would wire him and he would promptly come down and inspect the installation wherever it might be.

Mr. Child's reference to the early detectors seems to me to under-emphasize the importance of carborundum, which was the preferred detector in commercial practice until the advent of de Forest's triode. It was, in fact, employed in the Marconi wavemeter shown in Mr. Child's illustration. Operators often carried their own, which they used when carborundum was not supplied.

I had frequent recourse to Mr. Child's school when I was in need of operating talent over forty years ago, and I am delighted to know that he still carries on the good work.

New York, U.S.A.

ARTHUR H. MORSE.

# Push-Pull Transistor Amplifiers

By J. I. MISSEN,\* B.Sc., A.R.C.S.

*Practical Circuit Giving an Output of 400 mW with Point Transistors*

**T**HE use of duality in deriving transistor circuits from vacuum tube circuits was explained in the September issue of this journal in Part 8 of the series dealing with transistors. A brief mention was made of the transistor dual of the Class B thermionic valve amplifier, and a theoretical circuit for a power amplifier was given. The essentials of this circuit are reproduced in Fig. 1.

A practical point-contact transistor push-pull amplifier which has been developed from the circuit of Fig. 1 is capable of providing over 400 mW of a.f. power into a suitable load at under 10 per cent harmonic distortion. The driving power is within the capabilities of a single transistor stage.

**Limitations of a Conventional Transistor Amplifier.**—Before proceeding to a description of the actual circuit, it is worth while considering the reasons why a single transistor power amplifier of conventional design is not capable of delivering more than 20 mW of output power.

Typical static characteristics for the transistor are shown in Fig. 2. Collector current is plotted against collector voltage for various emitter currents. No appreciable control over collector current is exercised by negative voltages or currents at the emitter. The minimum collector current for a given collector voltage is therefore determined by zero emitter current.

The power developed in a given collector load resistor is obtained by drawing a load line of slope equal to the load resistance from a given h.t. voltage point on the collector-voltage axis. The power output is then:—

$$\frac{(V_1 - V_2)(I_2 - I_1)}{(2\sqrt{2})^2} \dots (1)$$

where  $(V_1 - V_2)$  and  $(I_2 - I_1)$  are the peak-to-peak collector voltage and current swings and the factor  $\left(\frac{1}{2\sqrt{2}}\right)^2$  converts to r.m.s. values.

The electrical characteristics of a transistor deteriorate with rise of temperature, so that the collector dissipation rating is limited, and most designs to 100 mW or less.

Now the dotted curve of Fig. 2 represents the maximum permitted collector dissipation, i.e. for every point on the curve,  $V_c I_c = 100 \text{ mW}$ . Thus the operating point must never lie outside the area between the curve and the voltage and current axes. In the example chosen, the load line for an h.t. of 50 volts has been drawn tangential to the curve of maximum permitted dissipation so that the collector dissipation reaches its maximum rating at one point in the cycle.

With this value (6.25kΩ) of load resistance, the collector dissipation at point A, corresponding to zero emitter current, is 88 mW. By utilising expression (1), the power output is found to be 20 mW.

It will be noted that the collector dissipation for

\* Research Laboratories General Electric Co. Ltd.

Fig. 1. Transistor dual of a Class B push-pull amplifier.

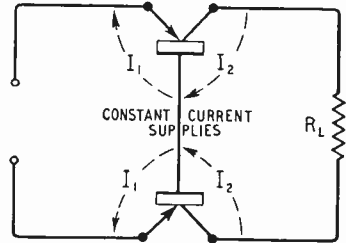
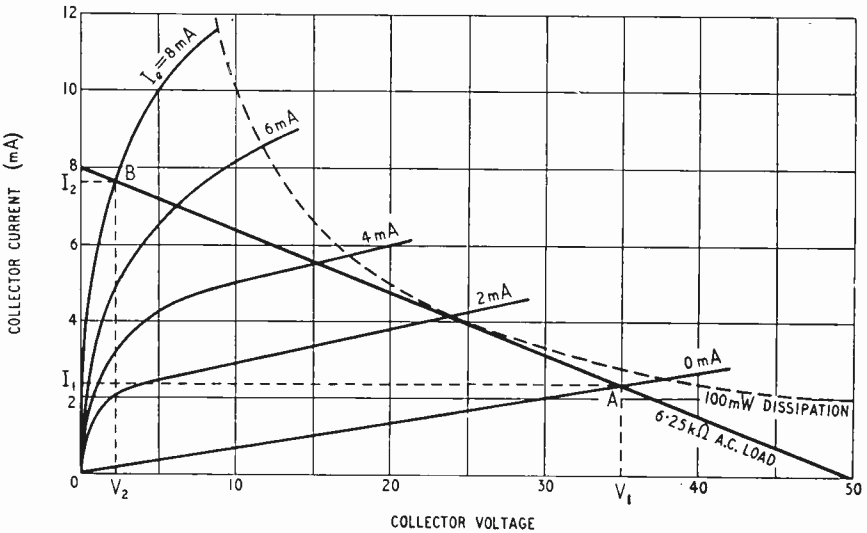


Fig. 2. Collector current/collector voltage characteristics of a point transistor.



the quiescent condition, defined by zero emitter current, is approaching the maximum permitted value.

Thus, to summarise, the power output from a point transistor used in the type of circuit peculiar to thermionic valves results in a power output limited to some 20 mW by virtue of the h.t. and load limitations imposed by the low collector dissipation rating. Furthermore, at the nominal quiescent condition of 88 mW collector dissipation, only a small change in h.t., ambient temperature, or transistor equivalent circuit parameters could result in the collector dissipation exceeding 100 mW, with disastrous results!

**Requirements for Higher Output Power.**—A new approach is needed if the transistor is to prove useful as a power amplifier which will provide a reasonable ratio of power output to collector dissipation.

The two main requirements are:

(a) A system of operation providing low collector dissipation in the quiescent condition, which will allow the use of a higher supply voltage.

(b) A type of power supply with "poor" regulation so that the quiescent collector dissipation is maintained well within the maximum rating.

If, instead of operating with zero bias, the emitter is given a large positive bias, then with a resistive collector load, the quiescent point would be B (Fig. 2), where the collector voltage is low, and the collector current relatively high. Under these conditions the collector dissipation is only 22 mW, which is a quarter of the dissipation when the transistor is used in a con-

ventional circuit. Thus condition (a) is satisfied. Requirement (b) can be met by arranging that the resistive collector feed is of such value that the load line of Fig. 2 does not cut the curve of maximum permitted dissipation.

However, in an a.f. output stage feeding a loud-speaker, an output transformer is required for matching to the low-impedance speaker. Now as requirement (b) necessitates collector feed resistors of high value, it becomes more efficient to run the output transformer in parallel with these resistors.

Combining these features, it is possible to evolve a modified push-pull output circuit for transistors in which the emitters are biased positively and the collectors are fed from a source of high internal impedance, thus permitting a much larger voltage and current swing at the collectors for a given dissipation. A simple circuit incorporating the above ideas is shown in Fig. 3.

**Equivalence Between Theoretical Dual and Practical Circuits.**—In Fig. 1 the constant-current supplies are indicated by dotted lines. Probably the simplest method for producing a current of constant value, irrespective of the termination, relies on a high voltage source E, in series with a high resistance R. If the circuit is completed by a resistance  $r$  ( $\ll R$ ) then

$$I = \frac{E}{R+r} \approx \frac{E}{R} = \text{constant} \dots \dots (2)$$

It will be seen that the power supply to the collectors and emitters of the circuit of Fig. 3 is virtually a constant-current supply. In general, a compromise must be effected in the values of E and R from the standpoint of power economy.

From a comparison of the circuits of Figs. 1 and 3 it is obvious that there are striking similarities, even to the parallel load. Thus in the case of the transistor push-pull amplifier, a circuit development on the basis of obtaining high power output with low collector dissipation leads to the same result as would be obtained by deriving the dual of the Class B thermionic valve amplifier circuit.

**Circuit Details.**—The complete circuit arrangement is shown in Fig. 4 and may be seen to be a development of Figs. 1 and 3. The constant-current supply for each collector consists of a battery in series with an inductance L and a resistance  $R_p$ , the battery being common to the two. The use of an inductance enables a lower battery voltage to be used than with a resistance alone: also it makes the a.c. impedance of the source high to audio frequency, so that its shunting effect on the load is less. Typical values for L and  $R_p$  are 20H and 2.2k $\Omega$  respectively.

The bias current to the emitters is obtained from a battery in series with resistors  $R_e$ . A typical value for  $R_e$  is 1,000 $\Omega$ .

A single battery is used for both collector and emitter. This is earthed at the positive end, and a tap corresponding to the emitter bias is connected to the base leads of the triodes. Thus the same battery may be used for the h.t. supply of preceding stages when necessary. Usual values for the battery would be -45V with base tap at -3V.

The output transformer is connected between the collectors via a blocking capacitor of value 1  $\mu$ F and is arranged to match from 5000 $\Omega$  to 15 $\Omega$ . The input transformer feeds the emitters via a 2- $\mu$ F blocking capacitor. Two G.E.C. point-contact transistors, type G.E.T.1, were used.

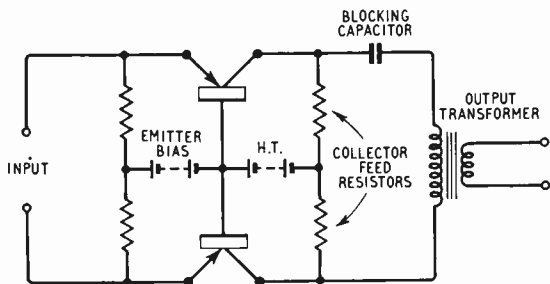


Fig. 3. Modified transistor push-pull output stage with positive emitter bias and output transformer in parallel with the high-value collector feed resistors.

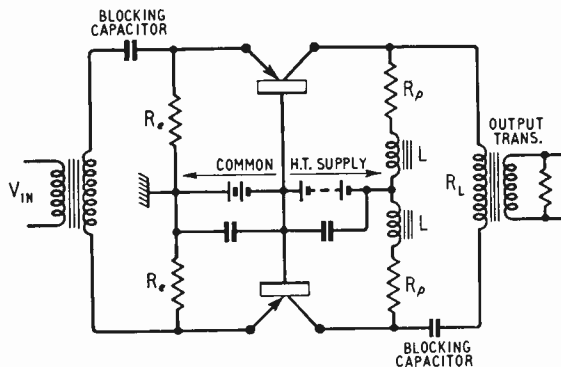


Fig. 4. Practical point transistor push-pull output stage. Typical component values are given in the text.

**Operation of the Circuit.**—The operation of a thermionic valve push-pull amplifier is usually analysed graphically. In this method the anode current/anode voltage characteristics of the two valves are combined on a common voltage axis, and both are symmetrically disposed with respect to the quiescent anode voltage. The load line is then superimposed on the two families of characteristics.

A similar procedure can be applied to transistors, but by virtue of the dual relationship between the "crystal triode" and the thermionic triode. The common axis is collector current.

The combined characteristics are shown in Fig. 5. In the example taken the quiescent current is taken as approximately 10 mA in each transistor, which is obtained when the emitter is biased to a current of approximately 10 mA. The collector dissipation of each transistor in the quiescent condition is approximately 20 milliwatts.

The d.c. conditions are determined by the value of the h.t. voltage and the resistances  $R_p$ , while the a.c. load is approximately  $R_L$ , if the shunting effect of the constant current network is small. Thus both d.c. and a.c. load lines are required to determine the operating conditions and power output from the curves of Fig. 5. The d.c. load line is drawn through the quiescent point of Fig. 5, to meet the voltage axis at a point corresponding to the battery voltage. The slope of the load line gives the value of the d.c. load. The a.c. load line similarly passes through the quiescent point. In Fig. 5 two a.c. load lines have been drawn, corresponding to  $R_L$  greater or less than  $R_p$ .

For the case of  $R_L$  greater than  $R_p$ , the peak voltage appearing between collector and base ( $V'$ ) exceeds the battery voltage, due to the back e.m.f. appearing across the inductance  $L$  in series with the battery e.m.f.

The peak-to-peak voltage appearing across  $R_L$  is thus  $2V'$ , and the power output is

$$P_{out} = \frac{(2V')^2}{8R_L} = \frac{(I' - I'')^2 R_L}{8} \dots (3)$$

The conditions prevailing during one half cycle of operation are indicated in Figs. 6 and 7. Suppose each transistor to be drawing a quiescent emitter and collector current of  $I_e$  and  $I_c$  respectively. If a sinusoidal input signal  $I_e \sin \omega t$  is applied between the emitters, the emitter currents will be modified accordingly. Given a peak input current swing equal

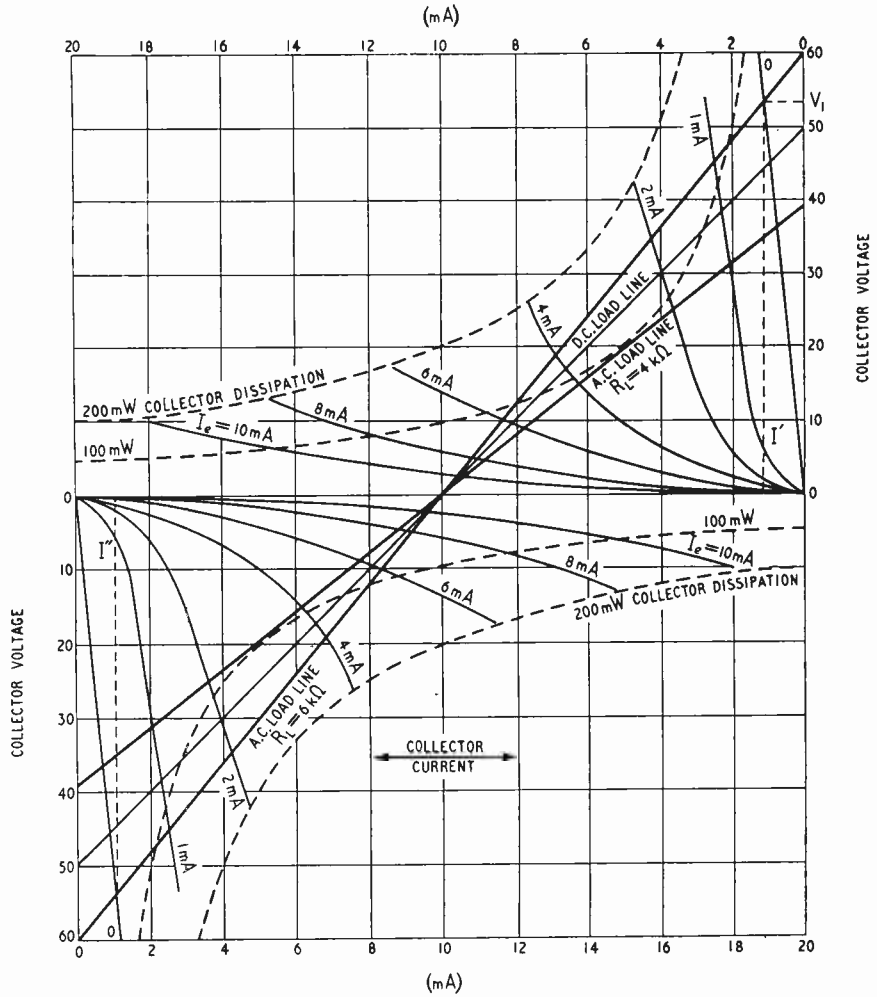
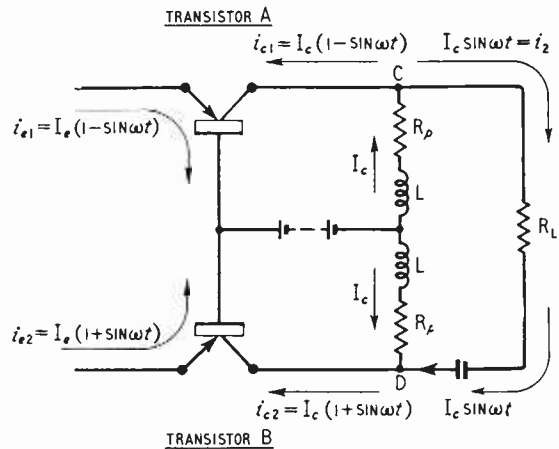


Fig. 5. Combined characteristics of two type G.E.T.I. transistors in push-pull.

Fig. 6. Paths followed by current during one half cycle of a sine wave.



to the steady emitter bias, then, on the negative half cycle, the emitter current of transistor A in Fig. 6 will swing to zero according to the relation  $i_e = I_e (1 - \sin \omega t)$ , for  $\omega t$  between 0 and  $\pi$ .

Assuming that distortion may be neglected, the collector waveform in transistor A will be indicated approximately by the relation  $i_{c1} = I_c (1 - \sin \omega t)$  as in Fig. 7. However, the collector current is supplied from a network which presents a high impedance to a.c. and maintains a constant current  $I_c$ . Thus the a.c. component of  $I_c$  is negligible, so that on equating the currents at the junction C shown in Fig. 6,  $I_c = i_{c1} + i_2$ , and on substituting for  $i_{c1}$ ,  $i_2 = I_c \sin \omega t$ , which is a half sine wave positive pulse of current, which passes through the load  $R_L$ .

At the lower transistor B the standing emitter bias will be increased by the positive-going signal, so that the collector impedance will be very low and will present very little impedance to the load current  $I_c \sin \omega t$ .

For the next half cycle, where  $\omega t$  lies between  $\pi$  and  $2\pi$ , conditions will be reversed, with transistor B biased to a high-impedance condition. A current pulse is thus driven through the load in the reverse direction, and back through transistor A, which is then in a low-impedance condition.

To summarise: the effect is that each triode is biased to a high-impedance condition in turn, so that as the collector current falls, a current flows through the load such that the instantaneous sum of collector and load currents over a half cycle is constant and equal to the current supplied by the constant-current network. The resultant current waveform through

the load over a complete cycle is sinusoidal and has a peak-to-peak amplitude of approximately  $2I_c$ .

In this push-pull amplifier the idle transistor is biased to a low impedance which is in series with the load, whereas in a thermionic valve push-pull circuit the idle valve is biased to a very high impedance, which is effectively in parallel with the load. ●

**Experimental Results.**—In general, the operating conditions and power output which were indicated graphically in Fig. 5, were obtained experimentally; allowance being made for the small amount of power dissipated in the idle transistor which is in series with the load. The power output was calculated from measurements of the voltage swing across a resistor which replaced the output transformer. For applications where a distorted waveform was acceptable, an output of over 0.5 watts was obtainable.

It will be observed from Fig. 5 that the upper a.c. load line passes through a region of the graph in which the collector dissipation exceeds 100 mW, i.e. outside the area enclosed by the 100 mW curve and the axes. However, during that part of the cycle for which the triode emitter is biased positively, the collector dissipation is approximately equal to that under quiescent conditions, and is considerably less than 100 mW, so that the mean collector dissipation is under 100 mW although the peak dissipation exceeds this value.

Experimental results over a number of hours, during which time the peak dissipation exceeded 100 mW for a small fraction of each cycle, have shown no deleterious effects on the germanium triodes.

Performance figures for the transistor push-pull amplifier are given in Table I. The first set of results gives the maximum power output obtainable without exceeding the mean collector dissipation rating, or allowing the harmonic distortion to exceed 10 per cent. Under these conditions the power output amounted to 420 milliwatts in a 5,000- $\Omega$  load.

The second set of results was obtained under conditions for which the collector dissipation never exceeded 100 mW, and the power output was then 200 mW. This operating condition, for which the a.c. load line is tangential to the 100 mW dissipation curve, is illustrated on Fig. 5.

It will be seen from Table I that the overall efficiency is lower than might be expected. This is due to the power dissipated in the collector feed resistors  $R_p$ .

Similar precautions with regard to bias are required as for a Class B thermionic valve circuit, in that h.t. must be switched off before the bias is removed. Failure to do so results in the collector dissipation rating being exceeded, with consequent failure of the transistor.

The circuit has been found to operate satisfactorily over a considerable period of time and has been successfully applied to an all-transistor super-heterodyne broadcast receiver and an a.f. amplifier.

Fig. 7. Waveforms of current under the conditions of Fig. 6.

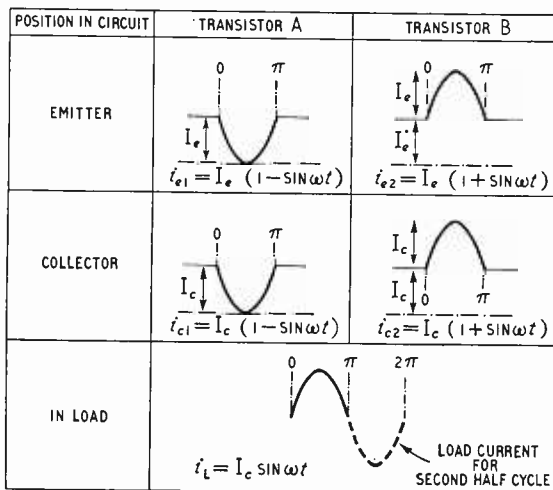


TABLE I

| Battery Voltage | Mean Collector Dissipation (Milliwatts) | Peak Collector Dissipation (Milliwatts) | Power Gain (db) | Efficiency (Per cent) | Harmonic Distortion (Per cent) | Power Output (Milliwatts) |
|-----------------|-----------------------------------------|-----------------------------------------|-----------------|-----------------------|--------------------------------|---------------------------|
| 50              | 100                                     | 150                                     | 12              | 28                    | 10                             | 420                       |
| 35              | 65                                      | 100                                     | 13.5            | 21.5                  | 9                              | 200                       |

# German Radio Show

An Engineer's Impressions  
of the Dusseldorf Exhibition

By J. E. COPE\*

**T**HE German radio exhibition this year was evidently modelled on our own Show, although the physical layout was rather different because it was held in several halls, each of which was somewhat smaller than Earls Court. Nevertheless, it included a large television studio with a public gallery, and programmes were transmitted from here to the various receivers in the exhibition. The cameras were operated from an O.B. van which had been driven into the studio, while a second van provided programmes from a nearby theatre. In another hall was the "Fernsehstrasse"—the equivalent of the Earls Court "Television Avenue." The quality of the pictures shown here was good, but in spite of the use of 625 lines, as against our 405, it was not on the average as good as that to be seen in our own "Television Avenue."

My greatest single impression was of the high quality reproduction of the average German radio set—and the fact that the public is prepared to pay for it. Table models often have two low-frequency loudspeakers and one tweeter. Many different makes of tweeters are available and several are of the electrostatic type. On the Grundig stand, a great deal of attention was attracted by an elaborate radiogram/tape-recorder combination which had no fewer than eight loudspeakers! There is evidently big business in tape recorders, and this, together with f.m. broadcasting and the recent introduction of the long-playing record, probably accounts for the great public interest in "hi-fi."

## Internal Aerials

With 108 f.m. stations now operating in Western Germany, there was naturally a large number of f.m. sets on show. Most of these were combination models with long, medium and short a.m. wavebands, and they all had internal aerials, including dipoles for the f.m., as well as facilities for external aerials. Many of the receivers used a ferrite rod aerial which could be rotated by a knob outside the cabinet to reduce interference to a minimum.

There is as yet no large-scale production of television sets in Germany and the receivers shown were generally pre-production models. However, public interest was high and there is no doubt that production will mount rapidly during the next twelve months. Many of the cathode-ray tubes were either American types or made from American glass parts, but the German production of 14-in and 17-in tubes is well under way. There was no evidence that any larger tubes are likely to be made in the next twelve months. Quite a number of 21-in sets were on show, but all of these had American tubes in them. The cheapest receiver I saw was priced at 800 marks, but it had no sound, and in order to use it one had to buy from the same company an f.m. set covering the television sound band.

Practically all the television receivers have 12-channel tuners, mostly copies of the American turret tuners, with at least one Oak-type switch and one eddy-current inductance tuner. The circuitry, too, tends to follow American practice, especially with things like inter-carrier sound and vision a.g.c. Many sets, however, use the a.c./d.c. series-heater techniques, as valve types are more like the British than the American—in some cases they are identical.

The American influence was also to be seen in the cameras used in the television studio, which contained American image orthicon tubes. These cameras, made by Fernseh G.m.b.H., have five-lens turrets, and focusing is achieved by moving both the turret and the tube, thereby eliminating the need for a counterweight. Critical adjustment of light intensity is obtained by the use of a variable density filter, the lens iris being set to the required depth of focus. This firm also showed an industrial television equipment using a small super-icoscope camera, while Grundig had a similar apparatus using a photo-conductive type of pick-up tube.

## Good Components

Components generally seemed to be of good quality and well designed, and in general were similar to those produced here and in America. Both germanium diodes and transistors are available, though the last mentioned only in small quantities, at prices between £1 and 30s apiece. Aerials of all shapes and sizes were on show, and they seemed to me to very cheap compared with ours. A television signal generator made by Telefunken that I happened to see struck me as being much more versatile than anything we have over here. Besides producing a variety of different waveforms, it included a wobulator and covered eleven television channels and two i.f. frequencies. In fact, it took about a quarter of an hour for the man on the stand to demonstrate the full capabilities of the instrument to me.

The German Post Office had a big exhibit and I was particularly impressed by their demonstration of the effect of various types of interference on sound and television receivers.

\* Pye. Ltd.

### PUBLICATION DATE

We regret that owing to a temporary re-arrangement at our printers it will be necessary to postpone publication of the November issue of *Wireless World* from October 27th until November 3rd.

# WORLD OF WIRELESS

Radio Servicing Certificate ♦ "Electronics": Official Ruling? ♦ European V.H.F. Stations ♦ Personalia

## Servicing Exams

NEW REGULATIONS have been introduced by the Radio Trades Examination Board for entry to the Radio Servicing Certificate examination which is conducted jointly by the R.T.E.B. and the City & Guilds.

The change reduces from five years to three years the minimum time which entrants must have spent in gainful full-time occupation in radio engineering or servicing and the age of entry from 21 to 19 years. The certificate, however, will not be issued until the candidate is 21. Entrants who have completed an approved course of technical instruction will in future have to serve only one year's full-time servicing instead of three years.

These regulations will apply to the 1954 examination which will be held on May 4th and 6th for the written papers and May 15th for the practical test. The closing date for entries is February 1st. Application forms and regulations may be obtained from the R.T.E.B., 9, Bedford Square, London, W.C.1.

## What is Electronics?

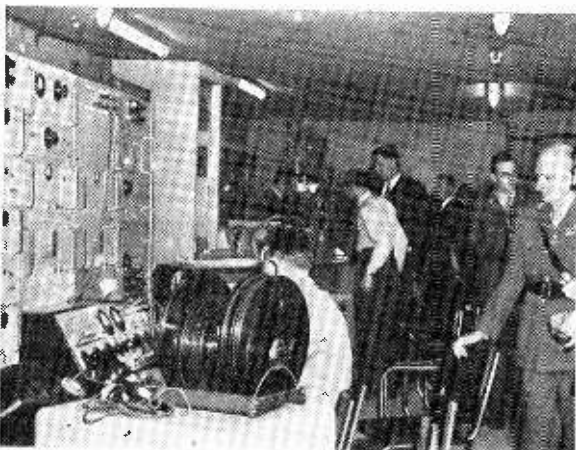
AN OFFICIAL RULING on the proper meaning of the debatable word *electronics* is on the way. The following definitions put forward by the International Electro-technical Commission have been submitted for approval by the various national committees.

**Electronics** (noun).—That branch of science and technology which deals with the study of the phenomena of conduction of electricity in a vacuum, in a gas, and in semi-conductors, and with the utilization of devices based on these phenomena.

**Electronic** (adjective).—Qualifies that which is concerned with electronics or any device which functions according to its principles.

## C.C.I.R. London Meeting

THE SEVENTH plenary assembly of the C.C.I.R., to which we referred in our last issue, was opened by the Postmaster-General, Earl De La Warr, at Church House, Westminster, on September 3rd.



FIELD MARSHAL VISCOUNT MONTGOMERY, who opened the Earls Court Radio Show, inspecting the sound reproducing equipment in the R.I.C. Control Room. This year's show attracted 295,240 visitors—over 5,000 more than last year.

Attended by over 300 representatives of some 50 countries, the work of the assembly is largely being conducted by comparatively small working parties, each covering a specific subject. The recommendations of these committees are brought before the main assembly for consideration and, if approved, incorporated in the findings of the assembly.

We hope to include in our next issue a report on the assembly which is scheduled to close on October 7th.

## Broadcast Station Guide

WITH the coming into force on July 1st of the Stockholm Plan for v.h.f. broadcasting in Europe most of the West German f.m. transmitters have changed their frequencies. These new frequencies and those of all the European v.h.f. stations, totalling about 150, are included in the seventh edition of our book, "Guide to Broadcasting Stations."

As it is two years since the publication of the sixth edition, the preparation of the new edition provided an opportunity of completely revising the information in each of the sections. Details of 1,800 short-wave broadcasting stations of the world and nearly 600 medium- and long-wave European stations are listed both geographically and numerically in order of frequency.

Operating details of some 40 European television stations and the frequencies used by the world's standard frequency transmitters are also given in the 104-page book, which is obtainable, price 2s, from booksellers or by post from our publishers, price 2s 2d.

## Educational Opportunities

IN ADDITION to the courses in radio and allied subjects to which we referred in our last issue we have been notified of both full-time and part-time courses covering the Brit. I.R.E. exam., the full technological certificates of the C. & G., the R.T.E.B. television and servicing exams., and the P.M.G.'s certificate exam., at the Norwood Technical College, London, S.E.27.

A "Student's Guide" to courses of study in engineering available in the Manchester area has been produced by the Manchester and District Advisory Council for Further Education. The Council, whose address is Education Offices, Deansgate, Manchester, 3, has also prepared a booklet listing the post-advanced lectures in electrical and mechanical engineering available in the area.

Courses for the radio amateurs' examination are being provided at the Grafton L.C.C. School, Eburne Road, Holloway, London, N.7, on Mondays. Applications should be made to A. W. H. Wennell (G2CJN), 145, Uxendon Hill, Wembley Park, Middx., secretary of the Grafton Radio Society, who are sponsoring the course. An amateurs' course is also being conducted at the Chichester Evening Institute, Orchard Street, Chichester, on Wednesdays.

## PERSONALITIES

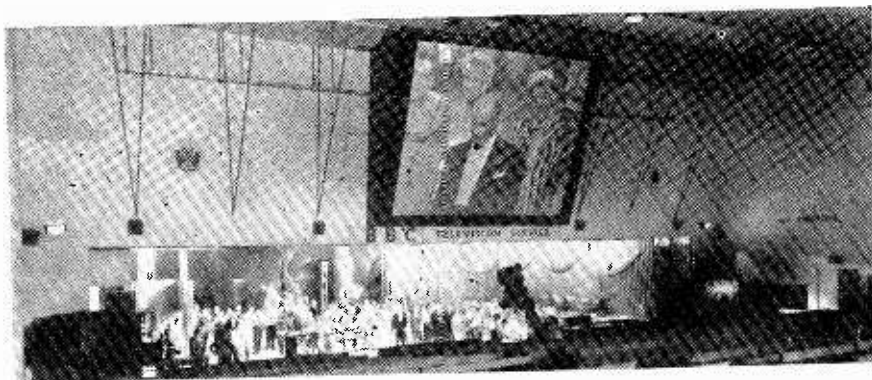
**Dr. B. V. Bowden, M.A., A.M.I.E.E.**, the new principal of the Manchester College of Technology, was head of the Computer Group of Ferranti which he joined in 1950. After spending three years in the Cavendish Laboratory, Cambridge, with Lord Rutherford and four years in the scholastic world he joined T. R. E. Malvern, from which he took a team to the Naval Research Laboratory, Washington, to work on an aircraft identification system. From 1945 he was for a short while at the Massachusetts Institute of Technology, after which he joined Sir Robert Watson-Watt's consulting organization before going to Ferranti's.



**L. H. Bainbridge-Bell**, whose absorbing personal interest is the clear presentation of technical information (particularly in diagrams), has joined the British Standards Institution as a committee secretary in the Electrical Section. He will assist in the preparation of glossaries and the standardization of terms and definitions in the electrical field. He recently retired from the Admiralty Signal and Radar Establishment which he joined in 1939.

**Edward B. Bull**, founder and managing director of Welwyn Electrical Laboratories, Ltd., of Bedlington, Northumberland, manufacturers of resistors and capacitors, died in August.

**Harry Diggle**, managing director of Hivac, the valve manufacturing subsidiary of the Automatic Telephone and Electric Company, died on August 17th. In 1932, in collaboration with Stephen de Laszlo, he founded the High Vacuum Valve



**LARGE SCREEN TV.**—A 21-ft screen erected above the proscenium at the Earls Court Studio and smaller screens at the sides enabled the audience to see the transmitted picture as well as the full stage production. The equipment was installed by Cinema-Television.

**F. T. Cotton**, B.Sc., who joined Hivac in January this year as engineer-in-chief, has been elected a director of the company. He was for 15 years with the Cossor organization and was for some time chief valve engineer of Electronic Tubes of High Wycombe. Since leaving Electronic Tubes in 1947 he has been with Ekco-Ensign and the English Electric Valve Company.

**W. E. Miller**, M.A. (Cantab.), who is to be the president of the British Institution of Radio Engineers for a second year, has been editor of the *Wireless and Electrical Trader* since 1940 and was previously technical editor for 14 years. His journalistic career started in 1925 when he joined the staff of *Experimental Wireless*, now *Wireless Engineer*.

The Trix Electrical Co., Ltd., have appointed two new directors: **C. E. Redrupp**, who has been in charge of technical development and design during his 20 or more years with the company, and **M. L. Berry**, who will continue on the sales side of the business.

## OUR AUTHORS

**E. W. Rogers**, contributor of the article on acoustic response curves in this issue, is chief of the Communications Department of Redifon, Ltd., having previously been chief designer in the department from 1945 to 1952. He served his apprenticeship in the Audio and Acoustic Laboratories of E.M.I. at Hayes from 1929 to 1936, following which he was for two years with Cossor's as a development engineer. He joined Redifusion, Ltd., an associate company of Redifon, in 1938.

**H. V. Harley**, contributor of the article "Valve Matching Using Resistors," on page 488, is a post-graduate student in the University of Wales, where he is doing research work for the Ph.D. degree. During the war he was a senior N.C.O. in the Royal Corps of Signals and in R.E.M.E.

**J. I. Missen**, who on page 467 discusses the application of transistors in push-pull amplifiers has, since 1949, been engaged in transistor development and circuit applications at the Research Laboratories of the General Electric Company, Wembley. He spent 4½ years during the war in R.E.M.E., maintaining Army radar and telecommunication equipment, after which he was for two years at the Royal College of Science where he gained a degree in Physics.

## OBITUARY

**R. C. Walker**, B.Sc.(Lond.), A.M.I.E.E., A.M.I.Mech.E., who was in charge of the technical and commercial development of photocells, Geiger Müller counter tubes and specialized electronic devices in the General Electric Company's Valve and Electronics Department, died on August 7th, aged 57. Mr. Walker's first association with the company was at the Osram-G.E.C. Lamp Works, Hammersmith, where he was engaged part-time while taking his degree course at Reading University. He joined the staff of the G.E.C. Osram Valve and Electronics Department in February, 1928. He was the author of a number of works on electronics and its application to industry.

Company, which was responsible for considerable work in the field of valve miniaturization. This company was succeeded in 1939 by Hivac, Ltd.

## IN BRIEF

**Thirteen Million.**—There are now over thirteen million holders of broadcast receiving licences in the United Kingdom. At the end of July there were 10,531,402 "sound" licences (including 195,075 for car radio) and 2,479,454 television licences, making a total of 13,010,856.

A series of lectures on "Solid State Physics" is to be given in London on October 20th and 21st by research engineers from the R.C.A. Laboratories, Princeton, U.S.A. There will be morning and afternoon sessions, with talks and discussions on recent developments in the fields of transistors, electronically active solids, photo-conductivity and television camera tubes. Particulars as to the place and time of the meetings, which were not fixed when we went to press, will be obtainable from the R.C.A. European Representative, C. G. Mayer, 55, Pall Mall, London, S.W.1.

**Colour Television** has been chosen by the Television Society as the subject of this session's Fleming Memorial lecture. G. G. Gouriet, B.Sc., B.B.C. (Engineering Research Department), has been invited to give the lecture at the Royal Institute, Albemarle Street, London, W.1, at 7.0 on February 12th and 25th. Admission will be by ticket obtainable from the Television Society, 164, Shaftesbury Avenue, London, W.1.

**Sound Recording Congress.**—An international congress on sound recording processes is being organized by the Société des Radioélectriciens for next spring. The congress, which is proposed to divide into four sections covering mechanical, photographic and magnetic recording and the problems of standardization, will be held in Paris from April 5th to 10th. Particulars are available from J. Matras, Secretary, Société des Radioélectriciens, 10 Avenue Pierre Larousse, Malakoff (Seine).

"**Electronics—Key to Progress**" is the theme of the ninth National Electronics Conference and Exhibition which is being held in Chicago, Illinois, from September 28th-30th. The proceedings of the conference will be divided into various sessions, including circuitry, ultrasonics, electron tubes, nucleonics, transistors, instrumentation and microwaves. The 100 papers will be published in the *Proceedings of the National Electronics Conference* (Vol. 9), which will be available early next year, price \$5.00, from the secretary of the N.E.C., 852, East 83rd Street, Chicago, Illinois.

"**Design for Production**" is the title given by the British Institution of Radio Engineers to a Convention being planned for next July (9th-13th) at Christ Church, Oxford.

An invitation to senior students of technical colleges and like institutions to visit their works at Watford, Herts, is extended by Wild-Barfield Electric Furnaces. The tours are conducted during afternoons (Monday to Friday) and include

an inspection of the Research and Development Departments as well as the production plant.

## BUSINESS NOTES

**Trix.**—The note in our last issue regarding the formation of Electric Audio Reproducers, Ltd., might be misconstrued to imply that the new company would market all the record-playing equipment previously handled by Phono Disc, Ltd. The Trix Electrical Co., Ltd., of 1-5, Maple Place, London, W.1, ask us to point out that they will continue to develop and manufacture Trixette gramophones for which Phono Disc, Ltd., were agents until August.

**Kelvin Hughes** equipment supplied for the 8,000-ton passenger liner *Maori*, scheduled to undergo her trials on September 30th, includes the MS26B echo sounder, which uses Teledeltos recording paper. The liner will be operated by the Union Steam Ship Company of New Zealand.

**Marconi Echometer.**—Designed primarily for coastal and estuary craft, which normally do not require soundings deeper than 100 fathoms, the new Marconi Marine visual-indicating echometer has a range of 0-130 fathoms. The Visette, as it is called, operates from a 24-volt d.c. supply, has a total power consumption of 20 watts and is completely self-contained in a case measuring 18 x 16 x 14 inches.

**E.M.I. Sales & Service, Ltd.**, have formed a **Recording Equipment Division** which is responsible for the domestic and professional recording equipment designed and produced by the company. Romer Hutton has been appointed sales manager of the Division with R. J. Wood as assistant sales manager and W. H. Y. Grainger as sales engineer.

**B.B.C.** has ordered four complete mobile television O.B. units from **Marconi's**. Each unit will be equipped with five cameras (two in reserve) with controls and mixers for both sound and vision.

**E.M.I.** tape recorders and associated equipment recently supplied to the **B.B.C.** include over fifty portable battery-operated recorders and eighty-five for studio use.

## NEW ADDRESSES

**Rees Mace.**—We were misinformed regarding the new address of the Depot of Rees Mace Marine, Ltd., in Swansea, given in our last issue. It should be 6, Coed Celyn Road, Derwen Fawr, Swansea, Glam. (Tel.: Swansea 87637).

**Truvox, Ltd.**, announce that during extensions to their Wembley works, the general office and home sales and export departments are temporarily at 15, Lyon Road, Harrow, Middlesex. (Tel.: Harrow 9282.)

## MEETINGS

### Institution of Electrical Engineers

Inaugural address of the president, H. Bishop, C.B.E., B.Sc. (Eng.), on October 8th.

Discussion on "Television" opened by the president on October 19th.

**Radio Section.**—Address by J. A. Smale, C.B.E., B.Sc. (chairman), on October 14th.

Discussion on "Long Playing Disc Records Compared with Magnetic Tape for Sound Reproduction in the Home," opener H. F. Smith, on October 26th.

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

**Cambridge Radio Group.**—Address by D. Weighton, M.A. (chairman), at 6.0 on October 13th at the Cambridgeshire Technical College.

**North-Eastern Centre.**—"Television Broadcasting Stations," by P. A. T. Bevan, B.Sc., at 6.15 on October 26th at the Neville Hall, Westgate Road, Newcastle-upon-Tyne.

**North-Eastern Radio Group.**—Address by F. H. Birch, B.Sc. (chairman), at 6.15 on October 5th at King's College, Newcastle-upon-Tyne.

**North-Western Radio Group.**—"Colour Television," by A. J. Biggs, Ph.D., B.Sc., at 6.30 on October 21st at the Engineers' Club, Albert Square, Manchester.

**South Midland Radio Group.**—"Special Effects for Television Studio Productions," by A. M. Spooner, B.Sc. (Eng.), and T. Worrick, M.Sc., at 6.0 on October 26th at the James Watt Memorial Institute, Great Charles Street, Birmingham.

**North Staffordshire Sub-Centre.**—"The Control of a Thermal Neutron Reactor," by R. V. Moore, G.C., B.Sc. (Eng.), at 7.0 on October 26th at the Technical College, Stafford.

**Southern Centre.**—"Special Effects for Television Studio Productions," by A. M. Spooner, B.Sc. (Eng.), and T. Worrick, M.Sc., at 7.30 on October 28th at the R.A.E. Technical College, Farnborough.

### British Institution of Radio Engineers

**London Section.**—"The Impact of Information Theory on Television," by D. A. Bell, M.A., B.Sc., Ph.D. (University of Birmingham), at 6.30 on September 30th.

**Annual General Meeting**, followed by "Printed Circuits: Some Principles and Applications of the Foil Technique," by P. Eisler, Dr. Ing. (Technograph Electronic Products), at 6.0 on October 21st.

Both the above meetings will be held at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

**North-Western Section.**—"The Detection and Cure of Parasitic Oscillations in Radio and Electronic Equipment," by H. Whalley (Metropolitan Vickers), at 7.15 on October 1st at the College of Technology, Manchester.

**North-Eastern Section.**—"The Impact of Information Theory on Television," by D. A. Bell, M.A., B.Sc., Ph.D. (University of Birmingham), at 6.0 on October 14th at the Institution of Mining and Mechanical Engineers, Newcastle-upon-Tyne.

**Scottish Section.**—"The Microwave Test Bench and Its Components—a practical introduction to waveguide work," by J. Bilbrough (Microwave Instruments), at 7.0 on October 8th at the Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2.

### Television Society

**London.**—"Recording Television Programmes," by C. B. B. Wood (B.B.C. Research Dept.), at 7.0 on October 9th.

"Flywheel Synchronizing and Scanning Circuits," by H. Fairhurst (Murphy Radio), at 7.0 on October 22nd.

Both the above meetings will be held at the Cinematograph Exhibitors' Association, 164, Shaftesbury Avenue, London, W.C.2.

**Bedford Centre.**—"Large-Screen Television," by T. M. C. Lance (Cintel), at 8.0 on October 7th.

"The Importance of the D.C. Component," by D. C. Birkinshaw (B.B.C.), at 8.0 on October 14th.

Both the Bedford Centre meetings will be held at the Clapham Road Schools, Bedford.

**Leicester Centre.**—Lecture-demonstration on the application of the cathode-ray oscillograph to television servicing by H. J. Beech at 7.0 on October 19th at the Leicester College of Technology.

### British Sound Recording Association

**London.**—"Fundamentals of Disc Reproduction," by S. Kelly, at 7.0 on October 23rd at the Royal Society of Arts, John Adam Street, London, W.C.2.

### Institute of Practical Radio Engineers

**Midlands Section.**—"Electrical Indicating Instruments," by W. Pierce (Crompton Parkinson), at 7.30 on October 5th at the Crown Hotel, Broad Street, Birmingham.

### Institution of Production Engineers

**Glasgow Section.**—"High-Frequency Heating and Induction Hardening," by R. H. Barfield, D.Sc., at 7.30 on October 15th at the Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2.

### Institution of Works Managers

**Glasgow Branch.**—"Electronics in Materials Handling," by L. Landon Goodman, B.Sc. (Eng.), (British Electrical Development Association), at 7.15 on October 26th at the Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2.

## CLUB NEWS

**Cambridge.**—The first lecture of the new session of the Cambridge University Wireless Society will be given on October 12th by J. M. Carter (Wright & Weaire), who will talk on tape recording. Sec.: R. C. Marshall, St. John's College, Cambridge.

**Cleckheaton.**—"Radar 1939-1945" is the title of the talk to be given by W. Ripley (G4AD) to members of the Spen Valley and District Radio and Television Society on October 7th. At the following meeting (October 21st) Capt. R. E. Perry, of the U.S.A.A.F., will speak on "Ham Radio in U.S.A." Meetings are held at 7.30 at the Temperance Hall, Cleckheaton. Sec.: N. Pride, 100, Raikes Lane, Birstall, nr. Leeds.

**Edinburgh.**—In addition to the regular meetings on alternate Thursdays at 25, Charlotte Square, Edinburgh, the Lothians Radio Society has arranged visits to the Kirk o' Shotts television transmitter on October 11th and 18th. Sec.: L. Stuart, 38, Caledonian Crescent, Edinburgh.

# TRANSISTORS

By THOMAS RODDAM

## 9.—Complementary Symmetry and Its Application in Circuits for Television Reception

COMMUNICATION engineers, as a class, are concerned with two quite different kinds of problems. On one side, the solid, plodding, public-service engineers, who have to do with telephones, transmitters and the like, are forced to consider the problems of life, stability and long-term reliability: just what this means you can see by looking in a recent *Bell System Technical Journal* for a series of papers on how to twist a wire round a tag. The broadcast receiver engineer, on the other hand, must always be penny wise: it is not for him to consider what the capitalized cost of current and repairs will be over a 20-year period.

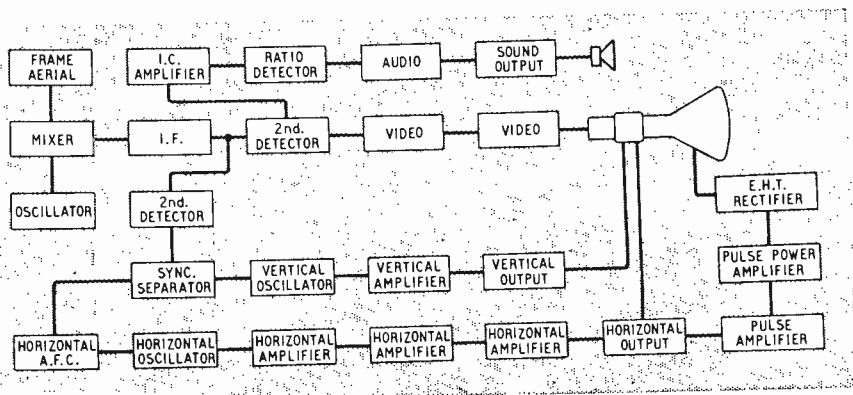
So far in this series we have tended to look towards the Marthas of the transistor world, but this month, for a change, we shall see what has been going on in another place, the receiver laboratory.

A television receiver probably contains more circuit types per cubic inch than any other electronic equipment: there are linear circuits and non-linear circuits, low frequency circuits and high, oscillators and amplifiers. The production of a completely transistorized television receiver is thus a rather striking stage in the development of the transistor: the production of one hundred television receivers would be a revolution and a revelation. The first television receiver using no ordinary valves—except, of course, the cathode-ray tube—has recently been described by Mr. G. C. Sziklai,<sup>1</sup> whose lecture in London was reported in the August issue of this journal. This receiver, which has a 5-inch picture tube, uses 37 transistors and takes only 13 watts from the battery. It is portable, but unlike most American receivers it cannot be tuned over a wide band, and is arranged to receive only one station, channel 4 of the American system (67.25 Mc/s).

The circuit techniques used in this receiver are of considerable interest, and it is proposed to give a short general survey of them in this article. A word of warning is necessary. Many of the transistors used in this receiver are either specially developed units or transistors picked out to fit a particular specification. Even if your rich uncle in America will send you half a gross of transistors you will not find it possible to build yourself a television set.

Fig. 1 shows the block schematic of the television

Fig. 1. Block schematic diagram of experimental transistor television receiver.



receiver. Although this diagram does not make it too clear, the receiver consists of a superheterodyne circuit in which the intermediate-frequency amplifier is followed by two second detectors, one for the intelligence, sound and vision, and one for the control functions, the synchronizing signals. Thus the upper second detector feeds into the video amplifier and into the inter-carrier frequency stages, ratio detector and audio amplifier. As you will remember, the American television system uses f.m. for the sound, and the sound signal can be extracted at the beat frequency between the sound and vision carriers. The lower second detector feeds into a sync separator and provides the control for the two scanning chains. This splitting was introduced because the sync amplifier loaded the second detector too much to give satisfactory performance in the intelligence channel.

The receiver uses a balanced diode mixer circuit which is tapped down on the frame-aerial/tuning-circuit system. The frame aerial is tuned by a parallel LC circuit to 67.25 Mc/s, and a 60 Mc/s local oscillator signal is injected at the mid-point of the frame. The oscillator itself, using a point transistor, is in appearance simply one of the circuits we discussed earlier, using the positive feedback produced by a high impedance in the base. As we mentioned in the previous article, however, the phase shifts in the transistor itself play an important part at these high frequencies, and the capacitance from emitter to earth, which does not appear in the circuit diagram, Fig. 2 forms an essential part of the oscillatory circuit. This oscillator produces a diode current of 1mA, and the mixer circuit is stated to have a loss of 6 db.

There are six stages of i.f. amplification, which are stagger-tuned and give a flat response from 7.5 Mc/s to 9.5 Mc/s. Two of these stages are shown in the circuit of Fig. 2 and it will be seen that an earthed

<sup>1</sup> "A Study of Transistor Circuits for Television," by G. C. Sziklai, R. D. Lohman and G. B. Herzog. *Proc. I.R.E.*, June, 1953, p. 708.

base circuit is used. The TA-166 is a point transistor, and this type of transistor is also used for the second detector. The only real difference between the i.f. amplifier stages and the detector is that the detector is operated at zero emitter bias current, thus giving the wanted non-linearity.

The video amplifier is, I suspect, not the arrangement which would be used for a new development. The circuit is shown in Fig. 3. The point transistor, TA-166, was required in order to get a sufficiently good response at high frequencies. The inductance  $L_3$  in the collector circuit is the usual peaking coil for compensation of the output capacitance. Additional compensation is provided in this stage by using positive feedback in the base: the combination of  $B_2$  and  $L_2$  provides an increasing amount of feedback as the frequency rises, while the stage is kept stable by the high impedance in the emitter circuit presented by the collector of the junction transistor. The main job of this junction transistor is to provide a fairly high input impedance, and the gain of this stage is reduced, with some improvement in response, as a result of the negative feedback introduced by  $R_1$ . Not shown in this circuit is a resonant circuit tuned to 1 Mc/s which

shunts  $R_1$ , and thus reduces the negative feedback to provide response correction. The resulting response is flat up to about 2 Mc/s. The bleeder resistors for the base bias which we discussed in Part 6 of this series will be noted in this circuit. It might perhaps be pointed out that the junction transistor here is a  $p-n-p$  type.

The load resistor is 2,700 ohms, and the TA-166 point transistor gives an output of 8 volts peak-to-peak across this load. The whole of this swing is used for picture, the sync pulses being crushed by overloading. This is another reason for providing the separate synchronizing system. The synchronizing path, which begins with the second detector shown in the third row of Fig. 1, is tapped down on the driving transformer. It starts off with its own detector, which is followed by two junction transistors of type TA153. The first of these is an earthed-base circuit without emitter bias and acts as a sync separator, the second is a conventional earthed-emitter amplifier circuit. The vertical oscillator is controlled by the integrated sync pulses, while a rather complex a.f.c. circuit, which I do not propose to describe here, is provided for the horizontal circuit.

The vertical oscillator itself is shown in Fig. 4. This is a variant on one of the circuits discussed in Part 5 of this series, though it is now the saw-tooth decay, up path 4 of Fig. 6, page 258, June issue, which is of interest, not the pulse. This oscillator is designed to run slightly slow, so that it can be driven by positive pulses applied to the emitter: these are the pulses produced in the vertical integrator. Three stages of amplification are used, the final stage, which produces

a peak-to-peak current of 100 mA in a 65-ohm, 45-mH deflection coil, using a "Sziklai special," being complementary symmetry<sup>2</sup>.

The key to this new idea of complementary symmetry is the possibility of making two kinds of junction transistors,  $n-p-n$  and  $p-n-p$ : once this possibility is realized it becomes logical to show the general set of junction transistor curves in the form of Fig. 5. These curves are the collector current-voltage characteristics, measured in an earthed-emitter circuit with base current as parameters. The + signs correspond to an  $n-p-n$  transistor and the - signs to a  $p-n-p$  unit. Normally, of course, these characteristics will not have numbers on the scales, but will be "generalized characteristics," but R.C.A. had a bright idea of producing a complementary pair, transistor and "transistor-

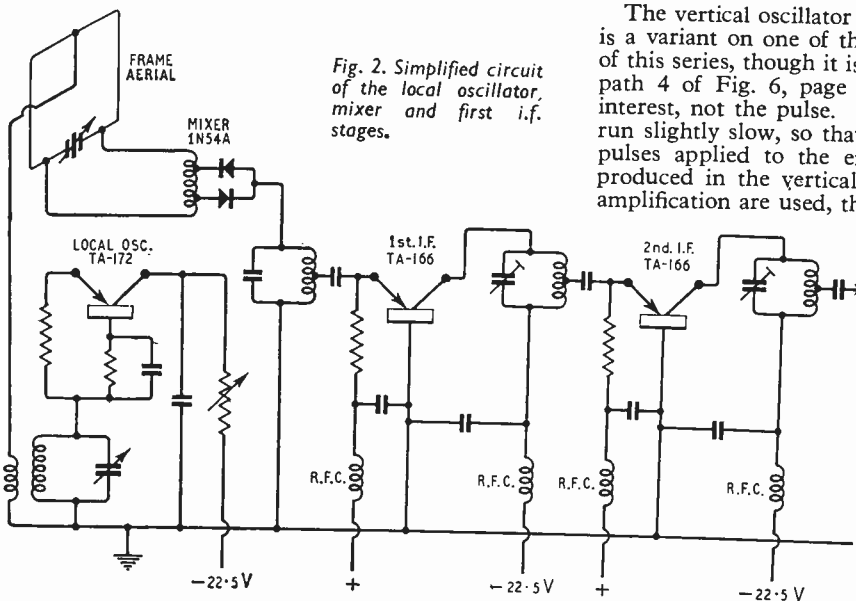


Fig. 2. Simplified circuit of the local oscillator, mixer and first i.f. stages.

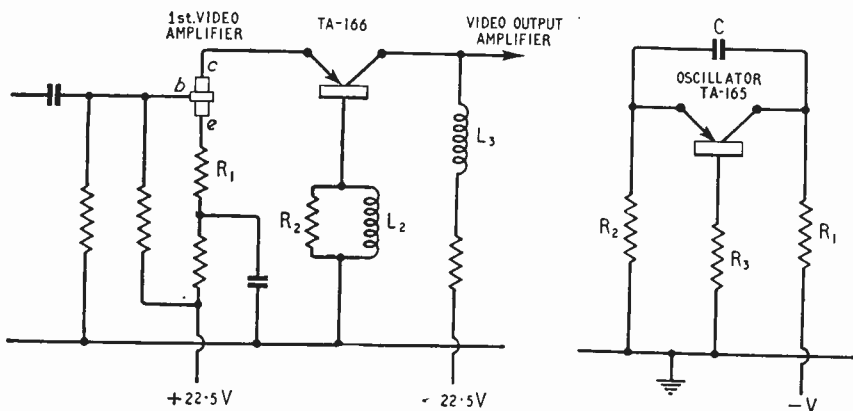


Fig. 3. Essential features of the video amplifier. Right: Fig. 4. Vertical-deflection oscillator

<sup>2</sup> "Symmetrical Properties of Transistors and their Applications," by G. C. Sziklai. Proc. I.R.E., June, 1953, p. 717

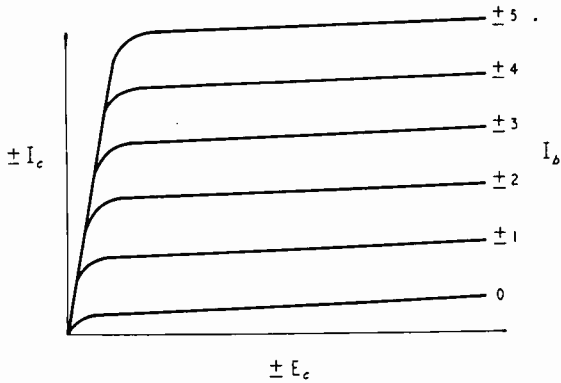


Fig. 5. Complementary characteristics of n-p-n and p-n-p junction transistors.

through-the-looking-glass," so that numbers could be put on which would apply to the mirror pair. If you now consider a working point somewhere in the middle of the diagram and a load line across it you will see that if the base current is increased, in the sense of "made more positive," the collector current will increase by becoming a smaller negative current, as the base current becomes less negative. It is very important to keep an eye on the signs here: a current of  $-6\text{mA}$  is considered to be less than a current of  $-5\text{mA}$ .

As a result of this effect, a mirror-pair of transistors fed in parallel, with outputs connected in parallel, will behave like a push-pull amplifier and will, in particular, give the well-known even-harmonic balance. The reader is recommended to examine this closely for himself, by testing what happens as the base current is driven.

A typical circuit is shown in Fig. 6, with some values. This circuit operates in Class A, giving a gain of 46 db. Higher gains are obtained if the load resistance is increased, as you would expect with a pentode-like transistor. In Fig 7 an alternative way of approaching the circuit is sketched. Here ideal 1:1 transformers are used to reverse the signs in the lower path. The mode of operation is easily followed: as A is made positive,  $b_1$  becomes positive and  $b_2$  negative;  $c_1$  goes negative, while  $c_2$  goes positive, but because of the second 1:1 transformer the point D is driven negative by both transistors. Now we replace the combination transformer: p-n-p transistor: transformer, by an n-p-n transistor and simply twist the lower half of the circuit up to the other side of the mirror plane, and we have, apart from the supply and bias circuits, the system of Fig. 6.

One version of this circuit will operate directly into the 500-ohm coil of a loudspeaker (one of the loudspeakers designed for use with the Peterson and Sinclair single-ended push-pull amplifier<sup>3</sup>), and the heavy and bulky output transformer normally needed is thus eliminated. A well-balanced pair of transistors will produce no standing current in the load: the coil is therefore not subjected to any permanent shift away from the centre of the field. This feature is of great value if the circuit is being used to drive the deflection coils of a cathode ray tube.

In the transistorized television receiver a circuit of this general type is used, but the load is connected in

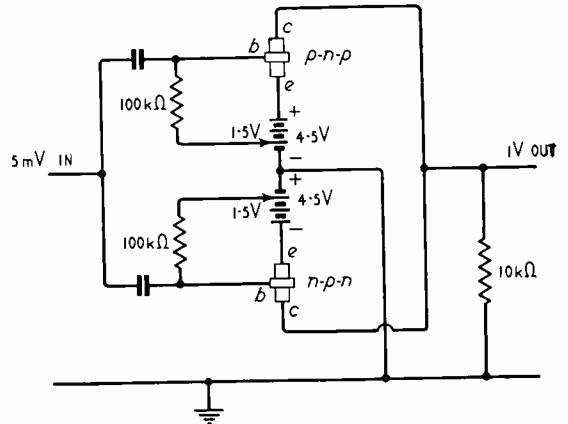


Fig. 6. Transistor push-pull amplifier circuit making use of complementary symmetry.

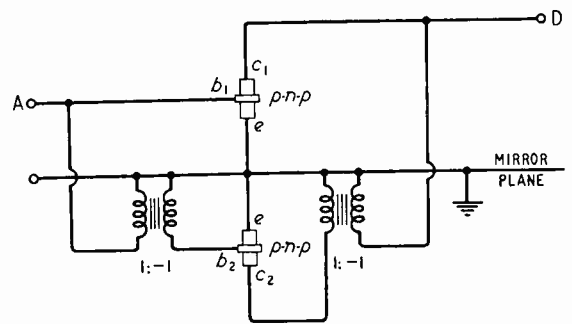


Fig. 7. Use of transformers to get push-pull operation with p-n-p transistors.

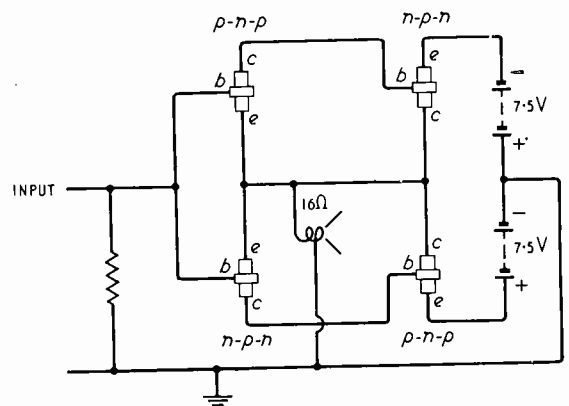


Fig. 8. Two-stage complementary symmetry Class B system with negative feedback.

the common emitter lead, and the two transistors are operated in the earthed-collector mode. Supply voltages of  $+4\frac{1}{2}$  volts give a current which varies from  $-50\text{mA}$  to  $+50\text{mA}$  in the 65-ohm, 45-mH coil of the vertical deflection circuit.

An amplifier based on this principle which is especially attractive is shown in Fig. 8. This is a Class B system directly coupled to a second Class B system with quite a large amount of negative feedback from

<sup>3</sup> Proc. I.R.E., Jan., 1952, p. 7, and W.W., May, 1952, p. 203.

output collectors to the emitters of the input stage. The feedback makes it possible to work into a 16-ohm load, and a maximum power rating on programme peaks of 0.5 watts is permissible. The input impedance is high, and the power gain is about 28 db. As the efficiency is nearly 50 per cent and the circuit takes almost no current in the absence of a signal, the power drain is only about 100 mW, a very surprising figure for a 500 mW output amplifier.

There are further variants on this theme of complementary symmetry, and some of these exhibit the same remarkable simplicity as Fig. 8, which, it should be noted, is a complete circuit diagram with nothing left out. An amplifier of this type contains no components except the transistors, the holders and the terminals. Design follows the usual combined characteristic process we already know in valve circuitry for fitting together the curved characteristics of Class B stages.

The line time-base system of a television receiver with magnetic deflection raises some special problems, because the amount of energy involved is very considerable. It is not the need to dissipate energy, for which we should need only high-power amplifiers: the problem in a horizontal deflection system is to control the large amount of energy which must be stored in the coils at the ends of the sweep. The charge on a capacitance represents potential energy, while the magnetic flux corresponds to the kinetic energy. We try to save up the energy in a capacitor for use in the next sweep, to economize in power consumption. Transistors can be of great value here.

The horizontal deflection circuit of the transistorized television receiver uses a cross-connected pair of transistors or a special symmetrical transistor unit. The basic arrangement and its equivalent circuit are shown in Fig. 9, in which the cross-connected pair of transistors

is replaced by a resistor R and a switch in the equivalent circuit. When the common base lead is held negative by, say 10 volts, the transistors provide a resistance of only about 1 ohm to currents in either direction—up to currents of the order of 500 mA—while if the base lead is made positive the switch is opened and has a leakage resistance which is of the order of 50 kilohms. The analysis of this circuit is carried out by considering three phases, starting from the switch open and system at rest condition.

The first phase being when the switch is closed. Provided that we do not allow this phase to last for times comparable with  $L/R$  the current in the coil grows linearly with time, and at the end of time T has reached a value  $ET_1/L$ .

The second phase being when the switch is opened. The coil is already "charged," and an oscillatory current is thus produced in the LC-circuit. After a half-cycle, which takes a time  $T_2 = \pi\sqrt{LC}$  the current in the coil has reversed, but the magnitude is again  $ET_1/L$ .

The third phase begins when the coil is carrying a current  $-ET_1/L$ . The switch is closed and the battery starts to drive a current into the coil. Just as in phase 1, the current rises linearly, but it is now arising from  $-ET_1/L$ , so that after a time  $T_3 = T_1$  the current will have reached zero.

These are just the conditions corresponding to the beginning of phase 1: no current in L, and switches closed. The linear run up of the current thus continues quite smoothly.

It is not very economical to use two transistors for this job of producing the horizontal deflection, and a special symmetrical transistor has been produced to replace the cross-connected pair. This symmetrical transistor is a p-n-p junction type in which the two p's are the same, so that you cannot tell emitter from collector. Many early transistors were like this, but it remained for Sziklai to see how this feature could be used and to ask the transistor makers, who had worked hard to find how to make emitter and collector different, to go back and rediscover how to make them exactly the same. Their success is indicated quite clearly by the curves shown in Fig. 10.

The general circuit arrangement of a deflection system using a symmetrical transistor is very similar to the circuit using the cross-connected pair, and anyone who is interested in more detail should turn to the two papers quoted. The actual performance obtained is rather interesting. For the 5-inch tube a peak-to-peak current of 1.2 A is obtained, and the supply consumption is only 70 mA from a 13-volt source. The peak flyback voltage is 120. The efficiency of the circuit is rather more than twice that of the best valve circuits, even if the valve heater is not included in the balance sheet. The losses are equally distributed between the transistor and the deflection coils.

There are quite a number of other applications for a symmetrical transistor: among those which may be mentioned are modulators, phase detectors, f.m. detectors and clamp circuits. These circuits can be studied experimentally by using a cross-connected pair, though some of the transistors have such normally undesirable properties that they might well prove of direct use as symmetrical transistors!

**Acknowledgement.**—Figs. 1, 2, 3, 4, and 9 are based on Figs. 1, 2, 5, 8 and 12 of reference 1, and Figs. 5, 6, 8 and 10 on Figs 1, 2, 8 and 14 of reference 2 (*Proc. I.R.E.*).

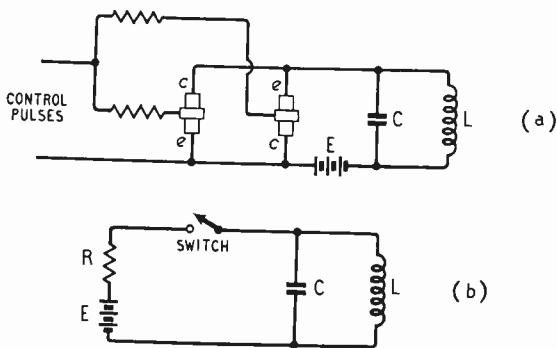


Fig. 9. (a) Circuit of transistor "switch" used in line time-base circuit. (b) Equivalent circuit.

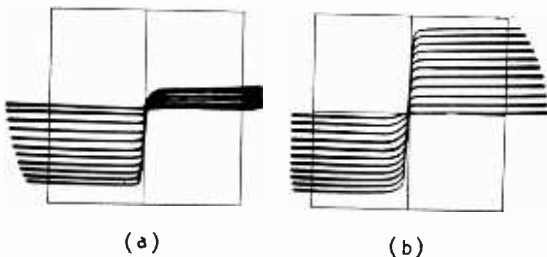


Fig. 10. Collector current curves taken on a curve tracer for (a) asymmetrical and (b) symmetrical junction transistors.

# More Valves for Microwaves

NEW readers (and old ones who have forgotten) start here. "Microwaves," for the present purpose, are chiefly those in what is known officially as the s.h.f. ("super-high" frequency) band, from 3,000 to 30,000 Mc/s, wavelengths 10 to 1 cm. Among other things they are used for radar and for linking up the B.B.C. television system. A notable example is the Manchester-Edinburgh chain of links on about 4,000 Mc/s. Valves working according to the usual principles are little or no good for such high frequencies; for one thing, the time that electrons take to cross from one electrode to another is an appreciable part of an s.h.f. cycle, and this leads to various complications; for another, it is difficult to make the distance between the tuning circuits and the working surfaces of the electrodes less than an appreciable fraction of a wave-length. By dint of making the electrodes part of the tuning system and reducing the electrode clearances to paper thickness, exceptional triodes ("disk-seal" type) have been produced capable of oscillating and even amplifying at around 3,000 Mc/s, but their power and amplification are small. A complete break-away from ordinary valves is the magnetron, capable of almost incredible performance under pulsed radar conditions—peak output at 3,000 Mc/s of several thousand kilowatts, for example. It can also be designed to work at much higher frequencies, but since the whole of the tuned circuit is part of the valve a different size of valve is needed for each frequency band. The magnetron is a diode, with heated cathode and positive anode, but unlike ordinary diodes its electrons flying from cathode to anode are influenced not only by the h.t. voltage but also at right angles by the force of a powerful magnet, and the energy imparted to them by the h.t. is not delivered to the tuned circuit after they have arrived at the anode, in the form of grid-controlled anode current, but actually while they are still flying around in the space between the electrodes. Incidentally, it is the interchange of energy between an electrode and electrons moving near it that puts the grid of an ordinary valve more or less out of action at these frequencies. This transit-time effect rules out ordinary valves because it comes in the wrong phase, but magnetrons profit by it because with the help of the magnet it is made to occur in the right phase.

Now that we have, I hope, become used to the idea of tuned circuits that are just little hollows or cavities, and the idea of electrons taking or giving energy to electrodes without actually touching them, it will be easier to tackle the two other main types of microwave valves—klystrons and travelling-wave tubes. After that we can sum up by comparing the merits and limitations of all four types.

I wonder, though, whether there is still some lack of conviction about the influence of flying electrons. Cavity tuning is just a further development of the tendency towards combined and distributed induct-

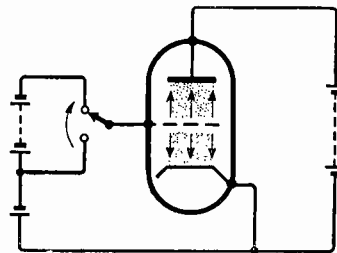
## 2.—Velocity Modulation of the Electron Beam

By "CATHODE RAY"

ance and capacitance exemplified on so many house-tops in the simple dipole, to say nothing of the acoustic analogy presented by sound resonance in rooms—or in a sea-shell held close to the ear. But analogies are not quite so helpful when it comes to visualizing the giving and taking of energy by flying electrons. A falling brick does not impart appreciable energy to anything until it actually hits it. One can study quite considerable books on valves without coming across any hint that the electrons do things to the valve circuits while they are still travelling through space. The reason is that except at microwave frequencies such effects are usually negligible. Of course, it follows directly from basic principles that work is done on a charge that is moving towards an opposite charge under the force of attraction, and vice versa, but this sounds rather highly theoretical and somehow it is difficult to picture action taking place in a circuit due to electrons moving *near* it. Yet that is what is happening in a capacitor with dielectric material between the plates. It can store more energy when the material is there than when it is not, because the material contains large numbers of electrons on an elastic string, as it were, and when a voltage is applied between the plates they move towards the positive plate, straining at the leash. When the capacitor is discharged they give up this extra energy while they are being pulled back *against* the attraction of the positive plate.

Or consider what happens at the grid of an ordinary valve (Fig. 1) if a large negative voltage is suddenly applied. All the electrons in the space move away from the grid as fast as they can. Those that had passed through the grid and were on their way to the anode are speeded by a kick in the pants from the repellent negative grid voltage, and those that were on their way towards the grid receive this blow in the face and hurry back on their tracks. The moving of all these negative charges away from the neighbourhood of the grid would upset the potential of the grid unless some negative charges were moved on to it, and these charges flowing in from the negative battery constitute a current, just as if a conductive

Fig. 1. When the grid of a valve is suddenly made very negative, all electrons in the space are driven away from the grid. While they are doing so, their movements cause grid current to flow, and if this condition is maintained by making the grid potential alternate at thousands of megacycles per second the resulting power loss is heavy.



path had been placed between grid and cathode. An s.h.f. signal applied to the grid alternates so rapidly that the wretched electrons are continuously being pushed and pulled to and fro before they have time to get anywhere, and the compensating current that has to flow in the grid circuit is so large that it inflicts intolerable damping on that circuit. Which is why the grid-controlled kinds of valve won't work. This resistive current must not be confused with the capacitive current that also flows and which could perhaps be neutralized by inductance without serious loss. Whereas no current flows into or out of a capacitance so long as the voltage across it is constant, a constant voltage continues to drive electrons away from the interelectrode spaces as long as any remain there.

Now suppose that electrons are kept out of the space by absence of anode voltage, combined with slightly negative grid. Switch on the h.t. voltage, and a mob of electrons will surge forward from the cathode. During the minute fraction of a micro-second during which they are crossing the space to the grid, the grid potential would be upset by the approach of this negative charge if a small positive charge were not brought on to the grid. In practice a positive charge is brought by removing electrons, and the flow of electrons *against* the e.m.f. of the grid bias source means that energy is flowing into that source. This energy, even if very small, must, come from somewhere, and, of course, in this case it is coming from the h.t. which is responsible for the forcible movement of electrons towards the grid.

### Klystrons

The various kinds of klystron are designed to transfer energy to and from circuits by electrons streaming past them rather than into them.

Imagine then that a stream or beam of electrons has been produced by a "gun," just as in a cathode-ray tube, and that it is shooting upwards at a constant speed. In Fig. 2 the numbers 1-10 on the left show the positions of selected electrons in the beam at "zero" time, which is indicated by 0 on the horizontal scale, marked in very small units of time. The diagonal lines enable the positions of the electrons to be found at other times; for instance, after 4 time units have elapsed electron 1 is at position 1', having moved four spaces upward; electron 2 is at 2', and so on. If the electrons were moving faster, this would be shown by diagonals sloping more steeply, and vice versa. Because they are all moving at the same speed all the lines are at the same slope.

Next, suppose that at the position marked 1 there are two holes or grids through which the beam must pass in quick succession, and that these electrodes are connected to opposite ends of a tuned circuit that is kept in oscillation (Fig. 3). Then during the half-cycles when the upper or second grid is positive there is an electric field between the grids tending to accelerate the electrons, and during the negative half-cycles the electrons are retarded. Let us trace this effect on the position-time diagram for several half-cycles (Fig. 4). Until the electrons reach position 1, where the grids are, everything is as in Fig. 2. The sine-wave drawn at the foot along the time scale shows that at zero time the inter-grid voltage is maximum positive, and the gain in speed of electron No. 1, which is then passing under its influence, is shown as a 25 per cent increase in the slope of its diagonal. The time units are now seen to be eighths of a cycle. So

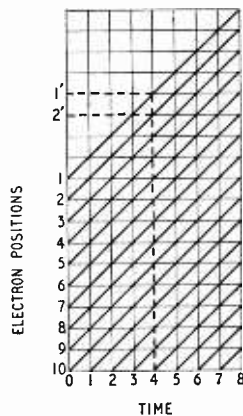


Fig. 2. Diagram showing progress of selected electrons upward at constant velocity, represented by constant slope of the diagonal lines.

Below: Fig. 3. In the klystron the alternating voltage across a tuned circuit kept in oscillation (here represented by conventional symbols, though actually a cavity resonator is used) is used to vary the velocity of a beam of electrons.

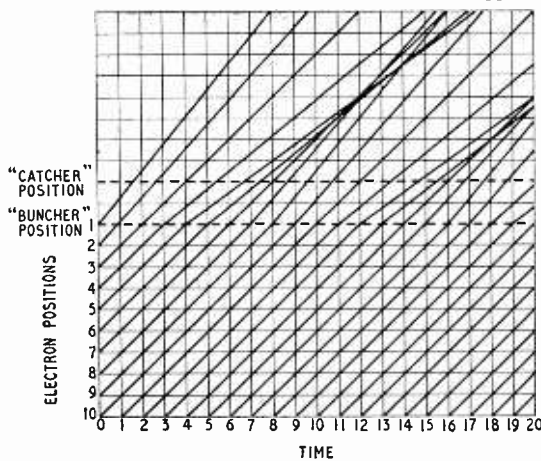
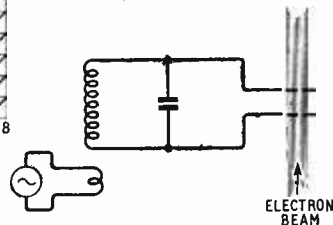


Fig. 4. When the alternating voltage across the tuned circuit (represented by the waveform at the foot of this diagram) is positive, an electron passing under its influence (at the "buncher" position) is accelerated, as indicated by a steepening of the diagonal line from there on. Negative voltages cause deceleration. The result is bunching, as seen at the "catcher" position.

one time unit later the voltage is  $1/\sqrt{2}$  or 0.707 times peak, and from position 1 onwards the second electron is shown travelling  $0.707 \times 25 = 17.7$  per cent faster than before. When the third electron passes between the grids their difference of potential is zero, so it continues at its original pace. No. 4 is retarded 17.7 per cent; No. 5, 25 per cent; and so on. If we now transfer our attention to a point two spaces above the grid position and watch the electrons fly past we notice—as the diagram clearly shows—that some of them come at longer intervals and others closer together in bunches, like a badly run bus service. Comparing them with the foot of the diagram we see that the periods of sparser electrons synchronize with the negative half-cycles of oscillation, and the bunches with the positive half-cycles. Remember that the electrons shown in the diagram are only selected "tracer bullets" representing the vastly greater numbers being shot upward. Compared with the average



beam current arriving at the grids, the current passing the higher position is alternately negative and positive, in synchronism with the oscillatory grid potentials. So if we were to put here a second pair of grids connected to a circuit tuned to the same frequency, periodically varying beam current would induce in this second circuit an oscillatory current. Since most of the energy of the electrons is due to the anode voltage of the gun, and the energy required from the first tuned circuit to bunch them is relatively small, it turns out that under suitable conditions the oscillatory power developed in the second tuned circuit is greater than that in the first. So the possibility of amplification is opened up. And by back-coupling the second circuit to the first, one can obtain continuous oscillation.

For obvious reasons the first pair of grids is called the buncher. The second is called the catcher, though this name is rather misleading, for it is the energy of the electrons that is caught, rather than the electrons themselves. There is in fact a final electrode called the collector, because that is what it does. The whole point of this scheme being to operate at microwave frequencies, the conventional tuned circuit shown in Fig. 3 is unsuitable. Resonant cavities are used, through which the beam passes. One form, shown in section in Fig. 5, is shaped like an American doughnut. Another type is actually a short section of coaxial "line." The gun consists of a cathode, surrounded except at the outlet by a control electrode at about the same potential, and an anode to bring the electrons out at speed; but except in high-power transmitting klystrons the anode voltage is lower than in television c.r. tubes—sometimes less than 1,000 V. Fig. 4 shows that the catcher might be even more effective if placed farther away from the buncher, but of course the phase difference between the two resonators would be different; and obviously the best position would depend on the initial speed of the electrons, controlled by the anode voltage.

This bunching process is called velocity modulation, to distinguish it from the process by which the control grid in an ordinary valve produces bunching at more or less constant electron velocity.

Klystrons have been designed on the principle just described with some success as amplifiers of microwaves, but unfortunately they are rather noisy so cannot be used effectively to amplify very weak signals. The same principle has been adopted in power oscillators developing up to several hundred watts continuously at around 4,000 Mc/s, which considering that

something of the order of 1 watt is enough for the B.B.C. television network links seems to be adequate, to say the least.

For low-power oscillators, used in signal generators, and especially as superhet oscillators in receivers, the choice is nearly always a modified form of klystron in which a single resonator is used as both buncher and catcher. It reminds me of the inexperienced driver who knocked down a traffic-control policeman, and on getting into reverse to apologize knocked him down again. In the klystron the reversing is brought about by a negatively charged electrode called the reflector, placed so as to repel the velocity-modulated beam soon after it emerges from the resonator. When the electrons find a fairly high negative voltage ahead of them they hurriedly reverse and pass once more through the resonator, and if things have been successfully arranged they do so in the correct phase for positive feedback and oscillation. The most convenient method of controlling the phase is by adjusting the reflector voltage.

### Tuning Facility

One advantage of the reflection klystron is that there is only one resonator to tune, so there is no possibility of the catcher being out of tune with the buncher. The resonator can be provided with one or more screw plugs for varying the internal volume and hence the tuning, or in some models the tuning is varied over a small frequency band by squeezing the cavity. Even without doing anything to the resonator one can vary the frequency of oscillation up to about 1 per cent—which is a considerable number of Mc/s—by varying the reflector voltage, and this is such a convenient method of frequency modulation that f.m. is usually adopted, for example in television microwave links.

In Fig. 6 the two-resonator and reflection klystrons are compared in simplified diagrams, and Fig. 7 shows the arrangement of electrodes in a typical reflection klystron. Note that the resonator is built into the walls of the valve in the same way as the grid and anode of a disk-seal triode.

It must not be imagined that the subject of klystrons has now been covered, for their behaviour is much more complicated than this simplified story would suggest. But we must press on regardless if we are to get in anything about the travelling-wave tube, which is the most difficult to explain of all. There is already a large book devoted entirely to it,

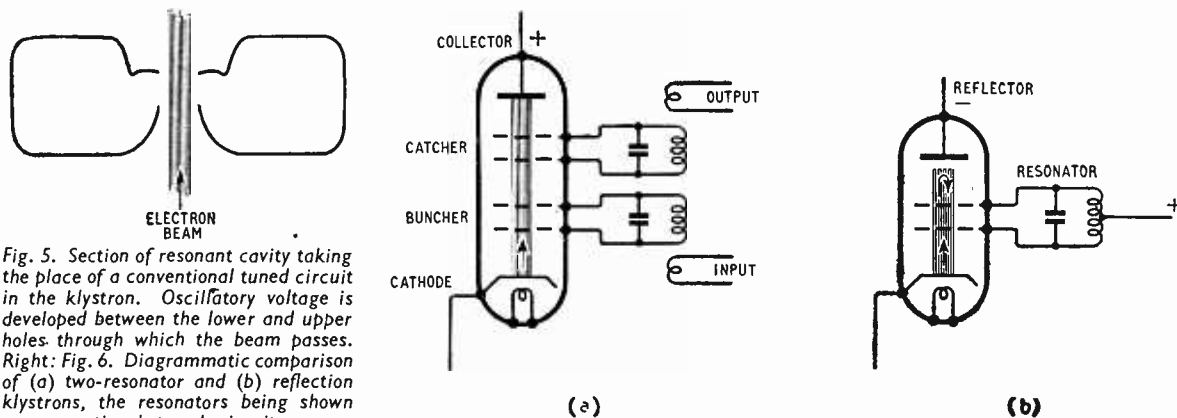


Fig. 5. Section of resonant cavity taking the place of a conventional tuned circuit in the klystron. Oscillatory voltage is developed between the lower and upper holes through which the beam passes. Right: Fig. 6. Diagrammatic comparison of (a) two-resonator and (b) reflection klystrons, the resonators being shown as conventional tuned circuits.

filled with abstruse mathematics. Like the magnetron and klystron, the travelling-wave tube draws on the energy of electrons flying through space at high speed—energy put into them by the steady h.t. supply. Unlike them, it has no resonator or other tuning device, so its functioning is not restricted to a particular frequency or narrow band of frequencies. It is, in fact, a unique and remarkable device—an aperiodic amplifier of microwaves. In the early days the only aperiodic (i.e., untuned) amplifier was the resistance-coupled kind, and it was effective only for audio frequencies, because of stray capacitance, especially Miller effect. With the development of high  $g_m$  screened pentodes the frequency band was gradually widened to include r.f. up to 1 Mc/s or so, and, with inductance compensation, higher still, to include the whole television v.f. band. But the wider the band the lower the amplification that can be obtained per stage. At still higher frequencies the effect of stray capacitance is so devastating that it can only be overcome by merging it into a tuned circuit, and of course that is effective only at and near the frequency to which it is tuned. As one gets beyond the v.h.f. band it becomes increasingly difficult to obtain any amplification at all, even with tuning—hence the strenuous efforts made in disk-seal triodes and klystrons. So the travelling-wave tube, which reintroduces aperiodic amplification in the s.h.f. band, of all frequencies, really is quite an astonishing device. The CV2188, for example, at a fixed adjustment gives 15-19 db gain at all frequencies between 3,000 and 4,600 Mc/s simultaneously—a bandwidth of 1,600 Mc/s!

The reason why the magnetron and klystron cannot do this, you remember, is that the d.c. power of the electrons is converted into alternating power by careful *timing* or synchronization effected by tuned circuits, just as in a watch the steady power of the mainspring is converted into regular pulses by the action of its "tuned circuit," the balance wheel. The magnetron, as at present known, is unsuitable for amplification, so can be left out of the comparison; the klystron, as we have just gathered, needs a tuned circuit to control the timing of the bunches of electrons and thereby apply their energy to the second—or the same—tuned circuit at the right moments to develop oscillations of greater amplitude. The travelling-wave (t-w) tube works on a different principle, for it makes use of the *speed* of waves, which is practically the same at all frequencies. Instead of the electrons being made to alternate in time they are made to alternate in distance, running alongside the waves and feeding them with energy continuously. This process is difficult to visualize in detail, but I think one can fairly easily get a rough idea of it, once the principle of energy transfer from flying electrons has been accepted.

In a klystron each electron comes under the influence of the bunching voltage only during the fleeting moment when it is actually passing between the fixed buncher grids. This period has to be kept very brief; otherwise the phase of the voltage would have time to change substantially, or even reverse, while the electron was still there. In the t-w tube it is kept under the influence during most of its journey, for the accelerating or retarding field is made to run along with it, and by so doing to maintain the correct phase all the time. When signals are sent along an ordinary waveguide or transmission line an electric field made in the signal pattern runs along it. But

as the speed is not far short of the speed of electromagnetic waves in space ("the speed of light") an enormously high voltage would be needed to make the electrons keep up with it. With reasonable voltages, an electron beam travels at about one-tenth this rate, so the solution is to slow the signal waves down to that. This is very simply done by passing them along a wire wound into a helix (a long single-layer spaced-turn coil) so that the length of the helix is about one-tenth the length of the wire. The signal to be amplified is introduced at one end of the helix, starting a wave moving along it. At the same end of the tube is an electron gun, shooting a beam along the tube inside the helix.

Fig. 8(a) shows diagrammatically a length of the helix in section, in which the electron beam and the signal are supposed to be travelling from left to right. For simplicity let us assume that the signal is a sine wave, the voltage along the helix at the instant considered being as shown in Fig. 8(b). The positive and negative peaks are marked along the helix, so at this instant the electric field inside the helix is tending to move

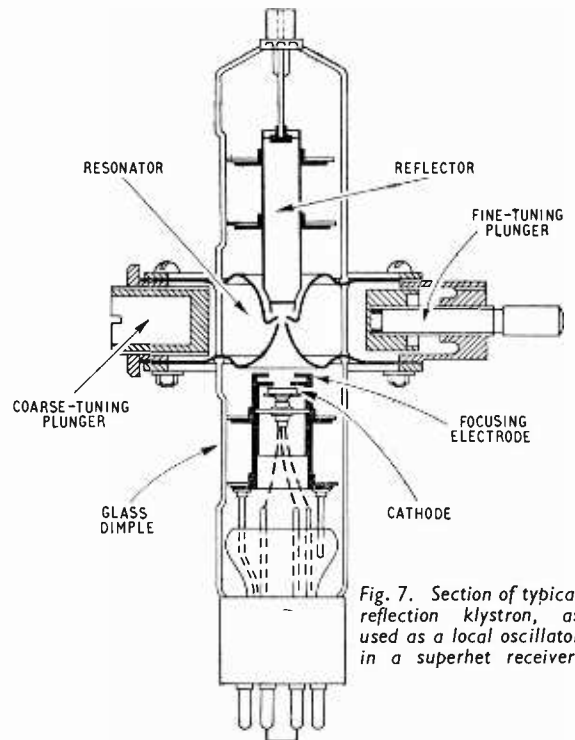


Fig. 7. Section of typical reflection klystron, as used as a local oscillator in a superhet receiver.

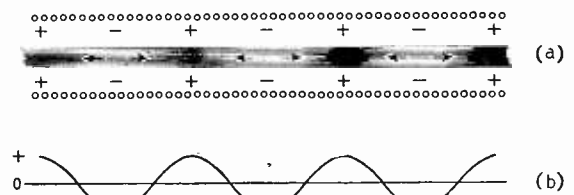


Fig. 8. Diagram representing at (a) the helix of a travelling-wave tube in section, with the electron beam passing through it from left to right. The wave potentials on the helix at the moment selected are shown at (b), and the resulting electric fields inside the helix tend to retard or accelerate the electrons in the beam as shown by the arrows, causing them to bunch (indicated by shading).

the electrons in the directions shown by the arrows. This movement, of course, is superimposed on the high-speed flow from left to right. Since the h.t. voltage has been adjusted to make this flow more or less keep step with the signal along the helix, the local attractions for the electrons are maintained all the way along, and so the electrons increasingly pile up in some places and thin out in others, as indicated by the shading. In other words, continuous bunching is occurring all along the tube.

Now the original unbunched electron stream was simply d.c., having no ability to affect the a.c. signals in the helix. But the bunched stream, which can be regarded as a series of positive and negative charges superimposed on the d.c., inevitably does induce signals in the helix, of the same wavelength as the bunching signal. While it is true that this original signal must have given up some of its energy to the electrons to make them bunch, this energy is very small compared with the energy of the bunches moving along at high speed. If the h.t. voltage responsible for their high speed is adjusted so that the phase of the signal induced by them is suitable, it builds up the original signal so that when it emerges from the helix it is stronger than when it went in. Which, of course, is exactly what is wanted.

As one would expect, the voltage needed to obtain maximum amplification is quite critical, and must be obtained from a stabilized supply. For if the speed of the electrons were much different from that of the signal along the helix they would be alternately bunched and debunched as they came into and out of step.

Obviously the electron stream must be kept to a straight and narrow path all the way through the helix, and this is a different matter from focusing in a cathode-ray tube, where it doesn't matter much if the beam spreads out a bit in the middle so long as it is well focused when it arrives at the screen. Besides a first and second anode system to get the electrons off to a good start, a strong magnetic field is provided all the way, as shown in Fig. 9, which is a simplified section of a t-w tube.

As not very much has been published about these tubes, here are a few details of the CV.2188 used in the 250-mile chain of microwave links from Manchester to Kirk O'Shotts, made by Standard Telephones and Cables, Ltd.\* This is the first regular service in the world to make use of these tubes. Each repeater station on the route receives signals in the 4,000 Mc/s band from the previous station, converts them to 60 Mc/s i.f. for amplification, and then converts them back to the 4,000 Mc/s band (but 37 Mc/s different from the received frequency) for re-transmission. The output from the frequency changer is not enough, so the duty of the t-w tube is to raise it from 25 milliwatts to about 1.5 watts. The second anode and the helix are earthed; the cathode is kept at -3,000 V, the first anode at -1,800 V, and the collector at +50 V (to prevent secondary electrons from leaving). Total current is about 14 mA (just over 40 watts), of which the first anode hardly gets any, and the helix only about 1 mA. So most is received by the collector, which is surrounded by a forced-air cooler. The helix, wound 19 turns per inch, has an inside diameter of 0.13in, and the beam diameter is

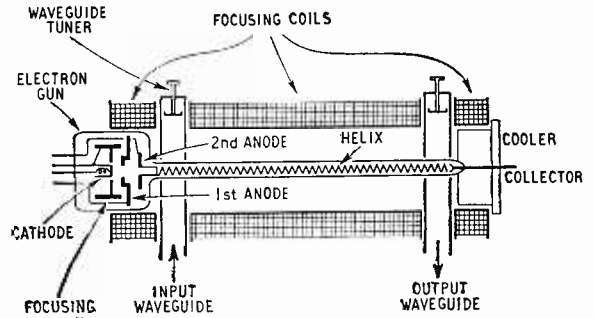


Fig. 9. Simplified section of travelling-wave tube with waveguides and focusing electromagnet in place.

0.09in. The average tube life is over 3,000 hours; the senility of a tube can be read off from the supply voltage stabilizer, which is arranged to raise the anode voltage automatically to offset the effects of old age.

For an American type of tube it is claimed that an output of 10 W is obtained in the 6,000 Mc/s band with 25 db gain, using 1,200 V. And for a receiving type the gain is 15 db to 0.5 mW, with a noise factor of 10 db, using 600 V 0.5 mA. (I can almost hear somebody remarking that travelling-wave tubes are only in their infancy!)

### Summing Up

And now for a final summing up of microwave valves.

**Disk-seal valves.**—They persuade ordinary valve principles to work at these unaccustomed frequencies by dint of extraordinary feats of manufacture. They both oscillate and amplify, but performance of even a modest order ceases above about 4,000 Mc/s, and unless some wonderful new technique is devised there seems to be little scope for substantially increasing either the performance or the frequency. Where it is sufficient to do the job it has the advantages of simplicity and small size.

**Magnetrons** (resonant-cavity type).—Unsuitable for amplification or low-power oscillation or any sort of gradual modulation, but unrivalled for high-power oscillation, especially when pulse-modulated as in radar. Simple and robust, and available for any of the microwave bands, but frequency not easily varied by more than a little, and prone to oscillate at more than one frequency at a time.

**Klystrons.**—Can be used as oscillators and (if of two-resonator type) as amplifiers, but in latter role are noisy. Particularly suitable as low-power oscillators, especially in superhet receivers, but can be designed for power output rivaling magnetrons in continuous rating and unlike magnetrons they lend themselves very well to frequency modulation.

**Travelling-wave tubes.**—Oscillate and amplify, but compare unfavourably with the others for oscillation. Unique in amplifying almost equally over very wide frequency band. Larger and more complicated than disk-seal triode or klystron, but in addition to wide-band characteristics, they beat the triode in performance and the klystron in noise-factor.

So we see that while for some purposes there may be room for choice from among these four types, for the most part each has its own job or jobs at which it does best.

\* "The Travelling-Wave Tube as Output Amplifier in Centimetre-Wave Radio Links," D. C. Rogers, *Proc. I.E.E.*, Part III, May, 1953, p. 151. "British TV Relay Uses Travelling-Wave Tubes," D. C. Rogers and P. F. C. Burke, *Electronics*, June, 1953, p. 156.

# Inexpensive Megohmmeter

*An Instrument for Measuring Resistance Over the Range 0.1 to 10,000 MΩ*

By H. E. STYLES, B.Sc.

**D**URING the course of experimental work, a need is often felt for equipment by means of which insulation resistance may be checked or resistances of the order of hundreds of megohms measured with reasonable accuracy. Such measurements cannot be made with the simple types of a.c. bridges normally available to most people, whilst d.c. tests usually require very sensitive, delicate and expensive measuring instruments or somewhat elaborate amplifying equipment.

This article shows how a simple, inexpensive and robust instrument may easily be constructed so as to permit accurate measurement of resistances within the range of 0.1 to 10,000 megohms or more under an applied potential of about 100 volts. In addition the instrument enables insulation resistance to be tested at about 500 volts, though at this voltage resistance measurements may be less accurate as they are not independent of variations in mains supply voltage. The same instrument can, with very little complication, be made to serve as an audio-frequency signal generator capable of producing any desired frequency from 0.25 to several thousands of cycles per second. Only one component, a one-megohm resistor, needs to have a precisely known value and calibration of the equipment is a matter of extreme simplicity.

The instrument is based upon the very simple circuit shown in Fig. 1 which will be recognized as the most elementary form of saw-tooth oscillator. Capacitance C charges through resistance R to the striking potential of the neon discharge tube S at which stage the capacitance becomes rapidly discharged until its potential falls to that at which tube S becomes extinguished. The potential of C then rises again and the cycle repeats indefinitely. Pulses of current are thereby produced in the circuit comprising C and S, and these pulses may readily be made evident by inserting a low resistance telephone receiver at the point marked X in Fig. 1.

The frequency at which pulses are generated will depend upon the characteristics of the neon tube S, the values of C and R and the applied voltage E which must, of course, be greater than the striking voltage of S. For any particular discharge tube, the frequency of the pulses will be inversely proportional to the product of C and R and directly proportional to E. If the latter be maintained constant, it is evident that for any chosen value of C, determination of the frequency of oscillation with different resistances at R will provide a means of accurately comparing their values.

An appropriate constant voltage can readily be achieved by means of the circuit shown in Fig. 2, which incorporates two additional discharge tubes as voltage stabilizers. Provided the latter are operated at a suitable current, the frequency of oscillation

produced by this circuit can be made independent of the supply voltage within quite wide limits. By suitable choice of capacitance the frequency of oscillation can be kept within easily countable limits for values of resistance ranging from one to 10,000 megohms. For purposes of signal generation, fine control of frequency can readily be obtained by means of the slightly modified circuit shown in Fig. 3.

Fig. 4 shows the circuit of the final instrument based upon the foregoing considerations. In order to render the equipment capable of being used for testing earthed circuits, power is taken from the mains via a double-wound transformer. The latter can, however, be of very small size, as it is required to supply only two or three watts, and the author has successfully employed one in which the primary and h.t. secondary windings are wound with 44 s.w.g. and 47 s.w.g. wires respectively.

An EB34 (VR54) valve is employed as a voltage doubling rectifier and with a 200-volt input this provides a peak output of about 560 volts d.c. The valve operates under conditions much more arduous than those for which it is rated, but no difficulties have been experienced on this account. The heater winding of the transformer is left floating in order to minimize potential differences between it and the valve cathodes, whilst the internal and external screens of the valve are left unconnected.

Resistances R<sub>1</sub> and R<sub>2</sub> together should be such as to allow a current of about 1.5 mA. to flow through the stabilizer tubes S<sub>1</sub> and S<sub>2</sub>, for which VS70s are used. Under such conditions of operation a variation of ± 10 % in mains supply voltage produces no detectable change in frequency of oscillation.

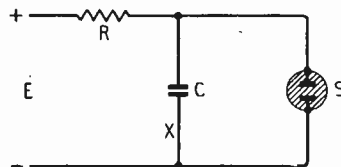


Fig. 1. Basic circuit of the megohmmeter.

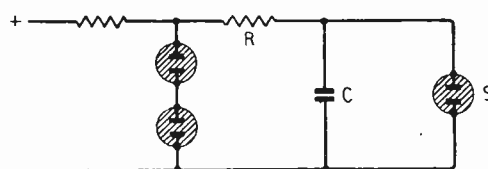


Fig. 2. Stabilized h.t. supply for the megohmmeter.

Switch A enables the stabilizer tubes to be disconnected so as to raise the test voltage to the peak value available from the rectifier. This voltage is, of course, not independent of mains fluctuations and may also vary according to the current passed by the resistance under test. For these reasons resistance measurements at the higher test voltage can only be regarded as approximate, but this is all that is normally required for insulation test purposes.

With switch A closed a stabilized potential of about 200 volts is maintained across tubes  $S_1$  and  $S_2$ , so that, as the striking voltage of the oscillator tube  $S_3$  is about 100 volts, resistance measurements are conducted at an applied potential of about 100 volts. It is important to know this as the resistance of some materials varies considerably with the applied voltage.

Switch B is the normal on-off switch fitted to the one-megohm volume control potentiometer  $R_3$  and when closed permits the latter to be employed to vary the frequency of oscillation produced by resistance  $R_4$  in conjunction with any capacitance selected by means of switch C. If the instrument is not required for use as a signal generator the switched potentiometer can, of course, be omitted.

Resistance  $R_4$  must be of accurately known value and such as will produce, in conjunction with a one-microfarad capacitance, an oscillation of easily countable frequency. One megohm will probably be found suitable but differences between discharge tube characteristics may necessitate choice of a somewhat different value. A CV188 tube is employed for the oscillator  $S_3$  though another VS70 could be used in this position. The former tube, however, appears to exhibit greater differential between striking and extinction voltages and therefore produces pulses of greater amplitude, whilst the use of a distinctive tube for the oscillator serves to obviate any possibility of inadvertently exchanging it with one of the stabilizer tubes.

The four capacitors connected to switch C have to withstand only the striking voltage of the oscillator tube, but their insulation must be beyond suspicion and components of high voltage rating are therefore desirable. The two capacitors of lower value can well be of the mica dielectric variety but good quality paper insulated capacitors may be used. Switch C must also be free from detectable leakage, one having ceramic insulation being preferable, whilst the oscilla-

tor tube base and holder must also be free from surface leakage in order to avoid shunting the capacitors with a resistance which would prevent them from charging at a correct rate. Switch B must be of good quality also, but in this case any leakage will be made evident during initial tests with the instrument.

Needless to say, the test terminals themselves must be very well insulated. The author employs a bakelite instrument panel upon which are mounted the test terminals. Surface leakage between these terminals could readily be detected at 500 volts, using the smallest capacitance, and it was therefore necessary to eliminate the effect of this by surrounding the terminal connected to the oscillator anode by a guard ring\* (on both sides of the panel) connected to the oscillator cathode. Surface leakage currents are thereby by-passed and prevented from charging the capacitance and producing false indications. Similar precautions may be necessary to eliminate surface leakage effects when testing high resistances and a guard ring terminal connected to the oscillator cathode is provided for this purpose.

### Calibration

Calibration of the instrument is effected as follows :- The test terminals are short-circuited, switch A is closed, switch B is opened and switch C is set so as to connect the one-microfarad capacitance into circuit. The number of clicks produced by the telephone receiver in exactly one minute is carefully determined. Let this number be  $N$ . Then if an unknown resistance,  $R$ , connected between the test terminals produces, in conjunction with the one-microfarad capacitance,  $n$  clicks per minute, its resistance will be given by the formula :  $R = \frac{N}{n}R_4 - R_4$ . If  $R_4$  is made exactly one megohm, this formula reduces to  $R = \frac{N}{n} - 1$  megohms.

With other values of capacitance the formula becomes :  $R = \frac{FN}{n}R_4 - R_4$  where  $F$  is the ratio of the capacitance of the 1.0- $\mu$ F capacitor to that of the capacitor selected for use. If the capacitors employed

\* For example, see "Measuring High Resistance," by M. G. Scroggie. *Wireless World*, June, 1952, pp. 236-238. Ed.

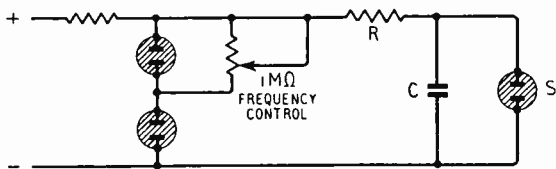
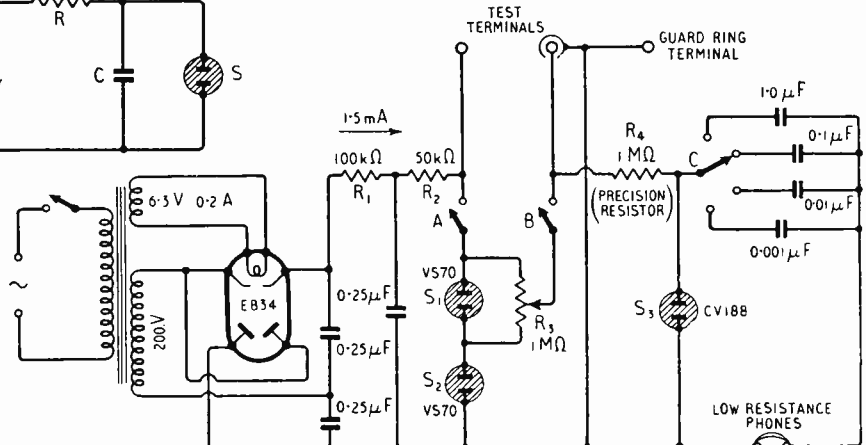


Fig. 3. Frequency control for a neon tube oscillator.

Right: Fig. 4. Complete circuit of the megohmmeter high resistance test set. The components mentioned in the text are given appropriate references in addition to their values.



possess precisely correct values, rotation of switch C will correspond to successive tenfold multiplication of resistance values. There is however no need to employ precision capacitors as the appropriate multiplying factors can easily be determined as follows.

Select a resistance which produces a fast but easily countable frequency with the 0.1- $\mu$ F capacitor. Count the number of clicks per minute. Change over to the 1.0- $\mu$ F capacitor and repeat the count. The ratio of these two counts will then give the desired multiplying factor to be applied to readings obtained with the 0.1- $\mu$ F capacitor in circuit. The 0.1- $\mu$ F capacitor can similarly be compared with the 0.01- $\mu$ F component and an appropriate factor for the latter derived. This procedure is repeated for the 0.001- $\mu$ F capacitor, the only difficulty being to find resistances of sufficiently high value for the purpose. Specimens of poor insulating materials such as wood, fibre and cardboard may be employed provided that checks are made to ensure their resistance remains constant during the course of the tests.

The last stage of the calibration procedure consists of determining the multiplying factor to be applied to all readings obtained when the test voltage of 500 is used. For this purpose a resistance of about 5 megohms should be connected across the test terminals and, using the 1.0- $\mu$ F capacitor, counts taken with switch A in both the closed and open positions. The ratio of these counts gives the required factor for obtaining approximate resistance values at the higher test voltages. In carrying out this particular calibration care should be taken to employ a resistor unlikely to exhibit any marked change in resistance when the applied voltage is raised from 100 to 500. A series of five separate one-megohm resistors should be satisfactory in this respect.

Careful tests have shown that for resistances up to some twenty megohms the instrument is capable of an accuracy sufficient to give results within 1% of the true values and it is believed that this accuracy holds good at higher values. The stability of the equipment can always be checked by taking a count with the test terminals short-circuited. Any change observed may be due to alteration in discharge tube characteristics with age but is more likely to be due to alteration in the comparison resistance  $R_4$  or to accumulation of slightly conducting films on the insulation of various components. No trouble of this kind has yet been experienced as the instrument can be housed in a tightly closed box, there being no appreciable evolution of heat.

## Single-sideband Receiver

THE single-sideband (s.s.b.) method of transmission is gaining in popularity on many long-distance short-wave radio circuits since it possesses several distinct advantages over the older double-sideband system. For example, the signal/noise ratio is better; less bandwidth is required for a comparable service; there is a marked freedom from non-linearity distortion due to multi-path transmission and greater traffic-handling capacity, since both sidebands can be employed independently.

In view of these advantages, more than usual interest attaches to the development by the equipment division of Mullard of an independent sideband communications receiver known as the Type GFR552.

It covers 4 to 30 Mc/s in four ranges and is intended for the following types of reception:—

1. A3—normal double sideband.
2. A3a—single-sideband with a pilot carrier 16 db below the peak sideband power.
3. A3b—independent sideband with pilot carrier 26 db below the peak power of either sideband.

The receiver is a double superheterodyne with intermediate frequencies of 3.1 Mc/s and 100 kc/s respectively. It is designed for continuous use on long-distance circuits for telephone and telegraph traffic and provides for simultaneous and independent reception of four telephone channels of 3-kc/s bandwidth or two of broadcast quality (6kc/s). Alternatively each sideband can be used to carry several audio-frequency telegraph channels.

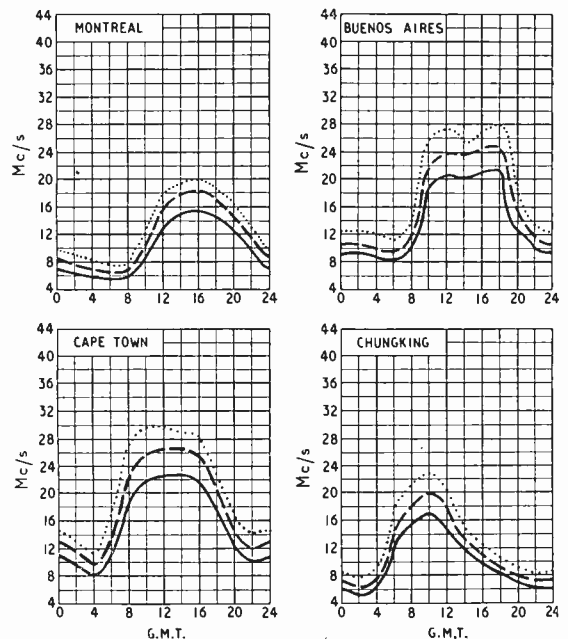
The receiver is assembled in an enclosed rack-type cabinet measuring 7ft high, 24in wide and 26in deep. The makers are Mullard, Ltd. (Equipment Division), Century House, Shaftesbury Avenue, London, W.C.2.

## Short-wave Conditions

### Predictions for October

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 October.

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



— FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE ON ALL UNDISTURBED DAYS  
 - - - PREDICTED AVERAGE MAXIMUM USABLE FREQUENCY  
 ..... FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE FOR 25% OF THE TOTAL TIME

# Converter for 200 kc/s

## Unusual Application of Crystal Control

By C. B. RAITHY\*

**A** VERY large number of communication receivers of both American and British manufacture do not include the long waveband and cannot therefore receive Droitwich on 200 kc/s.

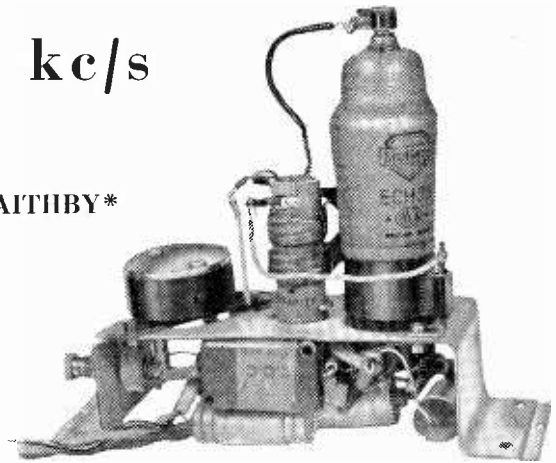
This is a disadvantage to both the "all-wave" listener and the transmitting amateur. For the former, if he wants to listen to the B.B.C. Light programme reception on 1,214 kc/s is often unsatisfactory in many areas. For the latter, the 200-kc/s transmission, if available, provides an excellent means of checking the calibration of oscillators.

The converter described here provides a simple means of receiving Droitwich on 200 kc/s on any reasonably well-screened short-wave receiver.

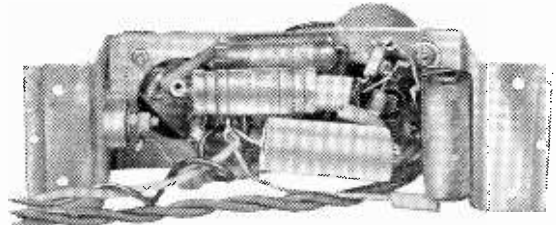
An ECH35 valve is used as a mixer with a crystal-controlled oscillator. The coil  $L_1L_2$  is a Wearite type PA1 but any equivalent coil is suitable.

The advantage of the design is that a wide range of crystals may be used including available ex-Government surplus. Crystal frequencies ranging from 3 to 10 Mc/s have been found satisfactory. Some actual frequencies used are 3.5 Mc/s (with the main receiver at 3.3 or 3.7 Mc/s), 8 Mc/s (with the receiver at 7.8 or 8.2 Mc/s), 10 Mc/s (with the main receiver at 9.8 or 10.2 Mc/s). A receiver frequency occupied by a very strong station should be avoided. Fortunately the input to the receiver from the converter is so great that the former's gain is greatly reduced by the a.g.c. action. No such difficulties were encountered on the frequencies mentioned.

If the converter is to be located inside a communication receiver, then its construction and shape will depend on the space available. In the one described and illustrated a small brass chassis, approximately



Crystal-controlled converter described in the text fitted with the ECH35 valve and below, an underside view of the chassis.



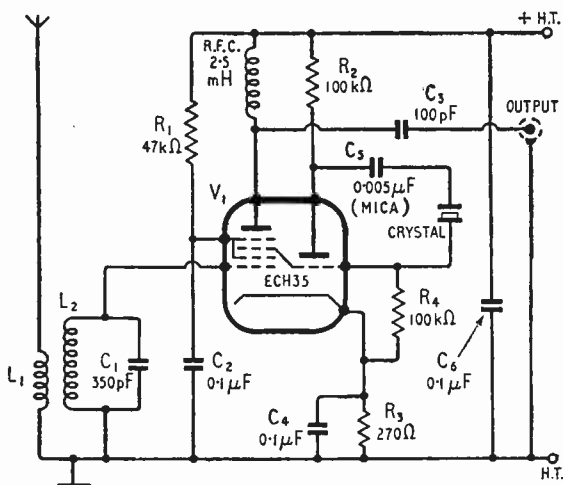
$4\frac{1}{2} \times 1\frac{3}{4} \times 1\frac{1}{4}$  in is used. The layout is not critical and any reasonable layout should prove satisfactory. If space is very limited a miniature frequency changer valve such as the UCH42 may be used, with appropriate circuit changes, instead of the ECH35. A length of coaxial cable conveys the converter output from the feed-through insulator on the left to the receiver aerial socket. If the converter is located within the receiver the power supplies of 250 volts d.c. and 6.3 volts a.c. can probably be taken from the existing supply unit. At 250 volts h.t. the current consumption is 10 mA, but satisfactory operation can be obtained at 130 volts,  $3\frac{1}{2}$  mA if economy is essential due to possible overloading of the receiver's power supply circuit.

When this is not possible a small separate power unit will be necessary. The converter can be used apart from the receiver and quite satisfactory operation has been obtained with about 30 ft of coaxial cable joining the two.

In this unit capacitor  $C_1$  is fixed and of 350 pF. If preferred a combination of fixed capacitor and paralleled trimmer may be used.  $C_1$  is not very critical, however. It is suggested 350 pF be used as a start. If the receiver has an "S" meter various values can be tried until the maximum reading is obtained. Alternatively, temporarily connect a normal variable capacitor of 0.0005  $\mu$ F maximum across  $L_2$  and adjust for optimum setting, remove, measure the capacitance on a bridge and connect in a fixed capacitor(s) of this value.

To put the converter into operation, connect the receiver's aerial socket to the converter and the converter's output terminal to the receiver. Insert a suitable crystal in the converter, switch on and tune the receiver to the crystal frequency to check that it is oscillating. Then tune the set 200 kc/s higher or lower for Droitwich. Select the better of the two.

\* Amateur radio station G8G1.



Circuit diagram of the crystal-controlled long-wave converter.

# Valve Matching Using Resistors

*Analytical and Experimental Methods of Equating Characteristics*

**O**CCASIONALLY circumstances arise when two or more valves having as nearly identical characteristics as possible are required. Perhaps a valve voltmeter is being built in which drift is to be minimized<sup>1</sup>; perhaps the mathematics of a novel circuit is simplified by the assumption that all of the valves have identical parameters.<sup>2</sup> To meet the need, negative feedback might possibly be applied to reduce unwanted effects,<sup>3</sup> or the required valves may be specially selected<sup>4</sup> from a number of the same type.

The home experimenter's valve stock may not be large enough to allow making a good selection, and the experimenter may wish to avoid the complication of negative feedback with its resulting reduction of gain. An ideal way out of the difficulty would be to modify the characteristics of the available valves, reducing their parameters to a common level. This idea can in fact be applied with a fair degree of success by using suitable resistances in conjunction with the valves. The matching is not perfect and does not take account of parameter changes caused by ageing or by fluctuations of heater voltage. Nevertheless the method is simple in principle and application.

Fig. 1 shows an elementary amplifier modified by the inclusion of the resistor  $R_1$  between the valve and its load impedance  $Z$ . From simple theory the alternating output voltage  $V_2$  for an alternating input voltage  $V_1$  is

$$V_2 = - \frac{\mu_1 V_1 Z}{r_{a1} + R_1 + Z} \quad \dots \quad (1)$$

where  $\mu_1$  and  $r_{a1}$  are the amplification factor and valve impedance respectively, the minus sign indicating the phase relationship between the input and output voltages. The same output would be obtained, in the absence of  $R_1$  if the valve had the same amplification factor  $\mu_1$ , but an impedance equal to  $(r_{a1} + R_1)$ . In accordance with the relationship  $\mu = g_m r_{a2}$ , the mutual conductance of the new valve would be

$$\frac{g_{m1}}{(1 + R_1/r_{a1})}$$

In Fig. 2, the amplifier is modified by the resistance  $R_2$  in parallel with the valve. The expression for the alternating output voltage is now

$$V_2 = - \frac{\left( \frac{1}{1 + r_{a2}/R_2} \right) \mu_2 V_1 Z}{\left( \frac{r_{a2}}{1 + r_{a2}/R_2} \right) + Z} \quad \dots \quad (2)$$

where  $\mu_2$  and  $r_{a2}$  are the amplification factor and valve impedance respectively.

Thus the combination of valve and parallel resistor

behaves as a new valve with an amplification factor

$$\mu_2 \left( \frac{1}{1 + r_{a2}/R_2} \right)$$

and impedance  $r_{a2} \left( \frac{1}{1 + r_{a2}/R_2} \right)$

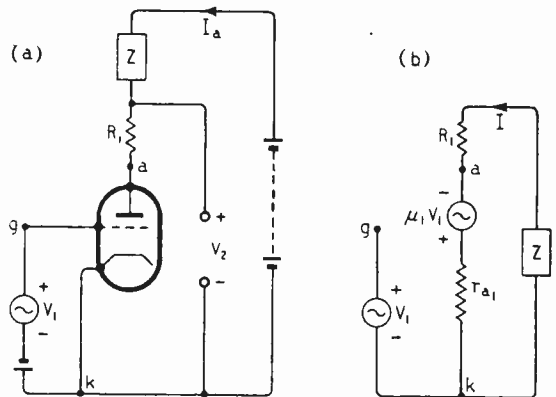


Fig. 1. (a) Simple amplifier, (b) a.c. equivalent circuit.

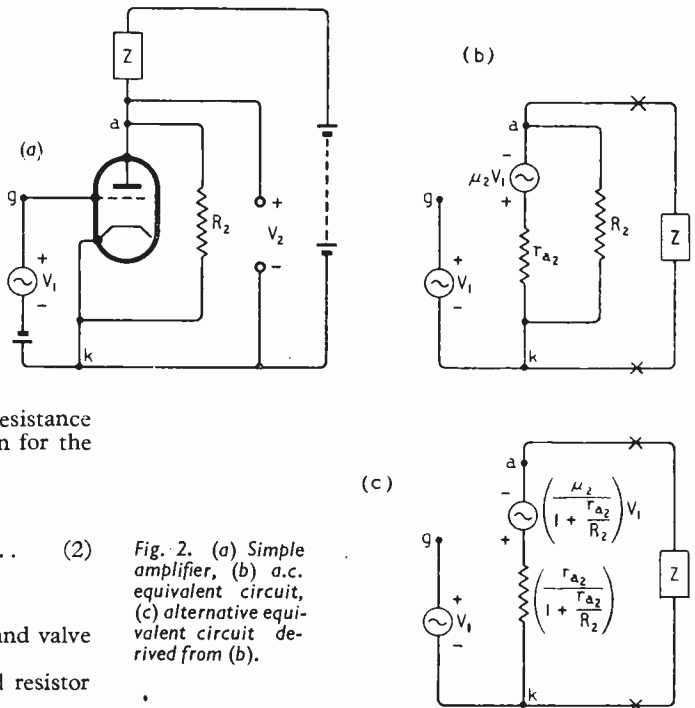


Fig. 2. (a) Simple amplifier, (b) a.c. equivalent circuit, (c) alternative equivalent circuit derived from (b).



By H. V. HARLEY, B.Sc.\*

This may also be easily seen by applying Thevenin's Theorem to the equivalent circuit of Fig. 2(b). The mutual conductance is  $g_{m2}$ , and is not altered by the parallel resistance.

In a like manner the parameters of the "equivalent valve" made from a true valve with both series and parallel resistances can be found. Fig. 3 tabulates the results.

The effective parameters of the combinations depend

both on those of the valve and on the resistances. Suitable choice of the resistances makes it possible to derive combinations with similar parameters, even though the valves themselves are dissimilar. Thus for equivalence of Figs. 1 and 2 the parameters of the one combination are made equal to those of the other.

Equating the amplification factors we have

$$\mu_1 = \frac{\mu_2}{(1 + r_{a2}/R_2)} \dots \dots \dots (3)$$

and for equivalent impedances

$$r_{a1}(1 + R_1/r_{a1}) = \frac{r_{a2}}{(1 + r_{a2}/R_2)} \dots \dots (4)$$

The required values of  $R_1$  and  $R_2$  may thus be found

\* Department of Electrical Engineering, University College of North Wales.

|                             | 1     | 2                                   | 3                                   | 4                                                                          | 5                                                        |
|-----------------------------|-------|-------------------------------------|-------------------------------------|----------------------------------------------------------------------------|----------------------------------------------------------|
| CIRCUIT OF EQUIVALENT VALVE |       |                                     |                                     |                                                                            |                                                          |
| AMPLIFICATION FACTOR        | $\mu$ | $\mu$                               | $\frac{\mu}{(1 + \frac{r_a}{R_2})}$ | $\frac{\mu}{(1 + \frac{r_a}{R_2} + \frac{R_3}{R_2})}$                      | $\frac{\mu}{(1 + \frac{r_a}{R_2})}$                      |
| IMPEDANCE                   | $r_a$ | $r_a(1 + \frac{R_1}{r_a})$          | $\frac{r_a}{(1 + \frac{r_a}{R_2})}$ | $\frac{r_a(1 + \frac{R_3}{r_a})}{(1 + \frac{r_a}{R_2} + \frac{R_3}{R_2})}$ | $r_a[\frac{R_3}{r_a} + (1 + \frac{r_a}{R_2})]$           |
| MUTUAL CONDUCTANCE          | $g_m$ | $\frac{g_m}{(1 + \frac{R_1}{r_a})}$ | $g_m$                               | $\frac{g_m}{(1 + \frac{R_3}{r_a})}$                                        | $\frac{g_m}{[1 + \frac{R_3}{r_a}(1 + \frac{r_a}{R_2})]}$ |

Fig. 3. Properties of "equivalent valves."

Fig. 4. Equivalence of valve-resistance combinations.

|                                                          | 1                       | 2                                                                                               | 3                                                            |
|----------------------------------------------------------|-------------------------|-------------------------------------------------------------------------------------------------|--------------------------------------------------------------|
| CIRCUIT CONFIGURATION                                    |                         |                                                                                                 |                                                              |
| PARAMETERS OF VALVES ALONE                               | $\mu_1; r_{a1}; g_{m1}$ | $\mu_2; r_{a2}; g_{m2}$                                                                         | $\mu_3; r_{a3}; g_{m3}$                                      |
| CONDITIONS FOR A.C. EQUIVALENCE WITH CIRCUIT OF COLUMN 1 |                         | $R_1 = \mu_1(\frac{1}{g_{m2}} - \frac{1}{g_{m1}}) + R_3(\frac{\mu_1}{\mu_2})$                   | $R_1 = \mu_1(\frac{1}{g_{m3}} - \frac{1}{g_{m1}}) + R_3$     |
|                                                          |                         | $R_2 = (\frac{\mu_1 \mu_2}{\mu_2 - \mu_1}) \frac{1}{g_{m2}} + R_3(\frac{\mu_1}{\mu_2 - \mu_1})$ | $R_2 = (\frac{\mu_1 \mu_3}{\mu_3 - \mu_1}) \frac{1}{g_{m3}}$ |

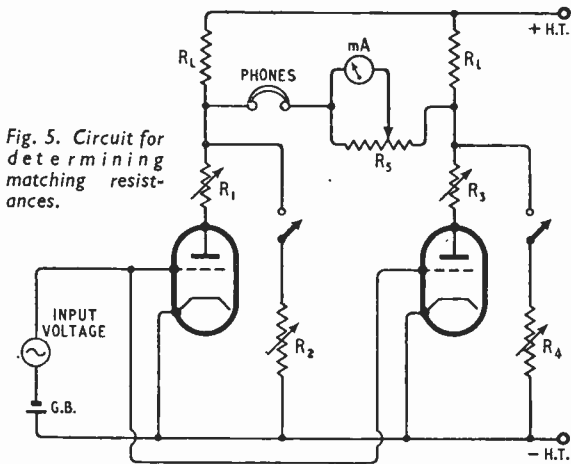


Fig. 5. Circuit for determining matching resistances.

simply by solving equations (3) and (4) for  $R_1$  and  $R_2$ , giving

$$R_1 = \mu_1 \left( \frac{1}{g_{m2}} - \frac{1}{g_{m1}} \right) \dots \dots \dots (5)$$

$$R_2 = \left( \frac{\mu_1 \mu_2}{\mu_2 - \mu_1} \right) \frac{1}{g_{m2}} \dots \dots \dots (6)$$

If one excludes negative resistances and negative mutual conductance valves, equations (5) and (6) can only be satisfied for  $g_{m1} \geq g_{m2}$  and  $\mu_2 \geq \mu_1$  (if  $\mu_2 = \mu_1$  then  $R_2 = \infty$ , i.e. this resistance is not needed). Thus the parallel resistance must be associated with the valve having the larger amplification factor and the series resistance with the valve having the larger mutual conductance.

It can be seen that the circuit arrangements of Figs. 1 and 2 could not have been matched had both the amplification factor and mutual conductance of one valve been greater than the corresponding parameters of the other.

For such a case, a more general "equivalent valve," such as in Fig. 3, columns 4 or 5, would be necessary. Fig. 4 details the more general conditions for equivalence of the valve-resistance combinations.

Depending upon which of the valves has the lower mutual conductance, either  $R_1$  or  $R_3$  of Fig. 4 may be zero. The  $g_m$  of the matched pair then equals that of the valve with the lower mutual conductance. By restricting the parallel resistance to the valve with the higher  $\mu$ , the amplification factor of the matched pair is made equal to that of the valve with the lower  $\mu$ . Neither mutual conductance nor amplification factor can be increased by adding resistances.

The resistances  $R_1$ ,  $R_2$  and  $R_3$  of the foregoing results could, of course, be incorporated in the actual amplifier load impedances, and the alternating output voltages could be taken at the correct level from the modified loads. However, it is of interest to examine the effect of the resistances as added in Figs. 3 and 4 on the d.c. characteristics of the combinations.

Let the same linearity of valve characteristics be assumed, as implied in the a.c. equivalent circuit analysis. The current taken by an "equivalent valve" may be found by combining with the true

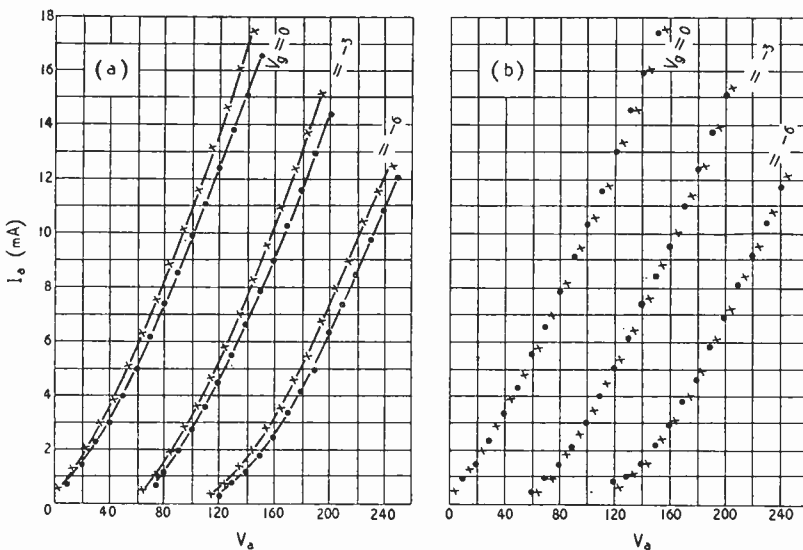


Fig. 6. (a) Anode characteristics of 6SN7 double triode, (b) "anode" characteristics of matched valve-resistor combinations. (x points for one triode section, ● points for the other triode section.)

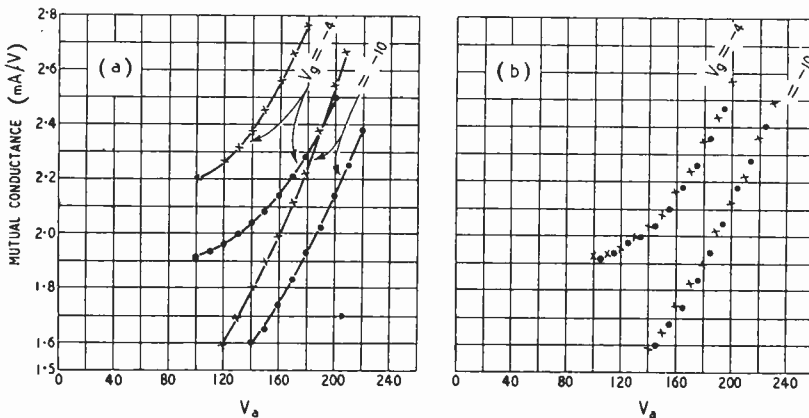


Fig. 7. (a) Mutual conductance curves for KT63 valves alone (strapped as triodes), (b) mutual conductance curves for matched valve-resistor combinations. (x points for one valve or combination, ● points for other valve or combination.) The matching resistances were calculated using valve parameters for  $V_a = 160V$  and  $V_g = -6V$ .

anode current the effects of voltage drops and shunt currents contributed by the added resistors. By so doing, one finds that a further condition has to be satisfied if d.c. equivalence of the valve-resistance combinations is to accompany a.c. equivalence. This condition, which is derived in the appendix, is independent of the added resistances, and can be simply expressed in terms of the valve mutual conductances or amplification factors. Therefore the possibility of obtaining similar d.c. characteristics for a.c. matched combinations depends only upon the characteristics of the valves themselves, and nothing can be done about it by adding resistances. A limited series of experiments with triode valves of like kind has shown, however, that matching of a.c. characteristics may in practice be accompanied by reasonable matching of overall d.c. characteristics. The latter effect is of importance as it affords a means of finding easily the resistances required. The circuit used is that of Fig. 5.

It is assumed at the outset that the valve-resistance combinations, when matched, will behave identically for both a.c. and d.c. Any single mutual characteristic curve of a combination will be defined by the effective anode current corresponding to a particular grid voltage, and by the slope of the characteristic (i.e. by the mutual conductance). Then any two combinations are matched if they have the same mutual conductance and the same standing current for given grid and h.t. voltages.

The resistances  $R_L$  of Fig. 5 are equal and of the order of 100 to 500 ohms.  $R_1$ ,  $R_2$ ,  $R_3$  and  $R_4$  are calibrated carbon track or wirewound variable resistors, and  $R_5$  is included to protect the milliammeter. The input alternating voltage is obtained from an audio frequency source. Because low values of  $R_L$  are used, the alternating voltage across each one of them will be proportional to the  $g_m$  of the valve-resistance combination feeding it. Equality of alternating voltage across each  $R_L$ , and thus equality of the mutual conductances of the combinations, is achieved by adjusting  $R_1$  or  $R_3$  until the sound in the headphones is a minimum. To keep the mutual conductance of the combinations as high as possible, either  $R_1$  or  $R_3$  should be zero. After being appropriately switched in,  $R_3$  or  $R_4$  is adjusted until the milliammeter reads zero. Slight readjustment of  $R_1$  or  $R_3$  may

now be required. When both a.c. and d.c. nulls are obtained, the calibrations of the four resistors give the resistances required to produce matched combinations for the particular h.t. and grid bias voltages obtaining.

Fig. 6 shows the matching achieved between the two sections of a 6SN7 double triode, using the above experimental method. The results of Figs. 7 and 8 were obtained by calculation from the equations of Fig. 4, the valves being KT63s strapped as triodes. It can be seen from Fig. 8(b) how nearly coincidence of d.c. characteristics has followed the a.c. matching. For Figs. 9 and 10 calculated values of resistance were again used, but with valves of more widely differing characteristics.

It is of interest that the valve-resistor combinations

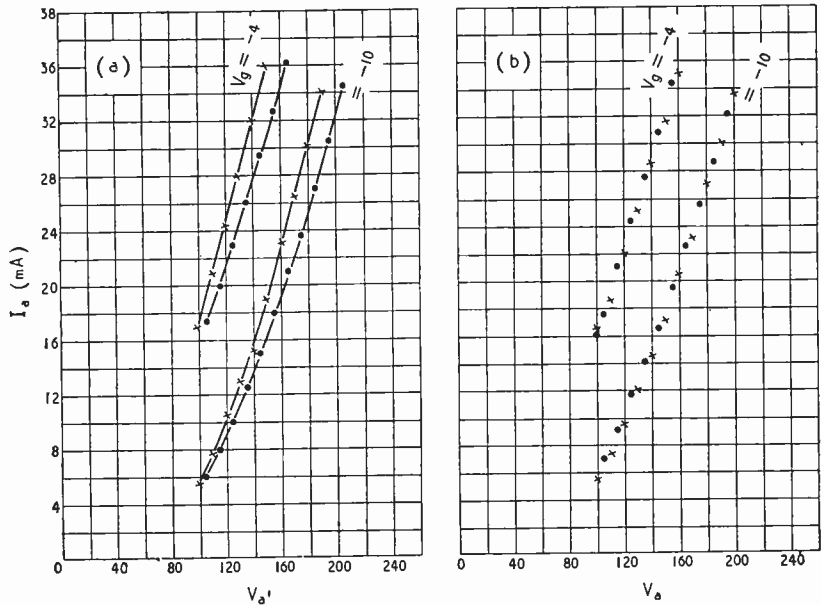


Fig. 8. (a) Anode characteristics of KT63 valves alone (strapped as triodes), (b) "anode" characteristics of matched valve-resistor combinations. (x points for one valve combination, ● points for other valve or combination.) The matching resistances were calculated using valve parameters for  $V_a = 160V$  and  $V_g = -6V$ .

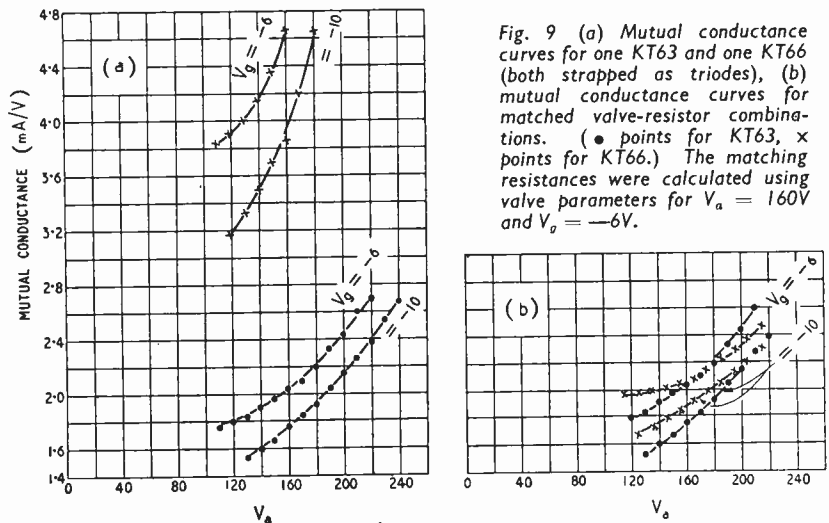


Fig. 9 (a) Mutual conductance curves for one KT63 and one KT66 (both strapped as triodes), (b) mutual conductance curves for matched valve-resistor combinations. (● points for KT63, x points for KT66.) The matching resistances were calculated using valve parameters for  $V_a = 160V$  and  $V_g = -6V$ .

Fig. 10 (a) Anode characteristics of KT63 and KT66 valves alone (both strapped as triodes), (b) anode characteristics of matched valve-resistor combinations. (● points for KT63, x points for KT66.) The matching resistances were calculated using valve parameters for  $V_a = 160V$  and  $V_g = -6V$ .

were reasonably matched, even though the parameters of the valves themselves were not constant over the range of operating voltages.

The results presented are for triode valves. In elementary analysis, pentodes are looked upon as constant current devices. To modify the characteristics of a pentode, a rather large resistance might be needed if connected between the anode of the valve and the load, whereas the desired result may better be achieved with an un-bypassed cathode resistor. This, of course, constitutes negative feedback.

**APPENDIX**

*Analysis of D.C. Conditions*

**Case 1.**—The equation of the more linear regions of the anode characteristic curve of a valve is closely approximated by

$$I_a = \frac{1}{r_a} (V_a + \mu V_g) + k \quad \dots \quad (i)$$

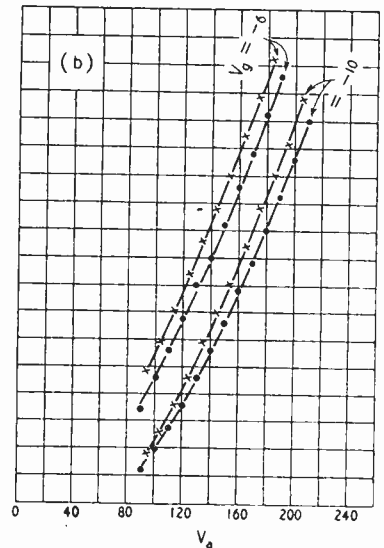
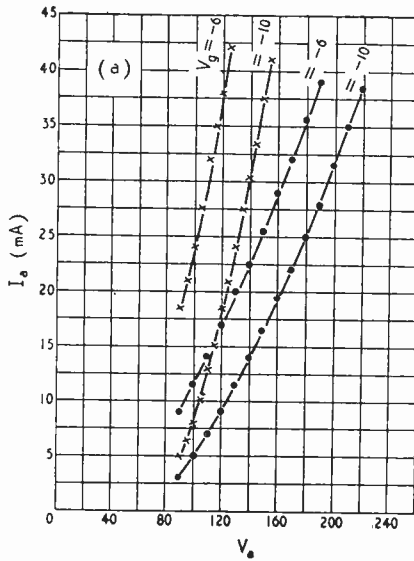
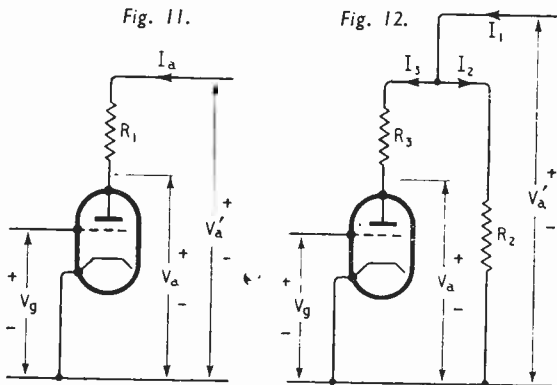
where  $I_a$  is the anode current,  $r_a$  and  $\mu$  the valve impedance and amplification factor respectively, and the constant  $k$  is the intercept on the  $I_a$  axis of the tangent to the anode characteristic for zero  $V_g$ . This constant,  $k$ , may be thought of as an additional valve parameter which must be considered when d.c. matching is desired.

Hence for Fig. 11 we may write

$$I_a = \frac{1}{r_{a1}} (V_a + \mu_1 V_g) + k_1 \quad \dots \quad (ii)$$

where the subscript  $_1$  indicates that the parameters apply to the particular valve in Fig. 11.

$$\text{Also } V_a = V_1' - I_a R_1 \quad \dots \quad (iii)$$



From (ii) and (iii)

$$I_a = \left( \frac{1}{r_{a1} (1 + R_1/r_{a1})} \right) (V_a' + \mu_1 V_g) + \frac{k_1}{(1 + R_1/r_{a1})} \quad (iv)$$

Comparison of the valve parameters of (i) with those of the valve-resistance combination in (iv) gives the same results as were derived earlier from purely a.c. considerations; see Fig. 4, column 2.

**Case 2.**—The effective parameters, including the effective value of  $k$ , may also be derived for the valve-resistance combination of Fig. 12. Using the suffix  $_2$  to denote the parameters of the valve alone, we have by comparison with equation (iv)

$$I_3 = \left( \frac{1}{r_{a2} (1 + R_3/r_{a2})} \right) (V_a' + \mu_2 V_g) + \frac{k_2}{(1 + R_3/r_{a2})} \quad (v)$$

$$\text{Also } I_2 = V_a'/R_2, \text{ and } I_1 = I_2 + I_3 \quad \dots \quad (vi)$$

Hence, from (v) and (vi)

$$I_1 = \left( \frac{1 + r_{a2}/R_2 + R_3/R_2}{r_{a2} (1 + R_3/r_{a2})} \right) (V_a' + \left( \frac{\mu_2}{1 + r_{a2}/R_2 + R_3/R_2} \right) V_g) + \frac{k_2}{(1 + R_3/r_{a2})} \quad \dots \quad (vii)$$

Comparison of (i) and (vii) shows the results of Fig. 4, column 4. For complete equivalence of the circuits of Figs. 11 and 12, equations (iv) and (vii) must have identical coefficients of current, of  $V_a'$ , and identical constant terms. Over and above the conditions for a.c. equivalence, the equations show that there is a further condition to be satisfied for d.c. equivalence, viz.:

$$\frac{k_1}{(1 + R_1/r_{a1})} = \frac{k_2}{(1 + R_3/r_{a2})} \quad \dots \quad (viii)$$

But, for equal mutual conductances of the combinations,

$$\frac{g_{m1}}{(1 + R_1/r_{a1})} = \frac{g_{m2}}{(1 + R_3/r_{a2})} \quad \dots \quad (ix)$$

whence, from (viii) and (ix) the additional requirement for d.c. matching is

$$\frac{k_1}{k_2} = \frac{g_{m1}}{g_{m2}} \dots \dots \dots (x)$$

which depends on the valves alone

The condition can also be expressed in the more illuminating form

$$\frac{\mu_1}{\mu_2} = \frac{X_1}{X_2} \dots \dots \dots (xi)$$

where  $X_2$  is the intercept on the  $V_a$  axis of the tangent to the anode characteristic (for a given  $V_g$ ) of the valve with the amplification factor  $\mu_2$ , and  $X_1$  is the corresponding intercept for the other valve.

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- <sup>2</sup> "Design of Cathode Coupled Amplifiers," S. G. F. Ross; *Wireless Engineer*, July 1950, p. 212.
- <sup>3</sup> "Simple Valve Voltmeter," S. W. Amos; *Wireless World*, Dec. 1950, p. 431.
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## BOOKS RECEIVED

**Dielectric Aerials**, by D. G. Kiely, M.Sc., A.M.I.E.E., A.Inst.P.—Critical review of existing methods and theory; design data and a 29-item bibliography. Pp. 129; Figs. 48. Price 8s 6d. Methuen and Company, 36, Essex Street, London, W.C.2.

**Atmospheric Electricity**, by B. F. J. Schonland, F.R.S.—Revised edition of a monograph dealing with the origin of atmospheric ionization, the electrification of thunderclouds and the lightning discharge. Pp. 95; Figs. 20. Price 7s 6d. Methuen and Company, 36, Essex Street, London, W.C.2.

**Principles of Electronics**, by H. Buckingham, Ph.D., M.Sc., A.M.I.E.E., and E. M. Price, M.Sc.(Tech.).—Introduction to the study of electrons in a vacuum or in low-pressure gases, and their application in valves, photocells and gas-filled devices. Pp. 335; Figs. 266. Price 15s. Cleaver Hume Press, 42a, South Audley Street, London, W.1.

**Einführung in die Vierpoltheorie der Electrischen Nachrichtentechnik**, by Richard Feltkeller.—Sixth edition of a mathematic treatise on four-pole networks used in telecommunications. Pp. 186; Figs. 102. S. Hirzel Verlag, Birkenwaldstr 185, Stuttgart.

**Permanent Effect of Water on Varnished Coils**, by H. R. Heap, B.Sc.—Electrical Research Association Report A/T138. Pp. 15; Figs. 7. Price 7s 6d. The British Electrical and Allied Industries Association, Thorncroft Manor, Dorking Road, Leatherhead, Surrey.

**Radio and TV Test Instruments**.—Collection of articles on test instruments for home construction. Pp. 128; Figs. 91. Price \$1.50. Gernsback Publications, 25, West Broadway, New York 7.

**High Fidelity**.—Reprint of articles from *Radio-Electronics* on the design, construction and measurement of high-quality audio equipment. Pp. 128; Figs. 106. Price \$1.50. Gernsback Publications, 25, West Broadway, New York 7.

**Television and Radio Repairing**, by John Markus.—Written to train a complete beginner in the art of servicing, with special reference to American requirements. Pp. 556; Figs. 208. Price 48s. McGraw-Hill Publishing Company, 95, Farringdon Street, London, E.C.4.

# "Cellular" Circuits

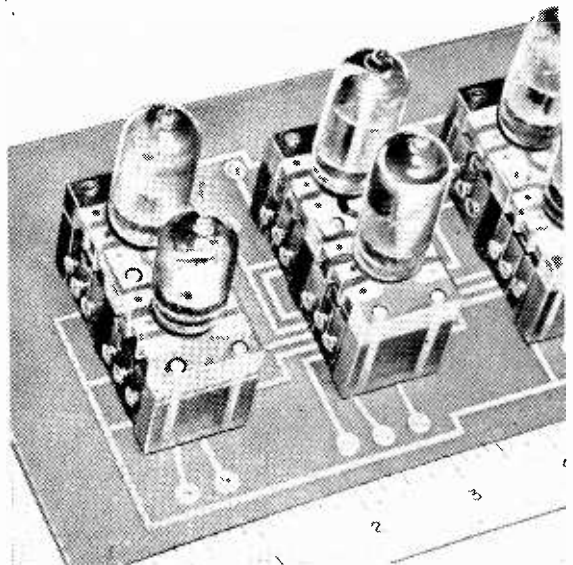
## *Solderless Assembly Method Using Small Replaceable Units and Printed Circuitry*

By MICHAEL LORANT

**PRINTED** circuits, in which conducting patterns etched on plastics take the place of conventional wiring, have come into fairly wide use. For the problem of connecting components and valves to the printed sheets several solutions have been offered. However, the diversity of these solutions and their inability to gain widespread acceptance indicates that the right answer has not yet been found.

In a novel approach to the problem made by the U.S. National Bureau of Standards, small three-contact moulded blocks or cells, each containing one or two circuit elements—resistors, capacitors, inductors, are pressed against the etched circuit pattern by means of springs that are extensions of the valve socket contacts. No soldering is needed. The individual moulded cells are about  $\frac{5}{16}$ in high by  $\frac{1}{8}$ in wide by  $\frac{1}{16}$ in thick. Each has three contacts, one on the top and two on the bottom. The cells are grouped together in "building blocks," each comprising two valves and twelve cells held in a compact bundle by means of a suitable frame. The top surface of the block consists of a spring assembly containing the valve sockets and the necessary spring contacts. When the block is fastened to the printed base-plate by means of screws, springs in the spring assembly apply substantial pressure to the top terminal of each cell and hold the two

*Part of a working circuit using the experimental cellular assembly technique. Each cell is fitted with a small knob and the blocks are spaced far enough apart to allow the cells to be withdrawn.*



bottom terminals firmly in contact with the printed circuit pattern. Positive and noise-free electrical connection is further assured by the application of a thin film of grease to the cell contacts.

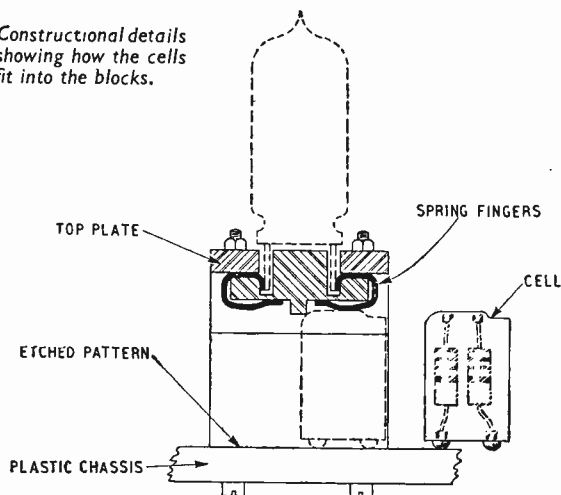
The two-valve block is considered an optimum-sized sub-assembly in the new system. Any number of the blocks can be mounted on a suitably printed base-plate of sufficient area. Potentially inexpensive, they are compact (about  $2\frac{1}{4}$  in  $\times$  1 in  $\times$   $1\frac{1}{8}$  in, not including the valves) and are easy to store and to handle. They are extremely rugged, and as long as a block is secured to the base-plate none of the cells can vibrate or shake loose.

A noteworthy feature of the technique is that it enables both blocks and cells to be replaced quickly without the use of plugs or connectors. If conventional plug-in assemblies were made as small as these blocks the plugs would add substantially to both size and cost. The elimination of both soldering labour and multiple connectors results in a double saving.

In case of trouble, an entire block can be easily removed for repair or replacement, simply by loosening the screws that hold it to the base-plate. Either on the spot or after return to the factory or servicing department, defective blocks can be quickly repaired by replacing faulty cells. Each cell is identified by suitable markings.

An important aspect of the use of three-terminal cells in the new technique is the fact that positive pressure can be maintained at three points, and only three points, by a single spring. Fortunately, in the great majority of electronic circuits no more than two circuit elements need be connected electrically to a single valve electrode. A three-terminal cell, therefore, besides being easy to hold under firm spring pressure, will in general provide enough electrical contacts for the elements associated with any valve

Constructional details showing how the cells fit into the blocks.



pin. Exceptional cases can be taken care of in the new system by providing for a spare cell not connected to the valve pins. It is also possible to provide for three-terminal cells of double or triple the standard thickness to accommodate occasional oversized elements.

An experimental nine-valve cellular circuit already constructed at the Bureau appears to confirm the practical possibilities of this type of construction. For convenience, the limited number of cells needed were formed at room temperature using a casting resin, although this is not the best material. For quantity production, cells could be moulded in phenolic by the process now in wide use for making resistors and capacitors. The components would be spot welded together and to the terminal tabs before moulding.

## B.B.C. TELEVISION EFFECTS

SOME interesting electronic methods of combining pictures are now being used by the B.B.C. in some of their television programmes. In one, known as "inlay," the picture from one camera is replaced over a chosen fixed area by the picture from another camera—the effect being rather like an inset magazine photograph. The changing from one camera to another is done by an electronic switch. This is controlled by the output of a flying-spot scanner, synchronized with the cameras, which scans a mask cut to the required shape for the inset picture. Thus when the flying spot comes out from behind the mask, light falls on the photocell and the electronic switch selects the main camera output; when it goes back behind the mask the light is cut off and the switch selects the output of the "inset" camera.

In the other method, called "overlay," the actors are seen moving against a background which is actually being generated by another camera or a film scanner. It achieves electronically the same effect as the familiar back-projection technique, but without all the cumbersome film apparatus that is normally needed. Simple addition of the two pictures would, of course, give a "ghost" effect, so parts of the background picture have to be removed to make room for the foreground picture.

This is again done by electronic switching between the two cameras, but instead of a mask to control the switch the apparatus uses a "silhouette" signal corresponding to

the outline of the foreground picture. To obtain this, the foreground subject, say an actor, is televised in front of a plain black background, and the resulting camera waveform is clipped top and bottom to produce a square pulse. When the pulse is "on" it causes the electronic switch to select the picture from the foreground camera and when it is "off" the picture from the background camera. Thus, wherever the foreground subject moves it is always fitted neatly into a suitably shaped hole in the background.

### "Television Engineering"

THIS is the title of a new textbook primarily intended for the B.B.C.'s operation and maintenance staff. The first volume, with the subtitle "Principles and Practice," written by S. W. Amos, B.Sc.(Hons.), A.M.I.E.E., and D. C. Birkinshaw, M.B.E., M.A., M.I.E.E., in collaboration with J. L. Bliss, A.M.I.E.E. (all of the B.B.C.), has just been issued by our publishers for *Wireless World* by arrangement with the B.B.C.

The first volume is divided into three parts: fundamentals; camera tubes; television and electron optics. Treatment is non-mathematical, except in the appendices. The book runs to 300 pages, with 188 illustrations. Price is 30s. (postage 8d).

# Flywheel Synchronization

Some Further Notes

By B. T. GILLING

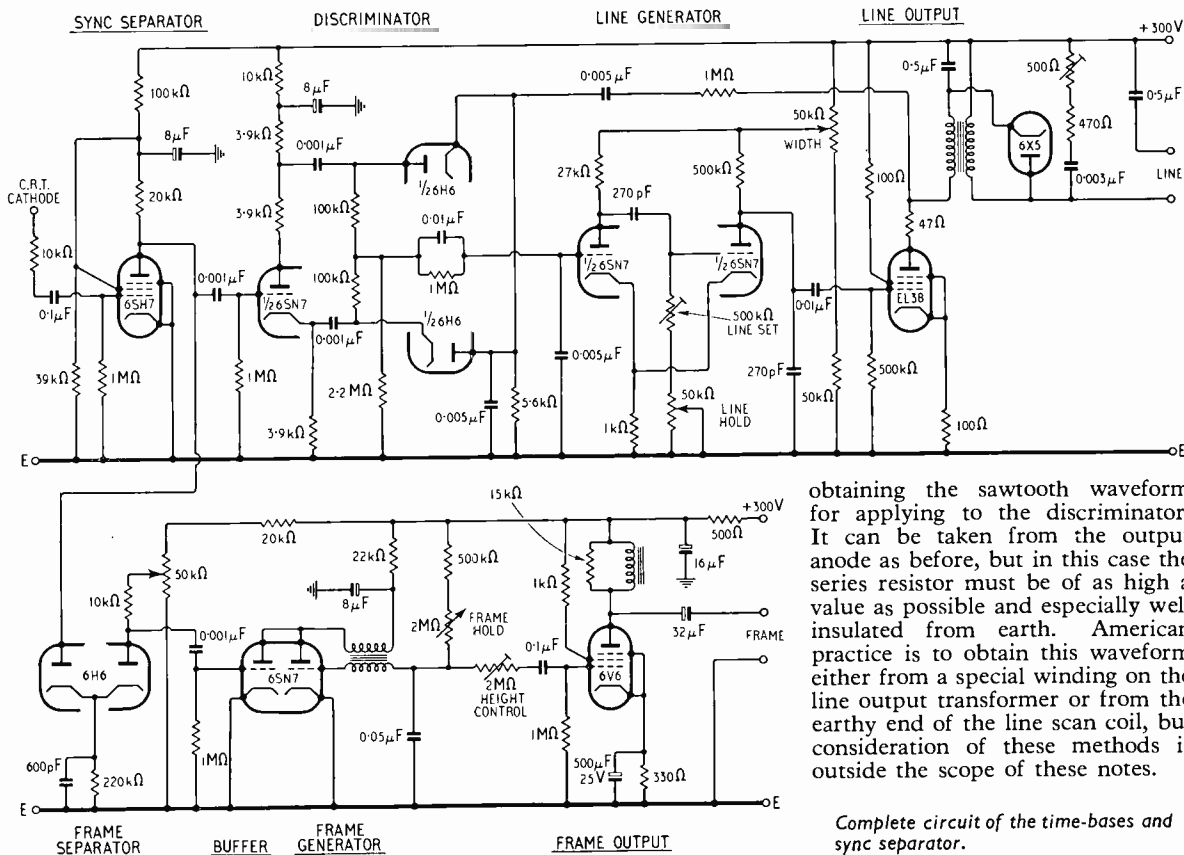
SINCE writing the original article (*Wireless World*, March 1953, p. 137) the writer has installed a multivibrator time-base in his receiver and he feels that the changes desirable when using this form of sawtooth generator are worth description. The complete circuit, from sync separator to line and frame output, used by the writer, is shown in Fig. 1. This circuit gives really steady verticals and frame interlace of a very high order. The frame separator is one of those described by G. N. Patchett (*Wireless World*, August 1952, p. 317, Fig. 19) and this article should be consulted. In the writer's set no correction for frame linearity proved necessary, but usually some is needed.

Turning to the line circuit, it will be seen when compared with the original diagram (Fig. 5, March 1953) that the d.c. amplifier is no longer used, control being taken directly from the discriminator to the first valve of the multivibrator. Also there is a 2.2-M $\Omega$  resistor connected from the junction of R<sub>6</sub>, R<sub>7</sub>, Fig. 5,

to earth. This forms the grid return of the first controlled valve to earth and was inadvertently omitted from that diagram. The pre-set 0.5-M $\Omega$  resistor in the grid of the second valve of the multivibrator in the new circuit is there to ascertain the total value. When this is found, it can be replaced by a fixed resistor, the 50-k $\Omega$  variable resistor then becoming the only line control. In the line output a conventional boost diode is employed enabling this stage to deliver a more than adequate output to cover a 12-inch tube working at 9 kV e.h.t.

The components in the output stages are all by Haynes Radio and are as follows: Scanning coils, S.112, line output transformer, TW5/109, frame output choke, LUS8F.

Apart from the output stages the circuit can be used in conjunction with wide-angle deflection and fly-back e.h.t. Several manufacturers supply components and suggested circuits for this, but when using them very special attention must be paid to the method of



obtaining the sawtooth waveform for applying to the discriminator. It can be taken from the output anode as before, but in this case the series resistor must be of as high a value as possible and especially well insulated from earth. American practice is to obtain this waveform either from a special winding on the line output transformer or from the earthy end of the line scan coil, but consideration of these methods is outside the scope of these notes.

Complete circuit of the time-bases and sync separator.

# Acoustic Response Curves

## Measurement Based on Subjective Equal Loudness Contours

By E. W. ROGERS,\* A.M.I.E.E.

**T**HE following notes are a by-product of the development of a pair of high-fidelity earphones which the writer undertook, partly for personal use and partly for monitoring purposes in a sound rediffusion network.

The resulting 'phones were based on metallic ribbon<sup>1</sup> and the opinion of a number of colleagues, based on listening tests of live and recorded material, was that the reproduction was natural, with the exception of a slight heaviness on the very low frequencies. Methods of calibrating the response were considered. As an artificial ear was not available, experiments were made to see if the Fletcher and Munson<sup>2</sup> calibration of the standard ear could be used.

The threshold-of-hearing response curve seemed a promising basis. Tests showed that a simple set-up of apparatus, Fig. 1, was sufficient.

A room was selected in the Redifon laboratories, the apparatus installed, and 18 people, over a period of some weeks, were persuaded to conduct the experiment and record their results. It was found early on, that to obtain repeatable results, the room noise had to be reasonably consistent, and all measurements were made during the factory normal mid-day shut down period. After some practice, nearly all the people making the tests were able to determine the level at which the sound of the input frequency became inaudible with a repeatable accuracy of  $\pm 2$ db over most of the range. An input level could be determined which, if increased by 2db, provided a definite sensation of sound in the ear; or, if reduced by 2db, was definitely undetectable. Slightly wobbling the frequency dial of the oscillator was a help. The measurements were tabulated from the attenuator setting required to reduce the signal to be inaudible at the prevailing room noise level, with one volt fed from the oscillator over the range 30 to 15,000c/s. The operators were particularly requested to search out peaks and dips, and to record the extremes.

The results were collected and prepared in graphical form. From the start, it was obvious that all had a general shape, roughly the inverse of the Fletcher and Munson curve, but some wider variations in detail were noted. Any curves with obvious freak dips or peaks were eliminated, and 12 of the original 18 were left which fell between two lines, deviating by about 10db. An average between these was calculated and drawn (Fig. 2).

The next step was to add the resulting curve to

the threshold of hearing, to obtain calibration of the earphones. An immediate difficulty arose. The background noise was definitely not below the threshold of hearing, as was obvious when making the tests. This subject is dealt with later in more detail. The Fletcher and Munson curves (Fig. 3) show the ear to be less sensitive to changes of intensity at low frequencies than to equivalent changes at middle and high frequencies. If, then, the noise level had an actual value of 30db, in other words, an artificial threshold of hearing of 30db at 1,000c/s, and the ear response curve for 0db were used, the resultant level plotted at 50c/s would be in error by 17db.

A calibrated microphone and amplifier were coupled to a frequency-selective amplifier (harmonic analyser) and the noise level measured over a range of frequencies. This indicated a much higher back-

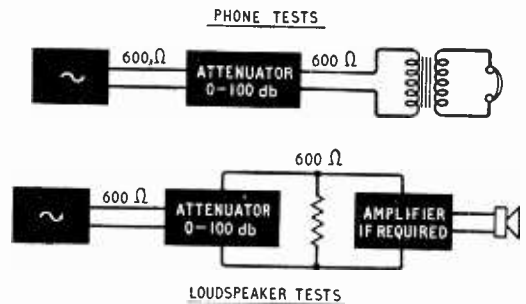


Fig. 1. The apparatus required is simple, both for testing earphones and loudspeakers.

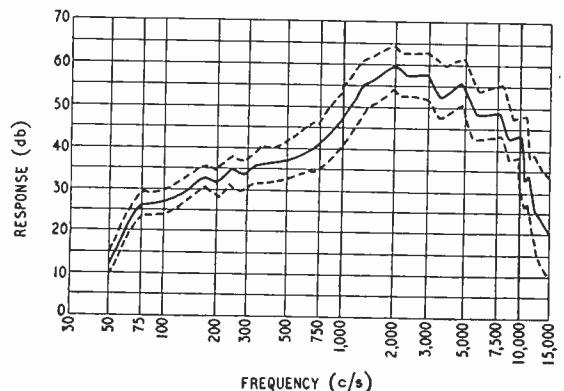


Fig. 2. Response (uncorrected) from attenuator settings for threshold level at different frequencies.

\* Redifon, Ltd.

<sup>1</sup> British Patent Specification 604908.

<sup>2</sup> Fletcher and Munson, *J.A.S. Amer.*, October 1933, page 82.



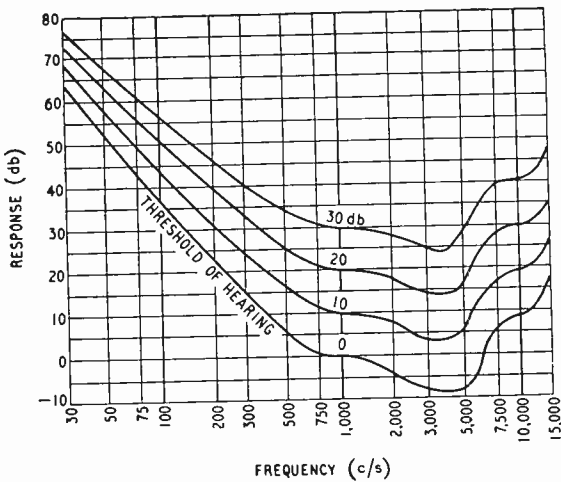


Fig. 3. Contours of equal loudness for normal ears (after Fletcher and Munson).  $0\text{db} = 0.00104 \text{ dyne/cm}^2$ .

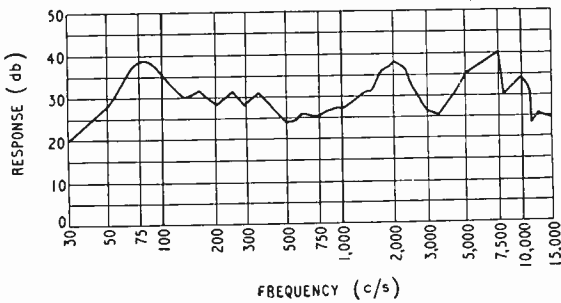


Fig. 4. Curve of Fig. 2 corrected by the 30db loudness contour, chosen as the equivalent noise threshold.

ground level than was expected, but it was found difficult to arrive at any actual figures for the results obtained, due to the rapid fluctuations which occurred at any particular frequency and to the random nature of the noise. A simple filter circuit was prepared, which gave a response, from 2,000c/s to 50c/s, roughly the inverse of the 30db ear constant-level curve, and level above those frequencies, the tests having shown that the noise components were concentrated in the lower band.

A high-gain amplifier was calibrated with the filter and the noise band measured in free air. Results showed a figure of 35 to 45db over a number of days, at mid-day. 40db was a somewhat startling figure for a room considered to be quiet. The next step was to ascertain the noise level at the ears, when covered by 'phones. This was established rather crudely by using the 'phones as a microphone in place of the calibrated microphone, and noting the difference of reading of the output when the 'phones were in free air and when worn on the head. The latter showed a reduction of 10db, approximately, giving a noise level of 30db for the tests. This curve was chosen from the equal-loudness curves, the average response added to it, and the resultant curve for the headphones was as shown in Fig. 4. The db scale has an arbitrary level.

At this stage, the 'phones were sent to the N.P.L. for calibration, the results are shown in comparison, in Fig. 5. The N.P.L. stated the curve gave results

which would apply equally well to the human ear up to 3,000c/s, but above that frequency, wider deviations could occur. They were unable, at the time, to extend the measurements above 8,000c/s.

The marked difference between the level of the two curves above 5,000c/s called for a careful re-check of all the measurements and calculations already made, but without changes. As, in effect, the N.P.L. were not warranting the figures above 3,000c/s, it was felt that the Redifon response curve could be substantially correct, but remained unproved. There is no evidence of the N.P.L. apparent cut off at 7,000c/s when swinging an audio oscillator around this frequency at any input level. As the N.P.L. curve actually calibrated the output in sound pressure units, against an input level to the primary of the 600-ohm transformer, it was a simple matter to calculate back to the actual sound level called the threshold of hearing in the original tests. This showed a level of 27db above the threshold of hearing which agreed quite well with the direct noise measurements.

The writer has re-checked the response curve with earphones (or his own hearing response) half-a-dozen times since the original calibration, with results between 30 and 9,000c/s within  $\pm 2\text{db}$  except for narrow-width deviation of larger amplitude. Above 9kc/s, advancing years have taken their toll, and the cut off frequency had dropped from  $15\frac{1}{2}$  to  $14\frac{1}{2}$ kc/s, and the level at 13kc/s has apparently dropped by 10db in 10 years. The tests have shown the importance of maintaining the same level of background noise, or alternatively, of knowing the value of this level, and using the correct curve. It has been found that a cold in the head can have a devastating effect on the high-frequency response of the ear. With heavy catarrh a 40db dip at 9,000c/s has been observed.

Some years later, the writer applied the same method in an attempt to calibrate loudspeakers, in various enclosures, in an ordinary lounge room in the domestic scene. The bugbear of measurements is standing waves at the lower frequencies, which make an ordinary response curve look like a distorted comb; also, the complexity of the gear required puts measurements beyond the facilities of the average radio enthusiast.

A few experiments indicated that standing waves apparently ceased to give trouble as the intensity of sound dropped towards the threshold of hearing. At 100c/s for example, measurements could be taken at 8ft from the loudspeaker in a room of floor space  $25\text{ft} \times 12\text{ft}$ , and be within  $\pm 3\text{db}$  with the head at different angles to the axis of the speaker, and with

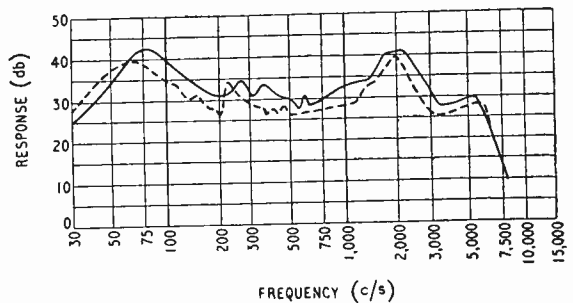


Fig. 5. Curves of two Redifon "foil" earphones, obtained by measurement of sound pressure output.  $20\text{db} = 1 \text{ dyne/cm}^2$ .

check measurements made over a number of days.

The possible explanation is that reflected sound, being of lower amplitude than direct sound, will reach the ear at a level below the threshold of hearing. It was found that measurements were less simple than when calibrating headphones, probably due to the attenuation of higher-frequency external noises by 'phones. Any noise of a non-steady character such as, the rustling of a newspaper, crackling of a fire, etc., had a completely demoralizing effect when exploring the lower registers. A steady noise, such as the mechanical vibration of a mains transformer, was not disturbing. It was, therefore, essential to have a room to oneself late at night, when traffic noises were at a minimum. Noise measurements in the writer's home in a rural area, showed figures varying between 25 and 30db under these conditions, and the 30db equal loudness contour was chosen.

First tests showed considerable inconsistencies in measurements above 6,000c/s which were puzzling until it was found the audio transformers in the amplifier and oscillator used, radiated energy in an erratic form at frequencies above 6,000c/s. This effect was eliminated by covering the offending apparatus with blankets. Fig 6 shows the response of two well-known loudspeakers of a 12in type, mounted in an 8 cu ft vented cabinet; Fig 7 shows the response of a small 3in loudspeaker mounted in a 1-cu ft box.

Points to be watched when making tests are:—

1. A reasonably constant noise level is essential. This means either local traffic noises must be excluded or tests to be made during the night hours.
2. It is probable that the noise level will have to be about 30db maximum to give reasonable results. Noise levels higher than 30db are unlikely to be con-

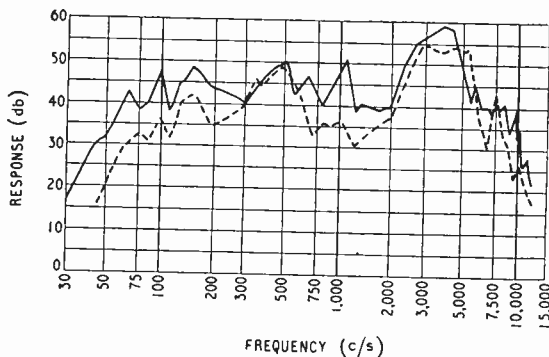


Fig. 6. Response curves of two 12in loudspeakers in 8 cu. ft vented cabinets. Microphone distant 8ft on axis.

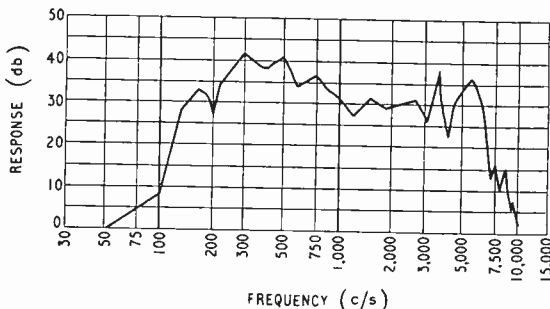


Fig. 7. Response curve of 3in loudspeaker in small vented box mounted on wall. Microphone 15 deg off axis, distant 6ft.

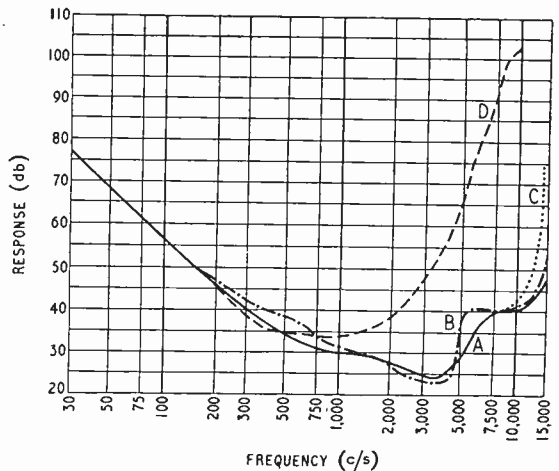


Fig. 8. Equal-loudness contour, 30db level. A, average normal ear; B, author's ears 1943; C, author's ears 1953; D, example of person with high-frequency deafness.

stant enough for repeatable results to be obtained. In rural areas, noise levels of 20db or less may be obtainable. As a guide, at a room noise level of 20db, a train five miles away can be distinctly heard through an open window, and the mechanical hum noises of a radio set would probably be audible at all parts of the room. It is probably safe to take the 30db noise level characteristic for the ear, unless the operator is confident he has exceptionally quiet conditions, when the 20db curve can be used.

3. Measurements should be taken as far away from walls and large objects as possible, preferably towards the centre of the room.

These precautions taken, it should be possible to compare differences between various loudspeakers and enclosure cabinets, etc., by assuming the average ear characteristics apply to the operator. Should means be available for checking these characteristics, then naturally the modified curve would be used. Great differences from the average can occur, as shown in Fig. 8.

Another method of approximating characteristics of the operator's ears is to repeat the experiment of a number of people (preferably under 30 years of age), measuring the response of a particular system and averaging the result, as described earlier.

If the particular characteristic of the ear can be estimated by one or other of these means, then it is the opinion of the writer that the overall performance of audio systems, under normal room conditions, can be ascertained with an accuracy at least equal to some other more complicated methods, between the frequencies of 30 and 11,000c/s. Much more investigation is required to confirm or disprove this opinion.

Probably, the easiest method of making measurements is to feed the variable-frequency oscillator via a calibrated attenuator into the pickup input terminals of the receiver or amplifier, the overall response of which can be determined in the usual way. It is obviously desirable that the hum level of the system should be lower than the prevailing noise level of the room at the distance at which the measurements are made from the loudspeaker.

In conclusion, the writer would point out that the opinions expressed are his own, and do not necessarily represent the views of Redifon, Ltd.

# Voltmeter Loading Again

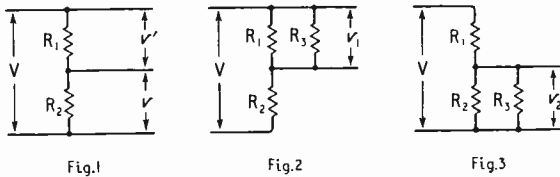
Measuring True Voltage With Only One Meter

By R. A. WIERSMA\*

IN the June issue the potentiometer method of measuring the true voltage in a high resistance circuit was described. This is, of course, the best method of measuring true voltage and can be recommended when measurements in high resistance circuits are carried out frequently. If possible the potentiometer should be fitted up in a permanent form, and perhaps combined with a diode to make it usable also as a peak reading a.c. voltmeter which will be accurate up to at least 50 Mc/s.

However, most people do not have sufficient use for such a device to justify making it up in a permanent form. When servicing or checking electronic apparatus, a large number of voltage checks may be made rapidly at various points in the circuit. Generally, the universal meter has sufficiently low consumption to measure all the voltages with the required accuracy. In cases of moderately high circuit resistance a higher voltage range on the meter is used. The lower consumption of the meter produces less disturbance of the voltage, but there is the disadvantage of having to read a small deflection. Occasionally the loading is too great even on, say, the 1,000-V range, or the deflection is too small to be useful, but it would take too long to find and connect up the necessary galvanometer and components for the potentiometer method. Nevertheless it is possible in many cases to deduce quickly the true voltage by using the universal meter only, in the following way.

Suppose we have two resistors  $R_1$ ,  $R_2$ , connected in series across a supply of  $V$  volts, as shown in Fig. 1,



and we wish to measure the voltage across  $R_2$ . The

true voltage is  $v = V \times \frac{R_2}{R_1 + R_2}$ .

The true voltage across  $R_1$  is  $v' = \frac{R_1}{R_1 + R_2}$ .

$$\text{Thus } \frac{v'}{v} = \frac{R_1}{R_2}.$$

Connect the voltmeter across  $R_1$  as shown in Fig. 2. Let the meter resistance be  $R_3$  on the range used.

The resistance of  $R_1$  and  $R_3$  in parallel is  $\frac{R_1 R_3}{R_1 + R_3}$ .

Thus the voltage across  $R_1$  and  $R_3$  in parallel, which is the voltage indicated on the meter, is

$$v_1 = V \times \frac{\frac{R_1 R_3}{R_1 + R_3}}{\frac{R_1 R_3}{R_1 + R_3} + R_2} = V \times \frac{R_1 R_3}{R_1 R_3 + R_1 R_2 + R_2 R_3}$$

Now connect the voltmeter across  $R_2$ , as shown in Fig. 3, using the same voltage range, so that the resistance of the meter is again  $R_3$ .

The voltage indicated on the meter is

$$v_2 = V \times \frac{\frac{R_2 R_3}{R_2 + R_3}}{\frac{R_2 R_3}{R_2 + R_3} + R_1} = V \times \frac{R_2 R_3}{R_2 R_3 + R_1 R_2 + R_1 R_3}$$

Examination of the expressions for  $v_1$  and  $v_2$  shows that the denominators are equal. Therefore  $\frac{v_1}{v_2} = \frac{R_1}{R_2}$  which is equal to  $\frac{v'}{v}$ .

That is, the ratio of the measured voltages is the same as the ratio of the true voltages, which exist when the meter is removed. From this we can obtain  $v$  as follows.

$$\frac{R_1}{R_2} + 1 = \frac{v_1}{v_2} + 1, \text{ or } \frac{R_1 + R_2}{R_2} = \frac{v_1 + v_2}{v_2}$$

$$\text{Hence } \frac{R_2}{R_1 + R_2} = \frac{v_2}{v_1 + v_2}$$

$$\text{and } v = V \times \frac{R_2}{R_1 + R_2} = V \times \frac{v_2}{v_1 + v_2}$$

So we must measure also the supply voltage  $V$ . This can be done on any suitable range of the meter. Actually, there is no need to memorize any formulæ, as the following simple example shows.

Reading across h.t. supply : 500V on 1,000-V range.  
Reading across upper resistor : 300V on 400-V range.  
Reading across lower resistor : 100V on 400-V range.

So the measured voltage across the upper resistor is three times the measured voltage across the lower resistor.

From the above theorem we deduce that, when the meter is disconnected, the voltage across the upper resistor will still be three times the voltage across the lower resistor, or the voltage across the lower resistor is  $\frac{1}{4}$  of the supply voltage, or 125 volts.

There are two limitations to the application of this

\* Wayne Kerr Laboratories.

method which must be borne in mind. First, the supply voltage  $V$  must be derived from a source of sufficiently low internal impedance, so that the connection of the meter in any of the three positions does not appreciably change the value of  $V$ . This can be assumed to be true when the total current drawn from the supply greatly exceeds the current drawn by the meter during the measurements.

Secondly, the analysis assumes a linear network, that is, one in which all the elements obey Ohm's law. This makes the method useless in certain valve circuits. For example, if  $R_1$  is the anode load of a

pentode, the d.c. anode resistance being represented by  $R_2$ , then since the anode current is almost independent of anode voltage,  $R_2$  in this case is extremely non-ohmic, and the method cannot be used. However, in the case of the screen grid of a pentode with a high resistance dropper, the voltage/current relation for the screen grid is roughly ohmic and the method should give a fair approximation to the true voltage.

The method is actually a simple application of Thévenin's theorem. Thus it is applicable to more elaborate networks than that described and can also be used on a.c.

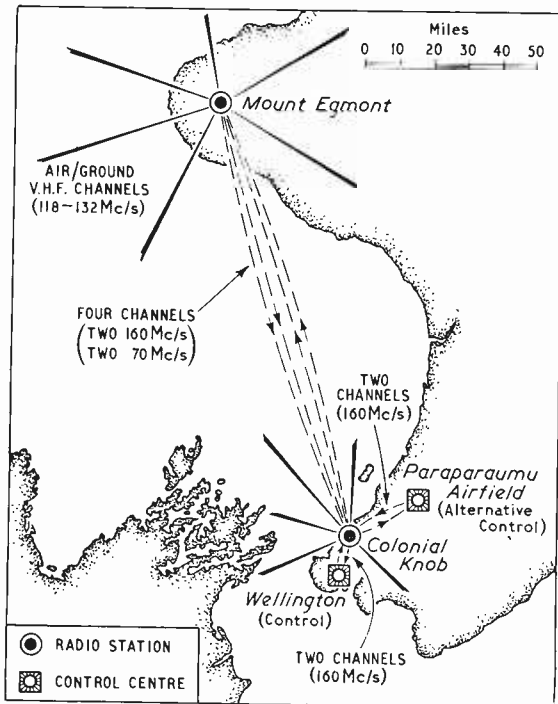
## Multi-Station Air-to-Ground Communications

### New Zealand V.H.F. Area Coverage Scheme Using Radio Links Throughout

**T**HE first stage of an extensive v.h.f. ground-to-air area coverage communications scheme will shortly be coming into full operation in New Zealand. Planned by the Civil Air Department it is operated entirely over radio channels with the control centred at Wellington and with transmitting and receiving stations at Colonial Knob, nine miles away, and at Mount Egmont, a further 132 miles distant.

An alternative control centre is to be set up at Paraparaumu airfield about 20 miles from Colonial Knob so that the final scheme will involve three two-way radio links, e.g., Wellington-Colonial Knob (9 miles), Colonial Knob-Paraparaumu (20 miles) and Colonial Knob-Mount Egmont (132 miles). The main radio centre of the system is thus at Colonial Knob.

Outline map showing the locations of the transmitting-receiving stations and the control centres



Each outgoing radio link carries six speech channels for modulating six v.h.f. ground-to-air transmitters, an engineers' speech channel and various audio tones for switching, monitoring and general control of the distant unattended stations. As the ground-to-air communication system is a simplex one requiring separate transmitting and receiving frequencies all radio-links are duplicated for the outgoing and incoming traffic and control channels. The tone circuits of the incoming links are used for remotely controlling and monitoring the receivers.

Each inter-station radio link is frequency modulated by a band of frequencies extending from 300 c/s to 30,000 c/s allocated as follows:—

300 to 3,000 c/s—engineer's speech circuit.

3,000 to 6,000 c/s—switching and supervisory tones.

6,000 to 30,000 c/s—six amplitude-modulated sub-carriers for ground-to-air (and vice-versa) traffic.

The suppressed-carrier single-sideband system is employed.

Since the lower sidebands only of each sub-carrier channel are used and mixed for transmission, speech is effectively scrambled and the secrecy of the system is therefore excellent.

For the inter-station radio links v.h.f. multiplex equipment designed jointly by Pye and Ericsson Telephones is employed.

Colonial Knob and Mount Egmont are at a good altitude (3,500ft and 1,500ft respectively) and so, despite the 132 miles separating these stations, the path is true line-of-sight. Transmitters of about 50 watts output and Yagi aerials having 10-db gain are expected to provide adequate and reliable signals in both directions without the help of intermediate relays.

Two radio channels in the 70-Mc/s and two in the 160-Mc/s bands are allotted for the main and stand-by equipments for this path and by operating in both bands simultaneously it is expected that some useful data will be accumulated in time on v.h.f. propagation over long distances. Ultimately the band giving the more consistent signals will be adopted permanently for the main service. As the remaining two links are comparatively short ones 10-watt transmitters operating in the 160-Mc/s band will be employed.

The six ground-to-air radio channels will be in the normal aircraft communications band of 118 to 132 Mc/s and will be amplitude modulated.

# Manufacturers' Products

NEW EQUIPMENT AND ACCESSORIES FOR RADIO AND ELECTRONICS

## E.H.T. Valveholder

A MINIATURE nine-pin (Noval) valveholder designed for use in television e.h.t. rectifier circuits where high voltages are encountered has been introduced by the McMurdo Instrument Co. Ltd., Victoria Works, Ashtead, Surrey. It is described as



McMurdo 25-kV e.h.t. Noval valve-holder.

the Type XM9/UV and consists of a nylon-loaded Bakelite socket moulded into a polystyrene sleeve designed to fit a chassis hole of the size used for a normal octal valveholder.

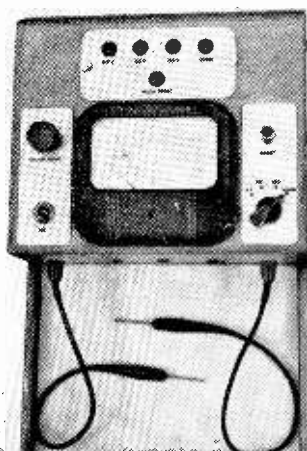
It is claimed that this valveholder will operate safely with a voltage difference of 25 kV between the holder contacts and chassis and it obviates the need for stand-off insulating pillars sometimes used for mounting e.h.t. rectifier valves.

## Battery Tester

A TEST set intended primarily for use in radio and electrical retail establishments handling h.t. and l.t. batteries, and which cannot be damaged by an overload however severe, has been introduced by Clive Courtenay and Company, 5, Horsham Road, Dorking, Surrey, and the price is £16 16s 0d.

Known as "Test Set Type A" it is a.c.-operated and provides three

Courtenay overload-protected counter voltmeter and test set.



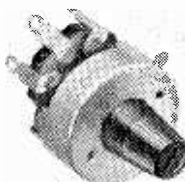
ranges for voltage measurements and one for resistance, the full-scale readings in each case being 2.5 V, 25 V, 150 V and 100,000Ω respectively. The voltmeter resistance is 200 Ωms/volts. The basis of the instrument is a 4½-in rectangular-faced moving-coil meter and this is flanked by a range-selection switch and an ohms adjuster, while above is a line of indicator lamps showing the range in use.

Electrical cut-outs disconnect the meter from the test circuit whenever a 50% overload occurs on any range and these operate about 10 times faster than the meter movement.

## Television Volume Control

A PRE-SET adaptation of the Model A carbon-track potentiometer produced by Morganite Resistors for use in television receivers is now available. As the illustration shows, the Type AP is fitted with a moulded "sugarloaf"-shaped insulated sleeve

Morganite Type AP pre-set volume control for television receivers.



over the spindle and this is designed for either finger or screwdriver adjustment. The volume control measures 1½ in diameter and is secured by two 6-BA screws.

General production is scheduled to commence on November 1st of all the popular resistance values. The makers are Morganite Resistors, Ltd., Bede Trading Estate, Jarrow, Co. Durham.

## Interference Suppressed Flashers

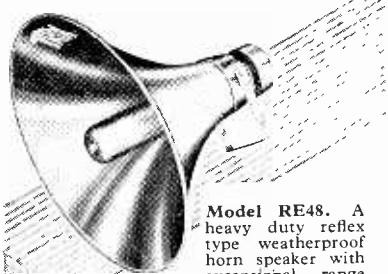
IN order to mitigate the nuisance of radio interference from flashing signs, the General Electric Company, Magnet House, Kingsway, London, W.C.2, in collaboration with the Post Office engineering department, has produced a lampholder adaptor flasher with a built-in suppressor. This has passed the relevant clause for interference suppression in BS800 covering the television bands of 40 to 70 Mc/s. It is also quite effective on the sound broadcast bands.

The price of this radio interference suppressed flasher is 14s and it is available for voltages of 100 to 260 and from 15 to 100 watts rating. A special version of the unit for use with Christmas and party decoration lamps is being developed.

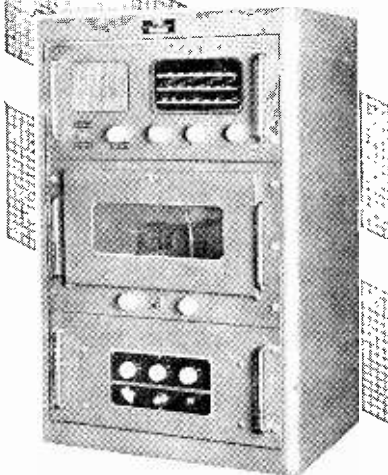
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# RANDOM RADIATIONS

By "DIALLIST"

## Business as Usual

WHEN THE DAVENTRY third programme station had to make a big reduction in its output power owing to aerial trouble I quite expected that reception in my home would become poor. It seemed more than likely that the lowered output would automatically put me well into the fringe area and that fading would become a nuisance. Nothing of the kind happened: the signal came in almost as strongly and quite as steadily as ever. Many people must have had much the same kind of experience, for I gather from a friend in the B.B.C.'s Engineering Department that there were surprisingly few complaints. A pretty good show, I feel, that the station's coverage should have been so well maintained while major repairs were in progress.

## Defining Electronics

ELECTRONICS HAS BECOME so enormous a subject that I doubt very much whether even *Wireless World* readers (who seem able to find most of the answers) will succeed in hitting on any concise definition which really covers it properly. R. A. Fairthorne's "study and application of sub-molecular phenomena as elements of control" in the September issue is surely over-wide; would it not include nucleonics and apparatus such as the synchro-cyclotron and the atomic pile? The same criticism applies to Henry Morgan's "anything electrical which I do not understand: how many radio or radar specialists, for example, would score good marks in an examination on the long-distance distribution of high power by grid systems? The best definition that I can think of is simply: Electronics is the branch of electricity mainly concerned with microamperes, microvolts and microseconds. Or, more briefly still, the "micro" branch of electricity.

## The Pity On't

ISN'T IT a queer and tragic thing that no sooner does science develop some new thing as a benefit for humanity than someone ups and says "by Jove, I can see a way of using that for killing people?" The in-

ventor of gunpowder thought of it only as a means of producing firework displays; but his fellows were quick to see how shortsighted this view was. It has been the same old story with the internal combustion engine, the aeroplane, the telephone and radio. Now it's to be the turn of that eminently peaceful development, television. It has been found, I read recently, that an airborne TV camera with a radio link can be used to direct artillery fire; the battery commander just watches a television screen, observes the bursts of his shells and orders appropriate corrections to the gunner. Simple; isn't it?

## Animal Radar

IT WAS ESTABLISHED some time ago that bats avoid obstacles by means of a kind of radar which uses sound pulses and sound waves. As he flies, the bat continually emits short, high-pitched squeaks. His eyesight is very poor but the returning echoes of his squeak pulses give him warning of anything in his way. How effective the system is was borne in on me when a bat came in through the open window as I sat writing these notes. Until I was able to shoo him out he flew at full

speed all the time, banking and swerving within an inch or two of walls, wires and so on, and never hitting anything. Birds which fly in flocks may execute those marvellous simultaneous turns with never a collision by using similar methods. Skeins of ducks and geese, for instance, keep up a continual clatter and most people must have heard the voices of a covey of partridges in flight. It has now been found that some fish which swim in dense shoals, especially those of the dim or dark deep waters, are not as dumb as they were thought to be. They, too, make high-pitched squeaking noises and it seems possible that they have their own type of marine radar.

## Dipoles and A.M.

A WHILE AGO, I mentioned that I could obtain excellent reception of the Wrotham f.m. transmissions with the simplest of indoor dipoles at a range of 50 miles, but that results on a.m. were not quite so good. One or two readers ask what I'm driving at: do I mean that dipoles aren't suitable for a.m. reception? Far from it; they're the right thing to use for any sort of modulation on the metre waves. The point is that with f.m. you get everything that's there, so long as your aerial brings in a signal of sufficient amplitude to work the limiter. My flex dipole on the picture rail of a ground floor room does this for f.m.; hence reception is fine. The amplitude of the f.m. signal does



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not vary, but remains constant. That of an a.m. signal is, by definition, continually varying, and on the indoor dipole parts of it fall below the minimum level required for proper reception. One of the big advantages of f.m. over a.m. is that a simple and inexpensive aerial suffices at considerably greater ranges.

### Soot and Whitewash

"FREE GRID" AND I have more than once had something to say about the average woman's inability to tune a broadcast receiver to anything like resonance. How often does one find a musical member of the fairer sex listening enraptured to a transmission from the Festival Hall and blissfully unconscious of horrid distortion due to mistuning? Still more surprising is their treatment of the contrast control of a television set. They turn it up and up until the screen image has the "soot-and-whitewash" appearance of a badly over-exposed photograph. Having diffidently offered to improve the picture, you show one such offender how to adjust for the maximum amount of detail. Her gratitude is mingled with flattering remarks about your cleverness. Thanks to you, she now knows exactly what to do. She may know what to do; but does she do it? Call a few days later and you are more likely than not to find her gazing contentedly at images sootier and more whitewashed, if possible, than those which you saw at first.

### All Sorts to Make a World!

Dear Sir,

In reference to your article in the July *Wireless World*, what earthly right have you to place upon the motorist the onus of spending money to improve your television entertainment? This interference is not due to any development in car engine design. This radiation, always present, is only apparent now as a nuisance because of the development of this "so-called" entertainment.

If 2,250,000 TV users want car owners to fit suppressors, let them provide the "couple of shillings" per car: we motorists will contribute the ten minutes to have them fitted.

Is it your theory that as the motorists already contribute so much to the national Exchequer, another couple of shillings will do them no harm? Or, perhaps, Mr. Diallist, you have shares in a company making the suppressors which your proposed legislation will make compulsory?

Yours truly, \_\_\_\_\_

# PILOT-LAMP HOLDERS

LARGEST RANGE IN  
THE WORLD



FROM the smallest Lilliput-Edison Screw size to the large Standard Edison Screw fitting, Bulgin Pilot-Lamp Holders cover every type of pilot lamp acceptance. Robustly manufactured from the finest materials and subjected to rigid tests, they are available with a wide choice of different fixing brackets, and include climatic-resisting grades. All made to relative British standards. The Largest Range in the World.

● L.E.S. Lilliput-Edison-Screw size for use in small instrument and portable equipments. (Available only without brackets. List No. L.E.S.22).

● M.E.S. Miniature-Edison-Screw size. Available with Rolled Shell or Spring Shell (M.S.S.) or with Moulded base for withstanding severe climatic conditions.

● M.S.T. Miniature-Single-Turn M.E.S. Another version of the M.E.S. type which accepts standard M.E.S.-cap lamp bulbs.

● M.B.C. Miniature-Bayonet-Cap (sometimes known as M.C.C. = Miniature-Centre-Contact). Designed with the usual range of fixing brackets, or without brackets, to accept M.B.C. (M.C.C.) Lamp-caps. A Tropical Moulded version of this is also available.

● C.E.S. Small-Candelabra-Edison-Screw. U.S.A. and Canadian Standard. The Socket size is intermediate between M.E.S. (E.10 of B.S.98) and S.E.S. (E.14 of B.S.98) and accepts lamps with small candelabra-cap.

● S.E.S. Small-Edison-Screw. Made to the usual high Bulgin specifications from the finest grade materials, with a wide range of bracket fixing arrangements.

● S.B.C. Small-Bayonet-Cap. Single or Double Contact. Suitable for Automobile Lamps and similar uses.

● E.S. Edison-Screw. Moulded or S.R.B.P. types available. Made to dimensions, fits and tolerances of B.S.98/E.27.

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# BULGIN

THE CHOICE OF CRITICS

MANUFACTURERS OF RADIO & ELECTRONIC COMPONENTS

A. F. BULGIN & CO. LTD., BYE-PASS RD., BARKING, ESSEX

Telephone: Rippleway 3474 (5 lines)

# UNBIASED

By FREE GRID

## The Mantle of Lord Roberts

DESPITE ALL THE TALK there has been of drastic measures to reduce the interference with sound broadcasting and television caused by the use of "unsilenced" electrical apparatus, the trouble is as bad as ever. Something will have to be done soon, however, not so much for the sake of allowing listeners and lookers to have interference-free enjoyment of broadcasting as in the national interest.

Now that information has been published about our guided missiles and the way in which they "home" on the quarry which they are chasing, I can refer freely to a grave menace to our national security which unsuppressed electrical interference is likely to cause in any future war.

It is quite simply explained. As most of you know it is possible for the radio operator of a plane to know when his craft is passing over or even near a large town, no matter how thick the fog or how well the town is blacked out, for he flies into a veritable cloud of electrical interference coming up from below. This elementary fact is no secret and I first referred to it in these columns many years ago.

The interference comes not only from the usual sources of which we think when it bedevils our enjoyment of broadcasting but also from the innumerable electric lighting switches which at any given moment are being operated in a large town. Now this is as well known to our potential enemies in Ruritania as it is to us, and after the marvellous accounts given recently of the deadly effect of our guided missiles on any marauding planes, the Ruritani-ans will waste no more money on constructing such out-of-date devices. Instead they will put all their resources into making guided rockets which will be steered in the general direction of our large towns and then left to "home" accurately on to the great clouds of electrical interference coming up from below.

"But," protest the Simple Simons in our midst, "could not we do the same to Strelsau and the other large cities of Ruritania?" Certainly we could, if the Ruritani-ans were such fools as to neglect to suppress every switch and every electric-bell make-and-break under their control. We ought to do likewise before it is too late and it should be made a treason-

able offence, equivalent to conveying information to the enemy, to omit to fit efficient suppressors to everything, including the thermostats in our electrically-heated bedsocks.

## Elec-Tick Clocks

MANY OF THE THINGS which people of to-day take for granted in the realm of radio and electronics were



A treasonable offence

originally suggested in the pages of this journal. The most notable instance of this sort of thing was s.w. broadcasting to the Empire, the idea of which was first put forward by the Editor of this journal. There are several minor instances of it, however, and one is recalled to my mind by the marketing, by a well-known firm, of a series of a.c. mains clocks which are provided with a homely synthetic tick.

I suggested this over twenty years ago when synchronous clocks were still something of a novelty. The reason was that I never could stand the creepy-crawly silence of mains-driven clocks and said so at the time. Now at last after all these years a manufacturer has satisfied my wants and, indeed, has gone one better than my suggestion, inasmuch as a knob is provided for cutting out the tick when you've had enough of it. The manufacturer has not, however, named his product an elec-tick clock as I did; doubtless he had more sense.

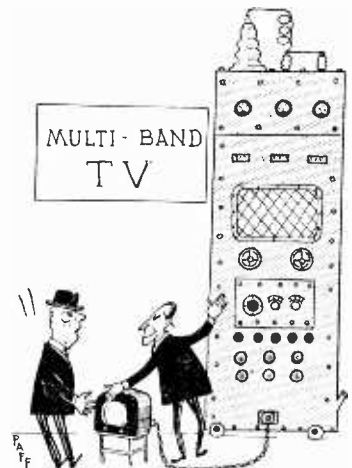
## History Repeating Itself

VERY OFTEN when some new industry arises, it appears at first to threaten an existing one, whereas in practice it has the very reverse effect and, in fact, gives it an unexpected

boost. When broadcasting began it seemed to spell ruin to those who depended for their living on making and selling gramophone records. But, as we all know, broadcasting not only created an unprecedented demand for records but improved the quality of them because the intensive research work on the valve and its associated circuits which it instigated led to electrical recording. The development of the gramophone pick-up in the middle twenties led to the radiogram and the result of all this was that records were put on the map to an extent they had never been before.

Now history is repeating itself. Just as the vendors of gramophones and records wrongly saw in sound broadcasting the "writing on the wall," now we find the makers of home ciné apparatus in the U.S.A. fearing that TV may put them out of business. It seems to me, however, that if the right steps are taken—and taken quickly—TV will boost rather than banish home movies. All that is wanted is the production of a television set with "pick-up terminals." or, in other words, provision for scanning home-made films and showing them on the c.r. screen.

The old-fashioned projector, which has to be dug out of its box and erected together with its screen every time a film is shown, can then be consigned to the junk heap and home-ciné dealers can sell these special TV sets instead of projectors. In principle there are no technical objections to such an arrangement and in practice there are no insurmountable ones. Once marketed, not only will a boost be given to home-taken films of the family but also to the sale of commercially produced sub-standard films of events like the Coronation and of complete plays, etc., for viewing when the television programmes fail to please.



No Sir! This is the set and that is the converter



# The PERFECT TEST TEAM



The illustration depicts a set of modern "AVO" testgear being used to measure the "Q" of the secondary winding of the second I.F. transformer on a chassis of unknown characteristics—just one of many tests which can be performed by this combination of instruments.

A signal of predetermined frequency from the "AVO" Wide Range Signal Generator is being fed into the Electronic Test Unit, where it is amplified and fed to the secondary winding of the transformer. The Electronic Testmeter is connected across the tuned circuit under test and from the readings obtained and the controls of the Electronic Test Unit, the "Q" of the circuit can be determined.

The three instruments, shown as a team, cover a very wide field in measurement and form between them a complete set of laboratory testgear, ruggedly constructed to withstand hard usage.



## ELECTRONIC TESTMETER

A 56-range instrument combining the sensitivity of a delicate galvanometer with the robustness and ease of handling of an ordinary multi-range meter. Consists basically of a highly stable D.C. Valve Millivoltmeter, free from mains variations and presenting negligible load on circuit under test. Switched to measure:—

- D.C. Volts: 5 mV to 10,000V.
- D.C. Current: 0.5μA to 1 Amp.
- D.C. Volts: up to 2,500V R.M.S.
- A.C. Volts: .1V to 250V R.M.S.
- .1V to 200 Mc/s.
- A.C. Power Output: 5mW to 5 Watts.

Decibels: —10db to + 20 db.  
Zero level 50 mW.  
Capacitance: .0001μF to 50μF.  
Resistance: 2 ohm to 10 Megohms.  
Operates on 100-130v. and 200-260v.  
50-60 c/s. A.C. mains.



## ELECTRONIC TEST UNIT

For measuring small values of A.C. voltage, inductance, capacity, and "Q" at radio frequencies. Although designed primarily for use with "AVO" instruments, it can be used with any suitable Signal Generator Valve Voltmeter combination.

As a Wide Range Amplifier, it is capable of an amplification factor of 40 ± 2—3db between 30c/s and 20Mc/s.

As a Capacity Meter, it covers measurements at radio frequency 40 ± 2—900pF. in two distinctly calibrated ranges.

As an Inductance Meter, it gives direct measurements from .5μH. to 50mH. in six ranges.

As a "Q" Meter, it indicates R.F. coil and condenser losses at frequencies up to 20 Mc/s.  
Operates on 100-130v. and 200-260v.  
50-60 c/s. A.C. mains.



## WIDE RANGE SIGNAL GENERATOR

An instrument of wide range and accuracy for use with modern radio and television circuits. Turret coil switching provides six frequency ranges covering 50 Kc/s. to 80 Mc/s.

- Range 1. 50 Kc/s.—150 Kc/s.
- 2. 150 Kc/s.—500 Kc/s.
- 3. 500 Kc/s.—1.5 Mc/s.
- 4. 1.5 Mc/s.—5.5 Mc/s.
- 5. 5.5 Mc/s.—20 Mc/s.
- 6. 20 Mc/s.—80 Mc/s.

Accuracy to within 1% of scale marking. Gives sensibly constant signal of good wave-form, modulated or unmodulated, over entire range. Minimum signal less than 1μV at 20 Mc/s and less than 3μV between 20 and 80 Mc/s. Gives calibrated output from 1μV to 50mV.  
Operates on 100-130v. and 200-260v.  
50-60 c/s. A.C. mains.  
Battery-operated model also available.

Sole Proprietors and Manufacturers:—

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**5** **REASONS**  
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**THIS BRITISH MADE**  
**TWIN TRACK**  
**Soundmirror**  
**TAPE RECORDER**

- 1 Twin track and choice of speeds 7½" per sec. or 3½" per sec.
- 2 Single Lever control for RECORD, PLAYBACK, FAST FORWARD, FAST REVERSE and STOP.
- 3 Headphones can be used for monitoring.
- 4 Output can be fed into amplifier, radiogram or film projector amplifier when required for use in public halls or theatre.
- 5 British Made throughout.



This latest Soundmirror Magnetic Tape Recorder, with its twin track and other refinements, is now available for early delivery. Book your order now, or write to the address below for free demonstration anywhere in the British Isles.

THE  
**Soundmirror**  
 MAGNETIC TAPE RECORDER

The Soundmirror as illustrated here, in handsome polished cabinet, is priced at . . . £69.10.0

A portable model is also available at . . . £74.10.0  
 Where desired, arrangements can be made for the purchase of either model to be spread over twelve or eighteen months.



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# THREE NEW DOUBLE TRIODES . . .



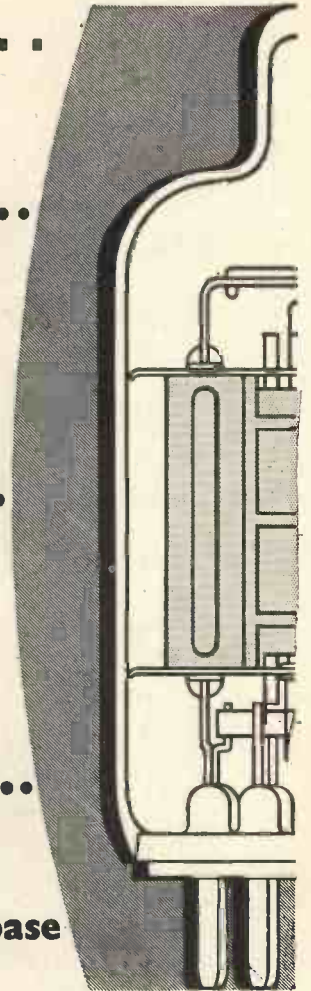
# ECC81



# ECC82



# ECC83



. . . On the Services' Preferred Noval base

### TECHNICAL DATA

#### ECC81

|                                   |         |
|-----------------------------------|---------|
| $V_a$ max. . . . .                | 300 V   |
| $p_a$ max. . . . .                | 2.5 W   |
| $I_k$ max. . . . .                | 15mA    |
| $g_m$ (at $V_a=200, I_a=11.5mA$ ) | 6.4mA/V |

The extremely high slope of this valve recommends it for use in grounded grid and cathode R.F. input stages working up to 300 Mc/s. The ECC81 is directly interchangeable with American type 12AT7.

#### ECC82

|                                    |        |
|------------------------------------|--------|
| $V_a$ max. . . . .                 | 300 V  |
| $p_a$ max. . . . .                 | 2.75 W |
| $I_k$ max. . . . .                 | 20mA   |
| $\mu$ (at $V_a=250V, I_a=10.5mA$ ) | 17     |

The ECC82 is a low- $\mu$  valve with an anode dissipation of 2.75 watts. These features make it particularly suitable for use as an R.F. oscillator or frequency multiplier. The ECC82 is directly interchangeable with American type 12AU7.

#### ECC83

|                                   |       |
|-----------------------------------|-------|
| $V_a$ max. . . . .                | 300 V |
| $p_a$ max. . . . .                | 1 W   |
| $I_k$ max. . . . .                | 8mA   |
| $\mu$ (at $V_a=250V, I_a=1.2mA$ ) | 100   |

An important feature of the ECC83 is its exceptionally high  $\mu$ . It is an ideal valve for use as a resistance-coupled audio-amplifier, as a phase splitter, or as an inverter. The ECC83 is directly interchangeable with American type 12AX7.

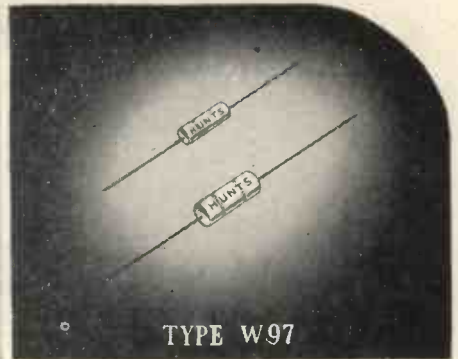
These three double triodes, the latest additions to the Mullard range of noval-based communications valves, provide equipment designers with types suitable for almost every triode application. Features common to all three valves include independent triode sections with separate cathode connections, and centre-tapped heaters that allow either series or parallel wiring (12.6V, 0.15A or 6.3V, 0.3A). Brief descriptions of these triodes are given here. More comprehensive information on these and other valves in the Mullard range of noval-based types will be gladly supplied on request.



MULLARD LTD.

COMMUNICATIONS & INDUSTRIAL VALVE DEPT.,  
CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, W.C.2

**REVOLUTIONARY**  
*in design—  
 and performance!*



## HUNTS "THERMETIC" MIDGET METALLISED PAPER CAPACITORS WITH A TRUE HERMETIC SEAL

**TEMPERATURE RANGE:  $-100^{\circ}\text{C}$  to  $+120^{\circ}\text{C}$**

**and to CATEGORY 'A', CLASS H.1**

With the hitherto unattainable temperature range of  $-100^{\circ}\text{C}$ . to  $+120^{\circ}\text{C}$ ., Hunts W.97 "Thermetic" midget metallised Paper Capacitors are to Category A ( $100^{\circ}\text{C}$ .) Class H1 (84 days tropical exposure) and are the smallest capacitors for their rating to this, the most stringent test condition of the R.C.S.C. Specifications.

Construction is the well known Hunts "castellated" metallised paper with rugged end connections ensuring freedom from intermittent open circuit and open circuits at low voltage. The capacitor unit is sealed in a metal tube with Hunts "Thermetic" compound, which also ensures mechanical rigidity of the end wires thus avoiding any reliance on foil and wire contacts for mechanical strength.

W97 Capacitors are non-inductive and suitable for operation at frequencies up to and in excess of 200 mc/s.

They are impregnated with a new material which is absolutely stable over the specified temperature range, and the temperature/capacitance co-efficient is infinitely superior to other types of capacitors in this class.

This unique capacitor is designed to withstand very high rates of "g", its rugged construction enabling it to be used in equipment where such conditions are encountered.

W97 can be supplied with a transparent plastic sleeve where insulation of case is required.

### TYPE W97 STANDARD RANGE

| LIST NO. | CAP. (μF.) | DIMENSIONS (inches) |                                    |
|----------|------------|---------------------|------------------------------------|
|          |            | L.                  | D.                                 |
|          |            | 200 volts D.C.      | Wkg. up to $100^{\circ}\text{C}$ . |
|          |            | 150 volts D.C.      | Wkg. up to $120^{\circ}\text{C}$ . |
| BM7      | 0.002      | 0.610               | 0.135                              |
| BM8      | 0.004      | 0.610               | 0.135                              |
| BM11     | 0.004      | 0.500               | 0.180                              |
| BM9      | 0.005      | 0.610               | 0.135                              |
| BM12     | 0.005      | 0.500               | 0.180                              |
| BM10     | 0.01       | 0.610               | 0.135                              |
| BM13     | 0.01       | 0.500               | 0.180                              |
| BM14     | 0.02       | 0.610               | 0.180                              |
| BM15     | 0.03       | 0.610               | 0.260                              |
| BM16     | 0.04       | 0.610               | 0.260                              |
|          |            | 400 volts D.C.      | Wkg. up to $100^{\circ}\text{C}$ . |
|          |            | 300 volts D.C.      | Wkg. up to $120^{\circ}\text{C}$ . |
| BM4      | 0.0004     | 0.610               | 0.135                              |
| BM5      | 0.0005     | 0.610               | 0.135                              |
| BM6      | 0.001      | 0.610               | 0.135                              |
| BM17     | 0.001      | 0.500               | 0.180                              |
| BM18     | 0.002      | 0.500               | 0.180                              |
| BM19     | 0.003      | 0.500               | 0.180                              |
| BM20     | 0.005      | 0.610               | 0.180                              |
| BM21     | 0.01       | 0.610               | 0.260                              |
|          |            | 600 volts D.C.      | Wkg. up to $100^{\circ}\text{C}$ . |
|          |            | 450 volts D.C.      | Wkg. up to $120^{\circ}\text{C}$ . |
| BM22     | 2.5 pF.    | 0.500               | 0.180                              |
| BM23     | 4 pF.      | 0.500               | 0.180                              |
| BM24     | 10 pF.     | 0.500               | 0.180                              |
| BM25     | 50 pF.     | 0.500               | 0.180                              |
| BM1      | 0.0001     | 0.610               | 0.135                              |
| BM26     | 0.0001     | 0.500               | 0.180                              |
| BM2      | 0.0002     | 0.610               | 0.135                              |
| BM27     | 0.0002     | 0.500               | 0.180                              |
| BM28     | 0.00022    | 0.500               | 0.180                              |
| BM29     | 0.00025    | 0.500               | 0.180                              |
| BM3      | 0.0003     | 0.610               | 0.135                              |
| BM30     | 0.0003     | 0.500               | 0.180                              |
| BM36     | 0.0004     | 0.500               | 0.180                              |
| BM31     | 0.0005     | 0.500               | 0.180                              |
| BM32     | 0.001      | 0.500               | 0.180                              |
| BM33     | 0.002      | 0.610               | 0.260                              |
| BM34     | 0.003      | 0.610               | 0.260                              |
| BM35     | 0.004      | 0.610               | 0.260                              |

A. H. Hunt (Capacitors) Ltd, Wandsworth S.W.18 · BAT 1083

REGISTERED TRADE MARK

**HUNTS**  
**CAPACITORS**  
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## The Vital Link . . .

. . . with safety in the hazardous enterprise of the deep sea trawler is its radio and radar equipment upon which safe navigation depends. Thousands of soldered joints contribute to the efficient functioning of this delicate apparatus. One dry or H.R. joint could mean the breakdown of a circuit, the destruction of the vital link, a perilous voyage.

### FAULTLESS FLUXING PRESERVES THE VITAL LINK

Dry or H.R. joints are impossible with Superspeed for the flux is always released in exactly the correct proportion. This faultless fluxing action is achieved by the unique STELLATE core which gives six points of rapid solder collapse. At soldering temperature the activated rosin flux is released immediately for effective spreading and wetting. Superspeed is being used more and more in the production of radio and radar equipment where faultless joints are essential.



### "WHITE FLASH" ACTIVATED ROSIN-CORED SOLDER

for general electrical, electronic and telecommunication work and all standard uses. A.I.D. and G.P.O. approved. Complies with M.O.S. Specification DTD 599. In all standard tin/lead alloys, 10-22 s.w.g. Also available in a range of coloured cores, indispensable for simple intermediate and final inspection and circuit or operator identification. Samples of Superspeed and the comprehensive Superspeed booklet gladly sent on request. Technical advisers are available for free consultation.

Cored and solid solder rings and solid solder washers supplied to customers' specifications.

# Superspeed

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# INSTANT TV TUNING!



## Cyldon

### 5-Channel, Switched

## "TELETUNER"

TRADE MARK

### Type TV.5

#### PERFORMANCE

##### **GAIN**

Power gain of the unit is 24dB. measured from the aerial input to the I.F. output, the mixer anode load for measurement purposes being 1k/ohm shunted by 12pF. As a practical example, using a two valve transformer-coupled amplifier with a bandwidth of 2.75 Mc/s (including sound rejector circuits) an aerial input of 25 microvolts modulated 100% produces 2 volts p.p. across the diode load.

##### **NOISE**

Noise figure on all channels better than 10.5dB.

##### **I.F. REJECTION**

Better than 45dB. on all channels at any spot frequency in the I.F. channel.

##### **IMAGE REJECTION**

Better than 60dB. on all channels.

##### **OSCILLATOR DRIFT**

Measured on channel 5, with stable H.T. supply, for a period of two hours after a warming-up period of two minutes, ambient temperature increased from 18° C. to 60° C., total drift 30 Kc/s. Drift, with change in H.T. supply from 160 volts to 230 volts, less than 10 Kc/s.

##### **SWITCH RESETABILITY**

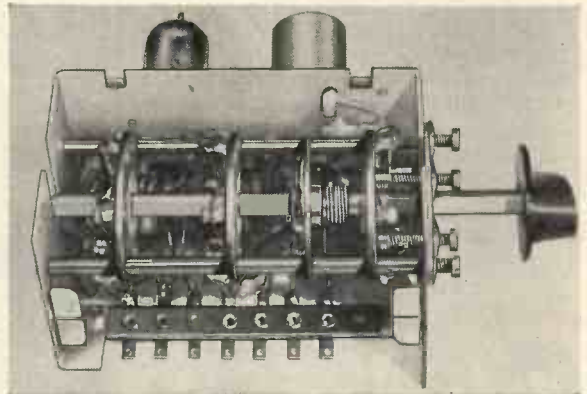
Better than 5 Kc/s on all channels.

##### **POWER REQUIREMENTS**

180 v. 12.6 v. at .3 amps. Heaters are series connected with both ends isolated from chassis.

Any one of the five B.B.C. Television Channels can be selected *instantly*—with single knob control—with this Cyldon switched "Teletuner."

The Cyldon TV.5 "Teletuner" comprises a pentode R.F. amplifier stage and a double triode frequency changer, channel selection being accomplished by the switching of incremental inductances. More constant performance over the television band is thus obtained by avoiding the tracking difficulties inherent in the infinitely variable type of tuner. Ease of handling by the user and rapid conversion as alternative transmissions become available are further important advantages of this unit.



Underside view of "Cyldon" TV.5 Teletuner, with casing removed.

Another Cyldon "Teletuner". . . Type TV.12, a 12-channel Tuner which performs the functions of RF amplifier and frequency changer of a television receiver. Write for booklet TV.1953 giving full details.

**SYDNEY S. BIRD**  
& SONS, LTD.

Contractors to Ministry of Supply, Post Office, and other H.M. Government Depts.

CAMBRIDGE ARTERIAL ROAD · ENFIELD · MIDDX. Enfield 2071-2



Synchronous Capstan motor. Improved response and signal-noise ratio. Simplified speed change. Provision for 1,750 reels, i.e. 45 minutes uninterrupted playing time per track at  $7\frac{1}{2}$ " per second and  $1\frac{1}{4}$  hours per track at  $3\frac{1}{2}$ ". More convenient unit form for portability. Lighter in weight. Provision for Superimposition.

# MAGNETIC RECORDING

*par excellence*

When, above all other considerations, quality and dependability in magnetic tape recording equipment are of paramount importance, it is inevitable that the choice should ultimately rest on Ferrograph.

Re-styled in appearance, the Ferrograph Model 2A is basically the same robust, time-proven and reliable instrument that set the standard in magnetic tape recorders on its introduction four years ago, and more than maintains the predominant position so worthily established.

It incorporates many refinements and facilities that have been requested by discriminating Ferrograph owners and users, and is unquestionably the instrument par excellence for sound recording and reproduction of the highest order.

## *British Ferrograph Recorder Co. Ltd.*

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## Make SUCCESS CERTAIN WITH THE



“TAPE - DECK” ★

Standard  $\frac{1}{2}$ " plastic or paper based coated tape. Track width 0.1". Two tracks permissible. Tape speeds of  $7\frac{1}{2}$ " per sec. and  $3\frac{1}{2}$ " per sec. Playing time 45 mins. and 90 mins. respectively for 1,750 ft. reel. Less than 1 min. rewind and rapid wind-on. Attainable frequency response,  $\pm 3$  DB, 50-12,000 c.p.s. at  $7\frac{1}{2}$ " per sec. or 50-6,000 c.p.s. at  $3\frac{1}{2}$ " per sec. "Wow" and flutter less than 0.2%. Long term speed stability better than 0.5%. Power Consumption 57 watts.

Where it is desired to construct a recorder of any special type to meet the diverse needs of Science, Education and Entertainment, completely satisfactory performance is assured by using the Wearite "Tape-Deck" as the basic unit.

Whilst its operational simplicity and robustness make it the ideal assembly for use by unskilled personnel, its technical performance, advanced engineering design and individual features will also commend it to the recording technician.

★ "Tape-Deck" is registered Trade Mark No. 684413 granted in 1949. The Manual of the Tape Deck — price 2/6 — can be obtained from your local dealer or direct if difficulty is experienced. The Manual contains a technical description of the "Tape-Deck" and suggests a tried and proven circuit for its best usage.

## WRIGHT & WE Aire LTD

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**for  
radio  
ceramics**

**STEATITE & PORCELAIN PRODUCTS LTD.**

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SP88



Now - a truly High-Fidelity, High-Sensitivity

MOVING-COIL MICROPHONE BY

**GOODMANS**

- the Z33



Reg. Design No. 870751.

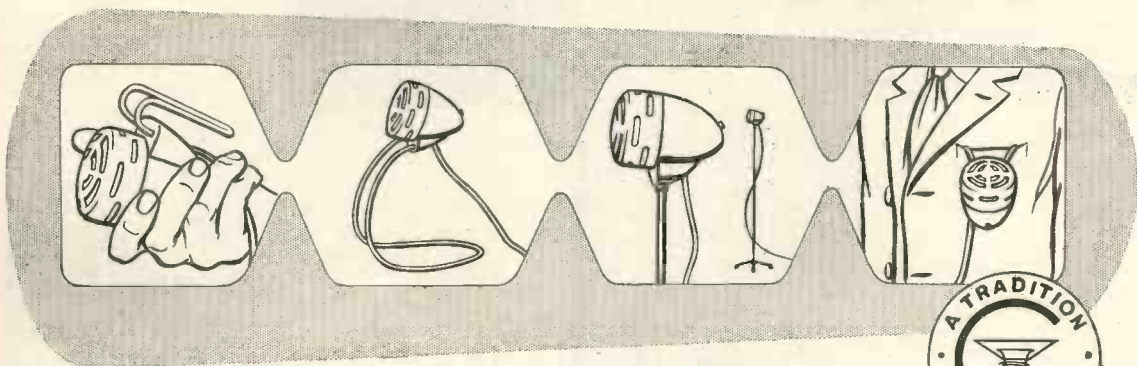
**SOME BRIEF DETAILS**

- ★ **Output Impedance** (standard model) 20 ohms.  
Sensitivity (20 ohms. imp.) — 87 db. with respect to 1 volt per microbar.  
Sensitivity (Hi Z) — 55 db. with respect to 1 volt per microbar.
- Frequency Response** 50 to 10,000 c/s with variation not more than  $\pm 5$ db.
- Dimensions** Overall Length 3 3/4 in. Max. diameter 3 in.
- Weight** (including 10ft. screened cable) 14 ozs.  
As above with transformer 16 ozs.
- Finish** Main body, Polychromatic Old Gold Front Cover and wire base anodised and dyed gold.
- ★ **Models also available with built-in matching transformer providing 200 ohms, 600 ohms and Hi Z impedances.**  
Incorporating recessed "ON-OFF" switch.

When a microphone is offered by a concern that has been a pioneer in high-fidelity reproducers for more than three decades, it is logical to expect it will be one that will satisfy the most discerning and critical user. The "Z33" is indeed such an instrument, for it sets a new and higher standard in performance and application. Moreover, its chaste appearance breaks new ground in modern design.

The illustrations below show its great versatility. This coupled with its **GREATER SENSITIVITY, WIDER RESPONSE RANGE** and **FREEDOM FROM "PEAKING,"** and the **VIRTUAL ABSENCE OF WIND NOISES,** makes it the ideal instrument for

**TAPE and DISK RECORDING  
PUBLIC ADDRESS WORK  
SOUND DUBBING ON CINE FILM  
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Full details are given in Folder No. M/1/W  
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Products of Pye scientific research cover  
ever-widening fields of application.

Information gained through experiment on each project is  
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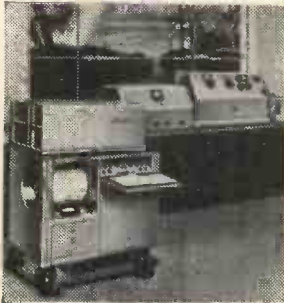
Through advances thus achieved Pye lead the  
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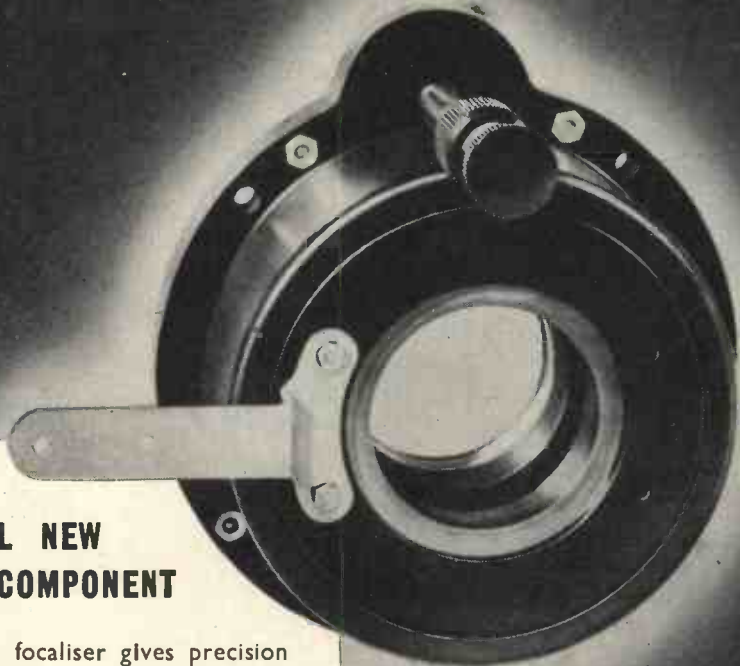
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PYE LIMITED



CAMBRIDGE ENGLAND

# THE ELAC "DUOMAG" FOCALISER



## THE SENSATIONAL NEW ELAC T/V COMPONENT

The DUOMAG focaliser gives precision beam focus and complete picture positioning with minimum effect on scan coils and ion trap assemblies. It is designed for use with magnetically focused tubes having 38 m/m diameter necks.

DUOMAG is a permanent magnet type unit using two concentrically mounted Sintered Oxide ring magnets arranged with opposed magnetic fields.

- Minimum stray magnetic field. Symmetrical, uniform and very low external field.
- Magnets of high electrical resistivity enable the unit to be placed in close proximity to high efficiency scan coils.
- All insulated construction—No risk of high voltage shock.
- Wide range picture shift.

### RETAIL PRICES IN U.K.

Low Flux, 37/6 ; Med. Flux, 39/6 ; High Flux, 42/-.

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# Standard crystals

giving 140 radio channels  
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## COMET

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"spot on"

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Standard  
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for frequency measurement and control

**I**N the de Havilland Comet, as well as in most of Britain's other leading aircraft, **STC** Quartz Crystals maintain the highest standards of accuracy under conditions where accuracy is vital.

Available with accuracies better than 50 cycles in one megacycle; artificially aged, gold plated and wire mounted **STC** crystals greatly reduce drift under working conditions. Moreover, they will maintain this high degree of accuracy under severe vibration and sharply changing climatic conditions.



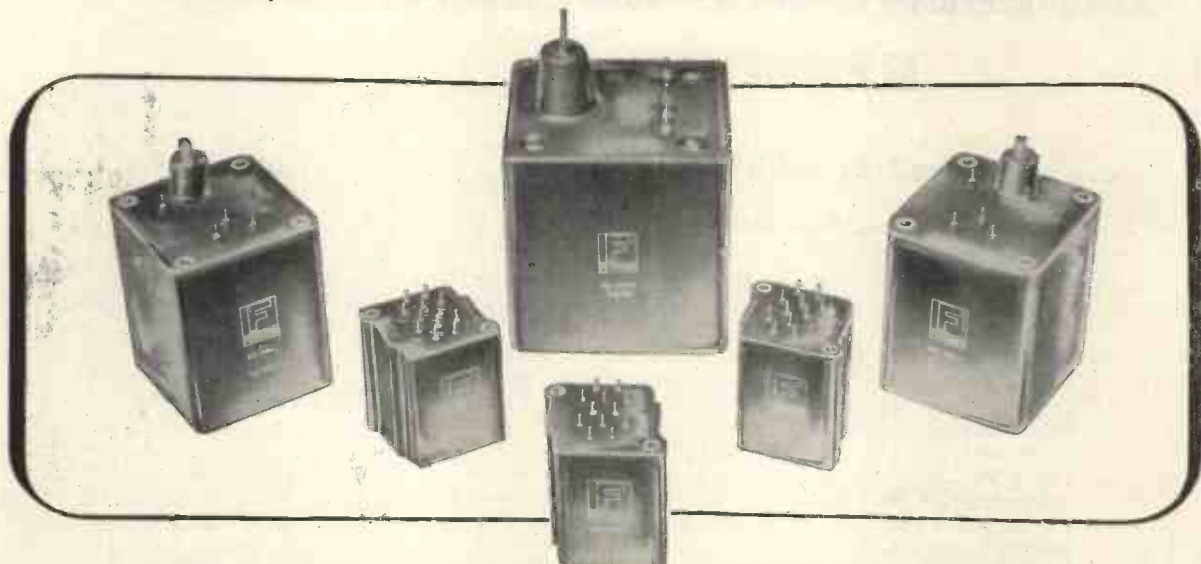
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Registered Office: Connaught House, Aldwych, London, W.C.2.

TELEPHONE LINE DIVISION

HARLOW INDUSTRIAL ESTATE (EAST), HARLOW, ESSEX  
HARLOW 2012/3/4

# A COMPLETE TRANSFORMER SERVICE TO THE ELECTRONIC EQUIPMENT MANUFACTURER



## THE NEW "PENTLAND" SERIES RESIN CAST TRANSFORMERS & CHOKES

Complete assembly sealed in resin block—suitable for incorporation in every type of electronic equipment—designed to meet, at low cost, the stringent requirements of Specification RCS.214—saving in weight and volume—suitable for power, signal, pulse and high voltage applications—designed to individual specification.



**"H" SERIES** — hermetically sealed oil-filled components. "C" core construction, conforming with RCL.215.



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**"M" SERIES**—hermetically sealed miniature type for power and signal applications.

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Enquiries to Technical Sales Dept : \_\_\_\_\_  
**FERRANTI LTD - CREWE TOLL - EDINBURGH 5**

*a new*  
**INDEPENDENT SIDEBAND  
 RECEIVER**

**... developed to British Post Office  
 Specification**

**T**HIS new Independent Sideband Receiver type GFR 552 is designed for operation on long-distance, point-to-point, short-wave radio links forming part of the international trunk network. On independent sideband working, the GFR 552 provides facilities for the reception of two single sideband signals, each 6 kc/s wide, one above and one below the frequency of a reduced-level pilot carrier. Each sideband will accommodate either two 3 kc/s wide telephony channels, or several voice frequency telegraph channels. The GFR 552 may also be used for reception of single sideband or double sideband transmission. In the case of the second application this receiver offers two advantages: firstly, the absence of non-linear distortion which occurs in normal d.s.b. receivers when signals are subjected to selective fading conditions; and, secondly, the ability to select upper or lower sideband for demodulation, dependent upon which is freer from adjacent channel interference. The circuit and chassis layout of the GFR 552 closely follows that of the Mullard Receiver GFR 551, which was based on a British Post Office design (Receiver, Radio No. 22).

Special features of the GFR 552 include a high order of oscillator stability and freedom from cross-modulation through which cross-talk between channels or inter-modulation between wanted and unwanted signals might occur. A brief technical summary is given below. More detailed information supplied on request.

**FREQUENCY RANGE**—4-30 Mc/s.

**NOISE FACTOR**—better than 7 dB over the band.

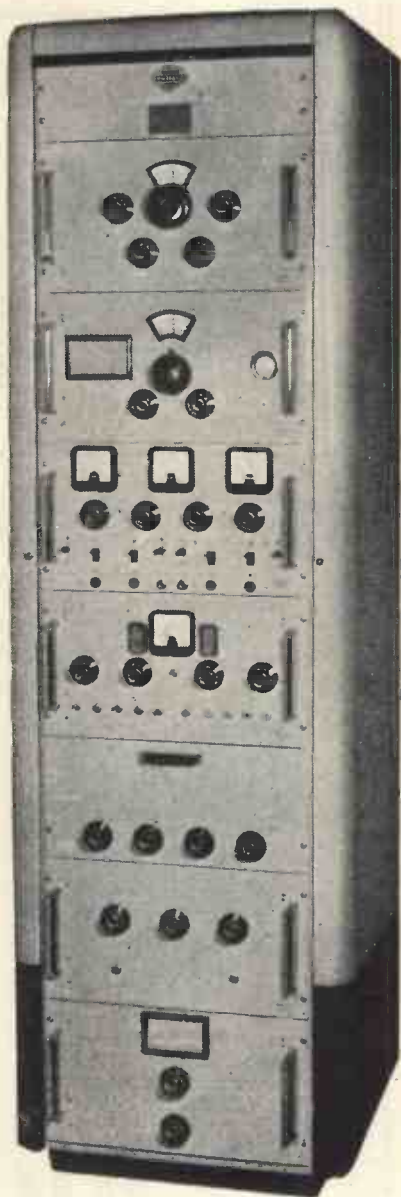
**SIGNAL TO NOISE RATIO**—25 dB for 4 microvolts peak sideband input over the band.

**SELECTIVITY**—The response is flat within 2 dB for sideband frequencies between 100 c/s and 6000 c/s. At 10 kc/s from the carrier frequency the response is -60 dB relative to the pass band.

**A.F.C.**—The a.f.c. system operates effectively with a pilot carrier level of -26 dB relative to 1 microvolt (which corresponds to a peak sideband level of 1 microvolt and a signal to noise ratio of 15 dB).

**NON-LINEAR DISTORTION**—Third order intermodulation products which might result in cross talk between sidebands do not exceed -50 dB relative to the sideband levels.

**OUTPUT**—Variable up to +14 dB relative to 1 mW into 600 ohms.



**Mullard**



**SPECIALISED ELECTRONIC EQUIPMENT**

MULLARD LIMITED, EQUIPMENT DIVISION, CENTURY HOUSE, SHAFTESBURY AVENUE, LONDON, W.C.2  
 (M1417)

# NATURALLY—

## he's using the NEW V.H.F. Pack Set

- ★ Exceptional spurious response rejection
- ★ Crystal controlled transmitter and receiver with high stability and selectivity
- ★ No tuning—simple to operate—only two controls
- ★ Light—compact—robust
- ★ Unbreakable aerial
- ★ Fully tropicalised.



*Now Available*

### TECHNICAL DATA

Frequency ranges: L46, 75—100 Mc/s.

H46, 100—140 Mc/s.

HH46, 140—184 Mc/s.

Weights: with all dry battery power pack for 10 hours' duration, 8½ lbs.; with accumulator battery and vibrator power pack for 16 hours' duration, 10½ lbs.

Transmitter Power Output: 100 mw.

Receiver Sensitivity: 2-3  $\mu$ v.

Spurious Responses: better than -70 db.



## BRITISH COMMUNICATIONS CORPORATION LIMITED

Second Way, Exhibition Grounds, Wembley, Middlesex.

Telephone: Wembley 1212



The new



**MAGNETIC  
TAPE  
RECORDER**  
*Type PMR/3*

*"from a pedigree line"*

And its SPECIFICATION

The Tape Player itself is of unit construction which enables many special requirements and applications to be met without compromise. The unit can be provided in rack mount order:-

Tape speeds  
 second, or

Synchrono

Remote op

Automatic back  
 reverse drive

purpose

Cassette tape

Rack mount

TAPE

# PRICES

**95 GNS. COMPLETE**  
 (exclusive of microphone)

**40 GNS. TAPE MECHANISM ONLY**

Limited supplies will be available  
 to the public commencing OCT. 1953

71" per second 60-10,000  
 plus or minus 3 db.  
 second 70-7,000  
 minus 3 db.  
 total harmonic  
 operating  
 50 db. using  
 tape.  
 low level  
 input.  
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 to in-  
 watt for ex-  
 tent  
 230 V.A.  
 frequencies  
 18" high x 18" deep  
 45 lbs.

**M · S · S · RECORDING COMPANY LTD**  
 POYLE CLOSE · COLNBROOK · BUCKINGHAMSHIRE · TELEPHONE · COLNBROOK 284



**WIDE RANGE  
CAPACITANCE  
BRIDGE**



For the accurate measurement of *in situ* capacitance or resistance, all measurements being made in the form of a three terminal network.

Capacitance range — 0.002 pF to 100  $\mu$ F in 18 ranges.

Resistance range — 1  $\Omega$  to 10,000 M $\Omega$  in 18 ranges.

Ranges increase in alternate decimal multiples of 3 and 10.

Frequency 1592 c/s ( $\omega = 10,000$ ).

Accuracy  $\pm 1.0\%$  of full scale on all ranges.

Full technical details are available on request.

## **CINEMA-TELEVISION LIMITED**

A Company within the J. Arthur Rank Organisation

**WORSLEY BRIDGE ROAD · LONDON · SE26**

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# - if you look for **BIG RESULTS**



It's a knockout—the vast improvement that results from the use of OSMOR "Q" Range Coils. No wonder our customers are enthusiastic! They tell us these "mighty marvels in miniature" are super selective and sensitive to a degree they never dreamed possible. And we guarantee them—they're the outcome of patient scientific research plus the highest technical ability. They put real "punch" into a set and score an easy win on these "plus" points:

- ★ Only 1in. high.
- ★ Packed in damp-proof containers.
- ★ Variable iron-dust cores.
- ★ Fitted tags for easy connection
- ★ Low loss Polystyrene formers.

**COILPACKS.** Now at new lower prices! A full range is available for Superhet and T.R.F. Mains or Battery. Size only 1 1/2in. high x 3 1/2in. wide x 2 1/2in. Ideal for the reliable construction of new sets, also for conversion of the 21 RECEIVER, TR 1196, TYPE 18, WARTIME UTILITY and others. Aligned and tested, with full circuits, etc. Fully descriptive leaflets available.



**4'-  
EACH**

## With **OSMOR** Lines—you're on the right lines!

A spotlight on just one of the range of **OSMOR "Q" coils**

### H.F. CHOKE Type Q.C.1.

Frequency coverage 150 kc/s. to 20 m/c Iron-dust core and single-screw fixing Prototype tested and approved by M. G. Scroggie, B.Sc., M.I.E.E. Ideal as anode load in TRF receivers, for decoupling and general purpose. Price 4/-.



TWO for the Price of ONE!

### The NEW **OSMOR** CHASSIS CUTTER

of entirely new design. Cuts two sizes of holes with any one reversible punch and die; and can be operated with a spanner or tommy-bar. Blanks easily removed.



Prov. Pat.

| Type | Hole Sizes      | Price |
|------|-----------------|-------|
| 1    | 1/4in. x 1/4in. | 19/6  |
| 2    | 1/2in. x 1/4in. | 18/9  |
| 3    | 3/8in. x 1/4in. | 22/6  |
| 4    | 1/2in. x 2in.   | 27/3  |

Post and Packing 1/- (any type).

Tommy Bars..... 1/3 each

### The **OSMOR "JIFFY PUNCH"**

For cutting smaller holes neatly and quickly with one blow of a light hammer.



Prov. Pat.

| Type | Hole Size | Price |
|------|-----------|-------|
| 1    | 1/4in.    | 6/6   |
| 2    | 3/8in.    | 7/6   |
| 3    | 1/2in.    | 8/9   |

Both types of cutters are of hardened Steel and are 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.

(Dept. W.46) BRIDGE VIEW WORKS, BOROUGH HILL, CROYDON, SURREY.

### DIALS

Type A. Glass DIAL ASSEMBLY (as illus.) measuring 7in. x 7in. (9 1/2in. x 9 1/2in. overall) mounts in any position 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. Pulley assembly for right angle drive if required 1/9 extra. P. & P. 1/6.



### METAL DIALS

Overall size 5 1/2in. 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 dials, 3/2.

We keep stocks of many radio components for use in published circuits, including:—

#### "WIRELESS WORLD"

"No Compromise" TRF Tuner. "Mid-get Mains Receiver." Sensitive 2 Valve Receiver. Television Converter (special coils in cans available), etc., etc.

#### "PRACTICAL WIRELESS"

3-speed Autogram. Modern I-valver. A.C. Band-Pass 3. R1155 Converter. Attache case portable. Modern high power Amplifier—2 and many others.

I.F.s. 465 k/c. Permeability-tuned, with flying leads. Standard size 1 1/2in. x 1 1/2in. x 3 1/2in. For use with OSMOR coilpacks and others, 14/6 pair. PREALIGNED, 1/6 extra.

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 somewhere to store her preserves.) 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).

(Trade supplied)

### OSMOR STATION SEPARATOR



Aerial plugs in here

Plug into Receiver

| NO. | METRES      |
|-----|-------------|
| 1   | 141-250     |
| 2   | 218-283     |
| 3   | 267-341     |
| 4   | 319-405     |
| 5   | 395-492     |
| 6   | 455-567     |
| 7   | 450-1550    |
| 8   | 410-530k/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.

**FREE!**

Send 5d. (stamps) for FREE CIRCUITS and full lists of coils, coilpacks and radio components.

**OSMOR** radio products Ltd.

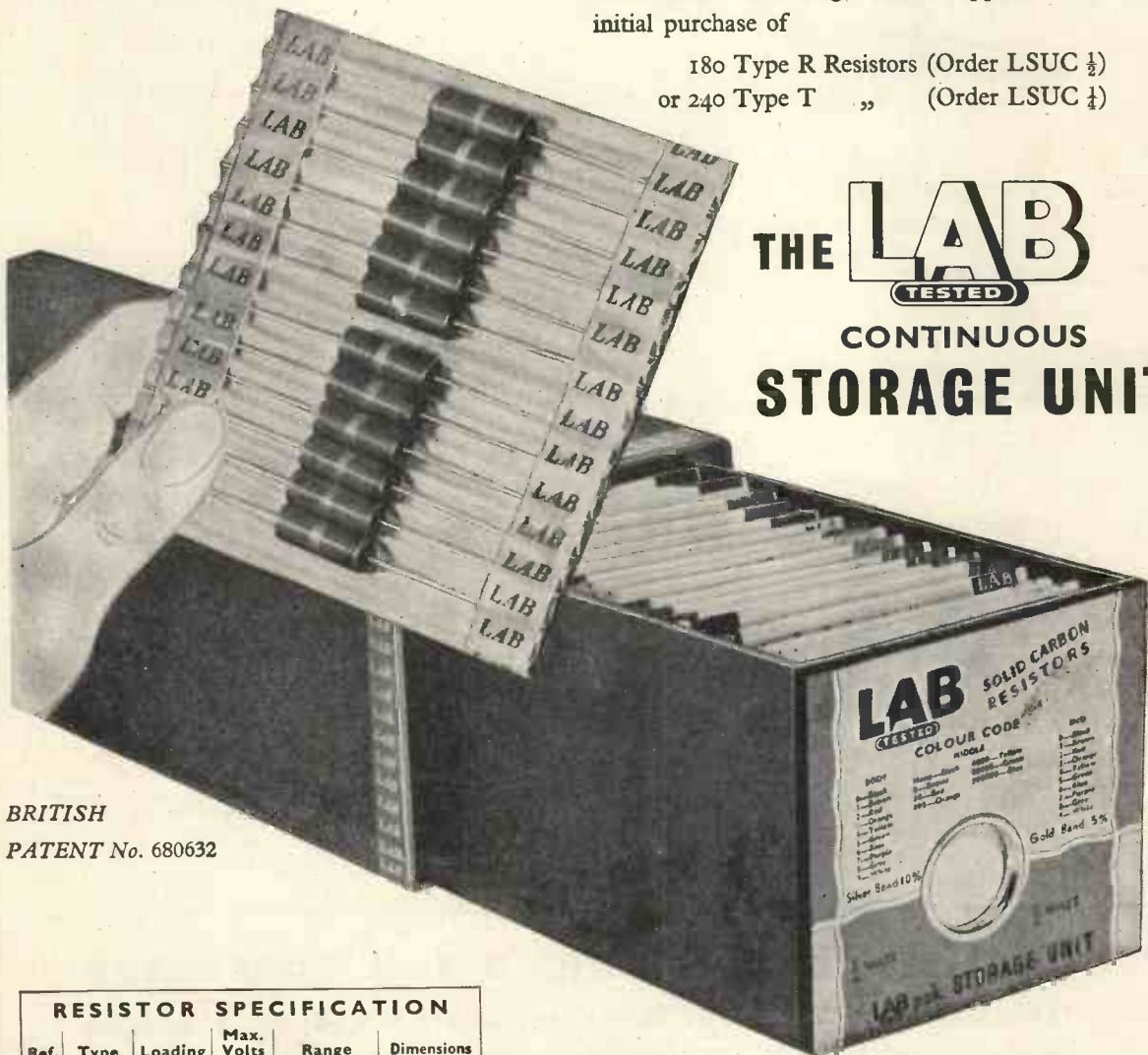
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- ★ Continuous storage
- ★ 700 resistors in a space 12" x 4" x 4"
- ★ Ohmic values separately carded
- ★ Finger-tip selection

Here's the most practical way of buying and storing resistors that anyone could wish for. Occupies only 48 sq. in. of shelf space. As easy to use as a card index. Rapid selection from 700 sorted and carded resistors. Continuous storage — empty cards merely replaced with full ones available from stock. The Lab Continuous Storage Unit is supplied FREE with initial purchase of

180 Type R Resistors (Order LSUC ½)  
 or 240 Type T „ (Order LSUC ¼)



## THE LAB (TESTED) CONTINUOUS STORAGE UNIT

BRITISH  
 PATENT No. 680632

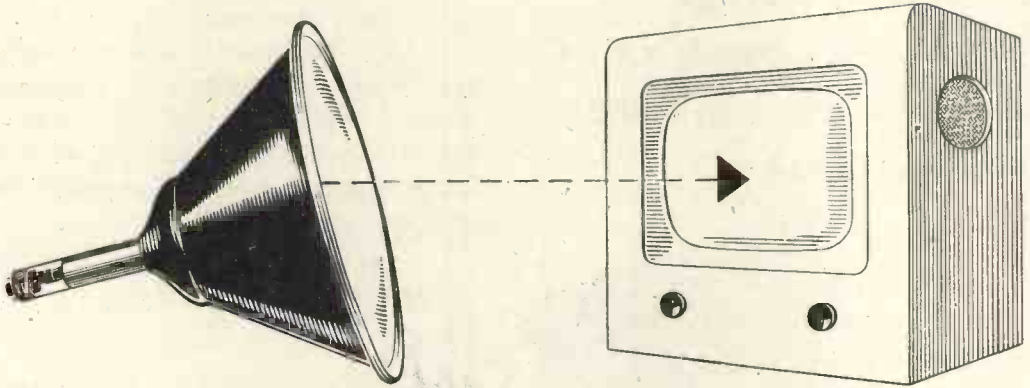
| RESISTOR SPECIFICATION |        |         |            |            |               |
|------------------------|--------|---------|------------|------------|---------------|
| Ref.                   | Type   | Loading | Max. Volts | Range      | Dimensions    |
| T                      | ½-watt | ½-watt  | 250        | 10 ohms to | 1 1/8" x 1/2" |
| R                      | 1-watt | 1-watt  | 500        | 10 megohms | 1 3/4" x 1/2" |

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 from

**THE RADIO RESISTOR COMPANY LTD**  
 50 ABBEY GARDENS, LONDON, N.W.8 · Telephone: Maida Vale 5522

# The professional touch



The 'ENGLISH ELECTRIC' Tube combines so many features which work to the home-constructor's advantage. Build your set around the 16-inch T.901 and you will be a long way towards achieving a picture of professional standards. This is why the 'ENGLISH ELECTRIC' Tube is specified for the 'Supervisor', the 'Tele-King' and 'Magnaview' circuits and 'View-Master' conversion circuit.

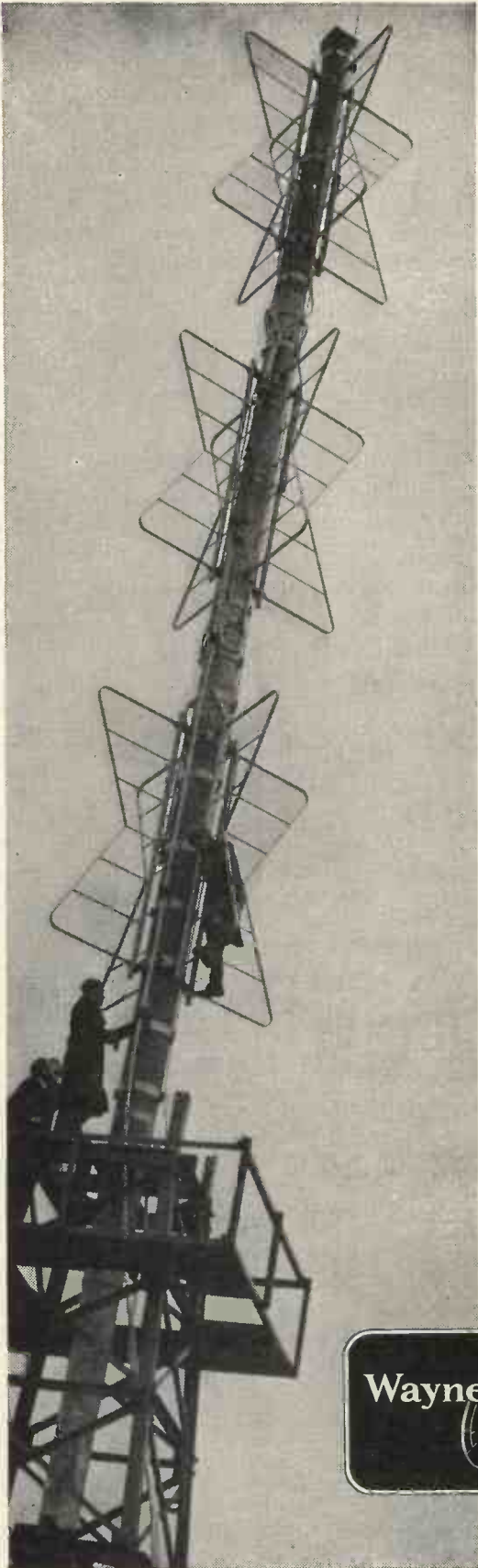
*Brilliant black and white picture focussing over entire screen area; excellent contrast range; almost flat face plate of high optical quality; wide angle scanning (70°); ion trap; high safety factor; easy to handle; short overall length (17-11/16") permits cabinet of shallow depth.*

## 'ENGLISH ELECTRIC'

**BRITISH MADE LONG LIFE 16" T901 METAL C. R. TUBE**

### **EXTRA BENEFIT and a full guarantee**

**'ENGLISH ELECTRIC' C. R. Tubes are backed by a unique tube reconditioning service which almost halves replacement cost. And with every re-conditioned tube, which is as good as new, comes a full 6 months' guarantee. Get the details from your Dealer.**



# Broad-band Matching

The photograph shows Marconi engineers erecting for test the three-stack super-turnstile TV aerial for the new B.B.C. transmitter at Pontop Pike. Wayne Kerr Bridges are used for matching feeders and transmission lines to the radiators.



FOR UNBALANCED  
MEASUREMENT FROM  
50—250 mc/s

## B.901

Susceptance: Equivalent to  $\pm 75 \text{ pF}$  to  $\pm 2\%$ ,  $\pm 0.5 \text{ pF}$   
Conductance: 0-100 mmho to  $\pm 2\%$ ,  $\pm 0.1 \text{ mmho}$



FOR BALANCED  
AND UNBALANCED  
MEASUREMENT FROM  
1—100 mc/s

## B.801 and B.701

Susceptance: Equivalent to  $\pm 230 \text{ pF}$  to  $\pm 2\%$ ,  $\pm 0.5 \text{ pF}$   
Conductance: 0-100 mmho to  $\pm 2\%$ ,  $\pm 0.1 \text{ mmho}$   
Susceptance: Equivalent to  $\pm 80 \text{ pF}$  to  $\pm 2\%$ ,  $\pm 0.5 \text{ pF}$   
Conductance: 0-100 mmho to  $\pm 2\%$ ,  $\pm 0.02 \text{ mmho}$



FOR BALANCED  
AND UNBALANCED  
MEASUREMENT FROM  
15 kc/s—5 mc/s

## B.601

Capacitance:  $0.01 \text{ pF} - 20,000 \text{ pF}$   
Resistance: 10 ohms — 10 megohms  
Inductance:  $0.5 \mu\text{H} - 50 \text{ mH}$   
Accuracy: 1% over major part of range

These Wayne Kerr Bridges are used with external source and detector for the measurement of aerials, cables, feeders, and a variety of components and materials.



Photograph by courtesy of Marconi's Wireless Telegraph Co. Ltd.

THE WAYNE KERR LABORATORIES LIMITED, NEW MALDEN, SURREY

# SAVE TIME AND MONEY—BUY ONE INSTRUMENT



Get quick accurate readings

*Resistance*

*Capacity*

*Inductance*

RESISTANCE: 0.1 to 1,000,000 ohms. 0.1 to 11 continuously variable plus nine-stage decade resistance gives 50 ft. scale length. Measured at D.C.  
 CAPACITY: 10 p.f. to 1,000 mfd. 10 to 1,100 p.f. infinitely variable plus nine steps if 1,000 p.f. Measured at 1,000 cycles.  
 INDUCTANCE: 10 microhenries to 1,000 henries. 10 to 1,100 microhenries infinitely variable plus nine steps if 1,000 microhenries. Measured at 1,000 cycles.

**MODEL UB 202 UNIVERSAL  
 IMPEDANCE BRIDGE**  
 Accuracy to  $\pm 1\%$

Everyday needs are catered for fully by this one compact, robust, high-quality instrument. It incorporates a valve oscillator giving 1,000 c/s and a visual null detector preceded by a two-stage tuned amplifier, whilst provision for passing current through

coils under test is also made. Both meters have overload protection. Whether your field lies in experimental, production or service engineering, this instrument will prove an indispensable aid. Please write for full specification.

## BRITISH PHYSICAL LABORATORIES LTD

Tel: RADLETT 5674-5-6



Radlett HERTS

dmBP12



**14** reasons why *those concerned*  
*with recorded sound choose*

# FERROVOICE

## MAGNETIC RECORDING TAPE

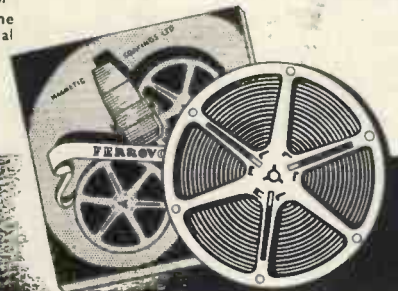
- 1** Does not curl—lies flat on the transducer head, giving better frequency response, and smooth tracking.
- 2** Has the lowest possible surface friction—reducing wear on transducer heads, and guide pillars.
- 3** Has the best possible dispersion of oxide particles, free from coagulation, and flocculation ensuring low noise level.
- 4** Is correctly heat-dried to preclude "blocking," and sticking, layer-to-layer, under storage conditions.
- 5** The Lacquer is formulated to attain the maximum adhesion to the base material.
- 6** Gives the highest possible signal-to-noise ratio—excelling in high-frequency response.
- 7** Has a superlative dimensional stability—negligible stretch, and the highest possible tensile strength.
- 8** Discourages static collection during fast-forward, and fast re-wind operations.
- 9** The Kraft Paper base has been selected after careful development with the paper manufacturers—flexibility, and supercalendering being prime considerations.
- 10** The Lacquers are pigmented with the highest grade powder. The individual particle size is less than one micron (0.000039 inch).

- 11** The pigment is dispersed and milled, with the highest degree of control, thus ensuring a uniform dispersion of the oxide particles within the binder.
- 12** The spools were designed to incorporate the "universal" hub, perfect balance, and negligible rotation noise.
- 13** "FERROVOICE" products are subject to continuous development by our technical staff.
- 14** "FERROVOICE" has a Coercivity of 270 oersted (BHC) remanence = 730 gauss, when subjected initially to a magnetising force of H = 2,000 oersted.

Suitable for Single or Double Track Recording. Length 1,200ft. on 7in. Diameter Spool—Frequency response 50 C.P.S. to 10 kc/s. at 7.5in. per sec. Breaking Strain exceeds 4 lb.

22/6

PRICE RETAIL



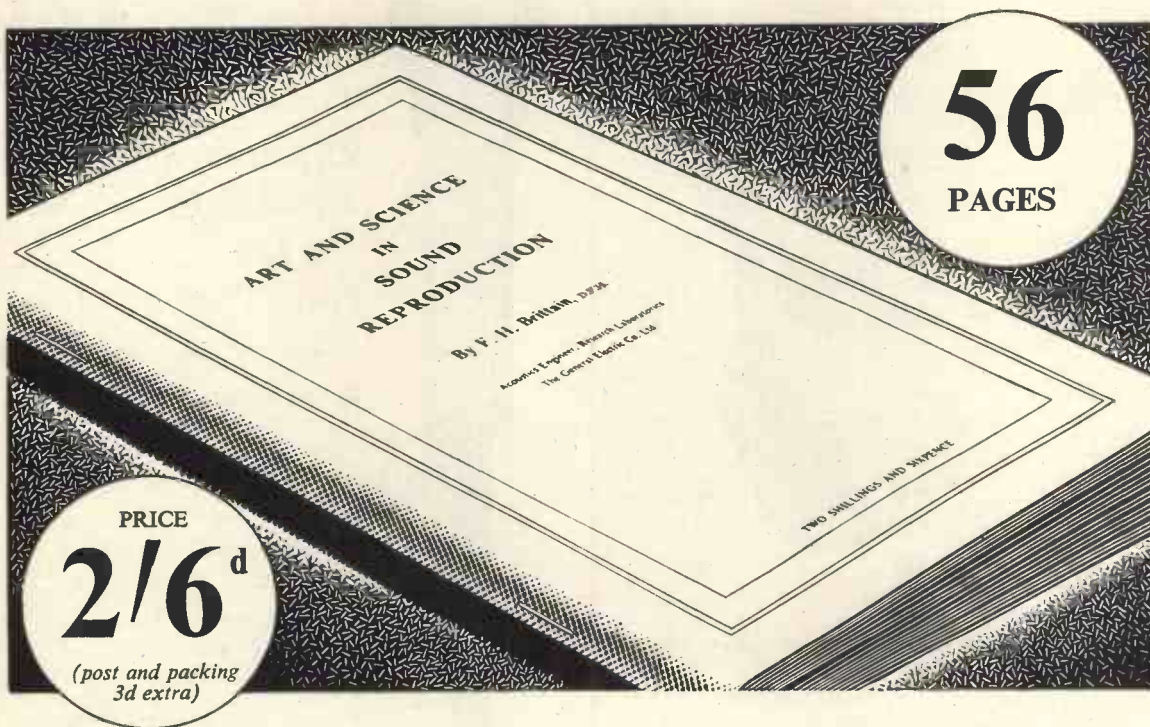
## MAGNETIC COATINGS LIMITED

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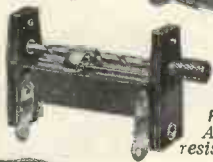
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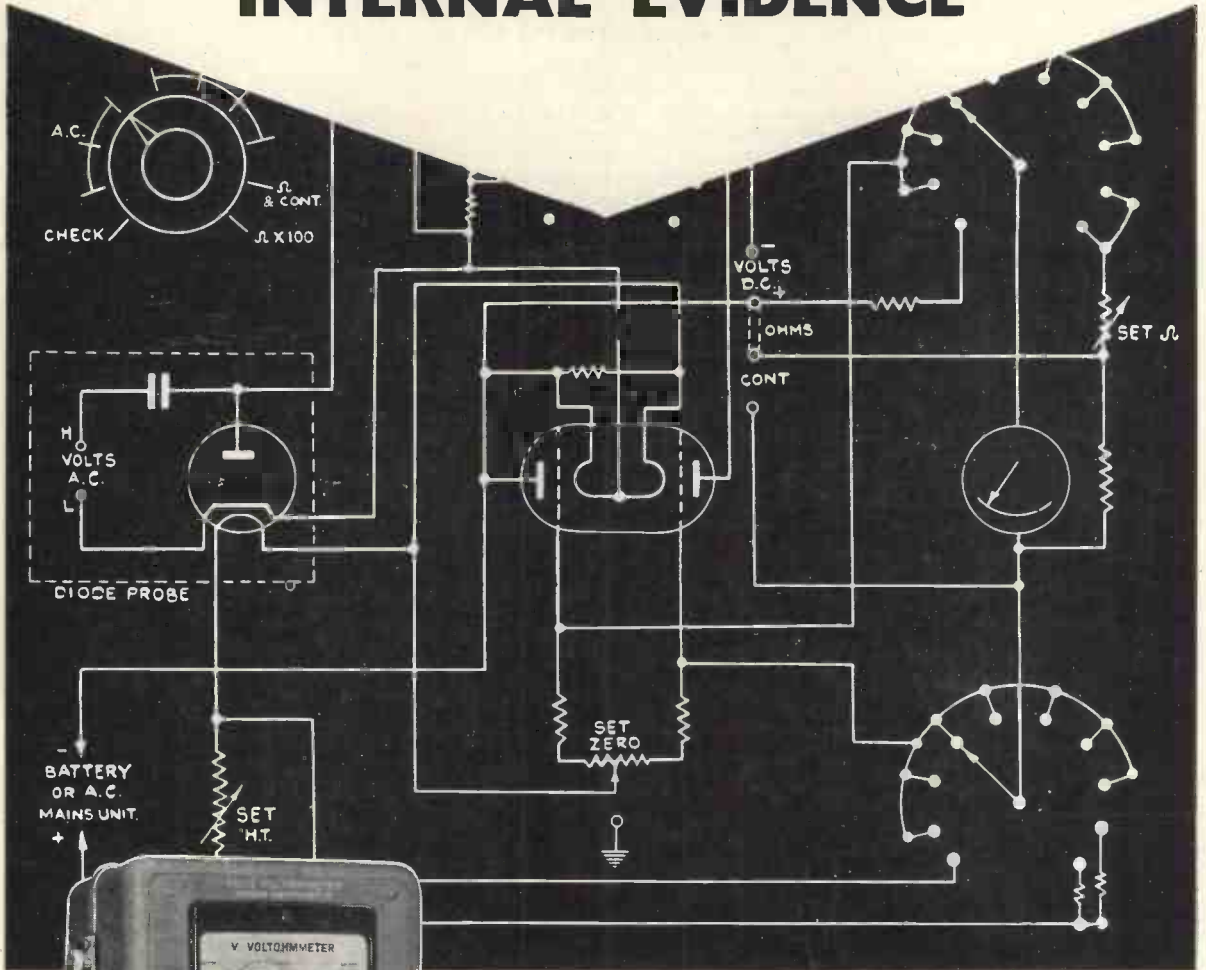
Standard model  $\frac{3}{16}$ " bit (illustrated)



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## Summarised List

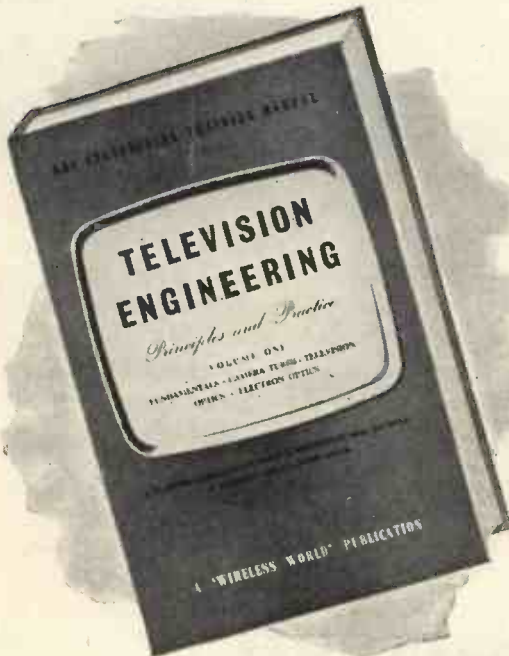
- MODEL VR/53 Ribbon Velocity Microphone of Studio Class.
- MODEL C/48 High Fidelity Dynamic Microphone Low Impedance.
- MODEL C48/S High Fidelity Dynamic Microphone fitted with on/off Switch Adaptor. Low Impedance.
- MODEL C51 General Purpose Low Impedance Dynamic Stand Microphone.
- MODEL CS1/Z General Purpose High Impedance Dynamic Stand Microphone.
- MODEL CH51 High Fidelity Handheld Dynamic Microphone in Diecast Case. Low Impedance.
- MODEL CH51/Z High Fidelity Handheld Dynamic Microphone in Diecast Case. High Impedance.
- MODEL H51/SB Single Button Carbon Handheld Microphone in Diecast Case.
- MODEL H51/DB Double Button Carbon Handheld Microphone in Diecast Case.
- MODEL HD/54 High Fidelity Dynamic Handheld Microphone in Light Weight Moulded Case. Low Impedance.
- MODEL HC/54 Single Button Carbon Handheld Microphone in Light Weight Moulded Case.
- MODEL HC2/54 Double Button Carbon Handheld Microphone in Light Weight Moulded Case.
- MODEL CI.51/HMT Dynamic Hand Microtelephone. Low Impedance.
- MODEL VC52/H Low Impedance Noise Cancelling Dynamic Microphone fitted to holding handle.
- MODEL VC52/B Low Impedance Noise Cancelling Dynamic Microphone fitted to Swivel Boom.
- MODEL LX55 General Purpose Crystal Microphone for Stand or Hand use.
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- TYPE CI/51 High Fidelity Dynamic Insert for Intercommunication equipment.
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Maximum Peak Anode Current (amps)

$I_a$  (pk) max. 5.0

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P.I.V. max. 10

Base

Super Jumbo push type.

This valve is a plug-in replacement for the American type 8008.

Characteristics are the same as the Edison Swan type ESU 872.

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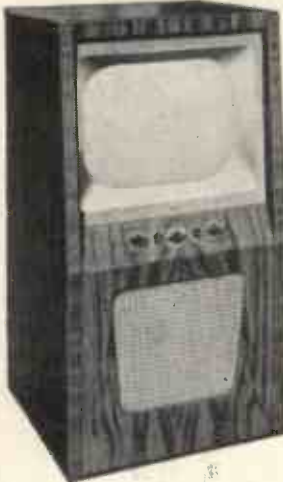
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**MAINS.** A.C. 200-250 Volts, 50 c/s.



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## TWO SPEEDS · SINGLE CONTROL FREE OF BACKLASH

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- Single control knob displaced axially to select the speed ratio.
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| 52       | 1,000                   | 3.3 feet               | 1 : 8        | 1 : 120 |
| 63       | 1,000                   | 3.3 feet               | 1 : 8        | 1 : 120 |
| 57       | 2,000                   | 6.6 feet               | 1 : 15       | 1 : 200 |
| 56       | 2,000                   | 6.6 feet               | 1 : 15       | 1 : 200 |
| 53       | 2,000                   | 6.6 feet               | 1 : 15       | 1 : 200 |



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- ★ Designed to obtain the best results from modern gramophone technique.
- ★ High quality.
- ★ 8 valves.
- ★ Full guarantee for TWO YEARS.

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# Outstanding Performance WITH THE

## **BURGOYNE** MAGNETIC TAPE RECORDER

# for only 32 gns!



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- ★ Fast forward and rewind.
- ★ Frequency response 30-9,000 c/s. at 7½in. per second (checked on Decca K1,804 Frequency test record).
- ★ Instantaneous braking of tape reels.
- ★ Supplied with Ronette "Coronation" high fidelity crystal microphone.

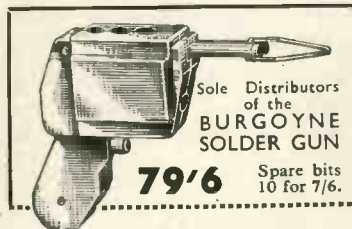
Three heavy-duty motors to obviate use of friction drives. Erase and bias frequency 50 kc/s. Power consumption approximately 80 watts. Output 4 watts. All controls and inputs mounted on front of cabinet on handsome engraved plate. Volume control and on/off switch. Bass treble controls for cut and boost operative on both record and playback. Separate radio and microphone inputs.

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# RONETTE

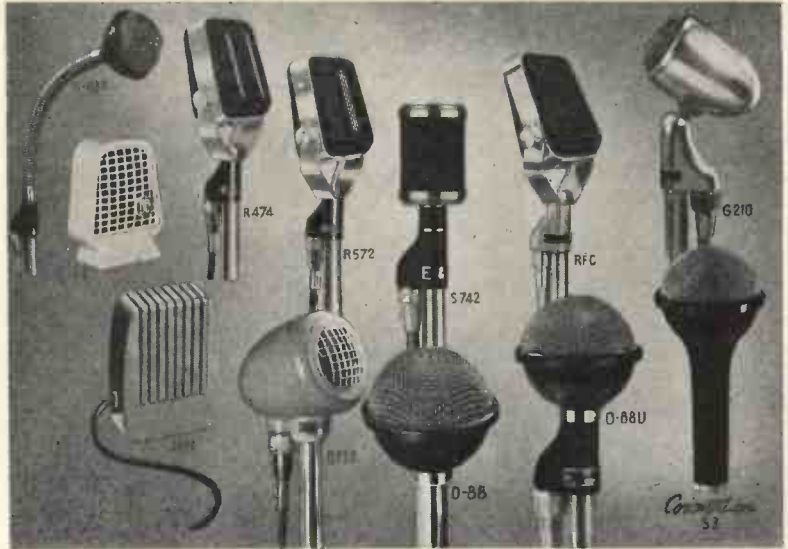
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RECORDER**

**PRICE 80 GNS.**

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To: Advertising Manager.  
From: Chief Engineer.

*Suggested "Wireless World" Advert.*

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P.S.—The new Test Tape TB53 for alignment of Heads and checking frequency response is now available.

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**GRUNDIG-  
THE  
FINEST  
TAPE  
RECORDERS  
IN THE  
WORLD**

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**QUALITY PRODUCTS**

**THOUSANDS OF VISITORS to the COLLARO**

**Stand** at the RADIO SHOW saw demonstrations of the new COLLARO Studio High Fidelity Pickup—the Pickup which tracks any long-playing record yet produced! They examined the '53 Series of Record Changers—Models RCS31 (a non-mixing changer) and RCS32 (a mixing changer) and their 3-speed equivalents, models 3RC531 and 3RC532, which incorporates a new,



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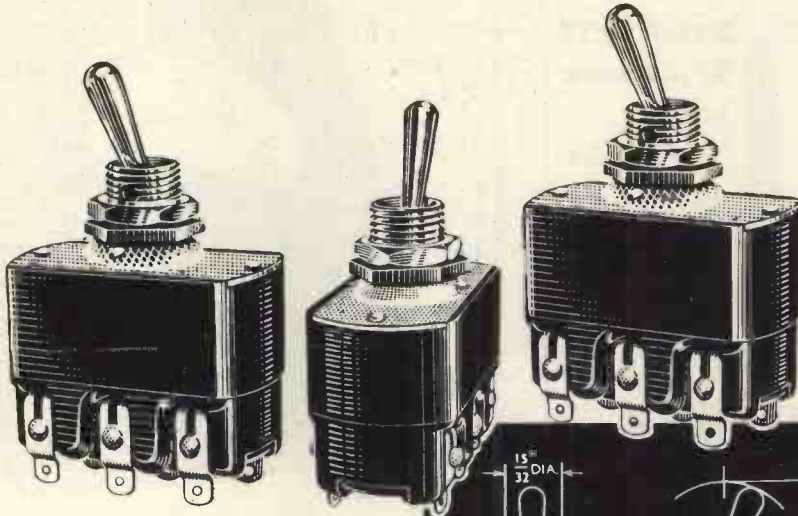
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*By Appointment to the Professional Engineer*



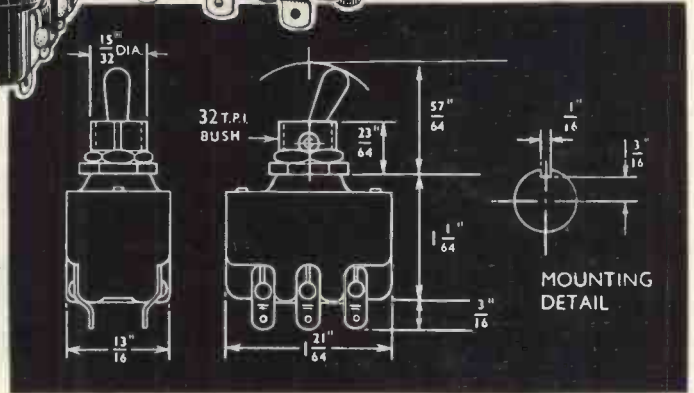
**TOGGLE SWITCH**

**6 AMP.  
DOUBLE POLE  
CHANGE OVER**

**FEATURES**

Catalogue No. 501085 (illustrated).

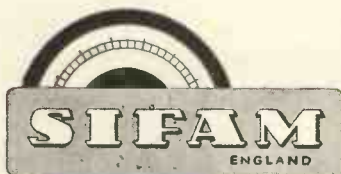
- 6 Amps. 250 Volts A.C./D.C. rating.
- Double Pole Changeover Operation.
- Internal Resistance: less than .002 ohm.
- Silver Plated Phosphor Bronze Contacts.
- Heavy Duty Chrome finish.



This new Painton 6-Amp. Toggle Switch Series has been designed to conform to the stringent performance requirements of the appropriate R.C.S.C. Specification. The 6 Amps. 250 Volts A.C./D.C. rating is conservative, and the Double Pole Changeover operation meets the requirements of most single or double pole switching applications. Essentially a quality component to be incorporated in the production lines in all kinds of electrical and electronic engineering, its multi-switching facilities make it also the ideal unit for prototype and laboratory equipment. Different bush and lever lengths from those illustrated can be supplied, to conform to RCL 151, or to meet individual requirements where the standard size is unsuitable.

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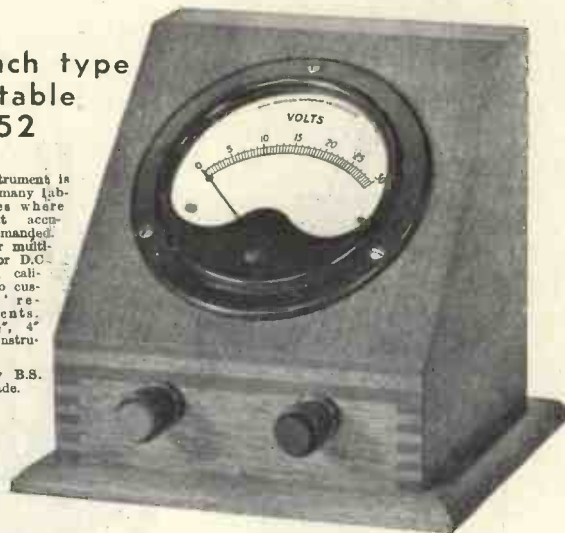
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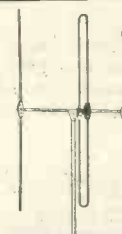


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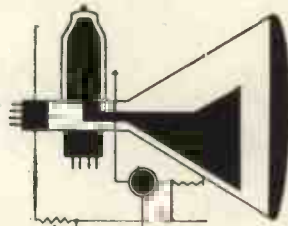
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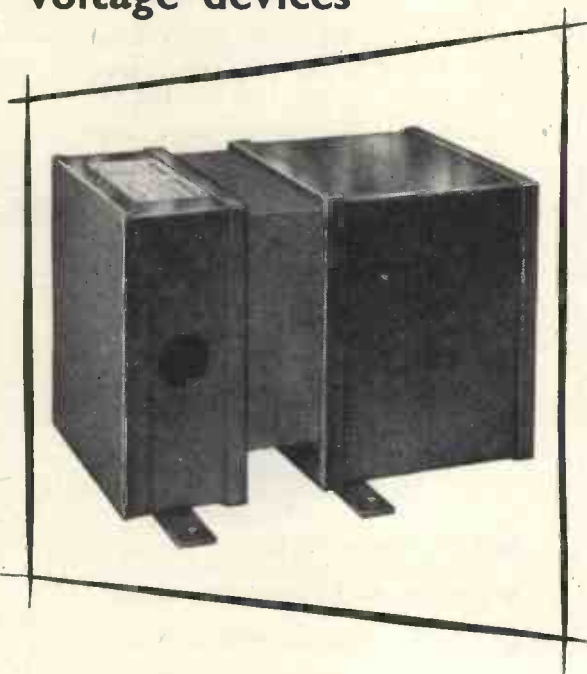
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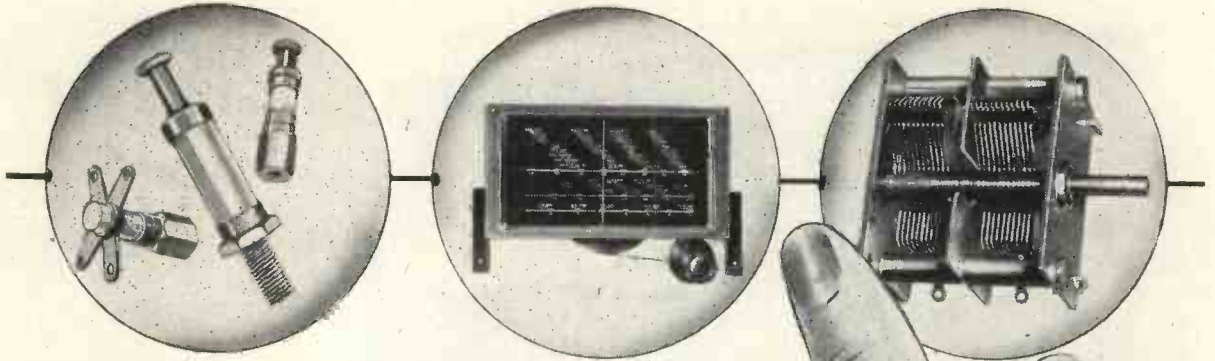
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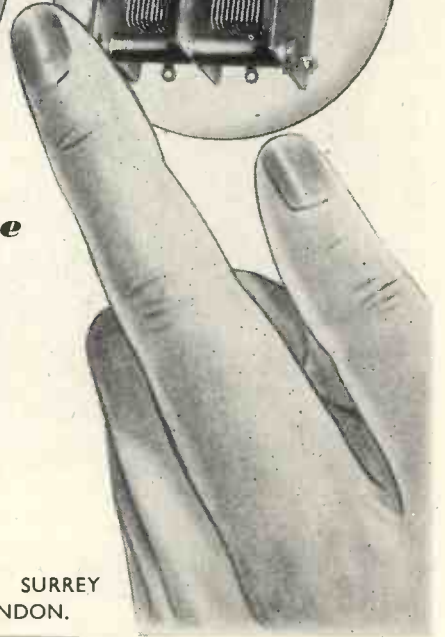
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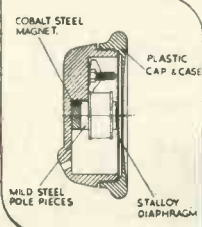
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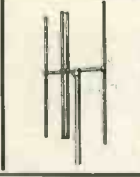
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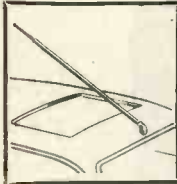


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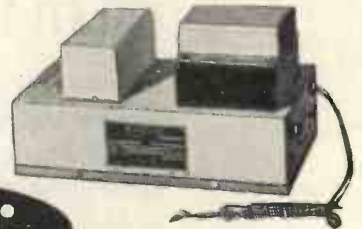
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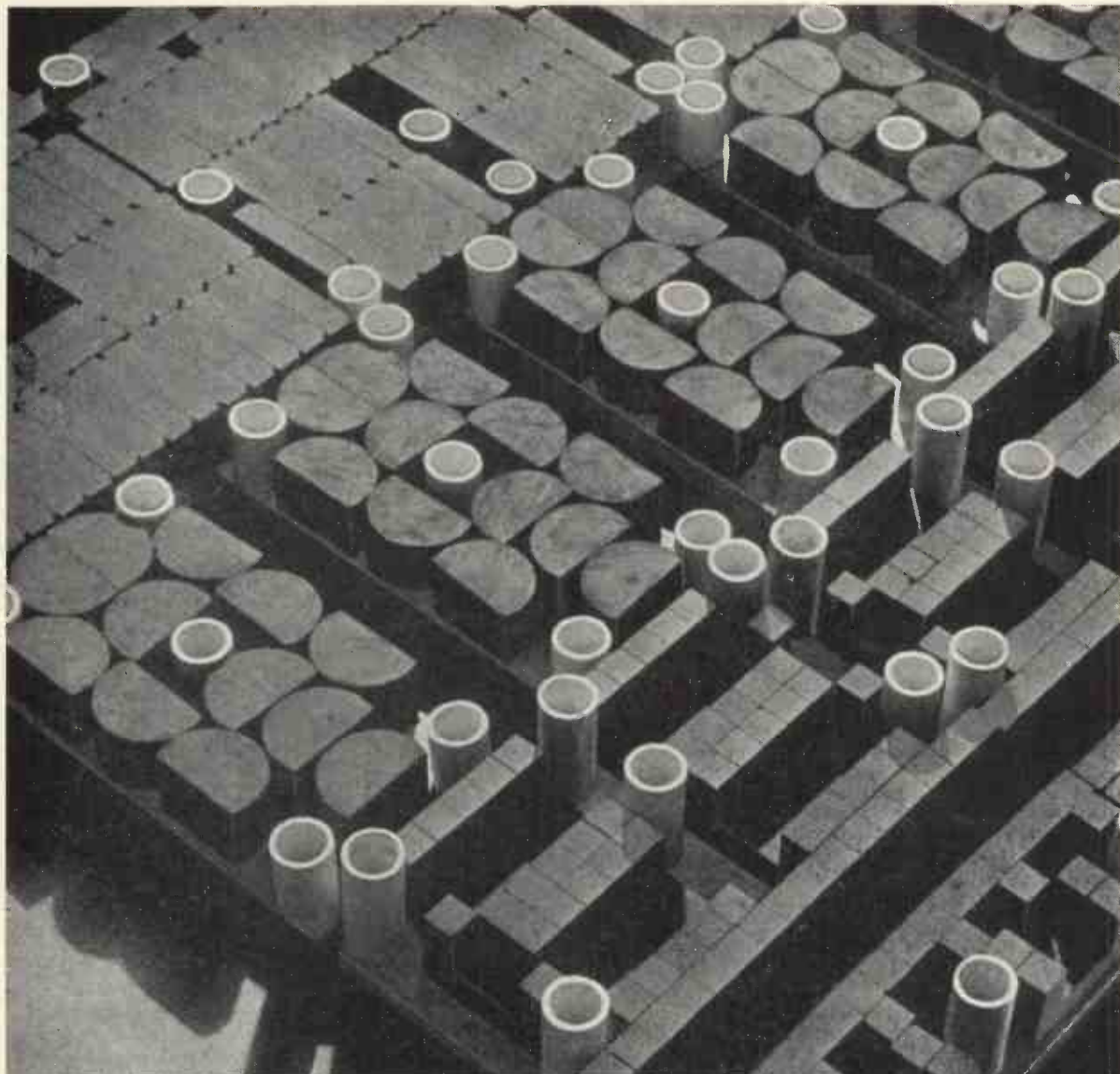
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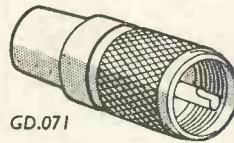
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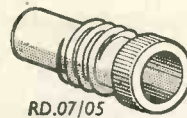
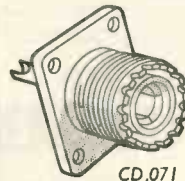
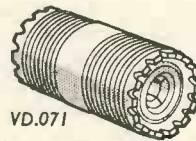
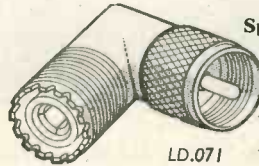
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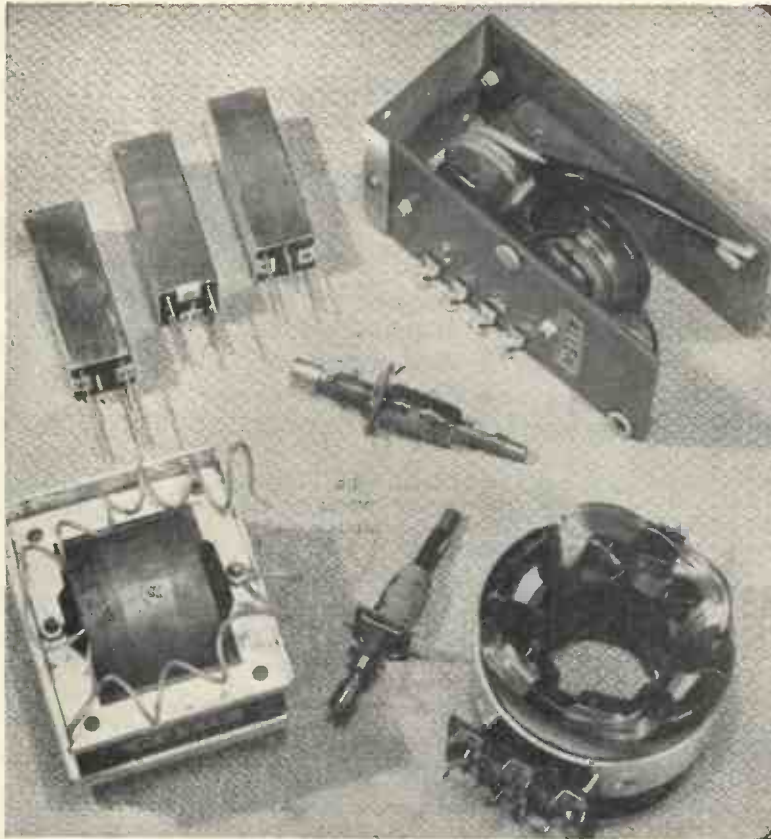
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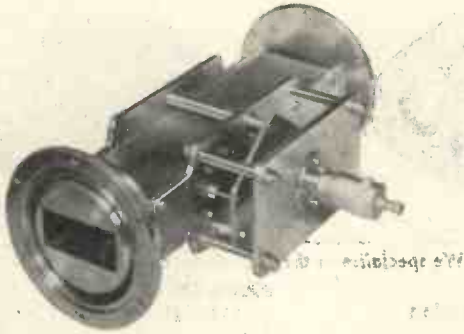
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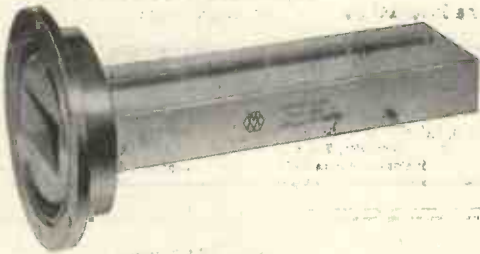
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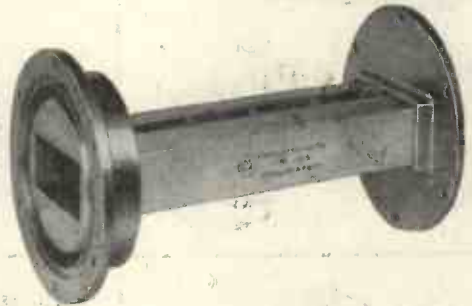
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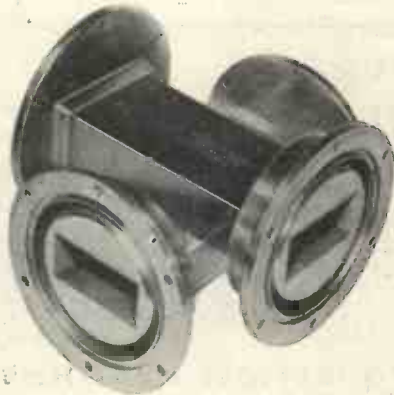
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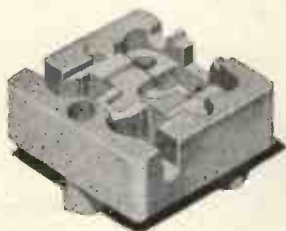
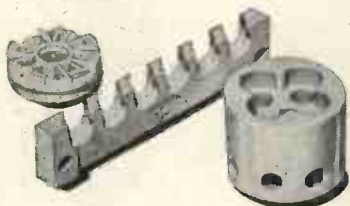
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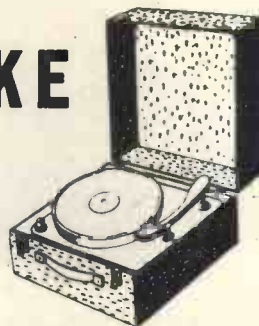
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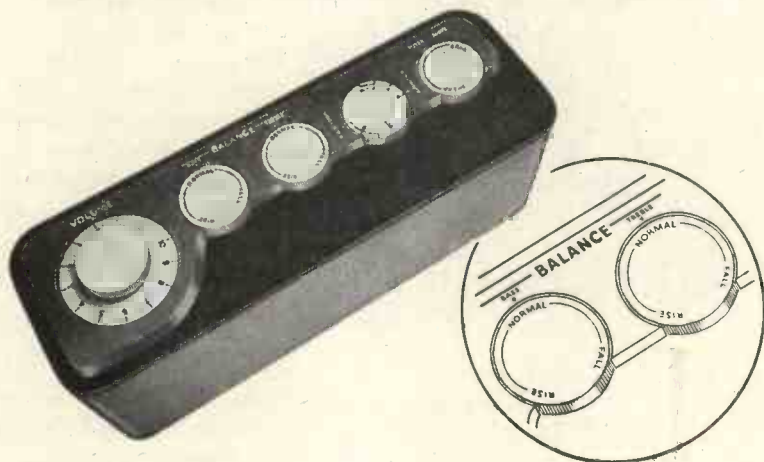
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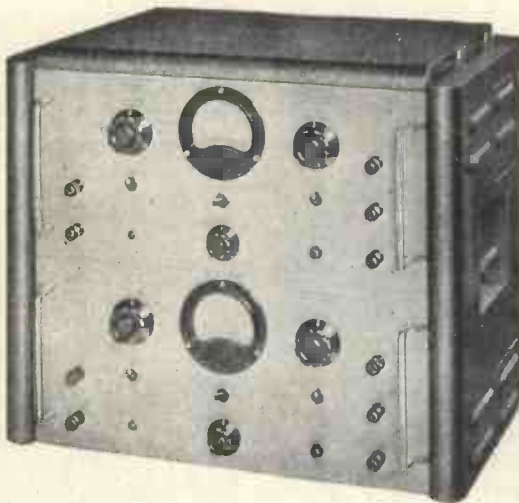
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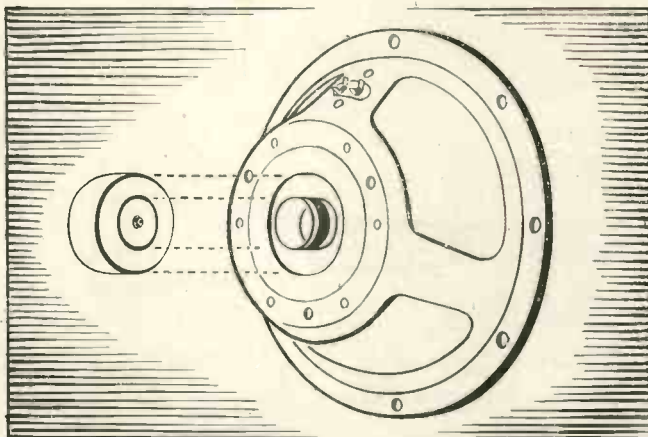
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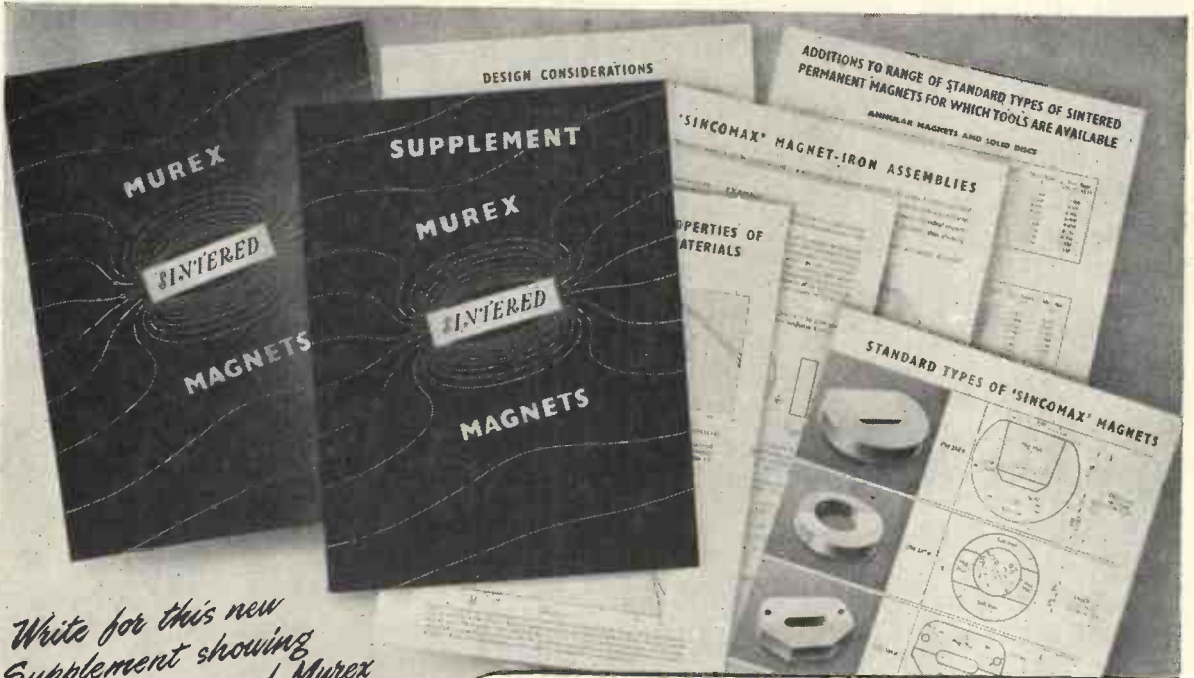
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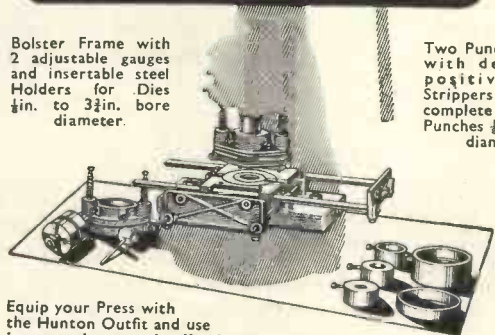


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P.F.A.

GW 18/C



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*A laboratory report of Goodsell Williamson Amplifier GW18/C, which was submitted to intermodulation tests.*

| I.M. Distortion | Power Output | Frequency Ratio 1 : 4 |
|-----------------|--------------|-----------------------|
| 2%              | 15 watts     | 40 & 2,000 c/s.       |
| 0.3%            | 10 watts     | 40 & 2,000 c/s.       |
| 0.9%            | 15 watts     | 100 & 2,000 c/s.      |
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**TYPE GW18**  
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**TYPE GW18/C**  
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GW12

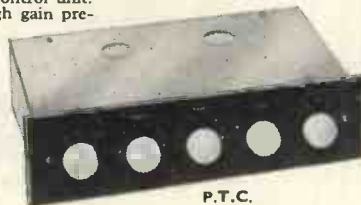


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**F.U.T.C.** Pre-amplifier tone control unit. Five stage low noise pre-amplifier and with six position equalisation switch. Seven position bass and treble tone controls and variable steep-cut, low-pass filter with cathode follower output. Position for two radio inputs and Microphone input if required. Sensitivity 10 to 15 Mv. on L.P.  
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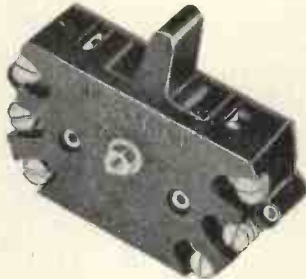
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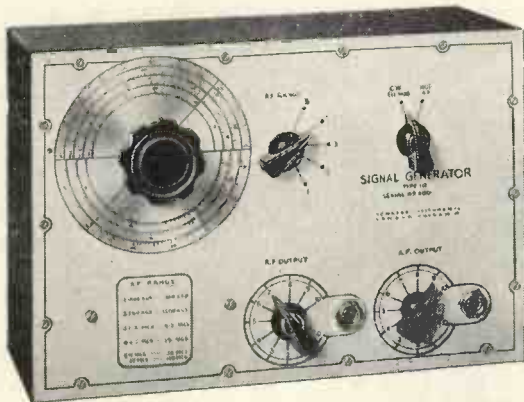
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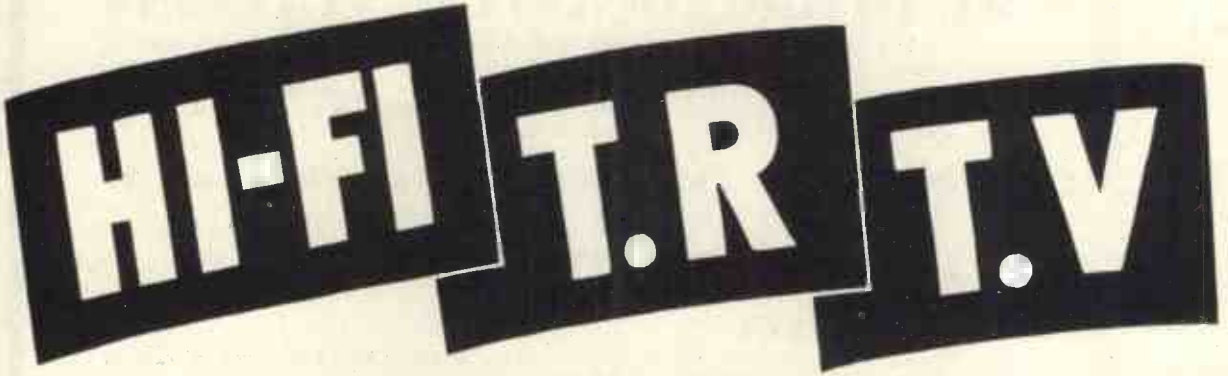
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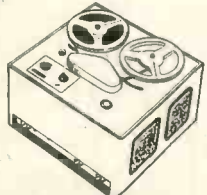
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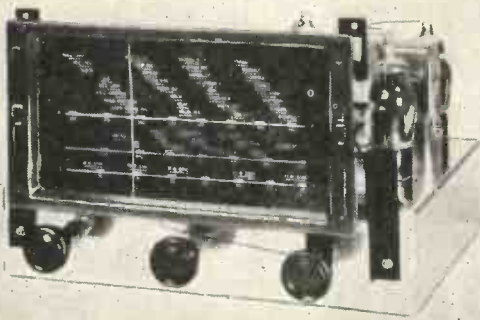
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|                                            |         |
|--------------------------------------------|---------|
| RM4 METAL RECTIFIERS .....                 | £1 1 0  |
| CZ1 BRIMISTERS .....                       | 3 6     |
| CZ2 BRIMISTERS .....                       | 2 6     |
| GD3 GERMANIUM DIODES .....                 | 7 6     |
| GD4 GERMANIUM DIODES .....                 | 7 6     |
| INVICTA T101 E.H.T. Bobbin .....           | £1 13 9 |
| INVICTA T101 Mains H.T. Bobbin .....       | £2 8 0  |
| INVICTA T101 Line output Transformer ..... | £2 1 6  |
| INVICTA T101 Frame Oscillator .....        | 19 11   |

BUSH TV12 and TV12A TYPE Line output Trans-  
 formers..... £1 15 6

FERRANTI TYPE E.H.T., voltage doubler 2.5 KV.  
 and 4 volt 1 amp. 6 KV Insulation .....

UNIVERSAL LINE OUTPUT TYPE AR/1. This transformer is a direct replacement for Alba T411, T421, Ferguson 842T, 843T, Peto Scott TV122, TV92, Regentone T20b, Vidor 396, 369, 369A, CN370, Beethoven TV50, TV50M, and Philco 1707, 1708. Every service engineer should have one in stock, 54/6. Trade discount to dealers.

UNIVERSAL LINE OUTPUT TYPE AR/2. As used in Decca 131, Etronic Projection, Peto Scott 165, 169, and White Ibbotson .....

HEATER ISOLATING TRANSFORMERS. For sets with cathode to heater shorts. Highest grade. Either supplied 1 : 1 or 230 volt input .....

ADCOLA SOLDERING IRON, with detachable bit .....

ALL ORDERS C.O.D. OR C.W.O.

PLEASE ADD POSTAGE UP TO 10/-, 1/-; £1, 1/6; £2, 2/-.

OPEN ALL DAY SATURDAY. HALF DAY THURSDAYS



OPEN TILL 6 P.M. SA TURDAYS

TELEPHONES: AMBASSADOR 4832 & PADDINGTON 32178

# PREMIER RADIO Company

(REGD.) S.M. MORRIS & CO. (RADIO), LTD. EST. 1928

(Dept. W.W.) 207 · EDGWARE ROAD · LONDON · W2

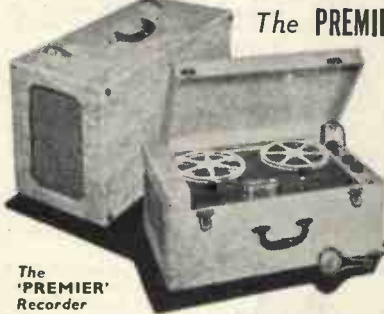
WORKING MODELS OF THE PREMIER TAPE RECORDERS CAN BE SEEN AT THIS ADDRESS.

## The PREMIER De Luxe PORTABLE MAGNETIC TAPE RECORDING KIT

PRICE

£37·4·0

(Plus 15/- Pkg., Carr. & Ins.)



The 'PREMIER' Recorder

This Recording Outfit has been designed for use with M.C.-2-111 'SCOTCH BOY' Magnetic Tape. With this new and improved high-quality tape a frequency of 50 c.p.s. to 9,000 c.p.s. at tape speed of 7 1/2 in./sec. can be readily achieved. Additional reels of 1,200ft. can be supplied at 35/-

★ Including ALL parts, Valves, Portable Cabinet, 8 in. Loudspeaker, Tape-Table, Reel of 'Scotch Boy' Tape and Rewind Spool, and Microphone.

THE 7-VALVE AMPLIFIER IS SPECIALLY DESIGNED FOR HIGH QUALITY REPRODUCTION

Brief Specification: VALVE LINE-UP: EF37A First Stage, 6BL7 Second Stage and Tone Control; 6V6 Output 6X5 Rectifier; VT501 Bias and Erase Oscillator; 7193 Record Level Amplifier; 6U5 Magic Eye Record Level Indicator. OUTPUT: 4 Watts. FREQUENCY RANGE: 50 c.p.s. to 9,000 c.p.s. CONTROLS: Volume; Record; Playback Switch; Treble Boost; Base Boost—on/off.

A VISUAL MAGIC EYE RECORD LEVEL INDICATOR is incorporated. The unit is housed in a superbly finished rexine covered portable cabinet which incorporates a compartment for the Microphone when not in use. Weight complete 33lb. Dimensions: 21in. long, 12 1/2in. deep, 9 1/2in. high.

THE RECORDER incorporates an entirely NEW VERSION of the famous LANE TAPE TABLE. Brief Specification: Made to high standards and incorporating features ensuring low level of 'Wow' and 'Flutter' throughout the full length of tape.

FAST REWIND. Provision for fast rewind and forward run in less than 1 min. in either direction. WIND AND REWIND WITHOUT UNLACING OF TAPE. INSTANTANEOUS BRAKING. THREE MOTORS obviating friction drive.

HIGH FIDELITY RECORD PLAYBACK (1 HOUR APPROX. PLAYING). The Table is fitted with high fidelity record playback head of new design wound to high impedance and a separate A.C. Erase Head. The Heads are half-track size allowing approx. 1 hr. playing from standard 1,200ft. Reel of Tape.

TAPE SPEED: 7 1/2 in. sec. For use on A.C. 200/250, 50 cycles mains only.

MICROPHONE: Crystal—specially designed for Premier by famous manufacturer.

### INSTRUCTIONAL BOOKLET . . . 2/6

This is credited if a complete kit of the Tape Recorder is ordered.

As is usual in all PREMIER KITS, every single item down to the last nut and bolt is supplied. The Chassis is punched and layout diagrams and theoretical circuits are included. When completed the PREMIER PORTABLE TAPE RECORDER compares MORE than favourably with any other make at double the price.

### SEPARATE UNITS CAN BE SUPPLIED AS LISTED BELOW—

|                                                                          |                             |
|--------------------------------------------------------------------------|-----------------------------|
| AMPLIFIER KIT (including 8in. Speaker) . . .                             | £11 0 0 plus 5/- pkg./carr. |
| AMPLIFIER (already built, wired and tested) £14 15 0 plus 7/6 pkg./carr. |                             |
| LANE TAPE TABLE & REWIND SPOOL £16 10 0 plus 7/6 pkg./carr.              |                             |
| PORTABLE CABINET (rexine covered) . . .                                  | £4 19 6 plus 5/- pkg./carr. |
| MICROPHONE . . . . .                                                     | £2 19 6 plus 1/- pkg./carr. |
| REEL OF NEW M.C.-2-111 "SCOTCH BOY" TAPE (1,200ft.) . . . . .            | £1 15 0 plus 1/- pkg./carr. |

To those unable to build this PORTABLE TAPE RECORDER we can supply it completely wired, tested and ready to plug in at **39GNS** Plus 1 gn. pkg./carr.

## PREMIER TABLE MODEL MAGNETIC TAPE RECORDER

### INSTRUCTIONAL BOOKLET . . . 2/6

This is credited if a complete Kit of the Tape Recorder is ordered



IN KIT FORM—The Kit includes ALL parts, valves, cabinet, loudspeaker, Reel of "Scotch Boy" Tape, Rewind Spool and the NEW Lane Tape Table already assembled (but excluding Microphone).

SPECIFICATION AS PREVIOUSLY ADVERTISED

Cabinets to suit the above can be obtained for **£29 : 8 : 0** (Packing and Carriage 15/-)

COMPLETE—to those unable to build this TAPE RECORDER, we offer it built, tested and ready to plug in, complete with "RONETTE" Microphone, Reel of "Scotch Boy" Tape and Rewind Spool.

SPECIFICATION AS PREVIOUSLY ADVERTISED **£35 : 15 : 0** (Packing, Carr & Ins 1 Gn.)

\* All the above Recorders are Fully Covered by the usual Premier Guarantee—3 months valves—12 months other components.

### CRYSTAL MICROPHONE

An entirely insulated crystal microphone which can be safely used on A.C./D.C. amplifiers. High impedance. No background noise, really natural tone. The ideal Mike for tape, wire and sound projectors. Price 22/6.

### MICROPHONE STAND BASE

Heavy Moulded Black Base fitted with standard thread adaptor. Dimensions: 7 1/2in. across, 2in. deep. Weight: 1 1/2lb. Post paid 3/11.



### MOVING COIL MICROPHONE

Low impedance. Incorporates press-to-talk switch. Housed in strong black bakelite case. Dimensions: 2 1/2in. wide, 2 1/2in. high, 1 1/2in. deep. Plus 1/6 post and packing **19/6**. A matching transformer for high impedance can be supplied at 3/6 extra.

### MICROPHONES

LUSTRAPHONE: Moving Coil; High Impedance. Stand Type: £5/15/6—Hand Mike 6/6/-.

RONETTE—Crystal Mike; incorp the filter Cell Insert; High Imped. Ball Type: £3/19/6. CRYSTAL MICROPHONE—Rotherme 2AD56. Especially recommended. £2/19/6. Table stands for all the above at 10/6 and 17/6.

# Announcing . . . The NEW PREMIER TELEVISOR

Three years ago we gave you the 6in., 9in. and 12in. Televisors which achieved tremendous popularity. Now after a considerable period of research our Technical Staff have designed a very worthy successor to these original Models.

Brief Technical Details are as follows:—

19 valves (plus tube) Superhet Receiver, tunable from 40-68 Mc/s without coil or core changing. Wide Angle scanning Flyback EHT giving 14 kV. Duomag Focalsiser permanent magnet focussing with simple picture centering adjustments, suitable for any 17in. or 14in. wide angle Tube. ma also be used with a 12in. Tube with very minor modifications.

THE COMPLETE TELEVISOR IS SAFE TO HANDLE, BEING COMPLETELY ISOLATED FROM THE MAINS BY A DOUBLE WOUND MAINS TRANSFORMER. ALL PRESET CONTROLS CAN BE ADJUSTED FROM THE FRONT, MAKING SETTING UP VERY SIMPLE.

VISION CIRCUIT. Common RF Amplifier, single valve frequency changer, two IF stages, Video Detector and Noise Limiter followed by special type of Video Output Valve. ALL COILS PRE-TUNED ASSURING ACCURATE ALIGNMENT AND EXCELLENT BANDWIDTH.

SOUND CIRCUIT. Coupling from anode of frequency changer, two IF stages, Double Diode Triode detector and first LF Amplifier, Diode Noise Limiter and Beam type Output Valve, feeding a 10in. Speaker. ALL COILS PRE-TUNED.

TIME BASES. 2 valve sync. Separator, giving very firm lock and excellent interlace.

Time Base may be used to convert existing Premier Magnetic Televisors for use with modern wide angle Tubes.

LINE TIME BASE. Blocking Oscillator using a pentode driving a high efficiency output stage comprising Ferroxcube Cored Output Transformer with Booster Diode.

FRAME TIME BASE. Blocking Oscillator driving a Beam Output Valve coupled through a Transformer to the high efficiency FERROXCUBE Cored Scanning Coils.

POWER PACK. Double wound Mains Transformer supplying all LT and HT using two full-wave Rectifiers.

AVAILABLE SHORTLY—WRITE FOR DETAILS



OPEN 10.15 P.M. SATURDAYS

TELEPHONES: AMBASSADOR 4012 & PADDOINGTON 3317/8

# PREMIER RADIO Company

(REGD.) B.H. MORRIS & CO. (RADIO), LTD. EST. 14 YRS.

(Dept. W.W.) 207 · EDGWARE ROAD · LONDON · W2

Terms of Business :  
Cash with order or  
C.O.D. over £1. Please  
add 1/- for Post Orders  
under 10/-, 1/6 under  
40/-, unless otherwise  
stated.

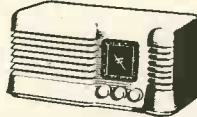
### BUILD A PROFESSIONAL LOOKING RADIO AT LESS THAN HALF TODAY'S PRICE

- We can supply all the parts to help you.
- Drum (2 1/2 in. dia.) 1/6
  - Driving head 1/6
  - Double pointer 4d.
  - Spring 3d.
  - Nylon Cord (yard) 6d.
  - Dial Front Plate 2/6
  - Engraved Glass Dial 180-550 and 800-2,200 m. With station names, new wavebands... 1/6
  - T. R.F. Coils, 180-550, 800-2,200 metres, pair 6/6
  - Punched chassis, 3-valve plus rectifier T. R.F. 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 £5.19.6, 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. x 6in. x 6in. Presents an attractive appearance. The valve line-up is: 717A—H.F. Pentode, VR116—Detector, APT4—Output, and Metal Rectifier.



### ONLY A FEW LEFT—BUY NOW! THE 'SOBELL' 4-VALVE SUPERHET TABLE RECEIVER

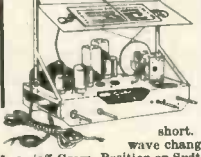
M. & L. WAVEBANDS

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 Green. Carrying handle incorporated in design. For use on 200/250 A.C./D.C. mains. Plus 5/- Pkg./carr./ins. **£8. 19. 6** Fully covered by Manufacturer's Guarantee



### MANUFACTURER'S SURPLUS STOCK

**5-VALVE SUPERHET RADIO RECEIVER CHASSIS**, built to high standards ensuring quality reception. **SPECIFICATION: VALVE LINE-UP:** 787, 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 14 1/2 in., height 13 1/2 in., width 6 1/2 in. Distance between controls, left to right from edge of chassis : 1in., 3in., 6 1/2 in., 3in. Plus 5/- pkg./carr./ins. **£7.19.6** The above Receiver is less Speaker and Output Transformer. A suitable 10in. Moving Coil Speaker and Output Transformer can be supplied at 29/- extra.

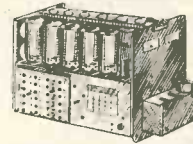


### LIMITED QUANTITY I132A RECEIVER UNITS COMPLETE WITH CIRCUIT

11-valve Superhet Receiver, covering 100 to 124 Mc/s. using four VR53, two VR58 and VR66, VR67, Y554 and VR57 valves. Fitted with Tuning Meter, slow motion drive, R.F. and L.F. Gain Control, etc. Circuit : R.F. amp., frequency changer, oscillator and stab., 3-I.F. amps., B.F.O. Det., first audio and output. Brand new, with circuit diagram. Price **59/6** plus 7/6 carriage.



### I124 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-W/W Pot. Meter Mica Tubular and Block Condensers, Ceramic coil former, 2 Westector WX6 and I.F. transformers, etc. Brand new in maker's carton at 17/6, plus 3/6 postage and packing.

### I155 RECEIVER UNIT

**SLIGHTLY SOLED** 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 6in. speaker is built into the unit. Price **25/5/-**, plus 5/- packing and carriage.



As a special offer, power supply unit including speaker together with R1155 receiver. **PRICE £16.19.6**. Plus 15/- pkg. & carr.

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.

### 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 25 UNITS

Containing 19 valves, 6—VR65, 2—6J7G, 2—VR116, 3—6Q79, 1—VR54, 1—VR137, 2—VR136, 1—VR92, 1—5Z4G, the Unit incorporates an R.F. strip followed by an IF strip, **£5/7/6**, plus pkg. and carr. 2/6.

### RF 26 UNITS

The ideal short-wave converter for T.V., variable tuning, contains 2—EP54, 1—VR137, **£2/19/6**, plus pkg. and carr. 2/6.

As a special offer we can supply the R1355 complete with RF.24 or RF.25 at 55/6 or with RF.26 at £4/17/0 plus carr.

### R3136 RADAR RECEIVER UNIT

Containing 19 valves, 6—VR65, 2—6J7G, 2—VR116, 3—6Q79, 1—VR54, 1—VR137, 2—VR136, 1—VR92, 1—5Z4G, the Unit incorporates an R.F. strip followed by an IF strip, **£5/7/6**, plus pkg. and carr. 10/-.

### CORRECT ASPECT WHITE Rubber Mask—Round or Flat

|            |       |            |      |
|------------|-------|------------|------|
| 6in. ....  | 8 6   | 9in. ....  | 9 6  |
| 12in. .... | 16 11 | 15in. .... | 27 6 |

### 6L INDICATOR UNITS

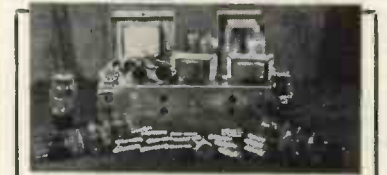
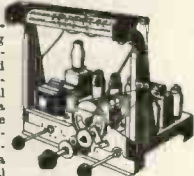
Complete with VCR97, 4—VR91. 3—VR54, **£3/15/-**, plus pkg. and carr. 7/6.

### LIMITED QUANTITY ONLY AVAILABLE AT GREATLY REDUCED PRICE THE FAMOUS 'ROBERTS' M.A.D.

All Dry Battery Portable (Ex-R.A.F.) This is a 4-valve superhet Receiver covering medium and long wavebands. Built-in Aerial. Housed in a superbly finished rexine covered case. Brand new in manufacturer's original carton. **£13.13.0** plus 7/6 pkg./carr./ins. (Complete with Battery 17/6 extra.)

### 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 H141DD 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.



### WILLIAMSON AMPLIFIER KIT

A complete kit of parts for the construction of the latest version of this famous amplifier, complete with valves, output and mains transformers. **15 gns.** Plus 7/6 pkg., carr. and ins. **WILLIAMSON AMPLIFIER TRANSFORMERS** (To specification) The Output Transformer 3.6 ohm sec., **£4/4/-**. The Mains Transformer PREMIER SP425A, **£3/7/6**.

### 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  |
| " K3/150                  | 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  |
| " R314                    | 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.              | .....   | .....   | ..... | 12/6 |

### ROTARY CONVERTER POWER SUPPLY UNITS

12 v. D.C. Input, 230 v. 30 mA. Output. Completely smoothed. Complete with case, 19/6, plus pkg. and carr. 5/-.

### 2 STAGE QUALITY AMPLIFIER Complete with 10in. Energised LOUDSPEAKER

4 watts output. A.C. 110/230 mains. **£6. 19. 6** plus 5/- carriage.



### FRACTIONAL H.P. MOTOR A 50 v. 3-phase A.C. motor, 1/40th h.p., by famous maker. Supplied complete with resistor, condenser and circuit diagram to convert the motor to i. h.p. for use on 240 v. single phase A.C. mains. Brand new, 25/-, plus 2/6 carriage and packing.

### MAGNETIC MARCHING COMPASS

Luminous Dial, enclosed in black bakelite case. Size: 3in. x 2 1/2 in. x 7 1/2 in. Price **18/6**.



### Govt. Surplus EX W.D. STEEL AERIALS

Also ideal for fishing rods—All Brand New 12ft.—3 1/2 ft. sections of copper-plated steel highly flexible tapering 1/2 in. to 1/4 in. Brand new in container. Plug-in type 6/9. Screw-in type 7/9. Packing and carriage 1/6. Insulated Base 3/-. Webbing waterproof carrying case with shoulder sling, 2/6.

### 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, 6/- complete.



OPEN TILL 8 P.M. SATURDAYS

TELEPHONES: AMBASSADOR 4933 & PADDOINGTON 31112

# PREMIER RADIO Company

(REGD.) R.M. MORRIS & CO. (RADIOS), LTD. EST. 49 YRS.

(Dept. W.W.) 207 · EDGWARE ROAD · LONDON · W2

Terms of Business :  
Cash with order or  
C.O.D. over £1. Please  
add 1/- for Post Orders  
under 10/-, 1/6 under  
40/-, unless otherwise  
stated.

**PREMIER MAINS TRANSFORMERS**

- All primaries are tapped for 200-250-280 v. mains 40-100 cycles. All primaries are screened. All LTs are centre tapped.
- SP178B, 175-0-175, 50 mA., 4 v. @ 1 a. 4 v. @ 2-3 a. 25/-
  - SP301E, 300-0-300, 120 mA., 4 v. @ 2-3 a. 4 v. @ 2-3 a. 4 v. @ 3-5 a. 28/-
  - 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, 160 mA., 5 v. 2-3 a. 6.3 v. 2-3 a. 6.3 v. 2-3 a. 36/-
  - SP376A, 375-0-375, 250 mA., 6.3 v. @ 2-3 a. 6.3 v. @ 3-5 a. 6 v. @ 2-3 a. 55/-
  - SP501, 500-0-500, 160 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, 160 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. 67/8
  - 250-0-250, 80 mA., 6.3 v. @ 4 a. 5 v. @ 2 a. 19/8
  - 350-0-350, 80 mA., 6.3 v. @ 4 a. 5 v. @ 2 a. 19/8
  - 200-250-250, output 3 v.-30 v. @ 2 a. 17/8
  - Charger, 2-6-12 v. @ 1.5 a. 12/6

**SPECIAL OFFER**

**DOUBLE WOUND AUTO-TRANSFORMER 250 watts.**

| Input/Output 100 volts | Output/Input |                      |
|------------------------|--------------|----------------------|
| 110                    | 113          |                      |
| 200                    | 116          |                      |
| 210                    | 119          | Price 42/8           |
| 220                    | 122          | Plus 2/6 Pkg., Carr. |
| 230                    | 134          |                      |
| 240                    | 146          |                      |
| 250                    |              |                      |

With the two windings connected in series a vast number of voltage tappings are available.

**PREMIER VARIABLE IMPEDANCE "MATCHMAKER" 10.15 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 16 watts audio 100 mA. Price, 45/-.

**WEYMOUTH MINIATURE I.F. TRANSFORMERS**

465 Kcs./s., iron cored, permeability tuned, 10/8 pair.

**WEYMOUTH MINIATURE COIL PACK**

Covering Med./Long/Short wave bands. Iron cored coils, gram position on switch. Dimens: Height, 1 1/4 in. Length, 3 1/4 in. Width 2 1/4 in. Spindle length 2 in. Price 19/8.

**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

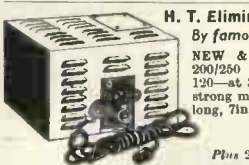
**BATTERY CHARGERS**

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: 6 in. long, 3 1/2 in. wide, 3 1/2 in. 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**

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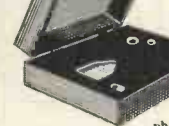
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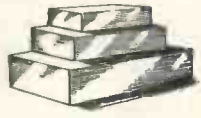
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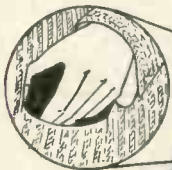
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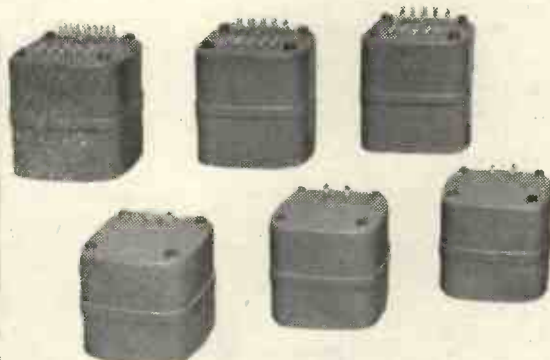
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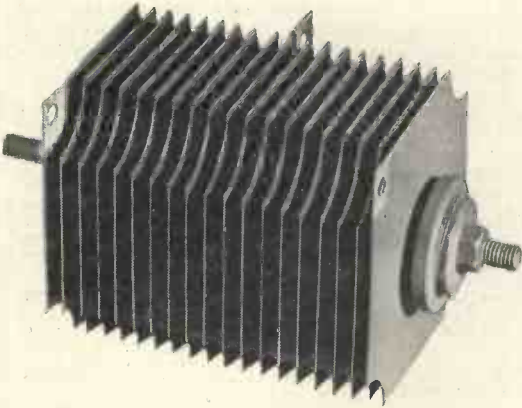
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(P.1.416)

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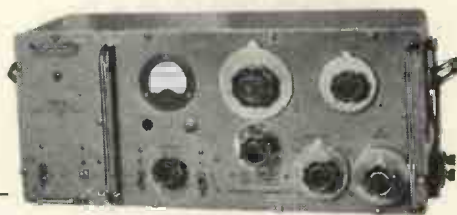
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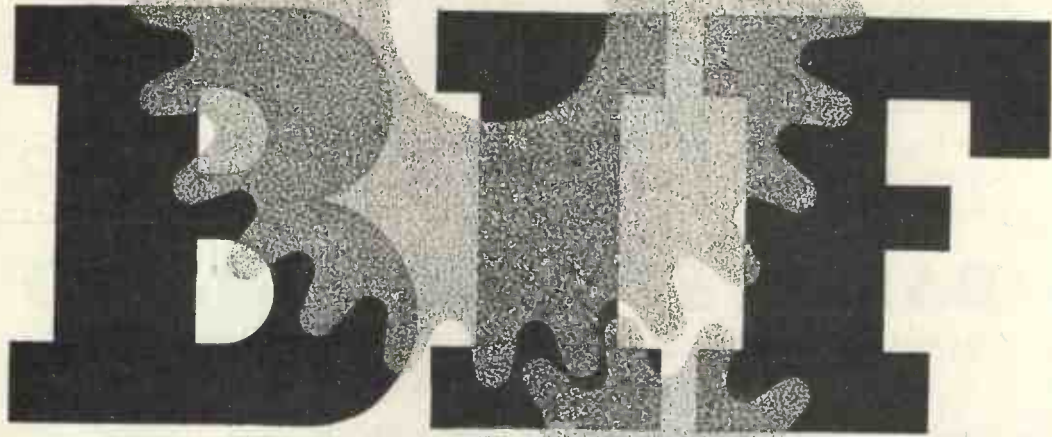
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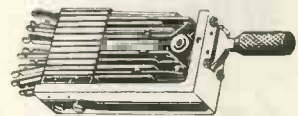
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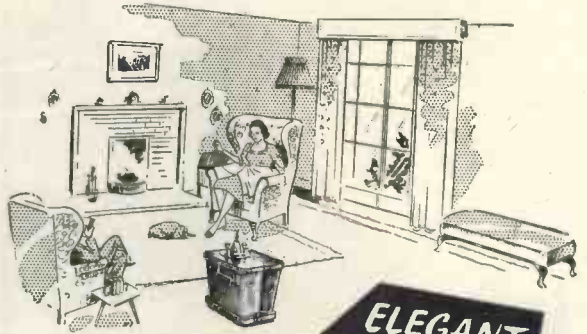
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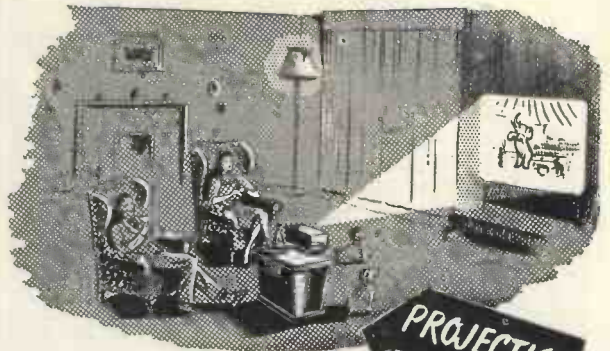
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W9



# WORLD'S MOST WANTED AUTOCHANGER



Music lovers everywhere are demanding the Monarch—the new idea in automatic record changers. Never before have they had such fidelity of tone; completely automatic selection of all records—12", 10" and 7"; such ease of operation and unfailing reliability.

Many leading set makers fit the Monarch as standard—your request for information will bring full details by return.





# VALVES, TUBES & CIRCUITS

## 10. NOVAL-BASED VALVES FOR AUDIO AMPLIFIERS

The designer of audio amplifiers must have at his disposal valves of several different types—valves suitable for use in the pre-amplifier stages; output valves capable, singly or in combination, of delivering the requisite amount of audio-frequency power to the loudspeaker; voltage amplifying valves of moderate gain for use in the driving stage preceding the output stage; and power rectifiers for providing the high tension supply to the amplifier.

There is everything to be gained when valves for all these functions form a complete range, designed for operation in combination. For many years a complete range of Mullard valves suitable for audio-frequency applications has been available. From time to time developments in the techniques of valve design and manufacture, or the emergence of new requirements in amplifier performance, have provided the impetus for the introduction of improved or even entirely new valves.

Quite recently audio-frequency amplification has assumed still greater importance, both by reason of comparatively new applications and on account of greatly extended use of amplifier equipment for all applications. The rapidly increasing use of 16mm. sound film equipment in the domestic, educational and advertising fields; the growing popularity of tape recording; the high quality sound accompaniment transmitted by the B.B.C. Television Service—these are but a few of the factors in the increased demand for valves especially designed for audio amplification and in the need for modification or extension of the existing range of valves.

In satisfying these requirements an opportunity is presented for incorporating in each type all relevant improvements which have been developed over a period of time; for planning ahead so that the new range will also meet foreseeable requirements for some time to come; and for adopting in each case the latest manufacturing techniques, including the use of the now preferred base—the Noval (B9A) nine-pin base.

The new range of Mullard valves for audio amplifiers comprises the following types:—

**EF86**—pentode pre-amplifier, incorporating all the improvements with respect to low microphony, low noise and low hum level associated with the EF37A and EF40 which it now replaces.

**ECC81** } double-triode voltage amplifiers for such applications as dual input circuits,  
**ECC82** } phase splitters, equalisation circuits etc. The range offers a choice of impedance  
**ECC83** } to suit particular circuits; each triode section has an independent cathode.

**EL84**—output pentode rated for 12W anode dissipation. A single valve gives an output of 4 to 5 watts into the speaker load and 16W can be obtained from a pair of EL84's operated in Class AB push-pull.

**EZ80**—full-wave power rectifier having a maximum output of 90mA.



Reprints of this advertisement, together with additional data, may be obtained free of charge, from the address below

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MVM246

BRITISH MADE  
**BRIMAR**  
 VALVES

**More reliable**

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Years of experience in the design and manufacture of Trustworthy special quality valves has resulted in *increased reliability throughout the entire BRIMAR Range.*

New techniques and the more accurate control of vital processes have resulted in manufacture of a more uniform and reliable product and in a lower rate of rejection. This, in spite of the fact that testing is more rigorous.

Reliability is especially important in the modern T/V Receiver which employs four times as many valves as radio and — fewer rejects in the factory will mean fewer failures in the field!

The Brimar 6AM6/8D3 and its direct equivalents the Z77, SP6, EF91 and 6F12 have been some of the most widely used valve types in post-war Television Receivers. Large quantities have been used in the following Manufacturers' sets:—

|          |              |
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| BAIRD    | K-B          |
| BUSH     | MARCONIPHONE |
| COSSOR   | MASTERADIO   |
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Use the improved BRIMAR 6AM6/8D3

to replace these valves at NO EXTRA COST



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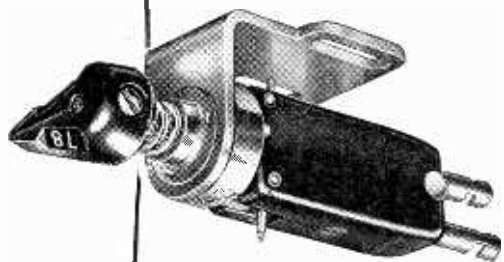
FOOTscray 3333

# First of the "Hi-g" Pick-ups

*Now available to gramophone manufacturers*



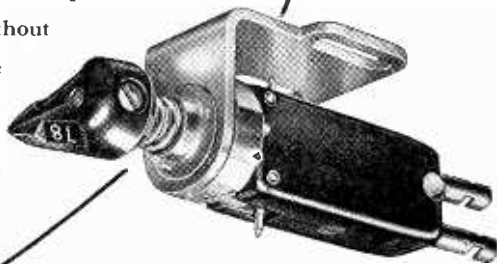
**TURNOVER  
PICK-UP CARTRIDGE  
TYPE HGP 33-1**



Here it is—the HGP 33, capable of tracking the highest modulation levels that can be engraved on either standard or long playing records.

Nominal output is one volt on standard records and  $\frac{1}{2}$  volt on long playing records. Response is smooth and completely without resonances. Equalisation can be easily carried out if required.

Technical Data Sheet on request.



- 1** *Extremely high compliance and low mass.*
- 2** *Styli easily replaceable without tools.*
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- 4** *Universal mounting.*



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# THE "BELLING-LEE" PAGE

Providing technical information, service and advice in relation to our products and the suppression of electrical interference.

**A vivid working demonstration made possible by the clever application of a well known Radar Technique.**

At the Radio Show, on the "Belling-Lee" stand was shown a normal television picture cut in half, each half showing a different condition. In the demonstration it simulated the difference, in a town like Bournemouth, of reception on a normal H type aerial, with that on a "Junior Multirod" with a masthead pre-amplifier. In practice the difference would be one of approximately 10 decibels, and the demonstration showed just what that would mean to the viewer in quality of picture, one half of which was impaired by the characteristic graining of the picture brought about by the use of excessive gain.

The same principle can be employed to provide an instantaneous



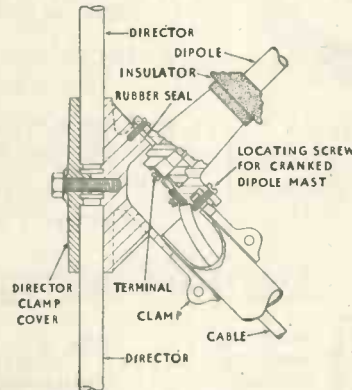
The illustration above shows a well known face with interference on one half of the picture and clear below.

comparison of two aerials, either straightforward or for correct orientation, or for the rejection of interference.

Many "Wireless World" readers will be well aware of how this is done, but for the benefit of the others, we would say that we employ a picture splitting unit combining two input signals and feeding to a common receiver. The two inputs are connected to two separate single valve amplifiers which are made inoperative alternately by the injection of a square wave signal on to the suppressor grids. The switching waveform is synchronized to the frame frequency. It will be understood that the half frame be so arranged as to be top or bottom or in the middle, as a band with a quarter frame above and below.

## The New "Kayrod"

The "Kayrod" is the most ingenious medium range aerial yet offered to the public. Technically it is better than some "H" types we have seen. It dispenses with both the crossarm and the mast. The heart of the "Kayrod" is



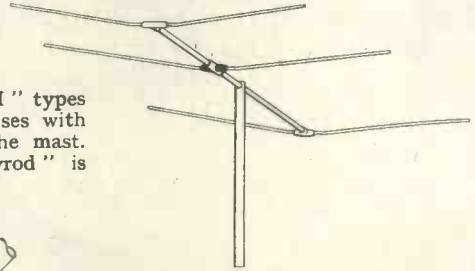
the centre casting and insulator combining the features of the reflector casting illustrated above. The inclusion of the ratchet bracket makes this aerial very easy and cheap to instal. The "Kayrod" is an additional useful weapon in the war against multiple images, but that doesn't mean that we claim it to be a "ghostmaster." The characteristics are such that it is good, but there will be many cases where the "Junior H" will give as good or better picture and still more cases where the "Junior Multirod" will be the answer.

## Screening of a T.V. Aerial

We are often asked if it is practical to connect a wire mesh or netting screen say  $\frac{1}{4}\lambda$  from the element of a T.V. aerial, between the aerial and some source of interference such as a busy road. The sensible answer is no. If you have to erect a T.V. aerial on a fairly high building that has a zinc roof, you may get rid of severe motor interference by setting the aerial well back, but in this case the screen is very large compared with the aerial and casts a wide shadow as it were.

## Horizontal Aerials with an Uplift

If a dipole or reflector tube of reasonable dimensions is held horizontally by one end, the free end will droop, and to us a drooping



aerial is an eyesore. You can increase the diameter and gauge of metal to uneconomical figures without gaining much. We therefore tried to put a "set" in the element so that its "droop" would bring it horizontal. From this thought we uplifted the element considerably, and now all "Belling-Lee" horizontal aerials are instantly recognised by this upswept feature. They are exceedingly well known around Newcastle and Belfast.

## Thank you Goodwood

At the time of writing this article we understood that all cars that were entered for the international nine hour race at Goodwood held on Saturday, 22nd August, must be fitted with ignition suppressors. Television reception at St. Mary's Institution

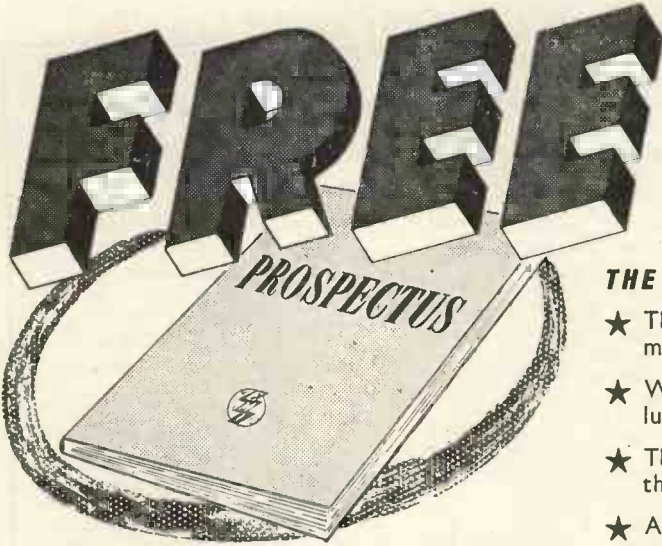


"Belling-Lee" "Sparkmaster"— Ignition Suppressor 2/6.

situated near the track has apparently been severely interrupted by previous racing, and the Duke of Richmond, owner of Goodwood and President of the British Automobile Racing Club has decided to make suppression a condition of entry. This is a wonderful example to the general public, many of whom still seem to fear that the performance of their cars will be impaired.

Written 27th August, 1953.

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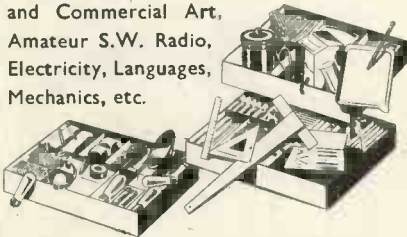
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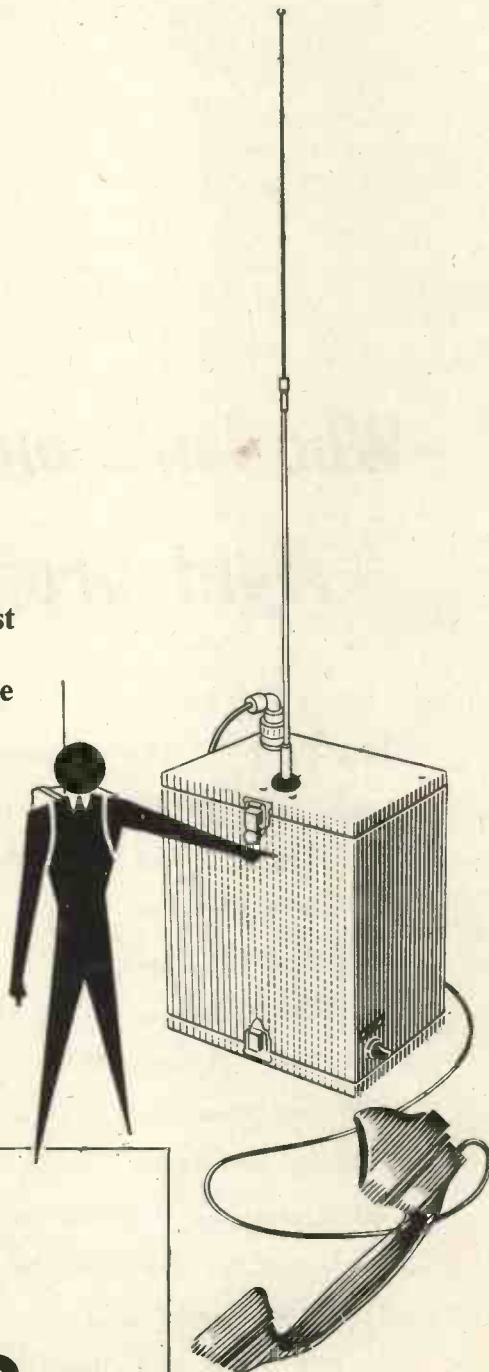
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Marconi mobile radio is the general name for a range of V.H.F. transmitter/receiver equipment designed to work under the most strenuous operating conditions. The range offers a choice of power up to 12W and a wide selection of frequencies to meet all operating requirements.



# MARCONI

## mobile radio

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Search your works for it and turn it in. You will be doing yourselves a great service.



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# Introducing

## Further additions to the range of **Clarostat†** WIRE-WOUND **Controls**

### TYPE 58 (Dual)

Two controls in tandem operated by a common spindle. Each control wound to any resistance up to 100,000 ohms linear. Diam. 1.21/32in. Total depth of case 1.9/16in.



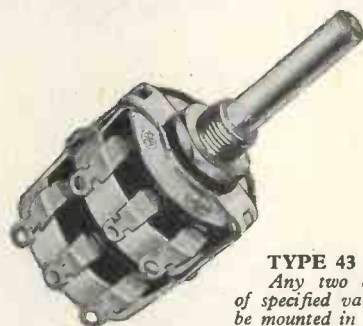
All Clarostat controls are manufactured with high grade Bakelite cases of rugged construction. Solder tags are heavily silver-plated and of special design, removing all danger of turning or loosening under operating conditions. The controls are fitted with metal dust covers which are firmly keyed into the Bakelite casing and connected to the fixing bush, thus providing automatic earthing of cover. Samples available on application.



### TYPE 58

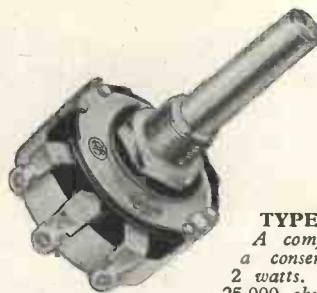
Conservatively rated at 3 watts: available up to 100,000 ohms linear. Diam. 1.21/32in. Depth of case 25/32in. Spindle diam. 1/4in. (insulated). Length to specification. Angle of rotation, mechanical 300°. Effective 280°.

All controls can be supplied with special windings and closer tolerances to specification. Can also be supplied fitted with single or double pole mains switch if required.



### TYPE 43 (Dual)

Any two controls of specified value can be mounted in tandem operated by a common spindle. Diam. 1 1/4in. Total depth of case 1.3/16in.



### TYPE 43

A compact control with a conservative rating of 2 watts. Available up to 25,000 ohms linear. Diam. 1 1/4in. Depth of case 19/32in. Spindle diam. 1/4in. (insulated). Length to specification. Angle of rotation, mechanical 300°. Effective 280°.

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Clarostat wire-wound Potentiometers are supplied with a spindle 2 1/2in. long with full length flat, individually packed in sturdy two-colour cartons. Delivery is prompt. Write for details of very attractive trade terms.

† Regd. Trade Mark



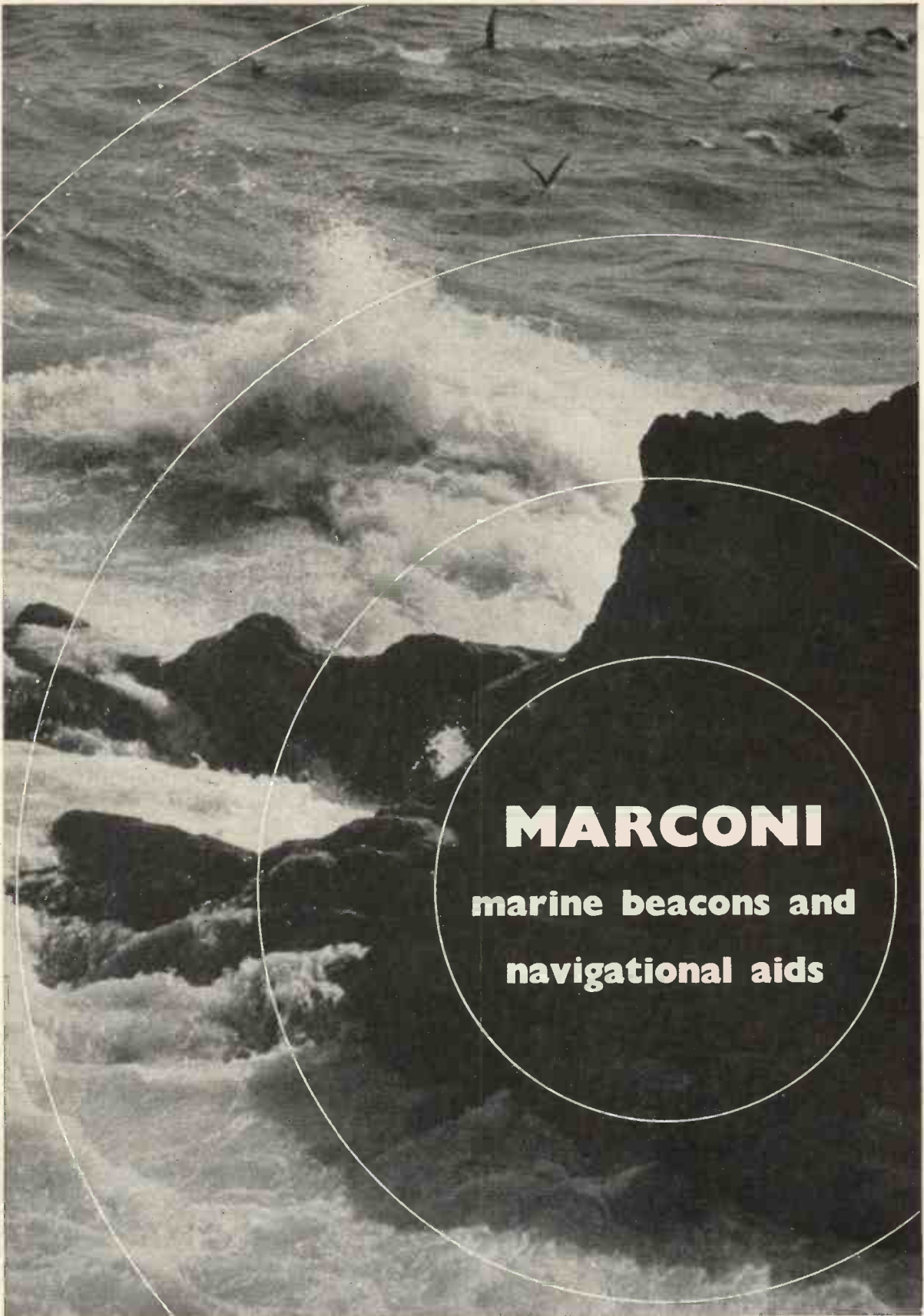
## Controls and Resistors



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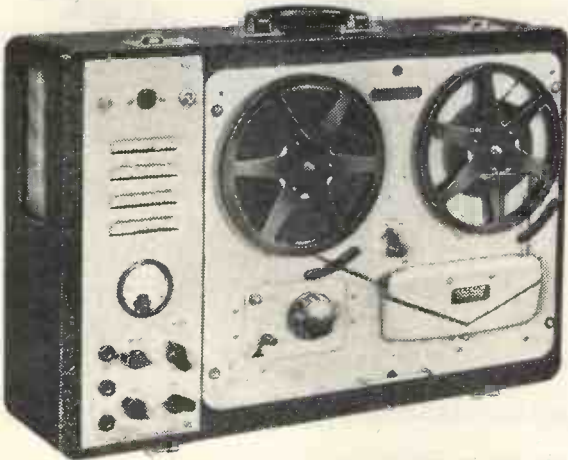


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The amplifier, speaker and case, with detachable lid, measures 8½ in. x 22½ in. x 15½ in. and weighs 30 lb.

PRICE, complete with WEARITE TAPE DECK ..... £84 0 0

**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.**

- ★ 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.

## The FOUR CHANNEL ELECTRONIC MIXER

is almost essential for the professional or semi-professional where a number of different items have to be mixed on one tape recording.

It is recommended by a number of tape recorder manufacturers for this purpose.

Any normal input impedance can be supplied to order, balanced or unbalanced, the standard being 15-30 ohms balanced.

The normal output is 0.5 volt on 20,000 ohms or less, but 600 ohms is available as an alternative.

The steel stove enamelled case is polished and fitted with an engraved white panel suitable for making temporary pencil notes.

An internal screened power pack and selenium rectifier feed the five low noise non-microphonic valves.

Used in many hundreds of large public address installations and recording studios throughout the world.



PRICE  
**£36.15.0**

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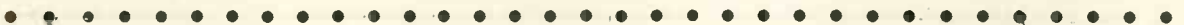


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We will not worry you with personal visits

# POLYTAGS...lead-through and stand-off insulators

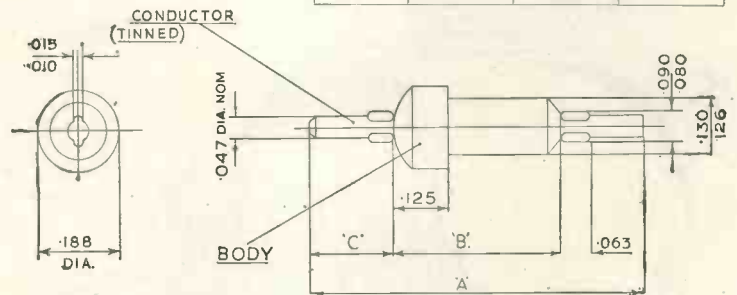
Polytetrafluoroethylene (P.T.F.E.) is an outstanding insulator. It is tough, durable and will not crack or arc. Its dielectric properties are substantially constant over a frequency range of 60 c.p.s. to at least 300 Mc.p.s. and are unaffected by temperature changes between minus 100°C. and plus 288°C. 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

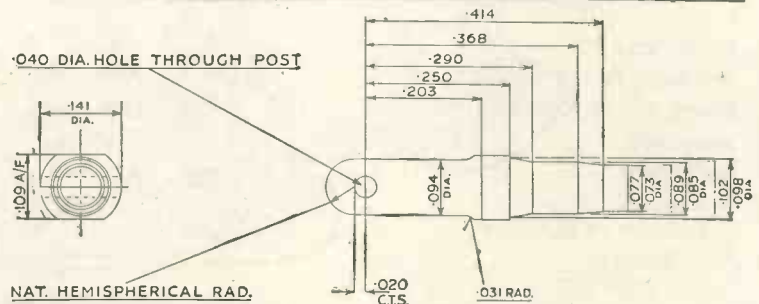


|      | A    | B    | C    |
|------|------|------|------|
| PT 1 | .750 | .375 | .188 |
| PT 2 | .875 | .500 | .188 |
| PT 3 | .563 | .375 | —    |
| PT 4 | .688 | .500 | —    |

## 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.

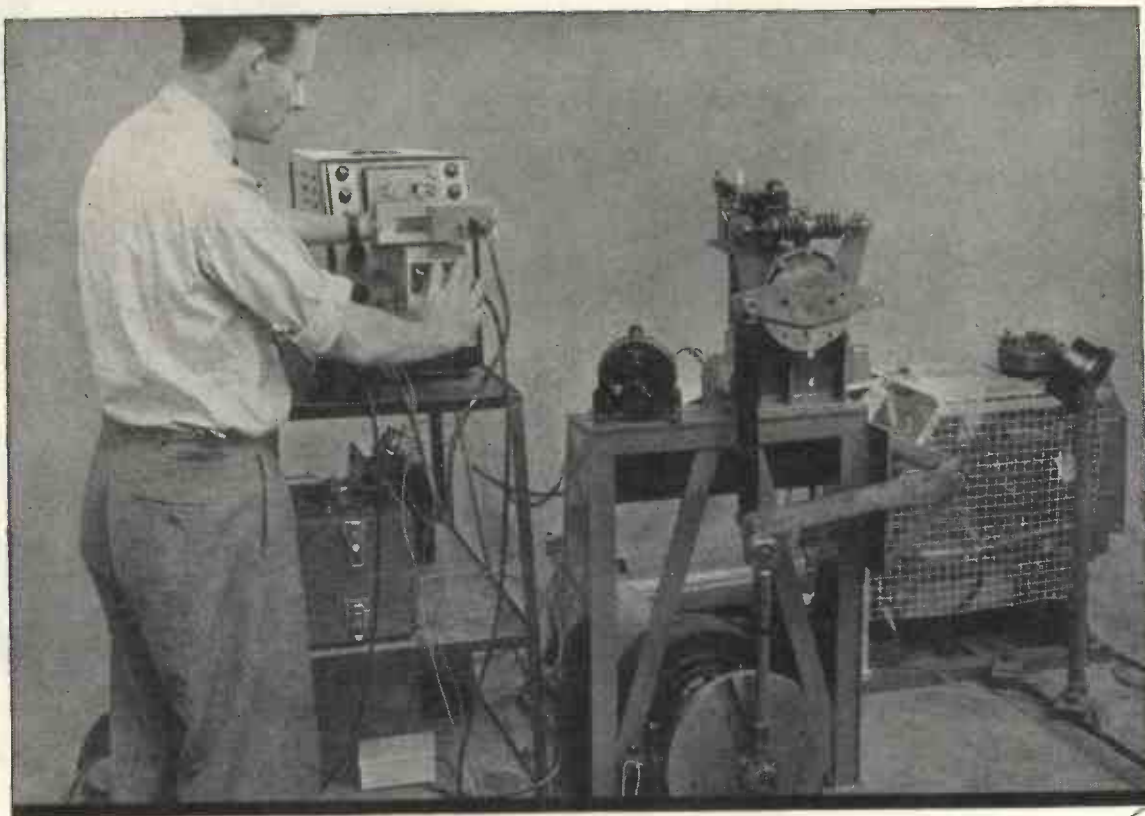
# EDISWAN



THE EDISON SWAN ELECTRIC CO., LTD.,

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For studying research and production problems arising in THE NUFFIELD ORGANISATION, the versatile Cossor Double Beam Oscillograph is used. In the investigation of Shock Absorber Noise, a screened microphone detects the audible effect of operation which is displayed on one of the Cathode Ray beams whilst on the other, the maximum deflection amplitude of the Shock Absorber is shown. By photographing these two related effects with the recording film camera, Model 1428, and adding a third Time Marking Trace to the photograph a valuable performance assessment is realized showing the precise interrelation of Noise, Stroke and Time.

*In displaying simultaneously the mutual effect of two related and variable quantities the Cossor Double Beam Oscillograph is solving many of the fundamental problems with which the research and development scientist is constantly beset. In addition, workers in every branch of Industry are realizing the infinite uses of this instrument in the detection and analysis of faults and the accurate monitoring of manufacturing processes.*

ALWAYS USE  
COSSOR  
TUBES &  
VALVES

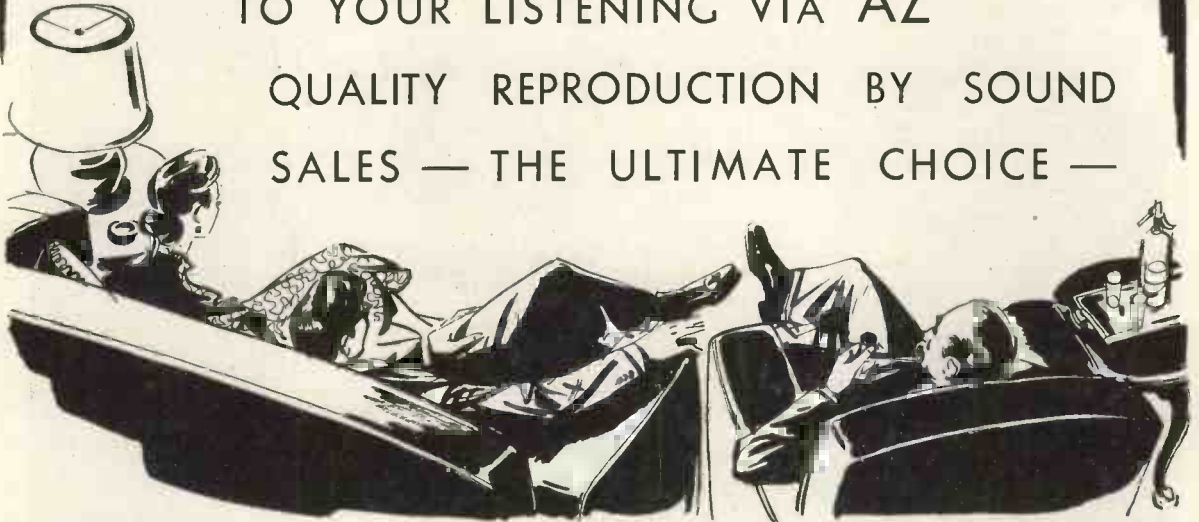
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T.A.18

## MODERN PRACTICAL RADIO AND TELEVISION

*Modern Practical Radio and Television* is quite different from anything else of its kind. It is not too advanced for the enthusiastic amateur to master, and it is a boon for any expert. It is, in fact, crammed from cover to cover with a wealth of general and specialized knowledge—knowledge that everyone interested in Radio and Television should have, ready at their finger tips. Supplied with *Modern Practical Radio and Television* there is a separate booklet, bound to match, which gives details of 48 circuits of popular models and a mass of useful formulae and data.

### SOME OF THE CONTENTS

Briefly, the contents include: Sound, Waves in Free Space, Electricity, Magnetism and Inductance, Capacity, Reactance and Impedance, Alternating Current, The Tuned Circuit, The Principles of the Thermionic Valve, The Signal Analysed, Detection, Design of the Super heterodyne, Practical Coil Design, Switches and Switching, Loudspeakers, The Gramophone Pick-up, Circuits Analysed, Local Interference, Fault-Finding Procedure, etc., etc.

### THE ILLUSTRATIONS

The book is lavishly illustrated with 16 full-page plates in half-tone and 405 diagrams in the text.

### SEND FOR FREE PARTICULARS

To The Caxton Publishing Co., Ltd., 42 Morley Hall,  
 St. George St., Hanover Sq., London, W.1.

Please send me, free of charge, particulars of "Modern Practical Radio and Television" together with your terms of easy payment.

Name .....

(Send this form in unsealed envelope 1½d. stamp)

Address .....

RT12 .....

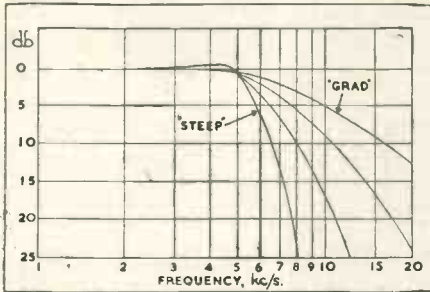
# LEAK equipment is unique—

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

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.



Frequency amplitude curves for the "TREBLE-3" position (5kc/s turn-over). Curves of the same slopes are obtained on the other two positions turning over at 7 kc/s and 9 kc/s ("—2" and "—1" positions).

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 inter-modulation 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.

## 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.

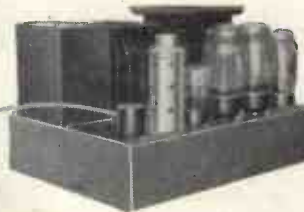
For laboratory use as a stabilised-gain audio frequency power amplifier. For the highest possible standard of disc recording. For the highest possible quality of reproduction from Pickup, Radio, Microphone, Film and Magnetic Tape. For use as a driver amplifier in the speech modulator chain of broadcast 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.

LIST PRICE IN BRITAIN 12 Gns.



£5. 10s.

## 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.

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.**

**STILL AVAILABLE  
15in. MAGNETIC TELE-  
VISION TUBE**



By famous maker. Specification Blue/White screen 9 Kv. ion trap triode, heater 6.3 v. at .55 amp., 50° deflection. New, with written guarantee, offered at approximately half price, £13/10/- each, plus 10/- carriage and insurance. H.P. terms £4/10/- deposit and 12 monthly payments of 18/3. Limited quantity, so order immediately.

**CONSTRUCTORS'  
PARCEL, SPECIAL  
OFFER**



Modern design, bakelite cabinet in ivory, blue or brown, complete with metal chassis punched out for speaker and 5 valves, etc. Parcel also includes moulded Perspex window, matched set of knobs, scale and hardboard back. Price 22/6. Carr. and pkg. 2/6.

**PORTABLE  
RADIO CABINETS**



Correct dimensions to take "P.W." "Mini Four" and similar midjet superhet or TRF. Internal dimensions 6 1/2in. high x 5 1/2in. wide x 3in. deep. Special plastic grained finish, 15/9 plus 1/6 postage and packing. De Luxe model covered with brown crocodile leathercloth and banded with grey lizard leathercloth, 22/6 plus 1/6 postage and packing.

**1154 TRANSMITTER**

We can offer this, unused and in original transit cases, complete with valves at £6 each—plus 12/6 carriage.



Model 314

Model 312 has a drawer on runners and cupboard space beneath. It is also slightly wider and slightly deeper than the others. Price 54/-.

Model 313A. Shelf and cupboard. Fitted half shelf inside cupboard. Price 45/-.

Model 313C. Drawer and cupboard, half shelf inside cupboard. Price 45/-.

Model 314. Five Drawer Chest, suitable for personal papers, etc. Price 54/-.

Add 5/- per cabinet for carriage and package.

**WHITEWOOD CABINETS**

Hundreds of uses in the home, office or workshop; for instance two of these and 2/- worth of hardboard (obtained locally) make an excellent desk or work bench. Sturdily constructed of well-seasoned softwood frames and fronts, birch ply top, sides and doors, hardboard backs and bottoms. External dimensions 29in. x 14 1/2in. x 13 1/2in.



The illustration shows Model 312 fitted up for record playing.

**NEW ADDRESS FOR CALLERS**

We have taken a shop within 5 minutes of FINSBURY PARK STATION. The address is: 29 STROUD GREEN RD.

**AMPLIFIER RACK—SPECIAL LOW PRICE**

This stands approximately 6ft. high, and was made originally for the G.P.O. The top panel contains the amplifier proper, which consists of an A.C. mains driven power pack, capable of delivery 200 mA. at 400 v. and, of course, the normal L.T. supplies, and the amplifier itself uses an MHL4 feeder and two PX25s in the output stage, giving approximately 25 watts. This top deck also contains the heavy duty output transformer. The lower panel contains the feeder unit which can be used as a pre-amplifier for microphone and gramophone work. You will observe that on the rack there is ample space for fitting a monitor speaker and an R.F. unit if same are required. Note that the anode current of the PX25 valve is monitored by a 2 1/2in. flush meter. Further note that these amplifiers were made by the famous MARCONI company. Complete as illustrated but less valves, unused and only very slightly storage soiled. Price £5/10/-, plus 12/6.



**RADIOGRAM CABINET**

Console Type Cabinet. With full grained walnut finish, will take standard type auto change gram unit. Price, £11/10/- H.P. terms, £3/17/- deposit, and 12 monthly payments of 16/9, plus 15/- carriage. Radio Chassis to suit. £8/19/6. H.P. terms. £3 deposit and 10 monthly payments of 13/-, plus 7/6 carr.

Auto Change Units. For long-playing and standard records with suitable pick-up head, £11/11/-.

**SPECIAL OFFER.** Cabinet Radio Chassis and Auto Changer, 29 gns. H.P. terms, £10/14/- deposit and 12 monthly payments of £2/3/-.



**LAST FEW  
£3/19/6.**

**LAST FEW**  
The Lectross warms room as it dries clothes bathing costumes, towels, etc. Size 3ft. wide, 3ft. high, and 5in. deep. It has four stove enamelled rails and works of AC or DC mains, consuming 650 watts. Fully guaranteed. Price £3/19/6 plus 7/6 carriage.

**THIS MONTH'S SNIP**

Due to a recent huge purchase of ungraded germanium and silicon crystal diodes we are able to offer these at less than cost. Also being ungraded you stand a good chance of finding one or more of the really expensive special purpose types. This month we are offering 12 assorted, all made by B.T.H. and G.B.C. for £1 post free. Every crystal is guaranteed to be in perfect working order.



**LAST TIME AT THIS PRICE**

We are almost sold out of 3 wave-band coil packs, but if you apply quickly you may still be lucky. Manufactured by a famous company—long, medium, short wave-bands and gram position. Complete with circuit, 19/6 post free.

**GREATLY REDUCED—  
CATHODE RAY TUBES**

VCR97. Brand new and unused, ideal for 'scope, etc. Price 12/6. Carriage and insurance 5/- extra.

VCR157. 6 1/2in. guaranteed full picture. 29/6 plus 5/- carriage and insurance.

VCR139A. 2 1/2in., 32/6 plus 2/6 carriage, etc.

VCR138. 3 1/2in. 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.

*This Blueprint  
FREE*

To advertise our latest purchase of germanium diodes suitable for crystal sets which we can offer at the very low price of 1/9. With each we give a free blueprint of a crystal set to be made from parts found in any junk box. You have a youngster friend who will be thrilled to make this little receiver.

**ELECTRONIC PRECISION EQUIPMENT LTD.**



**BE PREPARED**

For a cold winter by making our low cost Electric Blanket. 27 yards of special heater wire and blueprint 20/-. Blueprint only 1/6. Alternatively make a Bed Warmer. Constructional data 1/6.

**STAND OFF INSULATOR**

Vitreous porcelain. Price 1/- each or 10/- doz.



**UNBREAKABLE GLASS**

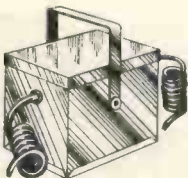
Is a parcel of toughened glass which we can offer at approximately a quarter of its cost. This glass, as many readers will know, can be dropped and will not break. In fact it is most difficult to break and is so useful for dozens of applications in addition to its original purpose of protecting viewers against flying glass in the event of an exploding Cathode Ray tube. We offer a parcel of five panels each 10 1/2 x 9 1/2 in. for 7/6, post free



**CONNECTING WIRE SNIP**  
P.V.C. insulated 23 s.w.g. copper wire in 100ft. coils, 2/9 each. Colours available: Black, Brown, Red, Orange, Pink, Yellow, White, Transparent. 4 coils for 10/-.

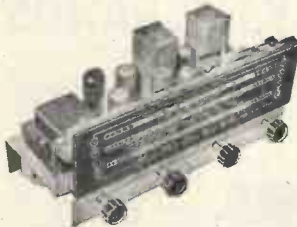
**SOMWEAVE**

This really lovely loud-speaker fabric we offer at approximately a third of today's cost. It is 42in. wide and our price is 12/- per yard or panels 12in. x 12in., 1/9 each. This is also very suitable for covering plain wooden cases, for portable radio amplifiers, etc.



**TRANSFORMERS**

12 v. 50 amp. output from 200-240 v A.C. mains. Primary and secondary separated by a special screen to prevent interference, this screen is brought out to the terminal block. Complete in metal case with carrying handle, price £4/5/- plus 5/- carriage and packing



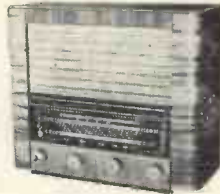
THE "WINDSOR" 5

This is a 5 valve A.C. superhet covering the usual long, medium and short wavebands. It has a particularly fine clear dial with an extra long pointer travel. The latest type local valves are used and the chassis is complete and ready to operate. Chassis size 15in. x 6in. x 6in. Price £9/19/6 complete with 8in. speaker. Carriage and insurance 10/-. H.P. terms £3/7/- deposit.

**TABLE RADIO CABINET**

Due to a special purchase, we are able to offer this very fine cabinet, size approx. 16 x 16 x 7—walnut veneered and satin finished. 37/6 carriage and packing 3/6.

Note. This cabinet is the correct one for the chassis above.



**ANOTHER LAST CHANCE OFFER**



Last year we purchased a large quantity of the Collaro Auto record changers type RC/511, 3 speed suitable for all types of records with the latest crystal pick-up but these have been selling very rapidly and it may well be that unless you buy one this month you will not be able to again, at this special price. We urge you therefore to order right away, the price is 11 gns., plus 7/6 carriage and insurance.

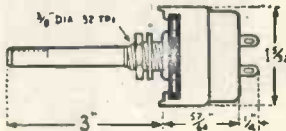
**PROFESSIONAL RADIOS YOU CAN MAKE**

You will find that the building of our all-mains radio receivers is simplicity itself, and the more you make the less time each takes, everything down to the last nut and bolt is supplied and everything fits together in a professional manner. When finished the receiver looks and plays as well as those being offered in radio shops at anything between £10 and £14. The one illustrated above we call "Occasional," in a choice of colours, Ivory or Walnut and the T.R.F. costs £6/1/6 to make, H.P. terms being £2/1/6 deposit and 10 monthly payments of 10/6. Constructor's booklet 1/6, post paid



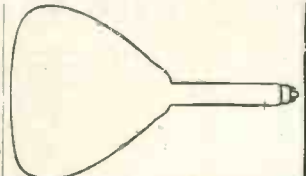
**VOLUME CONTROLS**

We carry a full range of standard-size volume controls from 2K, to 2 meg. Prices are: less switch, 3/-; Single pole switch, 4/-; double pole switch, 5/- We can also supply midjet-type controls, less switch, 4/-; single pole switch, 5/9; double pole switch, 6/6. Each of these midjet controls has a serial number and carries a 12-month guarantee by the makers; they are made on the new moulded track principle and really do perform well.



**IDEAL GENERAL PURPOSE RECEIVER**

The Elpreq "Wolsley" 5 valve A.C./D.C. superhet has a built-in aerial and is of convenient size and weight to carry from room to room. Powerful reception on long, medium and short waves — handsome wooden cabinet — illuminated glass dial, with station names. A.V.C. and usual refinements. Size 11in. x 5 1/2 in. x 7in with B.V.A. valves, 12 months' guarantee. Limited quantity only, £9/5/- or £3/2/- deposit and balance over 12 months carriage and insurance. 5/-.



**NEW 12in. T.V. TUBES**

A special purchase enables us to offer some brand new, latest type 12in. T.V. tubes at the special price of £11/10/- each. Each tube is in original carton and complete with makers guarantee. Carriage 10/- extra.



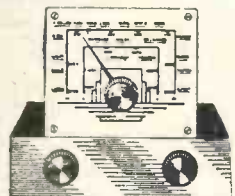
**12 CELL ACCUMULATOR**

This accumulator can be coupled up to give 24 v. with all cells connected in series or 12, 6 or 2 volts in series parallel arrangements. They were originally made for the Admiralty by a leading manufacture, have never been filled, and are in excellent condition. Each is contained in a wooden crate as illustrated. Post and insurance 2/6. Price 27/5.



**PLUGS FOR MODERN VALVE HOLDERS**

Each is fitted with rubber shroud. For B7G button base and type 2 for B8A. Price 1/4 each, discounts for quantities.



**ALL MAINS CHASSIS**

This is the equivalent of a 4-valve receiver for it uses three valves and a metal rectifier. It is all wired up ready to work off A.C. mains, complete with valves, ganged tuning, dust cored coils, on metal chassis. Tunes long and medium wavebands. Large clear dial. Receives Home Services, Light programme, Luxembourg, etc. Chassis size approximately 9in. x 4in. x 5in. Complete with valves, but less speaker. Obviously not the last word in receivers, but useful standby or for workshop, bedroom or even the greenhouse where a radio helps to make the job more pleasant. Few only left to clear at 49/6 plus 3/6 packing and insurance. Suitable speaker with matching transformer, 16/6. Nothing else needed.

**PYREX AERIAL INSULATORS**

Idea for aerial connections through cabin wall or through panels. Consists of glass dome with threaded rod and terminal ends and metal fixing flange. Price 2/- each.



## MULTIMETER KIT

This month our snip is possibly of most interest to newcomers to the art—it is all the essential parts for constructing a sensitive multimeter. The kit comprises 2in. moving coil meter, scale (calibrated volts—milli amps—ohms) close tolerance resistors, wire for shunts, terminals and full instructions. Limited quantity only so order at once. Price only 10/- complete.

**TRUVOX 12 in. P. M. SPEAKER, Type No. BX11.** Brand new in original cartons. £3 plus 2/6 postage and insurance.

**AMERICAN POWER PACK.** Built to operate H.R.O. receiver from British mains. Give 80-100 m/a. smoothed D.C. at 200 volts, also 5 volts and 6.3 volts. Totally enclosed in metal case. An extremely nice unit. Price £2/17/6, plus 5/- postage and insurance.

**MOVING COIL METER**  
0.5 m/a. 2in. flush mounting, Bakelite cased, can easily be made into multi-range test meter. Price 7/6, plus 6d. postage.

**HEAVY DUTY SPRINGS**  
For supporting cathode ray tubes, etc., 4 1/2 in., 5 in. dia. 6d. each, 5/- dozen.

**GRAMOPHONE UNIT**  
BSR 3-speed motor Type MU14 with Chancery pick-up and two crystal heads, one for long playing and one for normal records. £7/7/- plus 3/6 carriage and insurance.

**L.P. RECORD PLAYER**  
Made by Decca. Contains B.S.R. motor and Decca pick-up. Although we offer this at approximately half price it carries same manufacturer's guarantee as if the correct price of £9/9/- were paid. Price £5/5/-, plus 7/6 postage and insurance.

**1132 RECEIVER.** This is an 11-valve superhet, which covers 100-124 Mc/s. Fitted with extremely nice slow motion drive, tuning meter and both R.F. and L.F. gain controls. Complete and unused. 59/6, plus 7/6 carriage.

**COLLARO GRAM MOTOR AND TURNTABLE**  
TYPE A.C. 47. A centre drive spindle with governor control. 67/6, plus 2/6 carriage.

**INSTRUMENT TYPE SOLDERING IRON**  
This is fitted with a double element so that it will not burn whilst idling. Switch in handle brings in additional element whilst soldering. For 24 volt working. 12/6, plus 1/6 postage.

**PORTABLE CABINET**  
Has the modern look. Ideal for Tape Recorder or Record Player. Rexine covered. £3 each.

**DRY BATTERY REACTIVATOR**  
If you use a personal portable, this unit will save its cost in a matter of weeks. Mains operated. 35/- each.

## T.V. ON THE V.H.F. BANDS

The equipment below—which we offer at only a fraction of its original cost—was built to transmit and receive on the 10 cm. band. It may, therefore, help readers with their experiments on this band in connection with the proposed new T.V. frequencies. All equipment is unused.



**MAGNETS FOR MAGNETRONS**

These very powerful heavy magnets have many uses, in addition to their original job with a CV.186 or CV.64. Price £2/10/-, plus 2/6 postage.



**KLYSTRON-RHUMBATRON**

Type number is CV.43 and the device is complete with tuning slug. Price £3 each.



**WAVEGUIDE (A)**

The section is used for receiving and has a silicon crystal mounted in one arm. Price £1/15/- complete.



**WAVEGUIDE (B)**

This is for the transmitter output side and is tuneable. Price £1/12/6.



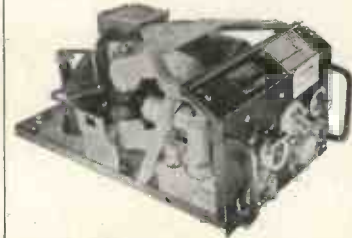
**PULSE TRANSFORMER**

Oil-filled and highly insulated. Price 12/6 each. Choke to match 22/6.



**COMPLETE 10 CM TRANSMITTER RECEIVERS**

Type numbers available include TR.3548-TR.3191-TR.3151. All are priced at £15 each, and contain all the above items in addition to blower motor—I.F. unit—suppressor unit, etc.



A

**UNCUT CLOCK CASES**

Clock cases, uncut but veneered and polished, very suitable for mounting electric or clock-work movements, also meters, barometer, etc. Price 8/6 each, plus 1/- post. Please give an alternative shape in case stock runs out.



C



B



D



**EX-ROYAL NAVY SOUND POWERED TELEPHONE**

These require no batteries, and will go for long periods without attention. Complete with generator and sounder which gives a high pitched note, easily heard above any other noise. Also fitted with an indicator lamp which in quiet situations can be used instead of the sounder, or where several 'phones are used together will indicate which one is being called. Size 7 1/2 in. x 9 in. x 7 1/2 in., wall mounting, designed for ships' use, but equally suitable for home, office, warehouse, factory, garage, etc. Price 57/6 each, plus 4/6 carriage.

**MILLIBAR BARO-METER, 7/6**



The heart of a barometer is a metal bellows which will expand and contract with the varying air pressure. The aircraft altimeter works on the same principle, a series of gears and lever amplifying the expansion and contraction of the bellows and so works the pointer. We can offer the ex-R.A.F. Sensitive Altimeter slightly faulty but containing the essential bellows, gears, wheels, etc., from which a good barometer can be made. Price only 7/6, plus 1/- post.

**FULL PICTURE VCR97**

We have had a new delivery of this now-famous electrostatic 6in. T.V. tube, these are not the cut-off type, and we guarantee a full picture, 42/6, carriage and insurance 5/-.



**SPRING LOADED TERMINAL BLOCK**

Fully insulated so is ideal for mains, terminal point fitted on bench of workshop or laboratory. Also suitable for temporary hook ups when testing components, etc., will save its cost the first week of use. Price 3/6.

**ADJUSTABLE THERMOSTAT**

250 v. heavy silver contacts can be adjusted to operate between 70—300 F. These are suitable for aquarium heaters, electric blankets, etc. 1 Amp. Model, 3/6. 2 Amp. Model, 5/6. 5 Amp. Model, 14/6. Post, etc., 6d. extra. Don't be cold this winter, make an Electric Blanket, blueprint 1/6, post free.



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.



**ELECTRONIC PRECISION EQUIPMENT LTD.**

**SUPERIOR 15" TELEVISION**



This fine walnut cabinet has been designed to take the "Superior 15," but it is equally suitable for other sets using the standard 15in. tube. Price is £11/10/- (or £3/17/- deposit), carriage £1.

**STOP PRESS**

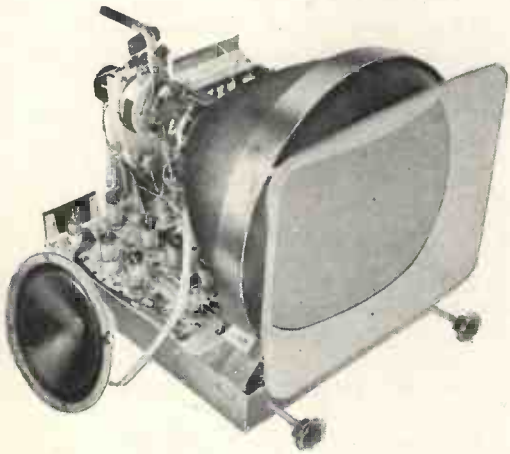
Superhet 5-valve A.C. mains, 3 waveband chassis made by Beethoven, chassis size 9½" x 7½" x 8½" with large illuminated dial. Complete with Mullard valves and Rola speaker, ready to work, £7/17/6 carr. and ins. 7/6.

**NEW ADDRESS FOR CALLERS**

We have taken a shop within 5 minutes of FINSBURY PARK STATION. The address is: 29 STROUD GREEN RD.



**ELPREQ "READY-MADE" TELEVISORS**



These are Five Channel Televisors employing completely tuneable superhet sound and vision receivers. They have noise suppression on both sound and vision and incorporate a special I.F. filter in the aerial circuit. The circuit is absolutely up to date, and in fact uses the latest Mullard valves. The 12in. model uses MV 31/74 with the tinted special daylight viewing face. The 15in. model uses the Cossor 85K tube. Price, either model, is £42/10/-, complete ready to receive sound and vision. Carriage and insurance £2 (partly returnable). H.P. terms, £14/3/6 deposit. Cabinets: 12in. (table model), £3/17/6, carriage, etc., 7/6. 12in. Console model, £7/17/6, carriage, etc., 10/-. 15in. Console model £11/10/-, carriage, etc., 15/-. Any cabinet may be purchased by h.p. Simply send one-third as deposit.



Illustration of the 12in. table model cabinet, price £3/17/6, complete with glass.

**ELECTRONIC PRECISION EQUIPMENT LTD.**

Post orders should be addressed to:—

**ELPREQ HOUSE (Ref 2.), HIGH STREET, WEALDSTONE, MIDDX.**

Personal shoppers however must continue to call at:—

**42-46, WINDMILL HILL, RUISLIP, MIDDX.**  
Phone: RUISLIP 5780 Half-day, Wednesday.

**152-153, FLEET STREET, E.C.4.**  
Phone: CENTRAL 2833. Half-day, Saturday.

**29, STROUD GREEN RD., FINSBURY PARK.**  
Half-day, Thursday.





A complete list of Iliffe Technical Books on Radio and Television will be sent free on application to the address below.

### RADIO DESIGNER'S HANDBOOK

Edited by F. Langford-Smith, B.Sc., B.E., SENIOR MEMBER I.R.E. (U.S.A.), A.M.I.E. (AUST.). 4th Edition. A comprehensive reference book, the work of 10 authors and 23 collaborating engineers, containing a vast amount of data in a readily accessible form. The book is intended especially for those interested in the design and application of radio receivers or audio amplifiers. Television, radio transmission and industrial electronics have been excluded in order to limit the work to a reasonable size. 1,474 pages.

42s. net. By post 43s. 6d.

### SOUND RECORDING AND REPRODUCTION

By J. W. Godfrey and S. W. Amos, B.Sc., A.M.I.E.E. This book has been written primarily as an instruction manual for B.B.C. engineering staff but will prove invaluable to all interested in the theory and practice of disc, magnetic and film recording. Special reference is made to equipment used by the B.B.C., and a number of appendices contains a generous amount of reference information not readily available elsewhere.

30s. net. By post 30s. 8d.

### ADVANCED THEORY OF WAVEGUIDES

By L. Lewin. Sets out the various methods that have been found successful in treating waveguide problems—the author selecting for discussion a number of topics as representative of the field in which the centimetre-wave engineer is now engaged. Many of these examples are concerned with the rectangular waveguide, but the reader will be able to apply the general principle to most of the cases encountered in practice.

30s. net. By post 30s. 7d.

### TELEVISION RECEIVING EQUIPMENT

By W. T. Cocking, M.I.E.E. 3rd Edition. Explains the fundamental principles involved and then describes each stage of the normal television receiver. The text includes notes on special circuits and gives practical details of receiver design. Other chapters are devoted to faults and their remedies, servicing of modern sets and the problems of obtaining selectivity. Mathematical data of particular value to the designer have been collated and appear in appendices.

18s. net. By post 18s. 8d.

### MICROPHONES

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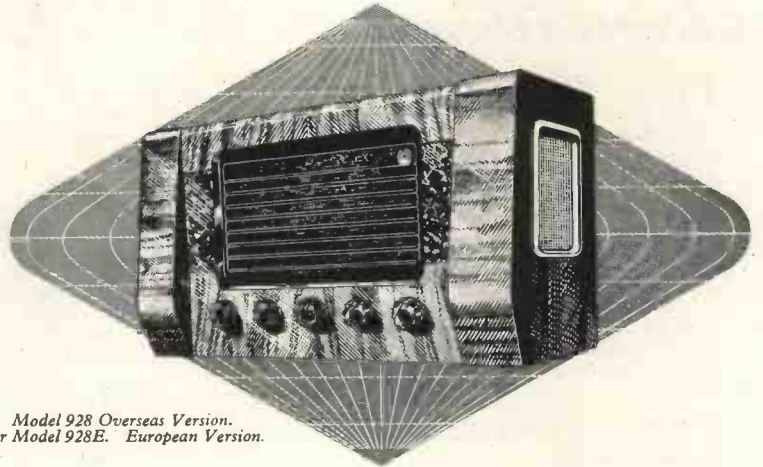


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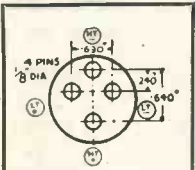
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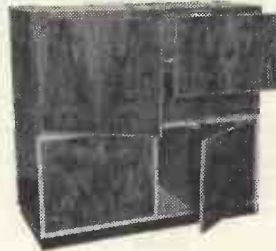
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| FSM63 (Midget). Output 250-0-250 v. 60 m/a., 6.3 v. at 3 amps., 5 v. 2 amps. ....                                          | 16/9 |
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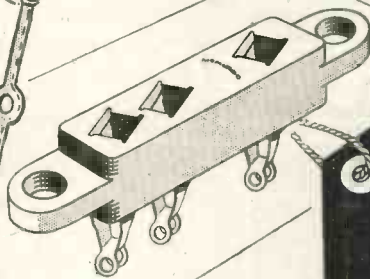
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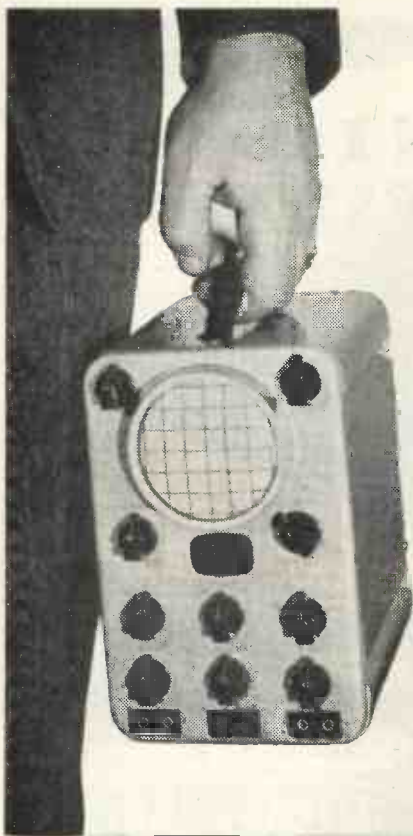
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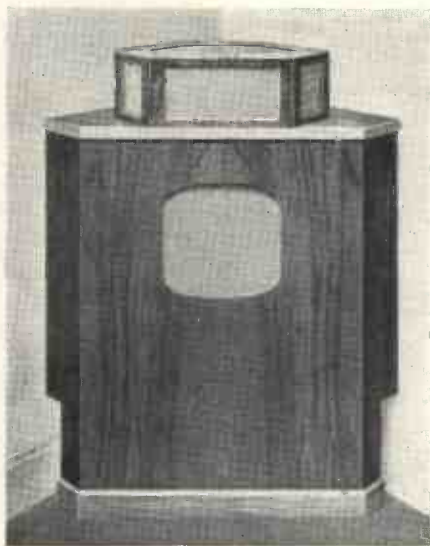
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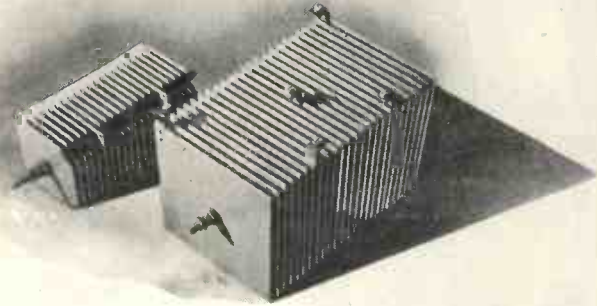
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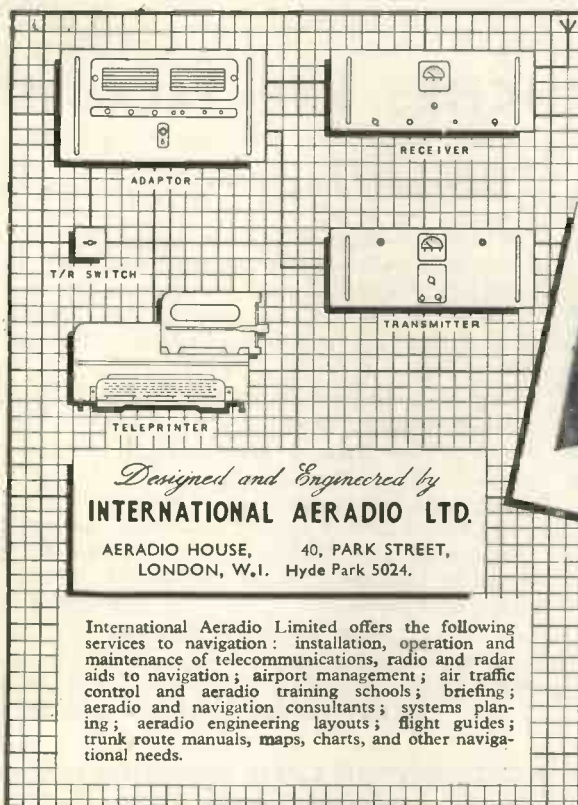
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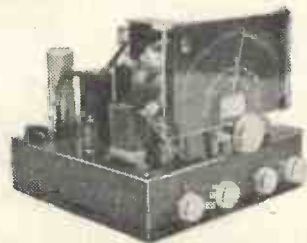
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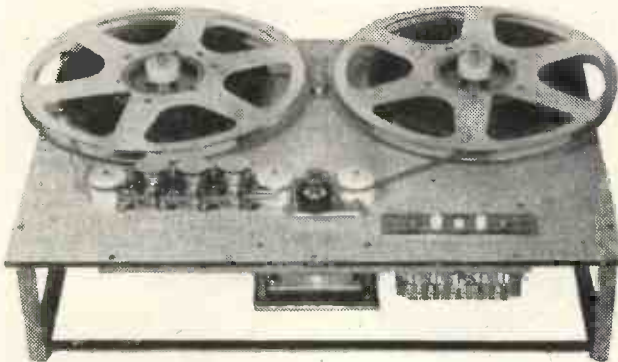


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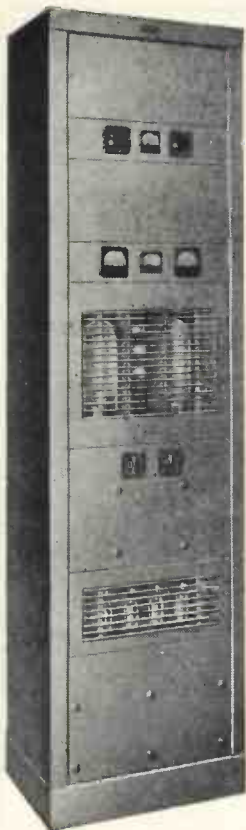
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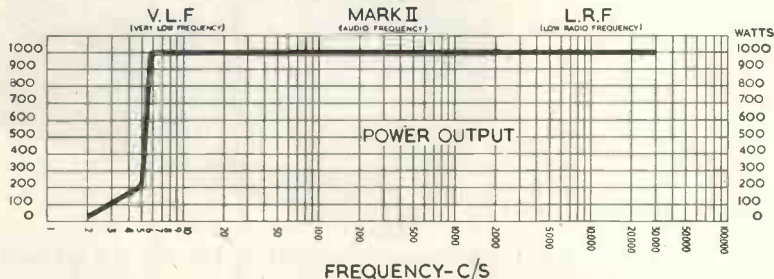
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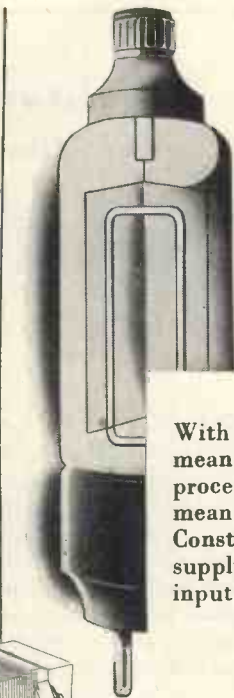
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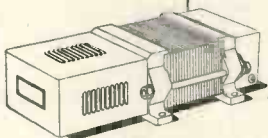
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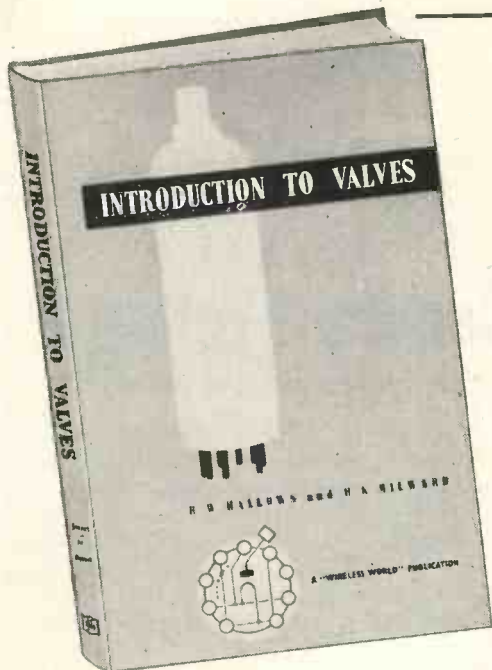
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| Rogers Minor              | £11 10 0 |

ALL GARRARD, CONNOISSEUR, DECCA and COLLARO HEADS AND STYLII IN STOCK.

**WEARITE 2A TAPE DECK.** £35. (Carriage extra.)  
All accessories for Wearite Recorder Amplifier now available.

**TRUVOX TAPE DESK 22 gns.** (Carriage extra.)



# THE TELE-KING

## A practical 5-channel SUPERHET TELEVISION RECEIVER

Using the new 16-inch cathode ray tubes and wide angle components for the home constructor.

Complete instructions, wiring diagrams and 32-page descriptive booklet.

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10 watts. 7.5 ohms impedance.  
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14in. MW36-22 ... **£19 9 3**  
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For 6 and 12 v. operation, complete with magnetic pick-up and volume control. In metal cabinet size 17in. x 14in. x 11in. Very limited quantity.  
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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.



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Sloping steel table, grey crackle finish, size 10in. high, 15in. deep, 19in. wide. Complete with pick-up, centre spindle drive Collaro motor, with adjustable speed, and 10in. turntable. For 200-250 v. 50 c.p.s.  
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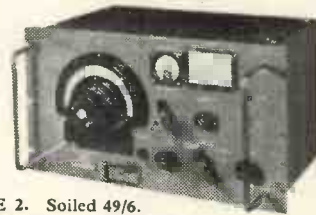
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| Cans                   |      | Tubular          |         |
|------------------------|------|------------------|---------|
| 16 mfd. 500 v.w.       | 3/6  | 1 mfd. 200 v.w.  | 1/- 9d. |
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| 8 + 32 mfd. 450 v.w.   | 3/11 | 8 mfd. 350 v.w.  | 2/-     |
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| 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     |
| 40 + 100 mfd. 350 v.w. | 7/6  | 32 mfd. 450 v.w. | 4/6     |
| 250 mfd. 350 v.w.      | 4/11 | 50 mfd. 350 v.w. | 4/6     |
| 1000 mfd. 12 v.w.      | 3/11 | 250 mfd. 12 v.w. | 2/-     |
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**MANY OTHER TYPES IN STOCK.**

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: 18x10x11in. Supplied with all valves, also circuit and calibration chart.

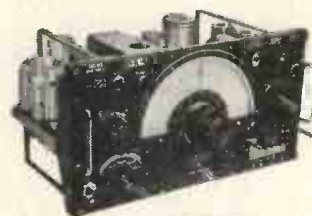
**R.1132.A RECEIVERS**



**GRADE 1.** Brand New 79/6. **GRADE 2.** Soiled 49/6.  
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**SPECIAL T.V. CONDENSERS**

|                        |     |                                                                 |      |
|------------------------|-----|-----------------------------------------------------------------|------|
| 32 + 100 mfd. 450 v.w. | 7/6 | .04 mfd. 12.5 Kv.                                               | 7/6  |
| <b>Bias</b>            |     | <b>High Voltage</b>                                             |      |
| 10 mfd. 25 v.w.        | 1/3 | .1 mfd. 2.5 Kv.                                                 | 2/6  |
| 12 mfd. 50 v.w.        | 1/3 | .1 mfd. 3 Kv.                                                   | 3/6  |
| 25 mfd. 25 v.w.        | 1/6 | .1 mfd. 3.5 Kv.                                                 | 4/6  |
| 25 mfd. 50 v.w.        | 1/6 | .1 mfd. 10 Kv.                                                  | 12/6 |
| 50 mfd. 12 v.w.        | 1/3 | .25 mfd. 2.5 Kv.                                                | 5/6  |
| 50 mfd. 25 v.w.        | 1/6 | .1 + .1 mfd. 3.5 Kv.                                            | 5/11 |
| 50 mfd. 50 v.w.        | 1/9 | <b>T.C.C. VISCONOL HIGH VOLTAGE CONDENSERS (Cathodray)</b>      |      |
| 75 mfd. 12 v.w.        | 1/- | .001 mfd. 15kV.                                                 | 10/- |
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| 100 mfd. 50 v.w.       | 2/6 | .0005 mfd. 25kV.                                                | 18/- |
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|                        |     | Plastic case, single bolt fixing. Other high voltage condensers |      |
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**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.

LASKY'S PRICE **£11.19.6**

USED MODELS **£7.19.6**

Scrap Receivers. Suitable for breaking down. Less All Valves **£2 10 0**

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Fully Assembled Power Pack and Output Stage, for R1155 Receiver. For use on 200-250 volts A.C. mains. LASKY'S PRICE **79/6**  
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**CRYSTAL DIODES**  
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**RF25 UNITS.** New, with valves. 19/11. Carriage 2/6.

**P.M. LOUDSPEAKERS**  
All less o'trans. new and unused. First quality.  
3in. ... 12/11 5in. ... 12/6  
6in. ... 13/6 8in. ... 15/-  
10in. ... 32/6  
All 12 inch speakers available free of purchase tax.

**15-INCH CATHODE RAY TUBE MASKS**

Cream rubber. Latest aspect ratio. Overall dimensions: 17in. wide, 13in. high. Price 17/6. Postage 2/- extra.

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# THE VIEWMASTER

ALL COMPONENTS IN STOCK

ANY SINGLE ITEM AVAILABLE SEPARATELY



### COILS

All models available including filter chokes. Price (except Alexandra Palace), 28/- per set. Alexandra Palace, 20/- per set. L9 RF choke, 2/-.

### CHASSIS

Sound-Vision, 18/6.  
Power-Pack/Time base, 18/6.  
Support for S.V. chassis, 6/-.

### LASKY'S LINE TRANSFORMER.

RF.EHT for line fly back. 6-8Kv. with EY51 heater winding. Suitable for home construction T/V 25/-.

### METAL RECTIFIERS

12v. 1a. .... 6/9  
12v. 1a. .... 3/6  
6v. 1a. .... 3/11  
6 & 12v. 4a. .... 18/6

### SENTERCEL RECTIFIERS

RM1 ..... 3/10  
RM2 ..... 4/3  
RM3 ..... 5/-  
RM4 ..... 18/-

### WESTINGHOUSE RECTIFIERS

All 250 volts input.  
14A976 80 mA 8/6  
14A86 250 mA 20/4  
14A100 300 mA 21/6

### W/B & PLESSEY

Line EHT trans. .... 32/6  
Frame trans. .... 23/6  
3 Mc/s boost choke ..... 5/9  
Width control. .... 7/6  
Scanning coil. .... 33/3  
Main choke ..... 15/6  
Focus ring ..... 22/6  
Heater trans.:  
WB/103 ..... 42/-  
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Front and rear C.R.T. supports ..... 21/6

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Low Flux .... 37/6  
Med. Flux .... 39/6  
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### POSTAGE STAMP TRIMMERS

Paxolin. Up to 100pf. 6d. each. 5/- per doz.  
Ceramic. Up to 100pf. 9d. each. 7/6 per doz.  
350 and 550pf. Ceramic 1/- each. 10/6 per doz.

### COIL PACKS

Medium and 2 short wave bands. Price 16/-.

### COIL PACKS

Long, medium and short wave bands. 29/6.

### METAL RECTIFIERS

WX3 and 6. Ea. 3/9  
14D36 ..... 12/4  
14A86 ..... 20/4  
14A100 ..... 21/6  
36EHT45 ..... 23/8  
36EHT50 ..... 26/1  
36EHT100 ..... 29/6

### PLESSEY

Scan coils per pair 25/-  
Width Control 6/6

### NOW AVAILABLE LARGE SCREEN WIDE ANGLE CONVERSION DETAILS FOR THE VIEWMASTER.

Send 3d. stamp for full data. Fully itemised price list of all Viewmaster components now available.

### ALL T.C.C. CONDENSERS

exactly as specified for use in The Viewmaster can now be supplied from stock.

### GRAM MOTORS



Rim drive, synchronous. For 200-250v. 50 c.p.s. Many uses. 9/6.

The television set you can build at home from standard parts.

A MODEL FOR EACH FREQUENCY. State station required.

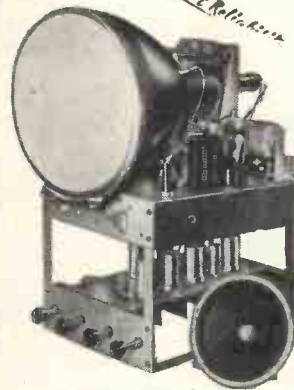
Brilliant high definition black and white picture. Superb reproduction. Uses 9in. or 12in. Cathode Ray Tube. Table or Console Model.

Incorporates all the latest developments.

Television for the home constructor at its finest.

Send to-day for the CONSTRUCTION ENVELOPE, 32-page booklet crammed with top-rate information and all the necessary data, also 8 full-size working drawings and stage by stage wiring instructions.

Alexandra Palace, Sutton Coldfield, Holme Moss, Kirk o' Shotts, Wenvoe, Pontop Pike, Belfast. State model required.



PRICE 7/6 per copy.  
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### TWO-GANG TUNING CONDENSERS .0005MFD.

No. 1. Miniature. With Perspex dust cover and trimmers. Size: 1 1/2in. x 2in. x 1 1/2in., 1/2in. spindle. LASKY'S PRICE, 8/6.  
No. 2. Midget. With trimmers. Size: 2 1/2in. x 1 1/2in. x 1 1/2in., 1/2in. spindle. LASKY'S PRICE, 8/6.  
No. 3. Midget. Less trimmers. Size: 2in. x 1 1/2in. x 1 1/2in., 1/2in. spindle. LASKY'S PRICE, 6/6.  
No. 4. Standard type. Size: 2 1/2in. x 2 1/2in. x 1 1/2in., 1/2in. spindle. LASKY'S PRICE, 6/6.

### I.F. TRANSFORMERS

465 Kc/s Iron dust cores in cans, midget type. Size: 1in. x 1in. x 2 1/2in. By Plessey. Price 9/6 per pair.  
WEARITE TYPE 550. 445-520 Kc/s. 10/- per pair.  
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### 3 SPEED GRAM MOTORS

Complete with motor board and turntable. Size: 8 1/2in. x 11 1/2in. x 5 1/2in. high. For use on 200-250 v. 50 c.p.s. LASKY'S PRICE 49/6

### T.V. TYPE MAINS AUTO TRANSFORMER

200, 220, 250 and 375 volt tapings, 250 mA. Also 5 v. 3 a.; 6.3 v. 7 a., and 6.3 v. 3 a. secondaries. PRICE 25/-.

### PORTABLE TAPE RECORDERS

Brand New — Unused — Complete. Fully assembled and wired. Ready to operate. Attractive carrying case. Twin track recording. Instant playback. Total playing time of 66 minutes. 6 Valves. A.C. Mains 200-250 volts. Fast rewind. Complete. Ready to switch on. Write for full illustrated details and circuit diagrams. LASKY'S PRICE £34.19.6  
Carriage 15/-.

### PORTABLE RADIO CABINETS



Rexine finish. In silver, blue or red. Complete with dial, pointer, knobs, back, speaker fret and 4in. p.m. speaker and handle. Size 13 x 7 x 10in. PRICE 37/6 complete. Carriage 5/- extra. Give second choice of colour when ordering.

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All 200-250 volts c.p.s. primary. Finest quality, fully guaranteed. MBA/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/-.  
AT/3. Auto transformer. 0-10-120, 200-230-240 volts 100 watt. Price 17/6.

### FILAMENT TRANSFORMERS

6.3 v. 1.5 a., 7/6.  
6.3 v. 3 a., 12/6.  
6.3v. tapped at 4v. 2 amps. 9/6.  
Special Transformer. 2 amps., with the following tapings: 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24 and 30 volts. Price 17/6.

### SMOOTHING CHOKES.

20 mA 40 H ..... 3/11  
40 mA 8 H ..... 3/11  
40 mA 10 H ..... 4/3  
100 mA 10-20 H ..... 7/3  
250 mA 10 H ..... 18/6



WILL MAKE A SUPER RADIO-GRAM.

## SPECIAL T.V. OFFER!

### 5 CHANNEL SUPERHET

Uses 15 valves. Originally made for projection, and is complete with line and frame time bases, sound-vision strip, and all controls.

### VALVE LINE-UP. MULLARD VALVES

V1. EF80, RF. amp.  
V2. ECL80 Freq. cha.  
V3. EF80 Vision IF, 13.4 Mc/s.  
V4. EF80 Vision IF, 13.4 Mc/s.  
V5. EB91 Vision demodulator and vis. int. limiter.  
V6. EF80 Video freq. amplifier.  
V7. ECL80 Sync. sep. and frame clipper.  
V8. ECL80 Frame time base.  
V9. EF80 Line time base blocking osc.  
V10. EL38 Line time base amplifier.  
V11. EB91 Protection circuit.  
V12. EF80 Sound IF, 9.9 Mc/s.  
V13. EBF80 Sound IF, 9.9 Mc/s.  
V14. EB91 Sound demodulator and noise limiter.  
V15. EL41 Sound output.  
Dimensions:—13in. wide, 12 1/2in. deep, 3 1/2in. high chassis. Overall height, 8in. Power supplies needed: L.T., 6.3 volts: H.T., 300 volts.

LASKY'S PRICE £8.19.6d.

Carriage 17/6d. extra

Supplied less projection unit, valves and power pack.

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# FIRST AGAIN. WIRE RECORDER SCOOP!

By a very well known manufacturer.  
Original list price £69/10/0.  
**BRAND NEW AND UNUSED.**  
Records from records,  
Microphone,  
Radio.



Includes a Garrard pick-up and can be used as a record player complete with its own amplifier.  
Complete with 7 valves, full operating instructions, circuit diagrams, and spool of recording wire.  
Fitted with tone control and magic eye recording level indicator.  
In attractive wood cabinet, medium walnut finish, with roll top.

**LASKY'S PRICE £27.10.0**  
Carr. & insurance 25/-

S.T.C. Ball and biscuit, moving coil microphone. £5/5/0.

Special price for microphone if purchased with recorder. 50/-.

**MAGNETIC RECORDING WIRE.**

- 1 Hour spools. 32/6.
- ½ Hour spools. 17/6.

**TWO-WAY TALKIE.** Sound powered inter-com. units. Can be set up anywhere, and gives effective communication up to a distance of 500 feet. Units can be purchased to give up to 4-way intercommunication. In metal case, brown crackle finish. Size: 6" x 5½" x 8". Complete with 5in. P.M. speaker and two U2 batteries.

PRICE:  
Master Unit, with 4-station selector switch **37/6**  
Sub-stations ..... 27/6  
Carriage 2/6 each.

**TAPE RECORDER AMPLIFIERS**

Complete with 6 valves: 1 5Z4, 1 6J5, 2 6V6, 2 6J7. Also 5in. p.m. speaker. Fully assembled and wired. On steel chassis, size 15½in. wide, 8½in. deep, 6in. high. Circuit available. Although new, these amplifiers are untested and may have minor faults. The price has accordingly been reduced to £7/15/- complete with all valves. Carriage 10/- extra.

**FAMOUS NAME MANUFACTURER. 3-SPEED AUTOMATIC RECORD CHANGERS**  
Turnover pick-up head. Brand new in maker's original cartons. Listed at £16/10/-. Auto change on all speeds. Plays mixed, 7-, 10- and 12-inch records. **LIMITED QUANTITY AT £11/10/-.** Carriage 7/6 extra.

**INTERCOM UNITS**  
4-station operation. For use on A.C./D.C. mains 200-250 volts. Supplied complete, with 3 new valves, ready for immediate installation. Fitted in attractive plastic cabinet. Suitable for use as baby alarm.  
**MASTER UNIT £7/15/-.**  
Carr. 5/- extra.  
Extension Units. Price 21/- each complete. Carriage 2/- each extra.

**OUTPUT TRANSFORMERS**

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| 40 mA Multi ratio .....      | 6/11  |
| 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 .....         | 4/3   |
| Miniature Pentode, 3S4, 1S4  | 4/6   |
| PX4 Intervalve .....         | 8/6   |
| 5:1 Intervalve .....         | 5/11  |

**SPEAKER FRET**

|                                 |      |
|---------------------------------|------|
| Expanded Metal. Silver Finish.  |      |
| 12in. x 12in. ....              | 3/11 |
| 12in. x 18in. ....              | 5/11 |
| Plastic White, 12in. x 5in. ..  | 2/-  |
| Wire, Bronze, 11in. x 8in. .... | 2/-  |

**C.R.T. MASKS. Brand New. LATEST ASPECT RATIO**

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|------------------------------------------------------------------|------|
| 9in. ....                                                        | 7/-  |
| 10in. ....                                                       | 7/6  |
| 12in. ....                                                       | 15/- |
| 12in. Flat Face .....                                            | 15/- |
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| 16in. Eng. Elect. ....                                           | 42/- |
| 16in. Double D .....                                             | 31/6 |
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**SOILED. NEW ASPECT RATIO**

|                                                   |      |
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| 9in. ....                                         | 5/-  |
| 12in. ....                                        | 7/6  |
| 12in. with fitted armour plate glass, cream ..... | 11/6 |
| 12in. do. Black .....                             | 8/6  |

**TEST PRODS**  
Fully fused, with retractable points, 4/11 per pair (1 red, 1 black).

**Co-Axial Cable. 70-80 ohms impedance.**  
Single core, 9/- doz. yards.  
Twin core, 12/- doz. yards.  
Twin feeder, 6/- doz. yards.  
**Co-Axial Connectors.** For standard ¼in. cable, 1/11.

**ARMOUR PLATE GLASS**

|                                              |     |
|----------------------------------------------|-----|
| 15in. Actual size                            |     |
| 16½in. x 13in. x ¼in. 6/11                   |     |
| 12in. Actual size 13in. x 10½in. x ¼in. .... | 4/- |
| 9in. Actual size 9in. x 8in. x ¼in. ....     | 3/- |

**MANUFACTURERS' SURPLUS T.V. COMPONENTS**

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|--------------------------------------------------------------|------|
| Wide Angle Scanning Coils. Low imp. line and frame .... pair | 19/6 |
| Scanning Coils. 35 mm. Low imp. line and frame .....         | 12/6 |
| Frame multi ratio output trans. ....                         | 10/6 |
| Focus Coil. 35 mm. electro magnetic ....                     | 12/6 |

**THE "UNIVERSAL" LARGE SCREEN AC/DC TELEVISOR.**

By A. S. Torrance, A.M.I.P.R.E., A.M.T.S.  
A 28 page booklet giving full instructions for building a large 17 inch screen television.

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| * Mullard valves and c.r. tube. | * Incorporates all latest developments. |
| * 5-channel superhet.           |                                         |

3d. POST FREE.

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# DE LUXE TELEVISION CABINETS

## OUR NEW 1954 12 inch MODEL (Mark II)



Can be supplied with cut out for 16in. c.r. tube, at no extra cost.

**LASKY'S PRICE £8.10.0d.**  
Carriage 12/6d extra.

This cabinet is now supplied complete with mask, glass, castors, shelf, bearers, c.r. tube neck end protector, back, speaker-fret, and baffle board. Finished in beautiful figured medium, light, or dark walnut veneer, with high polish.

Suitable for most home construction television receivers, including the "Viewmaster," "Practical Television," "Tele King," "Magnaview," "Wireless World," etc., etc.

WHY NOT CONVERT YOUR TABLE RECEIVER TO A CONSOLE MODEL. Adaptor frames for fitting 9in. or 10in. cathode ray tubes can be supplied if required.



Inside Dimensions —  
Depth 16½ ins.,  
width 17½ ins.,  
height 28 ins.

Overall height 32 ins. and width 18½ ins.

An allowance of 4/6d. will be made if the mask is not required.

### 9in. TABLE T.V. CABINETS



Medium shade mahogany finish. Complete with back, safety glass, speaker-fret. Internal dimensions: 19½ in. high, 16 in. wide, 14 in. deep.

LASKY'S PRICE 39/6 Carriage 7/6 extra.

Adaptor frame available for 6in. C.R. tubes. The aperture can easily be enlarged to take 12in. or 14in. tubes.

10 K.V. METRSIL E.H.T. REGULATORS. By Metrovick. Pencil type. 5/- each.

**SPECIAL C.R.T. OFFER**  
Brand new and unused 12in. ion trap cathode ray tubes. 6.3 volt heater, 7-9 Kv. E.H.T. 35 mm. neck. Black and white picture. By famous manufacturer.  
**PERFECT £12/19/6**  
Carriage and insurance 15/- per tube extra.

**LINE TRANSFORMERS FOR "ETRONIC" T.V. RECEIVERS**  
No. 1. For models 1536 and 1637. Complete with EY51 rectifier. 45/-.  
No. 2. 7Kv. type. 35/-.

**POT/METERS.** All values. Wire Wound from 3/6. Depending on wattage and length of spindle. Carbon. Less switch 3/3 each With s.p. switch... 4/3 each With d.p. switch... 5/6 each

VCR97 C.R. TUBES, new unused, 35/- Carriage 5/-.

EHT. Trans. for VCR97, 45/-.

Screen Enlarger for VCR97. Filter type, 17/6. Postage 2/6.

**DINGHY AERIALS WITH REFLECTORS**  
Umbrella type, with wire mesh reflector complete with setting up instructions. Mast not supplied.  
**LASKY'S PRICE 7/6** Post 1/6  
Good for T.V. and U.H.F.

**ANTENNA ROD SECTIONS**  
Steel, sprayed khaki. Each rod is 12in. long and ¼ in. diam. Any number can be fitted together.  
**PRICE 2/6 per doz., 6/- for 3 doz.**

C.R.T. Rear Neck Protectors, 2/6.

**12 VOLT D.C. MOTOR GENERATORS**  
Output 300 volts at 150 mA. D.C. 7,000 r.p.m. Size: 2½ in. diam. 6in. long. **17/6**  
**LASKY'S PRICE**

**INTRODUCING 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. Life-like reproduction of voice, music and events. 3 speeds, twin track recording at 3½ in., 7½ in., and 15in. per second. Fast forward and fast rewind using 3 motors.

**6/6 POST FREE**

BY THE CREATORS OF THE VIEWMASTER.

All components in stock. Write for list. Wearite, Bulgin, T.C.C., Collaro, etc.

### TELEVISION SELENIUM RECTIFIERS

The very latest "Sentercell" S.T.C. range.  
K3/40, 3.2 kV. .... 7/6  
K3/45, 3.6 kV. .... 8/2  
K3/50, 4.0 kV. .... 8/8  
K3/100, 8.0 kV. .... 14/8  
K3/160, 12.8 kV. .... 21/6

### DARK SCREEN FILTERS

18in. x 14½ in. .... 25/-  
14½ in. x 12½ in. .... 19/6  
13½ in. x 11in. .... 14/11

PERSPEX. 13½ in. x 10½ in. x ¼ in. Neutral shade, slightly marked, 4/11 per piece.

### SOLOON SOLDERING IRONS

220-250 volts. Latest model instrument iron 19/8 Standard model. .... 19/-

**ALL WAVE RADIO INTER-FERENCE SUPPRESSOR UNITS, 5/6 each.**

**JACK PLUGS AND SOCKETS** Standard size, 3/11 per pair.

### TOGGLE SWITCHES. BULGIN

S.P.S.T. .... 1/6  
D.P.S.T. .... 2/6  
D.P.D.T. .... 2/11  
Double pole change over 3/6

### 12 VOLT VIBRATOR UNITS

Output 230 volts 80 mA. BRAND NEW AND UNUSED. Size: 9 x 5 x 5½ in. Supplied less vibrator. Vibrator required is 6-pin synchronous. **19/6**  
**LASKY'S PRICE** Carr. 3/6 extra. Other types in stock from 15/-.

# RADIO

ow Road) Ltd.,  
**DDINGTON, LONDON, W.9**  
(Hospital)

485/487 Harrow Road, Paddington, London, W.10  
1979 and 7214. All Departments.

TERMS: Pro Forma, Cash with order, or C.O.D. on post items only. Postage and package on orders value £1-1/- extra, £5-2/- extra, £10-3/6 extra. Over £10 carriage free. All goods fully insured in transit.

**BUILD A PROFESSIONAL RADIO OR AMPLIFIER AT LESS THAN HALF TODAY'S PRICE**

**A MAINS OR BATTERY PORTABLE KIT**



A Midget 4-valve Superhet Portable Set covering medium and long-wave bands. Designed to operate on A.C. mains 200/240 volts, or by an "Aldry" battery. The set is so designed that the mains section is supplied as a separate unit which may be added at any time. The Kit therefore can be supplied (a) as an "Aldry" Battery Superhet Personal Set which can then be accommodated in the attaché case as illustrated (size 9 1/2 in. x 4 1/2 in. x 7 1/2 in.), this is attractively finished in lizard, maroon, dark green or blue rexine, or (b) as a combined Mains/Battery Superhet Portable Receiver, for which a polished cabinet is available to accommodate both Mains Unit and Batteries together. Circuit incorporates delayed A.V.C. and pre-selective Audio Feedback. Kit is complete in every detail and includes ready-wound frame aerials, fully aligned I.F. transf. and drilled chassis, etc.

Overall size of assembled chassis 8 in. x 4 in. x 2 1/2 in. This receiver, as illustrated can be completely built for approx. £10 (plus Mains Unit if required). Send 1/9 for the fully descriptive Assembly Book which includes Practical Layouts and complete price list of Components. Attaché case available separately. 37/6.

**THE DENGU ULTRA MIDGET SUPERHET COIL TURRETS WITH A ROTARY TURRET ACTION**

Type CT9 consists of a four station "pre-set" unit from which any three stations on medium waveband and one on long wave can be received by a turn of the turret switch. Price 39/6.  
Type CT10 is a 3 waveband coil pack incorporating a fourth switch position for 'Gram. Complete coverage is, long waveband 700-2,000 metres, medium waveband 190-570 and shortwave 15-50 metres. Price 22/8/-.  
A complete receiver circuit and all necessary data is included with each turret. These can be supplied separately for 6s.

**HIGH FIDELITY PICK-UP**

incorporating the CONNOISSEUR Lightweight Moving Iron Head. Includes a Connoisseur Matching Transformer for normal high impedance inputs. Price 39/6 (Plus 1/6 carr. & Ins.)

**TWO BATTERY PORTABLES**

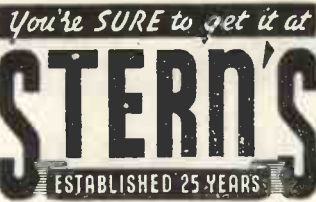
**(a) THE "MINI TWO-THREE"**

An "All dry" Battery Portable of midget size, 6 1/2 in. x 4 1/2 in. x 3 1/2 in., designed to cover medium waveband 190-570 metres, with use of short trailer aerial. The simple design of this Receiver is so arranged that either a 3-valve set or a 2-valve (afterwards easily converted to the 3-valve) can be made. Consists of a T.R.F. circuit using a regenerative detector with H.F. stage and a high gain output pentode. Valve line up 1T4-1T4-DL94. The 2-valve set can be completely built for 24/3/6 (Gess case), and the 3-valve for 25/3/- (less case). Each price includes valves, speaker and drilled chassis. They include Send 2/- for the assembly instructions: they include simple and complete practical component layouts and diagrams, which enable the most inexperienced constructor to successfully build either set. All components are available for separate sale, a price list being supplied with assembly instructions.



**(b) THE "MINI-FOUR"**

A 4-valve Battery Superhet Receiver designed to receive 4 pre-set stations, three on medium waveband and one on long wave to suit local conditions. Each station is obtained on the set by the turn of a rotary switch. No tuning is necessary. It is of midget size, being only 4 1/2 in. x 4 1/2 in. when completely built and is very easily assembled from diagrams supplied. Cost of all components to build this set, in accordance with the design, including a drilled and cut chassis and panel and new valves, is £9/10/- (or less valves for 23/7/6). Attractive carrying case finished in blue leatherette, 13/9-. Complete constructional data with a blue print, which shows the practical component layout and wiring diagram, together with an individual component price list, is available separately, 1/6. Our battery eliminators (illustrated above) available in kit form are suitable for all this set.



You're SURE to get it at

**The "Wireless World" 3-Valve Set**



A Midget 3-valve T.R.F. Receiver for operation on A.C. mains, covering long and medium wavebands.

We are able to supply all of the components to build this set, as designed and specified in the Feb. 1950 issue, including the drilled chassis. Valves and moving coil speaker, etc., at the following prices:—To construct complete chassis, less dial and drive assembly, 25/5/-. Ditto including dial and drive assembly, 26. To construct the complete set, including dial and drive assembly and cabinet, 27/3/6. Overall size of cabinet is 7 1/2 in. x 3 1/2 in. x 1 1/2 in. A reprint of the designer's article, giving circuit and assembly instructions (this is available separately for 9d.) together with a practical component layout is included with each of above assemblies.

**"PERSONAL SET" BATTERY ELIMINATOR**

A complete Kit of parts to build Midget "Aldry" Battery Eliminator, giving approx. 69 volts and 1.4 volts. This eliminator is for use on A.C. mains and is suitable for any 4-valve Superhet Receiver requiring H.T. and L.T. voltage as above, or approx. to 69 volts. The Kit is quite easily and quickly assembled and is housed in a light aluminium case size 4 1/2 in. x 1 1/2 in. x 3 1/2 in. Price of complete Kit with easy-to-follow assembly instructions, 42/6. In addition we can offer a similar COMPLETE KIT to provide approx. 90 volts and 1.4 volts. Size of assembled unit 7 in. x 2 1/2 in. x 1 1/2 in. Price 47/6.



**"MINI-TWIN" 1-VALVE BATTERY SET**



A design of a simple 1-valve 2-stage Battery Receiver, giving excellent results on medium and long wavebands and having exceptionally low battery consumption. Drilled chassis and practical diagrams make it the ideal set for the beginner to build. The complete chassis, including valve, can be built for 37/6 plus 8/11 P/Tax, the attractive plastic case is 9/6, and suitable headphones 14/9. The complete assembly instructions, layouts and a component price list, are available for 1/6. This Receiver also performs excellently, without modification, as a tuning unit, and in addition, with simple modifications for which a complete diagram is provided makes a first-class pre-amplifier for pick-up or microphone.

**A COMPLETE "CAR RADIO" FOR THE HOME CONSTRUCTOR**



11 1/2" x 4 1/2" x 3 1/2"

A design of a complete 5 VALVE SUPERHET RECEIVER employing an R.F. Stage and incorporating a separate VIBRATOR PACK size 4 1/2 x 2 1/2 x 6 1/2 in. for use on 6 or 12 volt D.C. supplies. We can supply all components to build this complete Receiver and Vibrator Pack including a Metal Case. Valves, Drilled Chassis and 5in. P.M. Speaker for 212/19/6. (Carr. and Ins. 5/6 extra). Or the receiver Components for 29/19/6, and the Vibrator Components for 23. This is NOT an EX-GOV'T. Receiver, it is a new design employing new Components. Send 2/8 for the complete set of ASSEMBLY INSTRUCTIONS, CIRCUITS and PRACTICAL LAYOUTS, including a complete individual Component Price List.

**A Famous Manufacturer's SHADED POLE GRAM MOTORS 10'6**

(Plus 1/- carriage and insurance.) Clockwise rotations and incorporates Mains Adjustment Panel. Could also be used as Recording Take Up or Rewind Motor.

**A COMPLETE 4 VALVE T.R.F. CHASSIS**

(Plus 7/6 Carr. and Insurance). Including a 5in. P.M. SPEAKER and VALVES.

FOR ONLY £6.9.6



This receiver is of the very latest design covering both Long and Medium Wavebands, and includes the modern BVA miniature valves. The line up being 12 BA5-12AT6-12AG-35W4. It incorporates Permeability Tuned Coils thus ensuring excellent selectivity and sensitivity. The overall size of the complete chassis including speaker is 10 1/2 in. x 4 1/2 in. x 8 1/2 in. An attractive Bakelite Ivory finished Cabinet size 11 1/2 in. x 5 1/2 in. x 8 1/2 in. is available for 16/6 (plus 2/6 carriage and insurance).

**SPECIAL OFFER**

A 12in. P.M. SPEAKER (2-3 ohm Voice Coil) by a very famous manufacturer for only 49'6 (plus 2/- carriage and insurance). THESE ARE BRAND NEW IN MAKERS CARTONS

**"HOME CONSTRUCTORS" THE NEW "SOUNDMASTER"**

**TAPE RECORDER IS NOW AVAILABLE**  
Send 6/6 for the complete set of building and operating instructions. These provide for an easily assembled complete PORTABLE TAPE RECORDER, including a component price list enabling all components to be bought separately.

**WE HAVE THE NEW W. B. "STENTORIAN" HIGH FIDELITY SPEAKERS IN STOCK**

|                     |         |
|---------------------|---------|
| Model H.F., 6-inch  | £2 10 6 |
| Model H.F., 9-inch  | £3 7 0  |
| Model H.F., 8-inch  | £3 0 6  |
| Model H.F., 10-inch | £3 13 6 |

These speakers are of the very latest design and provide quality reproduction for the lower price range. 3 or 15 ohm models are available.

**THE COLLARO MODEL AC47 GRAM UNIT £4.17.6**

(plus 3/- carriage and insurance) For use with 78 r.p.m. Records. Includes 12-inch Turntable and incorporates a variable speed control.

## 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. x 8in. x 7in. 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. Full descriptive leaflets are available separately for 1/-.

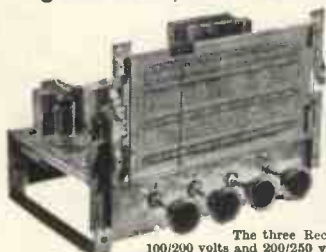
A 12-watt HIGH FIDELITY "PUSH-PULL" AMPLIFIER designed for A.C. mains 200 to 250 volts, employs 6 valves plus rectifier, with negative feedback, and comprises a main amplifier chassis and a remote controlled Pre-amplifier and Tone Control Unit, incorporating four controls—bass, treble, main volume or mixing control, and a radio, gram, microphone, selector switch. This control unit measures only 7 x 4 x 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.  
THIS AMPLIFIER COMPARES WELL WITH THE WILLIAMSON AND SIMILAR DESIGNS AT A FRACTION OF THEIR COST.



## 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 5-valve 6-waveband (4 Bandsread) Receiver.



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.

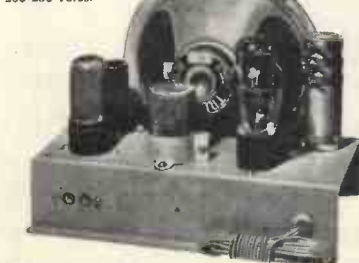
Brief specifications: Model B.3.—Valve line-up, 6BE6, 6BA6, 6AT6, 6BW6, 6X4—waveband coverage, short 18-60 medium 187-550, long 900-2,000 metres. Controls: (1) volume with on/off; (2) tuning (dialwheel type); (3) wavechange and gram; (4) tone (3-position switch operative on gram and radio). Negative feedback is employed over the entire audio stages. Chassis size: 11 x 7 1/2 x 8 1/2 in. high. Dial size: 9 1/2 in. x 4 1/2 in. 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.).

## THE WILLIAMSON AMPLIFIER

WE have the complete range of specified Components in stock for this famous quality Amplifier. Enquiries are welcomed and immediately dealt with. The complete assembly instructions and diagrams are available for 3/6.

## A Complete Kit of Parts to build a 3-4 WATT HIGH GAIN AMPLIFIER

or 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. x 5in. x 7in. and valve line-up 25Y5-b8H7-25L6. Price of complete kit, including drilled chassis and valves, £4/2/8, plus 6in. P.M. (which fits on chassis), 18/-, 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.

## MODERNISE YOUR OLD RADIOGRAM FOR

# £ 25

(plus 10/- carriage and insurance)

with the very latest equipment. We will supply the 3 waveband chassis on the left with the 3-speed auto changer on the right, complete with 10in. speaker for £25 (£28/7/6 with the Model B3P.P. Or £31/5/- with B3P.P. R.F.) This is less than half the price of comparable commercial three speed auto radiograms.

Brand new in Maker's Cartons, complete with mounting instructions.

- These units will auto change on all three speeds, 7in., 10in. and 12in.
- They play MIXED 7in., 10in. and 12in. records.
- They have separate sapphires for L.F. and 78 r.p.m., which are moved into position by a simple switch.
- Minimum baseboard size required 16in. x 12 1/2 in. with height above 5 1/2 in. and height below baseboard 4 1/2 in.

A bulk purchase enables us to offer these BRAND NEW UNITS at this exceptional price.



## SELENIUM RECTIFIERS

|                            |       |
|----------------------------|-------|
| 6 or 12 Volt 1 amp. rating | 7/6   |
| 6 or 12 Volt 2 1/2 " "     | 12/6  |
| 6 or 12 Volt 4 " "         | 17/6  |
| 6 or 12 Volt 6 " "         | £17/9 |

## 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. 2 1/2 amp. £2/5/3  
For 6 or 12 volt batteries at max. 4 amp. £3/2/8  
An easily followed Wiring Diagram is included with Each Kit.

## THE VIEWMASTER TELEVISOR

We have had very considerable experience in assisting customers to build this TV and can supply SPECIFIED COMPONENTS EX-STOCK. The assembly instructions showing practical layouts and price list are available for 7/6 for London, Sutton Coldfield, Holme Moss, Kirk-o'-Shotts and Wenvoe.

When submitting orders, please include post and packing charges.

## A DUAL CHANNEL PRE-AMPLIFIER and TONE CONTROL UNIT

This comprehensive PRE-AMPLIFIER and TONE CONTROL UNIT provides a full control of bass and treble in conjunction with a main Volume/Mixer Control.



It can be used with any amplifier and with any pick-up, the range of frequency control provided by the unit affording ample compensation for all types of pick-up and all natures of recordings, i.e., English, American and long-playing, without recourse to pick-up correction. The extreme flexibility of the bass and treble controls is such that the level of bass and treble can be set to suit any conditions irrespective of the volume output of the amplifier. Response characteristics are given in 12-watt amplifier advt. The unit measures only 7in. x 4in. x 2in. including self-contained power supply, and can be accommodated either on or away from the main amplifier, i.e., on the front panel of a cabinet or any other position. Price, including drilled chassis, valves (6SN7 and 6J5), £3/16/9. Complete assembly data is available separately for 1/-.

# 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/s.

|                            |      |
|----------------------------|------|
| 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 |



## SMOOTHING CHOKES

|                          |      |
|--------------------------|------|
| 250 mA. 7-10 H. 200 ohms | 16/9 |
| 250 mA., 3 H. 50 ohms    | 11/9 |
| 100 mA., 10 H. 175 ohms  | 7/6  |
| 80 mA., 10 H. 350 ohms   | 5/8  |
| 60 mA., 10 H. 400 ohms   | 4/11 |

## 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 |
| 120 v. 40 mA., 6 v. 1.5 a.     | 14/9 |
| 120 v. 40 mA., 6-0-6 v. 1 a.   | 15/9 |

## 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.

## TOP SHROUDED DROP THROUGH TYPE

|                                                              |       |
|--------------------------------------------------------------|-------|
| 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 |

## Primaries 200-230-250 v. 50 c/s. FULLY SHROUDED UPRIGHT MOUNTING

|                                                                                                                      |       |
|----------------------------------------------------------------------------------------------------------------------|-------|
| 250-0-250 v. 60 mA., 6.3 v. 2 a., 5 v. 2 a., Midget type 2j-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. 250mA., 6.3 v. 6a., 4 v. 8a., 0-2-6 v. 2 a., 4 v. 3 a., for Electronic Eng. Television                  | 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  |

## OUTPUT TRANSFORMERS

|                                                                                 |      |
|---------------------------------------------------------------------------------|------|
| Midget Battery Pentode 66:1 for 3S4, etc.                                       | 3/6  |
| Small Pentode, 5,000Ω to 3Ω                                                     | 3/9  |
| Small Pentode, 8,000Ω 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 8 watts 6V6 to 3 ohms                                                 | 7/11 |
| 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/- |

## E.H.T. TRANSFORMERS. 2,500 v. 5 mA.,

|                                                               |      |
|---------------------------------------------------------------|------|
| 2-0-2 v., 1.1 a., 2-0-2 v. 1.1 a., for VCR97, VCR517 or ACR2X | 35/- |
|---------------------------------------------------------------|------|

## 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.

## COLLAR TAPE DESK MOTORS, shaded pole type, clockwise or anti-clockwise, 29/9 each.

## DIAL BULBS, M.E.S., 8 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, 12/6.

## ELECTROLYTICS (Current production. NOT Ex-Govt.).

### Tubular Types

|                |      |
|----------------|------|
| 8μF 450 v.     | 1/11 |
| 8μF 500 v.     | 2/9  |
| 16μF 350 v.    | 2/3  |
| 16μF 450 v.    | 2/9  |
| 16μF 500 v.    | 3/9  |
| 24μF 350 v.    | 3/3  |
| 32μF 350 v.    | 3/9  |
| 32 mfd. 500 v. | 4/9  |
| 8-16μF 500 v.  | 4/11 |
| 25μF 25 v.     | 1/3  |
| 50μF 15 v.     | 1/2  |
| 50μF 50 v.     | 2/3  |

### Can Types

|                |      |
|----------------|------|
| 8 mfd. 500 v.  | 2/3  |
| 8 mfd. 500 v.  | 2/11 |
| 16 mfd. 350 v. | 1/11 |

## SPECIAL OFFERS. Germanium Crystal Diodes 2/3. Midget Mains Transformers (size approx. 2j x 3 x 2jin.). Screened Primary 220/240 v. 50 c/s. Output, 250-0-250 v. 60 mA, 6.3 v. 2.5 a. Only 1/5.

## CO-AXIAL CABLE. 75 ohms 1/2 in., 9d. yard. Twin screened feeder, 8d. yard.

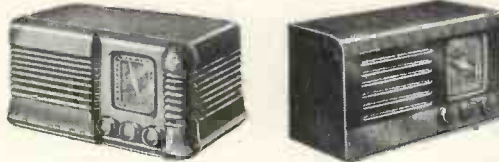
## EX-GOVT. CATHODE ISOLATING FILAMENT TRANSFORMERS. 6.3 v. to 6.3 v. c.t., 3/9 ea.

## MISCELLANEOUS EX-GOVT. ITEMS

Slydlock Fuses, 15 amp., 1/9. Bulgin panel mounting Fuseholders (ex-equip.), 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, Unused and guaranteed. 2 v. 16 A.H. Size 7 1/2 x 4-2in., 4/3 ea. Or set of 3 wired for 6 volts in wood carrying case 9-7-6in., 12/9, plus 2/6 Carr.

## BAKELITE AND WALNUT VENEERED CABINETS



Size approximately 12in. X 6 1/2in. X 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

Suitable fully punched superhet chassis (4 valves and rect.)

Dial Scales, 2 colour, 2 waveband, station named, glass

Dial Scales, 3 colour, 3 waveband, station named, glass

Suitable coloured Metal Backplates

"Push-on" Pointers

T.R.F. Coils, 2 waveband with circuit

Drum Drives, complete

Constructional Envelope of an All Mains

T.R.F. Receiver (3 valves and rectifier) which can be built in any of above cabinets (for approximately £5)

(for approximately £5)

## SELENIUM RECTIFIERS

L.T. Types

2/6 v. 1/2 a. h.w.

6/12 v. 1 a.

6/12 v. 2 a.

6/12 v. 4 a.

6/12 v. 6 a.

H.T. Types H.W.

70 v. 20 mA.

90 v. 20 mA.

120 v. 40 mA.

250 v. 50 mA.

350 v. 50 mA.

250/350v. 80 mA.

## EX-GOVT. E.H.T. SMOOTHING CONDENSERS

.02 mfd. 5,000 v. Bakelite Tubulars

.02 mfd. 8,000 v. Cans

.1 mfd. 2,500 v. Cans

.1 mfd. plus .1 mfd. 8,000 v., large blocks (common negative isolated)

## SPECIAL PURPOSE EX-GOVT. VALVES (GUARANTEED)

VR91, 4/11, SP61 (VR65) 2/9, VR56 3/11, AC6Pen 5/3, 807 7/11, 7193 1/3, 6J6 9/6, 954 1/11, 955 3/9, 6SH7Met 6/11, 12SC7G 6/11, RK34 2/6, VU120A 2/9, SP41 (VR65A) 1/11.

## EX-GOVT. WIRE WOUND POTS.

(Ex-equip., insulated spindles). Bakelite type, spindles approx. 1in. 2K, 2.5K, 5K, 10K, 15K, 20K, 50K, 100K, 2/3 ea.

## EX-GOVT. AUTO TRANSFORMER 50 c/s.

15-10-5-0-215-235 v. 200 watts... 25/9

## EX-GOVT. MAINS TRANSFORMERS.

All 230 v. 50 c/s input. 4.8 v. 1 a. output

Outputs 250-0-250 v. 40 mA., 6.3 v. 2 a., 5 v. 2 a.

350-0-350 v. 150 mA. 5 v. 3 a.

## VALVE SCREENING CANS. International Octal 3 piece, 10/6 doz., 1/3 each.

## EX-GOVT. SMOOTHING CHOKES

250 mA., 10 H. 50 ohms. Potted type ... 14/9

250 mA., 40 H. 200 ohms. Trop. type ... 17/6

250 mA., 20 H. 250 ohms. Tropicalised ... 13/9

250 mA., 10 H. 100 ohms ... 12/9

250 mA. 5 H. 100 ohms. Potted type ... 9/8

250 mA. 3 H. 500 ohms Potted ... 7/8

200 mA. 3-5 H. 100 ohms ... 6/11

150 mA. 15 H. 200 ohms ... 10/11

100 mA. 10 H. 100 ohms ... 6/11

100 mA. 15 H. 450 ohms. Tropicalised ... 5/9

100 mA. 5 H. 100 ohms. Tropicalised ... 4/8

50 mA. 50 H. 1,250 ohms. Potted type ... 8/11

## EX-GOVT. T.V. TYPE TRANSFORMERS. All 230 v. 50 c/s input.

610-0-610 v. 150 mA., 300-0-300 v. 150 mA., 1,250 v. 250 mA.

2 v. 3 a., 2 v. 3 a., 2 v. 3 a., 2 v. 3 a.

415-360-0-360-415 v. 250 mA.

375-345-0-345-375 v. 250 mA.

6.3 v. 6 a., 6.3 v. 6 a., 5 v. 3 a., 5 v. 3 a., 4 v. 3 a.

2 v. 2 a., 2 v. 2 a., 4 v. 3 a., 4 v. 3 a., high ins.

278-0-278 v. 80 mA.

350-0-350 v. 160 mA., 6.3 v. 6 a., 5 v. 3 a.

4 v. 6 a., 6.3 v. 6 a., 6.3 v. 6 a., 4 v. 6 a., 4 v. 3 a., 4 v. 3 a., 4 v. 3 a., 5 v. 2 a.

## EX-GOVT. RF26 UNITS. Brand new, cartoned, 49/6, plus carr. 5/-.

## EX-GOVT. BLOCK PAPER CONDENSERS

4 mfd. 500 v., 2/9

4 mfd. 1,500 v., 3/3

4 mfd. 1,000 v. 3/11

4 mfd. 2,000 v., 5/9

## EX-GOVT. HEAVY DUTY FIL. TRANS.

All for 230 v. 50 c/s. input. 6.3 v. 10 a., 17/6, 6.3 v. 12 a., 18/6, 6.3 v. 20 a., 22/6.

## EX-GOVT. CATHODE RAY TUBES

VCR517 (guaranteed full picture) ... 29/6

ACR2X (guaranteed full picture) ... 12/6

VCR139A with screen ... 19/6

Carr. 5/- ea. on first 2 items & 2/6 on last item.

# R.S.C. 25 WATT "PUSH PULL" AMPLIFIER

We are proud to introduce our A II Quality Amplifier, which 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  $\pm 3$  db. 50-20,000 c.p.s. **HUM AND DISTORTION LESS THAN 0.5 per cent.** measured at 10 watts, six B.V.A. valves, Marconi/Osram KT series output valves. A.C. only, 200-230-250 v. 50 c/c.s. 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 30/- extra.



**R.S.C. MASTER INTERCOMM. UNIT**, with provision for up to 4 "Listen-Talk Back Units" 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 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 27/6 each. Full descriptive leaflet 1/- The Master Unit can be supplied assembled and tested for 27/6 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.



has been obtained. 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.

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 FUSE-HOLDERS AND CIRCUIT.** Due to careful design the use of resistors for regulation of charge

**A PUSH-PULL 3-4 WATT HIGH-GAIN AMPLIFIER FOR £3/12/6,** plus carr. 2/8. 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 1/-.

**PERSONAL SET BATTERY SUPERSEDER KIT.**



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 33/9. Or ready for use 39/9. Size of unit 5-4-1 1/2 in.

**P.M. SPEAKERS.** All 2-3 ohms, 6in., Goodmans, 14/9, 6 1/2 in. Elac., 14/11, 6 1/2 in. 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, 6 1/2 in. Rola field 700 ohms, 11/9, 10in. R.A. field 600 ohms, 23/9. 10in. R.A. field 1500 ohms, 23/9. 10in. R.A. Field 1,000 ohms, 23/9.

**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 up 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. 1/2 a. Price with circuit 29/6. Or in working order, 37/6.

**WILLIAMSON AMPLIFIER KIT.** Complete set of parts (exact to author's specification) for construction of the original amplifier.



PRICE COMPLETE 14 gns.

**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 7 1/2-6-5 1/2 in. approx. Full descriptive leaflet 5d. PRICE INCLUDING WIRING DIAGRAMS 37/6. Or ready for use 15/- extra.

**CHASSIS**



|                                                                  |       |
|------------------------------------------------------------------|-------|
| 18 s.w.g. undrilled aluminium amplifier type (4 sided)           |       |
| 12in. x 9in. x 2 1/2 in.                                         | 6/11  |
| 14in. x 9in. x 2 1/2 in.                                         | 6/11  |
| 14in. x 10in. x 3in.                                             | 7/11  |
| 16in. x 10in. x 3in.                                             | 8/3   |
| 18 s.w.g. aluminium, receiver type. 6in. x 3 1/2 in. x 1 1/2 in. | 1/11  |
| 7 1/2 in. x 4 1/2 in. x 2in.                                     | 2/9   |
| 10in. x 5 1/2 in. x 2in.                                         | 3/3   |
| 11in. x 6in. x 2 1/2 in.                                         | 3/11  |
| 16 s.w.g. aluminium, receiver type, 12in. x 8in. x 2 1/2 in.     | 5/3   |
| 16in. x 8in. x 2 1/2 in.                                         | 7/6   |
| 20in. x 8in. x 2 1/2 in.                                         | 8/11  |
| 16 s.w.g. aluminium, amplifier type, 4 sided.                    |       |
| 12in. x 8in. x 2 1/2 in.                                         | 7/11  |
| 16in. x 8in. x 2 1/2 in.                                         | 10/11 |
| 20in. x 8in. x 2 1/2 in.                                         | 13/6  |
| 14in. x 10in. x 3in.                                             | 13/6  |

# 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.



**5 Harrow Road, Paddington, W.2**

PADDINGTON 1008/9 and 0401

OPEN MONDAY to SAT. 9-6 THURS. 1 o'clock.

**★ TRUVOX TAPE UNIT.** We are at last able to give immediate delivery on this long-awaited unit. Price £13/2/-, plus 5/- carriage. Details of the unit and of associated amplifier available on receipt of stamp. **★**

|                                                     |       |      |
|-----------------------------------------------------|-------|------|
| <b>VOLTMETERS.</b>                                  |       |      |
| 15 v. (50c) a.c. M.I. 2 1/2in. Flush Panel Mounting | ..... | 12/6 |
| 20 v. M.C. 2in. Square Panel Mounting               | ..... | 7/6  |
| 300 v. M.C. 2in. Square Panel Mounting              | ..... | 12/6 |
| 3,000 v. M.C. 2 1/2in. Flush Panel Mounting         | ..... | 25/- |
| 4,000 v. M.C. 2 1/2in. Flush Panel Mounting         | ..... | 25/- |
| 3,500 v. M.C. 3 1/2in. Projection                   | ..... | 21/- |
| <b>MILLIAMMETERS.</b>                               |       |      |
| 500 Microamp M.C. 2in. Round Panel Mounting         | ..... | 15/- |
| 1 M/A. M.C. 2in. Square Panel Mounting              | ..... | 12/6 |
| 1 M/A. M.C. 2 1/2in. Flush Panel Mounting           | ..... | 27/6 |
| 1 M/A. M.C. 2 1/2in. Desk Type                      | ..... | 12/6 |
| 5 M/A. M.C. 2in. Square Panel Mounting              | ..... | 7/6  |
| 10 M/A. M.C. 2 1/2in. Flush Panel Mounting          | ..... | 12/6 |
| 30 M/A. M.C. 2in. Round Panel Mounting              | ..... | 7/6  |
| 30 M/A. M.C. 2 1/2in. Flush Panel Mounting          | ..... | 12/6 |
| 60 M/A. M.C. 2in. Square Panel Mounting             | ..... | 7/6  |
| 200 M/A. M.C. 2 1/2in. Flush Panel Mounting         | ..... | 12/6 |
| 600 M/A. M.C. 2 1/2in. Flush Panel Mounting         | ..... | 12/6 |
| <b>AMP-METERS.</b>                                  |       |      |
| 1 Amp. T.C. 2 1/2in. Projection                     | ..... | 7/6  |
| 3 Amp. T.C. 2in. Square Panel Mounting              | ..... | 7/6  |
| 5 Amp. T.C. 2 1/2in. Flush Mounting                 | ..... | 10/- |
| 20 Amp. M.I. 2 1/2in. Round                         | ..... | 12/6 |
| 15 Amp. M.I. (50c) Projection                       | ..... | 35/- |
| 300 volts 50 CY. A.C. 5in. Dial Projection Type     | ..... | 50/- |

M.C. = Moving Coil. M.I. = Moving Iron. T.C. = Thermo-Coupled. All Meters are Brand New and in original cartons.

**RADIO-GRAM CHASSIS**  
 3 Wave-band Superhët. Med., long and short.  
 5 Latest Type MULLARD Valves.  
 4 Position Switching. Gram., med., long and short.  
 Provision for A.C. Mains 110/250 volts.  
 Extension Speaker x 7in. x 2 1/2in. Scale 8in. Square.  
 Or Chassis 13 1/2in. x 6 1/2in. x 2 1/2in. Dial 10in. x 5 1/2in.  
**PRICE £10/5/-.**  
**BRAND NEW AND GUARANTEED CARR. PACKING AND INS. 10/-.**

**SEND STAMPS FOR NEW 1953 28-PAGE CATALOGUE**

**6 WATT AMPLIFIER (UNDISTORTED)**  
 Manufactured by Parmeko and Sound Sales for Admiralty. 4 valves, PX25, 2-AC/HL, MU14. Output Matching and 3Ω and 15Ω, 100/250 v. A.C.  
**COMPLETE IN STEEL GREY AMPLIFIER CASE.**  
 £12-10-0  
**CALL FOR DEMONSTRATION**

**PYE 45 Mc/s STRIP, TYPE 3583 UNITS**  
 Size 10in. x 8in. x 2in. Complete with 45 Mc/s. Pye Strip, 12 valves, 10 EF50, EB34 and EA50, volume controls and hosts of Resistors and Condensers. Sound and vision can be incorporated on this chassis with minimum space. New condition. Modification data supplied. Price £5. Carriage paid.

9in. ESCUTCHEON. Brown Bakelite. Suitable plate glass and mask for 9in. tube. Price 7/6.

**T.V. PRE-AMPLIFIER FOR LONDON AND BIRMINGHAM.** Complete with 6AM6. Ready to plug in to your set, 27/6. P.P. 2/6.

**A GENUINE SPECIAL OFFER!**  
 3-Speed Auto Change Units by a Famous Manufacturer (Normal price is £16/10/-) ..... £10/10/- (Plus 7/6 carr. and insurance.)  
 Brand New in Maker's Cartons, complete with mounting instructions.  
 ● These units will auto change on all three speeds, 7in., 10in. and 12in.  
 ● They play MIXED 7in., 10in. and 12in. records.  
 ● They have separate saphires for L.P. and 78 r.p.m. which are moved into position by a simple switch.  
 ● Minimum baseboard size required 16in. x 12 1/2in. with height above 5 1/2in. and height below baseboard 2 1/2in.  
 A bulk purchase enables us to offer these **BRAND NEW UNITS** at this exceptional price.

**AMERICAN 12 v. DYNAMOTOR**  
 Output 250 volts, 60 mA. Weight 5 lb. Suitable for Car Radio or Electric Razors. 22/6.

**VCR139A. 2 1/2in.** Brand new in original cartons 35/-, carr. free.

**WELWYN WIRE-WOUND SLIDER RESISTORS**  
 MOUNTED ON PANEL FOR TV SETS  
 4 Bank: 100Ω, 500Ω, 2-10K ..... 5/-  
 4 Bank: 1K, 2-2K, 1-1 meg. (car) ..... 5/-  
 5 Bank: 200Ω, 2K, 3-10K ..... 6/-

**H.T. RECTIFIERS**

|                       |       |      |
|-----------------------|-------|------|
| S.T.C. 125 v. 60 mA.  | ..... | 4 6  |
| S.T.C. 125 v. 100 mA. | ..... | 5 0  |
| S.T.C. 125 v. 125 mA. | ..... | 6 0  |
| S.T.C. 250 v. 250 mA. | ..... | 18 0 |

**WESTINGHOUSE 14D/972** ..... 6 6  
 250 v. 25 mA. .... 2 0  
**S.T.C.M. 1/3 Noise Limiter** ..... 2 0  
**G.E.C. METER RECTIFIER, 1 mA.** ..... 11 6

**INDICATOR UNIT TYPE SLCS**  
 This Unit is ideal for conversion to a 'Scope Unit or basis for Midget Television. It contains C/R Tube type ACE10 (VCR193A) complete with holder and cradle, also earthing clip. 1-VR66, 2-VR65, 24 mfd. 550 v. wkg. condenser, potentiometers and a varied assortment of resistors and condensers. These Units are in new condition and packed in wooden dispatch cases. The C/R Tube will be tested before despatch. Dimensions: 8 1/2in. x 8 1/2in. x 11 1/2in. 45/-.

**W/W. PRE-SET VOLUME CONTROLS TYPE "901"**  
 100Ω, 500Ω, 2K, 10K and 30K ..... each 2/6

**RECEIVER R1355.** As specified for "Inexpensive Television." Complete with 8 valves VR65 and 1 ea. 6U4G, VU120, VR92. Only 23/6, carriage 5/-. Or brand new in original packing case 55/- carriage 5/-. RF, 25/-; RF25, 25/-; RF26, 59/6; RF27, 59/6.

**INDICATOR UNIT TYPE 182A**  
 unit contains VCR517 Cathode Ray 6in. tube, complete with Mu-metal screen, 3 EF50, 4 SP61 and 1 5U4G valves, 9 wire-wound volume controls and quantity of resistors and condensers. Suitable either for basis of television (full picture guaranteed) or Oscilloscope. Offered **BRAND NEW** (less relay) in original packing case at 79/6. Plus 7/6 carr.

**METRO-VIC (METROSIL) PENCIL TYPE E.H.T. REGULATOR up to 10 k.v.** particularly suitable for regulating E.H.T. Fly-Back 5/-

**RECEIVER UNIT TYPE 159.** Size 8in. x 6 1/2in. x 4 1/2in., containing VR91, VR92, CV66, VR65 and 24 v. selector switch. New condition, 15/-.

**VIBRATOR PACKS**

|                                                          |       |      |
|----------------------------------------------------------|-------|------|
| Input 6 v., Output 150 v., 40 mA.                        | ..... | 25/- |
| Input 6 v., Output 180 v., 40 mA. (ex. 21 set)           | ..... | 17/6 |
| Input 2 v., Output 180 v./90 v., 35 mA., 1.4 v., 250 mA. | ..... | 50/- |
| Input 6 v., Output 200 v., 80 mA. (Masteradio)           | ..... | 30/- |
| Input 12 v., Output 300 v., 100 mA.                      | ..... | 30/- |
| 6 v. V.b. Trans. 250 v., 80 mA.                          | ..... | 7/6  |

**STROBE UNITS.** Brand New. In sealed cartons, these contain 6 EF50s, 5 EA50s, 1 SP61, a host of condensers, resistors, transformers, chokes, relays, switches, 7 pots, and 5 smoothing condensers. Size 18in. x 8 1/2in. x 7 1/2in. Only 67/6.

**WALKIE-TALKIE TYPE "48,"** complete with 6 valves, 2VP23, EL2, DD, QP25, TP25 and ATP4, aerial rods, LF. trans., 1.6 Mc/s. mike trans. in new condition, but less transmitting components and coils removed by M.o.S., 35/-, carr. paid. (Less valves, 12/6).

**WEARITE**  
 705 Coll Pack 2 waveband ..... £1 17 10  
 501A and 502 465 kc/s. pair ..... 10 0  
 Wearite Mains Trans. Input 110/250 volts output 325-0-325 80 mA., 6.3 v. 2.5 amps., 0 v. 2 amps. .... £1 1 0

**L.T. RECTIFIERS**

|                               |       |         |
|-------------------------------|-------|---------|
| 6 v. 1 amp. G.E.C.            | ..... | 4 0     |
| 12 v. 2 1/2 amp. Westinghouse | ..... | 12 6    |
| 12 v. 4 amp. S.T.C.           | ..... | 17 6    |
| 12 v. 8 amp. S.T.C.           | ..... | £1 12 6 |

**VCR517C BLUE & WHITE 6 1/2in. TUBE**  
 This tube replaces the VCR97 and VCR517 without alteration and gives a full blue and white picture. Brand new in original cartons 35/-, carr. free. Three Months' Guarantee.

**PLESSEY** midget type 230 volts input, output 230-0-230. 50 mA., 6 volt, 2.6 amps., screened primary, 12/6

**WEYMOUTH SUPERHET MINIATURE COLL PACK**  
 Covering Med./Long/Short wave bands. Iron cored coils. Dimens.: Height 1 1/2in. Length 3 1/2in. Width 2 1/2in. Spindle length 2in. Complete with Circuit. Price 19/6.

**25/73 TRI196 RECEIVER**  
 This unit is complete with 6 valves, 2 EF36, 2EF39, 1 EK32, 1 EBC33 and 465 kc/s. I.F.T.s. Circuit and conversion data supplied, 25/- in new condition. Post Free.

**CATHODE RAY TUBES**

|                                                            |       |        |
|------------------------------------------------------------|-------|--------|
| VCR97. Guaranteed full T/V picture (carr. 2/-)             | ..... | £2 0 0 |
| VCR517. Guaranteed full T/V picture (with mu-metal screen) | ..... | £2 0 0 |
| 3BP1, with shield suitable for T/V or 'scope (carr. 1/6)   | ..... | £1 5 0 |
| MU-METAL SCREENS for VCR97 or 517. P.P. 1/6.               | ..... | 10 0   |
| 6in. ENLARGER for VCR97 or 517. P.P. 1/6                   | ..... | 17 6   |

**SHADED POLE MOTORS**  
 A.C. 200/250 v. 50 cycles, 2,000 r.p.m. Ideal for Tape Recorders. Gram. Motors, Timing Mechanisms or Switch Movements, etc. Size 2 1/2" x 3 1/2" x 2 1/2". Brand new, 10/8 each.

**S.T.C. RECTIFIERS E.H.T.**

|                         |       |        |
|-------------------------|-------|--------|
| K3/25, 650 v. 1 mA.     | ..... | 4 7    |
| K3/40, 1,000 v. 1 mA.   | ..... | 6 0    |
| K3/100, 3,500 v. 1 mA.  | ..... | 14 8   |
| K3/200, 10,000 v. 1 mA. | ..... | £1 6 0 |

**VR91 (EF50).** Brand new Red Sylvanian, original boxes ..... 10/-  
**VR91 (EF50).** Ex-brand-new units, 6/-, or ten for 50/-  
**PX25, 12/6.** Matched PX25's at 25/- per pair.  
 Raytheon CK510AX Sub-Miniature Valves, brand new, 5/-, GU50, 12/6.

**WANTED**  
 723 A/B and CV129 Klystron Valves, Philips Trimmers, 3-30 pF. RL18, NR88. Any quantity.

**No. 38 "WALKIE TALKIE" TRANS-RECEIVER,** complete with Throat Mike, phones, Junction Box and Aerial Rods in canvas bag. Freq. range 7.4 to 9 Mc/s. Range approx. 5 miles. All units are as new and tested before despatch, 24/10/-.

PLEASE ADD POSTAGE. ARTICLES UP TO 10/-, 1/- . £1, 1/6. £2, 2/-.

# ALPHA RADIO SUPPLY CO.

## MAINS TRANSFORMERS 3-Way Mounting Type.

**MT1.**  
Standard Tapped Primary 200/250 v.  
Secondaries 250-0-250 v. 80 m/a. 6.3 v. 4 amp. 5 v.  
2 amp. Both filament windings tapped at 4  
volts. Each 17/6.

**MT2.**  
As above with 350-0-350 v. 80 m/a. H.T. winding.  
Each 17/6.

**MT3.**  
Standard Tapped Primary 200/250 v.  
Secondary 30 v. 2 amps. with tappings at:—  
3 v.; 4 v.; 5 v.; 6 v.; 8 v.; 9 v.; 10 v.;  
12 v.; 15 v.; 18 v.; 20 v.; 24 v. Each 17/6.

**AUTO.** 0-10-120-200-230-250 v. 100 watts.  
Each 17/6.

### RECEIVER I132A

Contains EK32, 4 EF39, 6H6, 6J5, 3 SP61,  
P61, in good condition. Fitted with tuning  
meter, slow-motion drive and dial. Complete,  
with Circuit Diagram, 50/- each,  
carriage, etc., 7/6.

### FLEX AND CABLES

Twin Twisted PVC Flex 14/36. Crystal  
Colour 3d. yard. Per 100 yds. .... 19/6  
Push Back Wire 7/0076. Mauve, White,  
Blue, Green, yard ..... 2d.  
Twin Ribbon Feeder 300, yard ..... 6d.  
Coaxial Cable 75. 7/0076, yard ..... 1/-  
Twin Flat 14/0076 PVC Black, 3d. yard  
Per 110 yds. Coil ..... 21/-  
Screened Cable Single Core, yard ..... 6d.  
Screened Cable Twin Core, yard ..... 7d.

Headphones High Resistance CHR., pair 10/-  
Headphones Low Resistance CLR., pair 7/6  
Yaxley Switch 1 Pole 8 Way ..... 1/6  
Yaxley Switch 2 Pole 2 Way ..... 1/-  
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P.K. Self Tapping Screws No. 4, 1/2 in. doz. 3 1/2d.  
Rubber Grommets. Assorted, doz. .... 6d.  
Microphone Transformer 60-1 Ratio ..... 1/6  
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Grid Caps Octal Push-on Type, doz. .... 6d.  
Screened Grid Caps. British and U.S.A. .... 3d.  
Yaxley Switch 4 Pole 3 Way ..... 2/6  
Yaxley Switch 4 Pole 2 Way ..... 1/9  
Electrolytic Block Condenser 4 Mfd. 500 v. 1/6  
Crystal Diode ..... 1/8  
Bridge Rectifier, 12 v. 3 A. .... 13/9  
Single Gang. .0005 Mfd. Condenser ..... 2/9  
T.R.F. Switch ..... 1/-  
Standard Iron Element 450 w. .... 1/8  
Hydrometer Brand New in wood case ... 8/6  
Bulgin Toggle Switch D.P.D.T. .... 2/3  
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Car Bulb 6 volt 18 watt ..... 1/3  
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500Ω ; 600Ω ; 10KΩ ; 20KΩ ; 25KΩ ; 50KΩ ;  
100KΩ ; 1/2 megΩ ; 1 megΩ ; 2 megΩ.  
Each 1/-.

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Build a Radio in this up-to-date Cabinet.  
A modern looking Radio Cabinet complete with  
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11 1/2 in. x 5 in. Price £1/16/6.  
Post and Packing 2/-.



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The complete kit can be supplied for £6/6/-.  
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| 9004   | 6/3  | VR116 | 4/-  | VU39  | 8/6 |
| VR136  | 7/-  | VR56  | 7/-  | VR65A | 3/6 |
| VR66   | 3/9  | 954   | 2/-  | 956   | 3/6 |
| VU120A | 3/6  | CV71  | 1/-  | 9003  | 6/3 |
| 9002   | 6/3  | VR137 | 5/-  | 2X2   | 5/6 |
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| VR91   | 6/-  | CV188 | 3/9  | 6557  | 8/- |
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Available for 6 1/2 in. and 8 in. speaker units.  
Polished walnut finish. A very attractive cabinet  
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Price. 6 1/2 in. Type Cabinet, 15/6 each.  
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Gramophone motor, variable speed, manual  
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Pre Set Types 500Ω ; 200Ω ; 1,000Ω, each 1/9  
Standard 5Ω ; 200Ω ; 1,000Ω ; 2,000Ω ;  
5,000Ω ; 10KΩ ; 20KΩ ; 25KΩ ; 50KΩ, each 2/-

|                                                               |         |
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By various well-known makers.

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**Midget Types, less switch.**  
500 ohms, Ref.: 10W/8990 1/2 in. Sp. X/H428.  
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Price 2/3 each. Post 3d. extra.

**3-watt type.**

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5,000 ohms, Ref.: 10W/7796, 1/2 in. Sp. X/H423.  
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25,000 ohms, Ref.: 10C/538, 1/2 in. Sp. X/H422.  
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5-watt 2 hole fixing type. 270 ohms. Ref.: CLR/6003/12. W9259. 1 in. Sp. ASK FOR **2/-** Each POST 3d. EXTRA

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400 ohms, Ref. 10W/8534, 1/2 in. Sp. X/H571.  
500 ohms, Ref.: 10H/6924, 1/2 in. Sp. X/H666.  
2,000 ohms, 1/2 in. Sp. X/H425.  
25,000 ohms, Ref.: 10W/8572, 1/2 in. Sp. X/667.  
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**10-watt Toroidal Type.**

200 ohms, Ref.: W1363 wound on porcelain. ASK FOR **3/-** Each POST X/E172 6d. EXTRA

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25 watt 26 ohms. Vitreous finish, wire ends. Ref.: 10W/15688. Type AW3192. 3/- each, post 3d. extra. Doz. lots 30/-, post paid.

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10W/9305 W.W. on mica panel 43 x 18 mm. with fixing holes. 1.3 ohms. ASK FOR **3/-** Each POST X/H687 6d. EXTRA  
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Heavy duty. 1 ohm element NO former or mtg. ASK FOR **3/-** Each POST X/H688 6d. EXTRA  
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W.W. Bobbin type on former 10.5 cm. long 18 mm. dia. with fixg. holes. 40,000 ohms, tapped every 5,000 ohms. ASK FOR **3/6** Each POST X/H689 6d. EXTRA  
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**AR88LF, AR88D, CR100,** from stock. **RI155 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.  
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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.  
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**TYPE 73 VELLODYNE UNITS** in stock, £4/10/- each.  
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**MAINS TRANSFORMERS.** Special offer, not ex-W.D., 200/250 v. input tapped. Output 250-0-250 v. at 100 mA., 5 v. 3 a., 6.3 v. 4 a., 21/6 each.  
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**LARGE STOCKS OF MOTORS.** A.C./D.C. and A.C., 1/16, 1/12, 1/4, 1/2 h.p.  
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30 x 10 x 10 mfd. 450 volts and 20 mfd. at 25 volts... 10/6  
8 x 8 mfd. 475 volts D.C. .... 7/6  
25 mfd. at 50 volts D.C. .... 3/6  
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**Remote Switch,** navy type N.A.F.1118-2 carbon By Struthers. Dunn Inc. type CX1535AA ..... 17/6

Also available from stock—Hallcrafters B.C.610 transmitters complete. Please send for details.

**WANTED**

Wilcox Gay V.F.O. or any component parts for R.C.A transmitters E.T.4336. Also National H.R.O. spare parts.

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Primary, 200-250 v. P. & P. 2/-
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4 times. Unclamped, 32/6.
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.
Auto-wound, H.T. 280 volts at 360 mA.,
4 v. 3 amp., 2 v. 3 amp., or 6 v. 3 amp.
Separate 4 v. 3 amp., 10/6.
Auto-transformer, 110 v. 70 watts,
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250-0-250 80 mA. 6 v. 4 amp., 14/-
P. & P. 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/-.

Semi-shrouded drop thro' 280-0-280,
200 mA., 6 v. 5 amps., 5 v. 3 amps.,
27/6.
Semi-shrouded drop thro', 270-0-270
80 mA., 6 v. 3 amp., 4 v. 1.5 amp.,
13/6.
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60 mA., 6 v. 2 amp., 11/6.
Heater Transformer. Pri. 230-250 v.
6 v. 1 1/2 amp., 3/-; 2 v. 2 1/2 amps., 5/-;
2, 4 or 6 v. at 2 amps., 7/6; 2 v. 2 1/2 amp.
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8/6. 12-0-12 v. 2 amp., 9/6. P. & P.
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37/6. P. & P. 5/-.

P.M. SPEAKERS (closed field)

Table with 3 columns: speaker size, with trans., less trans.
2 1/2 in. .... 15/6
3 1/2 in. .... 13/6
4 in. .... 18/6
6 in. .... 18/6
8 in. .... 18/6
P. & P. on the above 1/- each.

10 in. less trans., 21/- P. & P. 1/6.
R. & A. 8 in. M.E. Speaker field coil,
1,600 ohms O.P. trans. 5,000 ohms.
5 amp., 18/6. P. & P. 2/-.

5 in. M.E. field coil 750 ohms with O.P.
trans. 17/6. P. & P. 1/-.

Extension speaker cabinet, in contrasting
walnut veneers, size 15 x 10 1/2 in.
Will take 6 1/2 or 8 in. speaker, 17/6.
P. & P. 2/-.

Volume Controls, Long spindle less
switch, 50K, 500K, 1 meg., 2/6 each.
P. & P. 3d. each.
Expanded aluminium speaker fret,
1 1/2 x 9 in., 2/-.

Volume Controls. Long spindle and
switch 1/2, 1 and 2 meg., 4/- each;
10 K, 50 K, 3/6 each; 1 and 1 meg.,
long spindle double pole switch, miniature,
5/- P. & P. 3d. each.
Trimmers, 5-40 pt., 5d.; 10-110, 10-250,
10-450 pt., 10d.

Twin-Gang .0005 Tuning Condenser,
5/- With trimmers, 7/6. P. & P. 1/-.

Line Cord. 3-way 0.3 amp. 180 ohms.
per yard. 1/3 per yard.

Twin-Gang, .0005 with feet, size
3 x 3 x 1 1/2 in., 6/6.
3-gang, .0005, with feet, size 4 1/2 x 3 x 1 1/2
in. 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. 9 in.
Enlarger 17/6, 12 in. 27/6.
Germanium Crystal Diode, 2/3 post paid.

Television Masks. White Rubber 9 in.
with glass, 7/6. Cream Rubber, 12 in.
with armour-plate glass, 15/-, 10 in.
Cream, 17/6 plus 1/6 P. & P.
T.V. Width Control, 3/6.
Used C.R.T. Tubes. Heater cathode
short 9 in. 45/- 12 in. 75/- 10 in. burn
9 in. 35/- 12 in. 55/- P. & P. on each
7/6.
CRYSTAL PICK-UP by famous manu-
facturer, complete with sapphire
trailer needle and volume control
23/- P. & P. on each 1/-.

EX-GOV'T. RECEIVER TYPE B28.
Complete coil up to 6 bands, 60 kc/s.-
450 kc/s. 500 kc/s.-30 Mc/s., 21/-.

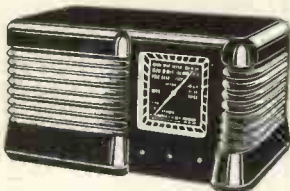
D. COHEN RADIO AND TELEVISION COMPONENTS

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 41, and 2/- up to £2. All enquiries and lists, S.A.E.

SPECIAL NOTE: NO GOODS SENT WHERE CUSTOMS DECLARATION IS APPLICABLE.

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Hours of Business: Saturday 9-6 p.m. Wednesday 9-1 p.m. Other days 9-4.30 p.m.



32+32 mfd. 4/- Bias condenser 1/- Resistor kit 2/- Condenser kit 4/- Cabinet as illustrated above complete but with 5 valve Superhet chassis, 23/6. P. & P. 3/6. As above but complete with new speaker and O.P. trans. to fit 36/- P. & P. 3/6. Medium and long-wave superhet coils with circuit 6/8. Iron core 465 Kc. IF's 7/8 pair. Miniature gang 5/6. Volume control with switch 4/8. Wave-change switch 2 x 8. Heater trans. Pri. 230/250 6.3 v. 3 amp. 7/6, 6 valveholders 2/-, 5 Obsolete Ex-Gov't. valves with circuit 14/6, 25 mfd. 25 wkg. condenser 11d. 8+16 mfd. smoothing condenser 3/6. Condenser kit (17) 7/6. Resistor kit (14) 3/6.

PERSONAL PORTABLE CABINET. In cream-coloured plastic; size 7 x 4 1/2 x 3 in. Complete 4-valve chassis. Scale and 3 knobs. Takes miniature 90 v. and 7 1/2 v. batteries 8/- post and pkg. 1/8. 3 in. P.M. Speaker to fit above, 10/- Miniature output transformer, 5/- Miniature wave-change switch, 1/8. Miniature 1-pole 4-way used as Volume and On/Off, 1/8. 4B7G valve holders 2/4. Midget twin gang fin. dia., 1/2 in. long and pair medium and longwave TRF coils fin. long x 1/2 in. 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 valves and batteries) could be built for approximately 51/- All valves to suit above available. Point to Point Wiring Diagram 1/-.

T.V. POWER SUPPLY CHASSIS, size 13 x 5 1/2 in. 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., 5 UAG, twin mains fuse, 11 pin output socket and mains lead. Assembled output 350 v. 200 mA. heaters 6.3 v. 7 amp., 70/- P. & P. 5/-.

MAINS UNIT comprising chassis 6 x 4 in., fully shrouded mains trans. 110/250 input, 32+32 mfd., 350 wkg., U50 rec., octal plug and mains lead. Assembled output 250 v. 70 mA. heaters 6.3 v. 2 amp., 25/- P. & P. 2/6.

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 6L6's in push-pull) 4/- 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 4 items by very famous manufacturer.

SPEAKER MATCHING UNIT comprising choke, 2 condensers and chassis size 6 x 2 1/2 in., 3 to 10 ohm. reversible, 12/6. P. & P. 1/6.

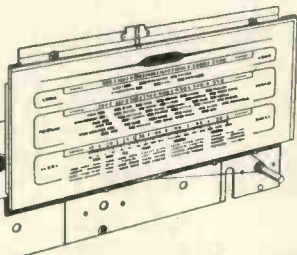


COMPLETELY BUILT SIGNAL GENERATOR. Coverage 110 Kc/s.-220 Kc/s., 300 Kc/s.-900 Kc/s., 900 Kc/s.-2.75 Mc/s., 2.75 Mc/s.-8.5 Mc/s., 8.5 Mc/s.-25 Mc/s., 17 Mc/s.-50 Mc/s.-25.5 Mc/s.-75 Mc/s. Metal case 10 x 6 1/2 x 4 1/2 in. Size of scale 6 1/2 x 3 1/2 in., 2 valves and rectifier, A.C. mains 230/250 v. Internal modulation 400 c.p.s. to a depth of 30 per cent., modulated or unmodulated. I.F. output continuously variable 100 millivolts. P. & P. 4/- 24/5/-.

CONSTRUCTOR'S PARCEL, comprising chassis 12 1/2 x 8 x 3 in., cad. plated 18 gauge, v.h., IF and trans. cut-outs, back-plate, 2 supporting brackets, 3 waveband scale, new wave-length station names. Size of scale 11 x 4 1/2 in., drive spindle, drum, 2 pulleys, pointer, 2 bulb holders, 5 paxolin international octal valve holders, 4 knobs, and pair of 465 IFs, 16+16 mfd. 350 wkg. semi-shrouded drop thro' 250-0-250 60 mA. 6 v. 3 amp. Pri. 200-250, and twin-gang 31/6. P. & P. 3/-.

CONSTRUCTOR'S PARCEL comprising chassis 8 in. x 4 in. x 1 1/2 in., with speaker and valve holder cut-outs, 5 in. P.M. speaker with trimmer, twin gang with trimmers, pair T.R.F. coils long and medium, four valveholders, 20 K. volume control and wave-change switch 23/- P. & P. 1/6.

465 Kc. MIDGET I.F.s. Q.120, long, 1 1/2 in., wide, 1/2 in. deep by very famous manufacturer. Pre-aligned adjustable iron-tuned coils, per pair, 12/6.



MAINS OR BATTERY SUPERHET PORTABLE COILS. Medium-waved frame aerial and long-wave loading coil. used as aerial coils. Midget iron-core screened L/M osc. coils, with circuit I.F. 465 Kc., 9/6.

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.

350-0-350 120 mA. 6.3 v. 3 a. tap 4 v., 5 v. 2 a. tap 4 v., 27/6.

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.

500-0-500 250 mA. 6.3 v. C.T. 4 a. 6.3 v. C.T. 3 a. 5 v. C.T. 3 a., 39/6. P. & P. on the above transformers 3/-.

Valve Holders, moulded octal Mazda, and octal, 7d. each. Paxolin, octal. Mazda and octal, 4d. each. Moulded 87G, B8A and B9A, 7d. each. 87G moulded with screening can. 1/6 each.

32 mfd., 350 wkg. .... 2/-
16 x 24 350 wkg. .... 4/-
4 mfd., 200 wkg. .... 1/3
40 mfd., 450 wkg. .... 3/6
16 x 8 mfd., 500 wkg. .... 4/6
16 x 16 mfd., 500 wkg. .... 5/9
8 x 16 mfd., 450 wkg. .... 3/9
32 x 32 mfd., 350 wkg. .... 4/-
32 x 32 mfd., 500 wkg. and 25 mfd., 25 wkg. .... 11d.
25 mfd., 25 wkg. .... 6/6
250 mfd., 12 v. wkg. .... 11d.
16 mfd., 500 v. 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., wire ends ... 4/-
100+200 mfd., 350 wkg. .... 9/6
16+16 mfd. 350 wkg. .... 3/3
Ex-Gov't. 8 mfd., 500 v. wkg., size 3 x 1 1/2, 2 for ... 2/6
60+100 mfd., 280 v. wkg. .... 7/6
16 x 32 mfd., 350 wkg. .... 6/-
50 mfd., 180 wkg. .... 1/9
65 mfd., 230 wkg. .... 1/6
8 mfd., 150 wkg. .... 1/6
60+100 mfd., 280 wkg. .... 8/6
50 mfd., 12 wkg. .... 11d.
32+32 mfd., min., 275 wkg. .... 4/-
50 mfd., 50 wkg. .... 1/9
Miniature wire ends moulded ... 7d.
100 pt., 500 pf., and .001 ca. .... 7d.

Combined 12 in. mask and acetone 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 9 1/2 x 4 1/2 in. 12 in. tube clamps, 2/-.

Smoothing Choke, 2 Henry 150 mA., 3/6. 250 mA. 4 Henry, 5/-; 250 mA., 10 Henry, 10/6; 250 mA. 8 Henry, 8/6.

P.M. Focus Unit for any 9 or 12 in. tube except Mazda 12 in., with Verier adjustment, 15/- P. & P. 1/6.

P.M. Focus Unit for Mazda, 12 in., with Vernier adjustment 17/6. P. & P. 1/6. Wide Anzle P.M. Focus Units, vernier adj., state tube, 25/- P. & P. 2/-.

Enrised focus coil, low resistance mounting bracket, 17/6 plus 2/- P. & P. Span 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 2 1/2 x 1 1/2 in. Q.110 removed from American equipment, 5/- per pair. Standard 465 Kc. iron-cored I.F.s. 4 x 1 1/2 x 1 1/2 in., per pr. 7/6. Wearite standard iron-cored 465 Kc. IFs. 3 1/2 x 1 1/2 in., 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-radio 3,500, 7,000 and 14,000, 5/6. 10-watt push-pull, 6/6 matching, 7/6.

PUSH-BACK CONNECTING WIRE. Doz. yds., 1/6. post paid.

STANDARD WAVE-CHANGE SWITCHES. 6-pole 3-way, 2/- 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, 2-pole 5-way, 4-pole 3-way and 4-pole 2-way, 2/6 each. P. & P. 3d.

MAINS OR BATTERY SUPERHET PORTABLE COILS. Medium-waved frame aerial and long-wave loading coil. used as aerial coils. Midget iron-core screened L/M osc. coils, with circuit I.F. 465 Kc., 9/6.

## SPECIAL THIS MONTH!

**PYE I.F. STRIP. RU. TYPE 196.** 10in. long x 1½in. wide x 2½in. high (overall). The smallest of miniature I.F. Strips using 10 valves, viz.: 8 CV138 (6AM6), 1 CV417 (EC91), and 1 CV140 (6AL5). Ideal for TV conversion. Brand new in original cartons. £5/10/- each, plus 2/6 carr.

**194 I.F. STRIP.** The well-known I.F. Strip for TV conversion, as mentioned in "Practical Television" and other publications. Complete with all valves, viz.: 6 VR65, 1 VR92 (EA50), 1 VR53. A few only available at 37/6, plus 2/6 postage.

**GRAM MOTORS.** A.C. mains (200-250 v.). This shaded pole inductance motor is ideal for rim drive turntable, wire and tape recorder work, fans, timing mechanisms, motion displays, driving small models, and various other small work. Size (overall) 3½in. x 3in. x 3in. R.p.m., 2,800 (approx). These motors are silent running. 8/6 each, plus 1/6 post.

**COLLARO GRAM MOTOR AND TURNTABLE, AC37** motor for 110-130 v. and 200-250 v. A.C. Governor speed controlled (78 r.p.m.). Brand new and worth £4/10/-. Our price 47/6, plus 2/6 post.

**INDICATOR UNIT TYPE 157.** Has same line-up as **INDICATOR TYPE 62.** The well-known unit for TV conversion or oscilloscope work. Complete with VCR97 C.R.T., mask and mu screen and all valves, etc. Brand new in transit case. Price £3/19/6, plus 7/6 carr.

**1132A RECEIVERS.** 11-valve superhet receiver, covering 100 to 124 Mc/s, using four VR53, two VR56, and VR66, VR67, VS70, VR54 and VR57 valves. Fitted with tuning meter, slow motion drive, R.F. and L.F. gain control, etc. Circuit: R.F. amp. freq. changer, oscillator, stab., three I.F. amps., B.F.D., det. 1st, audio and output. Brand new with circuit diagram. Price 59/6, plus 5/- carriage.

**BOMB SIGHT COMPUTOR, MARK XIV,** with 2 24 v. A.C./D.C. motors, a 24 v. repeater motor, gyro unit, dozens of gear wheels and anaroids, etc. Ideal for model makers, etc. 32/6 each, plus 7/6 carr.

**AERIAL COUPLING UNIT TYPE 39,** with 0-6 amp. R.F. 2½in. circular meter, 0-3 amp. thermocouple 2in. square meter, 100-watt loading lamp, aerial tuning coils, ceramic high-voltage condensers, etc. In strong wooden case, 13/6, plus 2/6 carr.

**CRYSTAL MONITORS, TYPE 2** (less valves and crystals). Useful chassis 7in. x 5½in. with cover. Contains 6-way Yaxley, on/off switch, indicator lamp holder, large phone jack, res., cond., L.F. choke and transformer, etc. In strong wooden case, 6/6 each, post free.

**RECTIFIERS, 220 v. 30 mA.,** at 2/6 each.; 6 v. or 12 v. 1 amp. F.W.B., at 7/6 each.; 6 v. or 12 v. 2 amp. F.W.B., at 12/6 each.; 12 v. or 24 v. 8 amp. F.W.B., at 27/6 each, plus 2/6 postage; 24 v. 80 mA., at 12/- dozen.

**ELECTROLYTIC CONDENSERS, 100 + 60 mfd. 450 v. (525 v.),** brand new, by well-known manufacturer (not Govt. surplus). List price 21/- . Our price 5/6 each, 54/- doz., with clips.

**SILVER-MICA CONDENSERS. 1200 pfs. 1%, 10,000 pfs. 5%,** at 6/- doz.

**2 v. LEAD ACID ACCUMULATORS, 7 amp. hours, size 4½in. x 3½in. x 1½in.** Unspillable type with celluloid cases, 5/6 each.

**R.F. UNITS TYPE 24.** The well-known unit used with the 1355 receiver for TV, complete with valves. Slightly soiled on outside. An absolute bargain at 14/6 each, plus 2/- post and packing.

**P.M. SPEAKERS. 10in. Rola** (less trans.). Brand new at 24/6 each, plus 1/6 post.

**VIBRATORS, 4-PIN 12-VOLT (ZA4878),** made by Mallory (type 650) Price 4/6 each, 48/- doz.

**GERMANIUM CRYSTAL DIODES, G.E.C.,** wire-ended, 2/- each, 18/- doz. VR65 VALVES at 3/6 each, 30/- doz.

**METERS** by well-known manufacturers. 0-200 mA 2½in. circular. Brand new at 10/6 each, plus 1/- post.

**OCTAL PLUGS.** Fits into int. octal holder to make a useful plug and socket. 9d. each, 8/6 doz.

**12-PIN PLUGS AND SOCKETS** at 9d. pair, 8/6 doz. pairs.

**POTENTIOMETERS, ½ megohm and 200,000Ω linear miniature** pots., long spindle, 2/- each.

**MIDGET 465 Kc/s I.F. TRANSFORMERS.** Dust core tuned, size 1½in. x 1in. dia. Price 6/9 per pair.

**KAROMOT (LOADED EBONITE) ROD, ¼in. dia. x 20in. long,** 4/6 doz., plus 1/- post.

**POLYTHENE RODS, ⅜in. dia., 12in. long,** at 6/- doz.

**COAXIAL CABLE. 75 to 80 ohms impedance.** Brand new at 9d. per yard (minimum of doz. yards).

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**1 KW TELEGRAPH TRANSMITTERS.** Two HF 300's output. Operation 3.5 mc to 16 mc.

**BC610 TRANSMITTERS** with speech amplifier, aerial tuning unit, etc. Brand new.

**RCA TRANSMITTERS.** Type FT-4336. Complete with original speech amplifier, crystal multiplier and VFO units. Unused and re-conditioned. Can be supplied with very large quantity of spares.

**RCA TRANSMITTERS.** Type ET-4332 modified by R.A.F. for use on crystal or master oscillator. Complete with speech amplifier.

**MAGNETO 10 LINE U.C. TELEPHONE SWITCHBOARDS** (complete).

**NO. 33 TRANSMITTERS.**

A.R.88D's, A.R.88LF's, A.R.77's, S27's, HRO, R.109 and others.

SCR510's complete with Power Pack and telescopic aerial.

All above items in excellent working condition. Working demonstration upon request.

**SPARES** A large selection available for SCR399 (BC610), ET4336, SCR610, EEB Telephones, and Teleprinters type 7B.

**TX VALVES** 805, 807, 813, 861, 866A, DET-16, 100TH and many others.

Large stock of Tx condensers, crystals and other components. Alignment and repair of communication receivers and all other short-wave equipment undertaken.

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**AIR MINISTRY COMMUNICATION RECEIVER R1155A.** Brand New. Frequency ranges—18.5-7.5 Mc/s. 7.5-3 Mc/s, 1,500-600 kc/s, 500-200 kc/s, 200-75 kc/s. Complete with 9 valves and Magic Eye. Guaranteed absolutely perfect. Price £9/10/-, plus 10/- for packing and carriage.

**I155 POWER PACK AND OUTPUT STAGE** complete with U50 and KT61 valves (not surplus) Black crackle case 12 x 8 x 5in. built-in 5in. pm Speaker and phone jack. 200-250 v. A.C. All connections terminate in Jones plug which enables instant operation of receiver without any modifications whatever. Matches in appearance with receiver. Made to "Wireless World" specifications. Built entirely from top grade new components, £7/10/- plus 3/6 carriage.



**G.E.C. VHF RECEIVERS** complete with 10 valves. Ex-Govt. As used by police. Used but guaranteed in excellent condition. Valves comprise ZA2's, 954's, or EF50's in HF and 1st Det. stages. Det 19 in local oscillator., KTW63's in three IF stages, D63 Det and AVC, LF H63, Output KT63, Noise suppressor D63, Power requirements 6v. 3a, 270 v. 80 ma. Frequency range 78.5-82 Mc/s. Intermediate frequency adjustable 8.3-9.8 Mc/s. Oscillator Crystal controlled (No Crystal included). Grey enamel steel case with lid 10 x 8 x 7in. Weight 22lbs. Note the amazingly low price, 39/6 plus 5/- carr.

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**OXYGEN MASKS. 6D/643 and 6D645.** Type G. Brand new. Individually boxed. £12/10/- per 100.

**GAUGES FOR DE-ICER.** New. Black bakelite Case. Approx. 2½in. diameter. 4 screw fixing. Calibrated 14.0 vacuum. 0-10 pressure. Individually boxed. £10 per 100.

**AMERICAN AIRCRAFT CABIN HEATERS.** Brand new. Type ABV-50D-H7-B. Makers "Surface Combustion" Columbus. 50/- each.

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**UNIVERSAL AVOMETERS MODEL 40** —very little used, thoroughly checked and tested. First-class multi-range test meter for **ONLY £9/19/6**.  
**50 Micro-amp. Moving Coil, 2½in. flush panel mtg., 65/-.**  
**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.

## 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 1½in.** 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 7/6 each.**

## CALBRATOR UNIT IIS

This unit is essentially a heavy duty power pack for 230 volts 50 cycles operation. It contains an extra heavy duty mains transformer, with one 6.3 volt winding, 5 volts for rectifier, and the H.T. is 325-0-325 volts. Heavy duty choke, appropriate smoothing condensers, rectifier, etc. Supplied complete with nine EF50's and 5Z4. In **BRAND NEW** condition at the give-away price of **82/6**, plus 7/6 carriage.

## COMMUNICATION RECEIVERS

**SKY CHAMPION 520R.** 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 RI155** 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. RI155N**, 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 RI155 to be used to operate speaker from 200/250 volts A.C. without ANY MODIFICATIONS WHATSOEVER. 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 ££££££££**  
 Deduct 10/- when purchasing any RI155 and power pack together.

**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 carriage

**U.S.A. DYNAMOTOR.** 12 volts D.C. input, 250 volts 60 mA. output. Weight 2½ 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

## TRAWLER BAND BATTERY RECEIVER RI224A

A 5-valve superhet receiver covering 30 to 300 metres in 3 wavebands with no gaps. I.F. 465 kc/s. Valve line-up: R.F. (VP23), F.C. (FC2A), I.F. (VP23), Detector 210LF, output 220 P.A. For headphone output but data supplied for speaker operation. Receiver contained in grey wooden cabinet, size 14½in. x 10in. x 9½in. MUIRHEAD slow motion dial. Brand new in original carton or case, complete with valves and air-tested. Requires 2 v. L.T., 120 H.T., 9 v. G.B. Circuit diagram included; for 79/6, plus 7/6 carriage.

## POLICE, FIRE, WROTHAM

The RI132A 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 RI155 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, RI132, RI481, RI392, RI155, etc. Lead for any specified set with Jones plugs, 10/- extra. All power packs guaranteed in working order.

**68R RECEIVER.** A four-valve battery-operated superhet, with standard 465 kc/s I.F.'s. Complete with all valves. Covers 3 to 5 Mc/s (60-100 metres). Handy for the 80-metre band. Circuit supplied. Price only **32/6**.

**RECEIVER RI225**, covers roughly 100-150 Mc/s, though sold primarily for break-up purposes. It contains 5 EF50's, 2 EF39's, and 1 EB34 and a host of other valuable components. This represents a very good buy at **ONLY 25/-**, plus 2/6 carriage.

## TRI196 RECEIVER

Receiver 25/73. This is a six-valve superhet receiver with 465 kc/s I.F.'s. Complete with all valves—2 EF39, 1 EK32, 2 EF36, 1 EBC33. In brand new condition with full conversion data. **SPECIAL OFFER 22/6**, plus 2/6 carriage.

**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 Sloydlock 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.

## POWER UNIT 247

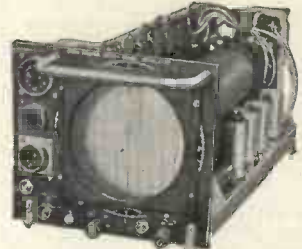
Enclosed in grey steel case, size 11in. x 9½in. x 7½in., with chrome handles. For 230 volts 50 cycles mains operation. Output 600 volts 200 mA., fully smoothed by 1,000 volt working paper condensers and extra heavy duty choke. Also 6.3 volt 3 amps. A complete power unit, including 5U4G rectifier and indicator light for only **52/6**, plus 7/6 carriage. New and in transit case. **THIS IS A REAL SNIP.**

## METAL RECTIFIERS

Selenium 230 volts 60 mA. at 5/-; 250 volts 100 mA. at 7/6; RM2 at 4/3, or two for 8/-; RM4 at 17/-, 12 v. 4 a. full wave bridge, 15/-; 12 v. 1 a., F.W.B. 6/6. 6 v. 3 a. F.W.B., 10/6. All types in stock. Heavy duty Westalite with square fins, size 8½in. x 4in. x 4in. Two units in full wave bridge give 48 volts 10 amps. D.C. **BRAND NEW** at **£5** per pair.

## INDICATOR UNIT 18

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 **79/6**, plus 7/6 carriage in original transit cases. Original circuit supplied **FREE** with each order, or 1/6 separately.



INDICATOR UNIT 182A

**INDICATOR UNIT 62A**, containing VCR97 C.R.T., complete with mu-metal screen. Valves: 12 EF50, 4 SP61, 3 EA50, 2 EB34. Otherwise as above. **BRAND NEW** in original transit cases. **ONLY £4/19/6**, plus 10/6 carriage.

**"INEXPENSIVE TELEVISION."** This book describes the building of a T.V. set from ex-Government surplus equipment. Price **2/9**, post paid.

**RI355 RECEIVER.** This justly famous receiver unit is specified for the "Inexpensive T.V." Valve line-up: 8 SP61, 1 VR92, 1 VU120, 1 5U4G. Slightly used, but in very good condition. **BARGAIN PRICE 29/6**, plus 5/- carriage and packing.

**BARGAIN OFFER.** The RI355, complete with RF24 unit tuned to whichever station is required (sound or vision) for only **62/6**, plus 7/6 carriage.

**RF26 and RF27** uses 2 EF54 and EC52. RF26 covers 50-65 Mc/s and the RF27 covers 65-85 Mc/s. Brand new and boxed, either type **59/6**.

**45 Mc/s PYE STRIP** Vision unit for London frequency, complete with 6 EF50 and EA50. Circuit provided. Price **£3/10/-**, plus 2/6 carriage.

**T.V. PRE-AMP** uses 2 EF50's and tunes to 45 Mc/s. Easily altered to other frequency. With valves, **19/6**; less valves, **10/-**. Post 1/- extra.

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**6in. MAGNIFYING LENS** for the VCR97, etc. First grade, oil filled. Now **ONLY 17/6**, plus 2/6 postage.

**CO-AXIAL CABLE.** Brand new 70/80 ohm with stranded inner conductor. Not ex-Govt. Price **1/-** per yard. Minimum per post dozen yards at **10/-**.

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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**.

**METAL RECTIFIER.** 12 volt 2 amp. full wave bridge type. Suitable for use with the above transformer. Price **10/6**.

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**MARCONI VALVE VOLTMETER, Model TF889.** New. £17/10/-.

**NEW TYPE 6H OSCILLOSCOPE UNITS.** Containing VCR97—with mu metal screen and rubber mask. 4 EF50s and 3 EB34s. Dozens of H.V. condensers, resistors and pots. Now is the time to buy these units before they are gone. Price £23/5/-, including "W./V." T.V. Scope Circuit.

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Type BC1046-R, Radio Receiver. 150-234 Mc/s. Price £12 the set. Carriage extra.

**VALVES.** 154, 8/6; 6AG5, 10/6; 117Z6, 12/6; 6SH7, 5/6; EF50, 6/6; 955, 954, 6/-; SG215, 6/6; Pen 220A, 6/6; TT11, 8/6; 42, 10/6; 9001, 9002, 9003, 7/6; 954-955, 6/6.

**MAINS TRANSFORMERS.** Input 200/240 v. Output 350-0-350 or 250-0-250 volt 80 mA. and 4 and 6.3 v. 4 a. and 4 and 5 v. 2 a. Price 21/6. Input 200/240 v. Output tapped 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30 volts, 2 amps., 21/6. All with one year's guarantee.

**D.P.D.T. RELAYS.** Operate at 200/300 volts D.C., 8/6. D.P. make and break, 8/6. We can supply any type of voltage and contacts at varying prices.

**NEW SELENIUM RECTIFIERS.** F.W. 12/6 volt 3 amps., 14/6; 4 amp., 22/6; 6 amp., 30/-; 1 amp., 8/6; 12 v. 100 mA., 3/-; 250 v. 100 mA., H.W., 9/-; 80 mA., 6/6; 250 v. 275 mA., 17/6.

**GERMANIUM CRYSTAL DIODES, 2/9.**

**VCR97 CRTs.** New and crated. Picture tested, 45/6. Bases, 3/6.

**NEW P.M. SPEAKERS.** 5in., 14/6; 6in., 16/6; Bin., 20/-; 10in., 27/6.

**0-500 MICROAMMETERS.** 2in., 15/6.

**M/C MICROPHONES** with matched Trans., 15/-.

**4ft. ROD AERIALS;** set of three, 6/-. Base, 3/6.

**FL5 FILTER UNITS, 8/6.** Same as FL8 but less switch.

**TYPE FT243 FREQUENCY CRYSTALS, 5.8 to 8.6 Mc/s.**

In 25 kc. steps, 8/-.

**6 VOLT VIBRATOR PACK.** Output 200 v. 60 mA. Complete in steel case, 22/6.

**6.3 v., 3 a. BULBS.** B.T.H.-G.E.C., 25/6 per 100.

**TRI196 TRANSMITTER SECTION.** New and complete but less valves, 4.6-6.8 Mc/s. Easily converted, 15/-.

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**SPECIAL VALVE OFFER.** 83 MV Rectifiers, 10/- 866A, 17/6 each, or 30/- pair. 807's 12/6 each, or 22/6 pr. 931A, 45/- 832, 35/- 829B, 80/- 813, 70/-.

**METERS.** 2 1/2in. Flush mounting M.C. 100 mA., 12/6 each; 2in. Flush Square 5 mA 10/-; 4 amp. thermo., 5/-; 2 1/2in. thermo., 0-2 a., 7/6; 2 1/2in. 2in. Flush 0-15 a. thermo. Proj. 2 1/2in., 7/6 each. 0-9 a. Hot wire, 5/-.

**CELESTION 10in. P.M. SPEAKERS.** Few only, 27/6 each.

**TWIN RIBBON FEEDER.** Standard K25 300 ohm ribbon, 9d. per yd. Co-axial cable, 1/2in. dia. 50 ohm, 8d. per yd. 7ft. length. 1/2in. dia. Co-axial with Pye plug one end, 1/6, post free. All other Co-axial and feeder, plus 1/6 post any length.

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**SPECIAL OFFER.** 300 ohm. Flat Twin 150 w. rating, 6d. per yd. (minimum 20 yds.) post free.

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**STANDARD 1/2in. T.V. CO-AXIAL CABLE,** 11d. yd. or 9/6 per doz. yds. or 9d. yd. in 100yd. coils. P. & P. 1/6, any quantity.

**STREAMLINED BUG KEYS** by famous manufacturer. Listed at over £4. Our Price 45/- only.

**SPECIAL TRANSFORMER OFFER.** PRI. 115, 210, 240 v. SES. 260/260 v. 100 mA. 6.3 v. 3 a., 6.3 v. 1 a. (for 6 x 5 Rec.) Universal Mounting, Limited Quantity, 17/6 each, post free.

**CARBON MIKE TRANS.,** 2/- each, P. & P. 6d.

**COMPLETE SET OF AR88 TUBES (14)** for LF or D model receivers, £5/10/-.

**TAPE RECORDING EQUIPMENT.** Desks by Bradmatic, Tamsa, Lane and Qualtape. Ex stock. Heads, Oscillator Coils, Tape and Reels always available. **GERMANIUM DIODES.** B.T.H., 2/-, G.E.C. 2/6.

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**TRUVOX TAPE DESK MARK III.** Incorporating high impedance mu-metal twin-track heads. Two-speed capstan, for tape speeds of 7½ and 3½ inches per second. Three heavy-duty motors allowing for fast forward and rewind facilities without tape handling. All controls operated by electrically and mechanically interlocked push buttons. Price £23/2/-. Send S.A.E. for full particulars. Plus 10/- carriage, etc. Delivery from stock.

**THE LATEST LANE TAPE TABLE.** Incorporating three heavy duty Lane motors; fast rewind and wind-on without tape handling; automatic braking; high impedance half-track heads; spool locking device. Tape speed 7½ in. per second. Price £17/10/-. Carriage 10/-.

**GARLAND UE7B RECORD PLAYBACK AMPLIFIER.** A revised version of our popular amplifier designed to suit Truvox Tape Desk or Lane Tape Table. New features include higher gain, magic eye record level indicator, and smaller size for incorporation in portables. Oscillator and power supplies included. Standard valves throughout. Formica control panel. Supplied complete with 8in. P.M. loudspeaker. Price £14/2/6 plus 7/6 carriage, etc.

**MAGNETIC TAPE.** Now available, the new Scotch Boy High Coercivity Tape MC2-III, with higher output and signal-to-noise ratio. Price 35/- per 1,200ft. reel. Still available: Scotch Boy MC1-III: 1,200ft., 35/-; 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. Magnetophone Tape: £2 per 1,200ft. reel.

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**TAPE RECORDER OSCILLATOR COILS.** 6.3 mH, 45 kc/s, for high impedance heads only. Price 6/9 each.

**MICA "POINT ONES."** Actual value 0.1084 ± 0.5 per cent. Can be used on A.C. mains voltage. 1/- each, or 9/- per dozen.

**STRANDED COAXIAL CABLE.** ¼ in. dia., 9d. per yd.; 12 yds. or over at 8d. per yd. Postage extra 1/-.

**GOODMANS H6 OUTPUT TRANSFORMERS.** Rated up to 30 watts push-pull; ten-section wound on silicon steel laminations with primary inductance of 100 H and negligible leakage inductance and capacitance. Primary 10,000 ohms C.T. Secondary 3.75 and 15 ohms. Price £3/3/-, plus 2/6 p. and p.

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**TYANA SOLDERING IRONS.** Lightweight 40 watt Irons with easily interchangeable elements and 3/16 in. diameter bits. Voltage ranges, 100/110v., 200/220 v. and 230/250 v. Price 16/9. "The iron that makes soldering a pleasure."

**VARLEY MAINS TRANSFORMERS.** Primary 10-0-200-220-240 volts. Secondary 300-0-300 volts at 150 mA., 5 volt at 3 amps., 6.3 volt at 4 amps., 6.3 volts at 1 amp. Open type construction. Price 45/-, post 2/6.

**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 grill, £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.

**DECALS.** 500 ¼ in. high white transfer letters and words for marking electronic equipment. Price 4/9 per book. The new Decals book for the amateur now available. 29 words per page, 4 pages radio and audio, 4 pages T/V and Scope, 2 pages misc. incl. Tx. and Tape Recording, 3/6 per book, post 3d.

**GENERAL PURPOSE TRIODES.** Type 2C/22 (7193), 6.3 v. heater, int. octal base. Similar to 6J5G, but anode and grid brought out to top caps. Price 11/6 per half-dozen, post paid (minimum quantity).

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**TELEVISION MAGNIFYING LENSES.** 6in. clear, 19/6; 9in. clear or filter, 50/-; 12in., clear or filter, 70/-; Please state which and add 5/- for carriage and packing.

**WHANDA WIRE AND CABLE STRIPPERS,** to take all size flexes and cables up to ¼ in. diam. with 3 alternative heads and triple screw adjustment. These are brand new and boxed, and the original price was 15/- each. Our price 5/- each, post paid.

**AERIAL RODS.** These popular rods, of tough steel copper-plated, are 12in. long, and fit into each other to make any length. Many hundreds of thousands sold to T/V aerial manufacturers and to the public. Price 3/6 per doz. or £1 per 100, post paid. £10 per box of 1,800 carriage paid U.K.

**TOROIDAL CERAMIC POTENTIOMETERS.** 260 Ω 50 w., 6/6. 17k. 100 watt, 8/6. **MAINS TRANSFORMERS.** All at 19/6 each. Post 1/6.

**MT1.** 250-0-250 v., 80 mA., 0-4-5 v., 2 A., 0-4-6-3 v. 3 A.

**MT2.** 350-0-350 v., 80 mA., 0-4-5 v., 2 A., 0-4-6-3 v. 3 A.

**MT3.** 0-30 v., tapped to give 3 v., 4 v., 5 v., 6 v., 8 v., 9 v., 10 v., 12 v., 15 v., 18 v., 20 v., 24 v., 30 v., all at 2 amp.

**MT4.** 4 v., 4 amp., 10 v. 4 amp.; 20 v. 3 amp., for battery chargers.

**MT5.** Auto; 0-10-120-200-230-250 v., at 100 watt.

**SMALL PAPER CONDENSERS.** In tubular metal cases with wire ends, ideal where electrolytics unsuitable. 0.25 mfd., 250 v., ¼ in. diam. x ¼ in., 1/- each; 1 mfd. 150 v., ¼ in. diam. x 1 ½ in., 1/3 each; 2 mfd. 250 v., ¼ in. diam. x 2 ½ in., in Neoprene sleeve, 1/9 each.

**MINIATURE LIGHT WEIGHT RELAYS.** 270 ohm, 18 v. Single pole on-off. Ex-American equipment. Price 2/9 each.

**WIRE WOUND RESISTORS.** Open, cement coated or vitreous enamelled. 4 watt, 50, 90. Price 1/- each. 6 watt, 30, 145, 270, 10 k., 15 k. Price 1/6 each. 10-15 watt, 5, 90, 100, 120, 170, 175, 200, 400, 700, 950, 1 k., 3.5 k., 4.5 k., 4.7 k., 11 k., 15 k., 25 k., 1/9 each. 15 watt, 650 ohm. Price 2/-.

**HIGH WATTAGE WIRE WOUND RESISTORS.** Capped end type, porcelain covered, at the following prices: 20 watt, 1/-; 40 watt, 1/3; 80 watt, 1/6; 100 watt, 1/9; 200 watt, 2/6; 3 ohm, semi-variable, 20 watt; 4 ohm, 40 watt; 13.852 + 1.352 + 8.352 ohm, 40 watt; 80 ohm, 40 watt; 350 ohm, 40 watt; 430 ohm, 200 watt; 5 k., 40 watt; 7.5 k., 40 watt; 12 k + 2 k, 80 watt; 20 k, 80 watt; 50 k, 100 watt; 75 k., 40 watt; 100 k, 200 watt. Packing and carriage extra on all of these resistors.

**METAL RECTIFIERS.** RM1, 125 v. @ 80 mA., 3/11. RM2, 125 v. @ 100 mA., 4/3. RM4, 250 v. @ 250 mA., 17/-; 14D/972, 250 v. @ 25 mA., 6/6. 12 v. 2 A., 6/-; 5 v. 1 A., 4/6. 12 v. 2 A., 12/6. 12 v. 2 ½ A., 16/6. 12 v. 4 A., 21/-.

**ELECTRO-MAGNETIC CONTACTORS.** Energised at 9-14 volt, ½ Amp; maximum switched current 40 Amps. In bakelite case. Price 2/9.

**PAXOLIN PANELS.** 3 ½ in. x 1 ½ in. x 3/32 in., 1/- per doz. 5/- per 100. 2 ½ in. x 2 in. x 1/16 in., 1/3 per doz. 6/- per 100. Many thousands available.

**MINIATURE MUMETAL TRANSFORMERS.** Auto-wound, giving approx. 2:1 ratio. Ideal rewind as head lift transformer, or lams can be used for recording heads. 2/6 each. **CATHODE-RAY TUBES.** Type 5CP1. 5in. green screen, electrostatic focussing and deflection. Callers only. Price 22/6 each.

**BRIMISTORS.** Non-linear resistors to protect valves from current surges: CZ1, 0.3 A., 3/6; CZ2, 0.3 A., 2/6; CZ3, 0.2 A., 1/6; CZ4, 1.25 A., 5/-; CZ6, 0.45 A., 3/6.

**HIGH FREQUENCY PENODES.** Type 65H7, high slope, octal based. 6.3 v. heaters. Price 6/-.

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| Brimar Radio Valve and Teletube Manual                     | 5/- |
| Wireless World Radio Valve Data, 3rd edition               | 3/6 |
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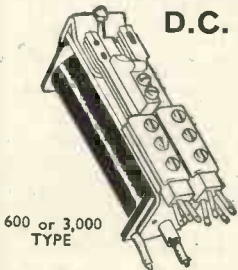
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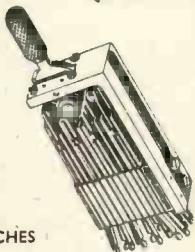
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**NEW RECEIVERS AND AMPLIFIERS**

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ARMSTRONG RF/103/1 10-valve 10-watt chassis, as new; offers around £12.—Box 0449. [1778]

C.R.100 Marconi communications receiver, as new, perfect order; what offers?—Box 3465. [1788]

DST100 Mk. III\* receiver, good condition; what offers?—Sykes, 41, Croydon Rd., Westerham, Kent. [1770]

TWIN turntables, amplifier, two loudspeakers, microphone (Universal Motors); £80 or offer; as new.—Box 0469. [1795]

FOR sale, two Canadian 58 sets, complete with head gear and power packs, as new; what offers?—J. E. Collins, 16, Woodlea Grove, Yendon, Leeds. [1780]

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]

TELEMECHANICS projection TV chassis with speaker, reflector and 18x13 1/2 perspex screen, used only for demonstration; £60 or near offer.—Sall, Ltd., 79a, St. Leonards Rd., Windsor. Tel. 1002. [1782]

TV, 16in 5-channel superhet console Teleking, tuned London frequency light walnut cabinet, 31x18x15, cost over £100 month ago; accept £50; trial against deposit.—Whitlock, Grove, Great Yeldham 253, Essex. [1678]

WILLIAMSON amplifier specified components with valves, £15; wire recorder deck, Garrard, B.S.R. motors, cost £14, unused, £9; 1155 receiver, perfect power-pack speaker, £9.—Dismore, 52c, Old Church Rd., Chingford, E.4. [1611]

ACOUSTICAL Q.A.12P amplifier and tuner, £30; tape record/replay amplifier, 6-watt output with separate power pack, £40; Decalcan 2-speed player, £20; Connaisseur motor, 2-speed, £12, Birmingham area.—Box 8765. [1611]

1 EXP. 125/2 Armstrong chassis, 14v, £25; 1 R.F.103 Armstrong chassis, 10v, £18; 1 4v all mains radio, £7/10; 1 sandfilled corner cabinet, Wharfedale design with Ro's G12, £6; all perfect condition.—Richards, 112, London Rd., Chemsford, Essex. [1667]

**LOUDSPEAKERS—SURPLUS AND SECONDHAND**

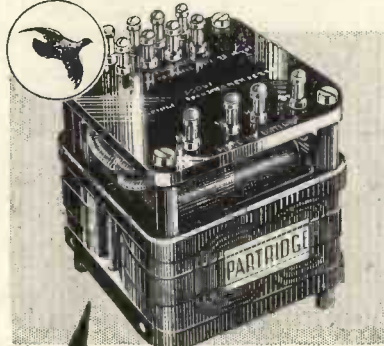
HARTLEY 215 speaker, £10; Collard 3/RCS22, £13; or exchange Avo 7.—Box 0439. [1768]

KLIPSCHORN, new this year, heard evenings; offers.—Benton, 5, Chesfield Rd., Kingsley. [1706]

HARTLEY-TURNER 215 speaker, perfect; £7.—Hart, 122, Rowe Avenue, Peasehaven, Sussex. [1779]

HARTLEY-TURNER latest 215, unwrapped, £12; Marconi B21 communications Rx, unused, £13; s.a.e. details.—Byrne, Gosberton, Lincs. [1784]

TYPE P.3064



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- Power Rating . . . 20 watts for less than 1% distortion.
- Leakage Inductance . . . less than 8 mH.
- Self Capacity . . . 500 pF per half primary.

Data Sheet No. 5 on request.

PRICE 98/- EX WORKS

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**PARTRIDGE  
TRANSFORMERS LTD**

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TOLWORTH SURREY  
Telephone ELMbridge 6737-8

**TEST EQUIPMENT—SURPLUS AND SECONDHAND**

FOR sale, Cossor model 1035, 4in double beam Oscillograph recently overhauled by manufacturer—Anders., Eyles & Co., Ltd., Westminster Electrical Works, Motherwell, [1720]

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]

G.R.650A impedance bridge, Dumont 5in oscilloscope, B.P.L. Wobbulator, Furzehill A.P.F.O. Hallcrafters, HT7 frequency standard, Canadian 58 trans./receiver, 1 Mc. crystal oven; offers invited; various ex-Gov. units and valves; stamp for particulars.—K. L. W. Cook, Radio Component Specialist, 2, Broadway, Andover. [1791]

**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]

ALL types of rotating electrical machinery up to 900 v.a.c., including rotary converters, rotary transformers, motors, petros, and diesel-engine generating p.a.n.s., 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.

JENSEL electric generating plants, 3kva, 230v, with push-button remote control, starting equipment, ready for use; £240.  
CHAS. P. WARD, Lordcroft 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., features latest AVA1, air-cooled diesel engine, alternator, self-energized automatic voltage control by winding on stator, d.c. output trickle charges or 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 24v 72 amp/hr batt., instruction book, spares; engine covered by Peters' inspection service; reduced price £260; free delivery; where only push start on plant, reduction of £6/10; a few from stock, others quick delivery; if you collect, or we deliver, battery is charged and a 10 cu ft concrete bed given free.

SEND p.p. for full description and photographs. ALSO above plant fitted Lister slow-speed water-cooled diesel and electric flywheels.  
ALTERNATORS, 230/1/50, 400VA, self-energized, 3,000rpm, ball bearing, £23/15 del.; also special television model same price; voltage regulator 30v, extra.

J.A.P. No. 2A 12h petros, engine, air cooled, 4-stroke, starting rope, tools; £17/10 delivered for above alternators.

RECTIFIER, rotary converters, guaranteed interference free. fitted radio and television filters, wt. 60lb d.c. input 12v 200ma, out. 24v 23v, 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; line above also supplied without smoothing, £25 del., immediate despatch; trade supplied.

AT a purchaser's home 60 mis. S.W. of Sutton Coldfield, a 24v TELEVISION converter was tested on Ekco television, 12in tube, stated consumption 135watts, d.c. current from battery only 9/8amps, 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 Ansel) [0013]

**DYNAMOS, MOTORS, ETC.—SURPLUS AND SECONDHAND**

FOR sale, Westinghouse rectifier set, RT 264/1-20/50 sing-e-phase in 200/50 dc-1 amp out, unused, cheap.—Box 8887. [1662]

H.F. alternators, 80v, 25a, 1,500 cycles; also hot wire ammeters, 0-1, 2 amps.—E.W.S. Co., 69, Church Rd., Moseley, Birmingham. [1613]

**FOR  
SALE AND WANTED  
ADVERTISEMENTS FORM  
TURN TO  
PAGE NO. 147**

Free from distortion



cannot introduce hum

**E.M.G. STEEP-CUTTING INFINITELY VARIABLE FILTER**

No other filter combines all the advantages of this model which are, briefly: to cut response above any desired level between 4,000 and 8,000 c.p.s. at an average steepness of 30 db. per octave, easy fixing (connects between 15 ohm speaker and amplifier output), robust construction, no distortion or appreciable loss of volume. Recommended for reducing surface noise on '78 records, cutting 'edge' on some L.P. records, and eliminating high-pitched interference on radio. Price £4/10/0. Leaflet on request.

**E.M.G. HANDMADE GRAMOPHONES & LTD.**  
6, Newman St., Oxford St., W.1  
Telephone: Museum 9971-2-3

**AMERICAN SURPLUS**

- **AERIAL EQUIPMENT.** Lattice ladder towers 50ft. and 100ft. Mast sets 20ft., 35ft. Tripod mast sets etc.
- **BAGS.** BG-56, ST-18, CS-34, CS-41 etc.
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- **CONTROL UNITS.** RM-12, RM-13, etc.
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- **LINE GEAR.** TE-92, LC-21, LC-60 etc.
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- **INSTRUMENTS.** M-209, M-139, FT-284 etc.
- **JUNCTION BOXES.** JB-69, JB-29, etc.
- **LAMPS.** 6, 12, 24, 110 volts etc.
- **LEGS.** LG-3, LG-10, LG-13 etc.
- **LOUDSPEAKERS.** LS-6, LS-12, MI-2968 etc.
- **METEOROLOGICAL.** ML-42, ML-117 etc.
- **MORSE GEAR.** BC-1016, TG-5, TG-10 etc.
- **MOUNTINGS.** FT-162, FT-237, FT-250 etc.
- **PANELS.** PN-31, PN-32, BD-LT etc.
- **POWER SUPPLY.** RA-34, RA-22, etc.
- **PLUGS.** PL-54, PL-55, PL-291 etc.
- **RECTIFIERS.** RA-36, RA-62, RA-39 etc.
- **GENERATORS.** PE-95, PE-204, GN-45 etc.
- **INVERTERS.** PE-206, PE-157, PE-117 etc.
- **RADAR.** SCR-268, SM, SO etc.
- **RECEIVERS.** BC-1147, BC-603, BC-1003 etc.
- **RELAYS.** BK-22, 21925, 25391 etc.
- **TELEGRAPH.** BE-71, M-222.
- **TELEPHONE.** BD-89, BD-96, EE-8 etc.
- **TELETYPE.** TG-7, BE-77, BA-87 etc.
- **TRANSMITTERS.** BC-902, CRN-30, SCR-493 etc.

Many other items too numerous to mention. Send your requirements. Lists available. All packing and shipping facilities.

**H. HARRIS**  
**ORGANFORD DORSET**  
Telephone: Lychett Minster 212

**NEW GRAMOPHONE AND SOUND EQUIPMENT**

**R**ECORDING equipment to the trade.  
**WEARITE** tape decks and special parts, disc recording machines.  
**BLANK** discs, Scotch-boy tape, Emitape.  
**RADIO** feeder units, microphones, etc.  
**ALL** from stock—Sound Discs (Supplies), Ltd. 178, Bispham Rd., Southport, Lancs. [1087]  
**TRUVOX** decks, 22gns; amplifiers to suit, 12gns and 18gns; complete in portable case (5in L/S); £57.—Below  
**WEARITE** decks, £35; suitable amplifiers with meter L. ind., £21.—Below  
**AMPS.** for Lane, Motek, from £12, or built to order, gram. amps. from 7gns; tuner units, 5/6ht, 10gns; T.R.F. 8gns; speakers, Barker Duode, 12gns; carr. free; all tape, post free.—Harding Electronics, 120a, Mora Rd., Cricklewood, London, N.W.2. [1727]

**H**IGH-fidelity FM, the very best RF signal converted to AF. See display advert.—Bel Sound Products Co., Marlborough Yard, N.19. [0185]

**C.J.R. ELECTRICAL & ELECTRONIC DEVELOPMENT, Ltd.**, manufacturers of high quality portable and console magnetic tap recorders for professional and amateur use; full details on application  
**BICKFORD Rd.**, Witton, Birmingham, 6, East 0822. [9968]

**F**ACTORY-built magnetic tape recording amplifiers, 4w R/P model, latest type B.V.A. valves, £15; to Wearite specification, £25; 12-valve professional model with separate record and play channels, 10w output, meter level, £45; Wearite, Truvox, Lane tape units, Grundig and Ferrograph recorders.—J.B. Electronics, 47a, Bulwer Rd., Leicester. Tel. 74579. [1799]

**C**INE-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 48gns, 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]

**P**OLLOCK lightweight m/c pick-up, response 40cs to 20 kc/s, h.f. resonance 25kc/s approx.; complete set of parts for constructing head, 25/-, plus 1/- postage and packing; building instructions, 5/-; sapphire stylus .001in or .0025in, 7/6; model also for thorns; 100:1 input transformer, steel case, 20/-, plus 1/- post, etc.—S.a.s. for details to A. M. Pollock, 14, Broomfield Lane, Hale, Cheshire. [9909]

**M**AGNETIC recorders, all types, new and secondhand for sale; hire service in greater London area only; mechanical and electronic repairs carried out by specialists: "Magnograph" 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 Magnograph Recording Co., Ltd., 1, Hanway Place, W.1. Tel. Langham 2156. [0236]

**GRAMOPHONE AND SOUND EQUIPMENT —SURPLUS AND SECONDHAND**  
**B**AIRD tape-recorder for sale, good condition. —Please send offers to Box 0100. [1703]

**WEARITE** tape deck, completely unused. quick sale; £29.—Tel. Prospect 1205. [1769]

**COLLARO** 3RC511 autochanger, 3-speed, 2 heads, cost £18/16, as new; £11.—25, Coniston Rd., Barnsley, Yorks. [1764]

**GRUNDIG** two-speed reporter as new complete tape, mike, 1st 284; £65.—Taylor, 125, Manchester Rd., Denton, M/C. [1629]

**T**WO E.M.I. Type 12 (long arm) P/Us, with transformer, v.x.c.: £5; 4 Presto cutter-heads, type IC (vertical fitting); £5 each.—Box 8891. [1666]

**C**OMplete M.S.S. disc recording equipment, consisting of 6ft P.O. rack with P/U pre-amp, mic preamp, RGD tuner unit, R11 main amp and preamp power unit; two CLED 78 rpm turntables with Rotocols and new P100 P/Us; £200.—Box 8890. [1665]

**F**ERROGRAPH magnetic tape recorder, £60; 10 spools Emitape, unopened, 25/- each; M.S.S. disc recording machine, 1953, £48; B.S.R. Monarch self-changer (unopened), £12; Wharfedale 10in speaker (unopened), £3; Reslo ribbon mike and stand, 47; Leak amplifier and prestage, as new, £30.—Box 0405. [1761]

**I**NFINITELY variable pitch M.S.S. studio disc tracking gear with B.C.C. type A recording head, very heavy 16in turntable driven by 4hp motor, whole machine mounted on iron framework and weighs 13cwt, ideal for all recording purposes especially making 'masters' from tape recorders, etc.; cost £80 but will accept £50 for quick sale as emigrating; will deliver.—31, Chimes Ave., London, N.13. [1709]

**V**ALVES WANTED  
**45/-** paid for new boxed 813s, 20/- for T240s, 24Gs, 811s; send details other surplus valves.—Box 8242. [1515]

Switch on to

**HENLEY SOLON**  
ELECTRIC SOLDERING IRONS

Solons save time; reduce costs. Solon soldering is always clean, reliable and simple. Five models, in voltage range 100-250; each with 6 feet Henley flexible. 65 watt; oval tapered or round pencil bits. 125 watt; oval tapered or round pencil bits. 240 watts; oval tapered bit.

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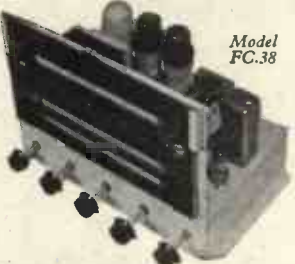
W.T.HENLEY'S Telegraph Works Co. Ltd.  
51-53 Hatton Garden, London, E.C.1

**AMPLIFIER TYPE 6**, complete with separate power supply unit. For 230 v. A.C. Supply. Has rack mounting front panel 19in x 15in, deep, containing volume control on/off switch, indicator light and 3in, 200 M/Amp. Meter. Output approximately 25 watts using 2 PX25 Valves and 1 MH14 Valve VU39 Rectifier, made by the famous Marconi Company. Price £31/- each, less valves. Carriage 10/6.  
**POST OFFICE TYPE RACKS**, Suitable for above amplifiers. For equipment 19in, 6ft, 6in, high for accommodating amplifiers, transmitters, receivers, etc., 39/6. Carriage 5/6  
**MAINS TRANSFORMERS**, Ex-AM. 500-0-500 at 150 M/Amp. 4 v. 4 amp centre tap winding twice 4 v. centre tap 3.5 amp and 10 v. at 1 amp. Standard mains input 0-250 v. 50 cycles. New condition. 25/-, Postage 2/6.  
**AERIAL COUPLING MASTS**, 4 section, each 5ft. long, 3in x 3in dia, 2 serials fitted in 3 foot canister. Price 7/6. Carr 3/6.  
**INDICATOR UNIT SLC NO. 5**, Suitable for conversion into oscilloscope, using a 139A or a 3BP1 Tube. Unit consists of 3 valves, two VR55's and 1 VR65, condenser 24 mfd, 500 v. working, tube holder and base, 4 pots., 2 group boards containing 22 resistors, 17 condensers, three 4-way sockets, the whole mounted on a chassis, 11 x 6 x 3 deep, complete with cover size 11 x 6 x 3in., open at one end to take glass screen. 17/6. Post 2/6.  
**ANTENNAS**, Half wave dipoles, 3in. long, each lapped 4 BA at outer ends for extension purposes. Moulded in polythene block together with approximately 12ft. of half inch co-axial cable. Brand new. Price 8/6. Post 1/6.  
**PRE-AMPLIFIERS**, R.F. Suitable for conversion for television amplifiers, chassis size 4in. x 3in. x 1 1/2in. deep. Complete with valve VR136 (EF64). New condition. Price 10/6. Post 1/6.  
**DESYN INDICATORS**, 24 v. Electric type, scaled 0-75 gallons, 2 1/2in. dia., would operate from a potentiometer by give 360° deflection. New and boxed. Price 3/6. Post 1/6.  
**AERIAL COUPLING UNITS**, Type G. Ref. ZA0843. Containing large inductances, variable transmitter tube condensers, 0.1 ma., M.C. meter, 2in. dia. indicator light, etc., with controls, brought out to front panel 15in. x 1 1/2in. Contained in metal box 15in. x 1 1/2in. x 1 1/2in. deep, with 2 1/2in. hinge lid, complete with circuit. These are in brand new condition, apart from external scratches, etc., to the case. Price 20/6. Carriage 5/6.  
**SLOW MOTION DIALS**, 5in., 200:1 ratio, scaled 0-100, ref. 10A/1531B. Price 4/6. Post 1/3.  
**ROTARY CONVERTER**, Deleo with 12 and 24 volt inputs, 265 volt at 120 m.a., and 540 volt at 26 m.a. output. New condition. 12/6. Post 2/-.  
**REV. COUNTERS BY SMITHS LTD.** 3 1/2in. dial. Scaled 10-8000 revs. per min. Luminous pointer. 29/6. Post 1/6.  
**OUR LARGE NEW 28 PAGE LIST NO. 10 IS NOW AVAILABLE, PRICE 6d. INLAND, 2/- OVERSEAS AIRMAIL.**

**A. T. SALLIS**  
93 North Road, Brighton, Sussex  
Phone: Brighton 25806

# Armstrong Quality Radio Chassis

The Armstrong range is especially designed to give the best in radio reception and the most faithful gramophone reproduction at an economical price. All the chassis are eminently suitable for use with the new 3-speed records because of the incorporation of independent BASS and TREBLE Controls which give AMAZING Realistic Reproduction.



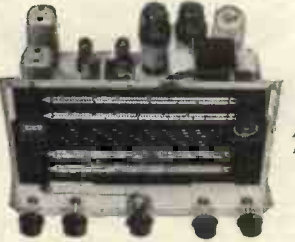
Model FC.38

## MODEL FC.38

An 8 Valve Superheterodyne chassis giving 8 watts push-pull output with negative feedback and separate BASS and TREBLE lift controls, Flywheel tuning and a magic eye. Three wavebands covering 16-50 metres, 190-550 metres and 1,000-2,000 metres. PRICE £23/13/-, including tax.

## MODEL RF.41

A 10 Valve Superheterodyne chassis giving 10 watts push-pull output with negative feedback and separate BASS and TREBLE lift controls, also a highly sensitive R.F. stage before the mixer. Flywheel tuning and a magic eye. Four wavebands covering 12-90 metres, 190-550 metres and 800-2,000 metres. PRICE £31/19/8, including tax.



Model RF.41

## MODEL EXP.125/A

A 14 Valve Superheterodyne chassis giving 15 watts push-pull output with negative feedback, two I.F. stages with variable selectivity and Radio Frequency Pre-Amplifier. Separate BASS and TREBLE lift controls. Incorporating five wavebands, giving continuous coverage from 12.5 to 550 metres and 1,000 to 2,000 metres. Flywheel tuning and a magic-eye. PRICE £48/19/5 including tax.

Our Showroom at the address as below is open daily from 9 a.m. to 6 p.m. and we are always delighted to demonstrate any of our Radio Chassis or supply any information regarding them. If unable to visit us please send for specifications required.

**ARMSTRONG WIRELESS & TELEVISION CO. LTD.**  
WARLTERS ROAD, HOLLOWAY, LONDON, N.7

Telephone: NORth 3213/4

### VALVES WANTED

URGENTLY required.  
URGENTLY required.  
URGENTLY required.  
55 VALVES CV. 177.  
PLEASE submit full details as soon as possible to Box 0063. [1696]

### 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]

COIL sets for TV converter. May issue "Wireless World." 12/6, post free; money-back guarantee.—C. O. Preston & Son, Healey Lane, Batley, Yorks. [1688]

TELEVISION—New 3/4in canned formers 2/3 ea., coil sets, EE, VM, PT, etc., from 18/6; FM. Rx. coil sets 75/-; 6mm cored formers 7/- do., 8mm 10/-; 3W4B min. switches 15/- doz.—Bel Sound Products Co., Marlborough Yard, N.19. Arc. 5078. Trade supplied. [0186]

FOR really good results you can do no better than use Osamor coils and colipacks, 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 Osamor lines are guaranteed. (Trade enquiries invited.) Dept. C.W.1, OSAMOR 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, 14/8; 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, 4/8; 4-pole cooker switches, 5/-; charge your dry cell batteries with our special charger from mains, complete unit, 14/9; new G.E.C. 1/4hp electric motors, 230v 8/p, £4/16.—Malden Transformer Supplies, Rear of S. Coombe Rd., New Malden, Surrey, Mal. 2655 (Longside of Malden S.R. Station). [0038]

### COMPONENTS—SURPLUS AND SECONDHAND

METADYNE generators, 45v, 60a, 2.7kW, totally enclosed, type MD70EX, new; £28. SELSYN motors, B.T.H. type SM1406. 230v ac Standard model, as new; £9 pair. CONSTANT frequency units, G.E.C. 100 Kc crystal controlled, two multivibrator units with jack points for 10Kc. 1Kc. 250c, 50c power unit, 230v ac, all mounted in standard rack 56in high with heavy angle base, enamelled finish, plated fittings, complete with crystal, 27 valves, circuit diagrams, etc., new; £45. MAGSLIP sine-cosine resolvers, 3in AP 10861, new, each in maker's tin; 45/-. AMMETERS, 5in, 0/14 amps, MI ac/dc, Grade 1, Proj. E.A.C., Ltd., new, boxed; 25/-. F. H. CRAWSHAY, 186, Pixmore Way, Letchworth, Herts. Tel. Letchworth 1147. [0251]

SUPREME RADIO, 746b, Romford Rd., Manor Park, London, E.12. Tel. III. 1260. Est. 17 yrs.

ALWAYS "Supreme" for good quality components at the keenest prices.

TWIN gang .0005mfd tuning condensers with detachable fixing bracket feet, our price 5/11 ea.

NEW stocks of electrolytic cond.: Tub./card w/ end 8mfd .450v, 1/11 ea.; also 8mfd 500v Drylytic tub./card w/ end, 2/9 ea.

METAL can 16+16mfd 350v, small, 2/3 ea.; 32+32+16mfd 350v small metal can cond., 3/6 ea.; 60+150mfd 275 v.d.c. wkg., this is a super bargain at 4/11 ea.; 25mfd 25v metal tag end cond., 1/3 ea.

10in P.M. speakers by famous maker, amazing bargain, 17/6 ea.

8in P.M. speakers, 13/11 ea.; 6 1/2in type, 12/11 ea.; 5in type, 10/6 ea.

T.R.F. coils for M.W./L.W. with circuit, 5/11 ea. pr.

SMALL vol./controls, 1meg or 1/2meg, with 1/spindle and d/p switch, 3/- ea.

1/2MEG or 2meg vol./controls less switch, 1/6 ea. or 15/- per doz. or mixed doz.

2p 2w W/C/CHANGE switches, 1/- ea. or 10/6 per doz.

MAINS trans. by Parmeko, universal fixing, primary tapped 0-200-220 240v, sec. 290-0-290v 80m.a., 6.3v 3amp, and 6.3v tapped at 4v. 2amp; with screen, our price 15/11 ea., inc. P/post.

WIRE-END crystal diodes with crystal set circuit, 2/- ea. or 22/- doz.

TWIN balanced feeder, 80ohm for television, 4d per vd.

FILAMENT trans., primary 0-250v, sec. 6.3v at 1.5a, 5/11 ea.; or 6.3v at 3 amp, 8/11 ea.

SPECIAL speaker bargain: 8in P.M. 2.3ohm v/c with out/trans. for 7K ohms load, cannot repeat at 13/6 ea., inc. p/packing.

IP/TS .465K/cs in small all-can 2 1/4in x 1 1/4in dia. with dust cores, 6/6 pr.

R.M.4 metal rec., 18/- ea.

P/PULL output trans, 10,000ohms C.T., 7watt max., our price 8/6 ea.

MANY other bargain lines in stock.

TERMS: c.w.o., no c.o.d., send 9d extra for postage orders under £5; 2 1/2d s.a.c. all enquiries and list. [0021]

# Armstrong perfection in Television

The three new Armstrong models now make up a range of Television which will suit all discriminating tastes. They are fitted with aluminised flat-faced rectangular Cathode Ray Tubes used with a tinted filter and pin-point focusing which coupled with full bandwidth and accurate interlacing ENSURES BRILLIANT DAYLIGHT VIEWING.

## T.V.5 14" CONSOLE

A highly sensitive, 19 valve, superheterodyne receiver which can be operated on any of the five channels, the selection of which is by the turn of a switch at the back of the Cabinet. In order to give the most faithful reproduction a 10in Loudspeaker is used with 4.5 watts output. An interference suppressor is fitted on sound and a variable suppressor fitted for vision. In order to present a very acceptable piece of furniture special attention has been paid to the appearance of the cabinet which is finished in a beautifully veneered over-all Walnut. The dimensions are 35in. high, 20in. wide, and 20in. deep and the Cabinet is fitted with silent running castors so as to facilitate easy movement about the room. PRICE 69 Guineas (including P. Tax).



## T.V.5 17" CONSOLE

This model is similar in all respects to the TV.5 14in. Console as described above, except that it is fitted with the large 17in. Cathode Ray Tube. This large tube gives a picture of exactly equal quality to the 14in. but of quite a considerable increase in size. PRICE 79 Guineas (including P. Tax).



Television Chassis showing easy removal of vision and sound receiver section for servicing. Both the TV.5 14in. and TV.5 17in. Models are available in Chassis form.

## TELEGRAM

The Television section of this model is exactly similar to the TV.5 14in. Console but there is included also the novel feature of the latest type 3-speed record player situated under a press-catch lid on the top of the cabinet. This therefore gives the gramophone enthusiast a medium for obtaining excellent reproduction from the latest records of all speeds as well as the very latest in Television. The cabinet dimensions and details are also exactly similar to the TV.5 14in. Console. PRICE 78 Guineas (including P. Tax).

As mentioned at the foot of our other column on this page we shall be delighted to demonstrate these Models at our Showroom or to provide any details required. Please write or call and see us.

**ARMSTRONG WIRELESS & TELEVISION CO. LTD.**  
WARLTERS ROAD, HOLLOWAY, LONDON, N.7

Telephone: NORth 3213/4



THE "FLUXITE QUINS" AT WORK

"Why they stick these on poles beats me This is far worse than climbing a tree Have you got the FLUXITE?" "Yes, we've got that all right But we're in the wrong garden!" cried EE.

See that FLUXITE SOLDERING PASTE is always by you—in the house—garage—workshop—wherever speedy soldering is needed. Used for over 40 years in Government works and by leading engineers and manufacturers. Of all Ironmongers—in tins from 1/- upwards.

TO CYCLISTS. For stronger wheels that will remain round and true, here's a time tested tip. Tie the spokes where they cross with fine wire AND SOLDER. It's simple—with FLUXITE—but IMPORTANT.

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SOLDERING PASTE

A Staunch Companion to Fluxite Soldering Fluid.

SIMPLIFIES ALL SOLDERING

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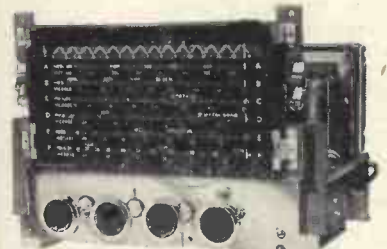
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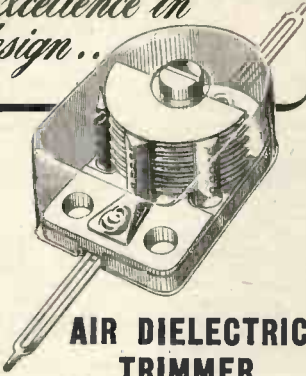
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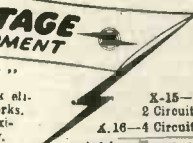
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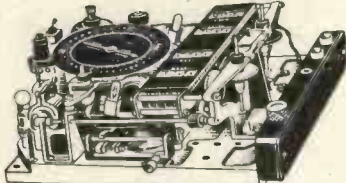
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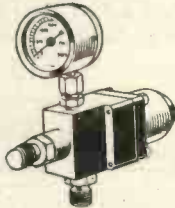
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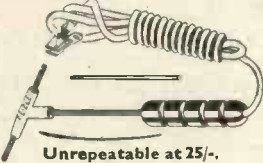
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**RADIO Engineer,** accustomed to service on domestic receivers, preferably driver, N.W.3 London area; permanency.—Box 0026. [1681]

**TELEVISION service engineer** wanted, able to drive.—Barnes, Spicer, Ltd., 4, Connaught Buildings, Worthing. Tel. 2241. [1755]

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**SHOP foreman** wanted for radio and electrical assembly; able teach and supervise girl labour.—South London district.—Write, giving full details, Box 8885. [1658]

**JUNIOR technical staff** for small radio and electrical firm; knowledge military equipment an asset.—Write, stating qualifications, experience, etc., Box 8885. [1660]

**REPRESENTATIVE,** experienced with good connections, required by established radio manufacturers, S.E. London district. Salary plus commission.—Box 0320. [1748]

**EXPERIENCED TV engineers** required for retail service; permanent positions at good salary.—Full details to Shenstones (op. Town Hall), Leyton, E.10. Ley. 1362. [9266]

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**RADIO testers and inspectors** required for production of communication and industrial electronic equipment.—Apply Mr. D. J. Lewendon, Winston Electronics, Ltd., 1, Park Rd., Hampton Hill, Middx. Tel. Molesey 2985. [1645]

**WORKS manager** required for radio and electrical factory to employ 50-100 personnel in South London area.—Write, stating qualifications, experience, etc., Box 8884. [1659]

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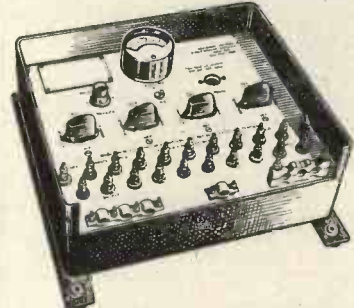
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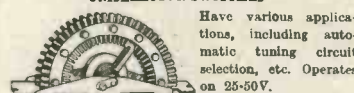
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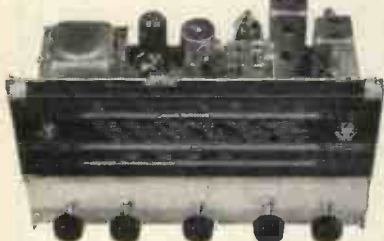
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(I) **ENGINEERS** for research and development work in the following fields: Radar, radio and electronic circuits, micro-waves, high power centimetric valves, vacuum and/or high voltage techniques, servo control and electro-mechanical devices and testing equipment associated with the above. Qualifications include a degree in Physics or Electrical Engineering or Mechanical Science or equivalent qualifications, and at least two years' previous experience. Salary according to qualifications and experience in the range of £500—£1,000 per annum. Please quote reference WE.

(II) **TECHNICAL Assistants** for experimental work in the fields listed in (I) above. **QUALIFICATIONS** required: a degree or Higher National Certificate in Electrical or Mechanical Engineering or equivalent qualifications. Salary in the range of £400—£600, according to age and experience. Please quote reference WT.

(III) **DESIGNERS and Draughtsmen.** **SECTION leaders,** leading draughtsmen, draughtsmen and junior draughtsmen, preferably with experience in any of the fields mentioned above. Salaries based on A.E.S.D. rates in the range of £350—£250 per annum with good allowances for special qualifications and experience. Please quote Reference WD. **THE company** has a staff pension scheme. Application forms from Mr. R. J. Hebbert, Staff Manager, Ferranti, Ltd., Hollinwood Lancs. Please quote appropriate reference. [1621]

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**ELECTRONIC circuit engineers** required immediately by rapidly expanding instrument company in East Anglia; write at once giving comprehensive details and salary required to—Box 0029. [1684]

**COMPONENTS manufacturer Midlands area** requires a man with commercial acumen and some technical knowledge to provide liaison between production, engineering and sales; commencing salary £800, with bonus and prospects.—Box 0406. [1766]

**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]

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**U.H.F. and TV engineer** for the development of components and accessories; wide experience with variety of receivers (e.g., from servicing) essential; East London area; state age, salary, experience, qualifications.—Box 8886. [1661]

**ARMY wireless reserve squadron Royal Signals** require good W/T operators; 15 days' training on full pay plus interesting voluntary work of national importance at home.—Details, Major Haylock, 230, Devonshire Ave., Southsea. [1732]

**SENIOR and junior radio development engineers,** preferably with Higher National Certificate or equivalent.—Write, stating age, experience, qualifications, etc., to the Personnel Manager, Bush Radio, Ltd., Power Rd., Chiswick, W.4. [1578]

**COILWINDING.**—New firm with strong financial backing requires engineer to take charge of small transformer, general coilwinding and assembly shop. Commencing salary £750 rising to £1,000 per annum as concern increases in size.—Box 0319. [1744]

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**EXPERIENCED** radio testers and inspectors required for production of communication and radio apparatus, also instrument makers, wiremen and assemblers, for factory test apparatus.—Apply Personnel Manager, E. K. Cole Ltd., Ekco Works Marnesbury, Wilts [10258]

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**B.B.C.** requires temporary tracer, period one year, for planning and installation department, central London; wages £6/5-£7/5; some training engineering, drawing and tracing; knowledge of electronic system desirable.—Apply E.E.O., B.B.C., London, W.1. [1714]

**TECHNICIAN** with experience in electronic work, required for development laboratory in large telecommunication engineering works; give particulars of experience, education and technical training, qualifications and commanding salary required; London, S.E. area.—Box 0172. [1712]

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APPLICATIONS should be made in writing to the Staff Manager, The Grove, Stanmore Common, Stanmore, Middlesex, quoting the appropriate reference and stating age, qualifications and experience. [1717]

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**MARINE** radio, senior development engineers required with considerable experience in the design of marine radio equipment to G.P.O. specifications.—Apply with full details and salary required to Chief Engineer, Communications, Redifon, Ltd., Broomhill Rd., Wandsworth, S.W.18. [1741]

**FERRANTI, Ltd.**, require electronic equipment testers, radio diagnosticians and radio mechanics for their North and South Manchester factories; standard rates of pay and excellent working conditions.—Write giving age and details of experience, to Labour Manager, Ferranti Ltd., Moston, Manchester, 10. [1728]

**TRANSFORMER** designer required for development projects involving audio-frequency power transformers, pulse transformers, oil filled units, etc.—Apply stating age, qualifications and experience to The Personnel Manager (Ref. R.G.), The General Electric Co., Ltd., Brown's Lane, Allesley, Coventry. [1730]

**ELECTRONIC** engineer required for development and testing of a wide range of electronic measuring instruments, previous experience desirable but not essential; excellent prospects for rapid advancement. In young and expanding organisation.—Rivlin Instruments, Ltd., 7a, Maitland Park Villas, N.W.3. [1650]

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**HOME** Office require Wireless Technicians at Pinner. Must have experience of installation and maintenance of V.H.F. equipment and prepared to travel. Subsistence payable whilst travelling. Salary £368-£483. Promotion and establishment prospects.—Write: Communications Branch, Home Office, London, S.W.1. [1746]

**ELECTRONIC** Engineer with thorough experience of commercial electronics, required to assist with the starting of a new department for an established company of electrical engineers located in East London; applicants must be keen and industrious and provide details of experience, age and salary required.—Box 0030. [1685]

**DESIGN** engineer required for work on audio amplifiers, electronic switching, and similar equipment for company engaged in the manufacture of communication equipment; present vacancy is in Central London area; good prospects for person able to work on own initiative.—Write, giving full particulars, Box 0074. [1752]

**RESEARCH** Engineer req. for work mainly on audio frequency circuits and measurements, high quality recording and reproduction of sound. Some experience preferable but not essential. Write giving fullest details of experience, qualifications, etc. to—Personnel Dept. (R/T), E.M.I. Research Labs., Ltd., Hayes Middx. [1745]

**TECHNICAL** assistant for work on interesting ultrasonics project. The successful candidate will be expected to work as part of a research team and experience in electronics development work is essential. Min. standard B.Sc. (Physics or Electrical Engineering) or N.C. Bristol area.—Write giving full particulars, age, exp., sal. req., etc., to Box 0375. [1760]

**ENGINEERS** required for interesting development work on the design of radio components; applicants should have good basic training and preferably some experience of the design of radio transformers, pick-ups, small electric motors, etc.—Please write with full details to ED/128, Personnel Dept., E.M.I. Engineering Development, Ltd., Hayes, Middx. [1670]

**WELL** established firm engaged in the manufacture and distribution of television and radio, require first-class experienced engineers to work in Greater London area; to the right men the job offers complete security and a fine opportunity for advancement; salary to commence £10 per week; driving licence essential.—Box 0258. [1751]

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- c) **ELECTRONIC TRIALS ENGINEERS** at a salary of up to £750 p.a.  
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- d) **ELECTRONIC TRIALS ASSISTANTS** at a salary up to £12 per week.  
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- e) **ELECTRONIC LABORATORY ASSISTANTS** at a salary up to £10 per week.  
Applicants should have either experience of:—  
i) The preparation of radar equipment for field trials for which a sound basic knowledge of radar circuitry is essential and special knowledge of radar equipment, AA No.3.Mk.7., would be advantageous.  
or ii) The preparation of information for drawing office and production department from circuit diagrams. Ref. 1066C.  
Applications should be sent to Dept. C.P.S., 336/7 Strand, London, W.C.2, quoting appropriate reference.

### SITUATIONS VACANT

**DEVELOPMENT engineer** required by E.M.I. Eng. Dev., Ltd., applicants must have sound basic training in electronics with experience in design of equipment incorporating servo mechanisms; the post carries a good starting salary and prospects.—Apply in writing with full details to Personnel Dept., ED/124, E.M.I. Eng. Dev., Ltd., Hayes, Middx. [1725]

**LABORATORY assistants** required (male or female) for research work on solid dielectric and electrolytic capacitors; H.N.C. or Inter. B.Sc. chemistry or physics, or a recognized equivalent essential.—Write, giving full details of age, education and experience, to A. H. Hunt (Capacitors), Ltd., Bendon Valley, Garbatt Lane, Wandsworth, S.W.18. [1673]

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**A LEADING manufacturer** of electrical measuring instruments has vacancies in the engineering department for design and development engineers of good technical ability; previous instrument experience an advantage; write, stating qualifications, experience and salary required to—The Chief Engineer, The Record Electrical Co., Ltd., Broadheath, A. Trincham, Cheshire. [1718]

**JUNIOR electronics engineer** required to assist in the development of an analogue computer; previous development experience is essential, and a knowledge of electronics is an advantage; applicants, who should be 21-24 years of age and hold the Higher National Certificate, should write, quoting full particulars, to—The Personnel Officer, E. Cowes, Isle of Wight. ref.: W.W./C.2. [1719]

**THE ENGLISH ELECTRIC Co., Ltd.** want a senior graduate with computing techniques (analogue and/or digital) to undertake development work on high priority defence project: must possess initiative and originality; permanent progressive post; salary according to age and experience.—Applications, quoting ref. 862E, to Dept. C.P.S., 336-7, Strand, London, W.C.2. [1754]

**TECHNICAL sales engineer**, aged 28-35; engineering degree or H.N.C. preferred; ability to discuss the applications of instruments, e.g., bridges, oscillators, frequency standards and resistance networks; also to service these instruments; able and willing to travel to any part of the British Isles; 16hp saloon supplied.—Apply, stating age, training, experience and salary required, to Box 0373. [1757]

**THE NATIONAL INSTITUTE FOR MEDICAL RESEARCH**, The Ridgeway, Mill Hill, N.W.7, requires an assistant for the instrument laboratory, G.C.E. or equiv., and an interest in physics essential; experience of the production of experimental apparatus and some knowledge of electronics are desirable; established superannuated post after probationary period.—Apply in writing to the Administrative Officer. [1710]

**DECCA RADAR, Ltd.** invites applications from young graduate scientists and engineers with good Honours degrees; the posts offer first-class careers with excellent prospects in radar engineering; British Nationality essential.—Only Candidates who have completed their National Service need apply.—Ref. CPH/1, Decca Radar, Ltd., Research Laboratories, 2, Tolworth Rise, Surbiton, Surrey [0246]

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**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 interested.—Apply in first case to Personnel Manager (Dept. R.D.), McMichael Radio, Ltd., Wexham Rd., Slough. Applicants must be of British Nationality. [1527]

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**PROJECT engineers** (aged 28-38) required for development of small electronic, electrical and radio components by well-known manufacturer; experience of this work and up-to-date manufacturing methods essential. Academic or professional qualifications advantageous; the positions are permanent and pensionable and salary commensurate with qualifications.—Applications (which will be treated in confidence), giving full details and an indication of the salary range expected, to Box 8963. Advertiser's staff are aware of the vacancies. [1675]

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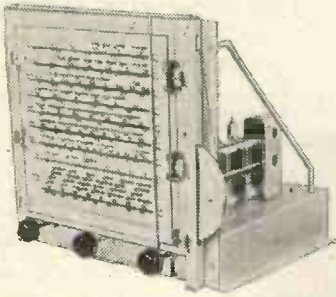


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**A**N experienced wireman is required by the Research Laboratories of The General Electric Co., Ltd., North Wembley, Middx., for work on prototype electronic equipment; candidates should be used to complete assembly of chassis from theoretical diagrams.—Apply in writing to Staff Manager (Ref. RLO/31), giving full particulars of age, qualifications and experience. [1759]

**E**LECTRONIC circuit engineer required for work on development of digital computers, in a West London location; familiarity with cold cathode circuitry preferred; five-day week, group pension and insurance scheme; starting salary in the range £700 to £1,000 according to age, experience and qualifications degree not essential.—Write Box Y 972, Willing's, 362, Grays Inn Rd., London, W.C.1. [1797]

**E.M.I. ENGINEERING DEVELOPMENT, Ltd.**, have two vacancies for electronic engineers for development work on car radio and magnetic tape recording equipment; applicants should have sound basic training in electronics with experience in the design and development of kindred equipments; positions offer good salaries and prospects.—Please apply in writing to the Personnel Dept., ED/123, E.M.I. Eng. Div., Ltd., Hayes, Middx. [1722]

**A**SSISTANT to chief mechanical engineer required for Nuclear Division; applicant experience in this field not essential, applicant must have considerable experience in the design of light electro-mechanical instruments, be familiar with RGS.1000 and be capable of handling projects with minimum of supervision; good salary to right applicant; pension scheme.—Full details to Personnel Manager, Burndep/Vidor, Ltd., Erith, Kent. [1697]

**B**ELLING & LEE, Ltd., Cambridge Arterial Rd., Enfield, Middlesex, require research assistants in connection with work on electronic components, fuses, interference suppressors and television aerials; applicants must be graduates of the I.E.E. or possess equivalent qualifications; together with similar laboratory experience; salary will be commensurate with previous experience; 5-day week; contributory pension scheme.—Applications must be detailed and concise, and will be treated as confidential. [10230]

**M**ICHAEL 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 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. [10198]

**T**HE ENGLISH ELECTRIC VALVE Co., Ltd., Chelmsford, Essex, has several attractive vacancies, junior and senior, for physics and engineering graduates to undertake research and development work on vacuum tubes; applications from graduates who have no qualifications as well as those with industrial and research experience will be considered.—Please write, giving full details and quoting Ref. 419J, to Dept. C.P.S., 336-7, Strand, W.C.2. [1674]

**S**ENIOR engineer and a junior are required by a small but progressive firm of electronic instrument manufacturers in Surrey for interesting development work on important projects; scope for initiative and self-expression; applicants should possess a degree in physics or the equivalent and should have industrial experience and a practical mind; both salary and prospects will be good for the right men.—Apply Box 8964. [1676]

**M**ICROWAVE engineers with experience of component design, and transformer designers with up-to-date knowledge of modern trends in materials, are offered exceptional opportunities for advancement with a rapidly expanding firm of electronic engineers; salaries which will be commensurate with the degree of responsibility and the prospects are excellent.—Apply giving full details to the Personnel Manager, Permax, Ltd., St. Ives, Hunts. [1693]

**E**LECTRONIC development engineers required for work in laboratory on instrumentation, industrial electronics and guided weapons; must have sound knowledge and experience of electronics and be capable of working on own initiative; salaries up to £1,000 p.a. depending on experience; excellent opportunities for capable men to progress in rapidly expanding organisation.—Apply to Technical Director, Winston Electronics, Ltd., 1, Park Road, Hampton Hill, Middx. Tel. Molesey 2985. [1644]

**A** PHYSICIST or electrical engineer with university degree or equivalent qualifications is required by the Research Laboratories of The General Electric Co., Ltd., North Wembley, Middx., for interesting and varied work in connection with the applications of germanium crystal valves to industrial and domestic electronics and communications equipment.—Apply in writing to Staff Manager (Ref. RLO/949), giving full particulars of age, qualifications and experience. [1724]

**E**LECTRONIC, for installation and service engineer required for work in field and laboratory, interesting and responsible post in new expanding department, duties embrace V.H.F., electronic and nucleonic activities in commercial sphere; applicants must have practical technical knowledge and servicing experience, preferably with electronic instruments.—Write stating age, qualifications, experience and salary required, to Personnel Manager, E. K. Cole, Ltd., Southend-on-Sea. [1798]

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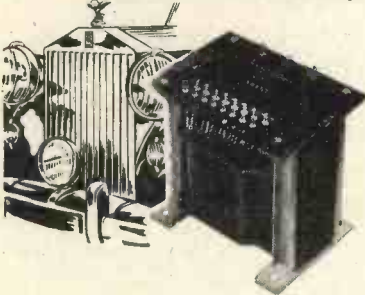
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**CHARGE hand radio mechanic (civilian)** required at London Fire Brigade Headquarters, Lambeth; applicants must have good knowledge of theory of radio communication and expe. of installation, servicing and repair of V.H.F. transmission and receiving equipment and be qualified drivers; 187s for 5-day 48-hr wk at 100 guineas including industry conditions; prospects permanency with superannuation; canteen.—Write Chief Officer, London Fire Brigade, Albert Embankment, S.E.1, stating expe. and age. (899.) [1698]

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**JOSEPH LUCAS (Gas Turbine Equipment), Ltd.,** invite applications for electronic engineers, some knowledge of servo mechanisms would be an advantage, should have university degree; these appointments are pensionable and offer good prospects to individuals with initiative and technical ability; salary will be in accordance with experience and qualifications.—Details of experience and qualifications should be sent to Personnel Manager, Joseph Lucas (Gas Turbine Equipment), Ltd., Shaftmoor Lane, Hall Green, Birmingham. [1774]

**DECCA RADAR, Ltd.,** requires a senior engineer to take charge of the testing of high-power centimetric radar equipment; previous experience of high-power radar, including receivers and A.C. systems, is required; good salary, commensurate with experience, will be offered to the right man, for whom there are excellent prospects in this progressive and expanding company; please apply giving full details of experience and stating salary required to: Ref. P.L.—Decca Radar, Ltd., 1-3, Brixton Rd., London, S.W.9. [0249]

**FERGUSON RADIO CORPORATION, Ltd.,** require an engineer with initiative and good technical background to take charge of a well-equipped laboratory engaged on the development of television receivers for mass-production; previous experience in this field is essential; education to degree standard is desirable but not essential; housing assistance considered.—Written application to Employment Manager, F.R.C., Gt. Cambridge Rd., Enfield, Middx., giving full details of qualifications, experience, etc., and quoting Ref. No. 4759. [1668]

**ELECTRONIC engineer** required by new division of prominent engineering company in Northern Ireland for development work on guided weapons and other projects; degree or equivalent in electrical engineering or physics, with good practical experience, preferably of d.c. amplifiers, electronic computation, pulse techniques, or miniature equipment; good salary and prospects for man with initiative; pension scheme, assistance with housing.—Send full particulars of age, qualifications and experience, and salary required, quoting E.E.2, to Box 8888. [1663]

**AUTOMATIC Telephone & Electric Co., Ltd.** have a vacancy for a technical writer in their Transmission Division at Liverpool, to prepare operating handbooks for multi-channel carrier telephone systems. Applicants must have had some experience in the operation of this type of equipment. The post is a permanent one with contributory pension scheme and usual staff conditions.—Please write Personnel Manager, Automatic Telephone & Electric Co., Ltd., Strowger Works, Edge Lane, Liverpool, 7, giving details of experience and qualifications and age. [1749]

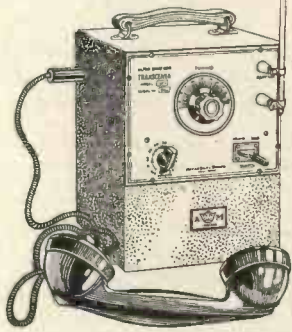
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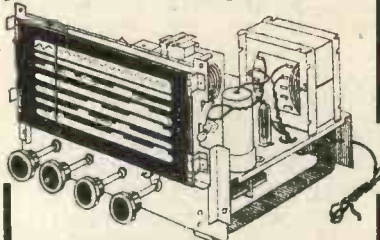
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**THE GENERAL ELECTRIC CO., LTD.** Brown's Lane, Coventry, require Senior and Junior Electronic Development Engineers for work on Guided Weapons and like projects, particularly in the field of Microwave and Pulse Applications. Mechanical Development 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; houses available to selected senior staff. Apply by letter stating age and experience to the Personnel Manager (Ref. R.C.1). [0259]

**ARE** you looking for hard work, interesting problems, and a reward proportional to effort? An engineering company on the outskirts of London engaged on an important guided weapon project requires several graduate electronic and mechanical development engineers; applicants should be British born between the ages of 25 and 30; salaries range from £600 to £1,000 and depend on qualifications and experience; the project is new, and there are good prospects for promotion; please write, in confidence, quoting reference WW/715, giving full details of experience to—Box 8971. [1680]

**ELECTRONIC** engineer or physicist required in the London area to fill post of chief engineer; candidates must possess university degree in engineering or equivalent and have had considerable experience in the design, development and carrying out of service equipment over a wide field with emphasis on radar, microwave and associated techniques; they must be capable of directing a team of qualified engineers on this class of work, of controlling a well-equipped laboratory and should be very familiar with standard procedure adopted by Government technical establishments; applicants, preferably British should write, in strict confidence, stating age and salary required and giving details of qualifications and experience to—Messrs. E. R. C. Ltd., c/o Martin's House, 29, Ludgate Hill, London, E.C.4. [1704]

**THE ENGLISH ELECTRIC CO., Ltd., Luton.** wish to extend their present laboratory facilities for study of the effect of environment conditions on guided weapons and their components; applications are therefore invited from SENIOR and junior engineers to direct and carry out this work; a wide variety of electrical, mechanical and physical testing is under consideration and although previous experience of guided weapons is desirable, it is by no means essential; the possession of an engineering or physics degree or similar qualification, coupled with some experience in designing and handling ingenious electrical and mechanical test contrivances would form a satisfactory qualification.—Please write, stating age, experience and qualifications and salary required to Director, C.P.S., 336-7, Strand, W.C.2. quoting Ref 1149. [1572]

**ELECTRICAL** engineers wanted by Ministry of Supply for Experimental Establishments mainly at Malvern, Worcester, Farnborough, Hanslope, Sevenoaks, Kent. Duties chiefly concerned with research, development or design in telecommunications, radar, electronics, instrumentation or light electrical measurements. Posts graded according to age, qualifications and experience in Scientific Officer class (requiring 1st or 2nd-class honours degree in Electrical Engineering or equivalent) or Experimental Officer class (requiring Higher School Certificate (Science) or equivalent—although H.N.C. or pass degree may be an advantage). Salaries: S.O. £217-£275, E.O. (min. age 26), £243-£299; Asst. E.O., £264 (age 18)-£576. Women somewhat less. Appointments unestablished. F.S.S.U. benefits may be available for S.O. class.—Application forms from M.L.N.S., Technical and Scientific Register (K), 26, King St., London, S.W.1, quoting D 232/53A. Closing date 13 October, 1953. [1705]

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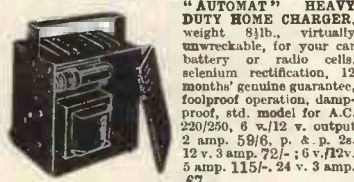
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