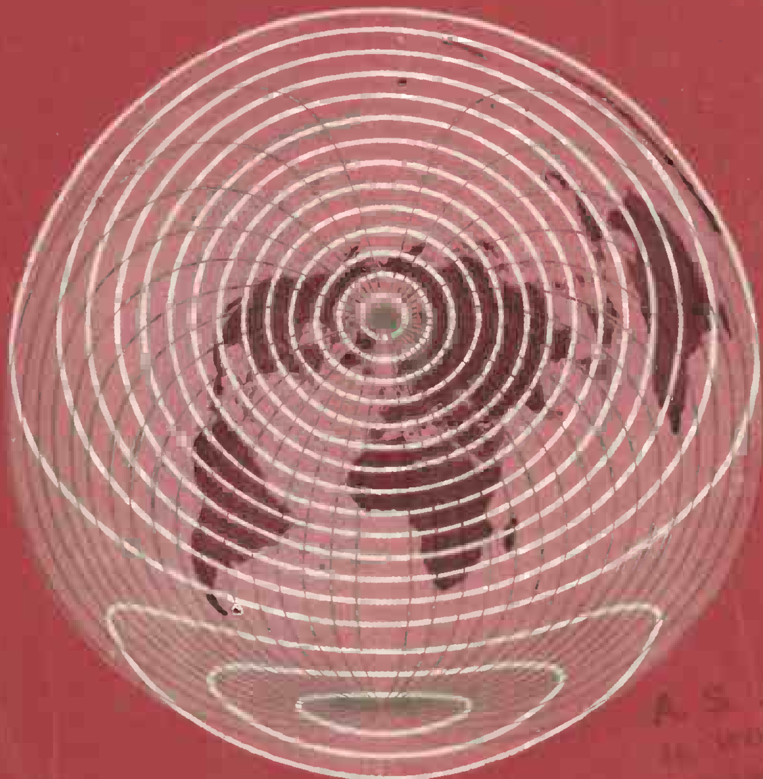
APRIL 1959 TWO SHILLINGS

Wireless World

ELECTRONICS
Radio · Television

PAGE 193–196 TRANSISTORIZED ABSORPTION WAVEMETER CIRCUIT



FORTY-NINTH YEAR OF PUBLICATION

Wireless World

ELECTRONICS, RADIO, TELEVISION

Managing Editor: HUGH S. POCOCK, M.I.E.E.
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APRIL 1959
Vol. 65 No. 4

Wireless World

Canutes of the Air

AT a meeting of the International Civil Aviation Organization (ICAO) last month in Montreal it was decided by a majority vote to recommend that the existing standard short-distance air navigation aid VOR (v.h.f. omni-directional radio range) should be supplemented by DMET (distance measuring equipment). Further, that "protection" for the combined system should extend to January 1st, 1975; in other words, wherever VOR/DMET is installed no change should require replacement of the equipment before that date. A strong case was made by the U.K. delegation with the full backing of the Ministry of Transport and Civil Aviation for the adoption of the Decca Navigator on grounds of greater accuracy and flexibility, but arguments based on technical merit failed to shake the resolve of the U.S., and other countries already heavily committed to VOR, to make do with the system on which so much capital has already been invested.

In principle VOR/DMET is simple; it is easy to understand and to use. It is a "rho/theta" system in which the radial distance (ρ) from a fixed beacon and the bearing angle (θ) are continuously presented to the pilot as dial readings. With this simple equipment the American pilot flies from one beacon to the next with the confidence of a mariner in a well-buoyed channel or of a late reveller finding his way home from lamp-post to lamp-post. Maximum deviations from course are liable to occur at points midway between beacons.

Decca is more sophisticated. Synchronized signals from a group (chain) of stations lay down a network of intersecting hyperbolic lines of constant phase difference which gives sustained accuracy of location up to about five times the distance possible with VOR/DMET. Thus greater flexibility for diversion and "holding" procedures is possible at times of bad visibility and congestion; movement is not constrained by reference to fixed points as in the case of omni-directional beacons. Another great advantage of the hyperbolic system is that, unlike "rho/theta" it can and has been adapted to automatic course plotting, which shows the pilot, by a glance at a chart, his present position and the effect of wind on the "holding pattern" he may be trying to sustain. Not only does this give the pilot confidence, but, since he can be relied upon to execute air traffic control instructions accurately, the controller and his overworked radiotelephone channels are relieved of the necessity of providing radar assistance and can concentrate on their proper functions of overall supervision and the control of movement in anticipation of troubles such as those which might arise from any incipient irregularities in flight schedules.

With traffic at times already filling the airspace available with existing standards of longitudinal and vertical spacing in a single airway, the only room for expansion is laterally, i.e., two flight paths in each airway instead of the single path available with the accuracy of existing range beacon methods of navigation. The Decca system can easily define a flight path to within ± 2 nautical miles at distances up to 150 miles from the centre of the chain so that in an 11-mile wide airway two flight paths with this tolerance would still have a 3-mile buffer zone between them. The opening up of new parallel flight paths would enable some of these to be allocated to jet aircraft, which must have an uninterrupted climb to and descent from their optimum height in the vital interest of fuel economy.

Such possibilities of immediate relief must, however, remain pipe dreams if the Montreal recommendations are subsequently endorsed by the Air Navigation Commission and ratified by a two-thirds majority of the 21 member states of ICAO. Although BOAC and BEA pilots are already enjoying the benefits of accurate visual tracking and could fly the additional lanes if these were sanctioned, it would be folly to extend the capacity of the system while foreign planes with less accurate aids have access to the air lanes. While the U.K. is a member of ICAO it will honour its obligations to provide VOR facilities and has in fact already ordered an extension of VOR coverage for airline operators who choose to rely on this system. There is, of course, nothing except initial cost and payload to prevent any aircraft from carrying both these short-range aids, together with Doppler and possibly inertial systems, to be used as circumstances dictate.

In the air the pilots will decide which system or systems serve them best in remaining masters of all navigational eventualities. On the ground air traffic control must continue to cut its cloth according to the performance of the less well-equipped aircraft. This in turn must set a limit on the expansion of air transport until such time as more precise flying is possible. When that day arrives the developments now taking place in the application of data processing and computers will have reached the stage when they can handle the increased volume of traffic that can be released. We have a feeling that present disappointments over the latest ICAO recommendations will have been forgotten long before 1975.

Elements of Electronic Circuits

1.—TIME CONSTANT AND DIFFERENTIATION

By J. M. PETERS, B.Sc. (Eng.), A.M.I.E.E., A.M. Brit. I.R.E.

When studying the operation of complete electronic equipments we sometimes find gaps in our knowledge of the basic electronic circuits, or "building bricks," of which the equipments are composed. This series of articles reviews some of the more common circuit "bricks" and explains the principles of operation of devices which are often simply dismissed by functional names such as "amplitude limiter," "clamp," "differentiator" and "integrator." The articles are written in a non-mathematical way and give emphasis to physical explanations.

LET us first consider a simple series circuit made up of a capacitor C and a resistor R, as shown in Fig. 1. If we apply a sudden voltage, V, to the input terminals, the voltage across the resistor will follow at once as shown in Fig. 2. If the input

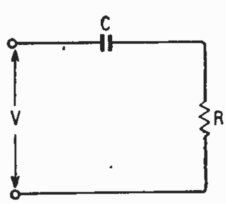


Fig. 1

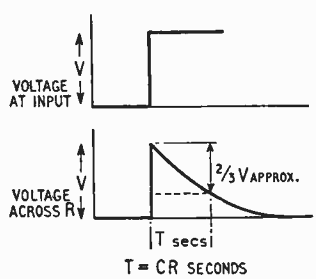


Fig. 2

voltage is maintained at a steady value the voltage across the resistor will drop as the capacitor C discharges through R. This rate of leakage through the resistor depends on the values of C and R; the greater the values of C and R the longer will this time be.

It can be shown from theory that about two-thirds of the charge on C will leak away in a time equal to CR seconds, if C is measured in farads and R is measured in ohms (alternatively C in microfarads and R in megohms). The product CR is known as the time constant of the circuit.

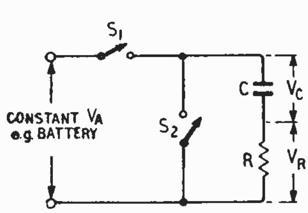


Fig. 3

Now let us consider the sequence of operations in the circuit shown in Fig. 3. With switch S_1 closed and switch S_2 open, V_A is applied to C and R. The capacitor therefore charges up and V_C grows. At the instant of closing S_1 the total V_A appears across R. This, however, decays in an exponential fashion, the sum of V_C and V_R being equal to V_A.

We now open S_1 and close S_2. As a result V_C is immediately applied in the opposite sense across R. Then V_R decays from a negative maximum to zero. V_C, on the other hand, decays from a positive maximum to zero.

The effect of switching S_1 and S_2 in a regular sequence is to apply a voltage square wave to C and R, and Fig. 4 illustrates the resultant growing and decaying of voltages V_C and V_R. When the CR circuit (with a CR value small compared with the time taken by other changes in the circuit) is

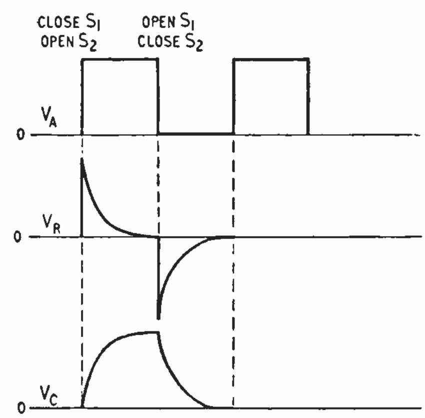


Fig. 4

used in this way it is called a differentiating circuit and the original square pulse is said to be differentiated when the voltage V_R is selected as the output.

Let us now consider the effect of different CR values on a square pulse. In the following illustrations, Figs. 5 and 6, the square wave V_A is assumed to be all positive.

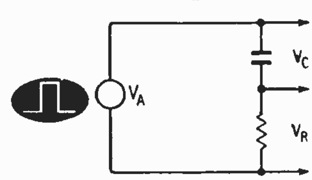


Fig. 5

First of all there is the case where the CR time constant is very much greater than the period of the applied square-wave voltage. Referring to Fig. 6, it is important to note that the voltage V_R always equals $V_A - V_C$. V_C gradually builds up to a voltage which varies slightly about $V_A/2$, while V_R ultimately becomes symmetrical about zero with its positive and negative peaks fluctuating about $V_A/2$ in a complementary manner to V_C.

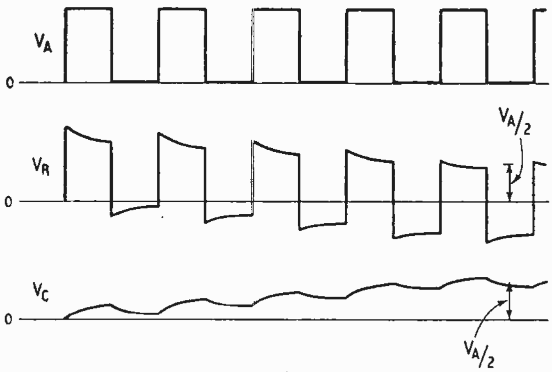


Fig. 6

V_R tends, therefore, to become almost a square wave oscillating about zero volts. It is also important to note that the slope of the charge/discharge portions of the waveforms depends on the magnitude of the applied voltage V_A.

Secondly there is the case where the CR time constant is equal to the period of the applied square wave voltage. Here, as shown in Fig. 7, V_C becomes more ripply, and more distortion occurs in V_R which is now much less like the square wave in Fig. 6.

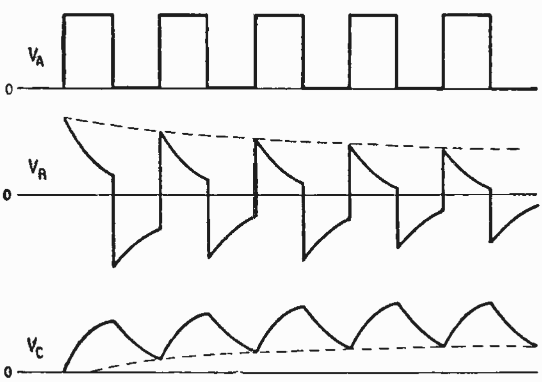


Fig. 7

Thirdly we have the case where the CR time constant is very much less than the period of the applied square wave voltage. V_C now approximates to the input square waveform, as shown in Fig. 8,

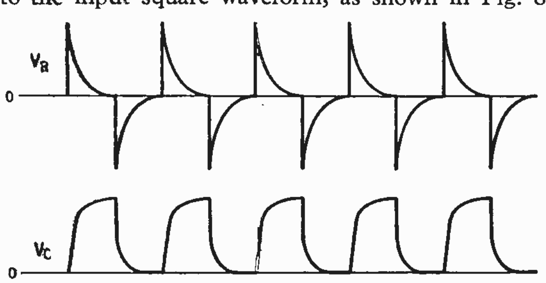


Fig. 8

while V_R consists of a series of very short pulses or "spikes," i.e. approaching a true differentiated square wave from a mathematical point of view.

Next we will look at the effect of different CR values on a linear voltage. Fig. 9 depicts a voltage

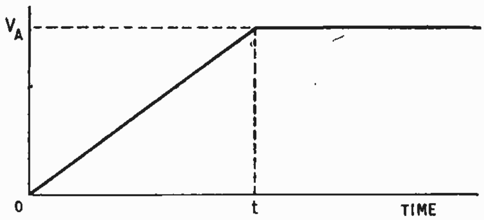


Fig. 9

which rises linearly from zero to a value V_A in time t. We will examine what happens when we apply this rising voltage to CR circuits (Fig. 10) of widely different time constants.

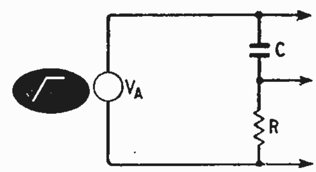


Fig. 10

First, the case where the CR time constant is greater than the period t. Referring to Fig. 11, V_A is the applied wave. C charges and V_C grows along AB. V_R is represented by AC so that the

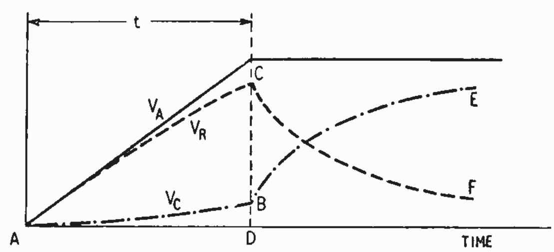


Fig. 11

linear edge of the waveform is only slightly distorted. After a period t, the capacitor C charges normally and V_C grows in accordance with BE whilst V_R drops according to the path CF.

Now referring to Fig. 12, we have the case where the CR time constant is less than the period t. V_A is the applied wave. C charges and V_C grows along AHG, after which the slope of GB is the same as that of the applied voltage. $V_R = V_A - V_C$, giving the curve AJG subsequently remaining

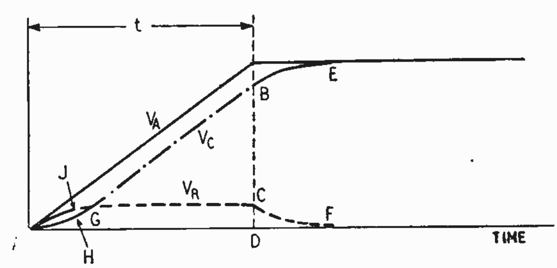


Fig. 12

constant at GC. Note that the value of the steady voltage CD = mCR, where m is the slope of V_A in volts/second.

Finally, let us look at the effect of different CR values on a recurring linear voltage—a sawtooth wave. The response of a CR circuit as in Fig. 10 to a succession of sawtooth pulses V_A is shown in Fig. 13, the voltage V_R only being considered. It is seen that for a circuit time constant very much greater than the period of the applied wave, V_R is not very distorted and the linear rise of voltage is little affected. With the circuit time constant less than the period t, V_R is very distorted. Therefore if distortion is to be avoided in CR coupling circuits they must be designed with long time constants compared with the period of the recurrent waveform.

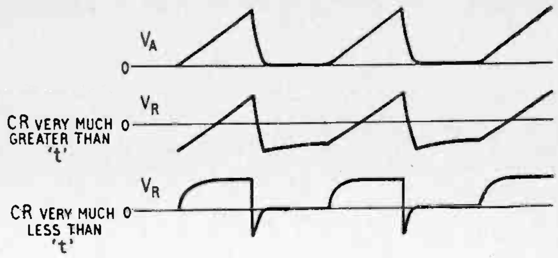


Fig. 13

Television Society's Exhibition

ONE might have expected the Television Society's Exhibition this year to say something significant about the topical subjects of new frequency bands, new standards and perhaps colour. But the threatened arrival of the Television Advisory Committee's report must have frozen everyone into silence, for very little was revealed of any recent technical investigations in these fields.

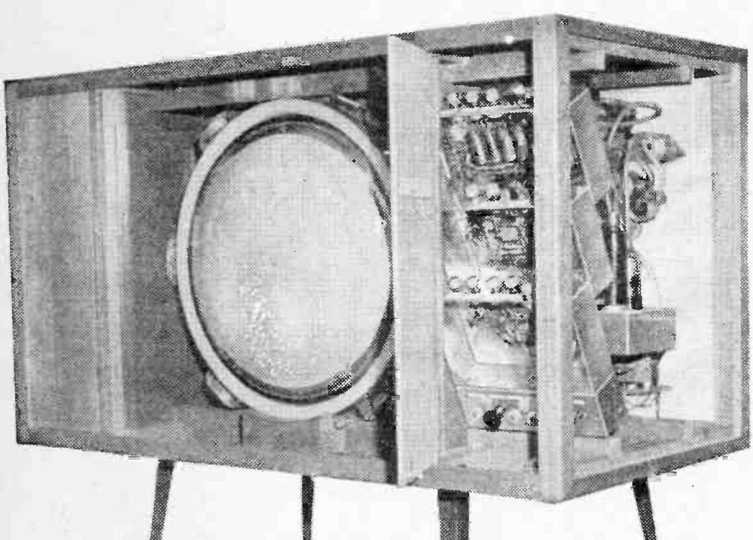
The problems of reception in Band V have already been discussed in *Wireless World** and types of tuners have been described. B.R.E.M.A. summarized the situation to date by showing examples of these tuners which they have provided to assist the T.A.C. in its deliberations. The so-called Group 1 type is a simple continuous tuner (see picture) consisting of an EC93 oscillator and a crystal mixer. This is intended to be clipped on to an existing Band-I/Band-III tuner, the valves of which are used as i.f. amplifiers. Such units have been used for some time in W. Germany for reception of u.h.f. television transmissions.

What is known as a Group 4 tuner is a Band-I/Band-III turret with special u.h.f. coil inserts. A double superheterodyne principle is used. A harmonic of the local oscillator is selected for the first frequency changing operation, which is achieved in a germanium diode mixer. The i.f. is amplified by the existing cascode valve in the tuner and then frequency converted again, using the oscillator fundamental and the existing pentode mixer valve. (See *Wireless World*, January, 1958, issue, p. 14.)

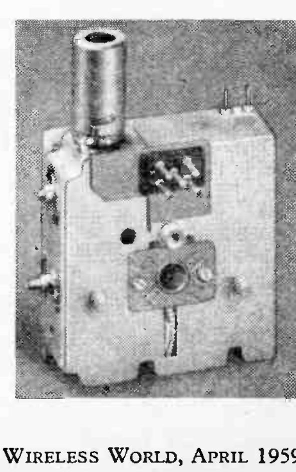
The third tuner shown by B.R.E.M.A. is called a Group 5 type and is a high-performance circuit incorporating an r.f. amplifier valve (A2521) to improve the noise factor. After the crystal diode mixer comes a cascode double-triode i.f. amplifier and then two further pentode i.f. amplifier stages. (See *Wireless World*, May, 1958, p. 244.) Nobody would suggest that this expensive circuit is a commercial possibility for domestic receivers, but it has been developed to achieve the level of performance which will probably be obtained from simpler tuners in the future.

Bush Radio demonstrated an all-electronic test pattern generator for 625-line C.C.I.R. standards. It was notable for the range of video information made available—actually comparable with Test Card C. As well as giving a linearity grating surrounded by a frame of black and white blocks, the pattern incorporates definition check bars of 1, 2, 3, 4 and 5 Mc/s and a five step "gamma

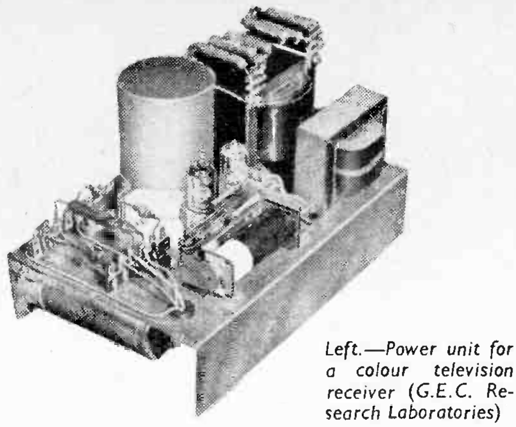
* "Reception on Band V," January, 1958, issue.



Above.—Colour television receiver constructed by John Ware, showing arrangement of chassis.



Right.—Band-V tuner unit for attachment to an existing tuner (B.R.E.M.A.).



Left.—Power unit for a colour television receiver (G.E.C. Research Laboratories)

wedge." The video signal is intended for distribution on an r.f. carrier (together with the associated f.m. sound carrier) throughout a factory in which 625-line receivers are manufactured.

Colour receiver development—very much in the background at the moment—was represented by an example of size-reduction in power supplies. We have already reported, in our July and August, 1958, issues, how G.E.C. Research Laboratories have achieved a reasonable size of experimental colour receiver by the use of a.c./d.c. technique in power supplies. A selenium rectifier voltage doubler has been used to get the 450-V h.t. supply from mains voltage. Now the Laboratories have produced an even smaller power unit (see picture) by the use of silicon diodes for rectification and voltage doubling. It measures about 9in × 6in × 5in and gives 400V at 400mA, 200V at 250mA and −150V stabilized. A thermal-delay relay system is incorporated to allow the receiver's heaters to warm up before the h.t. is applied.

Colour television of the N.T.S.C. variety has so far been quite out of reach of the average amateur constructor, partly because of its frightening complexity but mainly because of the impossibility of obtaining three-colour c.r. tubes and other special components. Not, however, out of the reach of John Ware, an architect, who demonstrated a complete, working 19-inch receiver for picking up the B.B.C.'s colour test transmissions. Although the circuit was based directly on H. A. Fairhurst's design (published in *Journal of the Television Society*, Vol. 8, and in *Wireless World* in March and April, 1956), Mr. Ware must be congratulated, not only on his ability in getting such a complex apparatus to work (no reflection on Fairhurst!) but on his enterprise in getting hold of the colour tube (a British experimental all-glass type). The layout, too, showed a rather original approach, being based on several small chassis arranged in echelon (see picture) to give easy accessibility to components and control knobs.

One way of dispensing with fine tuning controls in domestic television receivers is to have automatic frequency control of the local oscillator. G.E.C. Research Laboratories demonstrated how this could be done by using the variable capacitance properties of a semiconductor junction diode. The Colpitts oscillator of an ordinary commercial television set incorporated a reverse-biased EW76 silicon diode as a variable-capacitance tuning element. The capacitance of the diode varied in proportion to a control voltage which was derived from the sound i.f. signal via a double-diode frequency discriminator. The self-adjusting action of this servo loop was such that the control voltage altered the oscillator tuning to bring the sound i.f. signal to the correct frequency.

The suggestion that television signals might be relayed by tropospheric scatter over relatively long-distance links, instead of the usual line-of-sight links, emerged from another demonstration on the G.E.C. stand. This was a tape recording of speech transmitted over a 180-mile tropospheric scatter link between Coventry and Start Point. The frequency was 2,600Mc/s and a 1-kW transmitter was used with 12-ft diameter paraboloid aerials arranged for space diversity operation. The bandwidth was sufficient for five telephone channels, but by decreasing the range or increasing the power it was considered possible that a television channel could be accommodated.

Cathode-ray tubes on show included two new types on the Mullard stand for 110° scanning. These were the 21-inch type AW53-88, which is 5 inches shorter than an equivalent 90° tube, and the 17-inch type AW43-88, which is 3 inches shorter than the equivalent 90° tube. Both are electrostatically focused and have straight electron guns, using no ion-trap magnets.

When it is already difficult to generate sufficient power to scan these 110° tubes one has to avoid anything which allows a dissipation of this power. A demonstration on the Pye stand pointed out that an absorption of power can be caused by any aluminizing in the c.r.t. envelope near the scanning coils. A set of scanning coils connected to a Q-meter was placed first on a 110° tube with, and secondly on one without, aluminizing at the critical region, to show that a reduction of power loss is obtained in the second case.

AUDIO FAIR EXHIBITORS

TICKETS for the London Audio Fair which opens for four days at the Hotel Russell, Russell Square, W.C.1, on April 2nd, can be obtained free from exhibitors listed below and audio dealers. Some 60 of the 69 manufacturers who are exhibiting at this year's show will have private demonstration rooms in addition to space in the main exhibition. The show opens each day, including Sunday, at 11 and closes at 9. Admission on the first day is limited to the trade until 5.30.

Dated tickets are available from this office. Applicants should enclose a stamped addressed envelope and state the day for which the tickets are required.

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Veritone
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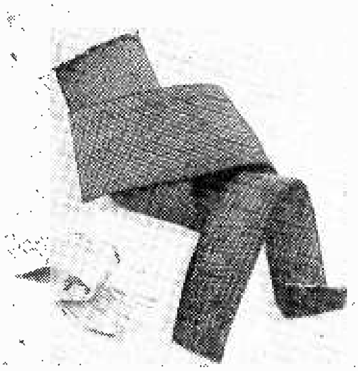
Vortexion
Walters (Sales)
Wharfedale
Whiteley
Wireless & Electrical Trader
Wireless World and *Electronic & Radio Engineer*

Technical Notebook

Flexible Ribbon Cable, suitable for applications where motion is involved, consists of parallel wires woven with Teflon and other yarns into a flat ribbon, as shown in the picture. Known as Tempbraid, the

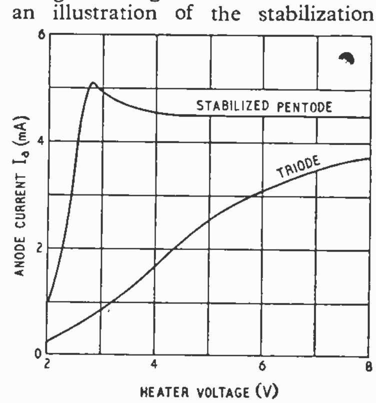


cable is manufactured in widths from ¼in to 3in by the American firm Hitemp Wires. The ribbon can be slit along its length if the yarns are first impregnated. With square or rectangular channels for cables, the ribbon type of construction allows a greater number of conductors to be packed in, since the cable harness builds up to a square or rectangular section instead of being circular. Also introduced by this firm is a flexible ceramic type of insulation on a new range of wires for operation at high temperatures. It is a vitreous enamel film, which is firmly bonded to the nickel-clad copper conductor, and is rated for continuous operating temperatures of at least 1000°F and up to 1500°F for short periods. The insulation is said to show no visible evidence of cracking when the wire is wrapped around a rod of five times its own diameter. High abrasion resistance is claimed and the material is resistant to oils, solvents and thinners, organic materials and water. At extremely high temperatures (about 2000°F) it starts to melt but does not burn.

Simulation of Doppler Effect for use in the testing of Doppler radar equipment (or in radar system simulators) presents some unusual problems—mainly the construction of an oscillator which is extremely stable and yet can have its frequency altered at a high rate to simulate "target" or observer movement. A solution to this problem is suggested in *Electronic Design* for 26th November, 1958, in an article by J. E. Tofler. The proposed system employs controlled variation of the time intervals between successive cycles of the output of a very stable oscillator. This controlled variation is achieved by a variable delay circuit external to the oscillator, which stays at a constant frequency. For the "at rest" condition for both target and observer the time delay is constant; to synthesize a target moving with constant speed a linear rate-of-change of delay is introduced, thereby "squashing-up" or "opening-out" the cycles from the oscillator in a manner corresponding to that of the actual Doppler phenomenon. Acceleration of the target (or observer) is synthesized by controlling the delay time in a square-law fashion (or in a more complex way to simulate increasing or decreasing acceleration). It is suggested that existing monostable circuits capable of producing a delay proportional to an applied potential are suitable (examples given are the phantastron and cathode-coupled multivibrator). Simple checking for correct operation is achieved easily, too: a sinusoidal variation of delay is employed, the total displacement (relative to the undelayed oscillator output) is displayed on a c.r.o., this being equal to the integration of frequency shift and the differential of velocity. An example given quotes an acceleration of ±400g, period 2 seconds. This corresponds to a displacement of 10.6μs and an apparent velocity of 5,600 m.p.h.

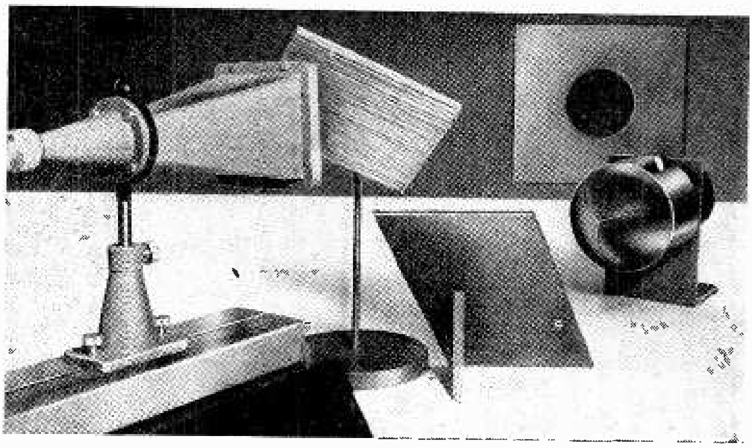
Compensating Compass for measuring the direction of the earth's field in the presence of a freely rotatable disturbing dipole is an interesting recent development by the Fighting Vehicles Research and Development Establishment. Such a disturbing dipole could be produced, for example, in a magnetic vehicle by induction due to the earth's field. Two points are chosen such that the ratio of the disturbing fields at them is known and is about two. At each point is placed a set of three flux-gate field measurement devices spaced at 120° intervals in a horizontal plane. Each flux gate feeds a different stator on two synchros, each set of three flux gates feeding the same synchro. The synchro rotors are locked together and the output of that associated with the greater disturbing field reduced in the known ratio of the two disturbing fields. A servo-motor drives the rotor system until the difference between the two synchro outputs is reduced to zero. In this case, since owing to the different synchro sensitivities the outputs due to the two disturbing fields cancel, the outputs due to the earth's field must also cancel to give an overall cancelled output. Since the earth's field is the same at both points, the outputs due to this can only cancel if each is zero, i.e., if the rotors become aligned at right angles to the earth's field.

Simple Emission Stabilization to offset drift caused by variations in heater supply voltages in d.c. amplifiers is described by B. C. Cox in the December, 1958, issue of the *Journal of Scientific Instruments*. It has been applied to a 6K7 pentode used as a triode, with the suppressor connected to the anode and the screen grid acting as the control grid. A 220-kΩ resistor is connected from the 225-V h.t. supply to the control grid. If the heater causes the cathode temperature to fall and the emission is reduced there is a consequent decrease of grid current. This decrease of grid current produces an increase of grid voltage (because the voltage drop across the 220-kΩ resistor is reduced) which restores the emission to practically its original value. Conversely, an increase of cathode temperature causes the grid voltage to be reduced. As an illustration of the stabilization



performance, the curves of anode current against heater voltage compare the stabilized triode-connected 6K7 pentode with an unstabilized and normally connected 6J5 triode.

Mechanical Microwave Frequency Shifting by means of a rotating 90°-corner reflector was demonstrated recently by Hilger and Watts. Q-band radiation (around 8mm) propagated in waveguide in the H_{01} mode is first transformed into a collimated vertically polarized beam using a square pyramidal horn.



A plano-convex polystyrene lens in the mouth of the horn equalizes the effective path lengths to all points in the horn mouth. The plane lens surface is "bloomed," i.e., horizontal grooves are cut in it to give a path length of $\lambda/4$ and an effective dielectric constant of the square root of that for the polystyrene lens material. This matches the lens to the air and avoids reflections. Such blooming is not necessary at the curved portion of the lens where for reflected radiation the path length differences cause considerable cancellation. The plane-polarized beam impinges on a flat metal reflector with a number of parallel protruding fins attached to it, this reflector being angled in such a way that the electric field has components both parallel and at right angles to the fins. The latter component is unaffected by the fins and is reflected with 180° phase change from their flat backing. The former component parallel to the fins effectively sees a portion of waveguide with a width equal to the spacing of the fins which is arranged to be beyond cut-off for Q-band. This component is thus reflected at the fins with a certain phase change. The resultant phase change between the two components (which includes that produced by their path length difference of twice the fin height) is arranged to be 90° so as to produce a circularly polarized beam. After straightforward reflection from a flat metal plane this beam impinges on a rotating 90°-corner reflector. Rotation of such a reflector through a certain angle rotates a plane polarized wave through twice this angle. Since the circularly polarized beam can be regarded as a plane-polarized beam rotating at the signal frequency, the rotating corner reflector alters the frequency of the circularly polarized beam by twice the reflector rotation frequency. This changed frequency radiation re-traverses the system undergoing similar transformations in the reverse order. A portion of the outgoing and incoming radiation in the waveguide is extracted, using a magic T, and the beat frequency produced on detection used to drive a loudspeaker.

Magnetic Xerographic Printing machine for reproducing books, magazines and newspapers has been built in prototype form at the Lithuanian Research Institute of Electrography, according to a recent report in *Soviet News*. It does away with conventional type and typesetting and uses instead a continuous belt of ferromagnetic tape on to which the printing pigment has been attracted. This is unlike the American and British xerographic system, in which the printing powder is attracted *electrostatically* to a charged selenium layer (see *W.W.*, January, 1959, issue, p. 20). Here the electrostatic charge patterns are formed by optically focusing the images of characters on to the uniformly charged selenium. In the Lithuanian system the images of characters are converted photoelectrically into electrical signals, which drive magnetic recording heads to impress corresponding magnetic patterns on the tape. The printing pigment, after being attracted to these magnetic patterns, is transferred to the paper by an electric field, as in the American and British system.

Heater-Circuit R.F. Chokes wound on cylindrical ceramic capacitors are described in an article on subminiature radar i.f. amplifiers by W. H. Kumm in *Electronic Equipment Engineering* for December, 1958. It is claimed that this form of construction produces a small self-resonant (i.f. 30Mc/s) choke with a very low resistance.

Cooling Crystal Mixer Diodes is often suggested as a means of improving receiver noise factor. However, recent noise factor determinations carried out by L. K. Anderson and A. Hendry on seventeen 1N263 mixer diodes at 9375Mc/s (X-band) both at 27°C and −196°C indicate that no worth-while improvement is obtained—in fact, some crystals gave an even slightly worse performance. This is reported (*I.R.E. Transactions on Microwave Theory and Techniques*, October, 1958) to be due to an increase in the noise temperature of the crystal as it is cooled. It is suggested that this indicates that flicker noise* in germanium crystals may be a significant factor at the i.f. used (30 Mc/s) and also that it is a temperature-dependent effect.

* Flicker noise is noise which occurs in semiconductors (and valves) in excess of the Schottky and thermal noise. It is thought to be due to holes meeting annihilation by electrons in a "trap," and it is normally considered only to be a problem at low frequencies because the spectral distribution of the noise energy is proportional to $1/f$.

Stereo Pickup Vertical Compliance should not be too great otherwise the stylus will not track the downward halves of high-acceleration vertical modulations. This is because in such half-modulations the stylus is no longer driven by the record groove but by gravity and the vertical stiffness of its suspension. This principle has been pointed out by Decca.

Electrolytic Polishing is being used on metal parts of complex shape which could not easily be polished by mechanical methods. The process developed by Electropol Processing at the Trading Estate, Farnham, Surrey, is intended for stainless steel, and the polishing is achieved by removing electrolytically a controlled amount of metal evenly from all surfaces of the article. For this the metal part is jigged then immersed in a chemical bath and subjected to an electric current to give a "de-plating" action. Usually the thickness of metal removed is of the order of half a thou'. The process is claimed to give a high degree of corrosion resistance to stainless steel because, unlike mechanical polishing, it removes certain metallic and non-metallic inclusions which have been introduced into the surface of the steel at the rolling-mill stage of manufacture. Greater resistance to surface adhesion of liquids or solids is also claimed. In the radio industry the process is being applied to the electron guns of cathode-ray tubes, and here a particular purpose is to remove unwanted burrs which would interfere with the correct electron-optical structure. For this the normal process has to be given a selective action so that more metal is removed at the burrs than elsewhere.

Compact Microwave Delay Lines constructed by spirally winding waveguide are described in *Electronics (Engineering Edition)* for October 24, 1958, by R. R. Palmisano and A. Sherman. A 40-ft long coil of half-size (internal dimensions of 0.2in by 0.9in) X-band waveguide can be wound in a diameter of only 15in. The attenuation increase due to the coiling is less than 1dB for this length of guide.

Loudspeaker Enclosure Calculations

USE OF A SIMPLE ANALOGUE COMPUTER

*By M. V. CALLENDAR**

THE basis of the computer is an electrical analogue circuit. This circuit is chosen in such a way that the differential equations which govern it are the same as those governing the acoustic system of which the performance is to be investigated.

In the computer an analogue network of this type is arranged on a panel bearing a number of control knobs labelled " Size of box", " Stiffness of loudspeaker suspension " and so forth. The necessary information is fed into the computer in the form of settings of these controls.

As shown in the block diagram of Fig. 1, the network is supplied from an oscillator which sweeps from 100 kc/s to 1 Mc/s. The output from the network is applied to an oscilloscope which exhibits it as a function of frequency. The network is so proportioned that the electrical response curve shown on the oscilloscope represents the acoustic response at frequencies between 20 and 200 c/s of an acoustic system having parameters as set up on the controls. The effect of varying any parameter is thus quickly seen.

Alternatively, a pulse generator can be substituted for the sweeping oscillator, in which case the transient acoustic response is shown by the oscilloscope. Fig. 2 shows typical c.w. and pulse responses for a bass reflex system, as seen on the oscilloscope.

The merit of this computer, as with others, is that problems requiring hours or days for solution by normal methods can be solved in a few minutes. In particular, the normal methods for solution of equations involving transient (or pulse) waveforms—classical or operational methods, or Laplace transforms—are all exceedingly laborious. And direct acoustic measurements, although no doubt the ultimate criterion, are time-consuming, and prone to increasing errors (due to wall reflections) as the frequency is lowered.

The network is designed on the basis of the electrical mechanical acoustic analogue principle†. We use the " acoustic impedance analogue " in preference to the " acoustic mobility analogue " and so we have the following table of analogues:—

Electrical	Mechanical	Acoustic
Inductance L	Mass m	Ac. mass m/A^2
Capacitance C	Compliance C	Ac. compliance A^2C
Current I	Velocity u	Ac. velocity $U=uA$
Voltage V	Force F	Ac. pressure $p=F/A$

* E. K. Cole Ltd.

† See, for example "Acoustics" by L. L. Beranek (McGraw-Hill)

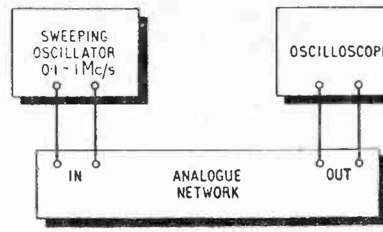


Fig. 1. Block diagram of computer.

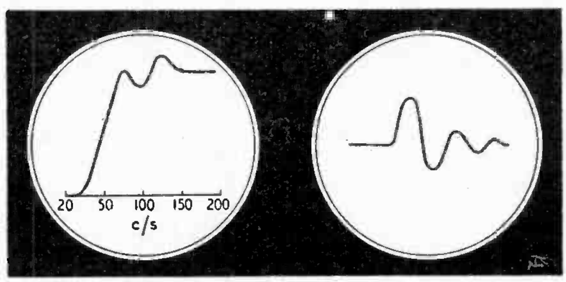


Fig. 2. Typical c.w. (left) and pulse (right) responses of a bass reflex cabinet.

Here A is the effective cross-sectional area of the acoustic circuit (e.g. A can be the area of the cone of the loudspeaker) and " compliance " is the reciprocal of stiffness (e.g. of the cone suspension).

There is no reason why the analogue network should operate at the same frequency as the acoustic circuit, provided that the elements are suitably scaled in value, and in fact a frequency 5000 times higher was found convenient.

Fig. 3 shows a simple analogue network suitable for computing and displaying the bass response of a moving coil loudspeaker in an enclosure with or without a vent. The output from the cone and from the vent can also be seen separately if required. The circuit can be modified if necessary to show the effect of other resonances of the air in the box, and of special shapes of box or positions of the vent. It is assumed that the cone moves as a rigid piston (this is usually true up to over 200 c/s) and that the walls of the enclosure are rigid. Voice-coil inductance and directional effects in sound radiation can be neglected in the low-frequency range under consideration. The m.k.s. system of units is used throughout.

As to the individual elements comprising the network shewn in Fig. 3:—

(a) The electromagnetic damping is the chief controlling factor at the loudspeaker bass resonance and is dependent upon the magnet flux and electrical source impedance (i.e. the negative or positive feed back ratio). This is represented by an *acoustic* resistance $R_X = B^2l^2/A_L^2(R+R_A)$, where B is the magnet flux, A_L the effective area of the cone and l the length of wire in the voice coil which has a resistance R and is fed from a source of effective resistance R_A. Other acoustic series resistances, except those intentionally introduced by added damping material, are usually much smaller than R_X.

(b) The loudspeaker itself is represented by the capacity $A^2{}_LC_L$ in series with the inductance m_L/A_L^2 where C_L is the compliance of the suspension and m_L the mass of the coil and cone.

(c) Under dynamic conditions, the mass of the loudspeaker cone is augmented by that of the "adherent" or "driven" air which is represented by the inductance m_a. Under many conditions we may put $m_a \approx 1/\sqrt{A_L}$.

(d) If the box is closed, the major effect of it is to increase the apparent stiffness of the loudspeaker suspension. It can therefore be represented by a series capacity C_B, the magnitude of which is given by $C_B = 0.7 \times 10^{-5} V_B$ where V_B is the volume of air in the box.

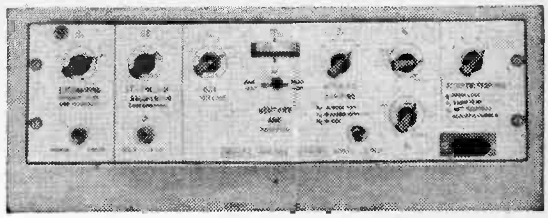
(e) If damping material is used in the box, this can be represented by a resistance R_C. The magnitude of R_C is usually difficult to calculate and is better measured by an electrical impedance test at resonance.

(f) A vent in the box can be allowed for by an inductance representing the mass of air vibrating in (and near) the hole. An approximate formula is $m_V = (1/\sqrt{A_V}) + (1.2t/A_V)$ where A_V is the area and t the length of the vent hole.

(g) If damping material is used in the vent, this can be represented by a resistance R_S. An additional resistive outlet is equivalent to damping in parallel with the vent, and corresponds to a resistance R_p.

(h) The current through the network when a voltage is applied is a measure of the acoustic velocity in cubic metres per second. The voltage across a small resistance (here 47 Ω) can then be used to indicate this current. Normally, however, we require the acoustic pressure, and this, at low frequencies and at a short distance from the loudspeaker, is proportional to frequency × acoustic velocity and can be obtained from the voltage across a small inductance (here 25 μH). The acoustic velocity output U_L from the loudspeaker is then given at the terminal U_L in Fig. 3. The pressure output from the vent or from the loudspeaker alone are obtainable by switching to p_V or p_L respectively as shown, the normal response being given by the difference between the two at p_C (provided that the listener is not too near the loudspeaker). The network allows for the change of phase angle between the two waves with frequency, but assumes that the vent is placed in the front of the enclosure at a distance of the order of a foot from the loudspeaker opening.

Provided that precautions normal to electrical circuits are taken, the computer in itself has an accuracy quite adequate for any actual requirement. But this accuracy is, of course, dependent upon the exactness or otherwise of the correspondence between the acoustic circuit assumed and the actual physical loudspeaker and enclosure. The results are, therefore, subject to the same errors (which may often be considerable) as ordinary calculations on the acoustic circuit. Such errors are of the same nature as the errors in electrical circuit calculations caused by the presence of unknown stray capacities or inductances at high frequencies. As always, calculation must be used to supplement direct experiment and cannot take its place.



Variable analogue network for loudspeaker in a reflex cabinet.

The sine-wave response of a loudspeaker with enclosure has been calculated by various writers (see e.g. Beranek's "Acoustics"), but in order to avoid excessive complications, the analysis has usually been confined to two particular cases, viz., either a closed box, or a box tuned by the vent to resonate at the same frequency as the loudspeaker's natural bass resonance. With the computer one can see at once the effect of varying the tuning of the box, as well as that of other parameters (such as an acoustic resistance in parallel with the vent) which have not usually previously been taken into account. And above all, the response to a pulse or step transient (which has not, to the writer's knowledge, been previously calculated) can be seen at a glance.

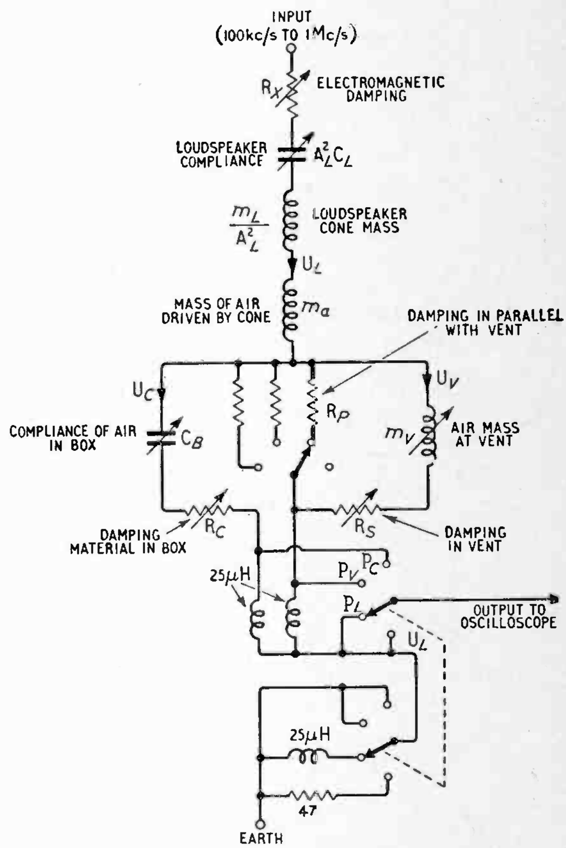


Fig. 3. Analogue network referred to acoustic output for obtaining the performance of a loudspeaker in a bass reflex cabinet.

French Components Show

THE international aspect of the components show, held recently in Paris, was emphasized by seeing, almost side-by-side, exhibits from countries as widely spaced as Hungary and America. The official title was "Deuxième Salon International," though it is in fact the twenty-second "Salon des Pièces Détachées" to be held in France. In all, about 310 organizations (excluding publishers) were represented, roughly 12% of these being "foreigners."

Sennheiser Electronic had among their range of microphones two interesting models. One was an extremely directional microphone (30° lobe-width for −3dB at 5kc/s) which is capable of a very high standard of reproduction. It consists of a split tube about 40-in long coupled to a moving-coil transducer, the split in the tube being divided up into short lengths by many small discs, mounted edge-on and at right-angles to the slot. Although the lobe-width broadens as the frequency is lowered the microphone still has a front-to-back ratio of 15dB at 200c/s. The "Mikroport" (developed by Sennheiser and Telefunken) uses a conventional cardioid moving-coil microphone whose output frequency-modulates a pocket-sized, battery-powered transistor transmitter. The transmitter centre-frequency is about 37Mc/s and this is picked up by a fairly conventional mains-powered f.m. receiver. The non-linear distortion is said to be less than 2% and ranges up to 300ft can be achieved.

Going to the other end of the sound-reproducing chain—the loudspeaker—many novel items were on show. For instance, G. Gogny were exhibiting their wide-range "Batterie Mondial" which consists of either three or six 3-in diameter units connected in series-parallel. The cones have, instead of the usual peripheral support, a repetition of the corrugated centring device mounted a short distance down the cone. This support is made from a fabric with a fairly "open" weave, the result being a very high compliance which produces a low fundamental resonance (42c/s) even with the small cone-system mass. Another loudspeaker unit, shown by Audax, uses an 18-in diameter metal ball as acoustic loading for an 8-in high-quality driver unit. To preserve a fairly resistive load on the driver the ball is divided into two resonant cavities, joined by a pipe: this unit is said to have a smooth response from 90c/s upwards.

Ferrivox market a complete set of parts for a multi-speaker system, including the output transformer and dividing filters. In the bass loudspeaker—a 12-in unit—the corrugated cone-edge support has cut in it a few narrow radial slots. This improves the compliance to the extent of reducing the fundamental resonance from 40 to 30c/s. Cabasse were showing the latest version of their 14-in bass unit—the 36IIBX—which has a nylon rear suspension, "plastic" foam at the periphery, and a magnet producing a total flux of 370,000 maxwells. Mounted in an appropriately large cabinet—for its resonance is 32c/s—the impressive bass produced drew big crowds to the stand.

Among the rather less sophisticated loudspeakers the inverted type of construction (magnet inside the cone) seems to be very popular, as do twin cone types and ferrite magnets. An example of these two latter points was the S.I.A.R.E. 7-in × 10-in elliptical unit. Also many small cone-tweeter units were on show.

Notable among the small portable gramophones was Radio Celard's "Radio Phonocapte." This has a four-speed turntable and pickup, long-, medium- and short-wave radio, a 1.2W amplifier with bass and treble controls and loudspeaker all in a box rather like a large handbag. Eight transistors and printed circuit construction are used, the power supply being derived from torch batteries claimed to last 100 to 200 hours. Teppaz, too, were showing a neat transistor gramophone.

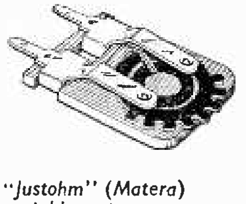
For stereophonic reproduction the general impresssion gained is that manufacturers feel that something better than the simplest-possible equipment is needed. It is interesting to note that some equipments have separate right and left treble controls. An example of both these trends is the Supertone "Tristan and Isolde" system whose amplifier and turntable are combined; but the loudspeakers are a pair of four-foot columns.

Turntables which caught one's eye were the Thorens TDK101 kit for a single-speed (33 r.p.m.) transcription unit and the Avialex, whose "works" are completely covered by a dust-proof metal shroud. Thorens, too, had a pickup arm on show with an ingenious lifting device which operates through the centre of the pivot.

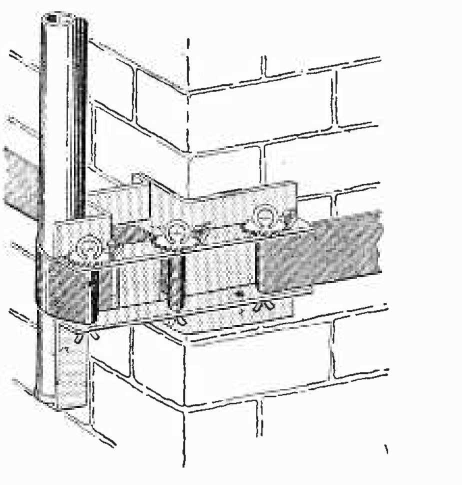
A pedestal-mounted, two-speed professional tape-recorder with a signal-to-noise ratio of 58dB was shown by L. I. E. Belin. Both this model—the F12—and the portable K30 have sealed plug-in head units which are supplied with a test certificate listing their performance. Tape-threading is very simple, as there are no pressure pads and the tape path is open to view throughout its length.

Little major development was apparent in the field of television components—110° scanning equipment is

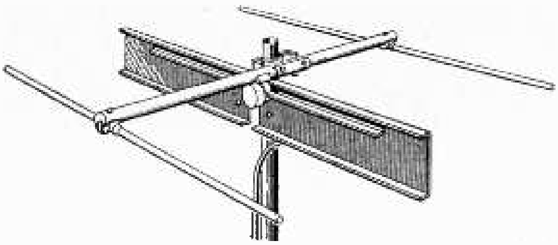
Chaume's printed circuit valveholder with screening-can retainer.



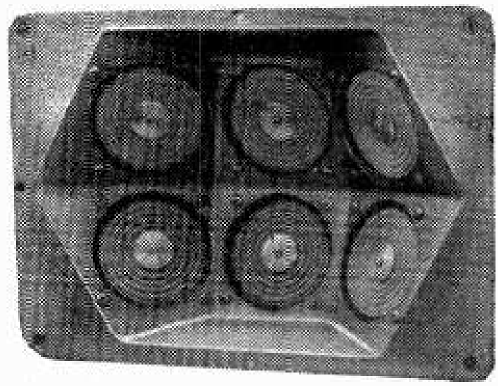
"Justohm" (Matera) variable resistor.



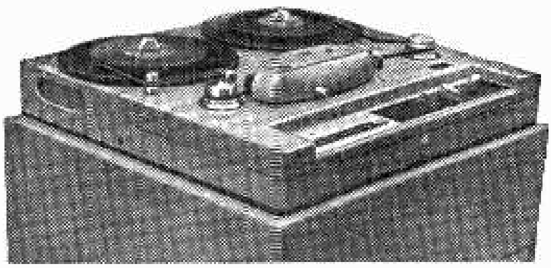
Strip-lashing for aerials (Balmet).



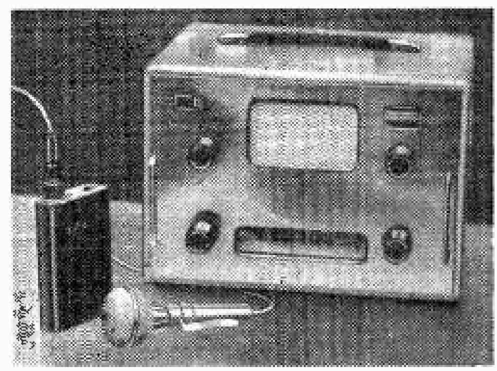
Portenseigne's pressed-aluminium Band-III dipole.



"Batterie Mondial" wide-range loudspeaker.



F12 tape recorder (Belin) with photo-electrically operated tape-breakage switch.



"Mikroport" wireless microphone with pocket transmitter and complementary receiver.

fairly well established and tuner design seems to have stabilized on the double-triode and triode-pentode arrangement, using rather-large coil assemblies and mounting the valves beside, instead of on top of, the turret. This makes it difficult to adjust coil cores on the "biscuit" in use and several manufacturers have mounted the coils at an angle to the biscuit to lessen the difficulty. Printed wiring does not seem to be popular, with one notable exception—a new tuner from Halftermayer. This uses a printed-wiring plate, which is dip soldered, and has printed-coil biscuits. Tuning of the individual coils is effected by means of eddy currents in small metal discs mounted on screws.

Several very interesting mechanical design features were noted in television aerials, the most original being possibly Portenseigne's new Band-III dipoles. These are stamped from aluminium sheet, so enabling a folded dipole to be made with unequal element widths without encountering the difficulties caused by having exposed tube joints at the outer ends of the elements.

A very neat chimney lashing system was shown by Balmet—this uses, instead of the more usual wire, a stainless or galvanized steel band about 2½-in wide. This is held and tightened round the chimney by a split pin and ratchet, the band being threaded through the "legs" of the split pin. The same fixing is used to hold the mast in a stirrup and, in view of its area of contact and strength (3,000lb in tension), enables a single band to be used in the majority of cases which require a double wire lashing.

Some interesting ideas were evident, too, in the small-parts field. Matera were showing a new small pre-set resistor—the Justohm—designed for printed circuit use. Instead of the conventional sliding contact selecting a portion of a deposited track, the track is graded and moves under two fixed contacts so that the area of track in circuit does not vary: thus there is no need to derate the component at low resistance values. Also because there is always some resistance in circuit the "Justohm" saves the cost of a limit resistor. Matera's potentiometer for printed circuits has highly-compliant metal-strip leads instead of tags—so avoiding any danger of damaging the circuit board by transmitting mechanical stresses to it from the control knob and easing replacement problems.

Two chassis fittings on F. Chaume's stand were noted—a dial-lamp holder moulded from "Rilsan" (a nylon-like substance) which offers good insulation resistance and a certain amount of flexibility whilst retaining securely the lamp, and B9A and B7G valveholders designed for printed circuit use. These carry a small spring clip, which is connected to the earth tag, for retaining and making contact with the valve screening can.

It was rather difficult amid the wealth of test equipment on view to pick out any specific items, but two multi-range meters which seem to depart from common practice are the Charvin Arnoux "Precitest" and the Metrix Model 462. The "Precitest" affords all the usual facilities of a medium-sized meter but each group of components—i.e. movement, shunts, cut-out, range-switch panel etc.—is replaceable without recalibration. Another unusual feature is that the meter is protected in three different ways; the movement and rectifiers are bypassed by semiconductor diodes in the event of overload, whilst these are backed by a cut-out and a fuse protecting the shunt and series resistors.

Semiconductor diodes are also used to protect the movement of the Metrix 462; but this is most notable for the facilities that are packed into a small space ($\approx$6in × 4in × 2in, weight $\approx$ 1½lb). Potential is measured with a sensitivity of 20,000Ω/V on both a.v. and d.v. ranges, the measurement of a.c. is provided for by indicating the potential developed across a resistor and the three "ohms" ranges permit the checking of resistances as high as 10MΩ and as low as 5Ω. Metrix were also showing a megohmmeter using a transistor-derived 500V supply, stabilized by Zener diodes.

WORLD OF WIRELESS

Component Production

A YEAR of "steady if quiet progress" is recorded in the twenty-sixth annual report of the Radio and Electronic Component Manufacturers' Federation presented at the annual general meeting on March 11th. The approximate value of last year's production of 1,940M components was £100M compared with the previous year's 1,750M components valued at £93M.

Nearly 42% of last year's production was used in domestic sound and television receivers; 31% in professional equipment; 15% was directly exported and the remainder used in audio equipment, defence equipment and in retail sales.

The total value of exported components and audio products was approximately £21M, an increase of £1M on 1957. Over half of this total was for audio equipment. Record players, changers, etc., increased by 17% to £8.6M; tape recorders and parts by 18% to £1.1M and loudspeakers and microphones by 7% to £960,000. Public-address and other sound-reproducing equipment accounted for £570,000—a decrease of 11% on 1957. By far the biggest overseas market for audio equipment is the U.S.A. which, up to the end of November, purchased £3.85M worth; Canada was the next highest with £960,000. The biggest individual market for components (including test gear) was Australia (£910,000), followed by India (£700,000).

It was announced at the A.G.M. that this year's Components Exhibition will be the last at Grosvenor House. In future it will be held at Olympia towards the end of May in alternate years—beginning in 1961. The Components Show will thus alternate with the Instruments, Electronics and Automation Exhibition, to be held next in May, 1960.

Technical Writing Awards

WITH the object of making more widely known abroad technical progress in this country, the Radio Industry Council awards each year up to six 25-gn premiums to writers of technical articles.

The awards for 1958, which will be presented by the new director of the R.I.C., Air Marshal Sir Raymund Hart, on April 15th, go to the following:—

V. J. Tyler ("A New High-Efficiency High-Power Amplifier," *Marconi Review*).
D. J. R. Martin ("New Types of D.C. Amplifiers," *Electronic & Radio Engineer*).
W. J. Bray ("A Survey of Microwave Radio Communication," *Electronic Engineering*).
S. Fedida ("All Travelling-Wave Tube Systems," *Electronic Engineering*).
E. Mendoza ("Electronic Developments at Very Low Temperatures," *British Communications and Electronics*).
E. Lloyd Thomas ("Analogue Computation," *British Communications and Electronics*).

The panel of judges, headed by Professor H. E. M. Barlow, of University College, London, last year included B. C. Brookes, lecturer in the presentation of technical information at University College, P. D. Canning (Plessey), F. Jeffery (Murphy), and E. H. Ullrich (S.T.C.).

Television Convention

DURING the Brit.I.R.E. Convention on Television Engineering to be held in Cambridge in July, Dr. Vladimir Zworykin will give the fourth Clerk Maxwell memorial lecture. Another overseas contributor to the convention will be Dr. S. K. Mitra, Emeritus Professor of Physics, Calcutta University.

The convention, which will be held in the University from July 1st to 5th, is being organized to cover not only the broadcasting aspects of television engineering but also its applications in science and industry. Sessions will be devoted to such topics as transmitters, aerials and propagation, cameras, receivers, video recording and colour techniques.

Particulars of the convention will be obtainable in April from the Institution.

Servicing

THE present scheme, operated jointly by the City and Guilds of London Institute and the Radio Trades Examination Board for the award of separate certificates for radio and television servicing, has been developed piecemeal over the past ten years and is now "obviously out of date," to quote the Institute. C. & G. and the R.T.E.B. have, therefore, decided that a complete revision of the existing scheme is urgently needed. It is hoped to publish a revised five-year scheme leading to a new combined Radio and Television Servicing Certificate shortly.

"Toute la Radio"—25 Years

WITH the March-April 1959 issue our esteemed contemporary *Toute la Radio* completes 25 years of publication. Since 1934, under the direction of Monsieur E. Aisberg, it has maintained a consistently high technical standard together with a characteristically lucid style of presentation. We extend our congratulations on past achievements and felicitations for the future.

Reconditioned Tubes.—Recent announcements that in the process of reconditioning c.r. tubes some manufacturers were rescreening and remetallizing them, has raised the question of purchase tax. H.M. Customs and Excise have ruled that whilst the possibility of these processes was not envisaged when last year's announcement on purchase tax on reconditioned tubes was made (see *Wireless World*, August, p. 353), they are prepared to accept rescreening and remetallizing as a minor repair and, therefore, not taxable. Incidentally, two tube manufacturers, Mullard and Siemens Edison Swan, have announced schemes for the reconditioning of tubes.

Navigation Award.—The captains and navigational crews from the Aircraft and Armaments Experimental Establishment who were concerned with the trans-ocean tests and evaluation flights of the Dectra navigational system have been awarded the Johnston Memorial Trophy by the Guild of Air Pilots and Air Navigators. The trophy is awarded annually for "the most outstanding feat or performance in aerial navigation, for the development of principles of air navigation, or for flights involving the development of the technology of navigation."

E.E.A. Council.—The following representatives of member firms of the Electronic Engineering Association will serve on the council for the ensuing year: A.T.E. (H. R. A. Wood), B.T.H. (V. M. Roberts), Cossor (F. J. Dellar), Decca Radar (C. H. T. Johnson), E.M.I. (W. C. Morgan), Ferranti (J. N. Toothill), Marconi's (F. S. Mockford), Metrovick (L. H. J. Phillips), Mullard (R. R. C. Rankin), Murphy (K. S. Davies), Plessey (P. D. Canning), Siemens Edison Swan (J. W. Ridgeway), S.T.C. (L. T. Hinton) and Ultra (E. E. Rosen). The new chairman is L. T. Hinton (see page 168), and the vice-chairman, R. R. C. Rankin.

Radio Industry Exhibitions, Ltd., has been formed by the British Radio Equipment Manufacturers' Association to organize the National and other British radio and television exhibitions. Under the reorganized Radio Industry Council (see last month's issue) B.R.E.M.A. undertook responsibility for "domestic" radio and television shows. The directors of the new company are F. W. Perks (British Radio Corporation), who is chairman, E. K. Balcombe (Alba) and Walter M. York (Ekco).

Relay Services Association has elected the following officers for the ensuing year: Sir Walter J. Womersley (president), F. J. Bellchambers (chairman), J. W. Kinsman (vice-chairman), and Lt. Cmdr. H. MacCallum, H. Noble, Cmdr. J. W. C. Robinson, W. T. C. Smeathers and A. D. Thomas (vice-presidents).

Stereophonic Broadcasting.—The Percival system of stereo transmission developed by E.M.I. is being demontrated in the U.S.A. The system, which, as described in our November, 1958, issue, radiates the two channels from a single transmitter, was demonstrated during the recent Chicago convention of the National Association of Broadcasters and also at the I.R.E. convention in New York.

Instrument Testing.—The British Scientific Instrument Research Association has established an electrical instrument test service at its laboratories in Chislehurst, Kent. Operated under the supervision of the National Physical Laboratory and using N.P.L. certified equipment, the department will test and issue certificates for instruments up to precision grade accuracy. Further information regarding this service, which is not restricted to members of the association, may be obtained from B.S.I.R.A., South Hill, Chislehurst, Kent.

Mullard "At Home."—Their second electronics exhibition in Mullard House, Torrington Place, London, W.C.1, is being arranged by Mullard for April 6th to 10th. The exhibition has been planned to give manufacturers, designers and professional users of electronic equipment an opportunity to see the company's latest developments in valves, tubes and semiconductor devices for industrial and communications purposes. Admission to the exhibition, which is open daily from 10 to 6, is by ticket obtainable from the company.

Fellowships in Metallurgy.—Applications are invited for the award of Mond Nickel Fellowships for 1959. The Committee awards up to five fellowships annually of an approximate value of £900 to £1,200 each. They usually take the form of a one-year travelling fellowship in metallurgy. Details and application form (returnable by June 1st) can be obtained from The Secretary, Mond Nickel Fellowships Committee, 4, Grosvenor Gardens, London, S.W.1.

Western Nigeria is planning to inaugurate a television service later this year. The two stations, which will operate in Band I using the 625-line standard, will be near Ibadan (the Western Region capital) and Ikeja, near Lagos. It is planned to devote not less than 50 per cent of transmission time to educational programmes. Equipment for the two stations is being ordered from Marconi's.

Soviet production of sound broadcasting receivers during 1958 totalled 3.9M—an increase of 10% on the previous year. The year's output of television receivers was 1M, which was 38% more than in 1957. These facts are given in the report of the Central Statistical Board of the U.S.S.R. Council of Ministers quoted in *Soviet News.*

Japanese Radiocommunications.—The number of radio stations in Japan now totals over 33,000; an eightfold increase during the past eight years. Of this total, 11,000 are used by the fishing industry, which heads the list of users, 4,500 by amateurs and 3,500 by the police.

Receiving Licences.—During January the number of combined television and sound licences in the U.K. increased by 145,311, bringing the total to 9,044,378. Sound only licences totalled 5,667,533, including 368,694 for sets fitted in cars.

South Wales V.H.F.—Wenvoe's fourth v.h.f. transmitter (for the Third Programme and Network Three) came into service on March 1st. It radiates with an e.r.p. of 120kW on 96.8Mc/s. Wenvoe's other frequencies are 89.95 (Light), 92.125 (West Home) and 94.3 (Welsh Home).

Sound insulation is being featured at the Factory Equipment Exhibition to be held at Earls Court, London, from April 7th to 17th. Among the 300 exhibitors are also a number of manufacturers of industrial communications equipment.

Demonstrations of their stereo and single-channel sound reproducing equipment will be given by Scientific & Technical Developments, Ltd., at their Wallington, Surrey, factory from March 30th to April 5th. Admission is by ticket available from S.T.D., Melbourne Works, Wallington.

Kaleidasound is the name given to the exhibition and demonstration of recording and reproducing equipment being held jointly by CQ Audio and Reps (Tape Recorders) at the Imperial Hotel, Russell Square, London, W.C.1, from April 2nd to 5th. Tickets are obtainable from CQ Audio, Ltd., 2, Sarnesfield Road, Enfield, Middx.

Heath Kits.—Daystrom, Ltd., the U.K. associates of the American Heath Kit organization, are giving demonstrations of their equipment at the Royal Hotel, Woburn Place, London, W.C.1, from April 2nd to 5th.

Receiver maintenance course, covering both sound and television, is being held at the Wesley Institute, Wesley Road, London, N.W.10, on Monday and Wednesday evenings from April 6th.

CLUB NEWS

Bexleyheath.—A repeat showing of the Mullard film "The Principles of the Transistor" will be given to members of the North Kent Radio Society on April 9th. A fortnight later they will have a demonstration of audio equipment by Whiteley Electrical. The club meets at 8.0 in the Congregational Hall, Chapel Road, on the second and fourth Thursday in each month.

Bradford.—A lecture on stereophony will be given by F. Thislethwaite at the April 7th meeting of the Bradford Amateur Radio Society. Meetings are held at 7.30 at Cambridge House, 66, Little Horton Lane, Bradford 5.

Cleckheaton.—The April programme of the Spen Valley Amateur Radio Society includes talks on the electron microscope by G. W. Reply at Leeds University (1st); the automatic telephone by a Post Office representative (15th); and on metal rectification by S.T.C. (29th). The last two meetings will be held at the George Hotel, Cleckheaton.

Wellingborough.—The April programme of the Wellingborough and District Radio and Television Society includes lectures on "The Romance of the Radio Star" by G. C. Wooldridge (2nd) and "Winding your own Radio Transformers" by J. Wagstaff (16th). The Society meets at 7.30 at Silver Street Club Room.

Personalities

Major L. H. Peter, M.C., A.F.C., M.I.E.E., has retired from the position of Chief Engineer with Westinghouse Brake and Signal Co., but will continue to act as a consultant. Born in 1891, he was educated at Blundell's School, and after studying under Professor Silvanus P. Thompson at City & Guilds, worked for 5 years in heavy electrical engineering before joining the Royal Engineers in 1914. The following year he transferred to the Royal Flying Corps and recalls that his first squadron was commanded by W. Sholto Douglas (now Lord Douglas of Kirtleside). He joined what is now the Westinghouse Brake and Signal Co. in 1919. In the early 1920s the discovery of the copper-oxide rectifier by Dr. L. O. Grondahl interested him and he devoted a great deal of time to its development and it was this and a general interest in "wireless" that brought him into contact with the radio industry. Major Peter was one of the six founder members of what is now the Radio and Electronic Component Manufacturers' Federation, of which he has been president for the past two years. He has just completed 50 years as a member of the I.E.E.

Major L. H. PETER

L. T. HINTON

L. T. Hinton, B.Sc.(Eng.), A.C.G.I., M.I.E.E., the new chairman of the council of the Electronic Engineering Association on which he represents Standard Telephones and Cables, has been with the company and its predecessors since 1920. He took an active part in the development and engineering of long-distance repeatered voice-frequency cable systems on the Continent and later worked in South America on trans-oceanic shortwave radio-telephone systems. Mr. Hinton's present position in S.T.C. is manager (trade associations).

J. R. Hughes, A.M.I.E.E., M.Brit.I.R.E., has been appointed a director and commercial manager of Hivac Ltd., a member of the Automatic Telephone & Electric Group. He has been with Hivac, latterly as chief commercial engineer, for some eleven years, having previously been for five years technical secretary of the British Radio Valve Manufacturers' Association.

J. D. Stephenson, M.Sc., Ph.D., M.I.E.E., a director of Mullard Limited, recently completed 25 years service with the company. Dr. Stephenson joined Mullard from Durham University where he took degrees in physics, applied science, and electrical engineering and did four years of research work.

Frank H. Spurling, who has been with E. K. Cole since 1951 and has been in charge of the technical sales writing section of the publicity department, is appointed press relations officer.

Sir John Dean, B.Sc., A.R.I.C., F.I.R.I., chairman and chief executive of Telegraph Construction and Maintenance Co., has been appointed a director of British Insulated Callender's Cables, which recently took over the Telcon organization. Sir John, who joined the original Gutta Percha Co. in 1922 and became chief chemist of T.C. & M. Co. in 1930, has been chairman of the company since 1954.

A. R. Boothroyd, B.Sc.(Eng.), Ph.D., for the past seven years lecturer in the Electrical Engineering Department of Imperial College, London, has been appointed by London University to the Readership in Electronics tenable at that college. Dr. Boothroyd, who is 33, graduated at Imperial College in 1946 and after a year as a research engineer with English Electric returned to the college as a research student. He received his Ph.D. degree for research in the field of network synthesis. As a lecturer he has specialized in communications and circuit theory and during the past few years his research has been mainly concerned with transistor circuit applications.

H. E. Drew, M.Brit.I.R.E., who has been appointed Director of Electronics Production (Air) in the Ministry of Supply in succession to **R. E. Sainsbury,** joined the Civil Service in 1938 after 14 years in the R.A.F. He joined the staff of the Bawdsey Research Station in 1938 and in 1946 went to the M.o.S. headquarters staff of the Directorate of Radio Production. Since 1951 he has been assistant director in the department of which he now becomes head.

Nyman Levin, B.Sc., Ph.D., A.R.C.S., D.I.C., F.Inst.P., since last July deputy director of the weapons group of the Atomic Energy Authority, has been appointed director. He is 53. Dr. Levin was with Marconi's from 1930 to 1940 when he went to the Admiralty. He was engaged on the development of microwave valves and equipment at what is now known as the Services Electronics Research Laboratory. Soon after the war he became head of the instrumentation group at the Admiralty Research Laboratory and in 1951 was appointed superintendent of the Admiralty Gunnery Establishment. From 1955 to 1958 he was Chief of Research and Development to Rank Precision Industries. He is succeeded as deputy director by **E. F. Newley,** M.Sc., A.M.I.Mech.E., A.M.I.E.E., who after 12 years in the Post Office Engineering Department joined the Admiralty at Teddington in 1949. He was appointed deputy chief engineer in the weapons group, A.E.A., in 1955 and since 1957 has been Chief of Warhead Development at Aldermaston.

Ian Campbell-Bruce has been appointed sales director of Muzicord (Sales), Ltd., which produces and supplies recorded programmes of music for use in factories, offices, etc. He is 44. On leaving Harrow in 1931 he was apprenticed to the Baird Television Co. In 1937 he joined the Air Ministry Directorate of Signals, was commissioned in the R.A.F. during the war and subsequently returned to the Air Ministry where he stayed until 1956. He was until recently sales director of Cossor Communications, Ltd.

J. B. Hassett has retired from the joint managing directorship of Hassett and Harper, Ltd., of Birmingham, which he founded 51 years ago.

J. D. Sinclair has been appointed manager of the Industrial Division of Amplivox, Limited. He will be concerned with marketing electro-acoustic equipment in the aeronautical and industrial communications field. He was formerly assistant chief of sales with Muirhead.

Peter Alsop has joined Technograph Electronic Products, Ltd., and is responsible for the Technical Sales Division in the computer, guided weapons, and airborne equipment fields. He was previously with E.M.I. Electronics where, during the past three years, he had been employed in an advisory capacity on the application of new techniques and processes, including printed circuitry and resin encapsulating.

John C. Duckworth, B.A., F.Inst.P., A.M.I.E.E., will become managing director of the National Research Development Corporation on April 1st in succession to the Earl of Halsbury who has retired. Mr. Duckworth, who is 42, was at T.R.E. (now R.R.E.) throughout the war. He was for three years at the Atomic Energy Research Establishment, Harwell, before joining Ferranti in 1950, where he was in charge of the development and design of the guidance and control system for the guided weapon "Bloodhound." For the past year he has been Chief Research and Development Officer of the Central Electricity Generating Board.

Peter E. Axon, O.B.E., Ph.D., M.Sc., A.M.I.E.E., has joined Ampex Electronics, Ltd., the recently formed U.K. subsidiary of the Ampex Corp. of California. Dr. Axon, who is an authority on both audio and video magnetic recording, will head this wholly-owned subsidiary of Ampex which will start the manufacture of instrumentation magnetic tape equipment at a factory in Reading in a few months. Dr. Axon, who is 41, was formerly in the Research Department of the B.B.C.

J. Moir, M.I.E.E., a frequent contributor to *Wireless World*, has joined Goodmans Industries as technical director and also technical consultant to Relay Exchanges, who recently acquired Goodmans. Mr. Moir was for nearly 30 years with the British Thomson-Houston Company, where for some time he had been responsible for the design and development of sound reproducing equipment at Rugby.

OUR AUTHORS

H. V. Griffiths, M.B.E., engineer-in-charge of the B.B.C.'s receiving and measuring station at Tatsfield since 1933, writes in this issue on long-distance propagation in Band I. He joined the original British Broadcasting Company at its Birmingham station (5IT) in 1924. He was engineer-in-charge of the experimental short-wave "Empire" transmitter (G5SW) at Chelmsford for a short time before transferring to the Research Department in 1928 for experiments in diversity reception conducted in conjunction with Marconi's. He was on the research staff of Marconi's from 1930 until 1933 when he rejoined the B.B.C.

John M. Peters, B.Sc. (Eng.), A.M.I.E.E., A.M.Brit.I.R.E., whose series of articles on elements of electronic circuits starts in this issue, is a senior production engineer at the Admiralty Surface Weapons Establishment at Portsdown. He served a student apprenticeship with S.T.C. after which he entered the electrical branch of the Navy. He was subsequently for a short time with Johnson and Phillips, of Charlton, before entering the Civil Service in 1950 in which he initially served at the Underwater Detection Establishment, Portland. He is 33.

F. R. W. Strafford, M.I.E.E., a frequent contributor to *Wireless World* during the past 26 years, starts in this issue a series of articles on aerial problems associated with the introduction of a second television service in Band III. He was for some years technical manager of Belling & Lee and is now a consulting radio and electronics engineer on his own account. He was a licensed amateur at 15½ and now operates station G2PD.

W. K. Hsu, Grad.Brit.I.R.E., writer of the article on reversible Dekatron counters, joined Elliott Brothers (London) last year, prior to which he was U.K. representative of the Radex Cosmo Co. He is 25 and since coming to this country has taken a post-graduate diploma course in control engineering at Battersea College of Technology.

OBITUARY

Thomas Lydwell Eckersley, B.A., B.Sc., F.R.S., one of the most brilliant research workers in the field of radiowave propagation, died on February 15th, at the age of 72 after a long illness. After taking a degree at University College, London, and doing some notable research work at the N.P.L. and the Cavendish Laboratory, Cambridge, he served during World War I in the Royal Engineers in Egypt and Salonika where his theoretical and experimental work on "night effect" and coastal refraction served to lay the foundations of his subsequent career. "T.L.," brother of "P.P.," joined Marconi's in 1919 and began research into the resistance of transmitting aerials and later propagation problems. He applied the phase integral method, familiar in quantum mechanics, both to the magneto-ionic theory of ionospheric propagation and to the problem of the effect of the earth's resistivity on the diffraction of radio waves round the earth. On much of this work the present-day systems of forward-scatter transmission are based. In 1940 Mr. Eckersley joined the Air Ministry, and two years later became Chief Scientific Adviser to the Inter-Services Ionosphere Bureau established at Great Baddow. Ill health compelled him to retire in 1946, but he continued as a consultant to the Marconi Company. In that year he was awarded a Fellowship of the American Institute of Radio Engineers. The citation stated, *inter alia:* "Both his approach to the problem from the standpoint of practical communications and his invention of mathematical tools useful in the computation of radiated fields are achievements of lasting value, acclaimed by the whole radio world and form a monument of which he may be justly proud." He received the I.E.E. Faraday Medal in 1951.

Sir Owen Richardson, F.R.S., discoverer of the fundamental physical law governing the emission of electrons from hot bodies—known as the Richardson Law—died on February 15th at the age of 79. Sir Owen, who was knighted in 1939, spent the greater part of his academic career at King's College, London, where for 10 years he occupied the Wheatstone Chair and was for 20 years director of research in physics. Prior to going to King's he was appointed, at the age of 27, professor of physics at Princeton University, where he stayed for 8 years. In 1928 he was awarded the Nobel Prize for Physics.

W. J. Picken, O.B.E., M.I.E.E., engineer-in-chief of Marconi's W/T Co. when he retired in 1946, died on February 24th at the age of 72. He joined the company in 1913 and was engaged with Captain H. J. Round on the direction finding and interception network which played a vital role in the anti-U-boat operations around our coasts. In 1919 he transferred to the company's research staff and was engaged on valve development work until 1928 when he was appointed valve controller. For part of the last war he was seconded to the Admiralty where he worked in the department responsible for the development of all valves for defence purposes. He became secretary of this department (known as C.V.D.) in 1946 on his retirement from Marconi's. Mr. Picken relinquished this post in 1953 since when he had been consultant to the English Electric Valve Co.

Frederick J. Camm, well-known editor of *Practical Wireless*, *Practical Television*, and a number of other "practical" journals published by George Newnes, died on February 18th. "F. J." who was 63 and had been with Newnes since 1930, was a brother of Sir Sydney Camm, director and chief designer of Hawker Aircraft, Ltd.

News from the Industry

English Electric Group.—Preliminary trading figures for last year have been issued by the English Electric Co. showing a group profit for the year after taxation of £3.017M compared with £2.951M in 1957. The Marconi group of companies, which is in the English Electric group, made a profit after taxation of £431,783 (about £34,000 less than in 1957).

Metal Industries, Ltd., have made an offer to acquire Avo, Ltd., who it will be recalled recently took over Taylor Electrical Instruments. In the electrical division of the M.I. Group is Igranic Electric (Bedford), and Brookhirst Switchgear (Chester), which are operated by Brookhirst Igranic, Ltd.

Sealectro Corporation, and its associated company Deltime Incorporated, both of Mamaroneck, New York, announce the opening of a British branch: Sealectro Corp., at Hersham Trading Estate, Lyon Road, Walton-on-Thames, Surrey (Tel.: Walton-on-Thames 6285). The U.K. branch, which is headed by F. R. Shacklady, S. T. Deakin and C. T. Nuttall, will handle the European sales of the companies' products.

Computation Laboratories.—I.B.M. World Trade Laboratories Corporation, of New York, announces the formation of a British subsidiary, I.B.M. World Trade Laboratories (Great Britain), Ltd. W. S. Elliott has been appointed managing director of the laboratories, at present at Hursley House, nr. Winchester, Hants, which are undertaking research primarily in the field of electronic data processing and computing.

Newton Victor, Ltd., the X-ray department of Metropolitan-Vickers, has introduced a specialized brazing service to industry. This service is being provided at the department's Finchley Works, where the plant is used in the manufacture of X-ray tubes and valves. The joints catered for include stainless steel to stainless steel; stainless steel to steel; copper to steel; steel to steel; copper to copper; steel to Nilo K; and Monel to other metals. A method of brazing beryllium has also been developed and applications for tungsten brazing can be investigated.

I.C.I. has brought into operation a large-scale development plant for the manufacture of high-quality silicon of semiconductor grade. The plant, operated by the I.C.I. General Chemicals Division on Merseyside, can produce silicon in either lump form for crystal pulling or in rod form for zone refining.

Marconi's have received a contract from the Ministry of Supply on behalf of the Air Ministry for the planning, supply and installation of a high-power station at the R.A.F Staging Post at Hitaddu in the Maldive Islands. In all, fourteen communications transmitters (ranging from 3.5-30kW) and nine receivers are to be provided, together with ancillary equipment.

Siemens Edison Swan are providing the radio-communications equipment for 12 new vessels for the Shell Tanker Fleet. Another A.E.I. Company—B.T.H.—is providing the vessels' radar equipment.

Felgate Radio, Ltd., of 6, Studland Street, London, W.6, is being voluntarily wound up. The Liquidator is J. H. Banfield, of Staple House, 51-52, Chancery Lane, London, W.C.2.

Lane Magnetic Recorder Co., of 23, Dyke Road, Brighton, is being wound up. The Liquidator is R. B. M. Knight, of 52, Old Steine, Brighton, 1.

Brush Crystal Company, Ltd., have started the commercial production of new piezoelectric materials—polycrystalline ceramics based on a lead zirconate-titanate solid solution—with a usable temperature range of up to 250°C.

Industrial Ceramics.—Royal Worcester Industrial Ceramics, Ltd., has been formed by Royal Worcester, Ltd., to market its industrial ceramic materials. The works are at Tonyrefail, Glam., and the London office at 30, Curzon Street, W.1. (Tel.: Grosvenor 1712.)

Racal's Instrument Division has been formed into a new company, Racal Instruments, Ltd. J. H. Head, late of Advance Components, Ltd., has joined the board of this new company as director and general manager.

Servomex Controls, Ltd., have concluded an agreement with Feedback, Ltd., whereby Servomex will manufacture and market Feedback designs. The range of equipment includes servo components and assemblies as well as apparatus for servo-system analysis.

EXPORTS

Scandinavian TV Link.—A combined multi-channel radiotelephone and television link between the Norwegian capital and Karlstad, Sweden, is being supplied by Marconi's, who will also extend the radiotelephone circuit to Arvika, Sweden. There will be three intermediate stations in the 190-km Oslo-Karlstad link.

Forward-scatter radiotelephone transmitting equipment for Nassau, which will form part of a link connecting the Bahamas with the U.S.A., is being supplied by Standard Telephones & Cables. Two 10-kW transmitters operating in the 2,000-Mc/s band will be used. They will also be installing a line-of-sight v.h.f. telephone network linking Nassau with the Eluethera Islands.

Radar.—A long-range early warning radar station, with associated communications networks and automatic direction-finding equipment, is to be supplied by Marconi's to the government of Jordan.

EMIAC II, the E.M.I. general-purpose analogue computer, is being demonstrated at a number of centres on the Continent during the next two months. Having visited Dusseldorf and Munich early in March, it is in Milan from March 20th to 25th and will then go on to Stockholm (April 3-9); Paris (April 16-23); and Hanover (April 26-May 5).

Calibration Centre in Delhi.—Marconi Instruments, Ltd., have seconded J. E. Taylor to Associated Instrument Manufacturers (India) Private, Ltd., to assist in the setting up and operation of a Calibration Centre in Delhi.

A **"Mercury"** electronic digital computer, valued at about £150,000, has been sold to the University of Buenos Aires, Argentina, by Ferranti.

Multi-channel carrier equipment for radiotelephone links has been ordered from Siemens Edison Swan by the Ghana Posts and Telegraphs Department.

India.—Thakral & Preece (Electronics), of 199, Tehsilpura, Amritsar, are anxious to contact manufacturers of electronic equipment with the view to representing them in India. The company, which is setting up a service organization in Delhi, has an office at 103, Hambrough Road, Southall (Tel.: Southall 4131).

A Second Band-III Programme?
—The Aerial Problem

By

F. R. W. STRAFFORD,* M.I.E.E.

How Gain, Directivity and General Performance of Existing Aerials Could Be Affected at Other Frequencies

THE radiation of a second programme—should it come—in Band III will raise important problems of aerial design and installation. Of the eight channels internationally reserved for Band-III television only four are, to the best of the author's knowledge, available at present. These are Channels 8, 9, 10 and 11.

One must assume, *a priori*, that co-siting of the radiators of the transmitters will be arranged, and that the effective radiated power of the two programmes will be substantially equal. In these circumstances the field strengths of the two transmissions would, under the ideal conditions of a flat and perfectly conducting earth, fall off equally in amplitude with increasing distance. Unfortunately, the propagation conditions are so modified by the practical introduction of uneven terrain, buildings and other structures, that the mere small difference in the frequencies of the two transmissions will result in a difference of field strength, at any randomly chosen site in a densely built-up area, of anything from zero to 20dB.

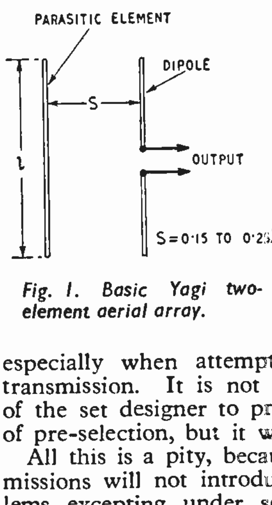


Fig. 1. Basic Yagi two-element aerial array.

This fact, alone, rules out the possibility of using an adjacent channel for the second programme. The present TV receiver would have inadequate input selectivity to prevent mutual interference, especially when attempting to view the weaker transmission. It is not beyond the technical skill of the set designer to provide the requisite degree of pre-selection, but it would be very expensive.

All this is a pity, because adjacent-channel transmissions will not introduce any major aerial problems excepting under severe ghosting conditions. This may sound a little puzzling and needs some explanation.

The amplitude of multi-path reflections (ghosts), coming in from various directions, is very sensitive to frequency. It has already been stated that the main field can change by 20dB in amplitude if the frequency is shifted, and the same applies to the ghosts. Thus, when installing a directional aerial to provide optimum de-ghosting on a particular channel, the aerial is rotated until the worst ghost is made to "sit" in one of the *sharp* minima of the directivity pattern of the aerial. If, now, reception were desired on a neighbouring channel the chances are that the major ghost would arrive from another angle, thereby necessitating a new position for the aerial. The present forest of aerials on the landscape is a sufficient eyesore without having to contend with rows of permanently erected ladders (supplied free with each aerial?).

Nevertheless, if the two programmes were radiated on adjacent channels the great majority of aerial installations would be suitable, without modification, on the previous assumptions of co-siting and equal radiated power.

For the purpose of this article it must be concluded that adjacent channels would not be used for any one service area and it may well be that a separation of two or even three channels may be chosen after due consideration of the technical problems associated with co-sited transmitters, especially if the radiators were all assembled on the same mast—which sounds like reasonable economy.

Hence, it is necessary to examine the aerial problem on the basis of a separation of two or more channels between the two transmissions. The problem is very much bound up with the field strengths of the two signals at a given site.

Local Reception.—At distances up to a few miles from the transmitters the field strength, in spite of the possible difference of 20dB between the two, will be adequate to provide sufficient receiver input from existing aerials. There may be local problems of mutual interference, but this is not an aerial problem.

Primary Area Reception.—Excluding the local portion of the primary area, most Band-III aerials are of the multi-element type based on the Yagi principle. This, basically, consists of the fed dipole plus a number of parasitic elements, one being used as a reflector and the others as directors. In order to obtain optimum performance the lengths of the parasitic elements are quite critical, which is the same thing as saying that the response of the aerial with respect to frequency is equally critical. This means that an *increase* of, say, five per cent in the lengths of the parasitic elements will worsen the performance to the same extent as a *decrease* of five per cent in the frequency. The reason why the Yagi array has these selective characteristics resides in the use of unbroken elements for the parasites. When an unbroken element—that is, an element without a centre feed to an impedance load—is acted upon by an electromagnetic wave the phase of the resultant induced currents varies quite rapidly with frequency. The gain and directional properties of the Yagi array are based on the effect, on the fed dipole, of the re-induced fields from the parasitic elements, and the optimizing of performance depends upon getting these fields in the appropriate phase.

The most simple example is that of the two-element Yagi, commonly referred to as the "H"

* Radio and Electronics Consultant.

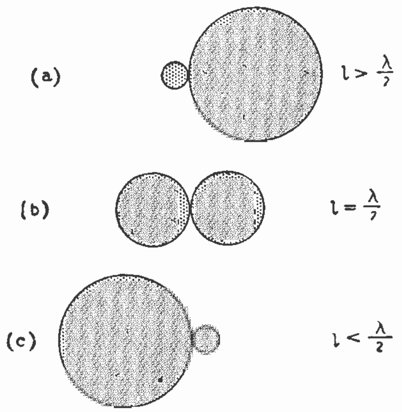


Fig. 2. Effect on gain and directivity of two-element Yagi by varying the length of the parasitic element.

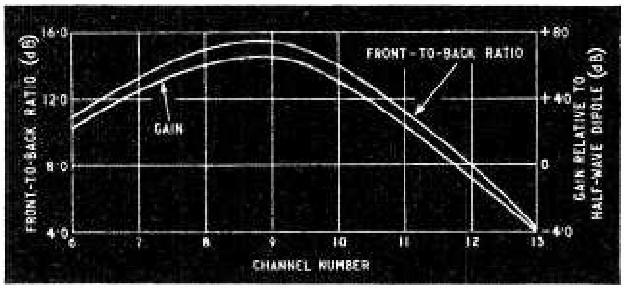


Fig. 3. Performance of a three-element Yagi over Band III.

aerial, Fig. 1. The effect of the phase of the induced current in the parasitic element on the gain and directivity of the array is shown in Fig. 2 (a), (b) and (c). The length of the dipole is not very critical and is usually cut to about 0.95 of half a wavelength, according to the diameter of the element, in order to obtain resonance. If the length, l, of the parasitic element is made about five per cent longer than a half-wavelength it acts as a reflector and the gain and directional characteristics of Fig. 2 (a) are obtained. If the parasitic element length is made equal to one half wavelength (Fig. 2 (b)) the array becomes bi-directional with equal gain in each direction. Decreasing l by a further five per cent completely reverses the directivity (Fig. 2 (c)). Hence, a total change of ten per cent in length can reverse the directivity and make such an aerial useless unless rotated through 180°. This means that a change of ten per cent in frequency will have the same effect, so that a two element array adjusted for optimum gain on the vision frequency of Channel 10 (199.75Mc/s) will exhibit reverse directivity on Channel 6 (179.75Mc/s). The array will become bi-directional, and the gain will fall by 6dB on Channel 8, although practical measurements indicate that the separation required is somewhat greater than the theory suggests. Even so, it is obvious that the Yagi array does not like working over a wide frequency band. In the U.S.A., where multi-channel television transmissions are commonplace, all sorts of technical subterfuges are used to provide some degree of wide-band operation over Band III, but the result is always a compromise. The Americans have the advantage of using a 300-ohm feeder which does increase the bandwith. It is rather pointless to go into the reason because there is very little chance of our industry departing from coaxial feeders, mainly because of the installation problems, such as the need for stand-off insulators every few feet, and so on.

Since gain and directivity of the most simple type of Yagi array is known to deteriorate, quite rapidly, with change of frequency, it is to be expected that the useful bandwidth becomes less in proportion to the number of elements employed. This means that the greater the channel spacing of two programmes the greater will be the aerial problem in the fringe area where arrays from five to ten elements are commonly employed. Concentrating, however, on the primary service area where, in general, the three-element array has proved satisfactory, it is instructive to examine the properties of a typical three-element Yagi comprising folded dipole, reflector, and director over the frequency range of Band III—that is, from 174 to 216Mc/s. The selected aerial was designed, basically, for Channel 9 vision, at which frequency (194.75Mc/s) the maximum forward gain and front-to-back ratio was obtained.

Fig 3 is a plot of the gain and front-to-back ratio from Channels 6 to 13 inclusive. During the measurements the aerial was fixed such that the line of the array pointed to the radiating source.

It will be seen that at a spacing of three channels upwards from Channel 9, that is, at Channel 12, the gain has fallen by 6dB—just halved—and while this loss might pass relatively unnoticed in that part of the primary service area nearest to the trans-

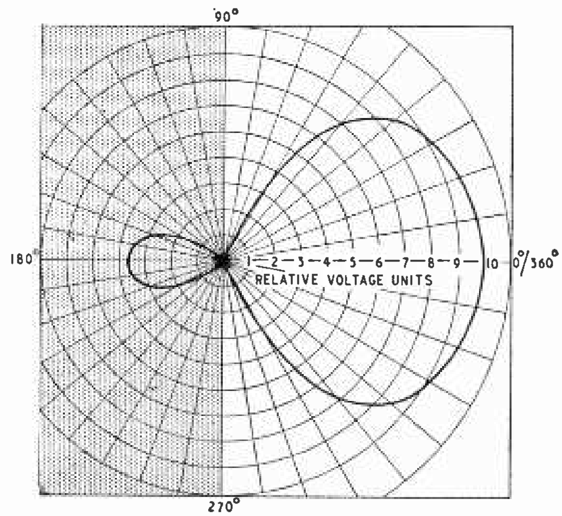
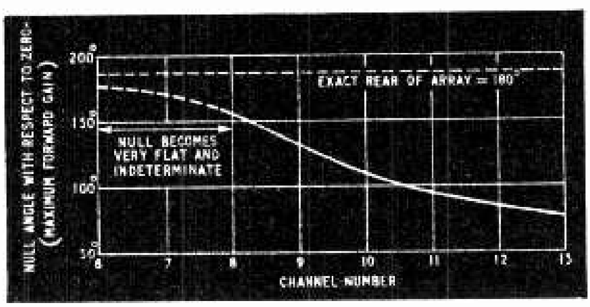


Fig. 4. Horizontal directivity of a typical three-element Yagi aerial. The shaded portion includes angles of useful ghost rejection.

mitter, say up to 25 miles, there might be quite a large sprinkling of noticeable degradation of reception at farther distances, particularly when nearing the boundary of the area. Even a spacing of two channels gives a loss of about 4dB. Statistically analysed—and that would mean hundreds of practical tests—there would be very little to choose between a spacing of two or three channels It is clear from the curves, however, that, if single-channel spacing were technically possible there would be no aerial problem so far as the local and primary service areas were concerned. This is wishful thinking in view of the earlier remarks in the article.

Turning to the front-to-back response; this falls off quite sharply with frequency so that operation two or more channels from the optimum will considerably affect the ghost-reducing characteristics of the array, and this could be serious in certain built-up areas where adequate signal strength is available to take care of any deviation from expected gain in the aerial, but a high front-to-back ratio must be maintained to eliminate ghosts.

The directional characteristic of a three-element Yagi does not exhibit a single null at the rear, nor can it be made to do so however much one attempts it by cut-and-try adjustment to the length of the reflector and director elements. In fact, it does not appear to be possible to obtain a 180° null in a two-element Yagi array (see Appendix). Fig. 4 is a typical directional response taken, in this instance, on the three-element array previously measured and, of course, on Channel 9. Very often, when eliminating *one* ghost, it is desirable to rotate the array so that the direction of the ghost coincides with one of the two nulls rather than the normal 180° position, for it is clear from Fig. 4 that greater rejection of the ghost will result by so doing. In fact, in most cases of de-ghosting this is the technique usually employed. It is very instructive to examine whether the angle of the null changes as one attempts to use the aerial away from its design channel. This is shown in Fig. 5, where it can be seen that a very considerable change in the null-



Above: Fig. 5. Null angle of Channel 9 three-element Yagi array at other channels.

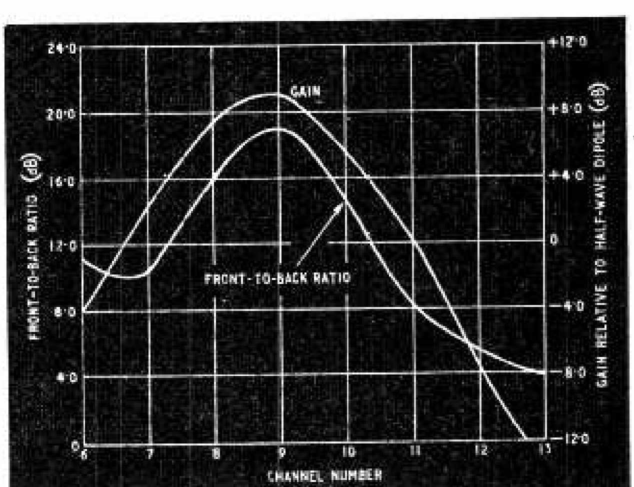
angle occurs even for operation one channel removed. In moving from Channel 9 to 10 the null moves forward by as much as 20° which would cause the re-appearance of any strong ghost eliminated on Channel 9. Three channels off optimum the null moves forward so much that it is only 75° from the position of maximum forward gain. Since the only troublesome ghosts come in from directions over the rear 180° of the aerial (shown shaded in Fig. 4), one may discount, completely, the ghost-removing qualities of such an aerial when operated two channels from the design frequency. If this sort of thing happens on three-element-Yagis it can be expected on similar arrays with more elements. Measurements confirm this, but matters are rather complicated because there are more than two nulls and a rather confusing family of curves results.

Fringe Area Reception.—It is in the fringe area that the really serious problems will be presented and Fig. 6 is a plot of the gain and front-to-back ratio of a six-element Yagi array optimized for maximum gain on Channel 9.

It will be seen that, at two-channel spacing, the gain has fallen by some 9dB on the higher-frequency side, and by 7dB on the lower-frequency side of Channel 9. This is an intolerable loss under genuine fringe conditions where the average aerial installation consists of a single or stacked pair of multi-element Yagis supported well above the house, usually on a guyed mast. One example of an area in which real fringe conditions exist is Cambridge. It should be stated that, where the array is mounted well above the highest point of the building the comparative field strength of two transmissions of equal radiated power will not vary to the extent predicted for the type of installation generally seen in the primary service area where the array is generally a few feet above chimney level, and, verv often, at gutter level. It is in these circumstances that differences of up to 20dB may be expected due to standing-wave effects. At a height of twenty feet or more above chimneys the variations are not likely to exceed 3dB except where there are large nearby structures such as multi-storeyed flats, churches, pylons, and so on. Even on the supposition of gaining 3dB of field strength on the removed channel the nett loss of 6dB would suffice to lose synchronization on a picture previously acceptable, and to produce a marked deterioration of a good picture. At a spacing of three channels the six element array is so inefficient as to be some 8dB *down on a simple dipole* on Channel 12, and 4dB down on Channel 6. Any installation engineer will know that the removal of a multi-element array, and its replacement by a simple dipole, in a genuine fringe area will result in either complete loss of synchonization or of picture. Fig. 6 also shows the rapid loss of front-to-back ratio as a function of de-tuning, and this adds to the problem of noise reduction and ghost removal.

There are two possible solutions to the problem. One is to have a second multi-element array opti-

Below: Fig. 6. Gain and front-to-back ratio of six-element Yagi array.



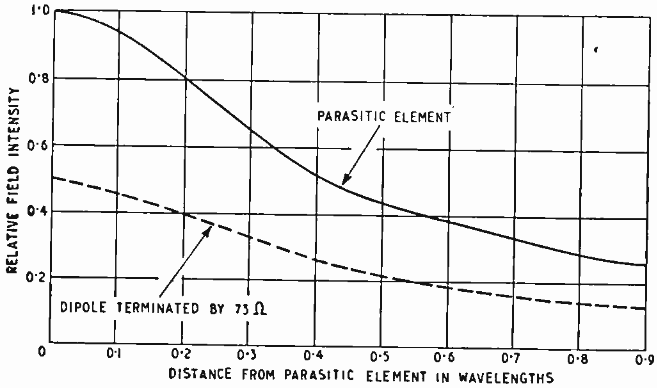


Fig. 7. Re-radiated field from resonant half-wavelength parasitic element in the absence of the main dipole element.

mized for the alternative channel and to connect it to the output of the other array. But aerials cannot be connected in parallel in the same manner as door-bells! Unless special precautions are taken the connecting circuits will interact to the detriment of both aerials, and some form of diplexer or cross-over selective filter will have to be developed to cater for the mutual isolation of two circuits whose frequency separation will be as low as 10Mc/s for two-channel spacing, and 15Mc/s for three-channel spacing. Unlike the simple diplexer used for isolating Bands I and III transmissions, some 150Mc/s apart, the new filter would appear to present some severe technical and economic problems. Nevertheless, it is a problem which must be faced because, if the second programme materializes, there will be the usual "add-on-something" period until wide-band aerials have been accepted. It is a well-known fact in the "Trade" that dealers are slow to anticipate new developments until the need becomes so pressing as to be almost chaotic, and there is nothing to suggest that this reluctant attitude would vanish overnight if some firm statement were made regarding the date of an alternative programme. There would be the last-minute rush.

The second, and technically sound, solution is to design an efficient wide-band aerial capable of providing a gain of not less than 6dB over the whole of Band III. The aerial should possess good directional characteristics and it would be desirable to combine useful Bands I and II properties. Even if this were not possible the aerial could replace the Band III section of a twin-aerial installation and be connected through the usual diplexer to the receiver. The concluding part of this article will consider the wide-band aerial together with a review of what has already been achieved.

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[1] "Radio Aerials" Chap. 5, Sec. 5.8; E. B. Moullin.

[2] "TV and Other Receiving Antenas." Chap. 9, p. 431: Arnold B. Bailey. (John F. Rider, Publisher, Inc.)

Commercial Literature

Electrical Resistance Materials; a booklet describing the properties and uses of various grades of nickel-chromium and nickel-chromium alloys, including some for use up to 1250°C. Available from Publications Department, Henry Wiggin & Company, 20 Albert Embankment, London, S.E.11.

Construction Kits by Heathkit. Illustrated leaflets describing briefly various equipments which can be constructed, including an oscilloscope, v.v.m., stereo amplifier, a 40-watt transmitter and a transistor portable receiver. From Daystrom, Gloucester.

Microphones, a pamphlet guide to the selection of Lustraphone types for particular uses, amplifying the details in the firm's catalogues. From Lustraphone, St. George's Works, Regent's Park Road, London, N.W.1.

C-Core Transformers and chokes, hermetically sealed and filled with dry air and oil, complying with Inter-Services specifications RCS214 and RCL215. Dimensions are tabulated or types with ratings from 5VA to 1600VA. From Standard Telephones and Cables, Edinburgh Way, Harlow, Essex.

Valves for Amateurs: a broadsheet of abridged data on transmitting and receiving valves and semiconductor devices. Frequency bands covered by transmitting valves are shown graphically and there is a table of equivalents. From Mullard, Mullard House, Torrington Place, London, W.C.1.

Air Surveillance Radar operating in the 10cm band with range in excess of 100 nautical miles and above 40,000 ft. Horizontal beam width of the double-reflector back-to-back aerial system is less than 1°. Descriptive brochure from Decca Radar, 9 Albert Embankment, London, S.E.11.

Quartz Crystals for frequencies between 1kc/s and 45Mc/s with tolerances of ± 0.01%. Some types in two-pin holders and others in glass valve envelopes. Also crystals for ultrasonic transducers, 100kc/s to 20Mc/s. Illustrated leaflet and price list from The Quartz Crystal Company, Wellington Crescent, New Malden, Surrey.

V.H.F. Tuners, switched and continuous tuning types; also a.m. and a.m./f.m. feeder units; and main amplifiers and control units for single-channel and stereo sound reproduction. Technical specifications and circuit descriptions in an illustrated booklet from C. T. Chapman (Reproducers), High Wycombe, Bucks.

Tape Dictating Machine weighing only 7½lb, with accessories available including foot control unit, stethoscope-type headset, desk finger-tip control unit and converter for operating from 12V d.c. power. Leaflet from Lee Products (Great Britain), Elpico House, Longford Street, London, N.W.1.

International Instruments Show

INSTRUMENTS from 55 manufacturers in 10 countries (see list) will be included in the 5th International Instrument Show being organized by B & K Laboratories. The exhibition is to be held at the Instrumentation Centre, 4 Tilney Street, Park Lane, London, W.1, from April 6th-10th. It will open on the first day at 11.45 and on subsequent days at 10.0 and closes at 7.0 except on Wednesday (April 8th) when it will close at 9.0. Application for free admission tickets should be made to the organizers at 4 Tilney Street, W.1.

Austria: Ludwig Siebold.
Denmark: Bruel & Kiaer, Danbridge, Disa Electronic, Struers Chem. Lab.
France: Jobin et Yvon.
W. Germany: Belzer-Werk, Deutsche Elektronik, Dynacord, Hackethal, W.T.W.
Holland: Peekel Laboratories.
Italy: Lares, Veam.
Sweden: Elema Schonander, Gustaffson, Sivers Lab.
Switzerland: Metrohm, Muller-Barbieri, Vibrometer.
U.K.: Advance Components, Avo, G. & E. Bradley.
U.S.A.: Ad-Yu Electronics; All American Tool Co.; Allen-Bradley; ASCOP; Audio Devices; Bourns; Branson Instruments; Burroughs Corp.; DeMornay Bonardi; Electrical Industries; Electronic Speciality; El-Tronics; Epsco; Hoffman Electronics; Huggins Laboratories; Hughes Aircraft; Kay Electric; Krohn-Hite; Micro-Power, Nuclear-Chicago; Pacific Semiconductors; Polarad Electronics; Polytechnic R. & D.; Precision Instruments; Raytheon Manufacturing; Sage Electronics; Sprague; Tape Cable Corp.; United Electrodynamics; Valor Instruments; Waterman; Weinschel Engineering.

Time Future — TELEVISION AND TRANSISTOR

By P. P. ECKERSLEY, M.I.E.E., F.I.R.E.

In two previous articles the first Chief Engineer of the B.B.C. has given an account of the early days of wireless communication and the development of sound broadcasting, with which he was intimately concerned. In this concluding article he gives his views on the growth of television and the technical and social impact of telecommunications in the years to come.

"THE Idiot's Lantern"—"A window opening upon the sentient world"—"Hamlet in a boot cupboard"—"A means to teach Democracy the art of being ruled"—"The ruin of the art of the film"—"Education's greatest boon"—"The ruin of Education"—"The refiner of man's mind, taste and manners".—"My dear! In the flats where Amanda has to live *everybody* has one. My dear! The *noise* and the *people*".—"We've given the old Duchess a television set and she loves it—except that Harding person".

Indeed, television provokes disparate opinion. It washes over the population night after night. Does it wash away the dross and so sharpen outlines, or does it ossify, thus cramping movement?

We remember the House of Lords in its finest hour; ancestral voices prophesying national disaster and ultimate degradation if we dared to let television come under the same kind of control as does "The Free Press of Democracy". We remember and wonder and sometimes we believe that the debate was about a truly vital issue, for television is power.

And all this because, some time in the early 'thirties, a Scotsman, the late John Logie Baird, said, in effect: "We now have the light-sensitive cell, we now have the thermionic valve, *ergo*, we now have television". But let it also be clear that Professor A. A. Campbell-Swinton, in a letter to *Nature* dated June 18th, 1908, described how a television service might be consummated. He proposed using a cathode ray tube with electromagnetic scanning coils for both transmission and reception. The scheme was more fully described by him on November 7th, 1911, when he took up the subject again as a basis for his Presidential Address to the Röntgen Society. The camera tube was to consist of a mosaic of photoelectric cells, thus, in principle at least, anticipating the Zworykin iconoscope and the Emitron camera.

I saw a good deal of Campbell-Swinton when television was first mooted; he was singularly modest, reticent even about his original proposals; he praised Baird for his insight, meaning his realization that, while the basic idea of television might not be new, nevertheless the instrumentality was ready to make it practicable.

Baird stood above his contemporaries in imagination, but, as events proved, below them in knowledge. Baird's first crude demonstrations stimulated the whole technical world to tackle the problem of producing a worthwhile service; in a few years the brains and resources of the big companies transformed those flickering images of the first demonstration into acceptable moving pictures.

I was truly sorry for Baird. He was, in my opinion, "fooled to the top of his bent"—told by a sensation-boosting Press that he was the world's greatest technical genius, that he stood head and shoulders above his contemporaries, dazzled by the prospect of millions of money, he was induced to "go it alone". Earlier than he did Baird ought to have gathered about him physicists, technicians and such, who, using the money so freely available would, without doubt, have built up a Baird system at least in no way inferior to those developed later on by the big companies. At last, but not soon enough, the Baird company did engage the services of one of the pioneers of broadcasting, the late Captain A. G. D. West, who eventually produced the Baird system. Readers will doubtless recollect that, in the early months of the Television Service in 1936, the B.B.C. put this system into service in parallel with another devised by the Marconi Company and E.M.I. and this other was the only one to be retained.

A recollection of Baird is of him throwing his hands into the air, crying "Don't talk to me of sidebands!"—it was just what I was talking to him about. How fatal to hopes are the brute facts of physics.

There is a law which says that citizens may be fined £10 for leaving litter in public places; some equivalent punishment should be visited upon those who unload their guilt in public. Confession may be good for the soul but it seems to me a weakling's indulgence—so much as a prelude to a confession.

Put quite crudely the fact is that I did not want television to succeed. Why? Largely because it would interfere with plans for expanding sound broadcasting, partly because it was a suggestion from outside; it did not arise within the B.B.C. Nothing that I in fact did, or could do, retarded the development of television, my external actions were correct and logical. I was right not to encourage the Baird ballyhoo and I was right to say "show us a worthwhile picture and we will try to transmit it". In fact, a television service was started after I left the B.B.C., but even then, in my heart of hearts, I still opposed and, here is the point, in opposing I found what I conceived to be technical reasons why television could not succeed. Taking the well-known formulæ for ground wave attenuation, knowing the order of carrier frequency required for a 3-Mc/s sideband, I calculated the ground-wave attenuation and found a service area of—well, say, a mile or two in radius! I forgot, because I did not want to remember, that metric waves do not come under the same laws as those hundreds of metres in length.

I became in fact the engineer who does not want a new idea to succeed and uses what dangerous little learning he may possess to deny and to oppose. Only this once have I been on the side of the devil and I learned a humiliating lesson. I must, however, compensate this abasement by stating, very firmly, that some of my ideas have been good enough to have been turned down by official opinion. Let the reader take this not as a confession but as a cautionary tale. But in the case of television neither my opposition, more ideological than influential, nor any one else's could have stood in the way; television had to come and I was silly not to realize it.

I do not own a television receiver. This is not an extension of past prejudice, it is because of a preference for a form of life which, while it does not scorn the delights of the electronic theatre cannot find time to indulge them; there is a preference for social contacts, books, theatre, concerts and a furtive pleasure in writing unpublished verse. I have, of course, spent many evenings looking at television programmes but not so persistently as to form habits of interpretation. This may have resulted in a more objective view and therefore more authority to detached criticism.

From an overhearing of casual conversation among experts and from desultory reading I gather that many technicians and others view the future of television as brightened by colour and limned by stereoscopy. I part company with such because I believe that before these improvements can be of any real value the viewing angle has got to be larger; more simply, in my belief, today's screen is too small. I know! I know! there are all sorts of "scientific" postulates about distance and angle and eyes and so on—the sort of thing that reminds one that a law of aerodynamics proves that the humble-bee cannot fly but "the bee, not knowing this, goes on flying".

It is fascinating to see how television programme producers are automatically trying to make a virtue of necessity, adapting their technique to this limitation of the small screen. The camera seems to be forced to convey its message by a successive showing of the detailed mosaic of the pattern rather than, as on the theatre stage, the pattern itself and by itself. In television emotion is, as it were, conveyed by a series of shots, first the tensity of the heroine's right toe, next the twitch of the nose, next the crook of a finger. The camera fidgets and this fidgets me.

It is rewarding also to see my theories about presentation again confirmed, this time in terms of television. The producer does his best to make a virtue of the necessity of the small screen but, to my mind, there is too little virtue because too little screen!

But even supposing the screen were larger, would colour make such a revolution as some would have us believe? We must not forget the extra cost of a colour receiver. Imagine when colour was first introduced to the cinema that picture theatres showing coloured films had charged extra; how many would have counted the cost worth while? We have seen black and white films that lifted us out of our seat and, even at N. Kalmus' orchidaceous best, others that sent us somnolently back to it. And think again when you have seen a film and someone asks you, three days later, was it in colour? You may find it hard to answer. Was it good? Your answer comes pat.

Again, stereoscopy—is it needed? Again, the cinema; 3D died; possibly those spectacles discouraged it, but that showed that they did not greatly benefit the spectacle.

If, however, the screen were enlarged then I believe that what are now more in the nature of stunts, what might be no more than palliatives for poor programmes, could be of benefit. First things first, and to me the big screen is a paramount necessity. (No advertisement intended.)

So far I may have revealed a grudging attitude towards television, it might be thought that an original prejudice lingers on and produces these curmudgeonly phrases, these half admissions. Maybe the impression may be so, but to oppose it let me quote what I wrote some twenty years ago when television was in its initial stages and when its future was uncertain. This, or something very like it, is what I wrote:

"Even as I run my eye down the titles some have changed, showing that a new item has superseded the old. Apparently I have missed a Choral Symphony from Moscow, but I can still watch "How it Works" in which I have a particular interest. So I lower myself into a chair and press the appropriate button on a remote control panel placed conveniently beside me. The voices accompanying the picture displayed on the screen 10 square feet in area are suddenly in the room, startling in their naturalness. A bit loud, so I reduce them with the volume knob under my hand. I must get my dinner soon or I shall miss the première of a new English comic opera called "Reading from Left to Right", otherwise I would stay to see the end of the tennis. But I shall get the results in my house newspaper tomorrow. This will be printed, while I sleep, by a machine in the lobby. Not a hint of background noise or spots on the picture spoils the programme and the sound quality is so lovely that reproduction criticizes every detail of the playing and speaking."

How do I pay for all this? I don't know. This is a dream not a nightmare. It's a whale of a dream!

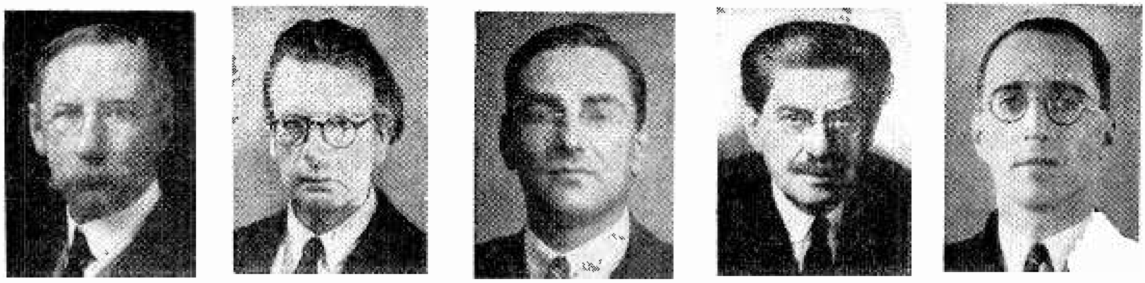
"I have a dream about the future. I see the interior of a living-room. The wide windows are formed from double panes of glass, fixed and immovable. The conditioned air is fresh and warm. Old-fashioned people would feel uncomfortable without the fire and fireplace, others might miss the raucous brown box we used to call 'the wireless.' But flush against the wall there is a translucent screen with numbered strips of lettering running across it. These are the titles describing the many different 'broadcasting' programmes which can be heard by just pressing the corresponding button.

"I glance down the list. Obviously programmes of the same sort are grouped together. The music group includes Scheherezada, Rimsky Korsakov (London), Beethoven's Ninth Symphony, Kosterkovitch conducting (Moscow). Then some lighter music: Waltz Time (Vienna), Sea Pieces, Macdowel (Manchester). Lighter still we come to Jazz Festival (Los Angeles) and the Harmony Hitch Hikers (New York). Talks break out more seriously: The New Farming (Norwich), The Severn Barrage—Special Reporters interview President Inst. Civil Engineers (London).

"Television programmes are set apart. I can, if I like, see the repeat of an old favourite, 'The Importance of Being Earnest' or 'Men's Semi-Finals, Centre Court, Wimbledon' or 'How it Works' (children).

Surely the future, as I adumbrate in the quotation, is possible, but it would be lazy not to discuss, in broad terms, what will be the means to what I believe to be a so desirable consummation.

Speculations about the future of anything, let alone technology, are bedevilled by political uncertainties. Will the nations continuously rave or will it dawn upon the Big Boys that "peace-loving" means more than a propaganda gimmick, that it is a state of being? Regardless of nationality, I mistrust the Big Boys; as a young man I was asked



An inevitably invidious selection of photographs of some of those to whom we owe the inception of the world's first television service. Reading from left to right: A. A. Campbell-Swinton, J. L. Baird, A. G. D. West, I. Shoenberg, A. D. Blumlein.

to join in a war to end all wars, twenty-five years later my children were told to join another which, so it would appear, was fought to end all peace. Perhaps the failure of the aims of the former will be compensated by an equal failure of the apparent aims of the latter; let us assume so and get on with predictions about a peaceful future.

We are familiar with international programme exchanges, my prediction for a peaceful world sees a notable increase in their quantity and quality.

The reproduction of programmes brought to us from overseas is usually comparatively poor when the international link is formed by long-hop radio (what would be likely to be called by today's word-spinners suprahorizonal transmission). This use of the ionized layer as a wave reflector has the disadvantage of introducing differential fading of the sideband components and even though the improvements due to single-sidebank working are remarkable, the result is just not good enough when compared with "local" reception. For this reason I predict that, as and when they become available, the broadcasting organizations will make use of ocean cables for inter-continental programme exchanges. For overland communication it will be either cable or line-of-sight radio; depending upon economics.

In other words, the future of international broadcasting will be modelled on present systems for national broadcasting. The post and telegraph administrations of the world are building and will continue to build their own national networks and will collaborate in setting up international links; the world's broadcasting organizations will use these facilities, as they do today; but the facilities will be expanded and perfected.

Before we leave this question of how the world's national communication systems may be internationally linked, it is interesting to observe that this could be done without the use of ocean cables; it could, in fact, be done by means of line-of-sight radio stations. I leave my readers the fun of studying the globe and finding paths, never longer than line of sight between islands, which would link the world. Anchored ships not allowed! I have not tried to solve the puzzle, but I am told it is solvable—remember, copying Chesterton, the way we linked up Spitzbergen by way of Cape Good Hope.

In dismissing the long-hop radio from my future it would seem that I could, *inter alia*, dismantle Daventry and still the Voice of America. The value of these "overseas services" is equated to two alleged benefits, namely (a) propaganda, (b) keeping in touch with the expatriate. Postulating that before long we shall be plunged into a world-shaking peace, "propaganda" in its nasty aspect is unnecessary; postulating an international network, the expatriate will enjoy his contacts with "home" from a "local" source not by a fading and often noise-drowned signal.

Go back to my dream of the future with its big screen and its multitude of programmes then propaganda in its acceptable aspects is clearly manifest; anyone anywhere can chose not only the offerings of his own nationals but those of the civilized world. Nation unto nation *shall* speak peace if my dream were to come true. Incidentally referring to today's propaganda in its nasty sense, I often pose myself these questions; if it is really potent then is it not jammed? If it has little value and is therefore not jammed what is the good of it?

Thus my dream of time-future must now be clear; a multi-frequency service devised from a network that spans the world and brings to the citizens of it, by wire or radio (depending upon which serves the needs of good quality the best), local, national and international sound and vision programmes immediately available by the pressing of a button.

I doubt it requires any miraculous invention to allow the evolution I envisage to take place. The bigger picture, colour, and a wide choice of programmes, all demand "frequency," meaning a transmission medium which will carry a wide gamut of frequencies and give substantially equal attenuation and low noise level to the components within it. Clearly the mean frequency within the favourable gamut must be higher than that used for either v.h.f. or television today. If radio transmission on these extreme high frequencies were to be used, then reflections, refraction and blind spots would make the service, to say the least, hazardous. No! I must return once more to my conviction that, in some way or another, the network that will serve the households of the future will be essentially conductive. Maybe the waveguide will be developed; it appears to hold fascinating potentials for a multi-channel system. Recent developments in pulse-code modulation indicate that the bugbear of noise may be squashed (that is if a bugbear is the kind of bug that can be squashed).

It is further certain that the transistor, when it and its associated components are made more reliable than they are today, will be of enormous assistance in building up these networks, whatever their ultimate form. The essential advantage of the transistor is its power efficiency and, in time, will be its durability. Clearly the power economy offered by the transistor will benefit the ocean cable in the sense that it will reduce repeater spacing and so permit a greater message capacity—meaning more telephone channels, a better transmission of pictures and so forth.

I used to hymn the valve with

"Hither bring in one content
Anode, grid and filament."

No rhyme occurs to me when the reason for the transistor is so clear.

There are, however, times when I could wish the facilities that the invention offers could be more discreetly used. Lying upon a Mediterranean beach last year the beneficence of sun and the soothe of sea were, to say the least, undermined by the squawk of portables made more portable by the use of semiconductors. The very fact that the transistor allows so much to be contained in so little forces the designer of the portable to use those very minor loudspeakers which in their outpouring commit a major nuisance. This by the way, the rough with the smooth, one expects in time to get a reasonably priced receiver giving good quality without the intromission of mains hum, believing that a battery would supply sufficient, because silent, power.

Some rule limiting the power output of all sets installed in flats or attached or semi-detached houses would receive my unqualified support. About an eighth of a watt would be a fair maximum. There is another solution and that is to build proper sound insulation into houses and flats—why dream?

Why dream? Because dreaming is the way to reality. But once one starts speculation about time-future dreams may become so vague as to be hardly worth recording. Maybe this already applies to what I have written; for fear of piling Pelion upon Ossa it is time to leave off.

May I nevertheless be forgiven if, in a few concluding paragraphs, I pull out the Vox Humana stop and tread rather sentimentally upon the pedals? I hope for forgiveness because I suspect my sincerity will be obvious.

It is my belief that the pursuit of happiness is man's sanest occupation. But by happiness I do not mean the facile escapisms of lounging and leering, of passivity and conformity, I mean the term to be related to creation, making things, be they material or of the mind.

To be thus creative within the ambit of science and technology can be a pure delight, in one sense a lazy delight since it is certain that one's opponent, matter, will never make a mistake. In human affairs more subtle considerations apply, the manœuvres of politics, management, diplomacy and so forth face incalculable human factors; the administration of justice is guided by criteria which are mutable. In its behaviour matter is timeless, its resistances once overcome are for every subdued. But it is this very characteristic of predictability upon which the intellectual satisfactions of scientific discovery and technological invention is founded. There is an exquisite satisfaction in mastering a problem, of seeing the symbiosis between mathematical analysis and experimental verification.

I often wonder whether today's engineer is aware of what a fund of pleasure he can draw upon; when I see the rush, as bell or blast signals the end of the day's work my wonder turns to commiseration. Or do I mistake the impulse? Do many, as I do, live with their problems, take them to bed, bath and train, and there, or anywhere fight them to submission?

Such sentiments about the delights of labour must not be taken to imply a rejection of leisure; on the contrary "all work and no play makes Jack a dull boy." I count holidays, and the full enjoyment of them by a complete rejection of work, the most potent means to get work well done. Indeed I often wonder if the foundation of happiness is not to treat work as most treat their hobbies and hobbies as most treat their work. Leisure does not imply just slacking about, its true value is the opportunity for a change of occupation. That occupation, even on a sun-lit beach, may still consist of a survey of the wide champaign of thought.

Yes! It can all be such fun, so gay and, be it stressed, not so deadly serious a matter as some appear to consider it. Immersed some rainy afternoon in a warm interior confronted by a new circuit, a new device, pricking out a graph, watching the needles of the instruments, surely the Lab is "Paradise enow."

If the speculations about possible futures that I have sketched in the foregoing fail to materialize then they will ascend to the limbo of the departed spirits of idealists—good company I feel. If, in degree, they prove sound then it will be because of the work of engineers who find more to do than just solve problems, who see beyond technological barriers and—by breaking them down—desire to add something notable to, at least, human convenience, at most human happiness.

The more likely rewards lie in the field of broadcasting which, with the guidance of men of good will, can become, increasingly, a teacher of tolerance and an instructor of good living. If broadcasting can continue to fulfil such a destiny then some of us, who, many years ago, dreamed possible futures and made them in part come true, may feel a measure of thanks for the opportunity and a measure of satisfaction in making use of it. But there is much more to be done; we who began hope it will be well done and therefore done in the mood of gaiety and enthusiasm without which nothing can be well done.

Books Received

Theorie der Spulen und Ubertrager by Richard Feldtkeller. Third edition of a treatise on coils and transformers with high-permeability cores. Pp. 187; Figs. 142. Price DM 24. S. Herzel Verlag, Birkenwaldstrasse 185, Stuttgart, N.

Electronic Circuits, by E. J. Angelo, Jr. Presents a unified treatment of circuits incorporating valves and transistors. Part of a comprehensive revision of courses in electrical engineering at the Polytechnic Institute of Brooklyn. Pp. 450; Figs. 561. Price 70s. McGraw-Hill Publishing Co., Ltd., 95, Farringdon Street, London, E.C.4.

Basic Electronics, by Paul B. Zbar and Sid Schildkraut. Second edition of a laboratory manual for the training of radio and television technicians sponsored by the Electronic Industries Association (formerly R.E.T.M.A.). Pp. 148; Figs. 118. Price 17s. 6d. McGraw-Hill Publishing Co., Ltd., 95, Farringdon Street, London, E.C.4.

Propriétés et Applications des Transistors, by Jean Pierre Vasseur. Essentially a practical treatise for engineers and advanced students, with a basic knowledge of radio techniques. Equivalent circuits and design formulæ are derived in all cases. Pp. 479; Figs 308. Price, 5,540 fr. Société Française de Documentation Electronique, 12, rue Carducci, Paris, 19.

Long Distance V.H.F. Reception

Observations and an analysis of the Causes of Interference in Band I

By H. V. GRIFFITHS, M.B.E.*

THE B.B.C. technical receiving and measuring station at Tatsfield has been observing over a wide band of transmission frequencies for many years and it numbers among its duties those of reporting upon ionospheric and other propagation conditions, and of identifying all signals likely to cause interference with B.B.C. transmissions. Radiotelephony from U.S.A. on v.h.f. was first observed in 1936 and U.S.A. radiotelephones have been logged in increasing numbers in the periods of maximum solar activity since then. A different mode of propagation has produced reception over shorter but sizeable distances, from places such as Warsaw and Western U.S.S.R., from which recognizable television has been displayed and the sound signals identified. A third mode of propagation, when it is evident, brings in West European broadcasts at fair strength, although they may normally be very weak or inaudible at other times.

It is hoped that the summarized results from post-war Tatsfield logs and reports may be of interest in showing the temporal variations in propagation by the three modes, but it should be understood that reception as indicated here does not differentiate between signals of widely different strengths, some very weak. Thus, a number of days of reception obtained at Tatsfield from distant stations does not necessarily indicate that interference with B.B.C. transmissions affected television viewers; the strength of the distant signal or the time of day it was heard may not have been "favourable" for actual interference to have been experienced, even in parts of the B.B.C. Service Areas receiving the lowest B.B.C. field strengths.

Another point of some importance is that the "intensity" of the sunspot maximum phases, characterized by the numbers of active sunspots, varies considerably in different cycles: the two maxima centred on the years 1947 and 1958 have been very intense but others recorded by observations (e.g. 1927) were much less so, in which conditions the probability of long distance reception in Television Band I would be small.

Modes of Propagation.—Three distinct modes of propagation are involved. These are:—

Ionospheric F-layer propagation over distances of several thousand miles in the sunspot maximum phase during the autumn-winter seasons. The highest frequency received has been 60 Mc/s.

Sporadic-E propagation over distances up to 2,100 km (1,300 miles approximately) occurring mainly in the summer season. There is some evidence that it may tend to occur more frequently towards sunspot minimum. Sporadic-E ionization occurs often in the form of large "clouds" in motion and there may be several reasons for its formation (see below). The highest received frequency has just exceded 70 Mc/s.

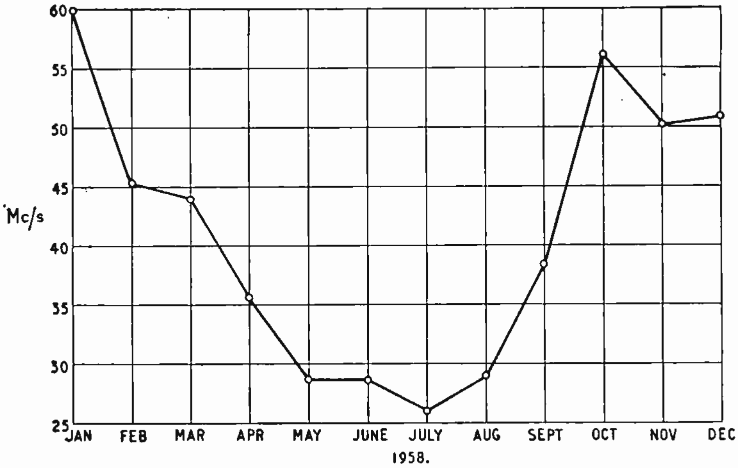
Tropospheric propagation over distances not usually greater than 900 km, 550 miles approximately (generally less). It occurs in weather conditions of high barometric pressure and still air (anticyclone). The terrain of the path must usually be fairly flat land or sea water, and the limits of propagation are often defined by high ground or mountainous country.

Occurrence of the Ionospheric-F Mode.—Ionization controlled by solar activity and varying in intensity with the sunspot cycle reaches a recurrent maximum at 11-year intervals; in the 19 sunspot cycles recorded by observatories since records began in 1749, the average duration of the cycle has been 11.1 years, with the longest period of 13.6 years and the shortest 9.1 years. The intensity of the maximum activity has also varied in different cycles over a quite wide range of sunspot "counts." Previous and present maximum phases occurred in May-June 1947 and February-March 1958 and these were very active, "high" maxima. In years about these high maxima, the practical maximum usable frequency (m.u.f.) for low wave-angles reaches the 40-Mc/s band during the *seasonal*, daytime peak period between the autumnal and vernal equinoxes, and on the days of highest activity in which the m.u.f. may be 10% or more above the average value for the month, frequencies up to 60 Mc/s may be receivable in the U.K. from North America. It is in these coincident conditions of high sunspot activity and high seasonal m.u.f. that reception may extend in the v.h.f. band below 60 Mc/s over the North Atlantic from U.S.A., and interference from this source with B.B.C. Television may result.

As yet, interference by this mode of propagation has been from North America and Canada only but this is probably because the number of v.h.f. transmissions originating from there is very large. U.S.A. signals in this band were first heard at Tatsfield in 1936, then more commonly in 1946-1948 and even more so in 1956-1958. Other signals, from West-Central U.S.S.R., have also been noted and, with possible increased use of Band I for high-power transmitters in East Europe, Asia or Africa, these paths may also contribute to interference in the future.

Previous (1947) *sunspot maximum.* The solar maximum phase was one of the two highest recorded to that date but was nevertheless lower than the 1958 maximum. In comparing the 1947 phase with that of 1958, it should be remembered that the number of transmitters in U.S.A. operating in the 40-60 Mc/s band was smaller in 1947 and the observations made at Tatsfield were also more restricted in man-hours, since B.B.C. Television was

* B.B.C., Tatsfield Receiving Station.



Highest received frequency per month from north and central U.S.A., north of latitude 30° N.

at an earlier stage of its development Nevertheless, reception was then recorded as follows:

Year	*Months—Days*	*Total days*
1946	Feb. (1), Oct. (1), Nov. (1), Dec. (2)	5
1947	Feb. (1), Oct. (1), Nov. (6) ..	8
1948	Feb. (1), Oct. (2), Nov. (2) ..	5
1949	Feb. (2)	2

Present (1958) *maximum.* The v.h.f. part of this phase has obviously not yet passed, although there will be a *seasonal* decline in the m.u.f. during the spring-summer months of 1959. Certainly, the 1958 maximum is unique in having the highest sunspot numbers ever recorded. The shape of the sunspot activity curve is commonly asymmetrical about the peak value, and previous cycles with a high maximum have usually shown a steep, rapid rise with a somewhat slower decline. Thus, it may be expected that the seasonal decrease of the m.u.f. will continue through the next few months but there may be a recurrence of long-distance v.h.f. reception in the 1959-1960 winter period. The data below is factual for the years 1956-1958, with estimates for 1959/1960 which may, of course, prove to be incorrect, since they are computed from the expected future trend of the solar cycle.

Year	*Months—Days*	*Total days*
1956	Mar. (7), Sept. (1), Oct. (12), Nov. (16), Dec. (26)	62
1957	Jan. (16), Feb. (5), Mar. (5), Sept. (2), Oct. (12), Nov. (21), Dec. (23)	84
1958	Jan. (28), Feb. (14), Mar. (2), Oct. (10), Nov. (27), Dec. (18) ..	99
1959*	Jan. (16), Feb. (9), Mar. (2), Oct. (9), Nov. (15), Dec. (15)	66
1960*	Jan.-Mar. (12), Oct. (18), Nov. (10), Dec. (12)	42

* *Estimated figure*

Note: The days of long-distance reception enumerated above include a proportion in which the signals were possibly too weak to cause significant interference to most B.B.C. viewers, other than those at the limits of normal B.B.C. reception.

Interference from "Forward-Scatter" Signals in the I.F. Band.—This should not be confused with the direct r.f. signals mentioned above, although it reaches the receiving aerial by ionospheric propagation and its occurrence is approximately concurrent with a proportion of the U.S.A. reception periods noted. It arises in the necessarily economical design of some television receivers, from inadequate selectivity against "break-through" of undesired signals using frequencies standardized in U.K. for intermediate frequency amplification. The recently standardized i.f.s. of 34.65 Mc/s (vision) and 38.15 Mc/s (sound) have since become actively used by high-power transmitters with measured r.f. field strengths in U.K. that at times exceed 2 mV/metre in winter afternoons in 1958. In these conditions, break-through may occur in some types of television receivers tuned to the lower channels in Band I but it can be reduced or eliminated by fitting an inexpensive, additional i.f. rejection filter in the aerial input connection to the receiver.

Sporadic-E Layer Propagation.—Reception over medium distances, between about 900 km (550 miles) and 2,100 km (1,300 miles) approximately, is at times obtained by refraction at about E-layer height or somewhat above, by "clouds" of ionization formed sporadically. Several reasons for the formation of sporadic-E have been proposed, including meteoric and cosmic ray bombardment, and by interactions from charged, cumulo-nimbus, "thunder-head" clouds, themselves at lower atmospheric levels. Each of these initiatory processes may contribute to the observed effects in reception: the "thunder-head cloud theory" has some support here since a proportion of sporadic-E effects seems to occur in conditions of hot, thundery weather in Europe. This type of sporadic-E reception is sometimes preceded, followed or is concurrent with tropospheric effects at higher frequencies, e.g., in Band II over shorter distances.

The incidence of sporadic-E interference is less predictable than the long-distance ionospheric-F propagation. There seems to be a tendency for it to occur more frequently in the years of only low or moderate sunspot activity† but it is commonly observed in summer each year, and in the peak years it has been experienced in the spring and autumn periods also.

Signals in the television Band I, propagated in this manner, have been identified from Central Europe (e.g. Poland, Western U.S.S.R.), the Central Mediterranean (e.g. Italy) and Black Sea U.S.S.R. regions. Besides the fundamental-frequency inter-

† The inverse relationship between atmospheric ionization and sunspot activity has recently been discussed in greater detail by E. P. Ney in a letter to *Nature*, February 14th, 1959, p. 451.—ED.

ference, there have also been numerous cases of strong harmonics from U.S.S.R. short-wave transmitters being audible in Band I. It should be noted that propagation from U.S.S.R. can occur at various times by refraction at F- or at E-layer heights, but that the supposed sporadic-E reception has mainly been logged in years of fairly low solar activity.

Observed Sporadic-E reception. Prior to 1953, the times allocated for v.h.f. reception and the listening facilities at Tatsfield were more restricted than they are now but signals were logged as follows:—

Year	*Months*	*Total days*
1949	June to Aug.	11
1950	May to Aug...	4
1951	May to July	4
1952	June and Aug.	3
1953	May to Aug...	19
1954	Jan., April to Aug. and Oct.-Dec. ..	45
1955	Jan. to Oct. Maximum in June to Aug.	86
1956	Mar. to Nov...	30
1957	Feb., Mar. and May to October ..	48
1958	June to December	34

Tropospheric Propagation.—The propagation of v.h.f. signals much beyond the radio horizon has been correlated with weather conditions, such as those producing "temperature inversion" or stratification, usually associated with high barometric pressure and still, windless air.

The most favourable periods for these conditions are usually in the months of January, June, July and August, but they can occur in other months. It should however be noted that the increase in strength, or abnormal reception, of v.h.f. by this mode of propagation is commonly selective in distance and to some extent in signal frequency: thus, a strong signal may be received at one place on one frequency but not necessarily at another not far-distant place, or (from the same station) in different v.h.f. band.

The number of Continental stations transmitting in Band I, at distances and over terrain likely to propagate to the U.K. tropospherically is not as great as in Band II. The principal signals in Band I originate in Holland Belgium, Northern France, Denmark, Norway, Sweden and (rarely) West Germany. Reception in this band over broken country from more distant countries such as Poland, Czechoslovakia, Italy, etc., is probably *not* tropospheric. When tropospheric reception occurs in Band II, in which stations are more numerous, there may be associated longer-distance reception in Band I that is seldom observed at Tatsfield, but may be more common in Northern U.K.

Observed tropospheric reception in Band I.—Cases of abnormal (tropospheric) reception noted in Band I are summarised as follows:—

Year	*Months—Days*	*Total days*
1955	Peak months May-Sept.	73
1956	Peak months May-Aug. and Sept.	45
1957	Including 14 days in July, 6 in June, 4 in Jan.	38
1958	5 days in May, 4 days each in June, Aug. and Oct. 2 days in Nov., 9 days in Dec.	28

Note: The poor summer weather of 1958 and, in a lesser degree, of 1957, is reflected above

Tropospheric reception in Band II. Days of abnormal reception, mainly in the summer months, have usually been more numerous:—

Year	*Total days*
1955	60
1956	76
1957	106
1958	74

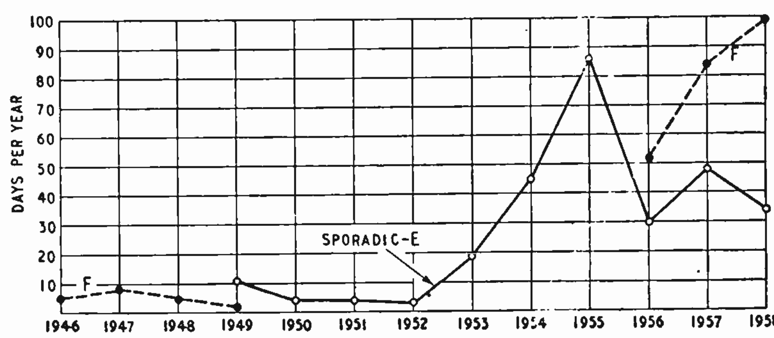
Interference with B.B.C. f.m. broadcasts is unlikely.

Conclusions.—During solar cycles of high sunspot number, in the years 0 ± 1 or so referred to the maximum of the cycle, "interference" in v.h.f. Band I is likely to occur on from 10 to more than 50 days in the year during autumn and winter afternoon and early evening periods, from U.S.A. and Canadian radiotelephones allocated frequencies in this band. On some types of television receivers, there may also be "interference" on the worst days in this period from other transmissions in the 30-Mc/s band breaking through into the i.f. of these sets, but this latter trouble can be reduced or eliminated by fitting filters at the receiver input. Future interference from other sources may possibly arise as the band becomes more commonly used. This "interference" is unlikely to affect all viewers; those in outer reception areas of Channel 1 are the most likely to detect it.

Interference from Mediterranean and East European stations can also arise by sporadic-E layer propagation occurring mainly in the summer months and perhaps more frequently in years of lower sunspot activity, with an annual incidence of from 4 to more than 50 days in the year, in the daytime or early evening period.

Interference may occur at intervals from tropospheric propagation of transmissions located in the coastal plains areas of Continental Europe during anticyclone weather conditions in any year. It is likely to be restricted to small areas of reception, mainly those near the North Sea and Channel coasts, and to be detectable at times from 30 to 70 days per annum

Acknowledgment.—The author is grateful for the assistance of Tatsfield operational staff in making the necessary observations and of R. A. Atfield and W. Hossack in assembling data from daily logs.



Observed long-distance reception by F and sporadic-E layer in Band I at Tatsfield.

Pickup for Low Record Wear

Notes on a Design to Track Within the Elastic Limit of the Record

*By J. WALTON**

IT has been the object of pickup design over the last decade or so to produce pickups that will track with less distortion to both the signal and record groove. In fact these two items to some extent go together.

Although a gradual transition to lighter and lighter tracking weights normally only gives a gradual improvement, there comes a critical point at which there is a sudden improvement with a change from permanent deformation of the groove at the first playing and considerable wear (as at present), to tracking within the elastic limit and the possibility of ending wear as we know it. Tracking within the elastic limit should also have its effect on various losses and non-linear deformations of the groove wall[1]. It also makes the reduction of stylus tip radius easier and can thus assist in decreasing tracing distortion[2]. A reduction in surface noise should occur as the wear decreases on both disc and stylus (with clean new discs). The improvement in the reproduction of transients should be pronounced.

Whilst the achievement of a pickup tracking within the elastic limit can thus be expected to open up a new vista in the world of sound reproduction, its universal usefulness will, of course, finally depend upon its "cost-availability". This factor has been considered throughout.

Effective Mass Required

In January 1955, F. V. Hunt of the Acoustical Research Laboratory, Harvard University, published the results of experiments[3] which not only show that with present-day tracking weights of 3 to 5gm we permanently deform the groove at the first playing, but also that under certain conditions the apparent stresses in the disc material could be less with a smaller tip radius.

Hunt's results indicate that a "needle force" of 1½gm on a 1 mil radius stylus might give operation within the elastic range. This means a tracking weight of 1.0gm and corresponding effective mass and compliance if the total dynamic forces are not to exceed 1½gm normal to the groove wall.

D. A. Barlow[4] considers a slightly lower figure than this is probable because of the difficulty of detecting the fine marks that would be caused in such experiments. However, a "half-thou" radius tip drawn over a flat record surface leaves a clearly visible mark if the loading is 2gm, and an "invisible mark" if the loading is 1gm! It would therefore appear that a very considerable change in the deformation of the groove and its rate of wear can be expected if the pickup is designed so as to keep the forces within such limits. So the objective was set of producing a pickup to track at 1.0gm (force of 1.5 gm maximum on groove wall) and therefore also a maximum dynamic lateral force of 1.0 gm. This pickup should also, if possible, give a high output.

Now every development project has a practical starting point no matter how arbitrary. The starting points in this one were the smallest sapphire rondel and piezo-electric crystal that were available in production, and a range of p.v.cs., nylon and metals for their inter-connection.

First of all the crystal (a twister bimorph about 0.325 in square and 0.02 in thick) was considered as being suspended freely (this will approximate to the truth at high frequencies where its inertia is most important), and consideration was given to its effective mass in relation to a driving point. Then, if the crystal is driven from a point external to its area, it is convenient in a first design approximation to consider it as turning about an axis through its centre of mass and at right angles to the line joining that centre and the driving point (stylus). It can be shown that its moment of inertia is the same for an axis that is either diagonal or parallel to the side, but since operation depends on a diagonal bend (a twist parallel

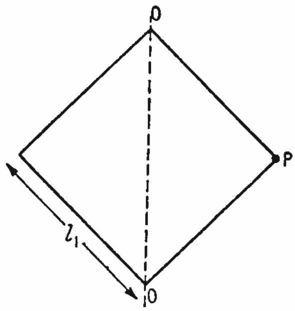


Fig. 1. Square lamina driven at one corner (P) in a direction at right angles to its plane so as to rotate about the diagonal O-O.

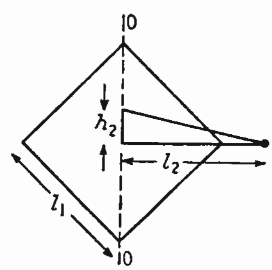


Fig. 2. Square lamina driven and moving as in Fig. 1, except that the driving point is outside the lamina and connected to it by a rigid triangular transmission arm.

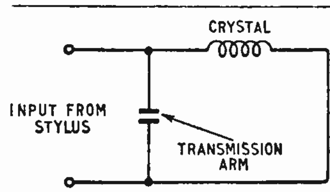


Fig. 3. Electrical circuit analogue of crystal and compliant transmission arm.

* Cosmocord Ltd.

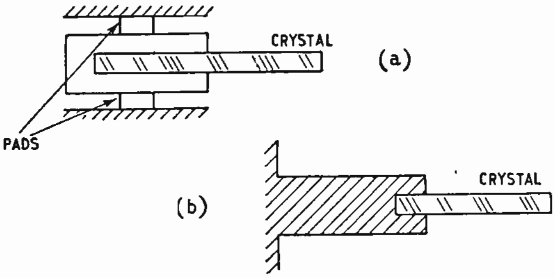


Fig. 4a Crystal supported by short " pads ".

Fig. 4b Crystal supported by long flexing arm.

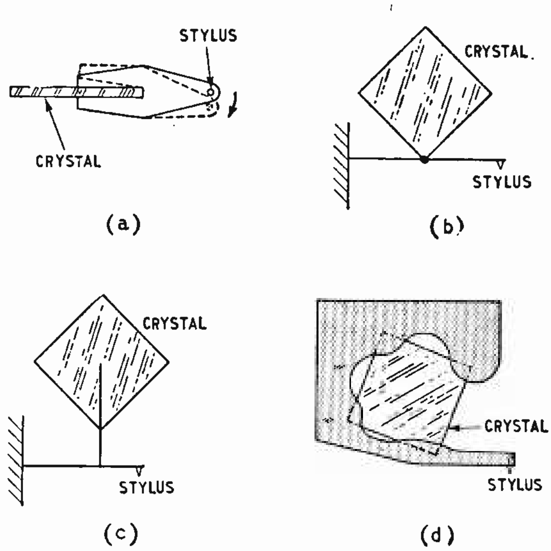


Fig. 5a A possible practical version of the crystal and transmission arm of Fig. 2. The dotted lines show how the stylus arm tends to lose contact with one side of the crystal when the stylus is deflected.

Fig. 5b A crystal and transmission arm arrangement which avoids the fault of Fig. 5a.

Fig. 5c A crystal and transmission arm arrangement similar to Fig. 5b, but in which the fault of Fig. 5a has been reintroduced.

Fig. 5d Practical version of Fig. 5b.

to one side), the most effective transmission will be along a diagonal.

Now the moment of inertia of a square lamina about a diagonal as shown in Fig. 1 is $m_1 l_1^4/12$ where m_1 is its mass/unit area, and l_1 is the length of a side. With a density of 1.7 gm/c.c. for rochelle salt, this gives an effective mass at P of $m_1 l_1^2/6$, i.e. 10 mgm.

Now for 1-gm tracking of a maximum modulation of 15 cm/sec at 10 kc/s, the required effective mass is equal to $1.0 \times 981/2\pi \times 10^4 \times 15$; i.e. 1.0 mgm, since the acceleration equals $2\pi \times$ frequency $\times$ groove velocity (neglecting the increase in acceleration due to tracing distortion). Ideally, this mass should be reduced to allow for the occasions when maximum displacement (which occurs at low frequencies and which effects the playing force through the compliance) occurs simultaneously with maximum acceleration.

It is thus necessary to try to reduce the effective mass of the crystal by finding the optimum length of a transmission arm. As a first approximation let us consider a crystal and transmission arm as in Fig. 2. The maximum width of the arm is determined experimentally according to its material. If both the crystal and arm are considered as rigid and turning together freely about O-O, then:—

Moment of inertia of crystal plus arm

$$= m_1 l_1^4/12 + m_2 h_2 l_2^3/12$$

where m_2 is the mass per unit area of the arm.

Combined effective mass at P

$$= m_1 l_1^4/12 l_2^2 + m_2 h_2 l_2/12$$

For minimum effective mass

$$\delta/\delta l_2 \text{ (effective mass)} = 0$$

$$\text{i.e. } l_2^3 = 2 m_1 l_1^4/m_2 h_2$$

which for the densities and thicknesses of usable materials gives an effective mass of 5 mgm. Since this is still insufficiently low, it is necessary to " decouple " the stylus from the crystal with a compliant transmission arm.

Compliant Transmission Arms

If we consider the system in terms of mechanical impedance at the stylus tip and convert into electrical analogues (see Fig. 3), we require a mechanical impedance at 10 kc/s of not greater than $2\pi \times 10^4 \times 10^{-3} = 60$ mechanical ohms, since mechanical impedance equals $2\pi \times$ frequency $\times$ mass. This corresponds to a compliance of not less than $(60 \times 2\pi \times 10^4)^{-1} = 2.4 \times 10^{-7}$ cm/dyne, since the mass of the crystal is relatively large. But, in any case, the compliance required to cope with amplitudes of 0.01 cm at 40 c/s at a tracking weight of 1 gm is approximately $0.01/981 = 10 \times 10^{-6}$ cm/dyne. Again, ideally this compliance should be increased to allow for the occasions when maximum displacement and acceleration occur simultaneously.

If the transmission is designed with distributed mass and compliance the required low mechanical impedance might be achieved. But before proceeding further with this thought let us consider the general configuration and what is involved in terms of production.

It is indicated that the construction must be some pliant material such as p.v.c. and experience shows that the minimization of the effects of variations in the dimensions of plastic mouldings or the fitting together of parts with production tolerances would be a useful trend in design. The following observations are made to this end.

Small variations in the lengths of short " pad " supports for the crystal can cause large variations in pressure upon them with resulting variation in performance (see Fig. 4a), but variations in the length of a flexing arm cause only proportional variations, i.e. comparatively much smaller variations (see Fig. 4b). Also, not only does the elimination of short pressure pads help consistency, but the use of long members in flexure tends to reduce non-linear movement and resulting distortion.

Also, the fit, for instance of a replaceable stylus in a transmission arm, can cause variations in the compliance of its connection. A rondel fixed permanently into the arm not only can have a connection which is considerably more rigid than the arm itself, but such a permanent fixture becomes almost obligatory if the mass of extra bushings, etc. is to be eliminated.

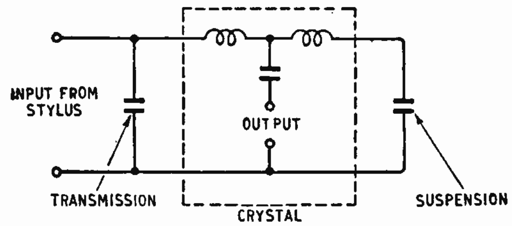


Fig. 6 Electrical circuit analogue of crystal with compliant suspension and transmission arm.

Another problem has been the resonances of individual members due to their own mass and compliance, but if mass and compliance are in fact to be distributed, as suggested above for the transmission arm, then by varying the cross section of the arm we can have a member that is aperiodic within limits and with the same compliance.

Furthermore, the transmission arm should move in the same arc as the crystal if unnecessary losses are to be avoided. The arm must also be such that its compliance is greater than can be expected at its join to the crystal, since some variation of fit is inevitable (particularly with metal transmissions). However, when Fig. 2 is translated into a practical system as in Fig. 5(a), the tendency of the stylus arm to lose contact with the crystal on one side (see dotted lines in Fig. 5(a) is found to be a less desirable feature than the uncorresponding arcs of motion of the arm and crystal in the alternative of Fig. 5(b), providing that the fault of Fig. 5(a) is not re-introduced as in Fig. 5(c). Thus, considering the above, it would appear that a possible system could be as in Fig. 5(d), a conception particularly suitable for the desirable one-piece construction.

Practical Results Achieved

At this point it may be as well to consider if there will be sufficient output from this basic arrangement. For a square crystal the output equals $10^{12}D/1700(W/T)^2$ volts, where W, T are the length of a side and thickness of the crystal respectively, and D the displacement in metres (from information supplied by Brush Electronics). If the system is without mechanical resistive loss, then considering the lowest frequencies for the first simple assessment, the displacement will be (amplitude on disc) × (crystal compliance) ÷ (mounting plus transmission compliance), since the crystal compliance is very much less than the transmission compliance. Now the crystal compliance is 113×10^{-10} W^2/T^3 metres/newton where W, T are in inches (Brush Electronics), which equals 0.15×10^{-6} cm/dyne; and the compliance of the transmission arm used is 15×10^{-6} cm/dyne. Thus for 1 cm/sec (r.m.s.) −20dB at 40 c/s, i.e. an r.m.s. amplitude of 4×10^{-6} metres, we get an output of 130mV, which for what it is worth, is a reasonable magnitude.

If the resonances of the crystal and its suspension can be arranged to be so distributed throughout the audio range that they modify the performance to correct for the recording characteristic, then a first approximation to the performance might be indicated by the circuit analogue of Fig. 6. The distribution of the main compliance between transmission and suspension assists in countering the tendency for the transmission compliance to give "drooping top." This procedure becomes akin to nodal clamping of the crystal.

At this stage experimental models were made to verify the above conceptions and lay a basis for further work.

In the beginning a rigid system was considered and an optimum length of arm deduced. Now it can be shown that this system has an optimum axis of rotation for minimum effective mass. For example, consider the excitation at P of a uniform bar as in Fig. 7.

Moment of inertia about O-O
$=M(l^2/12 + d^2)$
$=M\,(l^2/12 + [x - l/2]^2)$
where M is the mass of the bar.
Therefore effective mass at P
$=M(l/3x^2 - l/x + 1)$
For minimum effective mass
$\delta/\delta x$ (effective mass) $= 0$
i.e., $x = 2l/3$
when effective mass $=M/4$

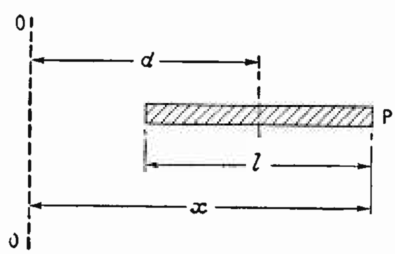
which is only 3/4 of its effective mass when pivoted about its centre of gravity.

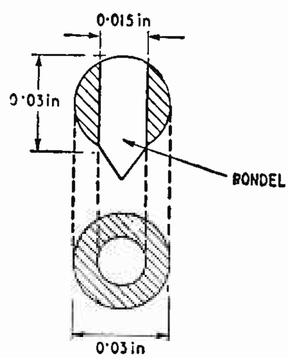
Without prolonging the argument, this principle can be applied to our system considering centres of areas of components and the effective centre of rotation of the whole, to find the best line of action through which the transmission from stylus to crystal can operate.

The transmission arm design evolved from the minimum dimensions required for integral support of the rondel to the bulk of the material required at its rear for damping the lowest internal resonance, i.e. that due to the mass of part of the internal support, transmission assembly and the whole crystal, resonating with the combined compliance thereof at about 2 kc/s.

The minimum mass of material that can be considered integral with the stylus (see Fig. 8) amounts

(*Continued on page 185*)





Above: Fig. 7 Long bar driven at one end (P) in a direction at right angles to its length and rotating about O-O (away from its centre of gravity).

Fig. 8 Material (shaded) which can be considered integral with stylus.

to just over 0.4 mgm (including rondel). The total effective mass, since the crystal is now well decoupled, is this mass plus that effectively offered by the transmission arm. The high-frequency impedance of this arm approximates to the effective mass of its front half i.e., $m_2 h_2 l_2/48$, which for this arm = 0.2 mgm. Thus the total effective mass is 0.6 mgm.

However, the effective impedance arrived at by finding the minimum tracking weight for the pickup on a measured velocity at 10 kc/s indicates a total impedance equivalent to nearly $1\frac{1}{2}$ times this mass. This is probably due to the mechanical resistance (as required for damping) in the p.v.c. and various schemes are afoot to improve on this.

In the meantime, however, a very useful development of a pickup tracking the largest modulation levels at $1\frac{1}{2}$ gm has been achieved and which has a superior performance with a brilliant attack on transients.

As is to be expected from an effective mass of about 0.6 mgm, the upper resonance of this pickup reaches 40 kc/s, since this resonance is given by $1/2\pi\sqrt{mC}$ where C is the compliance of the disc material (i.e. 2.8×10^{-8}cm/dyne) and m the effective mass. The response remains flat within 4dB to just over 20 kc/s. The output is the normal 200mV for a crystal cartridge into 2 MΩ.

Attention has been given to good tracing geometry, and also, as is so easy with this system, to correct proportioning of vertical and lateral compliances by altering the cross-sectional shape of the transmission arm. The intermodulation distortion is exceptionally low (at $1\frac{1}{2}$ gm), and experiments (rather lengthy in this case) are being conducted as to the effect on record wear.

The final form is sketched in Fig. 9. The one-piece construction not only has its effect on the possibility of making smaller moving parts and on uniformity of production performance, but also enables the cost to be reduced so that the whole pickup head can be replaced instead of merely the stylus, which is too tiny for home replacement. The stylus arm has sufficient vertical compliance to retract on the application of excessive pressure.

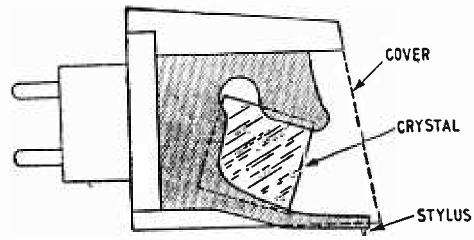


Fig. 9 Sketch of final form of pickup.

For use with this pickup it was found necessary to develop a special arm having very low side thrust and friction, and which was self-levelling and not very subiect to interference from external vibrations. The arm produced has a measured side thrust of 0.02 gm and vertical friction of less than 0.05 gm, and was found to still track without effecting the reproduction when the turntable was raised and lowered in time with the music!

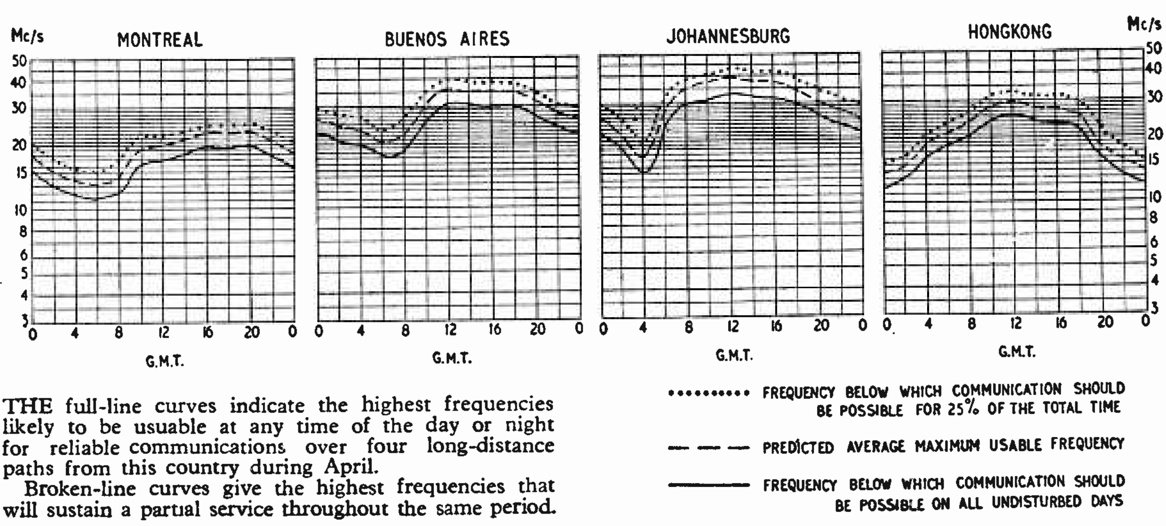
Development will proceed from the new level and any new cartridge (including a lightweight stereo) will be accommodated in the same arm.

REFERENCES

[1] O. Kornei, *Journal of the Society of Motion Picture Engineers*, Vol. 37, p. 569, (1941).
[2] F. S. Lewis and F. V. Hunt, *Journal of the Acoustical Society of America*, Vol. 12, p. 348, (1941).
[3] F. V. Hunt, *Journal of the Audio Engineering Society*, Vol. 3, p. 2, (1955).
[4] D. A. Barlow, *Wireless World*, Vol. 63, pp. 228, 290, (1957).

SHORT-WAVE CONDITIONS

Prediction for April



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

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

LETTERS TO THE EDITOR

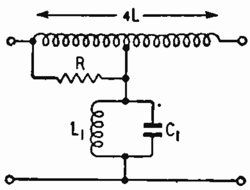
The Editor does not necessarily endorse the opinions expressed by his correspondents

"The Bifilar-T Circuit"

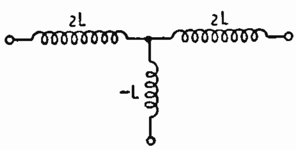
I READ the above article in the February issue with interest, though the many contortions to which the basic circuit was subjected in the course of the discussion prompted me to see if I could find a less cumbersome end-product than a lattice.

May I submit for the author's attention the following analysis of the given bifilar-T circuit?

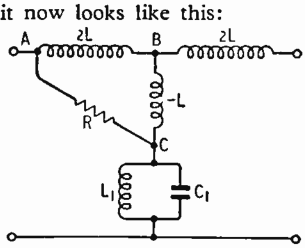
Here is the circuit:



The centre-tapped coil treated as a three-terminal net can be reduced to the following star arrangement (providing perfect coupling is assumed between the two halves of the coil):



The circuit now looks like this:

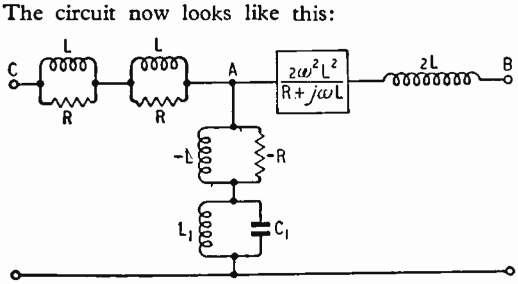


The points A, B and C now form the vertices of a delta, which can be converted to a star whose arms from A, B and C to the centre of the star have the following impedances respectively:

from A $(2j\omega LR)/(R+j\omega L)$
from B $(2\omega^2L^2)/(R+j\omega L)$
from C $(-j\omega LR)/(R+j\omega L)$.

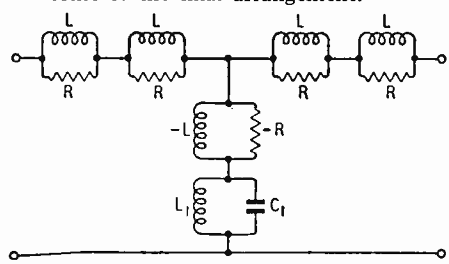
The first of these is the impedance of two coils each of inductance L, in series (uncoupled), and each shunted by resistance R, while the third is the impedance of one "coil" of inductance $-L$, shunted by a resistance $-R$.

The circuit now looks like this:

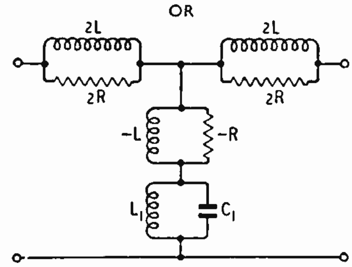


We now add the two impedances in the arm AB and get $(2j\omega LR)/(R+j\omega L)$, which is the same as the impedance of arm AC, and can therefore be similarly represented.

So we come to the final arrangement:



OR



An interesting phenomenon is that this simple T circuit is quite symmetrical whilst the original bifilar -T is apparently not so. This is readily accounted for if we recall that the centre-tapped coil 4L is a $1:-1$ transformer with perfect coupling, and so any impedances in its primary are reflected perfectly into its secondary circuit.

Having arrived at a symmetrical T, we can straightway apply standard simple formulae to derive the two primary constants, Z_0 and propagation constant, of the filter section.

The losses of the tuned circuit L_1C_1 can most easily be expressed, in this case, as a shunting resistance Z_D, the circuit's dynamic resistance. If this is possible, and R is made equal to Z_D, the impedance of the shunt arm becomes zero (causing infinite attenuation, therefore) at a frequency making the reactance of L_1 and C_1 in parallel equal to that of L, in sign and magnitude.

Saffron Walden. G. DE VISME.

The author replies:

Squadron Leader de Visme prefers to proceed by a star-delta transformation and would no doubt be equally happy to take the π-equivalent for the transformer to provide a bridged-T network which could then be reduced either by a star-delta or a delta-star operation. One of these processes was in fact used, I think, in the original *Wireless Engineer* editorial. As it turns out, the best sequence will finish up in a π-network so that end impedances can be incorporated. With the T equivalent, part of the top arms must be taken over to form filter half sections with these end impedances. This, sir, is where the shoe pinches: as I showed in my article the bifilar-T network by itself does not have the response we want in our television i.f. stage but depends very much on its interaction with the end elements. Of course, we should find this out when we applied the standard formulae for the two primary constants.

The multitudinous contortions to which the basic circuit was subjected involved very little algebra and no recourse to standard formulae. Apart from a five-inch slide rule and a copy of "The Golden Bough" I had no aids to science in the Austrian farmhouse in which I was staying. The treatment was regarded as an exercise in the solution of networks by first principles. You do not need standard formulae and they may hinder thought.

Squadron Leader de Visme calls the lattice cumbersome. Frequently, I agree, the lattice is not a satisfactory *construction* although its economy may be attractive and it sometimes offers the only practical way. For analysis, however, it has many advantages. When the lattice arms have the appropriate canonical form the cut-off frequencies of a filter are immediately apparent: with ladder networks only the frequencies of infinite attenuation can be seen at a glance. The pole-zero plots reveal immediately what kind of a filter we have and what factors determine the confluence of two bands. The Norton transformations lead us very early to the conditions for infinite attenuation.

THOMAS RODDAM.

THE differential transformer filter (with resistance cancellation) dealt with by Mr. Thomas Roddam in his article "The Bifilar-T Circuit" has interesting antecedents.

The reader is referred to the following:

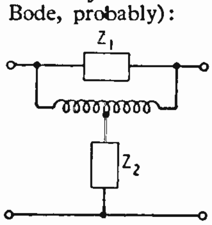
Fig. 16 of: Hendrik W. Bode: U.S. Patent 1,828,454 Oct. 20th, 1931, application dated 1st July, 1930.

A. Jaumann: "Uber die Eigenschaften und die Berechnung der mehrfachen Brückenfilter," *Elektrische Nachrichten-Technik*, Vol. 9, No. 7, 1932. Fig. 5b (actually 5a and 5b were switched around in this article, which is a bit confusing if you read it).

Jaumann says that the differential transformer filter using two transformers was disclosed in:

Riegger: German Patent 444.268, 1923.

But it seems to me that Jaumann worked out this one (independently of Bode, probably):



which is the circuit Mr. Roddam discusses in his article. E. A. Guillemin shows the same network (Fig. 48, p. 204) in his 1932 paper:

"A Recent Contribution to the Design of Electric Filter Networks" *Journal of Maths. & Phys.* (M.I.T.) Vol. XI, No. 2, 1932 pp. 151-211,

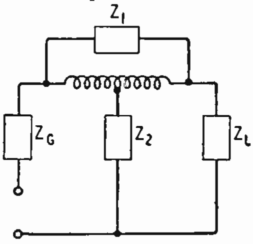
but gives no references.

O. Brune in "Note on Bartlett's Bisection Theorem for 4-Terminal Electrical Networks," *Phil. Mag.*, Ser 7, Vol. XIV Nov. 1932, pp. 806-811 attributes the network to Baerwald, and that reference is:

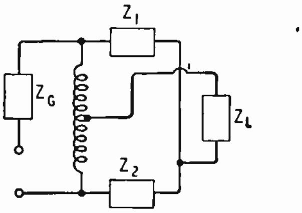
H. Baerwald: "Die Eigenschaften Symmetrischer 4n-Pole u.s.w.," *Sitzungberichte, Preuss Akad. Wiss.* Dec. 1931, pp. 781-829

Thus the use of this differential transformer circuit as a *filter* seems difficult to trace much earlier than H. W. Bode, 1930.

If one studies the complete circuit:



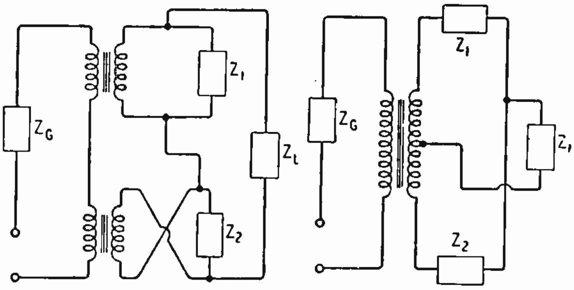
it is seen that the circuit can also be "turned inside-out":



In this shape the two impedances Z_1 and Z_2 of the first network have changed places with the generator and load impedances respectively. This circuit has also been used as a filter, especially by Jaumann.

If, in the first circuit above, a line input is placed at Z_G and a line output at Z_L the circuit becomes the familiar hybrid coil balancing circuit used in two-way telephone repeaters.

The two differential circuits shown here (both are equivalent to symmetrical bridge, or lattice, networks)



are closely related to the early differential galvanometers. Of two arrangements, closely related to these two circuits, Oliver Heaviside said in 1873:

"The great similarity between the systems of resistance measuring by means of the differential galvanometer and Wheatstone's Bridge, the latter having probably been suggested by the former, must have struck anyone who, etc."

See: O. Heaviside: "On an Advantageous Method of Using the Differential Galvanometer for Measuring Small Resistances." *Electrical Papers*, Vol. I, pp. 13-15 and *Phil. Mag.* Ser. 4, Vol. 45, April 1873.

Differential circuits are very old indeed in the shape of differential galvanometers.

They can be traced back to the older Becquerel

Ann. de Chim et Phys., Vol. 32, 1826, pp. 420-443, and Edmond Becquerel:

Ann. de Chim et Phys., 3 series, Vol. 17, 1846, pp. 242-290, and:

H. W. Dore: "Untersuchungen im Gebiete der Inductions-elektrizitat," Berlin, 1842.

Differential galvanometer circuits were referred to by S. Hunter Christie who in his Bakerian Lecture on Feb. 28th, 1833 (*Phil. Trans, Roy. Soc.* 1883, Pt. I, pp. 95-142) described the device which was most unreasonably named the Wheatstone Bridge just because Sir Charles described it, in his Bakerian Lecture, of June 15th, 1843.

Therefore, the circuit discussed in Mr. Roddam's article certainly opens up historical perspectives!

Ramstad, Norway. KAYE WEEDON.

The author comments:

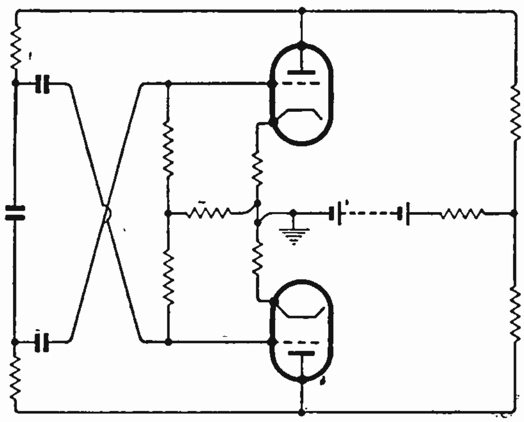
At first sight we might think that this circuit lay dormant for 80 years. In fact this was only one of the many devices which lay ready for the great work of Campbell and Zobel who considered the interaction of the network and its terminations. With the bridges we are concerned with the balance point and the load is relatively unimportant but with filters the source and the load are all important in defining the behaviour in the transition region. This fact is brought out in my article.

THOMAS RODDAM.

"Alternatives to the Wien Bridge"

IN the above article by J. F. Young in the February issue, the author states that he has found no reference in the literature to the use in oscillators of the circuits illustrated in Fig. 8 of the article.

Such circuits* were used by me in 1944 and are des-



[* One of which is reproduced herewith.—Ed.]

cribed in an article on "A push-pull resistance-capacitance coupled oscillator," published in *Phil. Mag.* in November, 1944 (Vol. 35, p. 715).

London, S.W.11. W. F. LOVERING,
Electrical Engineering Department,
Battersea College of Technology.

YOUR contributor, Mr. J. F. Young, describes several most useful alternatives to the well-known Wien bridge selective circuits in your February issue. His suggestion that the circuits Figs. 8(a) and 8(b) are more obvious than the usual arrangement appears to be borne out historically since they were, in fact, used as oscillators before the Wien bridge.

At first the C-R and R-C sections were isolated from one another by buffer valve amplifiers [1, 2] which also provided the necessary gain to maintain oscillation. Subsequently the two sections were cascaded [3] as shown in Figs. 8(a) and 8(b) of Mr. Young's article and the Wien half bridge (Mr. Young's Figure 1) was introduced at the same time.[3]

W. V. RICHINGS,
Dawe Instruments, Ltd.

[1] Lattmann & Salinger. "Über Rückkopplungsschaltungen ohne Resonanzkreise (On back coupling connections without resonance circuits)." *Elektrische Nachrichten-Technik* Part 4, 1936, p. 130.
[2] Yates-Fish, N. L., Willans, P. W. and Muirhead & Co. Ltd. British Patent No. 489,849 (Application 1937).
[3] Willans, P. W. and Muirhead & Co. Ltd. British Patent No. 497,148 (Application 1938).

The author comments:

I am grateful to the correspondents for adding to the knowledge of the history of these circuits. I understand that the Wien bridge was used in oscillators in the early 1930s, and that there is a reference in *General Radio Experimenter*, Vol. 6, Nov. 1931. The information added by the correspondents makes me even more astonished that the circuits appear to have been used so little compared with the Wien bridge.

Incidentally, I have noticed some errors in my original article. The calibration of the circle in Fig. 6 should be reversed, i.e., should increase clockwise, and in the first two lines on p. 95 the differential amplifier should be that of Fig. 4, not of Fig. 5. In the list of references, No. 11 should be *Electronic Engineering*, 23, p. 274 (1951). J. F. YOUNG.

Evaluating Aerial Performance

I WAS indeed pleased to see in the February and March issues Mr. L. A. Moxon's attempt at a "common sense" approach to aerial evaluation. Accurate evaluation of performance of a v.h.f. aerial is a difficult procedure, even for the specialists, and simple "rules of thumb"—such as remembering that the gain of an array of N half-wavelength elements will be approximately N times that of a single element—are of great assistance.

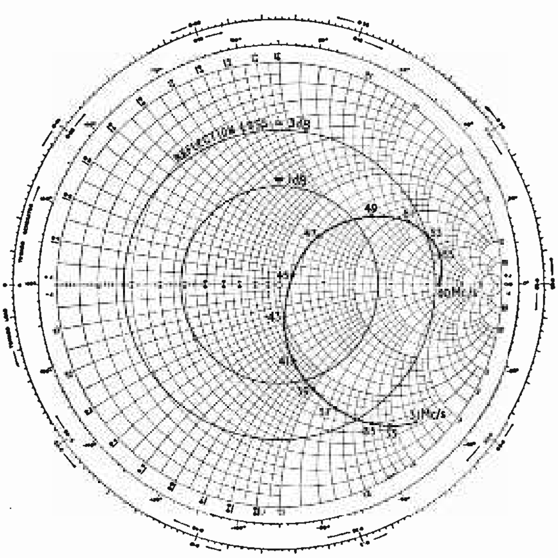
It is, however, most important that these rules be based on correct assumptions for, although they are themselves only approximate, the use of successive approximations in their derivation can easily render them incorrect to the point of being misleading.

An example of this is in the value given for the bandwidth of a Channel 1 dipole. The first assumption made in this calculation is that a thin linear dipole behaves in a similar manner to a transmission line having constant inductance and capacitance per unit length. This is obviously not true and must therefore be treated with strict reserve.[1] The approximation $X=jZ_0\cot 2\pi b$ is sometimes used to investigate the behaviour of dipole reactance *near to the first resonance*,[2] but it certainly cannot be extended to the point where Mr. Moxon suggests that radiation resistance equals reactance. Even the radiation resistance itself will have taken up a very different value from that at resonance by merely a few per cent change in frequency.

The second assumption which is made is that if the resistive component of the aerial impedance can be made equal to the magnitude of the reactive component a "3dB down" point will be reached. This is, of course, by analogy to the universal Q curves for tuned circuits where a generator of constant voltage or constant current (for series or parallel circuits respectively) is assumed. In the case of the dipole it is feeding a load, or is being fed by a source, whose impedance is made equal to the radiation resistance at resonance and a constant power must be assumed. Thus if the aerial impedance can be made R_r+jR_r a reflection coefficient of magnitude 0·45 will be obtained resulting in a loss in power transfer of only 1dB.

The accompanying Smith diagram shows the measured impedance plot of a typical commercial Channel 1 dipole, the impedance co-ordinates being normalized to 75Ω. It will be seen that the "3dB down" points are at

[1] E. B. Moullin, "Radio Aerials," p. 340 and Sergei A. Schelkunoff, "Antennas: Theory and Practice," p. 425.
[2] R. A. Smith, "Aerials for Metre and Decimetre Wavelengths," p. 40.



(*Continued on page* 189)

35.75 Mc/s and 53 Mc/s thus giving an impedance bandwidth of 17.5 Mc/s. Even the impedance bandwidth to ±0.5dB is 8.5 Mc/s and the variance with the approximate value is obvious.

Cheshunt. C. F. WHITBREAD.

Printed Circuits

I HAVE read with interest the contributions on the above subject. Having spent about 25 years on electronic faultfinding, in the factory and in the hard world outside, the toughest going met, so far, has been the few years spent as a mobile TV engineer. Bearing this in mind I cannot let the remarks about servicemen pass without comment. They show a complete lack of comprehension of the problems that are an everyday part of the job and are tinged with the usual hostility reserved for the unknown.

But to the subject. Ignoring all mechanical snags which, viewed dispassionately, just mean time, gained by the manufacturer, lost by service department, there is a major factor which seems to have been overlooked. It is that the print does not make visual sense; it is provided to connect components. Anyone attempting to reconstruct the circuit from its meanderings in the restricted time available in service work will end up in a mental home.

The manufacturing side knows the circuit and the location of each component intimately, therefore the method adopted to connect components has little or no effect upon fault-finding efficiency. The service engineer tends to look upon the manufacturer as the so-and-so who uses devilish ingenuity to make life more and more uncomfortable as the years go by, the latest thorn being the printed circuit. Why should he take this unreasonable attitude when the manufacturer finds no difficulty whatever. The answer lies in lack of knowledge, not of printed circuits as such but of the identity of every component on every panel of every one of the hundreds of different sets he is called upon to service, without this knowledge the printed panel makes as much sense as a junk box. Given an average wired layout, it is possible to follow, fairly rapidly, at least a major part of the circuit through and identity components by their location in the wiring.

"Haven't the fools ever heard of service data?" I seem to hear them say. The lamentable fact is that data for every set tackled is not always to hand, readily available or even available in the case of recent models. There would be much less cause for friction if every set had a circuit stuck on its back and the printed panels were also printed with component identities, colour coded for frame, line, sync, etc. Whether the serviceman is right or wrong, his word with a prospective customer for a new set counts for more than any amount of advertising. As this is so, surely some effort should be made by the makers to look at their products from the perspective of one who has to rectify their mistakes and then at least attempt to do something constructive rather than just adopt the attitude which W. I. Flack reflects in his letter in the March issue. Incidentally, may I dedicate to him the one that goes:—

"I told him it was the first turning after Bill Jones' Farm but he didn't even know where Bill's farm was. How can you help an idiot like that?"

Havant. R. J. WILSON

IN publishing a letter of mine in the March issue of the "Wireless World" in which I referred to an earlier letter from Mr. A. G. Tucker on the subject of printed circuits, I appear to have raised a minor storm, but I am indeed glad to note the interest which this has aroused. I feel however, that in the defence of printed circuits, I must continue this correspondence further.

I appreciate Mr. Tucker's comments on the speed with which his company repairs receivers and it is refreshing to know that such speedy service is available. I cannot, however, agree with him that printed circuit receivers have not been in existence long enough for their reliability to be confirmed, receivers being frequently life tested under adverse atmospheric conditions. I have also received reports some months ago from the U.S.A. referring to receivers at least six years old which did not show any appreciable deterioration. Furthermore, I myself possess a printed circuit receiver which is approximately five years old and as far as performance and appearance is concerned it is not appreciably different from the time that it was made.

The letter from Mr. E. Kisch leads me to believe that he has not had an extensive experience in the servicing of printed circuit receivers. I do agree with him that I could not readily spell out Czechoslovakia backwards, but if it happened to be printed on the reverse side of a piece of phenolic board as used in printed circuits and it was necessary to check the spelling then I would illuminate that side so that an outline of the image could be seen through the material and I am confident that I could see the letters sufficiently clearly for me to spell the word out backwards, forwards or inside-out. In the same way when I require to follow the wiring of a printed panel, I illuminate the reverse side of the panel and I can then see all the conductors clearly outlined A convenient method of doing this is to place a 25-watt lamp close to the reverse side of the board, alternatively, a pencil-type torch which gives only a small area of light may be used, and enables any conductor to be traced between any components.

I cannot accept his simile, of alternate words being printed on the front and reverse sides of a page. As he so very rightly says, "to print and read in the fashion that we do is an acquired habit" and "the experienced and skilled technician is used to looking at valve holders and coils from below", he has therefore acquired the habit of working back to front. Since we have all acquired the habit of reading theoretical circuit diagrams, in one plane only and since the printed circuit is after all only a physical conception of the circuit diagram, then I am quite certain that it would not take long to acquire the habit of following, understanding and repairing printed circuit receivers.

Finally, I was interested that Mr. Wesley-Collins made the point that "with a thorough knowledge of the basic theory combined with a logical approach, servicing of both types of circuits should not present undue hazards", that after all is what I stated in my previous letter. Regarding any cost saving due to the application of modern techniques, It goes without saying that these advantages are invariably passed on to the user. Any manufacturer who does not do that and thereby raises the cost of his equipment would soon fall behind in the very competitive industry in which we are engaged. W. I. FLACK.

Slough. Radio and Allied Industries, Ltd.

Relativity

THE following solution to the custard pie problem incorporated in my article in the March issue would, I think, be hard to beat. It comes from Mr. and Mrs. Peter Donaldson of Cambridge.

In mounting your custard attack
Your car gets a little push back.
If it keeps up its speed,
The engine will need
To supply the mv^2 you lack.

Another way of looking at the same thing is to reckon the work done on the pie by the motorist as the product of the force he exerts and the distance through which it acts. When the car is moving forward, that distance is greater than when it is standing.

"CATHODE RAY."

Reversible Dekatron Counter

Circuit to Allow Subtraction of Input Pulses from the Existing Count

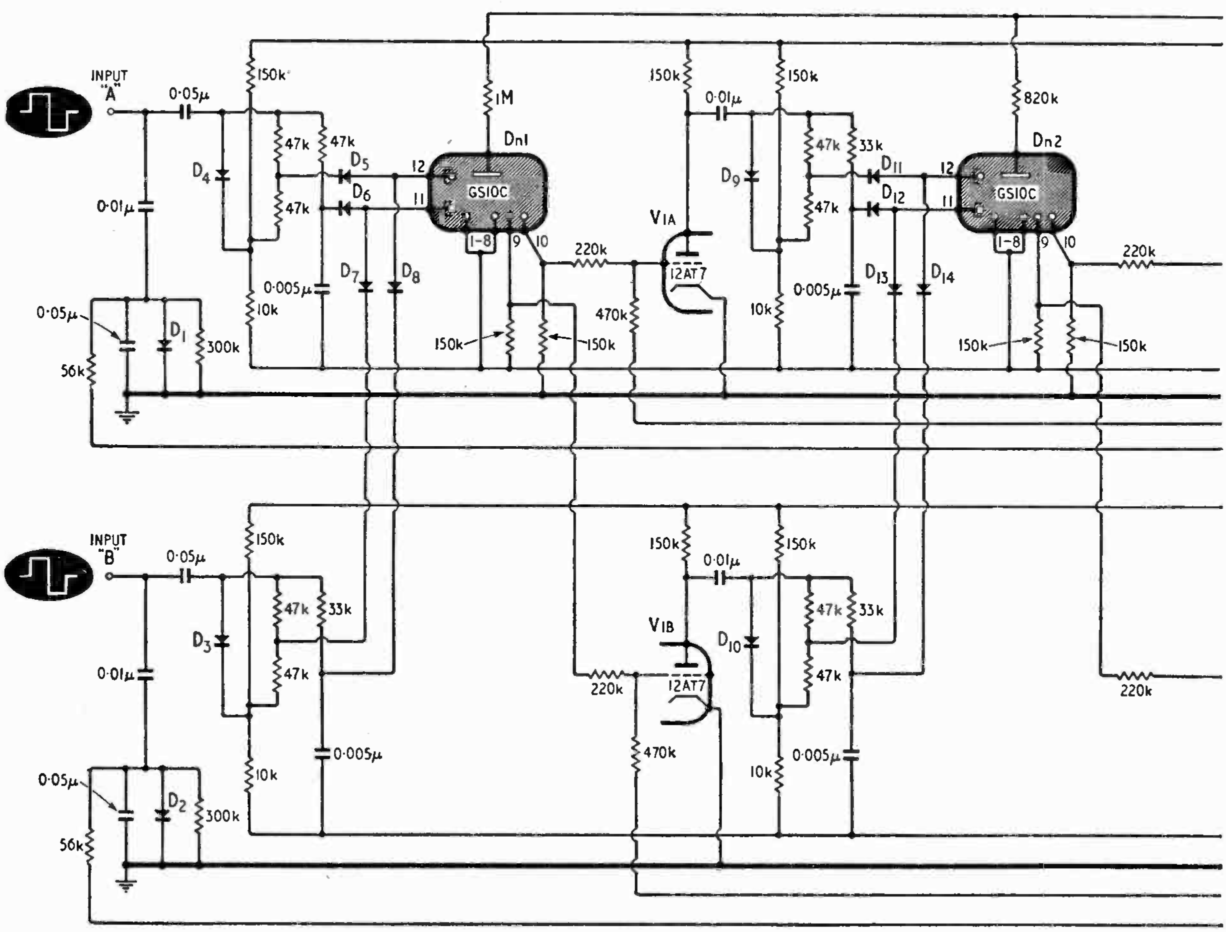
By ***W. K. HSU***

A DOUBLE-PULSE Dekatron tube consists basically of 30 cold-cathode diodes arranged in a circle around a common anode. The whole is enclosed in a gas-filled envelope. The common anode is connected through a high resistance to a potential of about 450 volts. The anode potential drop is just sufficient to maintain a glow and the maintaining voltage is insufficient to strike a second discharge. Therefore only one cathode glows. The glow is clearly visible through the glass top of the tube.

In a double-pulse Dekatron selector tube the first, fourth, seventh, etc. cathodes are connected together internally. So are the second, fifth, eighth, etc. The former may be called "first-guides" and the latter "second-guides." These guides and each of the remaining ten cathodes are connected separately to pins on the tube base. The base connections of a typical Dekatron are shown in Fig. 1.

Normally the cathodes are at earth potential, the first and second guides being biased positively. If the first-guides are pulsed negatively the guide adjacent to the glowing cathode becomes ionized and, because the anode discharge tends to follow the potential of the most negative electrode, the glowing cathode is extinguished and the discharge is transferred to the adjacent first-guide. Thus, if now the second-guides receive another negative pulse the glow follows on to them, but as these second-guides are positively biased the glow moves on to the next cathode. In Fig. 2 diode D serves to clamp the guides to a fixed potential. R_2 and C_2

Complete circuit diagram of the reversible counter.



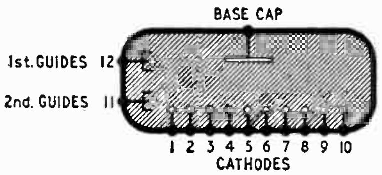


Fig. 1. Symbolic diagram of a typical Dekatron.

produce a delay so that guides first and second may be fed from a single-pulse input via C_1.

It is possible to transfer the glow in the opposite direction as mentioned above. This can be done simply by applying the guide pulses in the reverse order. If the former direction adds, then the latter subtracts.

The required cathodes can be connected to earth through resistors, say 150 kΩ, and across these positive pulses of about 30 volts may be derived to drive a following stage every time the glow arrives at the cathodes.

A normal adding Dekatron counter consists of a series of these tubes with interstage coupling pulse amplifiers. An output pulse is derived from the "10" digit of the "units" decade. After amplification it carries one digit forward in the "tens" decade, and so on. When the counter is to be reversible, difficulty arises in the interstage coupling valves because the "10" pulses still carry digits forward—

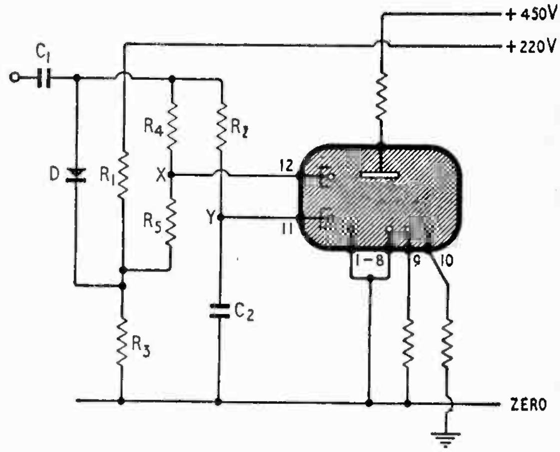
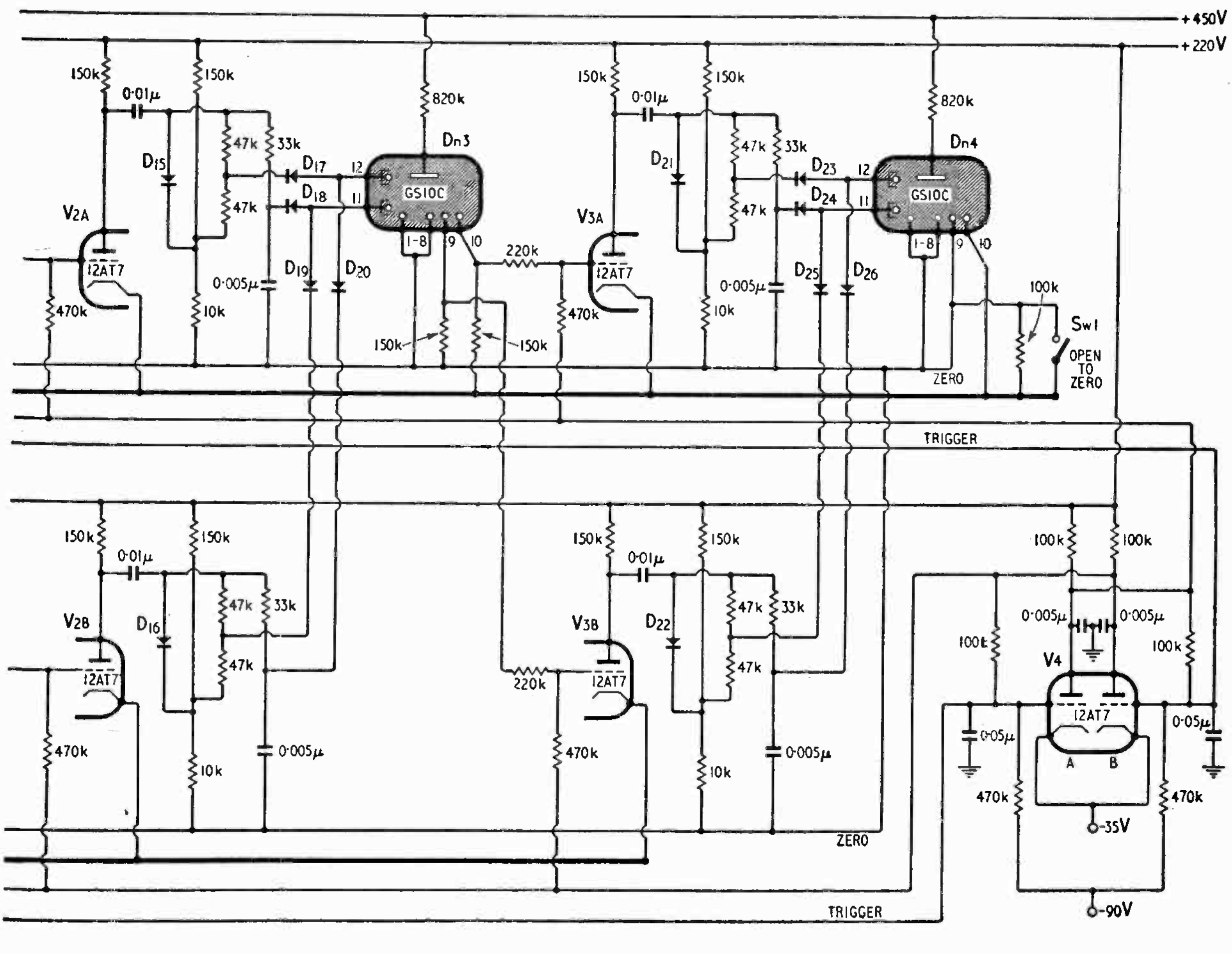


Fig. 2. Circuit for pulsing the first and second guides, X and Y being the guide feed points.

to add, even when the units decade reverses. These have to be suppressed and a "carry" signal from the 9's must be made to carry backwards one digit at the subsequent decade. One can easily make this comprehensible by considering numbers, say 28, 29, 30, 31, and going backwards, 31, 30, 29, 28 and so on.

Thus the two carry pulses, one from 10's, which must be effective only during addition, and the other



from the 9's, which must be effective only during subtraction. This difficulty can easily be overcome by the use of a flip-flop bi-stable circuit. Considering Fig. 3, the voltages shown are all with respect to earth. V_4 cathodes are dropped to a negative supply of − 35 volts so that on conduction the anode is about 15 volts positive with respect to its cathode, due to the drop in the internal resistance of the valve. This is equivalent to − 20 volts with respect to earth. During the cut-off condition the

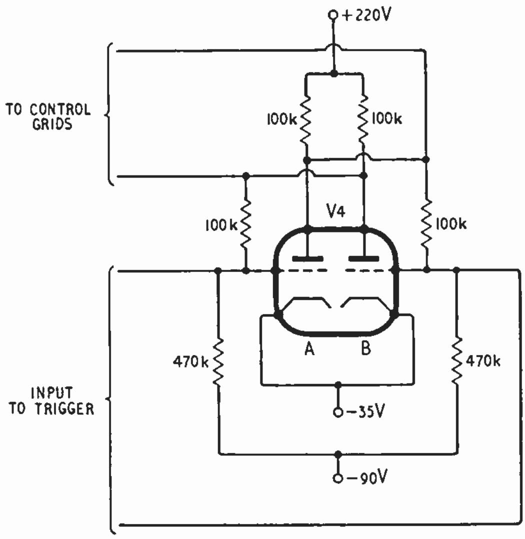


Fig. 3. Bi-stable circuit used in the reversible counter.

anode is at about 170 volts positive with respect to earth. These voltage changes are made to open and shut the gating amplifiers. Grids of V_{1A}, V_{2A}, V_{3A} are controlled by V_{4A}, and those of V_{1B}, V_{2B}, V_{3B} are controlled by V_{4B}. Suppose V_{4A} is in the conducting state; its anode is at − 20 volts. Owing to the potential divider connection of the resistors on the grids, namely 470 kΩ, 220 kΩ and 150 kΩ in series, the grids of V_{1A}, V_{2A} and V_{3A} are now biased at − 9 volts with respect to earth. Thus when a positive 30-volt pulse is coming from the 10's cathodes of the Dekatrons it will raise the grids of V_{1A}, V_{2A} and V_{3A} all positive, and these pulses are amplified and function to " carry " at the following decade.

On the other hand, V_{1B}, V_{2B} and V_{3B} are held at a positive potential via the potentiometer resistances 470 kΩ, 220 kΩ and 150 kΩ since V_{4B} is at cut-off. V_{1B}, V_{2B} and V_{3B} are now in a conducting state with slight grid current. A positive pulse coming from the 9's cathodes will not give a pulse output on their anodes. Thus in forward counting, pulses from the 9's are blocked and those from the 10's effect the carry. Similarly, in reverse counting, pulses from the 10's are blocked, but those on the 9's are carried forward to subtract.

The method of bi-directional coupling is by two standard coupling circuits connected in parallel. The first-guide output point on one is cross-connected to the second-guide output point of the other through two rectifiers wired back-to-back (i.e. D_5, D_8 and D_{11}, D_{14}, etc.), the Dekatron guide being taken to the junction of the rectifiers. The other Dekatron guide is connected to two more rectifiers similarly arranged to the remaining feeding points (namely D_7, D_6 and D_{13}, D_{12}, etc.).

In order to change the bi-stable circuit to the required state, parts of the incoming pulses are rectified by D_1 and D_2. The rectified voltage is fed to the grids of V_4 to accomplish the trigger action. Capacitors at the grids of V_4 serve to stabilize the state so as to produce locking action. Capacitors at the anodes of the bi-stable circuit bypass any stray pulses coming from the non-active parts of the coupling circuit which may be carried to the Dekatrons and introduce inaccuracies.

The counter may be zeroed to recount by opening the switch, SW_1 so that all digits, 1's to 9's, are now more positive than the zero digits, and so all the glows rest only on the zero digits for re-starting.

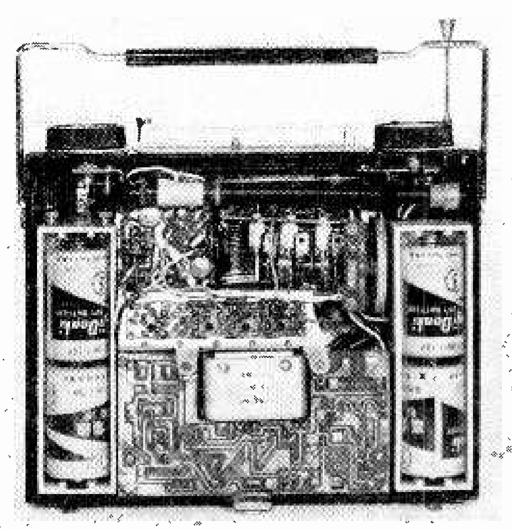
All components and valves are conventional and only a simple flip-flop circuit is additional. Input pulses may be from mechanical contacts, photo-electric cells, particle counting tubes, etc. In the complete circuit (p.72) two inputs are required, one of which advances the counting of digits while the other reverses the counting. Thus if the two inputs are energized together the number displayed on the counter remains unchanged.

Transistor F.M. Portable

IT was announced recently that the Sony Corporation of Tokyo, Japan, has introduced an all-transistor f.m./a.m. portable known as the Model TFM151. It employs 15 transistors and 4 germanium diodes in a two-band superheterodyne circuit covering 88 to 108Mc/s and 535 to 1605kc/s respectively. A ferrite-rod aerial is included for a.m. reception and a retractable rod aerial for f.m., but provision is also made for connecting external aerials if required. Likewise, either the internal 4 × 6-in elliptical loudspeaker or an external earphone may be used. The set operates from four 1.5-volt dry cells.

The circuit includes an r.f. amplifier using v.h.f. diffused grown transistors made by the Sony Corporation, and a 10.7-Mc/s i.f. is used for f.m. reception and a 455-kc/s i.f. for a.m. reception. The push-pull output stage gives 180mW maximum. Overall size of set is 3in × 8¼in × 9in and the weight 5½lb. It utilizes printed circuits.

Internal view of the Sony f.m./a.m. all-transistor portable.



Transistorized Absorption Wavemeter

Low-cost Sensitive Instrument Incorporating a Modulating Oscillator

By G. W. SHORT

SIMPLE absorption wavemeters of the type shown in Fig. 1 are widely used for testing and adjusting small radio transmitters. The tuned circuit is loosely coupled to the source of r.f. energy the frequency of which is to be measured, and the capacitor adjusted for maximum meter reading. Such instruments are very satisfactory, because they are free from spurious responses, simple to construct, and require no power supply. Their one disadvantage is lack of sensitivity. The power required to deflect the meter pointer must all be supplied by the signal source, and in practice the overall efficiency of the system is poor, for the following reasons. The crystal diode may be regarded as a d.c. generator. It is likely to have an internal resistance of some hundreds of ohms when passing a current of 1mA. The resistance of a 1-mA meter will probably be around 100Ω. A considerable proportion of the input power is therefore dissipated in the diode. At low-signal levels, the rectification efficiency will be very poor, partly because the current/voltage curve of the diode is not very bent at zero bias, and partly because the diode resistance is of the order of 10kΩ at zero current.

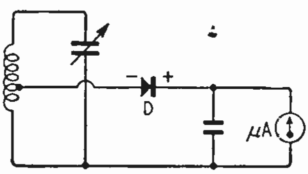


Fig. 1. Simple absorption wavemeter with diode detector.

These limitations are unimportant when the signal source is a transmitter, or a stage in a transmitter producing an appreciable amount of power, so that the necessary few milliwatts are readily obtained without imposing too much of a load. However, the writer required a means of making rough measurements of frequency on oscillators such as are used in battery receivers. Apart from the low power available, it was desired to make the measuring instrument sufficiently sensitive that a very loose coupling between source and indicator would suffice, because it is usually inconvenient to put coupling windings on oscillator coils, which may be in relatively inaccessible positions.

Since the only meter available was a 1-mA instrument some form of amplification was obviously necessary. The use of an r.f. amplifier was ruled out because the necessary valve and extra tuned circuit were too complicated, and a mains power supply would have been needed. Amplification of the d.c. output of the crystal rectifier is more attractive, since it can be done with a junction transistor worked from a single 1.5-V cell.

The first circuit tried was that of Fig. 2. The transistor is operated without external base bias current, so that, with no signal input, it is almost cut-off, and only the common-emitter collector leakage current (I'_{co}) flows. This was only about 100μA with the particular Mullard OC71 transistor used, and it was not considered that the battery drain justified the inclusion of an on-off switch. On tuning-in a signal, the transistor is switched on by the diode output current, and the meter deflection increases. The purpose of R_2 is to limit the meter current in the event of an overload. If R_2 and the meter resistance together amount to 1.5kΩ, then only 1mA can flow even if the transistor becomes a short circuit. In practice, one must allow for a reduction of battery voltage owing to deterioration, and use something less than 1.5kΩ, otherwise there will not be enough voltage left to operate the transistor properly at currents near 1mA. A total value of 560Ω was in fact used, so that the current was limited to rather less than 3mA with a new battery. R_2 also protects the transistor, and R_1 protects the diode from all but the grossest overload.

The base resistor R_1 was included for two other reasons. First, to increase the detector load resistance and so reduce damping of the tuned circuit and secondly, to enable the diode to be connected across the whole of the tuned circuit, in which position it receives the maximum possible signal voltage, a condition necessary for achieving good rectification efficiency. A 250-kΩ variable resistor was used, so that the optimum value could be found by trial and error. The optimum varies with frequency: at high frequencies the dynamic resistance of the tuned circuit is low and a low value of R_1 is best, while at low frequencies the reverse applies.

Although the circuit of Fig. 2 gave a marked improvement on that of Fig. 1, it was soon discovered that it is a poor performer at low-signal levels, the sensitivity increasing quite disproportionately to the signal strength. Some such effect was expected, because crystal rectifiers are inefficient at low levels, but the actual results were much worse than anticipated.

Upon reflection, it became obvious that one of the original assumptions was false, namely that the provision of R_1 results in reducing damping. It does, at high-signal levels, when the effective damping approximates to $R_1/2$. At low levels, however, the

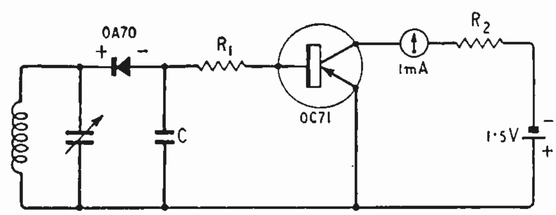


Fig. 2. Adding a transistor d.c. amplifier increases the sensitivity.

rectifier has a finite, and relatively low, resistance during both half cycles of the input wave, and, since C is a short circuit at the signal frequency, this low resistance is effectively across the tuned circuit, and causes heavy damping if the latter's dynamic resistance is large by comparison. If one is interested only in low-level signals, therefore, the circuit of Fig. 2 is useless. (Removing C removes the diode resistance damping, but reduces rectification efficiency still further, and is therefore not a cure.)

A second cause of poor sensitivity at low levels is the operation of the transistor near cut off. At low currents, the current gain is considerably reduced. To get the best out of the available components, therefore, it is necessary to "tap down" the tuned circuit so that coupling is optimum at low levels, and to operate the transistor with sufficient standing current to ensure that its gain is high. This leads to the circuit of Fig. 3. R_1 is used to adjust the base current to produce a convenient standing current (say 0.5mA). An on-off switch is now required, and this and R_1 can conveniently be combined in the form of a "volume control" with mains switch. A small forward current now flows through the diode. This is an advantage because it moves the operating point nearer the region of maximum curvature of the current/voltage characteristic. (In

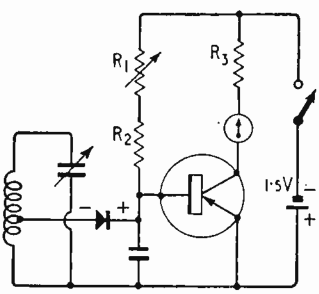


Fig. 3. Improved circuit with higher sensitivity.

the circuit of Fig. 2 a slight reverse bias is applied by the emitter-base voltage drop. This increases the diode resistance but reduces rectification efficiency.)

If the input signal is modulated, an audio output can be obtained from the transistor, and by the use of a matching transformer the full power gain can be realized. The actual increase in sensitivity is greater than that computed, since ears are far more sensitive than meters.

Unfortunately, most of the input signals encountered in practice are unmodulated carriers. It is, however, possible to modulate them. In principle this can be accomplished by means of a switch placed in one of the positions shown in Fig. 4, or in others, which will be obvious. If the switch is opened and closed at an audio frequency, then an audio note will be heard if there is a signal coming from the source. The arrangements shown in Fig. 4, where (a) and (c) amount to "chopping" the incoming carrier, and that of (b) to chopping the d.c. output of the dectector. Now, a diode is an excellent substitute for an on-off switch, and can readily be operated at a high frequency. The easiest modulation method to achieve is that of Fig. 4(c) and Fig. 5 shows how it is done. The diode is driven by an audio-frequency generator, and short-circuits the tuned circuit every time it conducts; i.e., once every cycle. The r.f. signal reaching the detector is thus amplitude modulated. A transistor audio-fre-

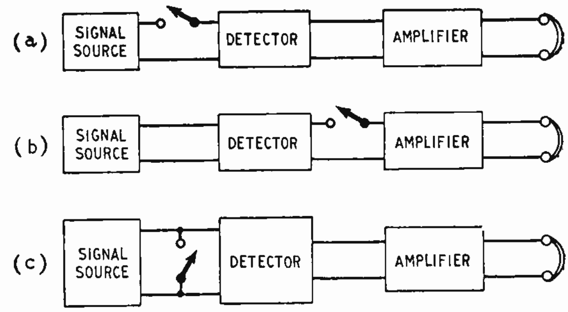


Fig. 4. Some possible ways of modulating the signal. The switch is assumed to be opened and closed at an audio frequency.

quency oscillator drives the modulator diode, the complete circuit being shown in Fig. 6. The oscillator shown is a Hartley, but any of the normal types can be made to function. A point to be watched is the d.c.-resistance of the coil or transformer used, which must not be so high that most of the battery voltage is wasted in it, leaving insufficient to operate the transistor. Some thought should be given to the state of the modulator diode D_1 when the oscillator is switched off. If it is left in circuit a reverse bias should be applied, otherwise unwanted damping of the tuned circuit will occur. In Fig. 6, with S_1 open, the battery votage is applied to the diode in the appropriate sense via the oscillator transistor. An alternative would be to place S_1 near to D_1 physically, and simply disconnect the latter, letting the oscillator run all the time.

Resistor R_3 controls the amount of modulation. A suitable method of selecting it is to apply a fairly large signal and try various values of R_3, with the oscillator working, until one is found that reduces the meter reading to rather more than half that obtained with the oscillator off. This gives a reasonable compromise between amount of modulation and additional damping. The presence of C_3 ensures that D_1 conducts in pulses. When it does so, its resistance falls to a value which is low compared with the dynamic resistance of the signal circuit, even at high frequencies when the L/C ratio is small, so a reasonable depth of modulation is always obtained.

The purpose of R_4 is to control the amplitude of oscillation. In practice it affects the frequency as well. It will not always be necessary. The writer used a centre-tapped a.f. choke for T_2. If a double-wound transformer is used, a tuned-collector circuit is recommended, with a turns ratio of about 4:1 (not at all critical). A frequency of 1 to 5kc/s is suitable.

The wavemeter was constructed in a box made of wood and hardboard. The coil (L_1) plugs into the top of the box. No permanent arrangement for coupling to the signal source is incorporated since one suited to the task in hand is easily improvised. In many cases it is possible to put the wavemeter coil near enough to the source to produce a meter reading, and unless the source is well screened it is nearly always possible to use the modulator and headphones. The latter system has the shortcoming that, while it is very easy to detect a signal, it is impossible to tune it in with precision, because the ear is not very sensitive to small changes in

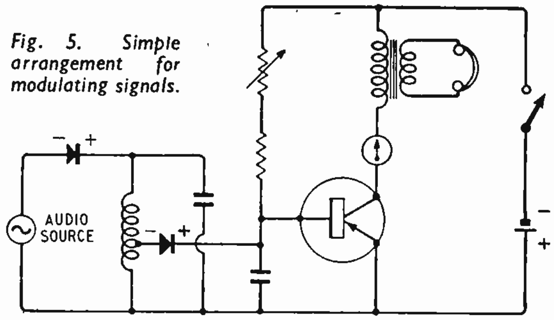


Fig. 5. Simple arrangement for modulating signals.

volume. The modulator has been found to be invaluable, however, for quick searching for signals of moderate strength. These are very easily heard, but produce only a small meter deflection, which can easily pass unnoticed if the tuning knob is turned quickly. The presence of an audio note at the appropriate part of the band enables the correct area to be searched slowly, so that the deflection is observed.

If a very wide frequency coverage is aimed at, the tuning capacitor must not have too small a capacitance, otherwise the self-capacitance of the coils used at the low-frequency end will restrict the band coverage. If the medium-wave band is to be covered, 100pF is about the minimum practicable value for C_1, and the upper frequency limit can then be extended to about 100Mc/s by using a fractional turn for the highest-frequency coil. The writer managed to cover 1 to 100Mc/s with five coils, but the calibration scales are crowded at the high-frequency end because the tuning capacitor has a straight-line capacitance law. A capacitor with a straight-line frequency law would be more suitable. If the total coverage required is small it is a good plan to restrict each band to a 2 to 1 range by using a trimmer. This will produce an open scale even with an s.l.c. tuning capacitor.

Tapped tuning coils may be used, as shown in the diagrams, but a separate coupling winding is equally suitable. In actual fact, it is more convenient to use a separate winding, wound over the earthy end of the main coil, since the optimum amount of coupling can then be found by trial and error without interfering with the main coil. At the highest frequencies, the detector diode can be connected across the whole coil without introducing too much damping. With reasonably good coils and adjustment of detector coupling it should be possible, using a 1-mA meter and strong signals, to divide each band scale into 100 useful divisions. This means that, at 1Mc/s, a frequency change of 10kc/s should be readily detectable.

The meter "reads backwards," as in the case of a grid-dip frequency meter. It is not necessary that the base-bias current control R_1 be variable. If a fixed value is used, the no-signal meter reading will vary somewhat with temperature. It has, however, been found useful to make R_1 variable, with a rather high maximum value. It can then be used as a backing-off control when strong signals are applied. A strong signal is liable to cut off the transistor and make measurement impossible, but if the bias current is then reduced it is often possible to bring the meter needle back to a convenient position. This procedure is sometimes more convenient than altering the coupling to the signal source.

The modulator is to be regarded as an optional extra. Even if it is not used, however, it may be worth while retaining T_1 so that headphones can be employed to identify modulated signals.

It would be possible, when the modulator is incorporated, to amplify the audio output, detect it and produce a meter reading or operate a "magic eye"-type tuning indicator. The sensitivity could by this means be increased enormously. The theoretical limit is that due to noise, but a practical one will be fixed at a higher level by stray coupling of the audio signal from the oscillator. It will be seen from Fig. 6 that if the portion of L_1 between the tapping point and the earthy end presents a finite impedance to the modulation frequency then some of the audio will be passed through D_2 to the transistor. If L_1 consists of many turns of fine wire, the leakage may be heard in the phones even without subsequent amplification. Another source of stray coupling is the internal resistance of the battery, hence the presence of decoupling capacitor C_6. Yet another is magnetic coupling between T_1 and T_2, which should be kept well apart and oriented so that the effect is minimized.

It is also possible to increase the sensitivity by using a more sensitive meter. However, the gain of the transistor will be reduced if the current through it is less that about 0.5mA. In fact, with many small transistors, the maximum gain is not

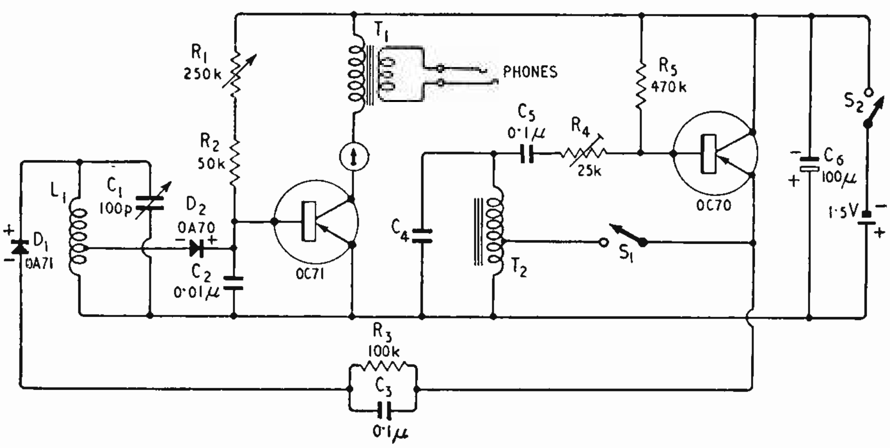


Fig. 6. Complete circuit diagram of wavemeter incorporating an audio oscillator and a diode modulator. If the primary resistance of T_1 is low it may be necessary to connect a current-limiting resistor in the collector circuit. C_4 is selected to tune T_2 to a suitable audio frequency.

achieved until the collector current is raised to about 3mA, but the reduction is not serious down to 0.5mA, or even 0.25mA. Unless one is prepared to incorporate a backing-off arrangement for standing current, there is therefore little point in using a meter with a f.s.d. much below 0.5mA. If a really sensitive meter is available (say, 100μA) then the circuit of Fig. 2 will probably be adequate. If the standing current in the transistor is then too great it can be reduced, at some cost to sensitivity, by connecting a resistor of a few thousands of ohms between base and emitter. If the standing current is rather less than the full-scale deflection value, the detector diode can be reversed and the meter will then "dip" on application of a signal, as with the circuit of Fig. 6.

COMPONENTS SHOW

THE 16th Annual Components Show organized by the Radio and Electronic Component Manufacturers' Federation is being held in London from April 6th to 9th. The 180 exhibitors listed below, a record number, are again being accommodated in two buildings—Grosvenor House and Park Lane House, W.1. It will be open daily from 10 to 6. Admission is by invitation ticket obtainable from the R.E.C.M.F., 21 Tothill Street, London, S.W.1, by engineers and technicians in the "user" industries, research, Government departments and the Services.

A.B. Metal Products
A.K. Fans
Air Control Installations
Allan, Richard, Radio
Amphenol
Anderton Springs
Anglo-American Vulcanized Fibre
Antiference
Ardente
Ariel Pressings
Armand Taylor
Avo

B.I. Callender's Cables
B.S.R.
Bakelite
Belling & Lee
Bird, Sydney S.
Bray, Geo.
Brayhead (Ascot)
Brayhead Products
Brimar Valves
British Communications Electronics
British Electric Resistance
British Physical Labs.
Brush Crystal Co.
Bulgin
Burndept

C.C.L.
C.I.B.A. (A.R.L.)
Carr Fastener
Cathodeon Crystals
Clarke & Co. (Manchester)
Collaro
Colvern
Connollys (Blackley)
Cosmocord
Creators

D.S.I.R.
Daly (Condensers)
Darwins
Dawe Instruments
"Diamond H" Switches
Dubilier
Duratube & Wire

E.M.I. Sales & Service
Egen Electric
Ekco Plastics
Electro Acoustic Industries
Electro Methods
Electronic & Radio Engineer
Electronic Components
Electronic Reproducers
Electrothermal Engineering

Enalon Plastics
English Electric
Enthoven
Erie Resistor
Ever Ready

Ferranti
Fine Wires
Formica
Fortiphone

Garrard
Goldring
Goodmans
Gresham Transformers
Guest, Keen & Nettlefolds

Haddon Transformers
Hallam, Sleigh & Cheston
Harwin Engineers
Hassett & Harper
Hellermann
Henley's
Henry & Thomas
Hinchley Engineering
Hunt (Capacitors)

I.C.I.
Imhof
Instrument Review
Insulating Components

J. Beam Arials
Jackson Brothers
Jobling

K.L.G. Sparking Plugs
Kimber Allen

Labgear
Langley London
Lewis Spring Co.
Linton & Hirst
Lion Electronic Dev.
London Electrical Mfg. Co.
London Electric Wire Co.
Long & Hambly
Lustraphone

M.O. Valve Co.
Magnetic and Elec. Alloys
Magnetic Devices
Mallory Batteries
Mansol (G.B.)
Marrison & Catherall
McMurdo Instrument Co.
Measuring Insts. (Pullin)
Mica & Micanite Supplies
Micanite & Insulators
Ministry of Supply
Minnesota Mining & Mfg.

Morganite Resistors
Mullard
Mullard Overseas
Multicore
Murex
Mycalex & T.I.M.

N.S.F.
Neill, James & Co.
Newmarket Transistors

Painton
Parmeko
Partridge Transformers
Permanoid
Plannair
Plessey Company
Plessey International

Radio Instruments
Reliance Cords & Cables
Reliance Manufacturing Co.
Reproducers & Amplifiers
Rola Celestion
Ross, Courtney & Co.

S.T.C. (Component Group)
Salford Electrical
Salter, Geo., & Co.
Scott, Geo. L., & Co.
Semiconductors
Siemens Edison Swan
Simmonds Aerocessories
Sims, F. D.
Smith & Nephew
Spear Engineering Co.
Staar Electronics
Stability Capacitors
Standard Insulator Co.
Steatite & Porcelain Prods.

Stocko (Metal Works)
Stratton & Co.
Suflex
Swift Levick & Sons
Symons, H. D., & Co.

T.C.C.
T.C.M. Co.
Taylor Electrical
Technical Ceramics
Technograph
Telcon-Magnetic Cores
Teledictor
Telephone Manufacturing
Texas Instruments
Thermo-Plastics
Thorn Electrical Industries
Truvox
Tucker, Geo., Eyelet Co.
Tufnol

Vactite Wire Co.

Walter Instruments
Wandleside Cable Works
Wayne Kerr Laboratories
Wego Condenser Co.
Welwyn Electrical Labs.
Westinghouse
Weymouth Radio
Whiteley Electrical
Wiggin, Henry, & Co.
Wimbledon Engineering
Wingrove & Rogers
Wireless Telephone Co.
Wireless World
Woden Transformer Co.
Wolsey Electronics
Wright & Weaire

Zenith Electric Co.

U.K. Receiver Sales

THE record figure of 2.02M television receivers were despatched to the home market by U.K. manufacturers last year. This was an increase of 11% on the previous year and of 24% on the average for the years 1956/57. As will be seen from the table, despatches of sound receivers (which includes car radio) and radiogramophones dropped last year. The percentage decreases on 1957 were 7 and 18 respectively. The figures in the table (in thousands) are based on returns from members of B.R.E.M.A.

	SOUND		RADIOGRAMS		TELEVISION	
	1957	1958	1957	1958	1957	1958
Jan. ...	98	87	26	18	127	113
Feb. ...	100	81	23	14	119	103
Mar. ...	112	89	19	11	102	99
Apr. ...	91	83	15	12	77	73
May	120	102	16	9	110	96
June ...	112	108	10	6	99	89
July ...	123	107	14	11	112	107
Aug. ...	118	92	20	13	140	133
Sept. ...	132	137	32	25	235	269
Oct. ...	134	148	32	32	273	353
Nov. ...	116	130	31	39	246	345
Dec. ...	102	100	29	27	176	238
Total* ...	1,357	1,265	266	218	1,816	2,020

*Any differences in totals from the sum of the items are due to rounding.

MASERS

By "CATHODE RAY"

Small-Scale Atomic Energy for Radio

RATHER to my surprise I found it in the dictionary, which I had possessed since long before the maser was invented. But the reference was to a large wooden drinking bowl—" Their brimming masers to the feasting bring." Well, all I can say about that is that if one did it nowadays the only outcome would be a mouthful of liquid helium, which would be cold cheer, to put it mildly. For in the contemporary sense "maser" stands for "Microwave Amplification by Stimulated Emission of Radiation."* Even if the word's origin is hardly respectable in the sight of classical scholars, it saves quite a useful amount of tongue-power.

The reason for my drawing your attention to masers is not that before you know where you are they will be challenging stereo as mandatory equipment in every well-appointed home. The most enthusiastic would scarcely predict that their sphere of application will be large. And the less enthusiastic might claim that they are already on the way out (see next month's discourse). But they do crop up fairly often in current scientific literature, as we see sometimes in "Technical Notebook." My main reason, however, is that masers are rather beautiful illustrations of the atomic behaviour I was talking about last year.

For those who have joined since, the relevant facts are that atoms consist of a small central nucleus surrounded by a number of electrons swirling about in orbits. These orbits are hazy as regards the precise position of the electron at any given moment, but very definite as regards its energy. The farther out from the nucleus, the greater the energy. But the two most significant features are, firstly, that these orbital energy levels are not, as it were, variable continuously like a tuning control, but only in fixed steps like a band switch. And the second is that only two electrons are allowed in any one orbit at a time, and even they have to be distinguished by spinning like tops in opposite rotations. So the set-up is that if there are $2n$ or $2n$-1 electrons per atom they normally fill the n closest-in and lowest-energy orbits.

It follows that the only amounts of energy that any electron can accept are those just equal to the difference between its present energy and what it would have in one of the vacant higher orbits.

As for the energy, it comes in packets of all sizes, but directly you specify a size you fix the frequency of the waves by which it is radiated from place to place, according to the quantum rule:

$$E = hf$$

where f is in c/s, E is in electron-volts, and h is 4.15×10^{-15}. Therefore (and this is the crux of the matter) to raise an electron from one orbit to another necessitates energy at the precise frequency E/h, where E is the energy difference between the two orbits. And when the electron drops back from one orbit to another—as it usually does very quickly if there is a vacancy—the frequency of the energy it radiates is determined in the same way.

The energy steps near the bottom end of the scale (i.e., between orbits nearest the nucleus) are of the order of several electron-volts, so the corresponding frequencies are the order of 10^{15} c/s. That is away up in the visible light band, or even beyond, in the ultra-violet. So one usually quotes examples thereabouts, such as the strong absorption of ultra-violet radiation from the sun by the atoms of the upper atmosphere. And gas-discharge streets lamps are familiar examples of light production at fixed spot frequencies by "excited" electrons dropping back into lower orbits.

The number of possible frequencies is much larger than a simple account of the matter might suggest, and often what looks on a spectroscope like a single frequency response turns out to be two or more very close together. So there are some very small energy differences and correspondingly low frequencies. Some of them even come as low as our radio bands. Hence the "microwave" in "maser." And we have just been reminding ourselves of some examples of

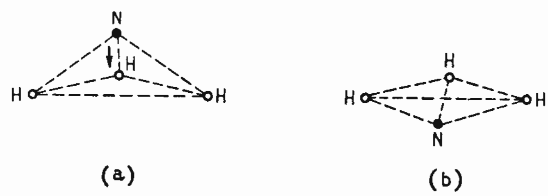


Fig. 1 Alternative shapes of an ammonia molecule (a) before and (b) after its nitrogen atom has jumped through its hydrogen triangle.

"emission of radiation" from atoms. But how about the "a" for "amplification"?

That, as Hamlet remarked, is the question. From what we have just recalled it seems that in these electronic energy exchanges one gets out exactly the amount one puts in. So the maximum prospective amplification is ×1, or 0 dB. That applies to atoms spaced so widely that they don't influence one another appreciably. In solid materials, where they are packed so closely that all the energy levels are split up like resonance peaks of coupled circuits, very complicated interactions cause the radiated frequencies (and therefore energies) to be in general lower than those needed to excite them (Stokes' Law). For example, what you see glowing in a fluorescent light is solid matter excited by electrical discharge through the tube generating radiation mainly at ultra-violet frequencies. If we are to get any amplification, then, it is clear that the excitation—raising the electrons to higher energy levels—must be done by some other source of energy than the signal to be amplified.

The next thing to note is that if the electrons dropped back (or *relaxed*) automatically to their lower levels in about 10^{-8} sec., as they do at visible

* Judging from a recent TV broadcast, most of the boffins pronounce it "mazer." Whether this is because (a) it traps them in a mental maze, or (b) they come up from Somerset where of course emission is ztimulated, or (c) they have been stimulated by the large wooden drinking bowls, I wouldn't know.

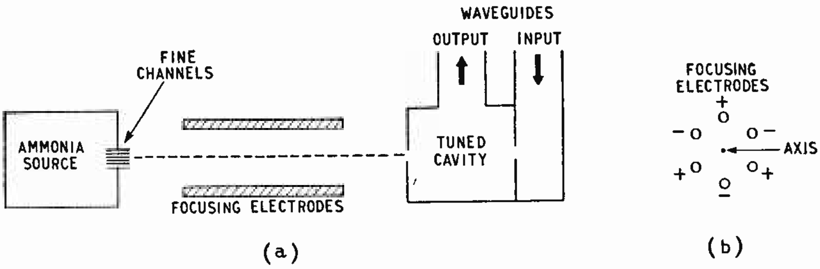


Fig. 2 Diagram showing the principle of an ammonia maser. (b) is an end view of the focusing electrodes shown in (a) in elevation.

frequencies, the uncontrolled and random delivery of energy would not amplify an existing signal properly. At the very much lower frequencies of radio, however, they normally stay quite a long time—more like 10^{-3} sec—in the upper levels. But if during that period they are exposed to a relatively small signal at their energy frequency, it is able to persuade or *stimulate* them to deliver up. Hence the "s" in "maser." This delivery of energy comes in phase with the stimulating signal, amplifying it.

At this point I'm in something of a dilemma. Truly electronic masers are a comparatively recent development, while an earlier type, which is not electronic at all in the sense we have just been considering, is too interesting to leave out. Although its basic principle is the same, its mechanism—and the form of apparatus used—is somewhat different. So let us digress a little.

When atoms come together to form molecules, they "click" into certain structural positions as a result of interaction between all their parts. Ammonia gas is peculiar in having two alternative molecular formations, with a sufficiently small energy change on going from one to the other to yield a useful microwave frequency. As you may remember, the chemical formula for ammonia is NH_3 which means that each of its molecules is a quartette made up of three hydrogen atoms and one nitrogen. The hydrogen atoms form the base of a shallow triangular pyramid, and the nitrogen the apex, as in Fig. 1.

If you have even been to an old-style lantern lecture, you may remember that the lecturer signalled to the operator by means of a slightly dished strip of steel, which when pressed sprang into a semi-stable alternative shape, radiating a sharp pulse of sound, heard by the operator (and the audience) as a click. Another click was emitted when the strip sprang back to its original form.

In somewhat similar manner, when the ammonia molecule is subjected to slight stress its nitrogen atom springs smartly through the hydrogen hoop, turning the whole thing inside out. At the same time it releases a very definite amount of energy (nearly 100 electron-microvolts) which, in accordance with $E=hf$, yields its radiation at the definite and unchangeable frequency of 23,870.13 Mc/s.

This frequency is specified to seven figures because it really can be relied upon to 1 in 10^7, which is a very useful constancy even in these days when considerably better has been done. But of course the disadvantage of constancy, for amplification, is that unless the signals you want to amplify are or can be at a frequency of 23,870.13 Mc/s it is just too bad. For some purposes it is quite possible to use this particular frequency. And where there is amplification there can usually be oscillation, and oscillation at a precisely known frequency can be used for checking other frequencies over a wide range.

Actually there are some precautions that have to be taken in order to obtain the frequency so precisely. It wouldn't do, for instance, to allow the ammonia molecules concerned to come close enough to "pull" one another. So in practice we must make them stream thinly into a high vacuum.

At normal temperatures the molecules in the higher-energy state are in a minority. So a given quantity of the gas contains more potential receivers of energy than givers. Far from amplifying a signal at the critical frequency, it would weaken it. So the potential givers of energy must be sorted out from the takers. This is done by what is known as a Stark-effect focuser, consisting of an array of electrodes in cylindrical formation around the ammonia stream, as in Fig. 2. Alternate electrodes are kept at high positive and negative potentials respectively. Along the axis, equal positive and negative are at equal distances and cancel out, so the electric field there is zero; but away from the axis it increases rapidly. The principle behind this is that excited molecules tend to move into weaker fields and unexcited into stronger. Consequently the excited ones are driven into the axial path, along which they eventually reach a cavity tuned to their radiation frequency. The others are deflected away.

A cavity is, of course, the microwave form of tuned circuit, and the input and output leads are waveguides. When a very weak signal is fed in, it stimulates the excited molecules to give up their energy, which adds to the signal, amplifying it.

Note that I said a *very* weak signal. In a part of the spectrum where energy is measured in electron-microvolts rather than electron-volts, the availability of energy would be small even if the ammonia were at atmospheric pressure. But since for the reason given it must be thinned out almost to a vacuum, the energy is very dilute indeed. In fact, the device overloads at not much more than 10^{-10} watts! That is not an insuperable objection, because the amplification can always be continued by more conventional amplifiers such as klystrons.

You may be asking who would go to the trouble and expense of a maser, with its vacuum pump and ammonia supply and other complications, if it is so drastically limited in output, and other kinds of amplifier have to be used anyway. The present-day answer might be no one, because other masers have been devised for amplification, as we shall see. But they, too, are neither cheap nor convenient. The real answer is that anyone who is more concerned with amplifying very weak signals than with cost and convenience should be interested in masers, because they differ basically from conventional amplifiers in using uncharged molecules instead of electrons. Below a certain level of signal strength, any kind of electron valve is useless as an amplifier, because the signal is drowned in valve noise—due to random electron charges, shot effect, flicker, etc. In radio

(Continued on page 199)

telescopes and radar systems, for example, the cost is already so vast that nobody is likely to jib at any reasonable device that greatly extends its range. Alternatively, for the same performance a first-stage amplifier with a better signal-to-noise ratio may actually save money, because every 3dB improvement enables the power of the transmitter to be halved. Masers have noise factors better than 1dB, contrasted with figures of the order of 15dB or worse for electronic amplifiers on the same frequency.

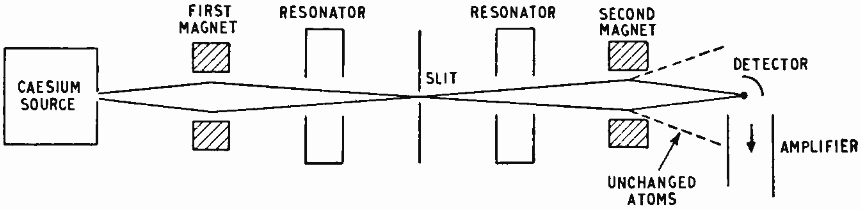


Fig. 3 Arrangement of a caesium " clock ", showing the paths of atoms in the two alternative energy states.

Its amplification (within its strictly limited output power) can be increased in the usual way by positive feedback. As with the old broadcast receivers of the 1920s, which relied heavily on this principle, it is not too easy to control so as to obtain regularity of performance. It is much easier to bring the feedback well up and let it oscillate. This it does, as in more familiar equipment, without any input signal to start it. Because the frequency depends on molecular forces which are not affected by the usual disturbing influences such as temperature, it is very reliable and constant and makes a good frequency standard. It has recently been developed to such an extent that an accuracy of ± 1 part in 10^9 has been claimed, the frequency being specified as 23,870,129,235 c/s!

Although not strictly a maser (because it doesn't amplify) a very similar device of even higher precision is the caesium frequency standard. Caesium is one of the "alkali metals", which have a single valency electron per atom. This electron can spin either in the same direction as the nucleus or in the opposite direction. The energy of the atom as a whole depends to a small extent on which, so if it changes from one state to the other there is an energy change, which happens to correspond to the frequency 9,192,631,830 c/s.

Transitions (changes from one state to the other) can, as usual, be stimulated by a signal of the right frequency. For frequency-standard purposes one must be able to tell when the frequency is right. This necessitates detecting when the transitions are being caused at the maximum rate. The frequency of a local signal generator, variable around 9,192 Mc/s, is adjusted until the rate is a maximum.

The problem, then, is to detect transitions. The amount of radiation caused is too small to be measured, so transitions are detected by making use of the fact that a spinning electron, being a spinning electric charge, is equivalent to a small current around a small turn, and therefore to a tiny magnet. So it reacts on an applied magnetic field. If the atoms are shot between the poles of a powerful magnet they are deflected, in opposite directions according to the direction of spin. If this is done twice, atoms having the same spin throughout are deflected twice in the same direction. But if they change state en route between the magnets, the second deflection cancels out the first.

Fig. 3 gives some idea of the arrangement. Caesium atoms, released by heating the metal, are made to stream into a vacuum, rather like the ammonia. The paths shown represent the two opposite types of atoms, deflected in opposite directions by the first magnet. Two cavity resonators, energized by an oscillator, are next encountered, and if the atoms are changed thereby the second magnet deflects them on to the detector; if not, they are deflected away, as shown dotted.

The target for the changed atoms is a heated tungsten wire, from which the atoms boil off minus an electron. Being now positively charged, they can be collected by a negative electrode and amplified to work an indicator.

Since a frequency standard is also a time standard. the two devices just described are sometimes referred to as the ammonia clock and cæsium clock. The latest news of the cæsium clock is that it should very soon be obtainable correct to one second in 1,000 years!

But let us get back to our masers. The comparatively recent three-level solid-state types look much less like the ammonia maser than the cæsium non-maser does. But the basic principle is the same.

You may be wondering how, if ammonia gas molecules had to be thinned out to the consistency of a fairly high vacuum to prevent their getting near enough to one another to affect their energy levels, one could possibly think of using solid material, where the molecules are packed so close that their energy levels are broadened out into wide bands. The answer is that the molecules whose energy levels are used *are* widely spaced by diluting them with a vastly greater number of idle molecules. This scheme reminds one of the transistor, in which a germanium or silicon crystal acts as a sort of solid vacuum, all the action being due to an incredibly small number of "impurity" atoms—perhaps only in the proportion of one to many millions of inactive atoms.

Again, the energy levels employed are not in the main series of electron orbit levels (which are spaced much too far apart for microwave frequencies), but are products of electron spin. The whole spin story is extremely complicated, and the particular part of it exploited in this maser is different from the one we looked at in connection with the cæsium clock.

There, the utilized energy difference was between atoms with electrons spinning in opposite directions

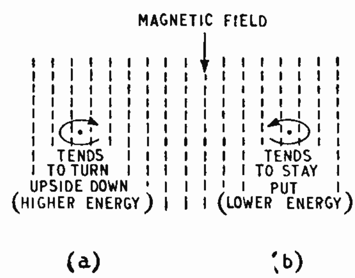


Fig. 4 The spin of an electron makes it a tiny magnet. Here two are shown with their magnetic axes parallel to an external magnetic field, (a) is in opposition to the field and (b) in the same polarity.

relative to their nuclei. In the maser, the difference is between different directions of electron spin relative to a magnetic field.

Fig. 4 may help to make this clear. The two electrons shown are equivalent to tiny magnets pointing in opposite directions. You can imagine them as microscopic compass needles. If there is no magnetic field, they have no tendency to point in any particular direction. But where there is a field they tend to line themselves up with it. Example (a), being oppositely aligned, finds itself possessed of energy to a maximum amount, for it is capable of turning through 180° against a certain amount of opposition, depending on the magnetic strength of the needle and the field. The other (b) has no such energy; it needs force to make it turn into any other direction. Between these extremes, a needle could have any intermediate amount of energy. But an electron, because it is subject to quantum restrictions similar to those that govern its orbits, can only have certain isolated energy values. These vary in almost exact proportion with the field, as shown in Fig. 5.

There are two interesting things about this. One is that a whole range of energy levels is available,

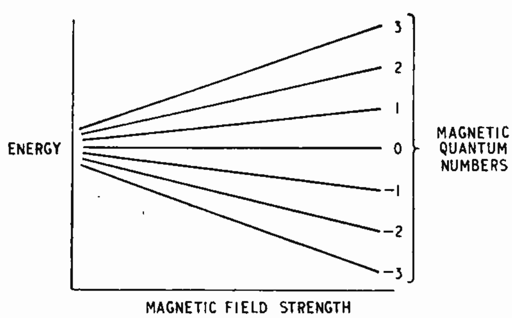


Fig. 5 The changes in energy, imparted by the external magnetic field in Fig. 4, develop along a number of separate lines (Zeeman effect). Three of these are utilized in "solid" masers.

not just two as in the ammonia and cæsium devices. They are not, in general, equally spaced. The other thing is that the energy differences—and hence the frequencies available—are continuously variable by means of the applied magnetic field.

The first thing enables one to do the exciting with power at a frequency different from the signal to be amplified. Obviously it would be no use trying to receive a very weak signal if a local oscillator was working on exactly the same frequency. So the oscillator is used to lift electrons from what might be called the basement of energy to the upper floor, and the signal works at the lower frequency corresponding to the shorter drop from upper to ground floor. The signal stimulates the excited upper-floor electrons to fall downstairs, yielding up that part of their excess energy.

Fig. 6 (a) shows how, in the absence of any exciting source, three consecutive energy levels might be populated with electrons. Between any two levels, there is a majority on the lower one, so any signal of the corresponding frequency would have a net loss of energy in raising electrons rather than a gain by their dropping back. The local oscillator,

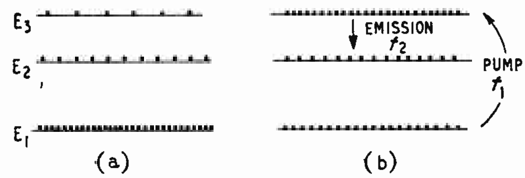


Fig. 6 Three Zeeman levels are shown here, with relative numbers of electrons in them indicated, (a) without excitation, (b) with excitation.

adjusted to frequency f_1 corresponding to $E_3 - E_1$, pumps electrons from E_1 to E_3 (Fig. 6 (b)), and a signal at frequency f_2, corresponding to $E_3 - E_2$, is thus enabled to benefit from the stimulated drop-back from E_3 to E_2. In a typical maser, f_1 is 9,400 Mc/s and f_2 is 2,800 Mc/s.

The apparatus of this maser is simple; it consists of a resonant cavity with suitable waveguide connections for f_1 and f_2, and a suitable crystal "doped" with a small proportion of atoms giving convenient magnetic energy levels. Lest that sound too easy, I must mention the inevitable snag—the need to work the whole thing at about −270°C. Hence the liquid helium mentioned in the opening paragraph. (In later models the requirement has been sufficiently relaxed for liquid oxygen, which is cheaper, to be used.) The reason for this, briefly, is that more normal temperatures keep the electrons in such agitation that they drop back and dissipate their energy before it can be usefully directed to signal amplification. In other words, the relaxation time is too short.

What may be an even more burning question in view of Fig. 5 is how the strong magnetic fields in the cæsium clock don't play Old Harry with the frequency stability. Again briefly, it is because the contrivers of that device cunningly select quantum number 0 for both upper and lower energy levels.

Before you run round to your dealer to buy yourself a maser and be told that it is temporarily out of stock, try waiting till next month to read all about another class of molecular amplifier—the mavar.

Interlocking Relay

AMONG some new relays introduced by Magnetic Devices, Ltd., Exning Road, Newmarket, Suffolk, is an interlocking model designed for alternate switching of circuits at regular or irregular intervals, as sometimes is required in electronic control equipments.

The Type 593 consists of a pair of small relays on a single mount with mutual interlock so that one or the other is always locked in. Either or both operating coils can be for a.c. or for d.c. operation and multiple contacts can be assembled on both relays. Type 593 is available as an open-type unit or hermetically sealed, the sealed version being mounted on 8-, 9- or 11-pin plug-in base according to the number of contacts fitted.

The maximum operating voltage is 140 d.c. or 250 a.c. and the current rating of the contacts is 5A at 30V d.c. or 250V a.c.

Magnetic Devices interlocking relay Type 593.

APRIL MEETINGS

Tickets are required for some meetings; readers are advised therefore to communicate with the secretary of the society concerned

LONDON

1st. I.E.E. Graduate and Student Section.—"Discriminators (F.M. Detectors) with particular reference to the Bond Disc" by S. J. Read at 6.30 at Savoy Place, W.C.2.

2nd. I.E.E.—Discussion opened by Sir Willis Jackson on "Women in engineering" at 5.30 at Savoy Place, W.C.2.

6th. Brit.I.R.E. Computer Group.—Symposium on "Large capacity storage devices" at 3.0 and 6.0 at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

6th. Radar & Electronics Association.—"Thermonuclear research" by Dr. T. E. Allibone (A.E.I. Research Laboratory) at 7.0 at the Royal Society of Arts, John Adam Street, W.C.2.

7th. I.E.E.—"An electron trajectory tracer for use with the resistance network analogue" by M. E. Haine and J. Vine at 5.30 at Savoy Place, W.C.2.

10th. I.E.E. Medical Electronics Discussion Group.—"Problems of sight, hearing and touch" opened by Professor E. C. Cherry and "Human engineering recording problems" opened by H. C. W. Stockbridge at 6.0 at Savoy Place, W.C.2.

10th. Radar & Electronics Association Student Section.—"A modern British marine radar" by D. C. Thomas (B.T.H.) at 7.0 at the Norwood Technical College, Knight's Hill, S.E.27.

14th. British Computer Society.—"The sorting of data—an attempt to measure the severity of the task" by Dr. D. A. Bell (Birmingham University) at 2.30 at the Northampton College of Advanced Technology, St. John's Street, E.C.1.

16th. British Computer Society.—"The mechanical translation of languages" by Professor L. Hogben at 6.15 at the Northampton College of Advanced Technology, St. John's Street, E.C.1.

17th. I.E.E.—"Engineering aspects of commercial television programme presentation" by T. C. Macnamara and B. Marsden at 5.30 at Savoy Place, W.C.2.

17th. B.S.R.A.—"The quest for quality" by P. Ford at 7.15 at the Royal Society of Arts, John Adam Street, W.C.2.

17th. Institute of Navigation.—"The Dectra trials" by Colonel C. Powell (Decca Navigator) at 5.15 at the Royal Geographical Society, 1 Kensington Gore, S.W.7.

21st. I.E.E.—Discussion on "The problem of maintenance of electronic equipment in the process industries" at 5.30 at Savoy Place, W.C.2.

22nd. Brit.I.R.E.—"The application of magnetic resonance to solid state electronics" by Dr. D. J. E. Ingram at 6.30 at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

23rd. I.E.E.—The Fiftieth Kelvin Lecture on "The Geophysical Year" by Sir David Brunt at 5.30 at Savoy Place, W.C.2.

23rd. Television Society.—"Design of experimental tuners for Bands IV and V television receivers" by K. H. Smith (Siemens Edison Swan) at 7.0 at the Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, W.C.2.

27th. I.E.E.—"The field strengths required for the reception of television in Bands I, III, IV, and V" by G. F. Swann at 5.30 at Savoy Place, W.C.2.

28th. Brit.I.R.E. Medical Electronics Group.—"Electron Microscopy" by Professor G. Causey and R. S. Page at 6.30 at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

BELFAST

14th. I.E.E.—"The use of analogue computing elements in the design of automatic control systems" by Professor J. C. West and Dr. J. L. Douce at 6.30 at the David Keir Building, Queen's University, Stranmillis Road.

BIRMINGHAM

27th. I.E.E.—"Stereophonic sound" by K. N. Hawke at 6.0 at the James Watt Memorial Institute.

BRISTOL

14th. Television Society.—"Wave guides and applications" by J. C. Parr at 7.30 in the Colston Room, Hawthornes Hotel, Clifton.

CAMBRIDGE

14th. I.E.E.—Six short papers on "Application of electronics" at 7.0 at the Cavendish Laboratory, Free School Lane.

CHELTENHAM

13th. I.E.E.—"Transistors in communication and control equipment—a general survey" by E. Wolfendale at 6.0 at St. Mary's College.

EDINBURGH

17th. Brit.I.R.E.—"Stereophonic sound and electrostatic loudspeakers" a demonstration and lecture by D. T. N. Williamson at 7.30 at the Department of Natural Philosophy, The University, Drummond Street.

MALVERN

2nd. Brit.I.R.E.—"A simple high-quality f.m. broadcast receiver employing a pulse-rate discriminator" by P. J. Baxandall at 7.0 at the Winter Gardens.

MANCHESTER

2nd. Brit.I.R.E.—"Principles of transistor circuitry" by B. R. A. Bettridge at 6.30 at the Reynolds Hall, College of Technology, Sackville Street.

NEWCASTLE UPON TYNE

8th. Brit.I.R.E.—"Radio exploration of the galaxy" by Dr. J. Baldwin at 6.0 at the Institution of Mining and Mechanical Engineers, Neville Hall, Westgate Road.

NORWICH

20th. I.E.E.—"High-quality sound reproduction" by J. Moir at 7.30 at Assembly House.

PORTSMOUTH

8th. I.E.E.—"Rockets and satellites" by Dr. R. L. F. Boyd at 6.30 at S.E.B. Canteen, Drayton.

SWANSEA

9th. I.E.E.—"Domestic high-fidelity reproduction" by J. Moir at 6.0 at the Conference Room, S.W.E.B. Showrooms, The Kingsway.

YORK

7th. I.E.E.—"The relation between picture size, viewing distance and picture quality" by L. C. Jesty at 7.0 at the Royal Station Hotel.

RANDOM RADIATIONS

By "DIALLIST"

Radiation Belts

DID you read the article in *Nature* (February 14th) by Professor J. A. Van Allen and L. A. Frank, of the State University of Iowa, describing the observations made by the American "Pioneer III" of radiation belts surrounding the earth? These belts are regions in which vast numbers of charged particles on their way to the earth are captured and held by its magnetic field. Their existence had been suggested, but the latest observations show that the number of such particles is about a thousand times as large as had been expected. Both the shape and the density of the belts are likely to be affected by variations in sunspot activity. At present each of the two belts discovered is shaped in section like a pair of capital C's arranged so: C Ɔ, both ends curving in towards the magnetic poles, where auroral displays and the consequent interruption of wireless communications are most common. The first belt is about 2,000 miles above the earth's surface: the second about 10,000. The authors calculate that any space traveller unlucky enough to spend an hour in either belt might receive 100 times the maximum dose of radiation permitted in a week for atomic energy workers.

Anglo-American Research

The discoveries made about these radiation belts may prove of considerable value to the joint Anglo-American research station, which is to be set up at Hillhead, near Fraserburgh in Scotland. The main object of those who work there will be to investigate possible means of counteracting interference with the working of radar when the aurora occurs. It is hoped that if some way of doing this can be found, distant early warning stations will be built in northern Scotland. One would have thought that the same problem of interruption during intense auroral displays would have cropped up in connection with the D.E.W. line, which stretches right across Alaska and the north of Canada; but I don't remember ever seeing a mention of it.

C.R.T. Repairs by Makers

IT'S good news that some manufacturers are now running a re-processing service for their c.r.ts. There can't be much doubt that there's good business to be done and the benefits to customers are indeed great. An important aspect of the scheme is that each tube will retain its identity in the course of re-processing and that there will thus be no liability to purchase tax. The cost of rebuilding a tube will work out at less than half that of a new one plus the P.T. that goes with it; and re-processed tubes will carry the makers' full guarantee. It has always seemed absurd that when the most expensive part of a TV receiver developed a fault the makers should have taken the attitude "Sorry, there's nothing we can do about it." After all, motor car manufacturers have for years undertaken the reconditioning of engines and that's very much on the same footing.

The R.I.C.

IT'S a sensible move, I feel, for the radio industry to reorganize itself into what one may call its domestic and capital goods branches. This means that the Electronic Engineering Association, though it will continue to co-operate with the Radio Industry Council, will no longer be a member of it. The annual radio show has, in general, been meant to appeal specially to the home user of sound and television receivers and sound reproducing and recording apparatus and has not catered very successfully for the people who place million-pound orders for telecommunications or broadcasting systems. It's the domestic side of the industry that interests the ordinary man and woman most. The show is in future to be run by a new company, Radio Industry Exhibitions, Ltd., formed by B.R.E.M.A., and I'm sure they'll see to it that the annual display at Earls Court, or wherever it's held, becomes better and better as it goes on.

Electronic Sex-Detection!

AN interesting device was exhibited recently at Los Angeles by the Farnsworth Electronics Co. of Fort Wayne, Indiana. This company has done a lot of work on infra-red techniques and the device was intended to demonstrate the extraordinary sensitiveness obtainable in a detector of such radiation. Looking rather like a penny-in-the-slot machine, it claims to be able to indicate the sex of a person who stands on its platform and presses a button by causing a window labelled "man," or another labelled "woman" to light up. Some ten inches or so above the level of the platform there's a detector which responds to minute amounts of heat. Should the subject be a man, the idea is that his trousers stop most of the heat radiation from his legs. On the other hand, a woman's nylon stockings don't. It's said to be a hundred per cent accurate—provided that those who consult it are wearing the traditional garments of their sexes. But it can't cope with a woman clad in trousers (and I don't blame it!) or a man wearing shorts, with bare legs.

Telephones Awheel

IT is now possible for some West German motorists whose cars carry the necessary v.h.f. wireless equipment to telephone as they drive to any number in the country. At present the service is confined to the *autobahnen* and to the neighbourhood of certain large towns. It is not a particularly cheap service, for the equipment costs well over £300 for each car and in addition there's a licence fee of over £50 a year. Still, many business firms have found it worth while to install it in order to keep in touch with their vehicles engaged in journeys about the country. It also enables business executives to keep in contact with their offices as they travel. Each licensed car has its own telephone number and can be called up as required. So long as you know roughly where the car is, it's quite easy. You just ring your exchange, give them the 'phone number of the car and its whereabouts. Exchange then puts you through to the appropriate v.h.f. station, from which the wanted car is called. There are 18 of these stations at present and work is going ahead with the other twelve needed for a country-wide service.

A New Missile?

NEVER let it be said that the Americans take themselves too seriously. Turning up some recent issues of *Electronic News* I came across an account of a new device, the MOLE (Molecular Orbiting Low-Level Explorer), in which a phase-inverted inertial "blind" guidance system will be employed to permit of downward launching. This is being developed by the designers of the well-known CAT (Consecutive Analysing Target-seeker), the night-missile with its special electronic fail-safe device guaranteeing nine lives. Security clearance for visiting these projects is obtained by feeding the subject's history into a modified Fliegenfinger computer and matching against the curve of an Accuracy Inc. non-linear potentiometer. Some modifications to this system will presumably be necessary as it has so far failed to clear President Eisenhower since he has corresponded with Mr. Kruschev, a known communist.

UNBIASED

By FREE GRID

"*Nuts*"

TO save you the trouble of rescuing the February issue from the waste-paper-basket, I would remind you that in it I told you all about my adventures with the English Electric Co.'s Deuce machine at the Electronic Computer Exhibition at Olympia. Deuce was, among other things, giving the day of the week on which any date A.D. fell, and I said I regretted that I did not ask it on which day September 5th, 1752, fell.

I received replies from the company's engineers in London, Stoke-on-Trent and Preston. They all wrote to tell me that Deuce would have replied "Nuts," which is the stock answer for any unanswerable question as, of course, mine certainly was*. It was just a catch question similar to many others such as "What was the name of the monarch who reigned in England and Scotland in 1690?" to which Deuce would certainly reply "Nuts" were it possible to put such a question to it.

I should like to thank all those who took the trouble to write to me. I should also like to congratulate the company for putting such efficient young ladies on the stand. They seemed to know all the answers, and so Deuce was, in a way, redundant.

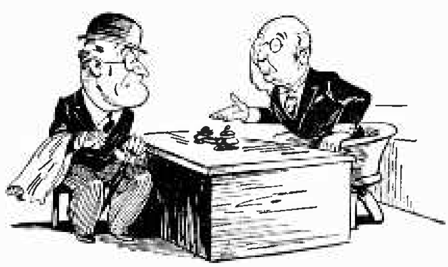
There is one thing which the Deuce engineers have not told me and that is the day of the week on which Julius Caesar invaded this country. The date was, of course, August 25th, 55 B.C., as every British schoolboy knows. Maybe some other computer manufacturer can tell me the day. After all, competition is a healthy thing.

Sub Rosa Recording

SOME time ago we heard a lot about telephone tapping, but there seems to me to be an even greater menace to the liberty of the subject. I refer to the growing practice of the *sub rosa* recording of interviews of a personal nature such as the painful one you have with your bank manager when you are seeking an overdraft.

A striking instance of this practice came to my notice recently when I had occasion to consult a psychiatrist. He was nothing if not efficient, and I soon found myself answering his pertinent—and sometimes impertinent—questions in a manner which I had no intention of doing when I first entered what I can only call his grill room. Although the consultation was very prolonged and I must have spoken several thousand words, I was astounded to notice that he did not take a single note.

The significance of this did not dawn on me until some days later when I had to return for a further consultation with this descendant of the world-famous pioneer whom the late Dean Inge referred to as "the unpleasant Dr. Freud." The psychiatrist had several pages of typescript on his desk to which he constantly referred when he was grilling me. I soon realized that at the previous interview my words must have



In the grill room.

been taken down on a concealed tape recorder.

Now I am sure you will think the psychiatrist did the proper thing when he used a man-made recorder to take down my words accurately instead of depending on the far less reliable Nature-made recorder which we call by the name of memory. It was obviously the logical thing to do.

But who expects to find logic on the patient's side of the desk in a psychiatrist's consulting room? Isn't illogicality one of the things the psychiatrist is trying to cure? Therefore as an illogical patient, I make no bones about saying that I profoundly disagree with you mentally normal people; to me this *sub rosa* recording smacks of the Gestapo.

My opinion is, of course, obviously illogical, but to my sad psychiatric way of thinking a patient should at least be accorded the same privilege as an arrested person is entitled to, namely a caution that anything he says will be taken down, etc. In other words, I don't mind the recording but I strongly object to the *sub rosa* business.

I wonder if any of you agree with me? If so it is obvious that you need treatment too.

Stereo Acoustics

I WAS delighted to see so much space in the February issue devoted to stereophony, or what should more properly be called stereo acoustics. Not only did the Editor let himself go with some very refreshing ex-Cathedra pronouncements, but the correspondence columns—always among the most interesting parts of any journal—were greatly expanded to accommodate the large number of letters on the subject.

With regard to the Editor's remarks I heartily endorse his plea for means to be provided for enabling listeners to make a proper comparison between stereo and non-stereo. I am glad to see that at this year's National Radio Show, the Audio Hall feature of last year is to be extended. But I do hope that some attempt will be made to provide a section where comparisons, such as the Editor suggests, can be made.

In his letter to the Editor, Mr. A. O. Milne points out that Nature has provided very few people with matched ears. I found out, over 50 years ago, that my own were far from being a pair, and so when I attended the Opera I always used a separate ear trumpet for each ear, a mechanical volume control being fitted to each. Nowadays, of course, I use two entirely separate transistorized hearing aids at all concerts.

Lately I have been trying the same thing for stereo listening as I do not want to be chained to the leads of a pair of headphones. Apart from being able to match up my two ears I find that the stereo effect is enhanced by turning the input end of each hearing aid to the opposite sidewalls of the room.

I also agree with Mr. Milne about the benefit of listening in complete darkness but I must give a word of warning. I found this so popular among my adolescent offspring of both sexes and their young friends that I had an ever-growing audience of young people eager to listen to stereo records in the dark.

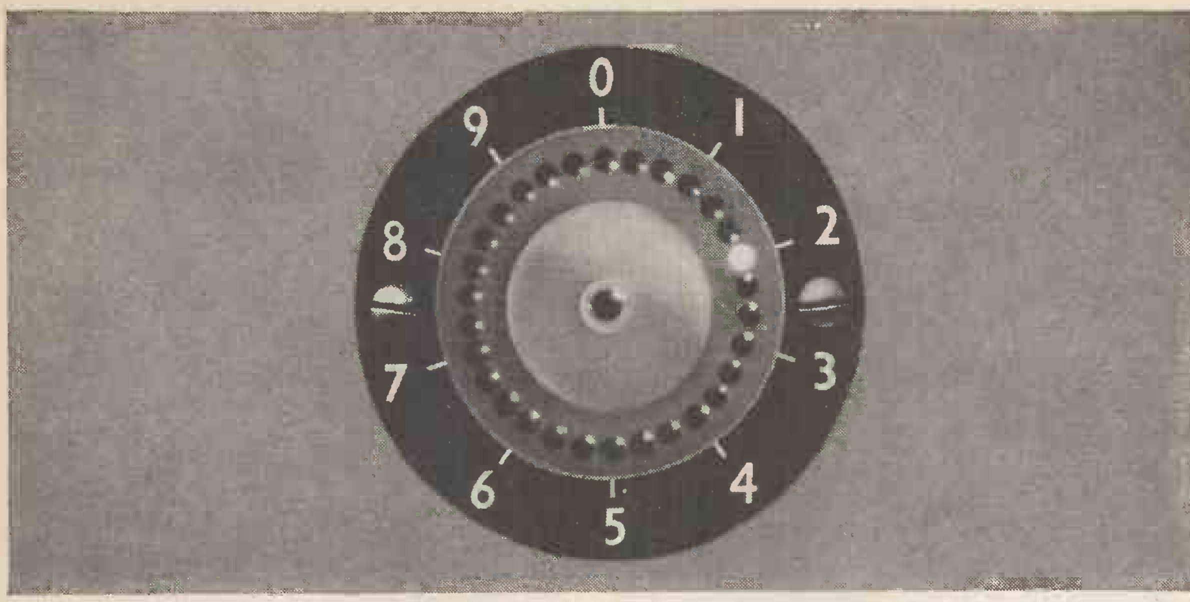
It was not until the manager of a local cinema, an old friend of mine, who, because of his occupation is well versed in one of the things which baffled even the wisdom of Solomon, dropped me a timely hint, that I realised that the young folks were turning my drawing room into a petting parlour. *verb. sap.*

Thanking You

I SHOULD like to thank Mr. H. C. Spencer for his kind remarks in the January issue in which he says he has received much constructive amusement from me for over thirty years.

I wonder if he has been confusing my writings with those of the past and present Editors as these are the only ones that have been going strong for over thirty years. I have been writing only since the issue of September 19th, 1930, so I still have 18 months to go before completing 30 years. Thank you, all the same, Mr. Spencer.

*There was no such date as September 5th, 1752. With the adoption of the Gregorian calendar that year the eleven days between September 2nd and 14th were omitted.—ED.



No interstage amplifier with this new Mullard counting tube

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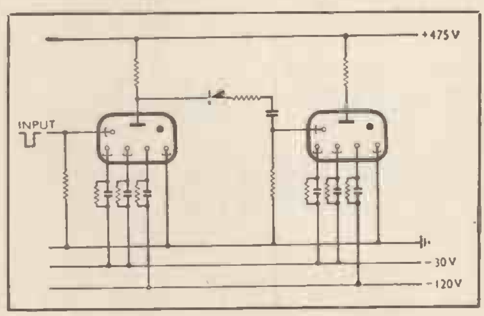

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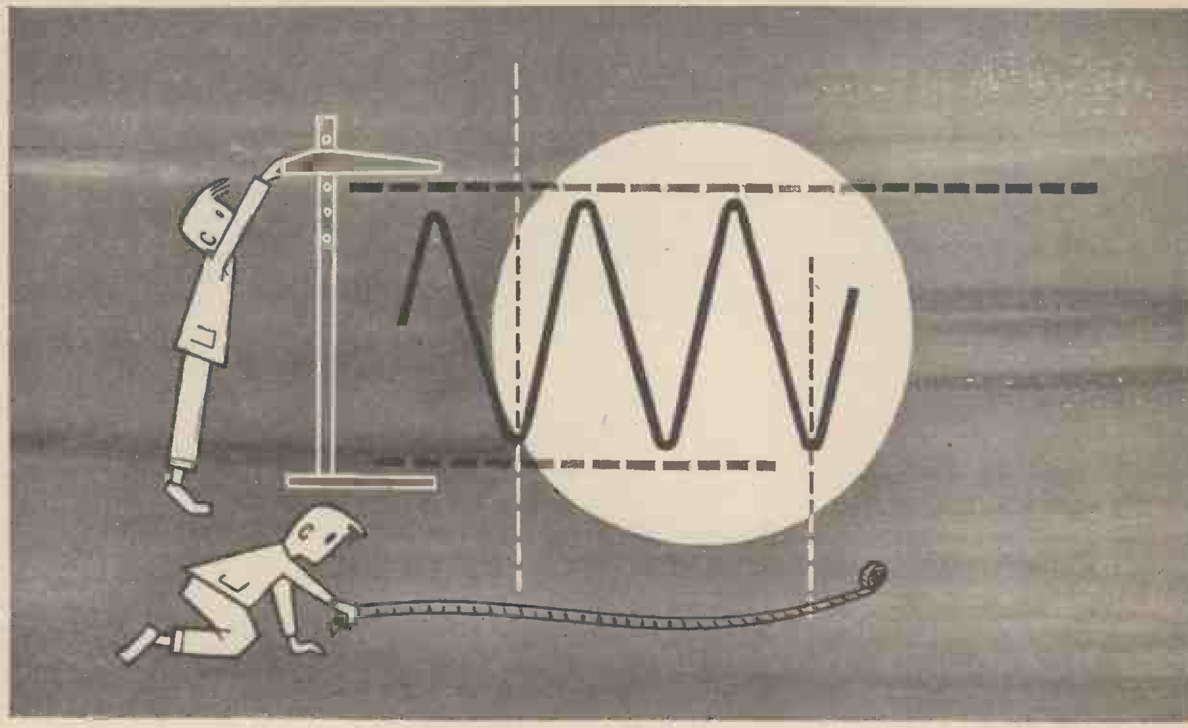

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KT30
KT32
KT33C
KT41
KT42
KT44
KT61
KT63
KT66
KT67
KT76
KT81
KT88
KTW61
KTW62
KTW63
KTZ41
KTZ63
KTZ73
L2
L4
L9
L21
L30
L63
L77
L610
LD210
LD410
LL2
LL4
LN152
LN309
LP2
LP4
LP6
LP25
LS5
LS7
LS650
LSD3
LSD7
LZ319
M2H
M6H
M125H
M8083
M8098
M8100
M8163
MH4
MH41
MH4105
MHL4
MHLD6
ML4
ML6
MPT42
MR10
MS4B
MSP4
MSP41
MSPEN
MSPENB
MT9F
MT9L
MT5544
MU12/14
MVS/PEN
N14
N15
N16
N17

N18
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N77
N78
N142
N150
N151
N152
N153
N154
N309
N339
N359
N709
N727
NC6
NC7
NC9
NC10
NC11/12
NC13
NC16
NC18
NE16/991
NGT1
NGT5
NR31
NS2
NS5
NSP1
NT57T
NT63A
NT86
NT98B
NT98C
NT100
NU2
NU4
NU5
NU33
O9D
OA2
OA2WA
OA3
OA4/G
OA71
OA150
OA159
OA161
OA172
OB2
OB2WA
OB3
OC3
OC44
OC45
OC71
OC72
OM4
OM5
OM5B
OZ4
OZ4A
OZ4G
P2
P4
P27/500
P215
P535/1E
P552/1E
P625
PA1
PABC80
PCC84
PCC85
PCC88
PCF80
PCF82
PCL81
PCL82
PCL83
PCL84
PD220A
PEN/A4
PEN/25
PEN/36C
PEN46
PEN220A
PEN383
PEN1340
PL21
PL36
PL81
PL82
PL83
PL84

PM07
PM2
PM2A
PM2B
PM4DX
PM202
POVT25
PP3/250
PP5/400
PP35
PP225
PT5
PT15
PTA
PX4
PX25
PY80
PY81
PY81F
PY82
PY83
QA2403
QA2404
QA2408
QB3/200
QF40
QP21
QP25
QQE4/20
QQV5/P10
QQV03/10
QQV06/40
QQV07/40
QS70/20
QS75/20
QS75/60
QS83/3
QS95/10
QS108/45
QS150/15
QS150/40
QS150/45
QS1200
QS1209
QV06/20
QV04/7
QY2/100
R1
R2
R3
R3/10
R3/16
R10
R16
R18
R19
R43
REL21
REL36
RG1/125
RG1/240A
RG3/522
RG6/45
RK20A
RK25
RK28A
RK34
RK39
RK47
RK48A
RK57
RK59
RK73
RK75
RK235
RKR73
RL37
RM1
RM1A
RM2
RM3
RM4
RS1006
RS1007
RS1009
RV200/600
RX233A
RX235
S22AF
S25A
S26A
S27A
S28A
S130
S130P
SD6

SD61
SIM2
SIM5
SP2
SP4
SP13C
SP22
SP41
SP42
SP61
SP210
ST11
STV70/20
STV280/40
STV280/80
SU750
SU2150A
T41
T200
TH4A
TJ1
TJ2
TJ3
TP1
TP8
TP22
TP25
TRC44
TRC45
TRC70
TRC71
TRC72
TT4
TT11
TT12
TT15
TT16D
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TTR31
TVO3/10
TVO5/12
TY1/50
TY2/125
TZ20
TZ40
U10
U12/14
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UABC80
UAF42
UB41
UBC41
UBF80
UBF89
UBL21
UC92
UCC85
UCH21
UCH42
UCH81
UCL11
UCL81
UCL82
UF21
UF41
UF42
UF43
UF80
UF85
UF89
UL41
UL84
UM4
UM11
UM35

UM80
UM85
UQ80
UU5
UU6
UU9
UY1N
UY11
UY21
UY41
UY85
V6/R4
V10/15A
V30
V226
V872
V884
V885
V888
V1120
V1906
V2023
VCR85
VCR97
VCR131
VCR138A
VCR139A
VCR140
VCR140A
VCR263
VCR511B
VCR516
VCR516A
VCR517A
VCR517B
VCR517C
VCR517E
VCR518A
VCR522
VCR526
VCR528
VCR529
VCR530
VCRX221
VCRX263
VCUC
VCUF
VCUN
VCUP
VGT121
VGT128
VI32
VLS492A/G
VLS631
VMP4G
VP6
VP21
VP23
VP41
VR21
VR32
VR37
VR53
VR54
VR59
VR75/30
VR90/30
VR91(A)
VR105/30
VR135
VR150/30
VS24
VS110A
VT4C
VT13B
VT23
VT45
VT46
VT58A
VT60
VT60A
VT61A
VT61B
VT68
VT82
VT93
VT94
VT100B
VT107
VT108
VT501A
VT510
VU29
VU33
VU39
VU71

VU72
VU113
VU120
VU120A
VU133A
VU134
VU504
VU508
VX3027
VX3147
VX3153
VX4024
VX6010
VX7006
VX7056
VX7083
VX9075
VY2
W21
W31
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W709
W719
W727
W2232
WD30
WD142
WD150
WD709
WE3A
WL417A
WL5846
X14
X17
X18
X21
X22
X22M
X24
X31
X41
X56
X61
X63
X64
X65
X66
X71
X77
X78
X79
X81
X143
X150
X715
X727
XC15
XFG1
XFR1
XFR3
XFY1
XR4
Y63/61
YF
Z14
Z19
Z21
Z21M
Z22
Z22M
Z31
Z62
Z77
Z142
Z150
Z319
Z719
Z729
Z759
Z900T

Contractors to British Commonwealth and foreign Governments, for Army, Navy and Air Forces, Post Offices, Civil Air Lines, etc.
Tubes can be supplied Commercial, C.V., or JAN specifications.
Our organisation is A.R.B. approved.

HALL ELECTRIC LTD

HALTRON HOUSE, 49-55 LISSON GROVE, LONDON N.W.1.

HALTRON HALTRON

Tel.: Ambassador 1041 (5 lines) Cables: Hallectric, London

TEST INSULATION and CONTINUITY with One instrument

the EVERETT EDGCUMBE

METROHM

The Metrohm represents a tremendous technical advance in insulation and continuity testers. It combines ease of operation and high technical quality with a sturdy robust design and construction which will ensure very many years of trouble-free service.

Here are some of the METROHM features:

- 500-volt insulation and continuity tests combined in a single instrument.
- Easy one-hand operation.
- Transistorised for high conversion efficiency.
- Printed circuit for extra reliability.
- Clear-reading protected dial.
- Positive steady readings.
- Back cover carried on moulded front panel.
- Practically ripple-free—only 0.1% ripple.
- Long battery-life.

PRICE: *Complete with detachable polythene front cover, leather sling strap and 5 ft. test leads fitted with crocodile prod clips.*

£21. 12. 0

250 and 100 volt models also available.

For fuller technical description and applications write for Sheet 242 A.

EVERETT EDGCUMBE & CO. LTD.

COLINDALE WORKS · LONDON · N.W.9

Telephone: COLINDALE 6045

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Branch Offices: BIRMINGHAM · CARDIFF · GLASGOW · MANCHESTER · SHEFFIELD

DBH/6587

Permanent Magnets

Design Advisory Service

No. 13

Television Applications -1

Advertisements in this series deal with general design considerations. If you require more specific information on the use of permanent magnets, please send your enquiry to the address below, mentioning the Design Advisory Service.

Television receiver circuits have been greatly simplified by the use of permanent magnets which require no current and do not generate heat. The main applications include focusing, ion traps, beam centring, picture correction and magnetic bias for linearity controls.

TV Focusing

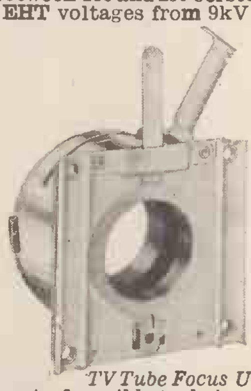
The magnetic focusing of television tubes is achieved by a concentric magnetic field acting as a lens. The focusing action results from the magnetic field which has a rotational symmetry about the axis of the lens.

The focal length f is given by

$$\frac{1}{f} = \frac{0.0347}{V} \int_{z=-\infty}^{z=+\infty} H_z^2 \, dz$$

where V *is the potential difference traversed by the electrons before they enter the lens and* H_z *is the magnetic field strength along the axis.*

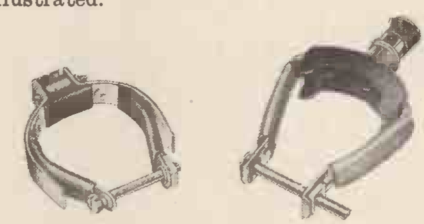
Axially magnetised 'Magnadur' 1 rings can be used for focusing and are mounted on the tube neck so that they can repel each other. Rings having peak central fields of between 180 and 250 oersteds will focus tubes with **EHT** voltages from 9kV to approximately 20kV respectively. Adjustment in the magnetic field is obtained by axial movement of one of the rings. This alters the working point of each magnet, thereby varying the field strength, and also affects the leakage field. The further the magnets are from each other, the stronger the central field inside the rings and the greater the focusing effect. Using this focusing system, picture shift can be made by slight movement of a mild steel ring on the face of the magnet nearest to the screen.



TV Tube Focus Unit

Ion Traps

To avoid ion burn of the screen of a picture tube, the electron gun is set at an angle and a simple magnet assembly giving a uniform diametric field is placed over the neck of the tube about ½" along the beam. This deflects the electrons through the grid and first anode while the heavier ions are relatively unaffected and strike a suitable target in the electrode assembly, and do not reach the screen. A field between 55 and 70 oersteds is normally required for this beam deflection and is obtained from a small cylindrical magnet, ⅜" long and 5/16" in diameter clamped between two mild steel semicircular pole pieces as illustrated.



Typical Ion Trap and Picture Centring Device

Beam or Picture Centring Devices

Magnets of various types are used to provide the magnetic field necessary to correct or shift the electron beam so that when it has passed through the deflection coils the picture is central on the screen. Usually the field required varies between zero and 10 oersteds.

'Pin-Cushion' Correction

To achieve good overall focus on 90° and 110° picture tubes, it is advantageous to have a pin-cushion shaped raster. The raster shape can be corrected by magnets placed one on each side of the deflection coils. 'Magnadur' 1 rod magnets 1¼" long x 3/16" dia. magnetised axially are normally adequate to correct this type of distortion.

By suitable choice of magnets and steel pole pieces, it is possible to increase the line scan width. This technique can be used as a means of making small adjustments to the line width.

Linearity Controls

A further use for permanent magnets is to provide the magnetic field to bias a Ferroxcube rod on which the linearity coil is wound. Adjustment in linearity can easily be made by moving the magnet so varying the degree of magnetisation of the Ferroxcube rod. A neat arrangement uses a 'Magnadur' tube approximately 1¼" long x ⅜" dia. with the Ferroxcube rod situated inside and the coil wound on the end of this rod.

If you wish to receive reprints of this advertisement and others in this series write to the address below.

Redifon brings you

2-Channel reception on a single carrier

with the NEW AFS-12 Twinplex Frequency Shift Converter

- DUAL OR NON-DIVERSITY RECEPTION
- AMPLE MARGIN FOR TRANSMITTER/RECEIVER FREQUENCY DRIFT
- VISUAL AND AURAL MONITORING
- REPLACES THE STANDARD F.S. CONVERTER
- INSENSITIVE TO RAPID FADING AND INTERFERENCE
- SELF-CONTAINED ISOLATED D.C. TELEPRINTER SUPPLY

The Twinplex Converter Type AFS.12 is part of a twinplex communication system which makes possible a two-channel radio circuit, whereby two telegraph transmissions modulate a single radio carrier-wave by causing the carrier to assume one of four specific frequencies at 400 c/s intervals. The Twinplex Converter is used at the receiving end to demodulate and separate the four audio tones from the radio receiver into two channels, each carrying the originally transmitted intelligence. The AFS.12 replaces the standard frequency shift converter for this purpose.

This new Twinplex Converter incorporates many new features which give performance on twin-channel operation better than that of most single channel frequency shift converters.

Input impedance:
600 ohms, balanced.
Input level:
—50 to +8 dbm.
Input frequencies:
1955, 2355, 2755 and 3155 c/s.
Input frequency shifts:
Minimum 400 c/s, maximum 1200 c/s.
Keying speed:
200 bauds maximum (240 w.p.m. max.)
Output:
Up to 75 mA into 2000 ohms, floating (self-contained) teleprinter supply.
Power supply:
100-125 and 200-250 volts, 50/60 c/s.
Mounting:
Standard 19 ins. rack.

REDIFON LIMITED Communications Sales Division, Broomhill Rd, Wandsworth, London S.W.18. Tel: VANdyke 7281

A Manufacturing Company in the Rediffusion Group

Introducing the *Redifon* Type RA.10

A NEW TRANSISTORISED SSB/ISB RECEIVER ADAPTOR

- DSB/SSB/ISB Reception.
- Full, partially suppressed or totally suppressed carrier.
- Upper/Lower Sideband Selection.
- AFC correction ± 3 Kc/s.
- Self-contained - A.C. Power Unit and Dual A.F. Amplifiers.
- Built-in monitor speaker and tuning indicator.

Facilities:

Reception of:

(a) DSB full carrier signals using either sideband—reconditioned with AFC or locally generated carrier.

(b) SSB partially suppressed carrier signals (up to 26 dB) using upper or lower sideband—reconditioned with AFC or locally generated carrier.

(c) SSB totally suppressed carrier signals using upper or lower sidebands—locally generated carrier without AFC.

(d) ISB partially suppressed carrier signals (up to 26 dB)—reconditioned with AFC or locally generated carrier.

(e) ISB totally suppressed carrier signals—locally generated carrier without AFC.

For the reception of DSB/SSB and ISB signals with Communication Receivers such as the Redifon type R.151, R.145 or R.150, or any Receiver which will provide 0.1 Volt R.F. Input between 95-480 Kc/s.

The RA.10 is completely self-contained with A.C. Power Unit and built-in dual A.F. Amplifiers, thus eliminating the need for interfering with existing Receiver power and audio wiring. Separate audio outputs associated with the upper and lower sideband are provided and a monitor speaker may be switched to either channel as required. The use of transistors reduces the size, weight, power consumption and heat dissipation to a minimum.

Input Impedance: 75 ohms.

Input Level: 0.1 Volt, r.m.s.

Unwanted Sideband Rejection: Better than 50 dB.

Intermodulation products: Better than 30 dB down.

Automatic Frequency Control: Up to ± 3 Kc/s.

A.F. Response: 300-3000 c/s. within 6 dB.

A.F. Output:

(a) 1.5 W. at 3 ohms for external loudspeaker.

(b) 0.5 W. at 3 ohms for internal speaker.

(c) 6 mW at 600 ohm balanced (upper sideband).

(d) 6 mW at 600 ohm balanced (lower sideband).

(e) Low impedance headphones output, internal speaker muted when in use.

Tuning Indicator: A meter is provided to assist in tuning the adaptor.

Power Supply: 100/125 and 200/250 V. 50/60 c/s. Single Phase, A.C.

Power Consumption: 30 W. approx.

Dimensions: 19" wide x 3½" high x 13½" deep.

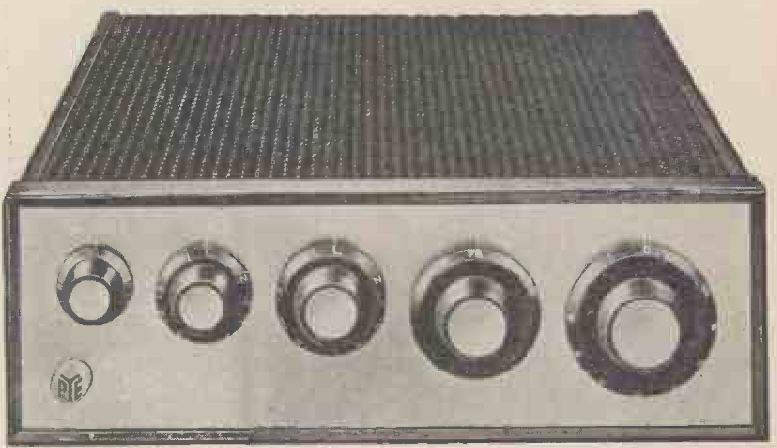
Weight: 27 lbs.

REDIFON LIMITED
Communications Sales Division, Broomhill Road, London S.W.18 • Tel: VANdyke 7281
A Manufacturing Company in the Rediffusion Group

Take an outstanding amplifier...double it...and you have the finest instrument of its kind available today

Mozart

DOUBLE 10 WATT STEREO AMPLIFIER



MODEL HFS20 (CHASSIS)
MODEL HFS20M (CASED)

TECHNICAL SPECIFICATION PER CHANNEL

PRE AMPLIFIER

Sensitivities P.U. 7 mV. Tape 100 mV. Radio 100 mV. Tape record output 300 mV at above specified input sensitivities.

Hum and Noise P.U. —55 db. Tape —60 db. Radio —60 db.

Frequency Response Tape 20 to 20000 cycles ± 1½ db. Radio 20 to 20000 cycles ± 1½ db. P.U. Within 1½ db of published relay curves.

Channel Separation between —40 db and —50 db overall.

Controls Volume: Continuously variable. Bass: + 10 db to — 15 db at 50 cycles. Treble: + 10 db to — 15 db at 10000 cycles. Balance: Variation of 6 db per channel. Illuminated Push/Push on/off switch.

Selector Switch 5 Position: Tape. Radio. 78 (all 78 records). L.P.O. (Pre 1955 recordings) L.P.N. (Recordings to R.I.A.A.).

Output 0.2 V into 100K for above stated input sensitivities.

Pick-up matching by "Dialomatic" compensation.

Control panel is identical in size and finish to the Mozart FM Tuner.

MAIN AMPLIFIER

Sensitivity 0.2 V.

Output 10 watts per channel.

Distortion 0.3% total harmonic at 9 watts.

L.F. Power Output 8 watts at 40 cps.

Loudspeaker Impedance 4, 8, and 15 ohms (with phase reverse switch).

Damping Factor 30.

Hum and Noise —70 DB with 100K input impedance.

Frequency Response 10-50,000 cycles ± 2 db.

Negative Feedback 27 db (in 3 loops).

Total Power Consumption 110 vA.

Mains 200 V to 250 V AC 50 cycles. 110 V to 120 V AC 60 c.p.s. (Export model)

HIGH FIDELITY IS A SPECIALIST BUSINESS

Meticulous attention is paid to every detail. Exacting performance tests are carried out at every stage. Hand-finishing is by experts. The result is a range of instruments which are among the finest available in their power rating.

PYE HIGH FIDELITY SYSTEMS

Tecnico Ltd., Sydney, Australia.

Pye Limited, Auckland, C.I. New Zealand.

Deutsche Pye G.m.b.H., Berlin-Zehlendorf-West, Roonstrasse 2, Germany.

Svenska Pye A.B. Landsvagen 47, Sundbyberg, Sweden.

Pye (Ireland) Ltd., Dublin, Eire.

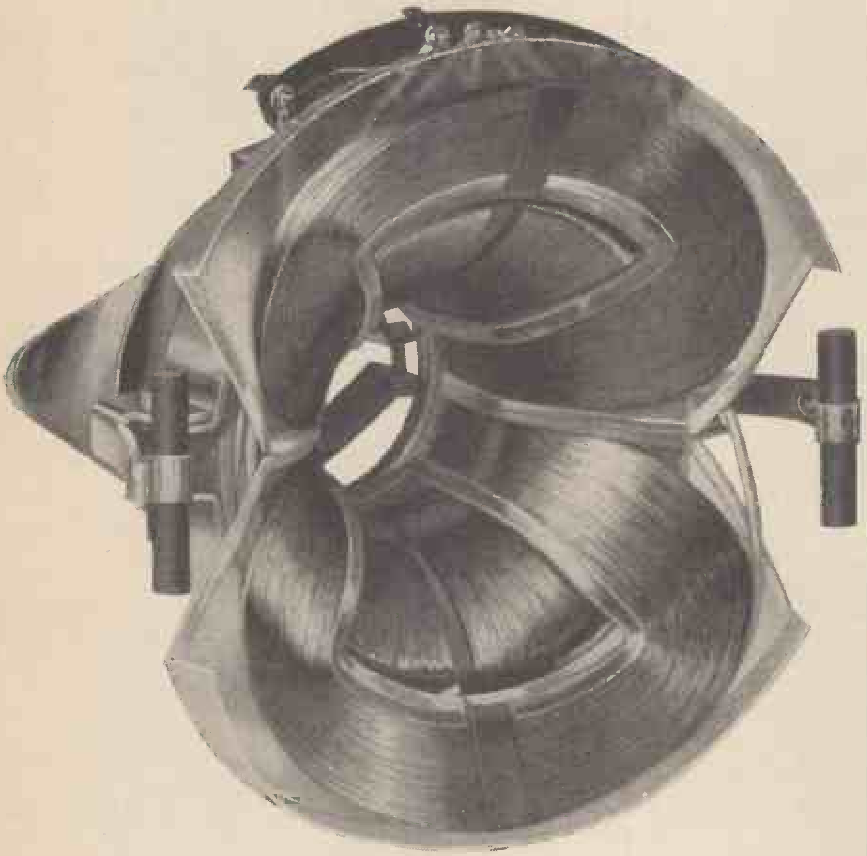
Pye Limited, Mexico City.

Pye (Canada) Ltd., Northline Road, Toronto.

Pye Corporation of America, 1149 Raritan Avenue, Highland Park, New Jersey, U.S.A.

PYE LIMITED, HIGH FIDELITY DIVISION. FAIRVIEW ROAD, LONDON, S.W.16

now in quantity production



ELAC 110° Scanning Coil

ELAC

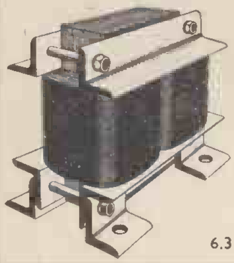
This latest ELAC deflection unit incorporates the new MULLARD Ferroxcube core Type FX 1981, enabling a "pull back" of 4 mm to be achieved without loss of sensitivity.
Line inductances of 5 to 30 mH with $\frac{L}{R}$ RATIO OF .8 and frame impedances of 2 to 70 ohms are readily available. The standard model is supplied complete with TUNGSTEN steel picture centring plates, positive tube neck clamping device and a terminal panel well removed from adjustment points.

ELECTRO ACOUSTIC INDUSTRIES LTD., Stamford Works, Broad Lane, London, N.15.
Tel: TOT 0505.

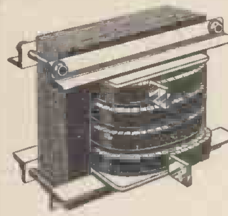
TRANSFORMERS

All for 220/250 V. Input, Other Supply Voltages as Required
CONTINUOUS RATING, Short Rating Transformers also available

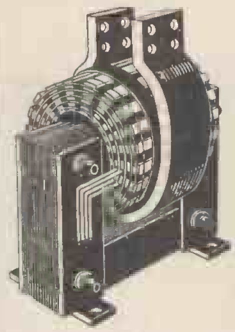
Each of the eight Transformers below:—



£6/10/-
OUTPUTS:
12 V. 40 Amps.
6-12-18-24-30 V. 12 Amps.
5 V. 80 Amps.
18 V. 30 Amps.
110-120 V. 4 Amps.
55 V. 12 Amps.
4 V. 100 Amps.
6.3 V. 18 Amps. or 12.6 V. 9 Amps.

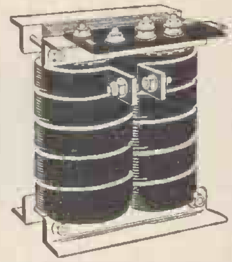


5 V. 140 Amps.	£8 10 0
110-120 V. 10 Amps.	£12 10 0
40 V. 25 Amps.	£13 15 0
5 V. 300 Amps.	£15 0 0
6-12 V. 50 Amps.	£8 10 0
12 V. 60 Amps.	£10 0 0
12 V. 100 Amps.	£15 10 0
50 V. 60 Amps.	£21 0 0
110 V. Centre Tapped 55 V. 25 Amps.	£26 0 0
10-15-25 V. 100 Amps.	£26 0 0
6-8-10-18-24 V. 100 Amps.	£28 0 0



4 V. 5,000 Amps.	£100 0 0
2 V., 10,000 Amps	£98 0 0
3.5V., 20,000 Amps.	£127 0 0
2 V., 30,000 Amps.	£130 0 0
10 V., 2,000 Amps.	£103 0 0

10 V.	1,000 Amps.	£59
10 V.	500 Amps.	£38
10 V.	750 Amps.	£48
9 V.	900 Amps.	£49
12 V.	1,000 Amps.	£64
15 V.	1,000 Amps.	£75
20 V.	800 Amps.	£80
10 V.	300 Amps.	£28

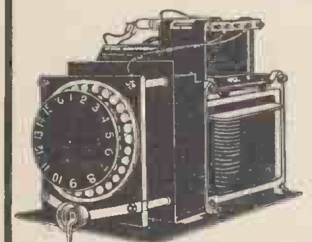


PORTABLE SHROUDED TRANSFORMERS

Each of the five Transformers below:—
£8.12.0.

6-12-18-24-30 V., 12 Amps.
24 V., 30 Amps.
110-120 V., 4 Amps.
12 V., 40 Amps.
55 V., 12 Amps.

Most Transformers up to 2 kVA can be supplied in a steel case with protected terminals and carrying handle.



VOLTAGE REGULATING TRANSFORMERS

£16

Input 230/240 V. Output 50 V. to 250 V. in 16 steps of 12.5 V. at 25 Amps. These are Auto Transformers with Quick Make-and-Break Tapping Switches.

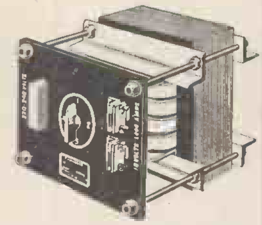
HIGH-VOLTAGE TRANSFORMERS

1450 V. 300 mA.	£8 10 0
3 kV. 2 mA.......	£4 0 0
10 kV. .23 mA....	£9 0 0
4 kV. 2.5 mA. ...	£5 0 0

TRANSFORMERS WITH SWITCHED TAP CONTROL

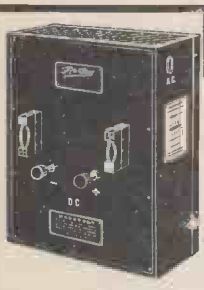
Available with one or more Switches, Ammeters, Fuses, etc.

TRANSFORMERS WITH INFINITELY VARIABLE CONTROL OF OUTPUT



Combinations of Transformer with attached Variac for very fine control.

MANY OTHER STOCK TRANSFORMERS



RECTIFIER SETS

All for 200/250 V. A.C.
(Other supply Voltages available)

Rectifier Sets with D.C. Output Control by internal taps.
D.C. Volts ON LOAD are stated.

110/120 V. D.C., 10 Amps. ...	£29 0 0
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200/250 V. D.C., 18 Amps. ...	£46 0 0
35/38 V. D.C., 50 Amps.	£40 0 0
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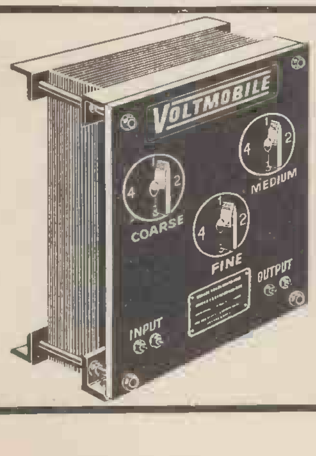

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Covering the range from zero Volts to supply Volts in 64 steps. This is achieved by switching ON LOAD.

INPUT 240 V. OUTPUT 0/240 V. Change per Step, 3.8 V. (1.6%)		INPUT 420 V. OUTPUT 0/420 V. Change per Step, 6.5 V. (1.6%)	
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350/440 V. 3 Phase input

12 V. 210 Amps. or 24 V. 105 Amps.	£78
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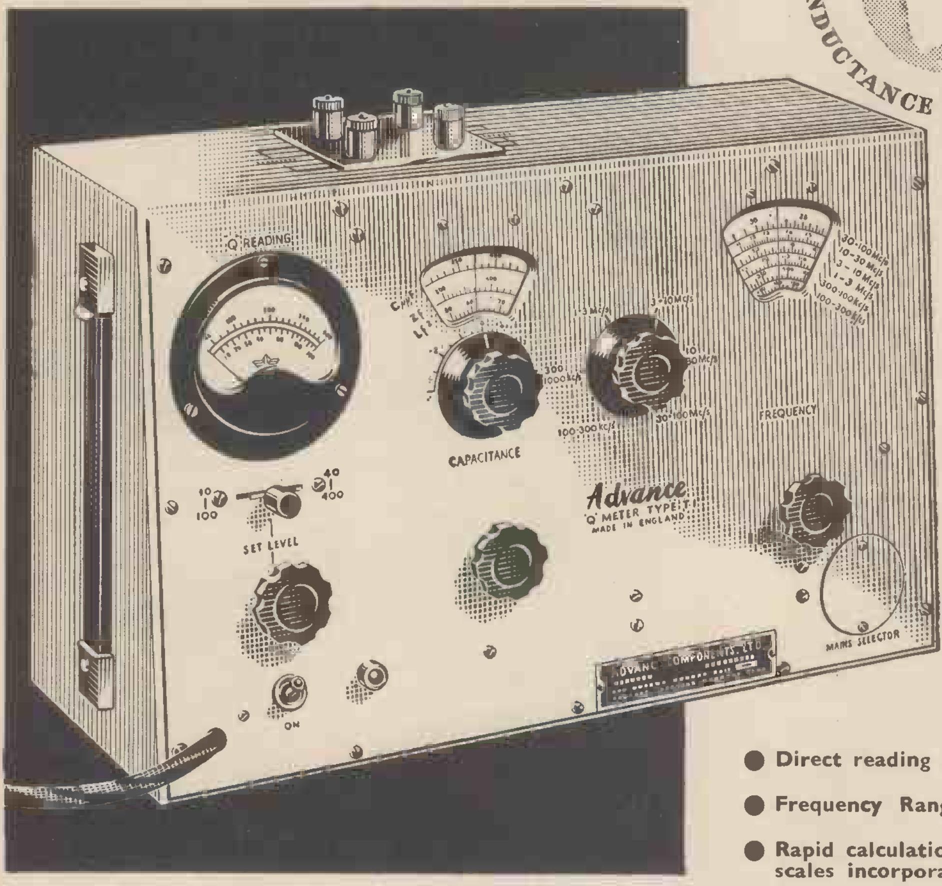
CIRCUIT MAGNIFICATION 'Q' METERS

INDUCTANCE CAPACITANCE



- Direct reading of 'Q' Range 10-400
- Frequency Range 100 kc/s-100 Mc/s
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- No 'Set Zero' problem

The 'Q' meters Models T1 and T2 provide a convenient method of making R.F. measurements of circuit magnification, inductance, capacitance and power factor at frequencies between 100 kc/s and 100 Mc/s. The two models are identical except that the Model T2 provides additional facilities for comparing 'Q,' inductance and capacitance, and is most suitable for the production testing of coils.

by **Advance** —to be sure!

Model **T1** nett price in U.K. **£65**
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Full technical details of Model T1 in Leaflet No. W31 and of Model T2 in Leaflet No. W44.

STANDARD INDUCTORS TYPE **Q101**

Consisting of 12 coil units covering inductances from 0.1 μH to 30 mH for use with the Advance 'Q' meters. Individually calibrated these coils are 'standards' for the laboratory

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Full technical details in Leaflet No. W55.

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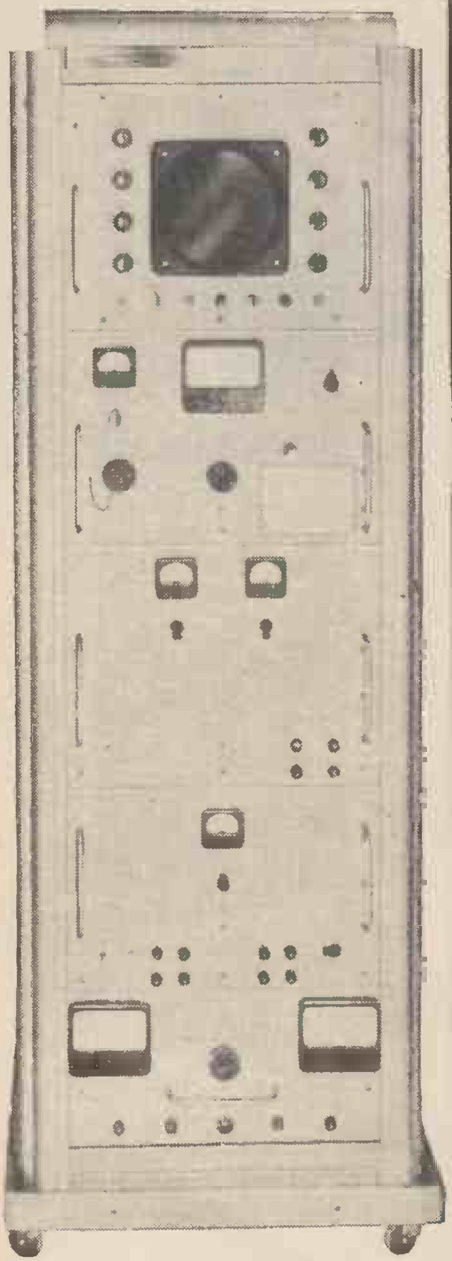

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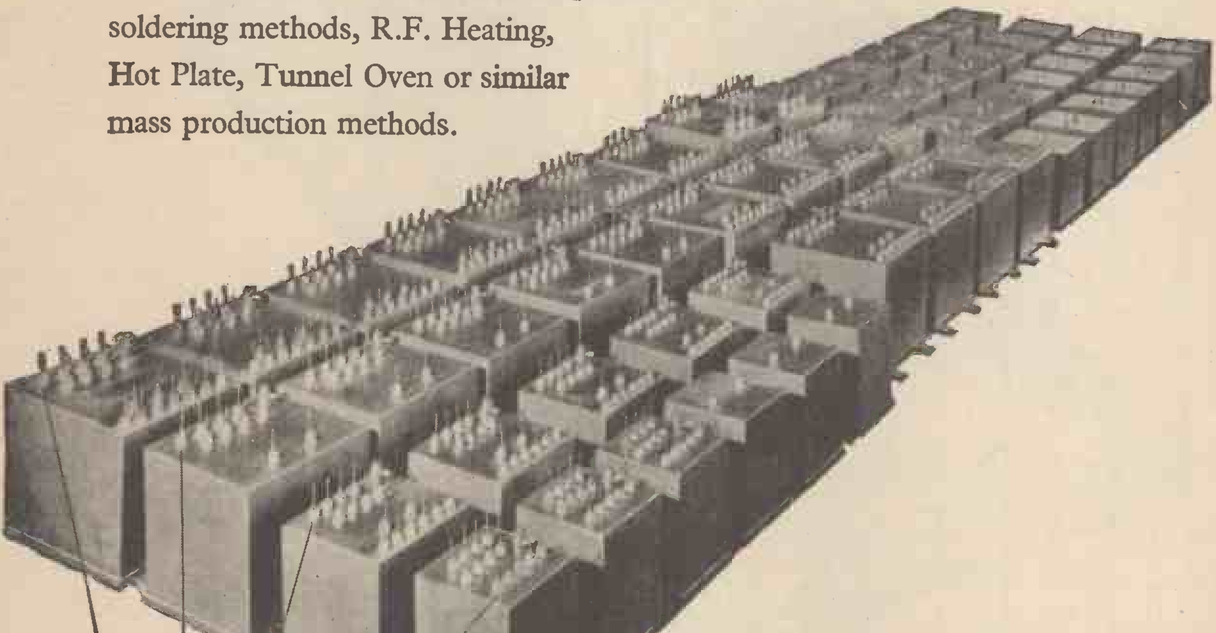
Quality Approved (Joint Service R.C.S.C.)

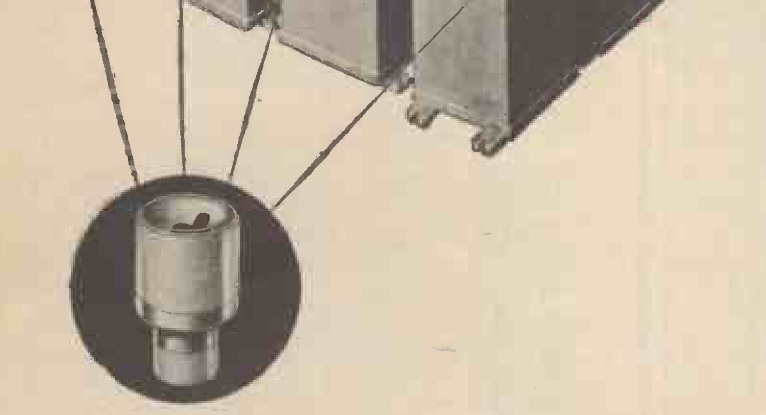
WILL MEET THE MOST EXACTING REQUIREMENTS

METALLISED BUSHES

Perfect Terminations

—made readily without special precautions by semi-skilled labour, employing simple hand soldering methods, R.F. Heating, Hot Plate, Tunnel Oven or similar mass production methods.





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Shouldered, Tubular, Conical, Disc and multi seals are included, assembled with stems if preferred.

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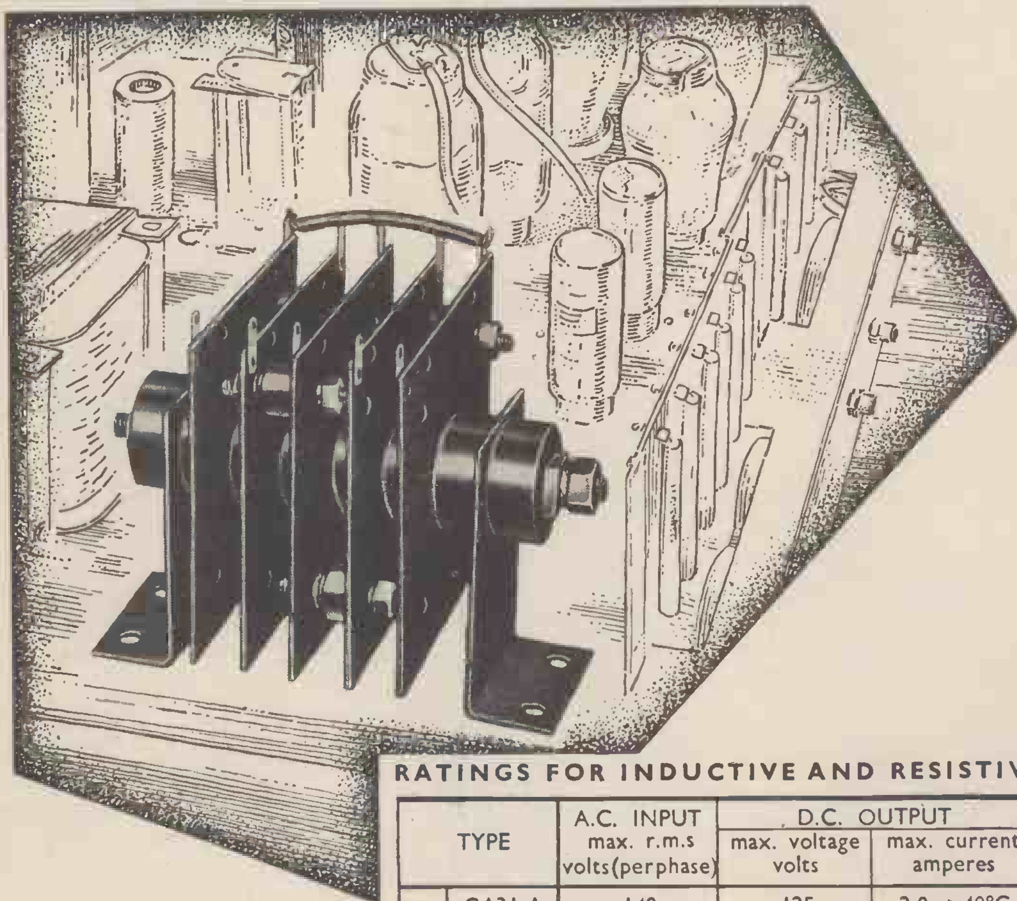

RATINGS FOR INDUCTIVE AND RESISTIVE LOADS

	TYPE	A.C. INPUT max. r.m.s volts (per phase)	D.C. OUTPUT max. voltage volts	D.C. OUTPUT max. current amperes	OVERALL LENGTH inches
SINGLE-PHASE	GA31-A	140	125	2·0 at 40°C	$3\frac{1}{2}$
	GA41-A	53	47	2·0 at 60°C	$3\frac{1}{2}$
	GA51-A	210	187	2·0 at 40°C	$3\frac{1}{2}$
	GA61-A	106	94	2·0 at 60°C	$3\frac{1}{2}$
	GA52-A	340	303	2·0 at 40°C	5
	GA62-A	170	151	2·0 at 60°C	5
	GA53-A	510	455	2·0 at 40°C	$6\frac{1}{2}$
	GA63-A	254	227	2·0 at 60°C	$6\frac{1}{2}$
THREE-PHASE	GB31-A	140	188	3·0 at 35°C	$4\frac{5}{8}$
	GB41-A	53	71	3·0 at 55°C	$4\frac{5}{8}$
	GB51-A	210	283	3·0 at 35°C	$4\frac{5}{8}$
	GB61-A	106	143	3·0 at 55°C	$4\frac{5}{8}$
	GB52-A	340	458	3·0 at 35°C	$6\frac{3}{4}$
	GB62-A	170	229	3·0 at 55°C	$6\frac{3}{4}$

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THE RESULT OF 4 YEARS' PROGRESSIVE DEVELOPMENT

THE STEREO PICKUP

for playing 45/45 records. Miniature ceramic type with replaceable diamond stylus. Constant velocity output approximately 20mV from each channel. Frequency range 20 to 16,000 cycles. Channel separation 20/25 dbs.

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Operates at 33⅓, 45 and 78 r.p.m. Non-ferrous turntable. Built-in large stroboscope with internal light source. Precision ground and lapped spindles. Adjustable nylon graphite bearings. Synchronous motor.

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Twin channel amplifier and pre-amplifier for reproducing monaural and stereophonic sound from disc, radio and compensated tape.
Ultra linear push/pull output giving 7.5 watts peak from each channel.

Amplifier £24 . 10 . 0
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SIGNAL GENERATOR Model 68 A/M

With Meter for Monitoring Output

Exceptionally Wide Range – 100 Kc/s – 240 Mc/s.

All on FUNDAMENTALS.

Designed for use in the servicing of television and radio receivers, and may also be used in the C-W alignment of discriminators, ratio detectors and the RF and IF stages of FM receivers. A meter is incorporated for monitoring output.

OUTSTANDING FEATURES:

Ranges	100 Kc/s–300 Kc/s, 300 Kc/s–1 Mc/s, 1 Mc/s–3 Mc/s, 3 Mc/s–10 Mc/s, 10 Mc/s–30 Mc/s, 30 Mc/s–55 Mc/s, 55 Mc/s–110 Mc/s, 110 Mc/s–240 Mc/s, all on fundamentals.
Scale Length	58in. (146 cms.).
Calibration	Accuracy ± 1%.
RF Output	100 mV normal.
Leakage	3μV Approx.
Attenuation	Coarse: 5 steps of –20dB. Fine: variable to –20dB approx. (rather more on low frequency ranges)
AF Output	Direct connection to the AF output, IV level maximum is provided.
Modulation	400 cycles sine wave, 30% depth.
Output Impedance	75 ohms, approx, via coaxial lead. Instrument supplied with dummy aerial.

★**Model 68A with identical specifications but not incorporating meter for monitoring output is available at Price £27/10/-.**

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NEW–Taylormeter Model 100A

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Sensitivity 100,000 o.p.v. D.C., 5,000 o.p.v. A.C.
Current readings from 0.2 microamps—10 amps. D.C. (10μA, 15μA, 250μA, 1mA, 100 mA, 1 Amp, 10 Amps).
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Ohms from 0—200 megohms in 4 ranges (self-contained).
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Accuracy 2% D.C. 3% A.C. 5% Ohms.
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Robust and suitable for everyday use.

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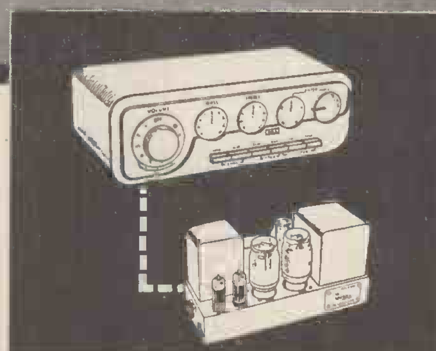
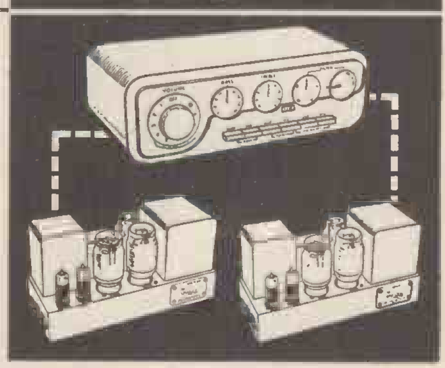
THE QUAD 22 CONTROL UNIT

... a new unit anticipating trends in future listening requirements



Used with a single QUAD II power amplifier

the unit provides every facility and refinement at present associated with the QUAD II control unit.



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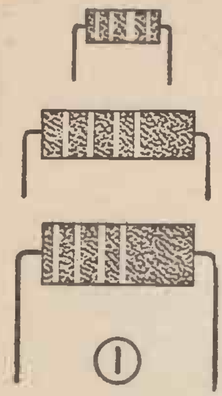

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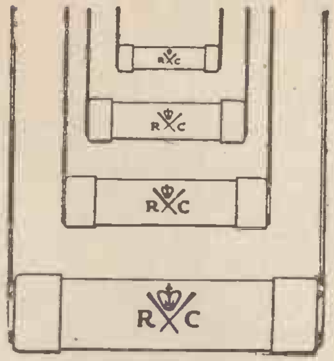

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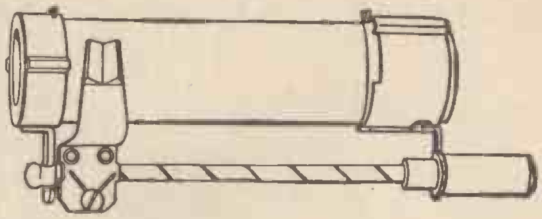

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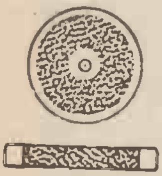

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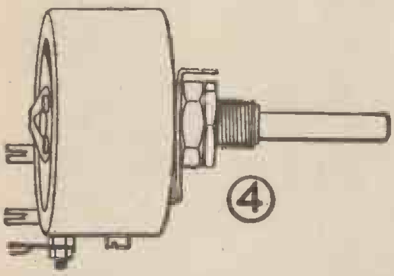

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3. * High Stability	1/10—3	1—50M	0.5% 1% 2% 5%
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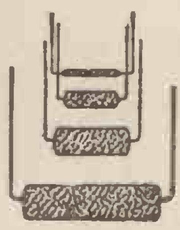
* The ubiquitous blue (1%) grey (2%) "HISTABS"



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NEW SIX CHANNEL MILITARY VERSION
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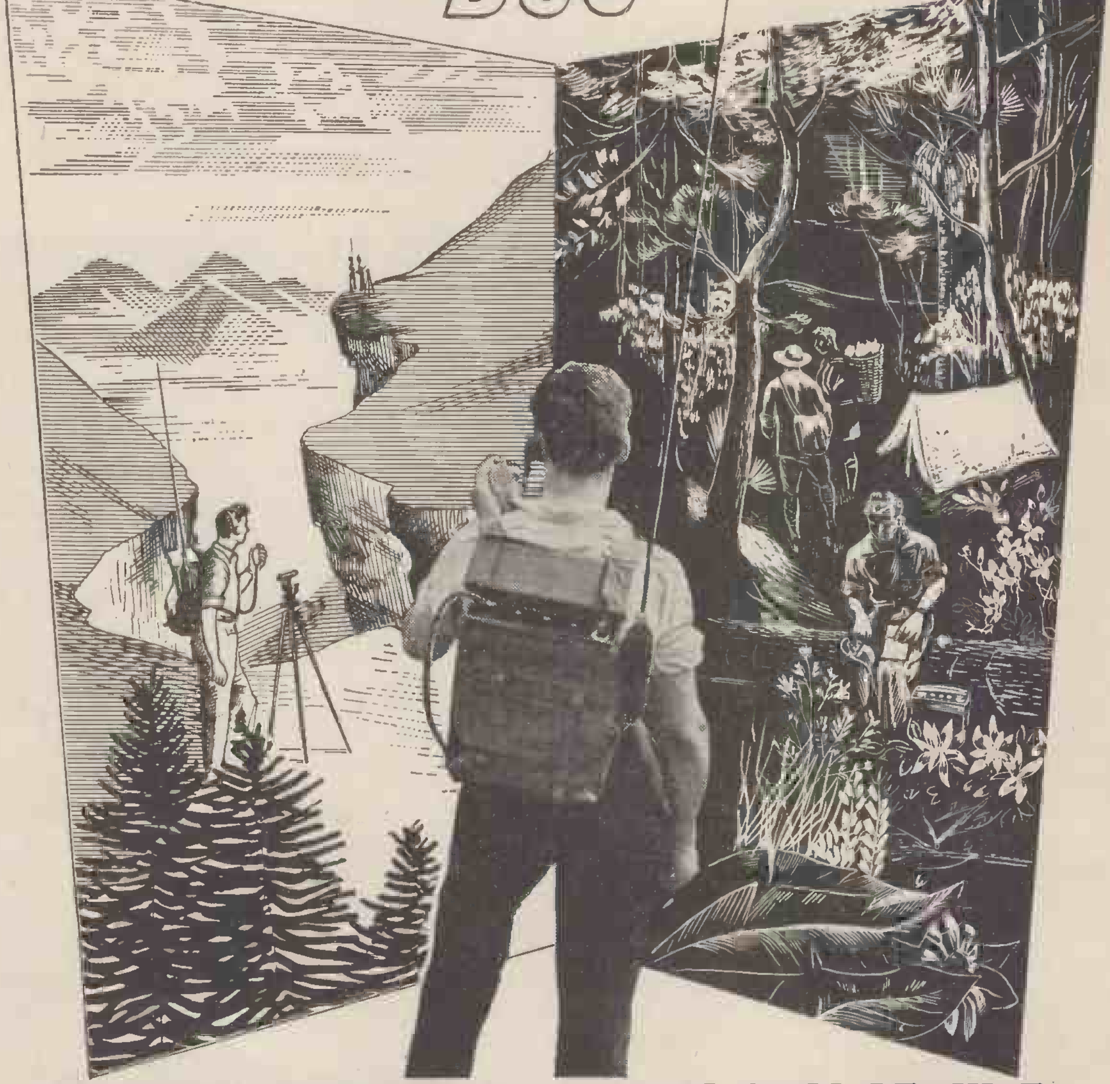

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PACKSET H.F. 156 TECHNICAL SPECIFICATION

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Channels 4-6:	4.5-7.5 Mc/s.
Transmitter:	C.W. or R.T.
	Power output 1.5 watts
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Power Supply:	Vibratory. Two 2 volt accumulators.

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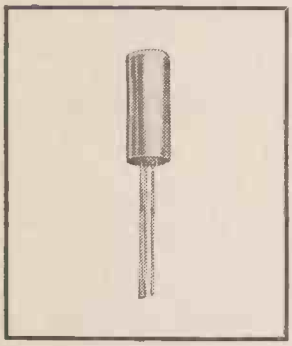

Silicon alloy transistors with low 'bottoming' voltage

SILICON

OC200 The OC200 is the first of a new range of silicon alloy transistors now being introduced by Mullard. This range has all the advantages of the well-known OC70 germanium series *plus* the silicon features of low collector leakage and high permissible operating temperature.

This duplication of the essential properties of the OC70 series—*including a low "bottoming" voltage*—enables designers to gain the maximum benefit from their experience with germanium transistors when using the new silicon types.

The wide junction temperature rating of these new transistors makes them suitable for use at high temperatures in aircraft, guided weapons and industrial equipment. This feature is exemplified by the OC200 which has a junction temperature rating of -55 to $+150°C$ with minimum α' (or β) controlled to a limit of 10 at $-55°C$ and 15 at room temperature.

The maximum collector voltage of type OC200 is 25V, but due to its low "bottoming" point it may be operated from supplies as low as 1.2V. The linearity of current gain with collector current is well maintained up to 50mA.

Like the OC70, the OC200 is well suited for use in pre-amplifier circuits. Its noise figure is, in fact, better than that of the germanium transistor. Write on your company notepaper to the address below for complete data.

ABRIDGED DATA

Silicon p-n-p alloy junction transistor OC200

$T_{junction}$	-55 to $+150°C$
V_{cb} (pk) max.	-25 V
v_{cb} max. (av. or d.c.)	-25 V
i_c (pk) max.	50 mA
I_c max.	15 mA
α' (or β) spread	15 to 60
Guaranteed min. α' (or β) at $-50°C$	10
Bottoming Voltage (I_c=7mA)	130 mV
Average noise figure	8 dB
$r_{bb'}$	125 ohms.

Mullard

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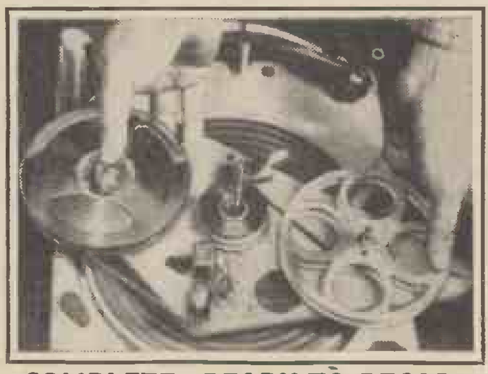
GRAMOPHONE TAPE RECORDER

- **Instantly turns your gramophone into a first-class Tape-Recorder.**
- **Records direct from radio or microphone.**
- **As easy as putting on a record. Slip it on—it's a tape-recorder! Lift it off—it's a record-player!**
- **Plays back at the flick of a switch through gramophone or radio.**

ALL THE ADVANTAGES OF A TAPE-RECORDER FROM YOUR RECORD-PLAYER OR RADIOGRAM—AT LITTLE EXTRA COST



Gramdeck is completely *new* . . . a revolutionary and ingenious invention that instantly turns your gramophone into a tape-recorder and back into a gramophone at will! Slip the Gramdeck onto your turntable and you have the finest tape-recorder you've ever heard. Lift it off . . . your gramophone is ready to play records again. There are no motors or valves to go wrong—and *you get a quality of reproduction that has to be heard to be believed!* Everyone is praising the Gramdeck. "*The quality is at least equal to that obtained from a good micro-groove disc,*" says a leading professional journal.

COMPLETE—READY TO RECORD OR PLAY BACK!

£13.12s CASH

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- ★ *Erase head. Fast motor re-wind or hand re-wind.*
- ★ *Instantly plays back through gramophone or radio.*
- ★ *Enables you to record outdoors, too!*
- ★ *Tone as good as you get from your radio or gramophone!*

"Ingenious—simply . . . why on earth did no one think of it before!" —THE TAPE RECORDER.
"Quality of reproduction excellent . . . real hi-fi results . . . potential is tremendous . . . both designer and manufacturer should be congratulated."—BRITISH RADIO & T/V RETAILERS' REVIEW.
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Hear music, speech . . . your favourite radio programme . . . the voices of your family—Gramdeck can record and reproduce them all with a wonderful depth and breadth of tone. And, because Gramdeck uses the equipment you already possess in your own gramophone, it costs a mere fraction of the high-quality tape-recorder normally required to obtain such excellent results. Full details, technical specifications, photographs, Easy Terms . . . everything you want to know about the amazing Gramdeck, are given in the fully-illustrated Gramdeck Book. Find out how you, too, can so easily have full tape-recording facilities! Send for the Gramdeck Book *today*. It's FREE!

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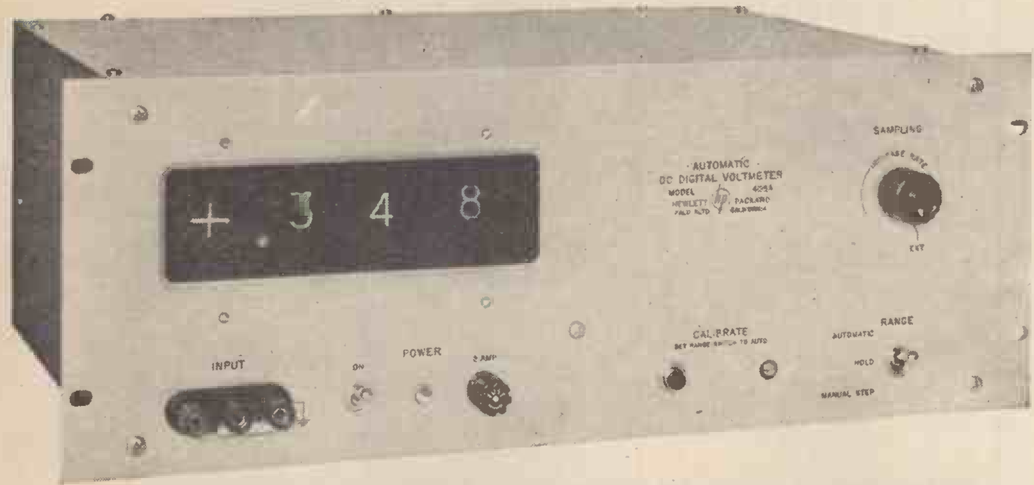
ONLY OBTAINABLE FROM AND GUARANTEED BY ANDREW MERRYFIELD OF KENSINGTON

HEWLETT-PACKARD DIGITAL VOLTMETER 405AR



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405AR DC DIGITAL VOLTMETER is a completely new instrument providing, literally, "touch-and-read" voltage measurements between 1 and 1,000 volts. *Range, even polarity, are automatically selected.* Readout is in-line, in bright, steady numerals.

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BRIEF SPECIFICATIONS

Range: 0.001 to 999 v. d.c.; 4 ranges.
Presentation: 3 significant figures, polarity indicator.
Accuracy: ±0.2% full scale ±1 count.
Ranging time: ½ sec. to 2 sec.
Input impedance: 11 megohms to d.c., all ranges.
Response time: Less than 1 sec.
AC rejection: 3 db at 0.7 c.p.s.; min. 50 db at 60 c.p.s.
Height: 7in. **Weight;** 26lbs.

HEWLETT - PACKARD COMPANY

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THE 5867 TRANSMITTING TRIODE

The 5867 is a transmitting triode with a maximum anode dissipation of 250W. It can be operated at full ratings up to 100 Mc/s, and at reduced ratings up to 150 Mc/s. Natural cooling is normally sufficient for frequencies up to 30 Mc/s, but at higher frequencies it may be necessary to direct one air flow on to the anode seal and another on to the base and thence over the bulb. For full electrical and mechanical details and for tables of typical operating conditions, please write to the Company. Details of any of our large range of valves will be sent on request.

EQUIVALENT TYPES:—
TY3-250
TB3/750
CV1350

This valve is eminently suitable for RF heating, both dielectric and induction.

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Telephone: Chelmsford 3491

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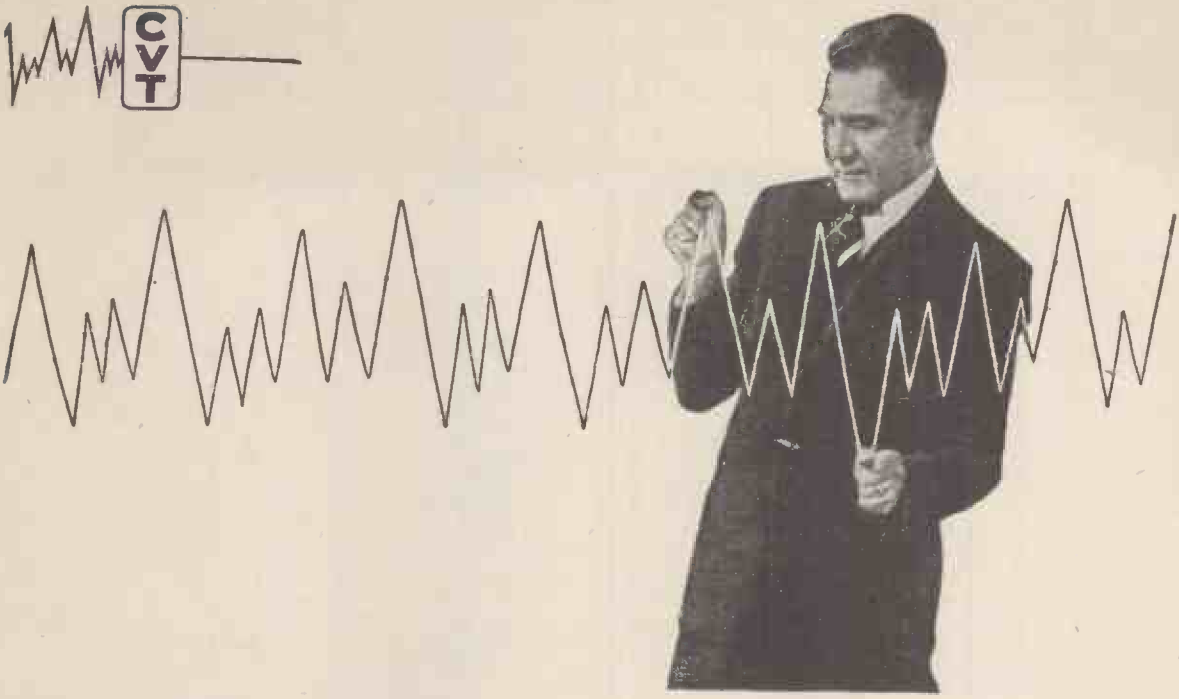

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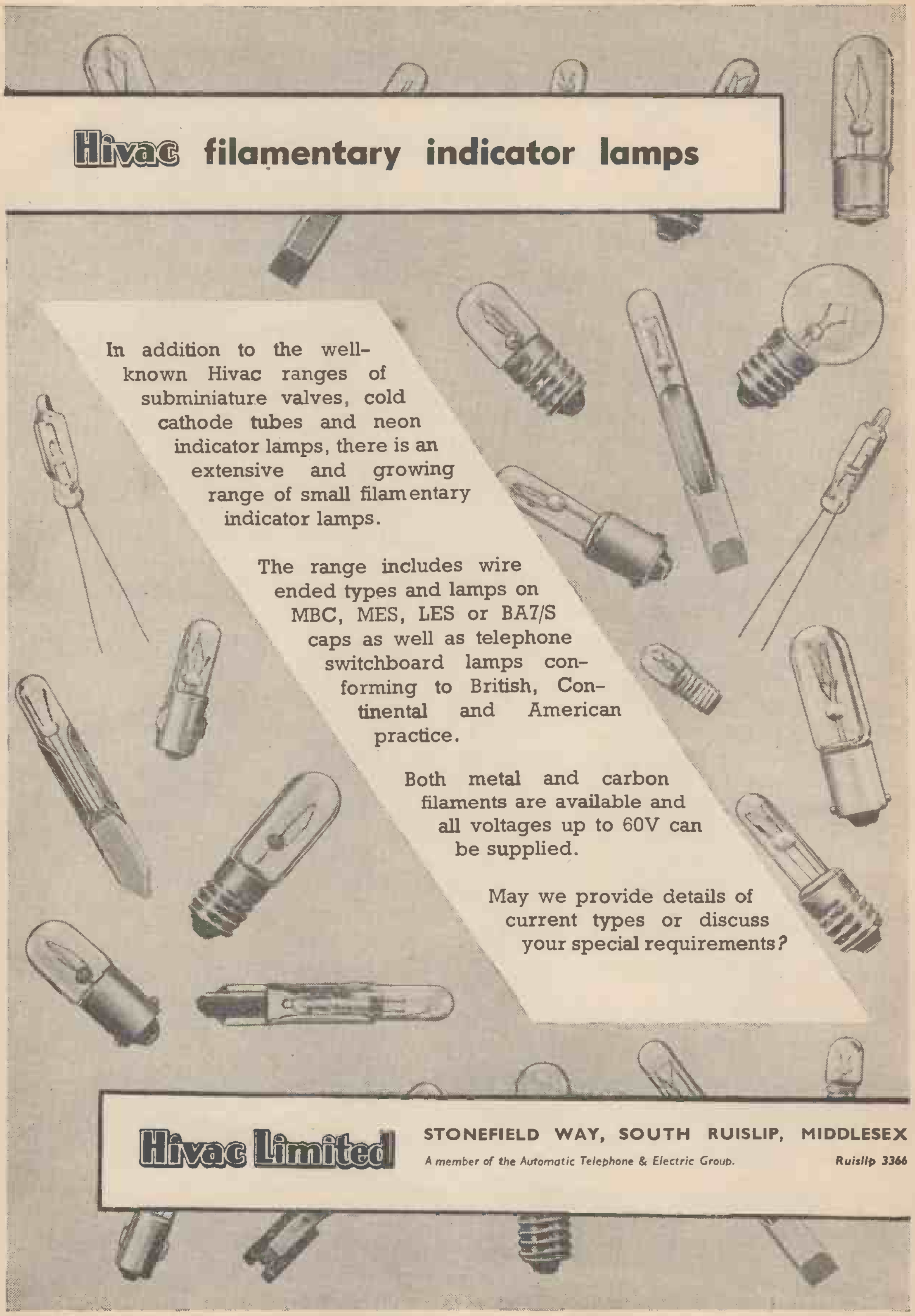
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A member of the Automatic Telephone & Electric Group.
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Promoted by the Electronics and Communications Section of
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21-27 MAY · EARLS COURT · LONDON

The INTERNATIONAL TRANSISTOR EXHIBITION will be held in the same building and at the same time as the *International Convention on Transistors and Associated Semiconductor Devices.*

●

These two events, both promoted by The Institution of Electrical Engineers, are attracting world-wide interest and an overall attendance of some 60,000 is anticipated.

●

The Exhibition will cover all types of semiconductor devices and their numerous applications, and will include transistor materials, equipment involving transistors and semiconductor techniques, and also various associated and specialized components for use in transistorized equipment.

●

Part of the Exhibition will be devoted solely to transistor research and development, and will include exhibits from government, industrial and university research laboratories.

●

Manufacturers wishing to participate in this unique Scientific Exhibition are invited to contact the organizing company.

●

Two thousand scientists and engineers directly concerned with transistors and their application, and coming from all over the world, are expected to attend the International Convention on Transistors, the opening lectures of which will be given by the inventors of the transistor—Dr. W. B. Shockley, Dr. W. H. Brattain, and Professor J. Bardeen.

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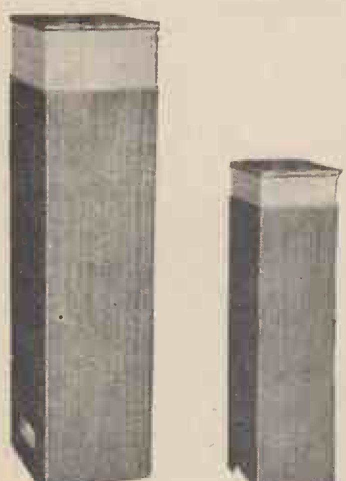

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Demonstrations at all leading Hi Fi dealers and at our London Office (109 Kingsway, W.C.2) every Saturday from 9 a.m. to 12 noon. Descriptive leaflets on all products free on request.

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Mains and Battery versions available

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- Anti-microphony spring mountings.

Supply Voltage	Mains Version 200-250 Volts Battery Version 6-9 and 4-6 Volts
Average Consumption	Mains 14 Watts Battery 95 M.A. max. (playing outside edge of 12", 78 r.p.m. record)
Stylus Pressure (Adjustable)	Mains 6-8 grammes Battery 11-12 grammes
Wow and Flutter	Combined wow and flutter not greater than 0.3%
Dimensions (As Illustrated)	Left to right 11¾" Front to back 11¼" Depth below top surface of motor board 2½" Height above motor board 2½" Weight: Mains Version 5 lbs. Battery Version 3¾ lbs

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ES/C/4

Audio Power Valves

TY7-6000A

TY3-250

for Relay Services
Public Address Systems
Vibration Equipment

Mullard audio power valves are available both for new equipment designs and maintenance. Full data for these power valves and details of xenon and mercury vapour rectifiers for associated power supplies are readily obtainable from the address below.

AUDIO POWER AMPLIFIER VALVES

	Type No.	pa max. (watts)	Va max. (kilovolts)	Ik max. (amps)	Power Output 2 valves (kW)
	Triodes				
For Maintenance	MZ2–200	275	2.4	0.4	1.2
For Maintenance	MY3–275	275	3.0	0.5	1.3
For new Equipment	TY2–125	135	2.5	0.25	0.7
For new Equipment	TY3–250	250	3.0	0.48	1.3
For new Equipment	TY4–500	450	4.0	0.7	2.4
For new Equipment	TY7–6000A	6000	7.2	2.8	20
	Tetrodes				
For new Equipment	QY3–65	65	3.0	0.22	0.27
For new Equipment	QY3–125	125	3.0	0.32	0.55
For new Equipment	QY4–250	250	4.0	0.45	1.2

POWER RECTIFIER VALVES

	Type No.	PIV max. (kilovolts)	Max d.c. output current (amps)	Typical heating up time (secs)
Mercury Vapour	RG1–240A	6.5	0.25	60
Mercury Vapour	RG3–250A/866A	10	0.25	60
Mercury Vapour	RG3–1250	13	1.25	60
Xenon	RR3–250/3B28	10	0.25	10
Xenon	RR3–1250/4B32	10	1.25	30

See Mullard valves and tubes on Stand 2 at the ELECTRONIC COMPUTER EXHIBITION Olympia, 28th November to 4th December.

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- ✻ **Particularly suitable for mobile applications.**

This crystal oscillator has been designed by A.T.E. to overcome the disadvantages of oscillators of the oven mounting type in situations where immediate operational availability is called for, i.e. transport and defence requirements. The unit has the advantages also of great compactness, very simple design and static components.

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Frequencies available: 4 Mc/s to 16 Mc/s.

Temperature range: Either — 20°C to + 70°C
or 0°C to + 50°C

Max. frequency excursions over temperature ranges:
Either ± 5 parts per million } as required
or ± 10 ,, ,, ,,

Output: 1 to 5 volts (according to frequency, etc.) into a load consisting of 100,000 ohms in parallel with 10 pF, simulating a following amplifier.

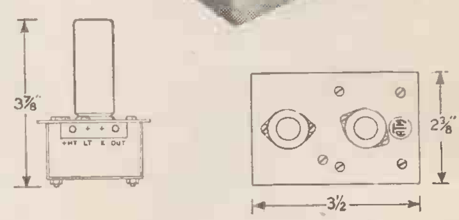
Power Supplies: HT 230 volts 8mA approx.
LT 6.3 volts 0.3 amps.

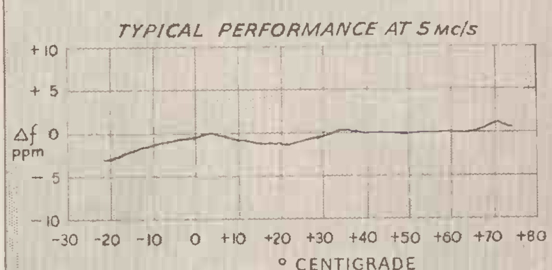
Crystals: Style E (B7G) Special Assembly.

Valve: EF91.

Finish: Grey enamel, on silver-plated copper.

Alternative designs—mains or battery operated—are available and other characteristics can be catered for to customers requirements.





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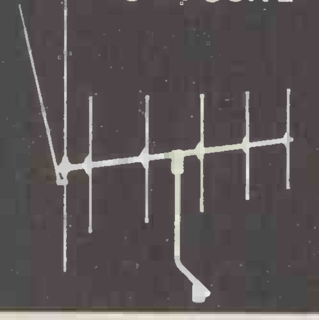

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Band I "V" electronically coupled to 5 Band III elements; complete with mounting arm and bracket.
Independently variable directivity on both bands.

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Optional extra for Band II Addex FM/L 7/6.

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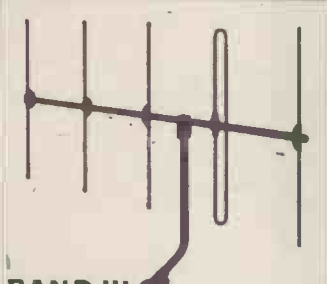
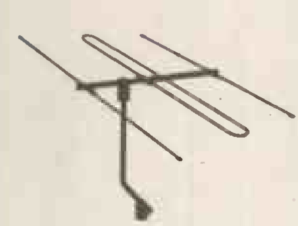
HL513 42/-



BAND III

FOR VERTICAL OR HORIZONTAL CHANNELS
Five-element folded dipole array complete with mounting arm and bracket.

353 32/6



VHF/FM

Three-element folded dipole array complete with mounting arm and bracket.

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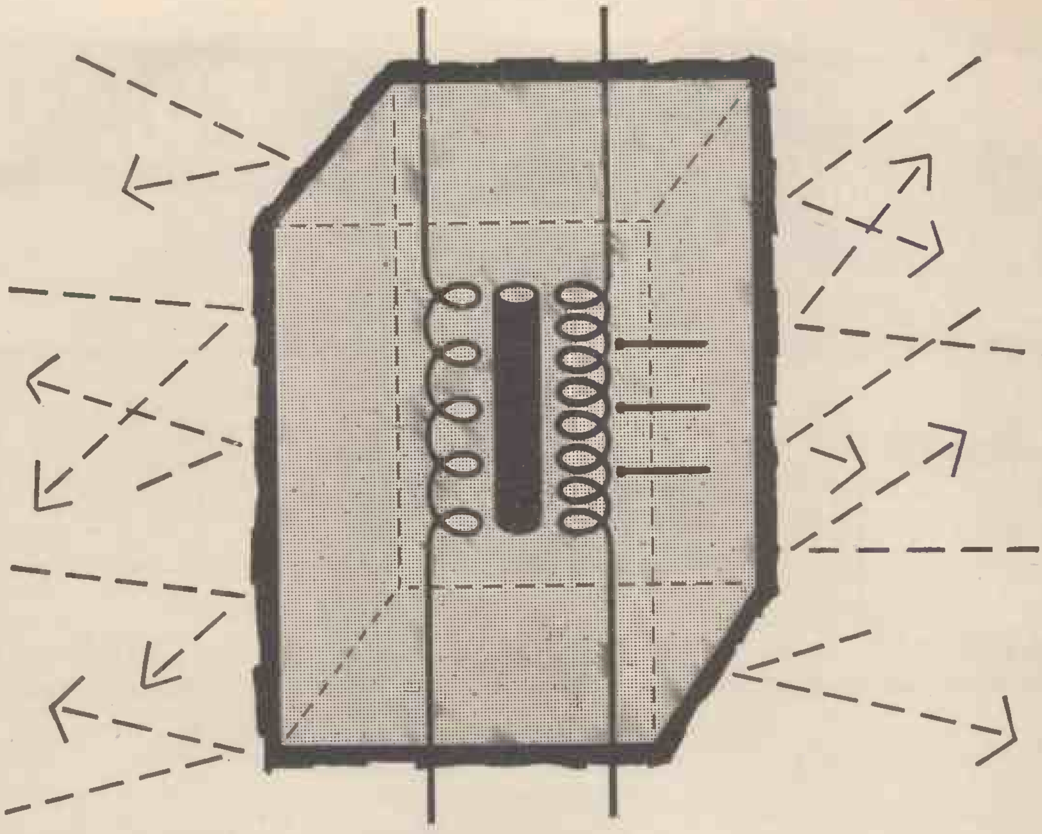

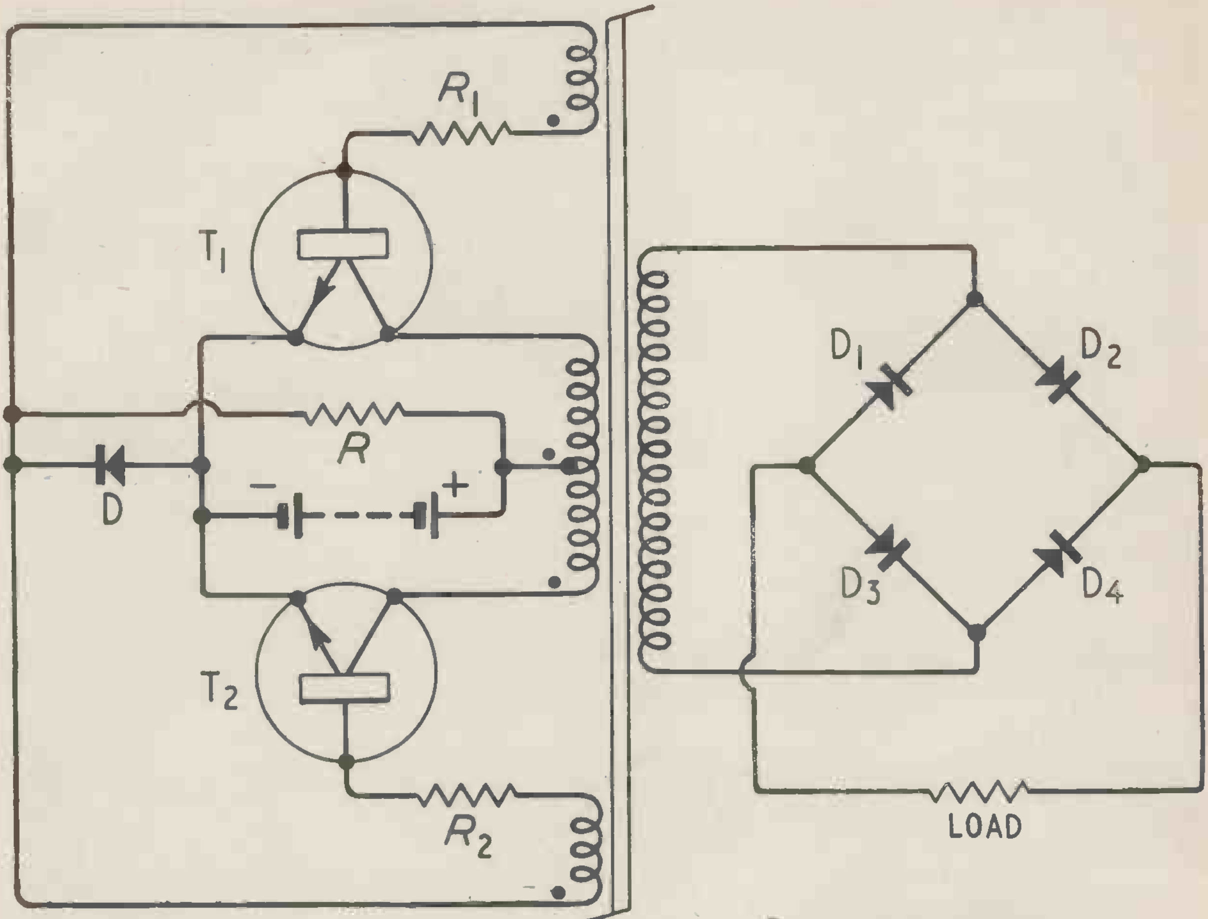

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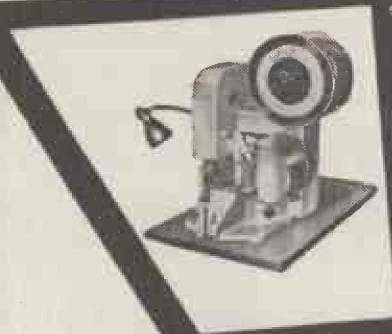
Lec Refrigeration

use *AMP FASTON receptacles



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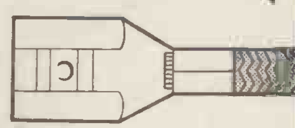
Faston Terminals utilised to make power connection to the Lec hermetic sealed unit used in domestic refrigerators throughout the world.*



Lec's popular 6 cu. ft. refrigerators. With acknowledgements to Messrs. Lec Refrigeration Ltd.

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THE FIRST COMPLETE RANGE OF CLOSE-TOLERANCE ZENER DIODES *AVAILABLE FROM PRODUCTION*

ACTUAL SIZE

Z2 SERIES ZENER DIODES

±5% Voltage Tolerance (Red and Green Sleeves)		±10% Voltage Tolerance (Red and Yellow Sleeves)		±20% Voltage Tolerance (Red and Blue Sleeves)	
TYPE	NOM. VOLTAGE	TYPE	NOM. VOLTAGE	TYPE	NOM. VOLTAGE
Z2A33	3.3	Z2A33	3.3	Z2A33	3.3
Z2A36	3.6	Z2A39	3.9	Z2A47	4.7
Z2A39	3.9	Z2A47	4.7	Z2A68	6.8
Z2A43	4.3	Z2A56	5.6	Z2A100	10
Z2A47	4.7	Z2A68	6.8	Z2A150	15
Z2A51	5.1	Z2A82	8.2		
Z2A56	5.6	Z2A100	10		
Z2A62	6.2	Z2A120	12		
Z2A68	6.8	Z2A150	15		
Z2A75	7.5				
Z2A82	8.2				
Z2A91	9.1				
Z2A100	10				
Z2A110	11				
Z2A120	12				
Z2A130	13				
Z2A150	15				

Characteristics and ratings of *SenTerCel* Zener Diodes are given in publication SIL/103A

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	110	210-240	9057
	235	105-135	9058
	110	105-135	9059
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	110	210-240	9061
	235	105-135	9062
	110	105-135	9063

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Snap action Mycalex Terminals, instantaneous fused voltage adjustment, low temperature rise and 2,000 V.a.c. flash testing of the fully isolated secondary are the main features of these components, which invite you to

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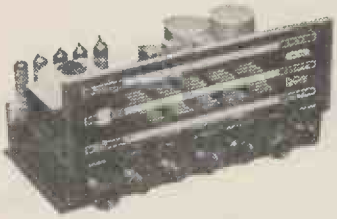
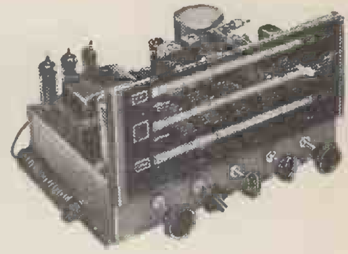


STEREO-TWELVE CHASSIS 37 GNS

JUBILEE CHASSIS 29 GNS



The Stereo-Twelve is the most complete unit yet produced for Stereo, giving 6 watts high fidelity push-pull output on each channel, 12 watts total. Full VHF band, medium and long wavebands with adjustable ferrite aerial on AM and automatic frequency control on FM. Stereo and monaural inputs for records, tape and radio and tape outputs for stereo and monaural tape recording. Comprehensive matching for all types of crystal pick-ups both stereo and monaural and speaker matching on both outputs of 3, 7½ and 15 ohms. A 12-valve chassis measuring 14½in. × 8in. × 7in. high which can easily be fitted with the help of the brass escutcheon and veneered facia board which are available.

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8 watts output from two independent high quality amplifiers with VHF and medium wavebands.

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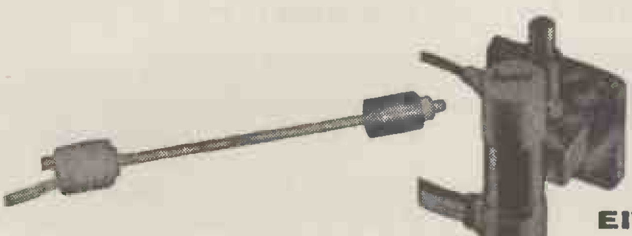

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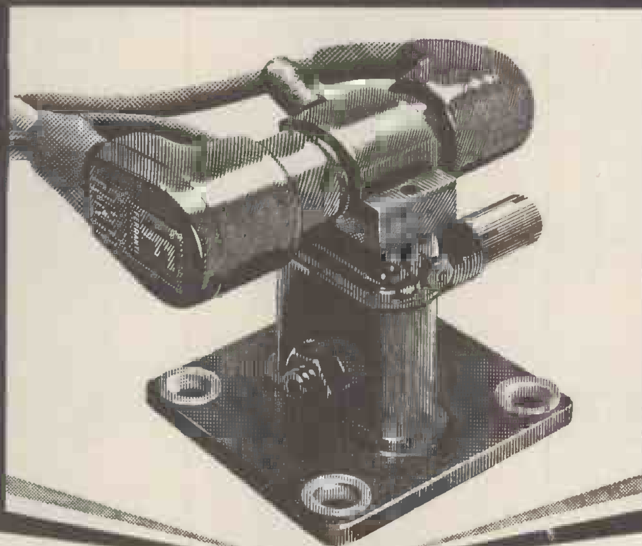

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Heater Voltage	6·3± 10% volts
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Frequency Range . . .	8,500-9,600 Mcs.
Resonator Voltage . . .	350 volts max.
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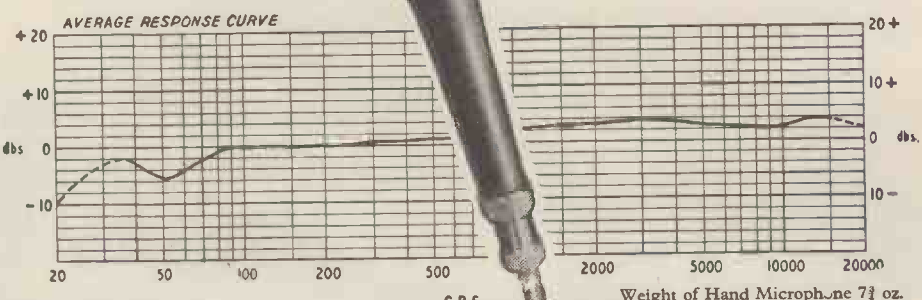
DP4 MICROPHONE

The new **Grampian** high output pressure type dynamic Microphone has a uniform, wide range, frequency response which extends from 50 c/s to 15,000 c/s. Designed to fulfil the needs of Public Address, Wire, Tape and Disc Recording, Call Systems, and communication equipment, this lightweight Microphone can be used close to the lips without undue frequency emphasis.

Low, medium or high impedance models are available together with a complete range of stand adaptors, stands, swivel holders, and switch assemblies. *Pack consists of Microphone (low impedance) with lead and plug, holder and swivel, adaptor and base. Weight complete in box, 2lb. 9 oz. (1.16 kilo). Size 10¼×5×2¾in.*



Output levels:
25 ohms—86 db below 1 volt/dyne/cm.²
600 ohms—70 db below 1 volt/dyne/cm.²
50,000 ohms—52 db below 1 volt/dyne/cm.²

Weight of Hand Microphone 7¾ oz.
Length of Hand Microphone 8¼in.
Diameter overall 1⅛in.

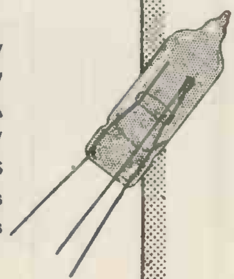
Grampian REPRODUCERS LIMITED
17 HANWORTH TRADING ESTATE, FELTHAM, MIDDX
Tel.: Feltham 2657/8 Cables: Reamp Feltham

3 TRIGGER TUBES DESIGNED WITH YOUR COSTS IN MIND

Speedier production and skilful design are benefits passed to you in the form of low prices — so low as to be comparable with the cheapest components used in electronic equipment.

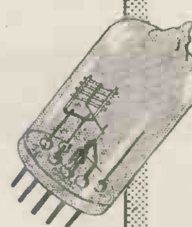
GTR 120 W

Anode voltage	180 — 310 V
Trigger striking volts	110 — 170 V
Anode current	3 — 9 mA
Tube voltage drop	95 — 140 V
De-ionization time	3 mS
Minimum ambient light	5 ft. — candles
Base	3 flying leads



GDT 120 M

Anode voltage	180 — 340 V
Trigger striking volts	105 — 155 V
Anode current	3 — 9 mA
Tube voltage drop	94 — 130 V
De-ionization time	10 mS
Minimum ambient light	Zero
Base	B 7G



GDT 120 T

Anode voltage	180 — 400 V
Trigger striking volts	100 — 155 V
Anode current	5 — 25 mA (60 mA peak)
Tube voltage drop	95 — 130 V
De-ionization time	10 mS
Minimum ambient light	Zero
Base	B 9A

The characteristics of these trigger tubes make them ideally suited for a multitude of applications where the use of precision tubes would be uneconomic.

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TUBE DIVISION
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NORTHERN ENGLAND	Farnell Instruments Ltd., *Wetherby Industrial Estate, York Road, Wetherby, Yorks.* (*Tel.: Wetherby* 2691/2)
MIDLANDS	Hawnt & Co., Ltd., 112-114, *Pritchett Street, Birmingham* 6. (*Tel.: ASTON CROSS* 4301)
NORTHERN HOME COUNTIES	W. J. Picton Ltd., 123*a Neasden Lane, London, N.W.*10. (*Tel.: GLADSTONE* 2718-4075)

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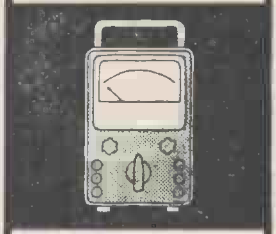
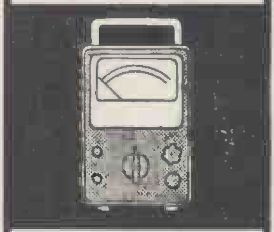
R.C.C. Bridge—*A quick balancing bridge measuring from 5 ohms–500 megohms and 5 pF–500 μF each in three ranges.*



D.C. Valve Voltmeter Microammeter—*A high impedance D.C. Valve Voltmeter reading 1–1,000 Volts and 0.1–100 microamps f.s.d. over seven ranges.*



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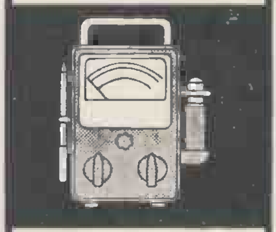

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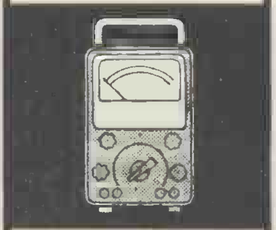

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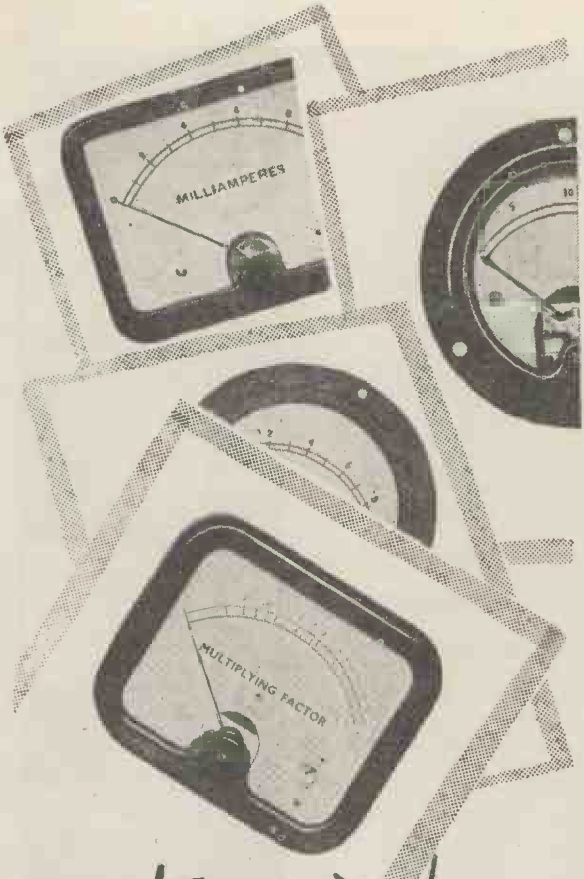
WHG/NT72



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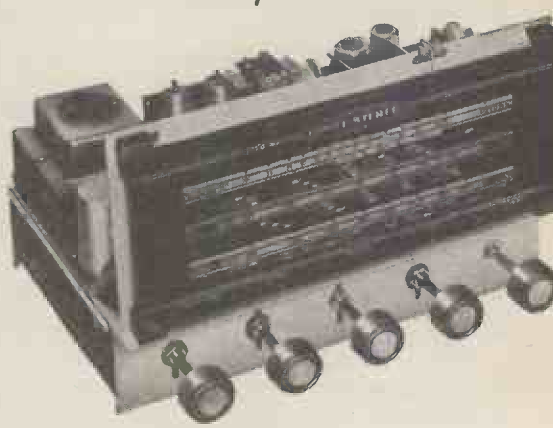

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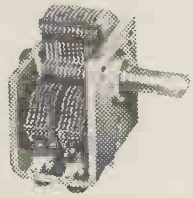

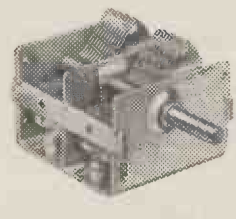

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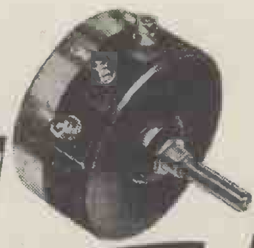

PIW Dia. 2⅜"
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1-500,000 ohms.
Data Sheet No.5

TW Dia. 1⅞"
5 Watt Max.
Range
1-100,000 ohms.
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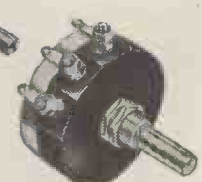

TT Dia. 1⅞"
5 Watt Max.
Range
1-100,000 ohms.
Data Sheet No.8

TS Dia. 1 5/16"
2 Watt Max.
Range
5-50,000 ohms.
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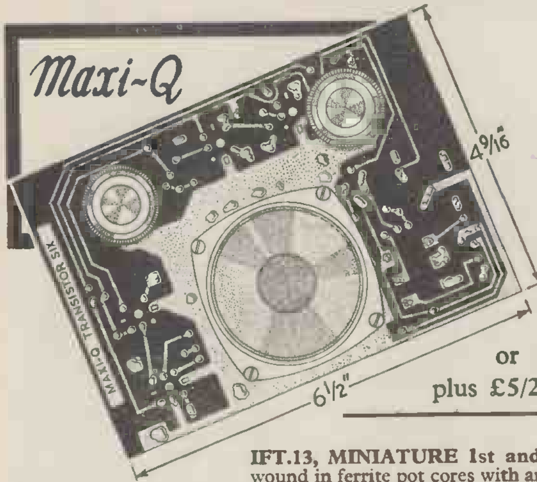

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Circuit Diagram, Complete assembly layout and price list for building this Receiver is available at **9d.**

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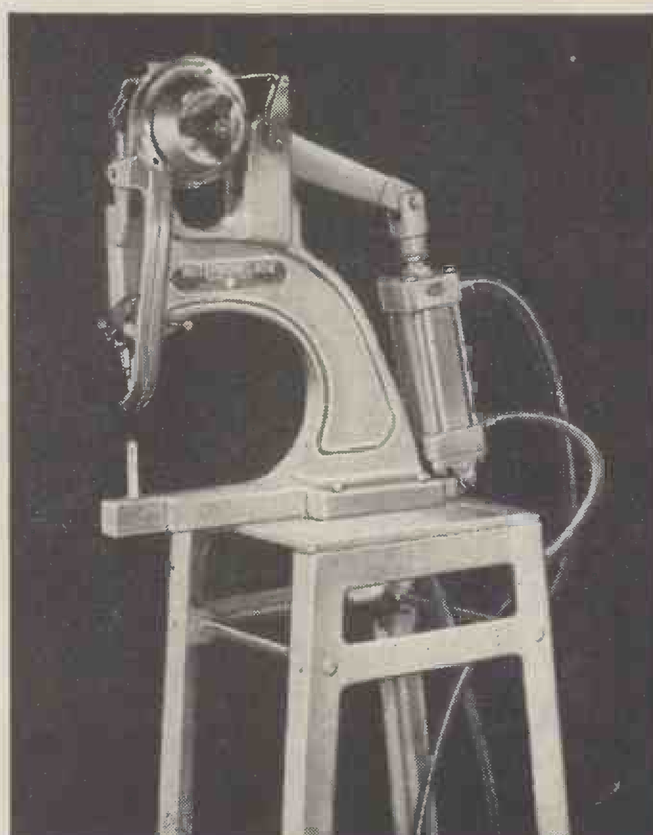

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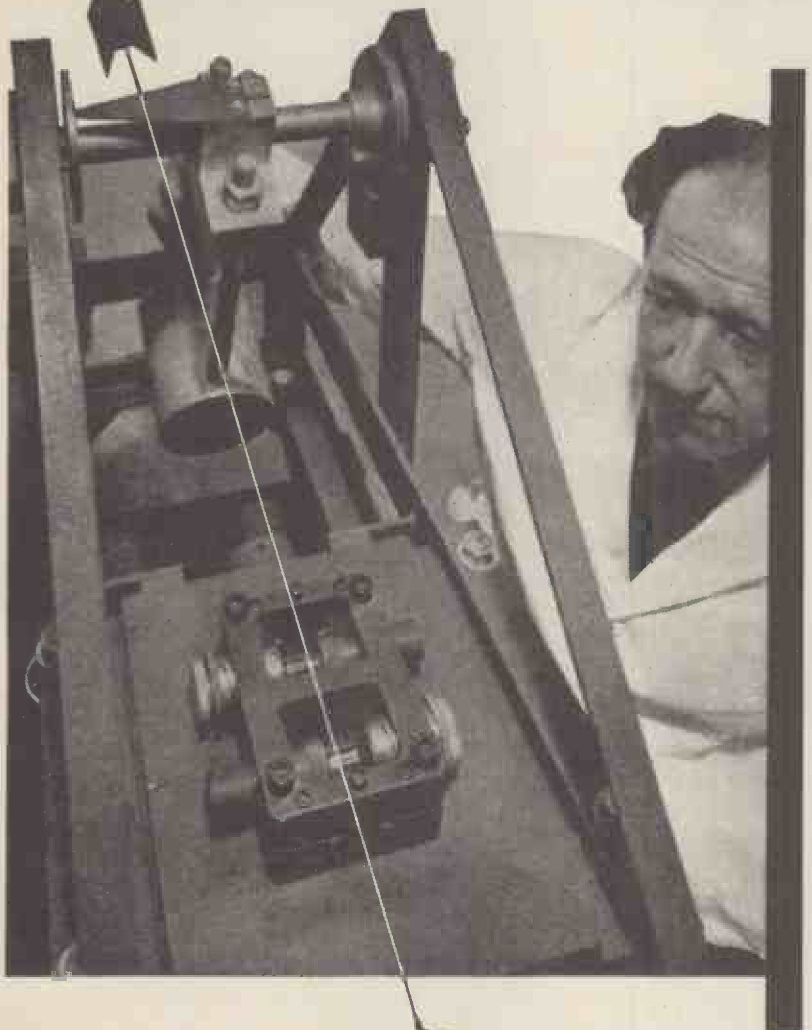

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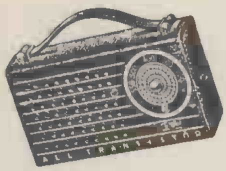
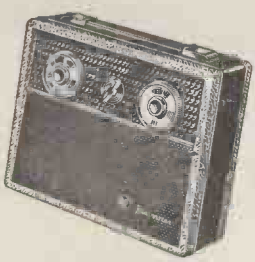
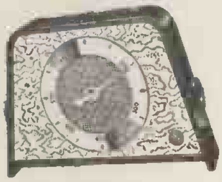


Model P150 BQ



Model P123 BQ



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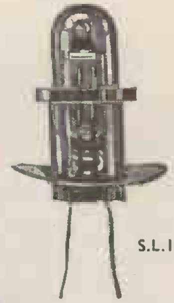

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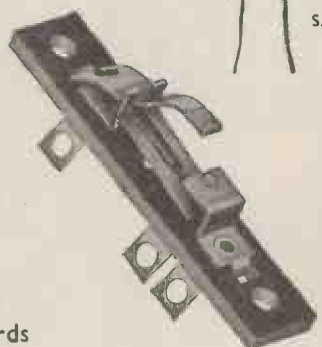
T.225

T.225: Miniature Slide Switch
Ideal T.V. mains switch

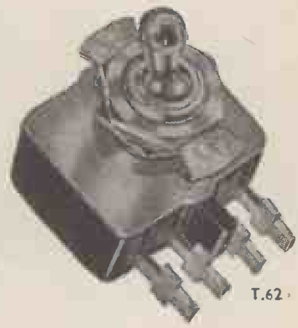
S.L.166: Very small low cost
mains neon indicator

T.280: Sensitive Snap Action Switch
Popular switch for tape recorders

T.626: Double pole 3-AMP switch
with tags to fit printed circuit boards



T.280



T.62

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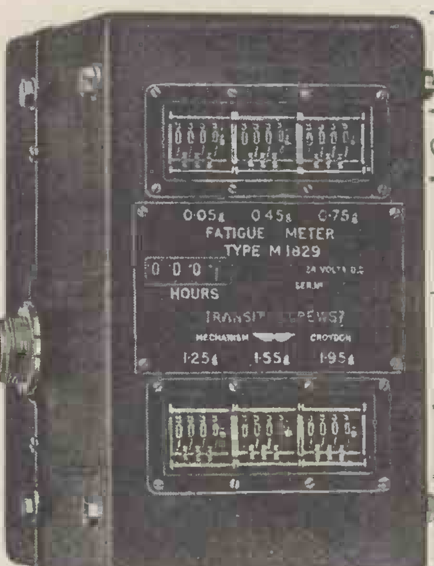
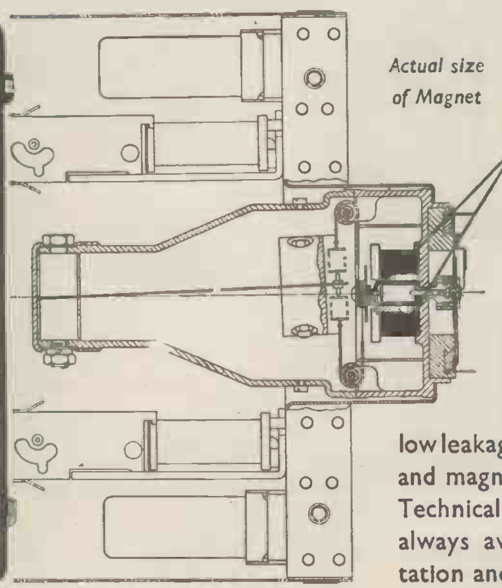
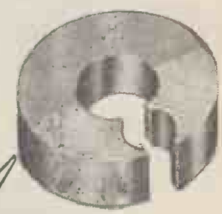




Actual size of Magnet



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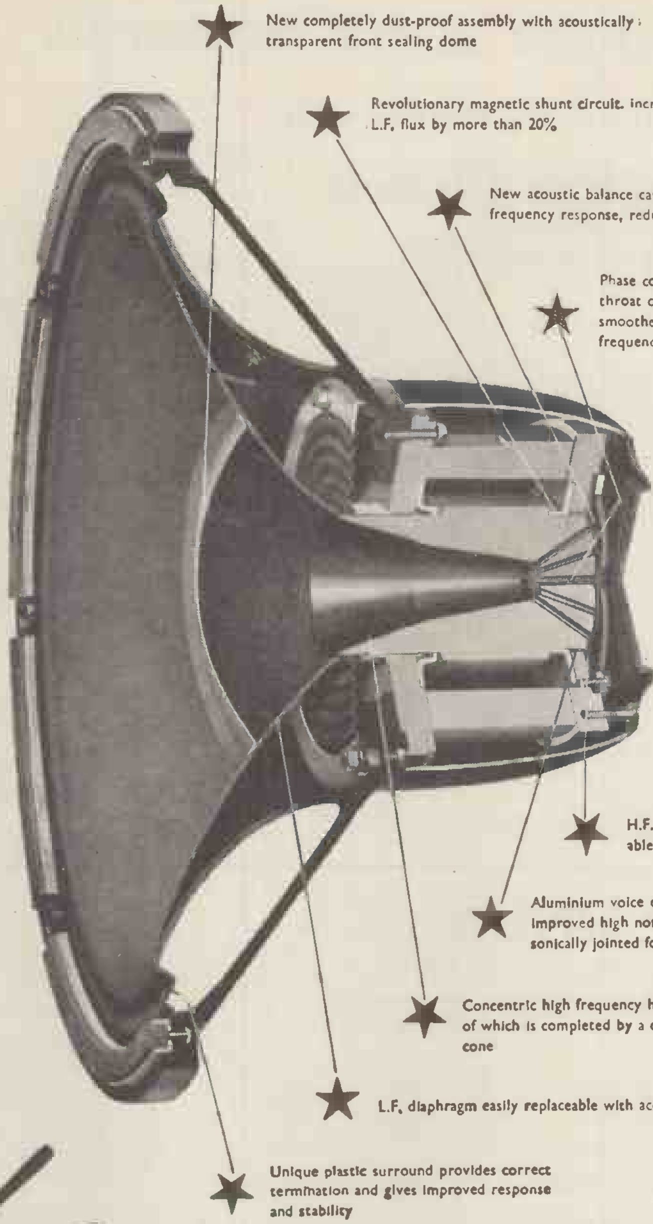

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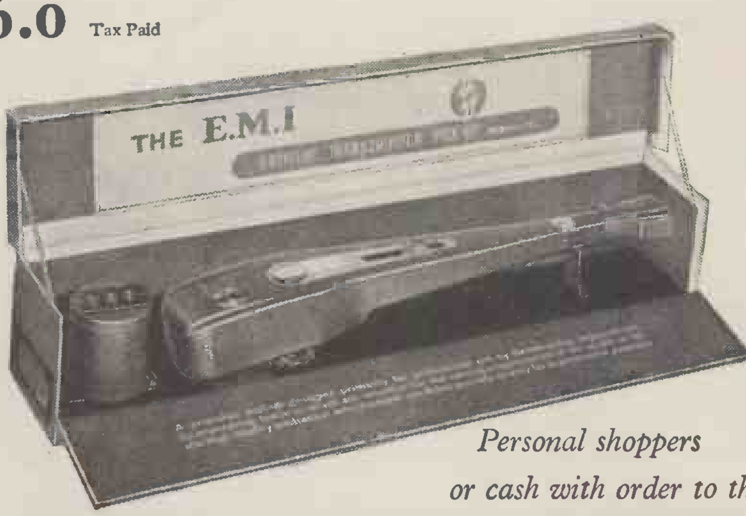

SPECIFICATION

Physical
Length 15⅞ inches (40.32 cms.) Approx.
Height 2½ inches (6.41 cms.) Overall
Width 2⅜ inches (6.03 cms.)
Centre of base to stylus tip 12 inches (30.72 cms.).

Stylus
A diamond stylus is fitted to the 33⅓/45 r.p.m. head supplied.

Head Impedance
1 ohm (measured at 1,000 c.p.s.).

Frequency Response
For a constant recorded velocity the frequency response is sensibly level within the following limits; with microgroove stylus, 20—16,500 c.p.s. With standard stylus 20—20,000 c.p.s.

Distortion
Measured at 400 c.p.s., the total harmonic distortion is less than 5% for a recording level of +20 db referred to 1 cm./sec. r.m.s. transverse velocity.

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50mV at secondary of transformer provided from a recording level of +10 db referred to 1 cm./sec. r.m.s. velocity.

Weight at Stylus Point
Variable from 3—10 grammes as required.

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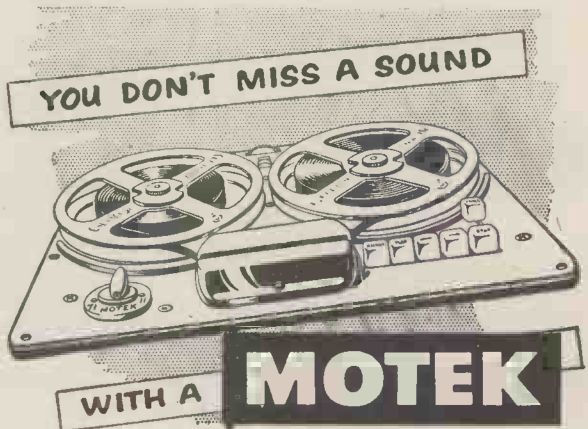

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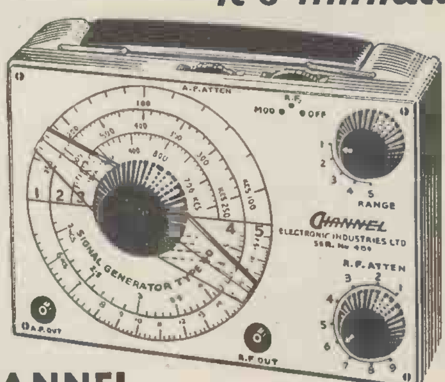

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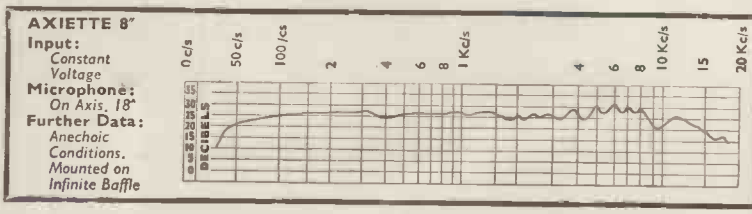
Flux Density:	*15,000 gauss on 1″ dia. pole.*
Impedance:	*3 or 15 ohms.*



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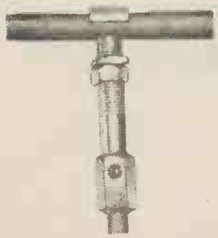

CABLE TAPPER UNIT TYPE 3B

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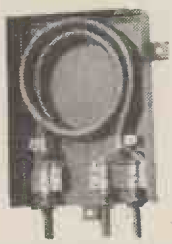

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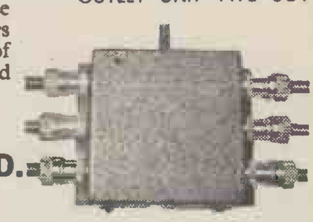

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APRIL 1959

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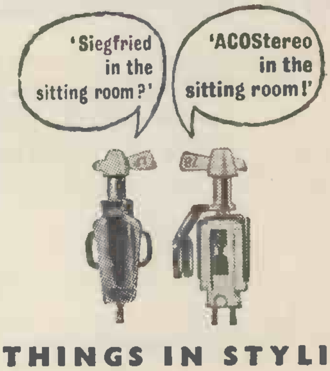

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When ultra high frequencies are likely to be involved, great care must be taken at the design stage to avoid a mis-match due to a badly designed connector in a line or circuit, or even due to malformation of or damage to a low melting insulant when soldering.

In the case of B.N.C. plugs and other connectors of this grade, the desired standing wave ratio is generally specified. Where high temperatures are likely to be involved, material other than polythene is called for; polytetrafluorethylene (P.T.F.E.) is sometimes used. Ceramics and glass seals are also employed as insulants in plugs of this kind to ensure sealing, and the ability to stand up to very high temperatures.

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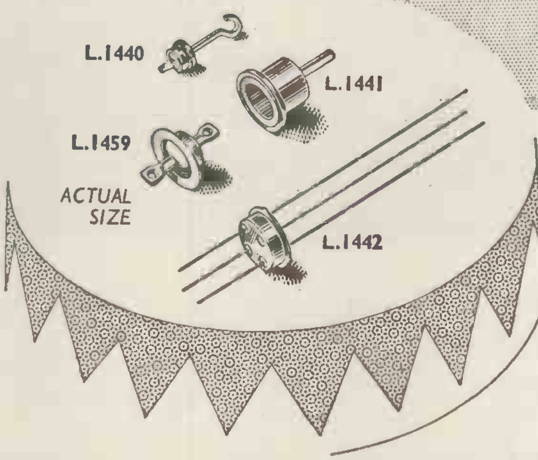

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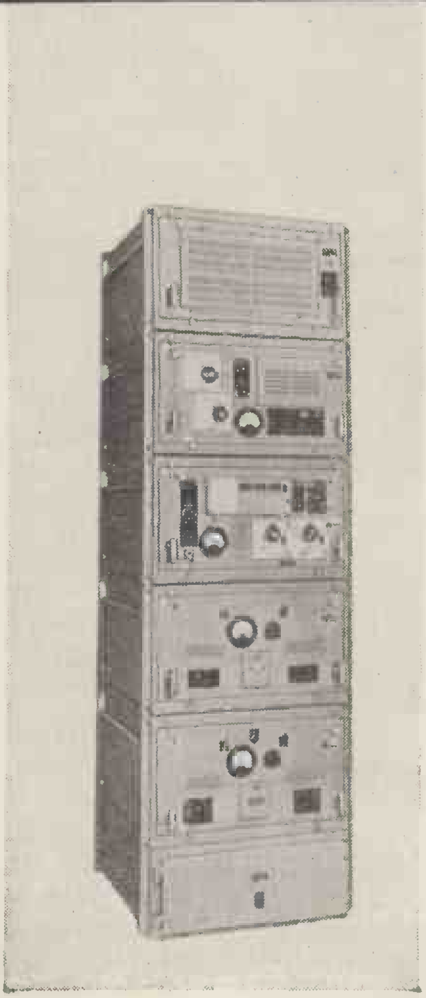

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Aspects of design

10

FRAME DEFLECTION FOR 110° C.R. TUBES

This is the tenth of a series of special features dealing with advanced problems in television and radio circuit design to be published by Siemens Edison Swan. The Ediswan Mazda Applications Laboratory will be pleased to deal with any questions arising from this or other articles, the eleventh of which will appear in the May 1959 issue.

The circuit illustrated here has been designed to take advantage of the ability of the 30PL13 to act as a frame output valve for use with 110° C.R. tubes when operating from an H.T. line of only 190 volts.

OUTPUT STAGE

The operating conditions of the tetrode output valve have been chosen to give adequate safety factors to accommodate both normal variations between valves and components, and deterioration of the valve during a reasonable length of life. The stage is operating at approximately "zero initial slope" conditions (see "Aspects of Design" No. 3).

A thermistor is included in series with the deflector coil in order to present a sensibly constant load to the transformer despite changes in temperature.

DRIVE CIRCUIT

A multivibrator comprising V_1 and V_{2A} generates an exponential sawtooth voltage across C_8. This waveform is virtually independent of the output stage and is then shaped by feedback from the output transformer primary before being fed to the grid of the output valve. R_{11} controls overall linearity while R_{13} controls the merging of flyback into scan. R_{16} across C_6 produces a more exponential sawtooth at this point and assists in generating the required S-shaped distortion in the final coil current. A blocking oscillator could be substituted for the multivibrator provided that the same waveform is produced at C_8.

When the controls are correctly adjusted the circuit has a fairly long flyback time which reduces the amount of shift required to centre the picture and so helps to reduce the problem of neck shadow.

Satisfactory deflection can be obtained at E.H.T. voltages up to 15 to 16 kV according to the sensitivity of the toroidally wound deflection coil. With a high sensitivity commercial design having the constants L_P = 19.3 mH and R_P = 7.4 ohms at 20°C and a thermistor giving 1.5 ohms at 25°C with 350 mA r.m.s., the following recommendations apply:

TRANSFORMER

⅞" Stack No. 69 Laminations Silcor 100 0.014" thick Magnetic and Electric Alloys Ltd.
Bobbin 1/16" Paxolin with end cheeks.
Secondary (wound on first) 265 turns 22 SWG Lewmex M. Three layers oiled silk between windings.
Primary 3 445 turns 33 SWG Lewmex M. Interleaved every 500 turns with 0.001" paper.
Air Gap 0.003"
L_p = 16.3 H R_p = 187 ohms R_s = 1.3 ohms.

WORKING CONDITIONS. With an E.H.T. voltage of 16 kV.

V_{HT} = 190 volts $I_{a(av)}$ = 43 mA
$i_{a(pk)}$ = 115 mA $I_{g2(av)}$ = 11.6 mA
$i_{a(min)}$ = 9 mA

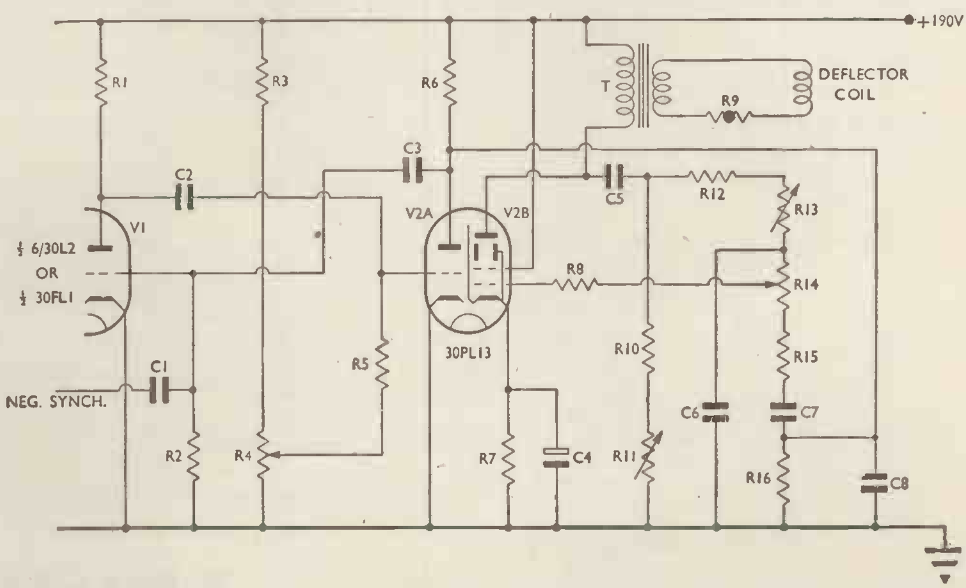
RESISTORS (½W 10% unless stated) (all potentiometers linear)

No. 1	47 k 1 W	No. 9	Thermistor
2	1 M	10	22 k
3	100 k	11	50 k Variable (Linearity)
4	100 k Potentiometer (Hold)	12	120 k
5	1.8 M	13	100 k Variable (Form)
6	680 k	14	1 M Potentiometer (Height)
7	300Ω 1 W 5%		
8	1 k	15	220 k
		16	1.8 M

CAPACITORS 200 V Wkg. 20% unless stated.

No. 1	47 pF
2	0.01μF
3	470 pF
4	250 μF 20 V
5	0.1μF
6	0.02μF
7	0.1μF
8	0.05μF

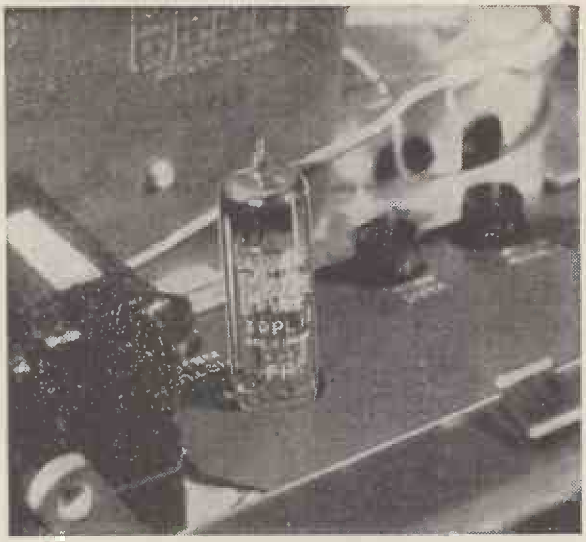
FRAME TIME BASE FOR 110° SCANNING



A NEW TRIODE TETRODE SPECIALLY DESIGNED FOR 110° FRAME DEFLECTION

EDISWAN MAZDA 30PL13

For ac/dc Mains Television Receivers



The 30PL13 is a triode-output tetrode valve combination for use in the frame deflection circuit of a television receiver.

The tetrode section is capable of delivering very high peak currents. This enables 110° cathode ray tubes operated at 15 to 16 kV to be scanned with H.T. supplies as low as 190 volts.

The triode is a general purpose type with identical characteristics to the 6 30L2 and may be used in the saw tooth generator circuit. (Characteristic curves for the 6/30L2 were published in the December issue.)

Heater Current (amps)	I_h	0.3
Heater Voltage (volts)	V_h	16

MAXIMUM DESIGN CENTRE RATINGS

		Tetrode	Triode
Anode Dissipation (watts)	$p_{a(max)}$	7.0	1.0
Screen Dissipation (watts)	$p_{g2(max)}$	2.4	—
Anode Voltage (volts)	$V_{a(max)}$	250	250
Peak Anode Voltage (Pulse Positive) (kV)	$V_{a(pk)max}$	2.0*	—
Peak Anode Voltage (Pulse Negative) (kV)	$V_{a(pk)max}$	0.5*	—
Screen Voltage (volts)	$V_{g2(max)}$	250	—
Heater to Cathode Voltage (volts) (r.m.s.)	$V_{h\text{-}k(max)r.m.s.}$	150†	150†
Mean Cathode Current (mA)	$I_{k(av)max}$	75	—
Grid 1 to Cathode Resistance (Self Bias) (MΩ)	$R_{g1\text{-}kq(max)}$	2	—

*Maximum pulse duration 4% of one cycle with a maximum of 800 microseconds.
†Measured with respect to the higher potential heater pin.

TRIODE CHARACTERISTICS

Anode Voltage (volts)	V_a	200
Anode Current (mA)	I_a	10
Mutual Conductance (mA/V)	g_m	3.4
Amplification Factor	μ	16

TETRODE OPERATION IN FRAME TIME BASE

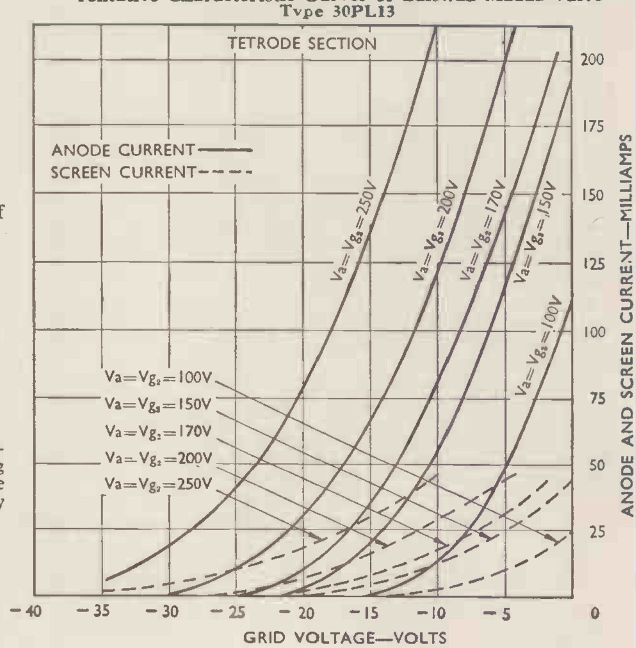
Allowance must be made in circuit design, not only for component variation, but for valve spread and deterioration during life. Values of total tetrode peak anode current, for an average valve when new and at the assumed end-of-life point for any valve, are as follows:

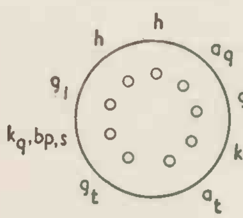
	V_a (V)	V_{g2} (V)	V_{g1} (V)	I_a (mA)
Average new valve	55	170	—1	175
Assumed end-of-life condition	50	170	—1	110

MAXIMUM DIMENSIONS

Overall Length (mm)	78.5
Seated Height (mm)	71.5
Diameter (mm)	22.2

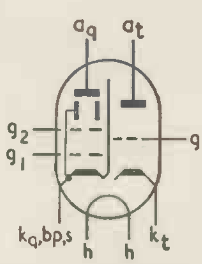
Tentative Characteristic Curves of Ediswan Mazda Valve Type 30PL13

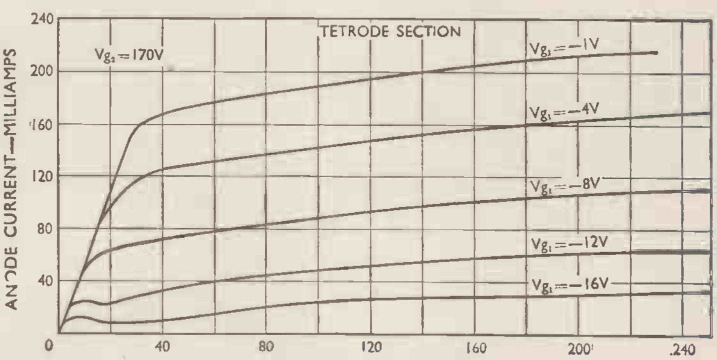




VIEW OF FREE END

BASE: Noval—B9A





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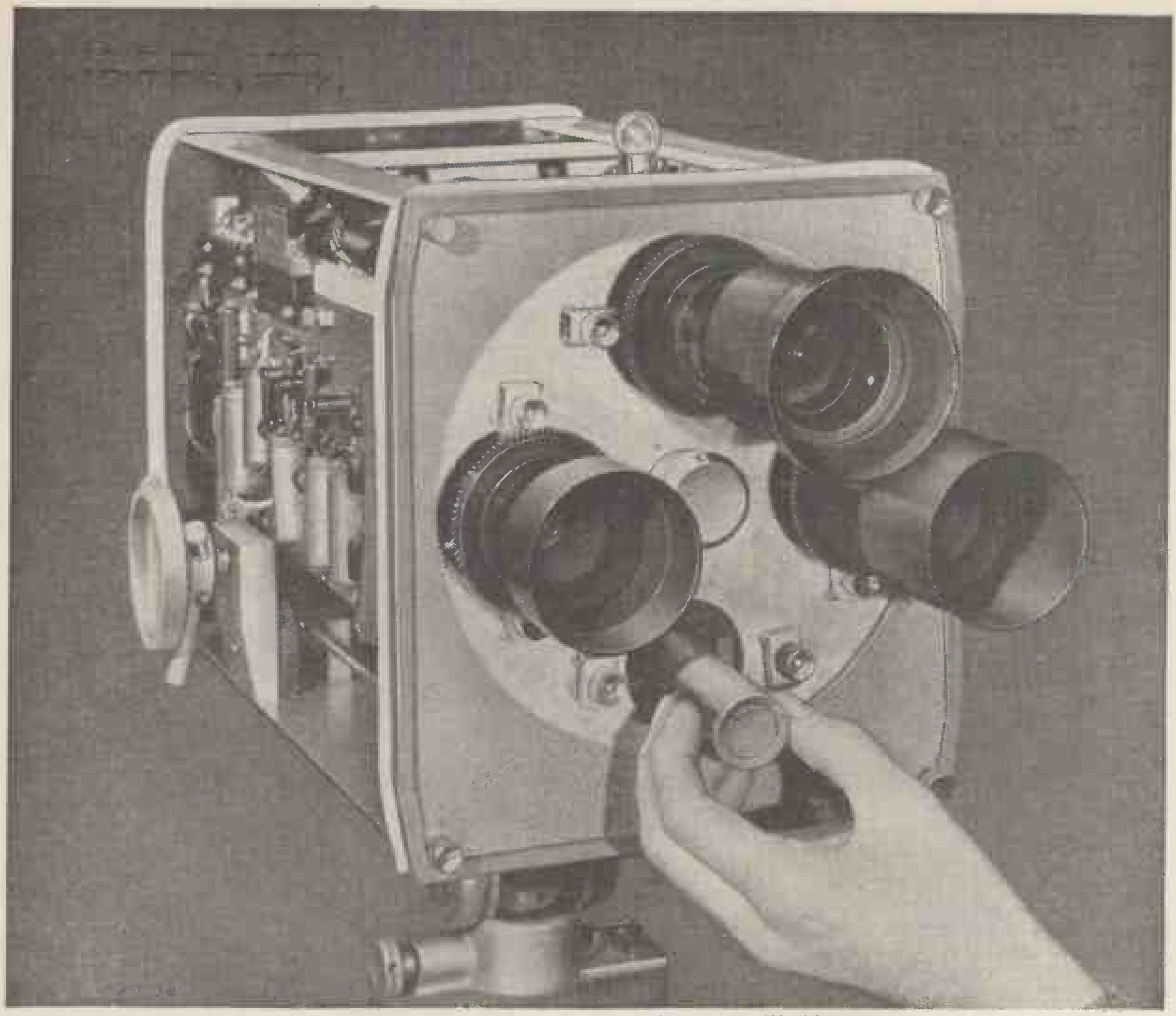

Camera Type 201 with panels removed illustrating accessibility

EMI Leads again with new TV Camera channel

A new vidicon camera channel, which offers considerable economy of operation, and has been specially designed to meet the needs of broadcasting organisations in the United Kingdom and overseas, has now been added to the E.M.I. range.

Known as the Type 201, the new camera channel utilises printed circuits and plug-in techniques to reduce size and weight to a minimum.

The Type 201 is particularly suitable for interviews, live news programmes and other studio work where the use of a larger Image Orthicon or CPS camera is not justified. It produces broadcast quality pictures on 405, 525 and 625 line standards, and is designed for use with E.M.I. vidicon tube 10667S or equivalents.

Used in conjunction with E.M.I.'s control panel type 216, the camera can be operated remotely, allowing several channels to be controlled from a single position.

The Type 201 camera channel has already been ordered by broadcasting organisations in the United Kingdom and overseas.

Type 201 camera channel features include:

* *Four lens turret with precise detent indexing.*
* *Optional remote control of focus, turret, and lens aperture.*
* *Light weight and compactness. Built-in 7" viewfinder.*
* *Two isolated composite or non-composite outputs.*
* *Complete accessibility provided by use of detachable printed cards.*

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BREAKDOWN VOLTAGE BETWEEN CONTACTS: greater than 3.5 kV d.c.

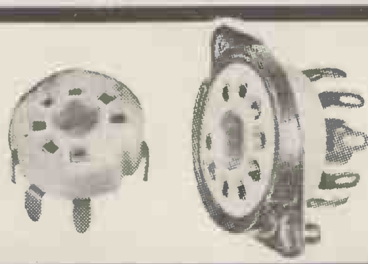
POWER FACTOR OF CERAMIC: better than 0.001

CONTACT RESISTANCE: less than 4 milliΩ

CAPACITANCE VALUE: less than 0.5pF pin to pin at 1 Mc/s.

For low moisture absorption, high insulating qualities and resistance to temperature, high stability ceramic valveholders are the obvious choice, and Plessey offer you a wide range at attractive prices. This is because they have successfully overcome certain manufacturing difficulties with ceramic materials and can now pass on to you the advantages of economic production. The exclusive design of the contact ensures constant pressure and low contact resistance throughout the working life.

Write now for samples and prices.

ceramic  valveholders

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Conversion units are also available. The regular models are retained with additions and improvements. Our high standard which has made these recorders famous has been maintained, resulting in their being chosen for the foremost musical centre in this country.

TWELVE-CHANNEL ELECTRONIC MIXER

★ This is similar to the 4-channel, but is fitted with 12 hermetically sealed controls, 12 balanced line microphone transformers potted in mu-metal boxes, and a mains transformer also potted in mu-metal. All components which can affect noise are tested and selected before insertion. It is supplied in standard steel case or 7in. rack panel.

30/50 WATT AMPLIFIER

★ Gives 30 watts continuous signal and 50 watts peak Audio. With voice coil feedback distortion is under 0.1%, and when arranged for tertiary feedback and 100 volt line it is under 0.15%. The hum and noise is better than −85 db referred to 30 watt.

It is available in our standard steel case with Baxendale tone controls and up to 4 mixed inputs, which may be balanced line 30 ohm microphones or equalised P.U.s to choice.

120/200 WATT AMPLIFIER

★ Will deliver 120 watts continuous signal and over 200 watts peak Audio.

It is completely stable with any type of load and may be used to drive motors or other devices to over 120 watts at frequencies from 20,000 down to 30 cps in standard form or other frequencies to order. The distortion is less than 0.2% and the noise level −95 db. A floating series parallel output is provided for 100-120 V. or 200-240 V. and this cool running amplifier occupies $12\frac{1}{4}$ inches of standard rack space by 11 inches deep. Weight 60lb.

Full details and prices of the above on request

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Telegrams: "Vortexion, Wimble, London."

Is your amplifier good enough for broadcasting and recording ?

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yes
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If NO we will send you full particulars of our amplifiers.

If YES we will make sure we have your name on our mailing list for details of our new stereo amplifiers and future products.

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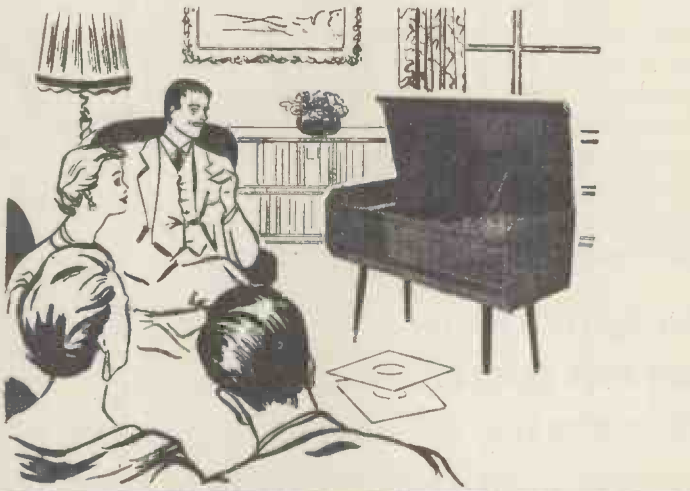

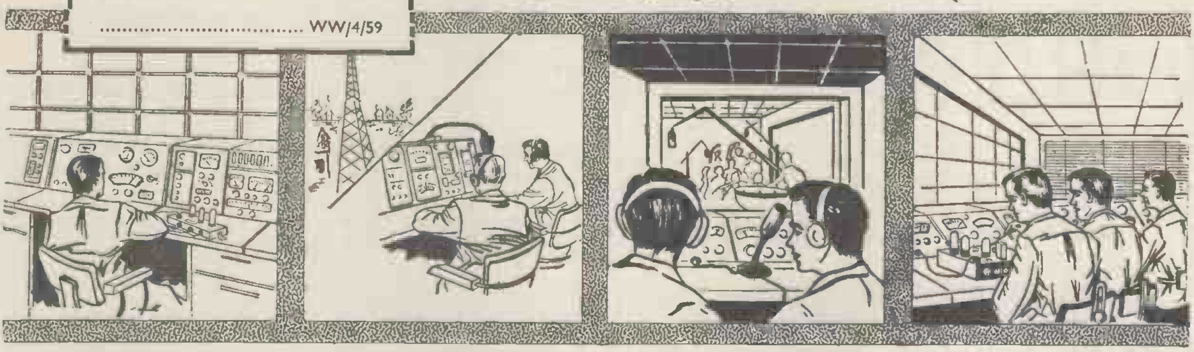

Leak amplifiers were the first in the world to be marketed with a distortion content as low as 0.1%, a claim received with incredulity in 1945 but which was subsequently confirmed by the National Physical Laboratory and has since become an accepted world-wide standard.

LEAK amplifiers are the choice of professional engineers such as the B.B.C. (over 500 delivered), the South African Broadcasting Corporation (600), ITV and many other Commonwealth and overseas broadcasting and TV systems, who use them for transmitting and/or monitoring (quality checking) the broadcasts to which you listen.

Also many of the gramophone records you buy are cut via LEAK amplifiers. This acceptance by professional audio engineers has led to a demand for Leak equipment from music-lovers throughout the world.

From long experience and by extreme attention to design details during development work on the pre-production models, we enable our craftsmen to achieve a high output per man-hour. The labour costs thus saved offset the increased costs incurred for high-grade materials, components and finishes, and this, together with quantity production (made possible only by a world-wide market), explains how quality products may be sold at reasonable prices.

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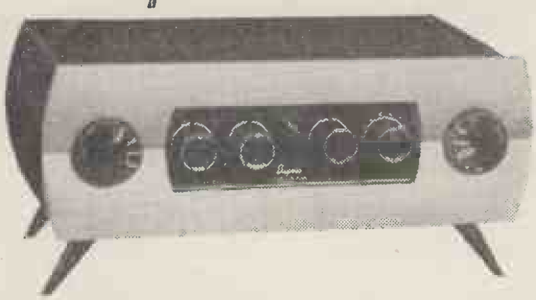
Chapman Stereo



Elegance coupled with outstanding performance have already earned an enviable reputation for the Chapman 305 Control Unit (illustrated above) and 305 Power Amplifier.

★ 8 watts per channel at 0.1%.
★ Direct from Tape Head CCIR.
★ Any low output magnetic P/U RIAA.
★ Distortion negligible all levels.
★ Spare power for Tuner.
★ Main Amplifier only 12×7×5in.
★ Separate balance control.
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★ For shelf or cabinet mounting.

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THE WAYNE KERR WIDE RANGE

Audio Oscillator

TYPE S.121

This instrument is now approved for Armed Services use. The reference numbers are:

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INTER-SERVICE—CT417

- ★ **10 c/s — 120 kc/s**
- ★ **Effective scale length 15 ft.**
- ★ **Rapid frequency selection**
- ★ **Accuracy ±1% ±0.5 c/s**
- ★ **Output : 0 — 30V and**
- ★ **+10 to — 70dB on 1 milliwatt into 600 Ω**
- ★ **Output stabilised to 0.2dB**
- ★ **Distortion <.25% to 20 kc/s, <.4% to 120 Kc/s**

THIS instrument meets the need for a first class audio signal generator in transportable form. Its wide frequency range and amplitude stabilised alternative output facility provide exceptional flexibility. For balanced output requirements a transformer is available with 600 Ω and 150 Ω secondary windings, both centre tapped.

A unique dial arrangement allows rapid selection of frequency over a scale effectively 15 feet long and greatly simplifies interpolation and extrapolation.

The S.121, which is mains operated from 110 to 250V, has overall dimensions of 17″ x 11½″ x 7½″ deep and weighs less than 30 lbs. The price is £130.

Other instruments in the Wayne Kerr range include:

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CC.10

Other Jason Test instruments

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- STABILISED POWER PACK
- VALVE VOLTMETER

The exact frequency of a generator may be found by connecting the output to the Crystal Calibrator when the self-contained audio-section and loudspeaker allow marker pips to be heard directly. These marker pips are generated at 10 mc/s., 1 mc/s., 100 kc/s. and 10 kc/s. so that generators in the range of 10 kc/s. to 250 mc/s. may be checked. The basic accuracy of 0.01% comes from the 1 mc/s. crystal oscillator.

To test the generator, it is therefore only necessary to know the frequency approximately at one point. In the absence of other methods, a wavemeter gives the best identification since it ignores harmonics. For example, if the unknown generator has a frequency of approximately 20 mc/s., the approximate frequency may be found with the 10 mc/s. harmonic, the crystal and counters being switched off to avoid any confusion. The crystal oscillator is then switched in, and the harmonics of 1 mc/s. allow exact calibration of the scale. The 100 kc/s. output is then added to allow finer calibration between the 1 mc/s. intervals.

The Jason Crystal Calibrator CC.10 is built into a standard case measuring 11½in. wide × 5¼in. high × 6½in. deep, and is available complete with valves, crystal and loudspeaker either as a ready built instrument or kit for assembly by the purchaser.

Price, as complete kit	£14 10 0
Price, ready built	£18 19 0

Professional Discounts

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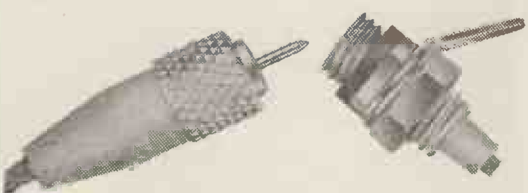
SUB-MINIATURE COAXIAL CONNECTORS



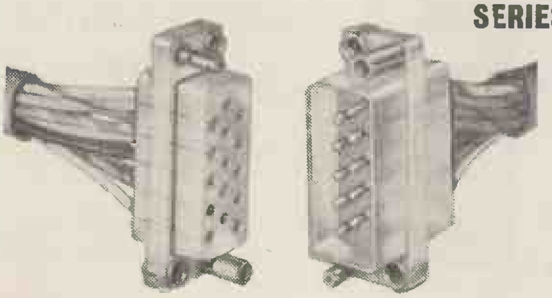
Approximately twice life size

As a contribution towards increasingly compact equipment, Plessey have introduced this new, highest quality and fully comprehensive range to allow a new approach on applications hitherto restricted by the limitations of existing connectors.

Designed for the matched impedance coupling of high frequency coaxial cables operating in the super high frequency bands, these connectors—

* have a working voltage of 650 volts Peak at sea level, and matched impedance coupling of 50 ohm lines is accommodated.
* have hard gold plated contacts on silver plate to give maximum performance with minimum voltage drop.

SERIES '110' (15- and 30-way) MINIATURE RECTANGULAR CONNECTORS



Developed specifically by Plessey to meet the demand for a safe, inexpensive connector for commercial applications, this new series embodies excellent electrical and mechanical characteristics, and the many unique features that make it really outstanding include :—

* Plug pins and socket inserts are polythene shrouded to dispense with gaskets and ensure insert anchorage.
* Mismating is prevented by corner pins and corner sockets.
* Extreme simplicity of wiring, demands less-skilled operation than the orthodox methods of soldering pins *in situ*.

For further information, please write for Publication numbers 128 and 114.

Plessey

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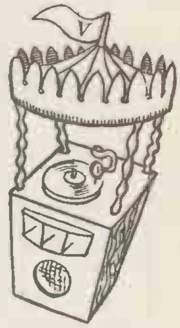
Tops for TOPS

THE NEW VITAVOX TR30 High Frequency Unit is an ideal component for the owner of a K12/10 or K12/20 Loudspeaker which refuses to wear out. The TR30 incorporates the necessary capacitor for attenuating the input at low frequencies and needs merely to be connected in parallel with the L.F. unit to provide a dual-channel system of outstanding quality. The nominal cross-over frequency is 2000 c/s and the TR30 extends the response by approximately one octave. A Balance Control CN246 can be connected, if desired, to adjust the performance to suit particular acoustic conditions.

The price of the TR30 is £6 10s. (P.T. extra). Send for a leaflet now.

Come to the Fair!

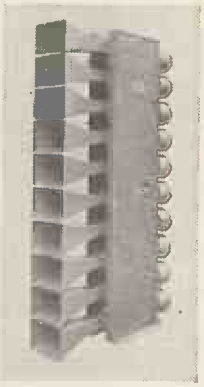
THE LONDON Audio Fair is being held at the Hotel Russell, Russell Square, from Thursday to Sunday, April 2nd-5th inclusive. A comprehensive display of VITAVOX products will be seen on Booth 7, and HALLMARK Loudspeaker Systems incorporating the DU120 Loudspeaker can be heard in Demonstration Room 322. Stereo (no trains) will be the order of the day as we are convinced that this should now be regarded as the standard medium for the serious listener.



Tickets for the Audio Fair can be obtained from your dealer or from us in case of difficulty.

Fortissimo

FAR FROM the domestic scene is this new VITAVOX product, the Type 150/10 Power Column Loudspeaker recently ordered by the Admiralty for installation in H.M. Aircraft Carriers. Fitted with ten fully weatherproof horn-loaded pressure units the loudspeaker has a power handling capacity of 150 watts and generates a sound pressure of 96 db above .0002 dyne/sq. cm. at a distance of 100 feet on axis. The loudspeaker has the exceptionally broad distribution pattern of 140° wide x 15° high and provides intelligible speech reproduction over a wide area in noisy conditions.



Specialists in audio engineering, VITAVOX Limited are well equipped to undertake the design of special apparatus of this nature.

curvaceous

THE ILLUSTRATION shows a HALLMARK Loudspeaker System being tested in the VITAVOX anechoic chamber. The laboratory is fully equipped for response and distortion measurements without which facilities the loudspeaker engineer is reduced to working largely by trial and error methods and performance becomes a matter of conjecture.

Response curves alone, however, tell only a fraction of the

cont'd. in col. 2

cont'd. from col. 1

story and are useless as a guide to the relative merits of the products of different manufacturers, particularly unless identical testing methods and conditions are employed. For this reason curves taken in the VITAVOX laboratory are used for development purposes only and are not issued for publication.

Continuous investigation and experimentation ensures that the VITAVOX loudspeaker you buy today has a standard of performance to meet the requirements of tomorrow.

★ *Fully descriptive literature on all VITAVOX products is freely available on request.* ★

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These are extracts of some recent reviews of the DU120 Duplex Coaxial Full Range Loudspeaker and Hallmark Loudspeaker Systems. If, like us, you have ever been fooled by those dots in the theatre advertisements, you will take no notice of the extracts but will wish to read the reviews in full. We shall be happy to send reprints on request.

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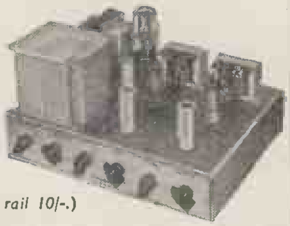

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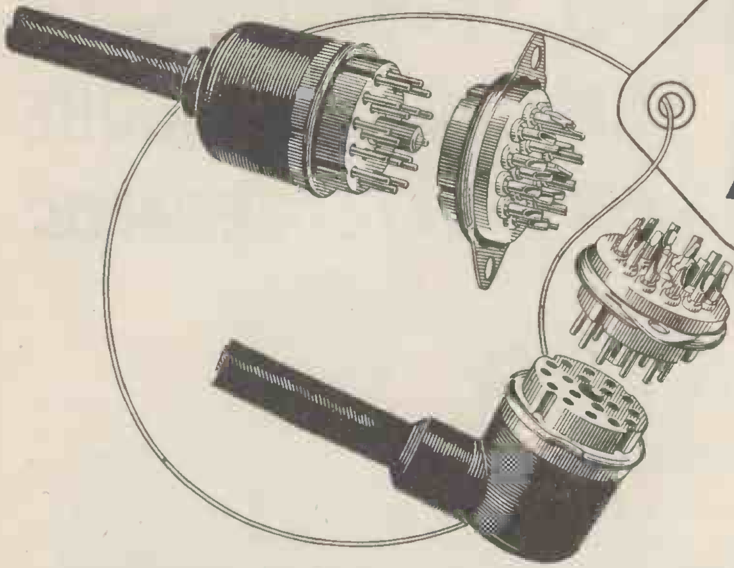

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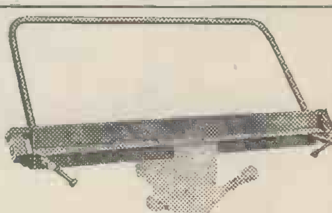

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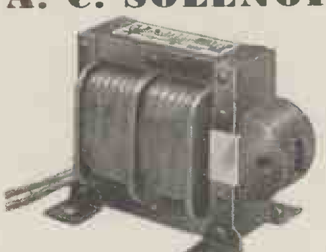

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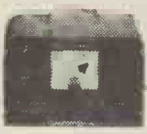

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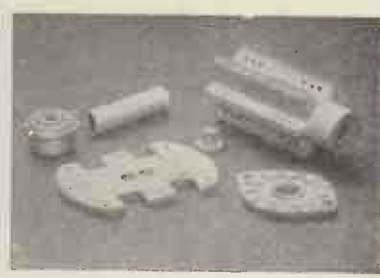

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Brenell Stereo Deck	£33 16 0	$101

★ STANDARD DECKS

Wearite 3A	£35 0 0	$100
Wearite 3B	£40 0 0	$114
Brenell	28 gns.	$84
Truvox	26 gns.	$78

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- TAPES BY ALL LEADING MAKERS

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Column Eight	£21 15 0	$45
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Wharfedale Super 3	£6 19 11	$16
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Lenco GL58/R.O. and Stereo P.U.	£29 3 10	$62
Garrard 301	£26 8 3	$54
Garrard 4HF/Stereo P.U.	£19 17 7	$41
Garrard TA/Mk. II motor	£9 15 8	$22
Connoisseur Motor	£28 6 3	$57
Collaro 4TR200	£14 11 0	$30

Also available Garrard, Collaro and BSR Auto-changers with stereo or mono pick-ups.

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Goldring 600	£11 13 6	$24
Garrard Arm and P.U.	£14 3 3	$29

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Leak Point One Stereo Pre-Amp.	£21 0 0	$60
Avantic	£29 8 0	$84
Pamphonic 3000	£31 10 0	$90
Rogers Control Unit	£18 10 0	$53
C.Q. Twin Four	21 gns.	$63
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Dulci DPA/10/2	24 gns.	$72

(SINGLE CHANNEL)

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Quad Control Unit	£19 10 0	$56
Rogers Cadet	10 gns.	$30
Rogers Junior	£17 0 0	$49
Rogers Pre-Amp.	£8 0 0	$23
Rogers Switched FM Tuner	£15 17 2	$33
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Chapman AM/FM	£29 8 0	$60
Jason JTV Tuner	£26 13 10	$55
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Ortofon Head	£33 14 0	$69
Ortofon Arm	£14 0 11	$37
Decca	£22 0 0	$45
Elac Stereotwin Cartridge	£19 17 7	$40
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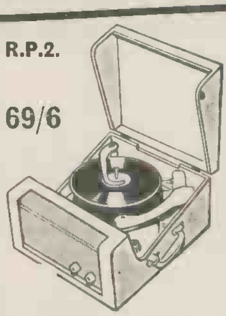
DUKE & CO. FOR RECORD PLAYER CABINETS

R.P.2.

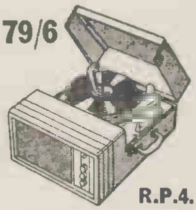
69/6



A beautifully styled cabinet Made by a famous manufacturer. In polka dot cloth with clipped lid and carrying handle. Size 16 x 14½ x 8½in. deep. Will take B.S.R. Monarch 4-speed Autochanger and 4 x 7in. elliptical speaker and most of the modern portable amplifiers. Carr. & Ins. 4/6.

Stylish cabinet by famous manufacturer. Cloth covered in contrasting colours (red and grey). Grilled front controls panel. Size 15 x 19 x 8¾in. deep. Beautifully made—a cabinet of which you can be really proud. Takes 4-speed B.S.R. Autochanger. 6½in. round or elliptical speaker. Room for any amplifier of your own choice. Carr. & Ins. 4/6.

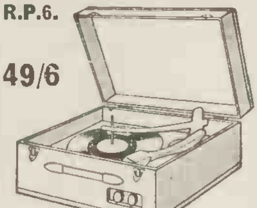
79/6



R.P.4.

R.P.6.

49/6

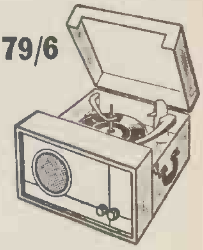


Elegant cabinet, cloth covered in grey or red, with sunken control panel and speaker fret. Size 13 x 17 x 8in. deep. Takes a B.S.R. Monarch 4-speed autochanger. 7 x 4in. elliptical speaker and most of the modern portable amplifiers. Carr. & Ins. 4/6.

R.P.3.

A delightful looking cabinet 14¾ x 17¾ x 8¾in. in two-tone leatherette. Will take a B.S.R. Monarch 4-speed autochanger and 6½in. round speaker.

79/6



Carr. & Ins. 4/6.

★ B.S.R. MONARCH 4-SPEED AUTOCHANGERS

Incorporating auto and manual control, complete with turnover crystal p.u. and sapphire stylus. P.P. & ins. 5/6. **£6 . 19 . 6**

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Incorporating auto and manual control, complete with studio crystal p.u. and sapphire stylus. P.P. & ins. 5/6. **£7 19 . 6**

U.A.12. LATEST B.S.R. MONARCH 4-SPEED MIXER P. & P. 5/6. **£8 . 9 . 6**

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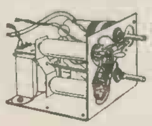
★ AMPLIFIERS ★ *12 Months' Guarantee*

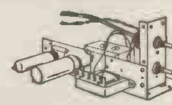
PORTABLE AMPLIFIER MK. D.2. 79/6
Printed circuit. Latest design. Dimensions 7 x 2¼ x 5in. A.C. only. Mains isolated 3-4 watts output. Incorporating the latest ECL82 triode pentode output valve giving higher undistorted output. Volume and tone controls. Knobs 2/6 extra. P. & P. 3/6.

PORTABLE AMPLIFIER MK. D.3. 89/6
De luxe model. Printed circuit. Latest design. Dimensions 7 x 2¼ x 5in. A.C. only. Mains isolated 3-4 watts output. Incorporating the latest ECL82 triode pentode output valve giving higher undistorted output. Volume, treble and bass control. Knobs 3/6 extra. P. & P. 3/6.

PORTABLE AMPLIFIER MK. D.4. 69/6



Brand new. By famous manufacturer. Especially built for portable record players. Dimensions 4½ x 3½ x 4in. A.C. only. Two valves: EL84 as high gain output valve; EZ80 as rectifier. Volume and tone controls. Knobs 2/6 extra. P. & P. 3/6.



PORTABLE AMPLIFIER MK. D.1. 59/6
Brand new. Latest design with printed circuit. Dimensions 7 x 2¼ x 5in. A.C. only. Mains isolated. 2-3 watts output. Incorporating EL84 as high gain output valve. Volume and tone controls. Knobs 2/6 extra. P. & P. 3/6.

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Brand new. Including sapphire needles for L.P. and standard, giving fullest range and finest tone obtainable for any player. Can be fitted to all standard pick-up arms. P. & P. 9d.

MOTOR BOARDS 2/6
For 4-speed autochangers. P. & P. 1/3

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8in. P.M. SPEAKERS 8/9
With O.P. transformer fitted 10/-.

To suit most Record Players. 6½in. Round P.M. Speakers, 12/6. 4 x 7in. elliptical Speakers, 19/6. Postage 2/9.

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Polished oak cabinet of attractive appearance. Fitted with 8in. P.M. Speaker W.B. or Goodmans of the highest quality. Standard matching to any receivers (2-5 ohms). Switch and flex included. Ins. carr. 3/6.

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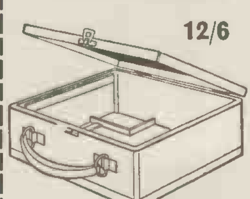
Smart cabinet. Size 14½ x 12½ x 6½in. Various two-tone colour schemes with white handle and piping. Takes T.U.9 B.S.R. single player unit, 4 x 7in. elliptical speaker and amplifiers Mk. D.1 or Mk. D.2. Carr. & Ins. 4/6. **35/6**

STURDY CASE

12/6



8½ x 7½ x 3½in. deep. Covered in burgundy and grey washable rexine. Strong clasp, hinges and handle. Ideal for portable radio chassis or transistor set. Can be adapted to hold eighteen 7in. long-playing records. P. & P. 2/6.

★ A FEW ONLY ★

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£12 . 19 . 6
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COLLARO CONQUEST STEREO
11 guineas Carr. & ins. 5/6.

STEREOPHONIC AMPLIFIER
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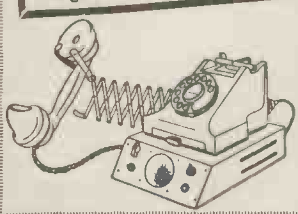
12 Months' Guarantee
Printed circuit made for portable Stereo record players. Size 3 x 5¼ x 9¾". A.C. only. Mains isolated. Twin amplifiers each side giving 3-4 watts output. Tone, Volume & Balance controls Knobs 3/6 extra. P. & P. 4/6.

STRONG PHOTOGRAPHIC SLIDE CASE 17/6
Rexine covered. Size 8 x 12¾ x 2¾in. deep. Will hold 150 of those expensive coloured transparencies in numbered partitions. This is the answer to that aggravating search for that particular photograph and will, of course, keep them safe from damage. P. & P. 2/6.



TELEVOX TELEPHONE AMPLIFIER 89/6

Invaluable in a noisy office or workshop. 3 valves UY41, UF41, UL41. 3in. speaker and a suction-type vibration microphone. A.C./D.C. Size of amplifier 7 x 11 x 3in. Fits any type of G.P.O. telephone. P.P. & Ins. 4/6.

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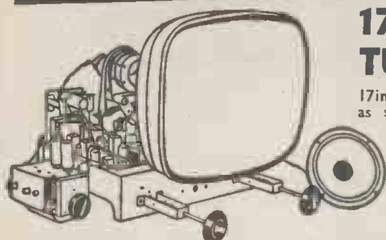

17" T/V CHASSIS TUBE & SPEAKER 16 GNS.

17in. Rectangular Tube on modified chassis. Supplied as single channel chassis covering B.B.C. channels 1-5, or incorporating Turret Tuner, which can be added as an extra, at our special price to chassis purchasers of 50/- giving choice of any 2 channels (B.B.C. and I.T.A.). Extra channels can be supplied at 7/6 each. Chassis size 12 x 14½ x 11in., less valves Similar chassis are used by well-known companies because of their stability and reliability. With Tube and Speaker less valves, 16 guineas. Complete and working with valves and Turret Tuner 24 guineas. 12 months' guarantee on the Tubes. Three months' guarantee on the valves and chassis. Ins. carr. (incl. tube) 25/-.

POWER PACK AND AMPLIFIER 19/6
R.F. E.H.T Not tested. Amplifier stage 6V6 with O.P. trans. 3 ohms matching. Smoothed H.T. 350 volt at 250 m a. 6.3 volt at 5 amp. 22 volt at 3 amp. 6.3 volt at 4 amp and 4 volt centre tapped. Less valves. Drawings free. Size 14½ x 8 x 7in. Ins. carr. 5/6.

GANG CONDENSERS 1/9
Salvage, guaranteed. Standard size two gang .0005 (500 pf). All tested and guaranteed. P. & P. 1/3.

GANG CONDENSERS 1/9
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GANG CONDENSERS 1/9
Salvage, guaranteed. Three gang. .0005 (500 pf). All tested and guaranteed. P. & P. 1/3.

14" T.V. CHASSIS, TUBE & SPEAKER 11Gns.
As above with 14in. Rectangular Tube. Twelve months' guarantee on Tube, three months' guarantee on chassis and valves. Chassis with Tube and Speaker (less valves), 11 guineas. Complete and working with valves and Turret Tuner 19 guineas. Ins. carr. (incl. tube) 25/-.

POPULAR PLESSEY 12" T.V. CHASSIS 39/6
This is a real bargain for anyone wanting to make up their own T.V. at a very low cost. I.F.'s 10.5-14 Mc/s. Simply adapted for a 12 Channel Turret Tuner and can be modified to take a larger tube. A chassis in one unit. Untested. Less valves, tube, speaker and scanning coils. (All can be supplied as extras) Circuit diagram available at 3/6 or free with order. Carr. and ins. 10/6.

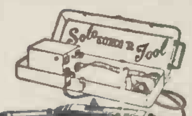
SOUND/VISION & I.F. STRIP 25/6
Plessey. Tested. I.F.'s 10.5 Mc/s sound. 14 Mc/s vision. Eight valve holders. Less valves. Size 8½ x 5 x 4½in. Circuit incl. The tuner unit plugs directly into this chassis. P. & P. 2/6.

SOUND/VISION & I.F. STRIP 5/9
Salvaged. Complete sound and vision strip. Eight valve holders. Less valves. I.F.'s 16-19.5 Mc/s. Size 8½ x 4½ x 4½in. Drawings free with order. P. & P. 2/6.

SOUND/VISION & I.F. STRIP 5/9
Salvaged. Superhet. Eight valve holders. Less valves. I.F.'s 7.25 Mc/s sound. 10.75 Mc/s vision. Vision complete from input up to vidio output. Sound complete from input to A.F Amplifier. P. & P. 2/6.

TIME BASE 4/9
Containing scanning coils, focus unit, line transformer, etc., less valves Drawings free with order. P & P. 2/6.

SOLO SOLDERING TOOL



110 v., 6 v., or 12 v. (special adaptor for 200/240 v. 10/- extra). **12/6**
Automatic solder feed including a 20ft. reel of Ersin 60/40 solder and spare parts. It is a tool for electronic soldering or car wiring. Revolutionary in design. Instantly ready for use and cannot burn. In light metal case with full instructions for use. Post 2/9.

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On plastic spools. 60/40 3-core Ersin. 20ft for 1/6. Will fit the Solo Tool. Post 4d.

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Finest quality. 75ft. x ½in. in sealed metal container. Post on 1 tin 9d. Post on 6 tins 2/-.

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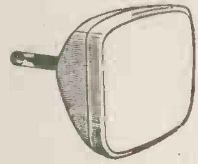
12 volt at ½ amp 0-200-250 volts primary. P. & P. 1/9. **12/9**

HEATER TRANSFORMER 3/9
2-1 ratio or 1-2 ratio auto transformer. 2 volt at 1.4 amp primary, 4 volt secondary. P & P. 1/9.

CLOCKWORK MECHANISM 1/9
A perfectly engineered clockwork unit with a fully enclosed clock-type spring, gear train and escapement. Ex W.D. (Type ROF (B) 40 SL). Can be modified for use as a darkroom timer, clock, or any mechanism requiring activation. For the amateur mechanic with ideas it offers considerable scope. Drawings free with order. Post 1/-.



REGETTERED IMPROVED VACUUM T/V TUBES

12 months Guarantee

17 in. Rect. **£7 . 10 . 0**

14 in. Rect. **£5 . 10 . 0**

Our 12 months' guarantee (6 months' full replacement, 6 months' progressive) illustrates our wholehearted confidence in the tubes we offer. We sell many hundreds a week throughout the country and have done so for the past seven years. Many of them go to the trade, i.e. to Insurance Companies, Renters and Retailers, who are thoroughly satisfied with our supplies. Remember they also hold a 10 days' money-back guarantee.

9in., 10in., 14in., 15in. and 16in. Round Tubes. Our special offer of these sizes £5.12in. T.V. Tubes £6. Three months' guarantee on round rubes. Ins. carr. 15/6.

T.V. MASKS 17in. White 9/9. Grey 10/9. Post 2/-.

T.V. MASKS 12in. Soiled 1/9. Post 1/6.

T.V. AERIALS 25/6.
For all I.T.A. channels. Outdoor or loft. Three elements. P. & P. 2/6.

AERIALS 15/9
B.B C. indoor type. Folded dipole with 12ft. co-ax. cable fitted. Post 1/9.

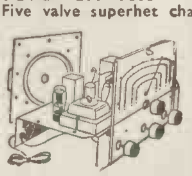
T.V. AERIALS 7/9
For all channels Complete with co-ax. cable. For use indoors or in the loft. Postage 1/3.

MIDGET RADIO 5 VALVE SUPERHET
49/6 Five valve superhet. Can be used on 110-250 volt mains A.C. or D.C. Compact little set using 12K8, 12K7, 12Q7, 35L6 and 35Z4 G.T. valves. Five inch speaker Cabinet size 17 x 8 x 6in. Carr. and ins. 3/6.

CHASSIS 1/-
Six or 8 valve latest type, midget valve design for A.M or F.M. Brand new. Cadnium plated. Size 12½ x 7½ x 2¾in P. & P. 1/9.

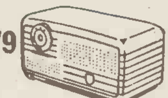
IDEAL CHASSIS 39/6
Five valve superhet. A.C. Radio or radiogram chassis. Three wavebands and gram switched. 8in. P.M. speaker included. Set of valves 45/9 extra. Chassis size 19½ x 7½ x 9in. Carr. 5/6.

SUPER CHASSIS 99/6
Five valve superhet chassis including 8in. P.M. speaker and valves. Four control knobs (tone volume, tuning w/ change switch). Four w/bands with position for gram., p.u. and extension speaker. A.C. Ins. carr. 5/6.



POWER PACK AND AMPLIFIER 9/9
Output stage PEN 45. O.P. trans. choke. Smoothed H.T. 325 volt at 250 m.a. 4 v. at 5 amp. 6.3 v. at 5 amp. 4 v. at 5 amp. centre tapped. Valve base for rectifier. Octal or 4 pin. Output is taken from standard plugs. Less valves. Ins. carr. 5/6.

BAKELITE CABINETS 5/9



Brand new. Colour brown. Attractive design. Size 12 x 7 x 5½in. Ideal for small receivers, convertors, etc. P & P. 3/9.

MAINS TRANSFORMERS
Drop through type 12/9
350-0-350 volts at 250 mA., 6.3 volt at 4 amp., 6.3 volt at 4 amp., 4 volt at 3 amp., 22 volt at .3 amp., 4 volt centre tapped at 1.5 amp. Primary 200-250 volt. 50 cycles. P & P. 3/9.

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350-0-350 volt at 80 mA. 12 volt at 1.5 amp., 4 volt at 2 amp. Primary 100-120-200-250 volt. Fully shrouded. Ideal for mains auto transformers P. & P. 2/9.

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0-205-225-245 volts at 300 mA Isolated windings of 6.3 volt at 2-6 amp., 6.3 volt at 3-6 amp., 2 volt at 1-4 amp. P. & P. 3/9.

O.P. TRANS 1/3
standard size 2-5 ohms. Post 1/-. 20 for £1. P. & P. 5/6.

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We stock equipment of Quality by all leading makers • QUAD • LEAK • ROGERS • DULCI • AVANTIC • PAM • JASON • B.T.H. • ARMSTRONG • CHAPMAN • GRUNDIG • VERDIK • HARTING • G.E.C. • WHARFEDALE • GOODMAN • W.B. • T.S.L. • COLLARO • GARRARD • B.S.R. • LINEAR • RECORD-HOUSING, etc., etc.

Leaflets available on request. Write or call for individual attention. Terms available if required.

RECORD HOUSING "NORDYK" UNITS

The above illustrated cabinets are available at £21/12/-, inc. Plus C. & P. £1. Terms available.
WE NOW STOCK THE FULL RANGE OF "RECORD HOUSING" CABINETS. These cabinets are renowned for their excellent quality and superb finish Send for illustrated leaflet of complete range.

MULLARD 510 HIGH-FIDELITY AMPLIFIER

Our printed circuit version of this excellent amplifier, with ULTRA. LINEAR PUSH-PULL output stage, giving an exceptionally high quality output of 10 watts (max.). Built-in Controls are provided for independent bass and treble Tone correction to suit all types of signal input. Will match all crystal or high impedance magnetic pick-up heads, F.M.. A.M. or A.M./F.M. tuners or tape recorder output. All required components of best quality to Mullard Spec. are offered at a special inclusive price of £9/9/- plus 3/6 P. & P. Instruction Book containing full constructional details theoretical, practical wiring diagrams, itemised, price list available separately at 3/6 post free.

"TRU-SOUND" STEREO AMPLIFIER

This amplifier offers superb quality at very moderate cost and is suitable for use in conjunction with any standard or stereo record player. Brief spec.: Twin amplifiers delivering a total of approx. 7 watts. Output to match 3 ohm loudspeakers. Valve line up 12AX7, 2-ECL82, EZ80. Negative feed back employed in both channels. Controls: volume, tone and balance. Supplied with attractive gold control panel with black lettering, brown and gold control knobs. Overall size 9 x 6 x 5in. Control panel 9 x 2in. Price only £8/10/-, plus 3/6 P. & P.

PORTABLE GRAM AMPLIFIERS

RC2A. Small PRINTED CIRCUIT single-valve high-gain amplifier for the smaller type of portable. Employs latest type ECL82 valve. Further details on request. Price only 59/6 plus 2/- P. & P.
RC3A. A superior quality 3-valve amplifier employing EZ80, EL84 and ECC83. With separate bass and treble controls. Price £3/19/6 plus 2/6. P. & P.

A QUALITY RECORDER FOR 39 GNS.

Comprising:

	£	s
Collaro Mark IV Tape Transcriptor Deck	£25	0
Special ready built amplifier	£14	14
8 x 6in. elliptical loudspeaker	£1	10
Special de luxe Portable Cabinet with gilt fittings	£4	10
Collaro Mike (or similar)..	£2	5
1,200ft. spool E.M.I. tape..	£1	15
TOTAL	£49	14

OUR SPECIAL INCLUSIVE PRICE ONLY 39 GNS. if all items purchased together. Terms: £4/19/- deposit and 12 monthly payments of £3/3/-. C. & P. 15/- extra. Full assembly instructions provided. Note: We shall be pleased to wire the tape deck switches for you if you wish, at an extra charge of £1. Send stamp for further details.

LOUDSPEAKERS AND ENCLOSURES

We stock all leading makes including B.T.H., Wharfedale, W.B., Goodman, etc., etc. Enquiries invited.

HARTING STEREO TAPE DECK

For the Connoisseur of genuine High Fidelity for inclusion in any High Fidelity combination. The Harting STEREO Tape Deck is a professionally made and designed unit of the highest standard. Where first class reproduction of Stereo or standard tapes is required this deck cannot be beaten. Will record Monaurally at 7½in. per sec. or 3¾in. per sec. Wow and flutter guaranteed to be less than 0.1 of 1% at 7½in Frequency response: 30-20,000 c/s. ± 2db. at 7½in. 30-16,000 c/s. ± 2db at 3¾in. This fantastic response is maintained both on Stereo and Monaural playback, and is entirely due to the latest type of TELEFUNKEN Record/Playback and erase heads employed. Further details on request.
PRICE 42 GNS. plus 15/- C. & P. Terms: £4/10/- deposit plus C. & P. and 12 monthly payments of £3/10/4.

JASON J.T.V. TUNER

All components for building this long awaited tuner, covering 3-BBC/FM and BBC/ITV sound channels, can be supplied ex stock, at a special price of ONLY £13/19/6, P. & P. 3/6, including all valves and PRE-FABRICATED FRONT END TURRET. Incorporates built-in power supplies, tuning indicator and series noise limiter on AM. Comprehensive assembly instructions together with itemised component price list available separately at 2/6 post free. NOTE: Please state Local Channels when ordering.

"ROLEX" SPECIAL HEAVY DUTY MAINS/BATTERY AMPLIFIER. Very smart unit housed in grey crackle finish case with chrome and cream fittings. For use on A.C. mains 200/250 v. or 6 v. D.C. battery. Valve line-up 6SK7, 6SN7, 6SL7, 2-6V6, 6X5 and 629C vibrator. 20 watts output to match 4, 8, 16, 250 and 500 ohm speaker systems. Ideal for P.A. work, etc. Size 13½in. × 8½in. × 7¾in. Mike and gram inputs with separate gain controls, tone control. Brand new, fully guaranteed. ONLY £15/15/-, plus 7/6 P. & P. Terms: £1/11/6 deposit plus P. & P. and 12 monthly payments of £1/4/10.

RECORD UNITS

COLLARO AC 3/554
Three-speeds single record Player for A.C. mains, 200/250 v. Cream finish, complete with turnover crystal pick-up incorporating the well-known high output "T" type head. Strictly limited quantity at £5/19/6 plus 3/6 P. & P.

LATEST B.S.R. UA12
Stereo 4-speed auto-changer unit complete with FUL-FI stereo cartridge for monaural or stereo records. Brand new and fully guaranteed. £12/12/- plus 3/6 P. & P.

B.S.R. MONARCH
Mixer Autochanger in cream and gold. £6/19/6, plus P. & P. 3/6. Limited Stocks.

THE LATEST COLLARO "CONQUEST"
4-speed autochanger in cream with Studio "O" insert. £7/19/6. plus P. & P. 3/6.

GARRARD RC. 121D MK. II STEREO MONAURAL 4-SPEED AUTOCHANGER
Complete with GC8 plug-in crystal head and sapphire styli for monaural records. Brand new, fully guaranteed. Limited stocks. ONLY £11/0/6, plus 5/- P. & P. NOTE: Garrard L.P. Stereo plug-in head for above available as optional extra for £2/0/1 inc. P.T. Terms available.

GARRARD RC120/4H
4 speed autochanger with GC2 insert. Brand new, fully guaranteed. £9/9/0 plus 3/6 P. & P.

GARRARD 4HF
A quality 4-speed single-record unit complete with TPA12 transcription arm and GC8 crystal pick-up. Size (space reqd.) 17¼ x 13¾ x 3½in. above board and 3¼in. below. PRICE £19/7/10. Plus 3/6 P. & P.

GARRARD 4S.P.
This famous single-record 4-speed unit complete with GC2 turnover crystal head and sapphire styli available in limited quantity. Brand new and fully guaranteed. Only £6/19/6, plus 3/6 P. & P.

A SUPERB NEW TRANSISTOR PRINTED CIRCUIT POCKET PORTABLE (BY PERDIO)

A most attractive receiver employing 6 selected transistors and covering Medium and Long wave bands. Housed in smart cream plastic case, size 5¾in. x 3¾in. × 1½in. with gilt table stand and control knobs. All necessary components for construction of this beautiful receiver are available at a special inclusive price of £9/19/6, plus 2/6 P. & P. including comprehensive, easy-to-follow instructions (available separately. 2/6 post free).

EXTRA SPECIAL OFFER ! !

A small three-valve PORTABLE RECORD-PLAYER AMPLIFIER mounted on baffle 12 × 7in. with High Flux 6½in. Loudspeaker. Valve line-up ECC83, EL84, EZ80. Incorporates separate bass and treble controls. Max. output 3 watts. Will match all types of high impedance pick-up. Ready to use. £5/12/6 plus 3/6 P. & P.

NEW STYLE CABINET finished in two-tone Leatherette. Will accommodate above Amplifier and Baffle without modification, also most types of Ancillary Equipment. Overall size 18 x 13½ x 8½in. Fitted with carrying handle. £3/9/6 plus 5/-. P. & P. NOTE. If both items purchased together they will be supplied at a special inclusive price of £8/7/6 plus 6/6 P. & P.

Our advantageous deferred terms are available on any single item over £5. Your enquiries invited.

If not stated, please add postage on orders under £1. Cash with order or C.O.D. (charges extra).

Open : Tottenham Court Road: 9 a.m. to 6 p.m. Mon. to Fri., Sat. 1 p.m.
Holloway Road: 9 a.m. to 6 p.m. daily, Thurs. 1 p.m., Sat. 5.30 p.m.

G.W. SMITH & CO (RADIO) LIMITED

Phone: GERRARD 8204/9155
Cables: SMITHEX LESQUARE
3-34 LISLE STREET, LONDON, W.C.2

WESTON MODEL 772 TESTMETER

A.C. VOLTS	D.C. CURRENT	A.C. CURRENT
2.5 v.	100 micro/a.	500 ma.
10 v.	1 ma.	1 amp.
50 v.	10 ma.	5 amp.
250 v.	50 ma.	RESISTANCE
1,000 v.	100 ma.	100 ohms
D.C. VOLTS	500 ma.	1,000 ohms
2.5 v.	OUTPUT METER	100k. ohms
10 v.		10 megohm
50 v.		
250 v.		
1,000 v.		

Supplied in perfect working order complete with rexine carrying case, internal batteries and instructions, **£8/19/6** each. P/P 4/-.

COSSOR DOUBLE BEAM OSCILLOSCOPE TYPE 339

Operation 110/200/250 volts A.C. 120 watts. Time Base 10 positions. 6 cps. to 250,000 cps. Amplifier 10 cps. to 2,000,000 cps. Sensitivity, Y1.Y2.3.1 v. D.C. 1.1 v. rms. X. 2.25 v. D.C. .8 v. rms.

Supplied in good working order complete with handbook and circuit. **£27/10/-** each. P/P £1.

EVERSHED VIGNOLES MEGGER OHMMETERS

2 ranges. 0-1,000 ohms and 0-200,000 ohms. Ideal for all continuity, polarity tests, etc., supplied brand new, boxed, with leads and instructions. **59/6** each. P/P 2/-.

300FT. COPPER AERIAL WIRE. Ex-U.S.A. 3/6 per reel. P/P 1/-.

LEACH AERIAL CHANGEOVER RELAYS. 12 v. D.C. double pole transmitter type. New, boxed, **7/6** each. P/P 9d.

MARCONI SIGNAL GENERATORS TF-517. Frequency coverage 10–18 Mc/s. 33–58 Mc/s and 150–300 Mc/s. Operation 200/250 volt A.C. Supplied in good working order, **£12/10/-** each. P/P. 10/-.

750-WATT AUTO TRANSFORMERS. Ex-Admiralty, fine jobs. Tapped from 110 to 230 volts. Brand new, **69/6** each. P/P 5/-.

HEAVY DUTY MAINS ISOLATION TRANSFORMERS. 230 volt input. Output 230 volts 5 amps. Housed in ventilated metal case, unused, **£5** each. P/P 10/-.

MUIRHEAD PRECISION STUD SWITCHES

4 banks, 1 pole 24 positions each bank. Self cleaning heavy duty contacts. Brand new, **17/6** each. P/P 1/-. Ditto, 2-bank, **10/6**.

AMERICAN SUPER LIGHTWEIGHT HEADPHONES. Res. 50 ohms. Fitted with rubber earmoulds, extremely good quality, ideal if used for long periods. **15/-** per pair, brand new, boxed. P/P 1/3.

CR.100 SPARES KITS

Complete set of new valves 2 X66, 2 U50, 2 DH63, 2 KT63, 6 KTW61. Also set of resistors, condensers, pots, toggle switch and output transformer. Supplied new and boxed. **59/6** each. P/P. 4/6.

HALLICRAFTER SX-24 SKYRIDER DEFIANT RECEIVERS
One of the finest communication receivers made. Frequency coverage continuous from 550 kc/s to 42 Mc/s. Incorporates crystal filter, S meter, variable bandwidth, etc., operation 110/230 volt A.C. Supplied in perfect order at **£25** each. P/P. 10/-. Further details on request.

MARCONI B.29 L.F. COMMUNICATION RECEIVERS. Self contained 7 valve receiver similar to CR.100 covering 15 kc/s to 560 kc/s on 4 bands. Operation 200/250 v. A.C. Supplied in good condition and complete but not tested. Only **£3/19/6** each. P/P. 10/-.

ROTARY CONVERTERS

12 v. D.C. input, 230 volt A.C. 150 watts, 50 cycles output. Housed in wooden case and fitted with voltage control slider resistance, switch, plugs and A.C. mains voltage output check meter. Supplied in perfect condition, individually tested, **£9/19/6** each. P/P. 10/-.

PARMEKO MAINS TRANSFORMERS. Input 230 volts. Output 350/0/350 volts 150 mA. 6.3 v. 4 amp., 5 v. 4 amp. Brand new, **32/6** each. P/P. 2/6.

R.1155 " N " TYPE SUPERSLOW MOTION DRIVES. Brand new, **12/6** each. P/P. 1/-.

AMERICAN GEARED MOTORS

24 volt D.C. motor fitted with precision gearbox giving twin outputs of 20 and 6 r.p.m. Also operates on 12 volts. ¼in. shafts. Brand new, **19/6** each. P/P. 1/6.

CV967 1in. C.R.T. 4 v. HEATER. Suitable for oscilloscopes, etc., **25/-** each. P/P. 1/-.

CRYSTAL MICROPHONE INSERTS. Only 4/6 each. P/P. 6d.

ALKALINE NIFE ACCUMULATORS

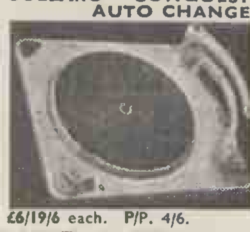
Banks of 10 cells giving 12 v. 45 A.H. Unused in wooden crates, **£5/10/-** each. P/P. 7/6. Size 26½ x 8½ x 5½in.

MIDGET NIFE ACCUMULATORS. Single units, ideal for models, etc., **2/3** each. P/P 9d.

12-VOLT MOBILE AMPLIFIERS. Ex-Admiralty. Mic. or gram. inputs, 10 watts output to 3 or 15 ohm speakers. Not new but in good working order, **£8/19/6** each. P/P. 5/-.

RCA ET 4336 PLATE TRANSFORMERS. Special release, brand new in original transit cases. Primary tapped 200/250 v. 50 cycles. Secondary, 2,000/0/2,000 v. 400 ma., tapped 1,500/0/1,500 v. Price **£12/10/-** each. P/P. £1.

COLLARO CONQUEST 4-SPEED AUTO CHANGERS



Turnover crystal pickup with permanent stylus. Mixed loading, manual or auto. Brand new, complete with all instructions, etc. **£6/19/6** each. P/P. 4/6.

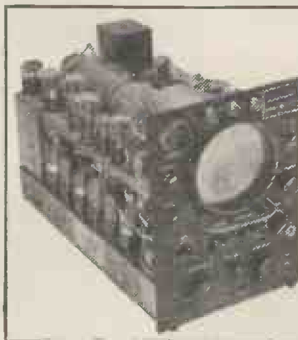
AMERICAN MULTI-RANGE TESTMETERS

1,000 ohms per volt, 400 microamp basic movement.

A.C. VOLTS	D.C. VOLTS
2.5 v.	2.5 v.
10 v.	10 v.
50 v.	50 v.
250 v.	250 v.
1,000 v.	1,000 v.
5,000 v.	5,000 v.
D.C. CURRENT	**RESIST'CE**
1 ma.	500 ohms
10 ma.	100k. ohms
100 ma.	1 megohm
1 amp.	DECIBELS −10 to +69

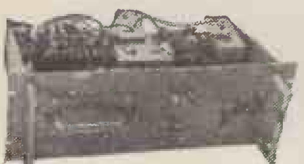
ALL BRAND NEW. COMPLETE WITH INTERNAL BATTERY TEST PRODS AND INSTRUCTIONS. **£5/19/6** EACH. P/P 3/-.

LORAN INDICATORS APN4



Another release, all brand new. These units contain a 5CP1 C.R.T. 14 6SN7 valves, 8 6H6, 3 6SL7, 1 6SJ7 and a 100 kc/s. crystal, also many thousands of useful components. Ideal for conversion to an oscilloscope. **£5/19/6** each. Carriage 10/-. Circuitry supplied.

ADMIRALTY POWER UNITS 234A.



200/250 volt A.C. input. Output 250 volts 150 mA. and 6.3 volts 6 amps. Fully smoothed, double choke and paper condensers, fused and fitted with input and output plugs. Sockets are provided on the front panel for meter check. Housed in grey metal case for standard 19in. rack mounting. Supplied brand new, **59/6 each.** P/P 7/6.

FERRANTI TESTMETERS TYPE Q.

D.C. VOLTS	A.C. VOLTS	D.C. Current	Ohms
3 v.	15 v.	7.5 ma.	25,000
30 v.	30 v.	30 ma.	
150 v.	150 v.	150 ma.	
600 v.	600 v.	750 ma.	

500 ohms per volt on all ranges. B.S.S. first grade accuracy on all self contained ranges. Supplied in perfect working order complete with leads, battery, instructions and rexine covered carrying case. Price **72/6** each. P/P 2/6.

COSSOR 343 GANGING OSCILLATORS. A.M./F.M. signal generators covering 70 kc/s to 21 Mc/s. 400 cycles int. mod. F.M. sweep 0 to 50 kc/s. Operation 110/200/250 v. A.C. Supplied in perfect condition externally and internally, complete but not tested, **£5/19/6** each. P/P 7/6.

HOOVER MIDGET ROTARY TRANSFORMERS. 2¼ x 4½in. Input 12 v. D.C. Output 310 v. 30 ma. Brand new and boxed, **12/6** each. P/P 1/3.

6-VOLT VIBRATOR POWER PACKS. Output 120v. 30 ma. Fully smoothed, uses standard Mallory 4-pin vibrator. New and boxed, **12/6** each. P/P 2/-.

METER BARGAINS

50 Microamp. D.C. M/C., flush sq. in.	119/6
50 Microamp. D.C. M/C., proj. rd. 2½in.	49/6
100 Microamp. D.C. M/C., flush rd. 2½in.	42/6
500 Microamp. D.C. M/C., flush rd., 2in.	15/6
500/0/500 Microamp. D.C. M/C., proj. rd. 2½in.	19/6
1 Milliamp. D.C. M/C., flush rd. 2½in.	25/-
50 Milliamp. D.C. M/C., flush sq. 2in.	7/6
200 Milliamp. D.C. M/C., flush rd. 2½in.	9/6
30 Amp. D.C. M/C., flush rd., 2½in.	9/6
15 Volt D.C. M/C., flush rd., 1½in.	10/6
25 Volt D.C. M/C., proj. rd. 2in.	8/6
120 Volt D.C. M/C., flush rd., 3½in.	32/6
300 Volt A.C. M/I., fluhs rd., 2½in.	25/-
300 Volt A.C. M/C., rectifier, flush rd., 2½in.	25/-
500 Volt A.C. M/I., flush rd., 2½in.	25/-

ALL BRAND NEW AND TESTED

BARGAIN GRAM MOTORS. Garrard centre drive motors complete with turntable, 220/250 v. A.C. Adjustable mechanically from 0–45 r.p.m. Only **22/6** each. P/P 3/-.

MINE DETECTORS No. 4a

Complete equipment comprises Search Head, Amplifier, Headset, Control Box, Telescopic Rods for Search Head, Search Head Test Unit and Test Depth Measure, and Haversack.

Operation is from a standard 60 v./1.5 v. combined dry battery. The unit will detect ferrous or non-ferrous metals to a depth of 24in. giving maximum signal but can be used at greater depths giving lower output. Ideal for tracing underground pipes or cables and any hidden metallic objects.

Complete equipment supplied brand newi n original transit cases complete with circuit and operating instructions.

PRICE

99/6 EACH

Carriage 10/6.

100-WATT ROTARY CONVERTORS. Input 24 v. D.C. Output 230 v. A.C. 50 cycles, 100 watts. Housed in grey metal case with input/output plugs. Supplied brand new, **92/6** each. P/P 7/6.

150-WATT ROTARY CONVERTORS. Two models available, either 12 or 24 v. D.C. input. Output 230 v. A.C. 50 cycles, 150 watts. Brand new, **£7/10/-** each. P/P 7/6 ea.

PARMEKOTABLE TOP TRANSFORMERS. Input 230 v. 50 cycles. Output 620/550/375/0/375/550/620 volts 250 mA. Also 2–5 volt 3 amp. windings. Size: 6¾ x 6¼ x 5½in. Brand new only **45/-** each. P/P 5/-.

FERRANTI POTTED FILAMENT TRANSFORMERS. Hermetically sealed, ceramic terminations. All new and boxed, Type 1: 200/250 v. input. Output 6.3 v. C.T. 5.6 a. tapped 5 v. 6.3 v. CT, 4.8 a. tapped 5 v. 6.3 v. CT, 1 a., tapped 4 v., **19/6** each. Type 2: Input 200/250 v. Output 6.3 v. CT, 3.3 a., tapped 5 v. 6.3 v. CT, 1 a., tapped 4 v. 6.3 v. CT, 9 a. 6.3 v. CT, 6 a., **15/6** each. P/P 2/-, each type.

MARCONI TEST EQUIPMENT. TF144G Standard Signal Generator, 85 kc/s to 25 Mc/s. Recond., **£65.** TF-373 Universal Impedance Bridges. Recond., **£55.** TF.854. Signal Generator, 9.1 to 10.7 cm. Brand new, with power unit, **£100.**

HALLICRAFTER S.27 COMMUNICATION RECEIVERS. F.M. or A.M. coverage 27 to 143 Mc/s on 3 bands. Incorporates S meter, var. sel. B.F.O., etc., output for phone or speaker. Operation 110 or 230 volt A.C. Supplied reconditioned in perfect working order, **£32/10/-** each. P/P 10/-.

R.1155 COMMUNICATION RECEIVERS. Trawler Band Models L & N. Supplied in perfect working condition, **£12/19/6** each. Standard model B receiver, fitted with improved N-type drive, in perfect working order, **£7/19/6** each. 7/6 carr extra on both receivers. **Combined A.C. Mains Power Pack and Audio Output Stage, 85/-** extra. Illustrated instruction book with each receiver

EDDYSTONE MAINS POWER PACKS. 200/250 volts input. Output 175 volts 60 ma. and 12 volts 2.5 amps. Double choke and condenser smoothed, 5Z4 rectifier. Housed on grey metal case. Supplied new and unused, **32/6** each. P/P 3/6.

VORTEXION PORTABLE AMPLIFIERS Operation from 200/250 volts A.C. or 12 volts D.C. Separate inputs for microphone or gram. Output matched to 7.5, 15, 250 or 500 ohms. Incorporates volume control and full switched tone control. Valve line-up: 6Q7, 6J5, 6V6, 6V6, 5Z4. Size 8¼ x 6½ x 17½in. not brand new but supplied in perfect working order, fully tested, **£10/10/-** each. P/P 6/-.

45 AMPERE NIFE ACCUMULATORS. Single cells, 1.2 v., **12/6** each. P/P 2/-.

POTTED MAINS TRANSFORMERS. Primary 230 volts. Secondary 350/310/0/310/350 volts 220 ma., 6.3 volts 13 mps. 5 volts 3 amps., **49/6** each. P/P 3/-.

R.1294 V.H.F. RECEIVERS. Coverage 500 to 3,000 Mc/s. Perfect condition, with handbook, **£35** each. P/P 10/-.

PORTABLE PRECISION VOLTMETERS BRAND NEW instruments by famous manufacturer. Housed in polished teak case. Moving iron movement reading A.C. or D.C. volts on 2 ranges, 0–160 v. or 0–320 v., 8in. mirror scale. Accuracy within 2% Supplied at a fraction of original cost, **£5/19/6** each. P/P 3/6.

A.C. MAINS VOLTAGE REGULATOR TRANSFORMERS. Input 230 v. Output variable from 185 to 250 v. at 24 amps, or 185–250 v. input, 230 v. output, **£12/10/-** each. P/P 10/-.

UNIVERSAL AVOMINOR TESTMETERS

Small, compact, accurate instrument. Resistance measurements from 0 to 20 k. ohms, D.C. volts from 0 to 500 v., A.C. volts from 0 to 500 v., D.C. current from 0 to 500 mA. Supplied in perfect working order, complete with leather case and leads. **£5/10/-** each. P/P 2/6.

G.W. SMITH & CO (RADIO) LIMITED

Phone: GERRARD 8204/9155
Cables: SMITHEX LESQUARE
3-34 LISLE STREET, LONDON, W.C.2

CONSTRUCTORS' PARCEL FOR TRANSISTOR POCKET RADIO

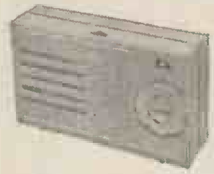
Size 5½" x 3¼" x 1¼"

SPECIAL PRICE
55/- P.P. 2/6
Component lists supplied.

- ★ Attractive moulded cabinet (blue, red or cream) with gold. 12/6.
- ★ J.B. 208 and 176 pf screened gag. 10/6.
- ★ Miniature 2½in. speaker to fit. 21/6.
- ★ 3 ohm output transformer. 10/-.
- ★ 5 transistor printed circuit board. 5/6.
- ★ Circuit of 5 transistor radio. 1/-.

THE IDEAL BASIS FOR A POCKET TRANSISTOR RADIO

THE TELETRON "TRANSIDYNE"



Size 6¼" x 3¾" x 1¾"
Weight 20 ozs.

- ★ 6 EDISWAN TRANSISTORS.
- ★ TCC printed circuit.
- ★ 120 mW output push-pull.
- ★ Med. and long waves.
- ★ Components identified.
- ★ Long-life batteries.
- ★ EASY TO BUILD.

All components for construction including cabinet, printed circuit, etc., can be supplied or

£11.19.6 P.P. 2/6.

All parts sold separately.

SEND 9d. FOR CIRCUIT, PLANS AND PRICES

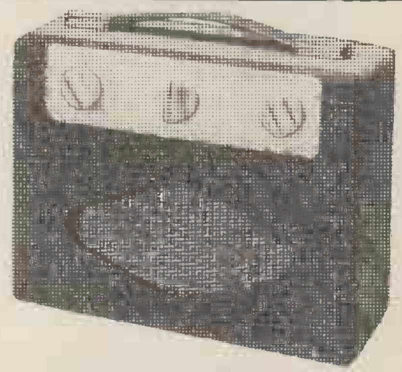
THE "TRANSISTOR–8"
COMBINED CAR-RADIO/PORTABLE
PUSH-PULL SUPERHET

This Portable 8 Transistor Superhet is tunable for both Medium and Long Waves and is comparable in performance to any equivalent Commercial Transistor Set.
Simplified construction enables this set to be built easily and quickly into an attractive lightweight cabinet supplied.

- ★ ALL EDISWAN TRANSISTORS.
- ★ 250 Milliwatts Output Push-Pull.
- ★ Medium and Long Waves.
- ★ Internal Ferrite Rod Aerial.
- ★ 7×4 Elliptical High Efficiency Speaker.
- ★ Drilled Paxolin Chassis 8¾ x 2½in.
- ★ Transistor Holders.
- ★ New Point to Point wiring and practical layout.
- ★ Economical. Powered by 7½ v. battery
- ★ Highly sensitive.
- ★ Ideal car radio.

Car Radio Conversion Components 8/- extra. A.V.C. 4/3 extra.
325 MW version 40/- extra.

We can supply these items including Cabinet for £11/10/-. P.P. 2/6. All parts sold separately.
Send for FREE circuit diagrams, assembly data, illustrations and instructions, and full shopping list.



NEW! SPECIAL 2 WATT POWER OUTPUT STAGE USABLE WITH "TRANSISTOR-8"

SIX TRANSISTOR POCKET SUPERHET

STAR FEATURES
- ★ Medium and Long Wave.
- ★ 6 Selected Transistors
- ★ Printed Circuit.
- ★ Internal Ferrite Aerial.
- ★ 30 ohms Speaker.
- ★ Instruction Booklet.
- ★ Low consumption.
- ★ Attractive Plastic Cabinet. (Red, Blue and White colours).
- ★ Easy to Build.

This set is recommended as an ideal Portable Highly sensitive, selective, containing the latest features giving simplicity in construction with amazing results.

All items supplied special inclusive price of
£9 . 19 . 6 P.P. 2/6.

ALL COMPONENTS SOLD SEPARATELY.
SEND FOR FREE LIST

"THE MINOR"

The smallest transistor radio offered on the market. Case size only 3 x 2 x ⅞in. Variable tuning over medium waves. Uses a three-stage reflex circuit of high efficiency. Total cost including Personal phone; transistor; long life miniature battery, circuit and complete layout diagrams and all components:

★ Internal ferrite aerial.

post free **52/6**

All components sold separately.

Circuit, layout diagrams and shopping list free.

NEW! SOLAR-3 NO BATTERIES; OPERATES BY LIGHT, as described in Feb. issue 'Radio Constructor.' Send for free list.

"THE MAJOR"

2-transistor portable.

STAR FEATURES
- ★ No aerial or earth.
- ★ Variable tuning over medium waveband.
- ★ Internal ferrite aerial.
- ★ Foreign stations (in areas of reasonable reception).
- ★ Drilled and mounted chassis.
- ★ Four-stage reflex circuit.
- ★ Highly efficient.
- ★ Economical (1½ mA. consumption).
- ★ May be assembled within an hour.
- ★ Complete layout diagrams.

Size 4½ x 3 x 1¾in. Total weight less than 4 oz.

We can supply all items including EDISWAN TRANSISTORS, case and personal earphone for... **72/6** post free

All parts sold separately.

Circuit, layout diagrams and shopping list free.

HENRY'S RADIO LTD.
(Dept. W/WAP)

5, HARROW ROAD, PADDINGTON, W.2
(Opposite Edgware Road Tube Station) PAD 1008/9

1. PIRANI CONTROL UNIT

Includes:
- ★ 6in. 1 mA movement meter with mirrored scale.
- ★ Fully set Wheatstone Bridge.
- ★ Complete in best quality case.
- ★ Built-in galvo-shunt.

ONLY **£5/19/6** P.P. 5/-
Including Circuit diagram.

2. PIRANI DIFFERENTIAL LEAK DETECTOR.

Includes:
- ★ 2-arm Wheatstone Bridge.
- ★ Masses of high quality switches and controls.
- ★ Best quality wood case.
- ★ Galvo-shunt.
- ★ Circuit diagram.

ONLY **59/6** P.P. 5/-

3. PYE SCALAMP GALVANOMETER

Includes:
- ★ Pye Scalamp Galvo type 2000.
- ★ Mains or battery operation.
- ★ Sensitivity (typical) 33.5 mm/μA. 0.670 mm/μV.

ONLY **£12/10/-** P.P. 5/-

EVERSHED VIGNOLES WEE MEGGER
500 volt 50 Meg. BRAND NEW sealed in cartons with leather case and handbook.
£12/10/-
100-volt type used but in new condition. With Leather case. **£6** Post free.

RADAR UNIT TYPE 1683
Complete with the following valves: 2—6C4; 832A; 829B; 2—5R4G; 3—6AC7; 6V6GT; 931A photo multiplier with associated network. Also 2-blower motors. Input 30-115 volt 400 to 2,600 c/s. cd 26 v. d.c. BRAND NEW. and boxed. **£6/10/-** Post free

RCA 6½-inch P.M. SPEAKER in Cabinet. With vol. control and 600 ohm Line Trans.
27/6 PP. 2/6

RF UNITS TYPE 25 Switched Tuning 30 to 40 Mc/s. Includes 3 SP61's. Carriage 2/6. **10/-**
TYPE 26: Variable tuning, 50 to 65 Mc/s. Including 2 EF54's and 1 EC52. Carriage 2/6. **25/-**
(Circuits in stock for both types 9d. each.)

STROBE UNIT
Complete with: 6—EF50; 5—EA50; SP61. Relays, etc. **35/-** P.P. 2/6.

APQ9 HF UNIT
Includes 931A photo-multiplier. 2—807, 3—6AC7, 2—8012 HF. Gear drives. Blower motor. Mains transformer, etc. **£7/10** P.P. 7/6.

159 UNIT
Containing EA50, VR91, CV66, VR65, Relay Coils, etc. 12/6 P.P. 2/-.

CRYSTAL MIC. INSERTS

¾in. Square	3/6
Acos ¾in. Round	5/-
Acos 1½in. Round	7/6
Acos 2in. Round	12/6

Lightweight moulded hand microphone case suitable for any of the above inserts.
ONLY **2/6** P.P. 6d. per item.

PACKARD BELL PRE-AMP.
Complete with screened case with 6SL7GT; 28D7; relay; leads, jack plugs; handbook, etc. Sealed in carton.
ONLY **12/6** P.P. 2/-.

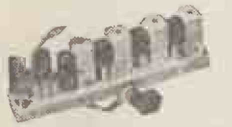
SCR522 TRANSMITTER/RECEIVER
All complete in new condition less valves.
35/- P.P. 5/-.

RADIO AND TV VALVES ETC.
OVER 400 DIFFERENT TYPES IN STOCK: SEND FOR NEW FREE LIST.

QUARTZ CRYSTALS
A large range of frequencies in stock from 100 Kc/s. upwards. Fundamentals: 54th and 72nd harmonics etc. Send for NEW free complete list

PYE 45 Mc/s STRIP TYPE 3583
Complete with 12 valves. 10—EF50; EB34; EA50, with modification data.
ABSOLUTE BARGAIN **39/6** Carriage 5/6.

"372" MINIATURE IF STRIP 9·72 Mc/s



The ideal F.M. conversion unit as described in "P.W." April/May, 1957. Complete with 6 valves, three EF91's, two EF92's and one EB91. I.I.F.T's etc., in absolutely new condition. With circuit and conversion data.
12/6 (less valves) **37/6** (with valves)
Postage and packing 2/6 (either type)
FM AT ITS CHEAPEST!

ROTARY CONVERTER
24 v. D.C. to 230 v. A.C. 50 cycles. 100 watts. Brand new and unused.
£5/10/- Carr. 7/6.

426 CONTROL UNIT
Includes: 4—EF50; 2—SP61; EB34; multibank switches; pots; transformer, etc.
ONLY **30/-** P.P. 3/-.

NEW TRANSISTORS:—
(Junction Type PNP)

Ediswan XA104 6 Mc/s osc/mixer, RF	18/- ea.
Ediswan XA103 4 Mc/s RF and IF amp.	15/- ea.
Ediswan XB104 Audio Output etc.	10/- ea.
Matched pair XB104 for up to 250 mW audio output	20/- pr.
Continental OC44 12 Mc/s osc/mixer, RF amp.	30/- ea.
Continental OC45 6 Mc/s IF and RF amp	25/- ea.
Continental OC72 up to 350mW push-pull	20/- ea.
New market power transistors:	
V15/10P; 15 volt 10 watts	17/6 ea.
V15/20P; 15 volt 10 watts	39/- ea.
V15/30P; 15 volt 10 watts	48/- ea.
V30/10P; 30 volt 10 watts	48/- ea.
V30/20P; 30 volt 10 watts	54/- ea.
V30/30P; 30 volt 10 watts	57/- ea.
V15/201P; 15 volt 2 watts	25/- ea.
V30/201P; 30 volt 2 watts	35/9 ea.
Red spot 800 kc/s Audio amp.	7/6 ea.
White spot 2 to 5 Mc/s RF etc.	12/6 ea.
Green/Yellow Audio Amplifier	7/6 ea.
Red/Yellow 1.5 to 8 Mc/s RF or IF etc.	15/- ea.

Data sheets available on all types.
FULL TRADE DISCOUNTS. LARGE RANGE OF SUBMINIATURE TRANSISTOR COMPONENTS IN STOCK: SEND FOR NEW FREE LIST.

WAVE-GUIDE WATTMETER
Type W8921 10 cm. Complete in transit case. BRAND NEW **£5/10/-** P.P. 7/6.

VHF TRANS/RECEIVER Type TR1920, 100 to 120 Mc/s. IF frequency 9.72 Mc/s; Bandwidth 40 Kc/s, 4 channel crystal controlled VHF airborne trans/rec. Complete with 21 valves, transmitting crystal and 24-v. rotary unit, all contained in metal case. In new condition with full circuit diagram. Circuits sold separately, 1/9 post free. **£8/19/6** P.P. 10/6

VHF 10-CHANNEL TRANS/REC Type 1986. Frequency range 124.5/156 Mc/s. IF frequency 9.72 Mc/s; Bandwidth 23 Kc/s.

Sub-units	Type	With valves	Less valves	P.P.
TRANSMITTER	81	75/-	25/-	2/6
RECEIVER ...	114	27/6	7/6	2/6
IF Amplifier ...	476	37/6	12/6	2/6
24 v. Rotary unit	3	15/-	—	2/6
10-way Control unit	382	6/-	—	9d.

All the above are in absolute new condition. Full circuits available, 1/9 post free.

CRYSTAL CALIBRATOR
For No. 19 Set.
10 Kc/s; 100 Kc/s; 1 Mc/s.; spot frequencies; Crystal controlled oscillators; includes 5—12SC7 valves, neon modulator handbook, etc.
BRAND NEW **£4/19/6** Post free.

MIXER UNIT TYPE 79
Frequency range 172 to 190 Mc/s. Comprising: VCR139A Cath. ray tubes; 7—EF50; EF55; 4—EA50; 2—EB91; SU4; VU120, and EC52. Standard main.input 200-250 volts 50 c/s. Ideal Scope Basis
£5/10/- Carriage 5/-.

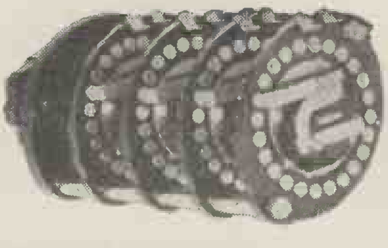
WALKIE/TALKIE TYPE 38 TRANSMITTER/RECEIVER
Complete with 5 valves. In new condition. These Sets are sold without Guarantee, but are serviceable. **22/6** P.P. 2/6.
H/phones 7/6 pair, Junction Box, 2/6. Throat Mike, 4/6. Canvas Bag, 4/-. Aerial Rod, 2/6.

TRANSMITTER/RECEIVER, Army Type 17 Mk. II
Complete with Valves, High Resistance Headphones, Handmike and Instruction Book and circuit. Frequency Range 44.0 to 61 Mc/s. Range approximately 3 to 8 miles.
Power requirements: Standard 120 v. H.T. and 2 v. L.T.
Ideal for Civil Defence and communications. BRAND NEW **45/-**
44-61 Mc/s. Calibrated Wavemeter for same, 10/- extra.

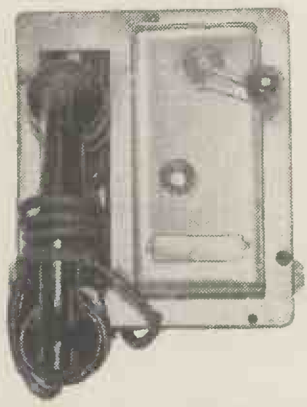
SYNCHRONIZER UNIT
Includes: 3—6L6M; 12—6AC7; 6SQ7; 5—717A; 6—6SN7GT; 6H6; slow motion drive, blower motor, transformer, etc. **£4/19/6** P.P. 5/-.

HENRY'S RADIO LTD.
(DEPT. W/WAP)

5, HARROW ROAD, PADDINGTON, W.2
(AT JUNCTION OF EDGWARE ROAD AND HARROW ROAD) **PAD 1008/9**



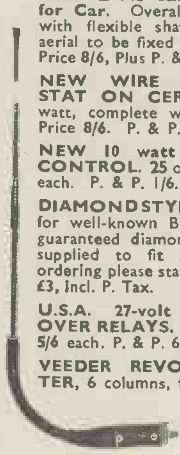
MUIRHEAD PRECISION, 4 bank, 1 pole, 24 position Stud Switch. Heavy duty contacts, brand new, original boxes. Price 17/6 each, P. & P. 1/-.



SOUND POWER TELEPHONE UNIT, no batteries required. Fitted with neon indicator lamp and high pitched buzzer, operated by built-in generator. Entirely self-contained, ex Admiralty. Rebuilt and guaranteed working. Effective up to half a mile, waterproof.

£3 Unit or £5/17/6 pr. Carr. 7/6. Master Units to take five extensions also available. £4 each.

SOUND POWER TELEPHONE HANDSETS. New, 17/6 each, P. & P. 2/-.



AERIAL AS ILLUSTRATED. Ideal for Car. Overall length 33in., khaki, with flexible shaft which enables the aerial to be fixed firmly in any position. Price 8/6, Plus P. & P. 1/6.

NEW WIRE WOUND RHEOSTAT ON CERAMIC. 58 ohms, 50 watt, complete with instrument knob. Price 8/6. P. & P. 1/6.

NEW 10 watt DUAL VOLUME CONTROL. 25 ohms, plus 25 ohms, 7/6 each. P. & P. 1/6.

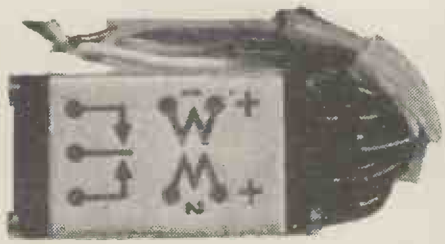
DIAMOND STYLI. We are distributors for well-known British manufacturer of guaranteed diamond styli, which can be supplied to fit any pick-up. When ordering please state requirements. Price £3, incl. P. Tax.

U.S.A. 27-volt 4-pole CHANGE-OVER RELAYS. Brand new and boxed, 5/6 each. P. & P. 6d.

VEEDER REVOLUTION COUNTER, 6 columns, fitted reduction drive, built inside small unit. New 8/6 each. P. & P. 2/-.

HIGH SPEED RELAY. Siemens, two bobbins, 1,000 ohms each. New, 10/6 each. P. & P. 1/-.

PACKARD BELL RELAYS, 12/24 volt, 650 ohms coil, 2 pole changeover, 1.5 amp contacts. Brand new. Price 5/6 each, P. & P. 6d.



MINIATURE MOVING COIL DIFFERENTIAL RELAY. Two coils 350 ohms each. Operating current minimum 140 microamp, nominal 400 microamp, maximum 8 milliamp. One pole two way, or, centre stable. Two way contact current 100 mA at 50 V A.C. or D.C. Size $1\frac{1}{4}$ x $\frac{7}{8}$ x $\frac{3}{4}$in. Price: 22/6 each.

EVERSHED AND VIGNOLES. Circuit testing Ohms Meter, pattern "S" complete with testing prods, inst. book, etc. Two ranges: 0-3 and 0-30 ohms. Brand new, guaranteed perfect, as illus. Offered at fraction of maker's price. £4/17/6 each. P. & P. 2/6.

TRIPODS. Solid wooden legs 38in. long, metal top and metal toes. As new. Price 10/6 each, plus 3/- carriage.

E.H.T. COILS
Vibrator type, input 12 V. D.C., output 12-15 KV. New. Price: 17/6 each. P. & P. 1/6.

MUIRHEAD VERNIER DRIVE. Scaled 0-180 degrees, ratio 31/1, dia. 3in., as fitted to R.F.26 units. Complete with lampholder. In manufacturers' original packing. New, 8/6 each. P. & P. 1/6.

PRESSURE GAUGES
U.S.A. make, new. 0-150 lbs. p.s.i. Price 10/6 each. P. & P. 1/6.

AUTO TRANSFORMERS, step up, step down. 110-200-220-240 v. Fully shrouded. New.

300 watt type £2/2/- each. P. & P. 2/6. 500 watt type £3/3/- each. P. & P. 3/9. 1,000 watt type £4/4/- each, P. & P. 6/6. Also 60 watts, 19/6 each. Plus P. & P. 2/-.

AIRCRAFT CINE CAMERA G45B Mk. III, fully modified, fitted with f/3.5 triple anastigmatic lens, takes 25ft. of 16 mm. film, fitted with 24 v. motor. 16 exposures per sec. Mint condition, brand new, in maker's original packing. £6/10/- each. P. & P. paid.

20 WAY STRIP containing standard Post Office telephone Jack Sockets, overall size 11 x $3\frac{1}{2}$ x $\frac{1}{2}$in. New. Price 15/- each. P & P. 1/6.

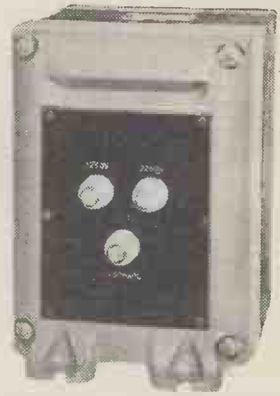


PLATE TRANSFORMER of very best U.S.A. make, brand new, original manufacturers' cases. Input tapped at 190/210/230/250 V. Output 2250-0-2250, centre tapped 400 mA. Nett weight 76 lbs., size 13in. × 9in. × $6\frac{1}{2}$in. Price £6/10/- each, plus carr. 10/-.

METERS BRAND NEW GUARANTEED PERFECT

Charging Types

$2\frac{1}{2}$ amps D.C. M.I. 2in. fl. rnd.	7/6
5 amp. D.C. M.I. $2\frac{1}{2}$in. fl. rnd.	11/6
$7\frac{1}{2}$ amp. D.C. M.I. $3\frac{1}{2}$in. proj. rnd.	12/6
9 amp. D.C. Hot Wire W.R. $2\frac{1}{2}$in. fl. rnd.	6/6

Voltmeters

12 V. D.C. M.C. $2\frac{1}{2}$in. proj. rnd.	8/6
20 V. D.C.M.C. 2in. fl. sq.	9/6
25 Volt D.C. M.C. 2in. fl. rnd.	7/6
30 Volt M.I. 3in proj. rnd.	10/6
40 Volt M.C. 2in. fl. sq.	9/6
250 Volt A.C. rectified moving coil linear scale $3\frac{1}{2}$in. fl. rnd.	35/-
300 Volt A.C. M.I $2\frac{1}{2}$in. fl. rnd.	22/-
400 Volt A.C. M.I. $4\frac{1}{2}$in. fl. rnd.	35/-

Milliammeters

5 mA. M.C. 2in. fl. sq.	12/6
30 mA. M.C. $2\frac{1}{2}$in. fl. rnd.	9/6
50 mA. M.C. 2in. fl. sq.	7/6
200 mA. M.C. $2\frac{1}{2}$in. fl. rnd.	9/6
500 mA. M.C. $2\frac{1}{2}$in. fl. rnd.	9/6
1 mA. M.C. 2in. sq. fl.	19/6
500 Microamp latest type Ernest Turner 2in. fl. rnd. with mounting ring and scaled 0-5 moving coil	19/6

Thermo-coupled

350 mA 2in. rnd. plug-in	3/6
500 mA. 2in. rnd. plug-in	3/6

POSTAGE ON ALL METERS 1/-.

U.S.A. PRECISION SERIES 834S MULTIRANGE TESTERS for A.C. and D.C. volts, ohms and milliamps., basic movement 400 microamps., in wooden carrying case, complete with test prods. new batteries, guaranteed perfect. Price £5/19/6. P. & P. 2/6.

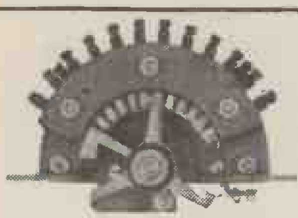
MIDGET ROTARY TRANSFORMERS. $2\frac{1}{4}$in. dia x $4\frac{1}{2}$in. Input 11.5 volt Output 310/365 volts at 30 mA. Brand new 17/6 each. P. & P. 1/6.

DYNAMOTOR (Rotary Convertor). 6 volt in, 250 volt out at 100 mA, ex new equipment, 25/- each. P. & P. 3/-.

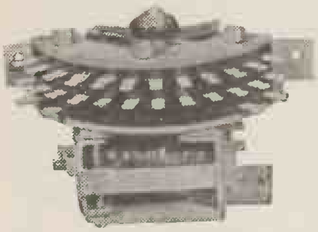
MICROPHONES — NEW. Throat, British, magnetic, 4/6. P. & P. 1/-.

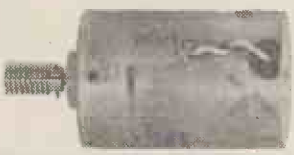
HEADPHONES. 4,000 ohms, imported new, 15/-.

SERVICE TRADING COMPANY →

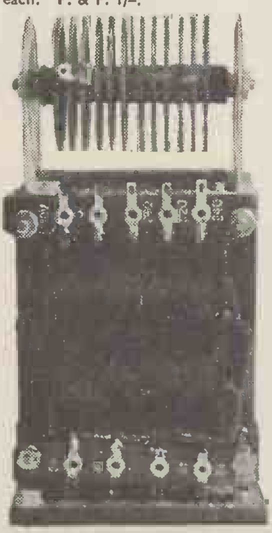


MINIATURE UNISELECTOR SWITCH, two banks of ten plus home contacts, one bank continuous of normal. 30 ohms coil for 24 volt operation. Brand new, manufacturer's packing. Price 22/6 each. P. & P. 2/6. Illustrations above and below.





MINIATURE P.M. MOTOR 12/24 volt, reversible, 1¼in. dia. New Price 9/6 each. P. & P. 1/-.

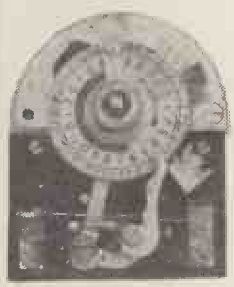


TWELVE PLATE F.W. BRIDGE CONNECTED RECTIFIER mounted on 200/250 volt A.C. input transformer. Output 36/40 volt D.C. at 1.2 amps. New, perfect. Price 16/6. P. & P. 3/6.

200/250 v. A.C. MOTORS. New 1/80 h.p., 2 drives, direct 6000 r.p.m., reduction 300 r.p.m. 22/6 each. P. & P. 2/6.

No. 100 RM VARIABLE VOLTAGE TRANSFORMERS, as illustrated above. Brand new in manufacturers' original cases. Input 230-volt A.C., output variable from 0 to 270 volt at 9 amperes. Price £15 each, plus carr. 12/6.

NEW UNCHARGED UNFILLED 12 VOLT ACCUMULATOR 9 ampere in unspillable plastic cases. Comprises 6×2 volt separate cells connected by terminal strips. 6×5½×4½in. over terminals. Price 19/-, plus P. & P. 2/9. Wooden carrying case for same with lid and strap price 3/6.



VENNER 8-day clockwork Time Switch. Contacts 1 amp. 230 volt, 24 hour phase, ¼ hour divisions, allows setting for one make and one break to be made every 24 hours, complete with key. Used but guaranteed perfect. Price 27/6 each. P. & P. 1/6.

12 v. D.C. AMPLIFIER, as new, for operation on 12 v. car battery, 10 watts undistorted output, with 6L6 valves in push-pull. Mike/Gram input, tapped output 7½, 15, 62, 100, 250 or 500 ohms. £12/10/- each. Carr. 15/-.

No. 200 CU VARIAC, Tandem model. Input 230 volt A.C., output variable from 0 to 270 volt at 4½ ampere. New. Price £9 each, plus carr. 10/-.

NEW CARPENTER'S TYPE POLARISED RELAYS. 2 × 9500 turns at 1,685 ohms.

Price 22/6 ea. P. & P. 1/-.

NEW MOVING COIL HEADSETS, complete with Tannoy carbon hand microphone, with plug suitable for No. 19 set. Price: 12/6 each plus P. & P. 2/-.

L.T. TRANSFORMER, real heavy duty job, extremely well made for continuous duty. New in original manufacturers' cases. Input 110 v.-260 v. multi-tapped, 50 cycles, single phase. Output 28-29-30-31 v. at 21 amperes. Price 69/6. Carr. 9/-.

BRAND NEW SELENIUM FULL WAVE BRIDGE TYPE RECTIFIERS, in manufacturers' original packing. D.C. output 36 v. 10 amp., made up of 12 × 110 mm. dia plates. These fitted in cooling funnel (removable), size 11½in. × 8in. × 4¾in. Price 45/-. P. & P. 3/3.

WE ARE EXPERTS AT OVERSEAS PACKING & SHIPPING!

SERVICE TRADING Co.

PERSONAL CALLERS ONLY: **9 Little Newport Street, London, W.C.2.** *Tel: GER 0576* *(Early Closing Thursday)*

ALL MAIL ORDERS: **47-49 High Street, Kingston-on-Thames.** *Telephone: KINgston 4585*

ALL-AMERICAN-SPARE-PARTS.

PLEASE NOTE. This advertisement is designed for the connoisseur of American Equipment, therefore it is not illustrated. We cannot enter into any correspondence with anyone not conversant with such equipment.

OZ4	5/-	3C24	20/-	6J6	5/-	6V6GT	7/6	56	6/-	830B	9/-
OZ4A	5/-	3D6/1299	4/6	6J7	9/-	6V6G	6/-	57	5/-	832	25/-
1A3	3/6	3-16	5/-	6J7G	6/6	6X5GT	7/-	58	6/-	837	12/6
1B3GT	5/-	4E27	80/-	6K6GT	7/-	6X5G	6/-	59	6/-	843	7/6
1B23	11/-	5D21	£5	6K7	6/9	6Y7G	8/-	71A	4/6	860	30/-
1B24	11/-	5R4GY	9/6	6K7GT	6/-	7A4	7/-	75	8/-	872A	35/-
1B26	11/-	5T4	10/-	6K7G	4/-	7A5	7/-	76	9/-	874	11/-
1B32	10/-	5U4G	7/-	6K8	9/6	7C7	8/-	77	6/-	878A	7/-
1D8GT	6/-	5W4	10/-	6K8GT	8/-	7E6	6/-	78	8/-	884	10/-
1E7G	6/-	5X4G	10/-	6K8G	7/-	7H7	9/-	80	8/6	930	8/-
1G4FT	7/-	5Z3G	8/6	6L5G	6/-	7K7	8/-	82	8/-	954	2/-
1J6G	6/-	5Z4G	10/-	6L6	10/-	7R7	9/-	83V	12/-	955	3/6
1LB4	6/-	6-4	5/-	6L6GA	8/6	7V7	6/-	84-6Z4	6/-	956	3/-
1LC6	6/-	6A3	4/-	6L6G	8/6	10	10/-	85	7/-	1201	3/6
1LD5	3/6	6A6	5/-	6L7	7/6	10Y	12/-	89	6/-	1203A	4/-
1LH4	5/6	6AB7	5/-	6N6	7/6	12A6	5/-	100TH	45/-	1267	8/-
1LN5	5/-	6AC7	5/-	6N7	6/6	12AH7	7/-	217C	17/6	1603	6/-
1N21	5/-	6AG5	5/6	6N7GT	7/-	12C8	7/6	267B	30/-	1611	5/6
1N23	10/-	6AG7	8/6	6P7G	6/6	12H6	2/6	350B	8/-	1622	10/-
1P5GT	6/-	6B4G	4/6	6S7	7/-	12J5GT	3/6	393A	25/-	1624	6/6
1R4/1294	5/6	6B7G	6/-	6R7	9/-	12SA7GT	10/-	WL-417A	15/-	1625	6/-
1-V	4/-	6B8	6/-	6R7G	8/-	12SC7	1/6	446A	14/-	1626	4/6
2A3	8/-	6B8G	3/-	6SA7	7/-	12SG7	6/6	446B	14/-	1629	4/6
2A5	8/-	6C4	5/6	6SA7GT	5/6	12SH7	4/9	705A	17/6	2051	12/6
2B7	6/-	6C5	6/-	6SC7	10/6	12SJ7	6/-	713A	8/6	7193	2/9
2C26	3/-	6C5G	4/-	6SC7GT	5/6	12SK7	5/-	715B	97/6	8010	22/6
2C34	2/6	6C6	4/6	6SG7	7/-	12SL7	7/-	717A	8/6	8018	8/6
2C43	55/-	6C8G	5/-	6SH7	5/-	12SQ7GT	8/6	723 A/B	52/6	8020	6/-
2C46	70/-	6F5G	7/6	6SJ7	7/6	12SR7	6/-	724B	15/-	9001	5/-
2E32	30/-	6F5GT	7/6	6SK7	5/6	12U5	7/-	726A	27/6	9004	4/-
2J31	45/-	6E5	8/-	6SK7GT	5/-	28D7	6/6	801	6/-	9005	6/-
2J39	£10	6F6G	5/-	6SL7GT	7/-	37	7/-	801A	12/6	9006	4/-
2X2	4/-	6F8G	8/-	6SN7GT	5/6	38	7/-	803	22/6	**CATHODE RAY TUBES**	
3A4	6/6	6G6G	3/-	6SQ7	6/6	39/44	6/-	805	30/-	2BP1	30/-
3B4	8/-	6H6	2/3	6SR7	6/6	42	9/-	807	6/6	3JP7	20/-
3B7/1291	5/6	6H6GT	1/9	6SS7	8/-	42E	9/-	808	20/-	5CP1	25/-
3B22	80/-	6H6G	1/3	6ST7	7/-	43	10/-	813	80/-	5FP7	45/-
3B24	10/-	6J5	5/-	6U6	8/-	45	7/-	829	30/-	5MP1	17/6
3B28	30/-	6J5GT	4/6	6U7	8/-	46	6/-			5GP1	40/-
		6J5G	3/6	6V6	9/6	53A	3/-				

RCA-A.R.88—SPARES

Dial Assembly, 10/- each.
Dial Vernier, 6/- each.
Voltage Tap Sw., 4/6 each.
Flex coupling, 2/6 each.
Knobs, small, 2/- each.

COILS

1st-2nd-FR-Osc. Antenna—All frequencies 5/- each.
Air Trimmer (2-25 mmfd.), 3/6 each.
Range Switch, 8 bank, ceramic with screens, 15/6 (p.p. 2/6).
Filter Chokes, 18/6 each.
Terminal Board, set of 3, 2-way, 3-way, 5-way, 5/- set.
Pot. 1 meg. Tone Con., 3/- each.
Pot. 66k R.F. Gain, 3/- each.
Wave Trap, 5/-.
Crystal Phasing Trimmer 3/6 each.

I.F. TRANSFORMERS

4th I.F. 10/-, B.F.O. I.F. 10/-, Crystal I.F. 10/-.

RCA.-E.T.-4336—SPARES

Meters 0-500 milliamps. 2½in. round flush. 12/6 each.
Meters 0-100 milliamps. 2½in. round flush. 12/6 each.
Resistor, Large, 3,150 ohms, 150 w. 8/6.
Resistor, Large, 31,500 ohms, 150 w. 8/6.
Resistance, 600 watt 110 v. E.S. 4/6.
Flexible Coupling, 4/6.
Tube Socket, Large Jumbo. 4/9 each.
Tube Socket, Small Jumbo. 3/9 each.
Capacitor, 15 mmfd. 6/6 each.
Capacitor, 31 mmfd. 6/6 each.

RCA.-L.F. SPEAKERS

15in. 15 ohms, 30 watt, £9/19/6 (carr. 15/-).

RCA.- H.F. HORN SPEAKERS

15 ohms, 30 watt, £8/10/- (carr. 10/-).

HALLICRAFTER-S.27.—SPARES

Switch selectivity, 3-bank with on/off switch. 7/6.
Tuning Capacitor, 47.5 mmfd. 3 section. 17/6.
Tuning Gear Assembly. 17/6.
Inductor Chokes, 2 henries. 17/6.
Inductor Chokes 10 henries. 17/6.

HALLICRAFTER-S.36-R.B.K.-13—SPARES

Transformer Power Mains 115/230 v. 50/60 cycles, 39/6. P.P. 3/6.
Transformer, Audio. 25/-. P.P. 2/-.
Reactor, Dual Filter Choke, 3-12 henries. 22/-. P.P. 3/-.
I.F. Transformers, 1st, 2nd, 3rd (5 25 m/cs.). 10/6 each.
Coils, 1st, 2nd, 3rd. Ant., 1st, 2nd, 3rd, R.F. 1st, 2nd, 3rd O.S.E. 6/- each.
Coil, BFO. 10/6 each.
Reactor, Line Filter. 6/6 each.
Capacitor, 4-8-8mmfd. 650 v. d.c. 18/6. P.P. 2/-.
Other Spares. Resistors, condensers, switches, tube holders, etc.

NATIONAL-H.R.O.—SPARES

6-volt Vibrapacks. 35/- each. P P. 3/6.
Tuning Condensers, 4-gang. 50/-.
Knobs, ½in. bush cw. osc. selectivity, audio gain, phasing, R.F. gain, all at 3/3 each.
I.F. Transformers, 2nd, 456 kc/s. 8/6.
I.F. Transformer, B.F.O., 8/6.

PLEASE ADD POSTAGE AND PACKING. ALL GOODS OFFERED SUBJECT TO BEING UNSOLD.

When ordering please quote manufacturer's part number where possible.

MAIL ORDERS & TRADE ENQUIRIES:
9A DIANA PLACE,
EUSTON ROAD,
LONDON, N.W.1,
TELEPHONE: EUSton 1636/1637.

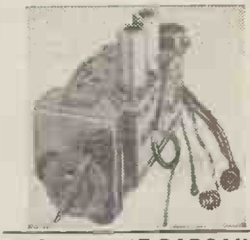
Lowe Bros

PERSONAL CALLERS:
199 MILE END ROAD,
LONDON, E.1.
(EARLY CLOSING THURSDAY)
(A FEW DOORS FROM STEPNEY GREEN STN.)
TELEPHONE: STEpney Green 2579.

LASKY'S RADIO

SPECIAL OFFERS OF TURRET TUNERS

By Cyldon and other well-known makers. New and unused in maker's cartons. List price 7 gns. A few examples:—
P.10.L. (series heaters), I.F. 9-14 mc/s. **59/6.**
P.16.H. (series heaters), I.F. 16-19 mc/s. **99/6.**
E.10.L. (parallel heaters), I.F. 9-14 mc/s. **£5/19/6.**
Post 3/6.
All other types in stock. List on request.



BARGAINS IN 4-SPEED MIXER AUTO-CHANGERS

Collaro RC.456. Incorporating auto and manual control. Complete with Studio crystal p.u. and sapphire stylus. LIST £13/17/-. **LASKY'S PRICE £7.19.6** Post 3/6.

B.S.R. 4-spd. mixer Auto-Changer type UA8, manual and auto-control, complete with latest B.S.R. "ful-fi" pick-up. Carr. & Pkg. 5/- **£6.19.6**

Garrard 120, Mk. II, £9/19/6.
Garrard 121, Mk. II, £10/19/6.

COLLARO 4-SPEED SINGLE PLAYER

Model 4/564 with Studio T or O p.u.
£6.9.6
Post 3/6

Garrard 4SPH Single Player, **£7/19/6.** Post free.

Collaro "Junior" 4-spd. motor and p.u. with HGP59 cartridge. Post 2/6. **89/6**
Motor only **59/6**, post 2/6.
Pick-up only **29/6**, post 2/6.

GARRARD Auto-Changers, Transcription Motors, Pick-Ups, all latest models in stock.

CARRYING CASES

Large range of Cases for single record players, auto-changers and tape decks, at bargain prices. Call or send for list.

MULLARD 510 AMPLIFIER KIT

All specified components and your choice of transformers and chokes by Partridge, Haddon, W/B, Ellison or Gilson.
COMPLETE KIT of parts and printed circuit as low as **£9.9.0**
Details on request.
Book 3/6 post free. Printed Circuit separately 22/6. Also available built ready for use. Price according to transformers used.

3-3 AMPLIFIER

Built to Mullard's exact specification, with 3 Mullard valves EL84, EF86, EZ81, complete with front panel.
Post free. **£8.8.0**

FAMOUS MAKE
DE LUXE TAPE RECORDER

BRAND NEW AND UNUSED

LISTED AT 64 GNS.
LASKY'S PRICE
42 GNS.

Complete with Lustraphone "Lustrette" mike and 1,200ft. tape
Carr. and Ins. 21/-.

Limited number only

Embodies the famous Collaro Tape Transcriptor Mk. IV. Tape deck, 6-valve Hi-Fi amplifier, and 10in. × 6in. elliptical speaker, in handsome case superbly finished two-tone simulated lizard. Overall size: 18½in. × 15½in. × 7½in.

TWO HIGH GAIN INPUTS for radio/gram and mike, each separately controlled and can be mixed, so that speech and singing can be superimposed on an orchestral background. Two outputs, monitor headphones and extension speaker.

4 WATTS UNDISTORTED OUTPUT. Freq. range at 7½in. per sec., 50/12,000 c.p.s. Separate bass and treble controls, automatic equalisation on all 3 speeds. Magic eye level indicator. Upper and lower track recordings can be made quickly without spool reversal and a safety device prevents accidental erasure. Three speeds, 3¾in., 7½in., 15in. per sec., digital counter, pause control.

For A.C. mains 200/250 v. GUARANTEED FOR 12 MONTHS.

Demonstrations at both addresses. Available on H.P. terms; deposit and monthly payments to suit you.
The carrying case only can be supplied for 79/6 plus carriage.

"LINEAR" TAPE DECK AMPLIFIER. Type LT45. A complete unit (power pack and oscillator incorporated) suitable for Collaro Tape Transcriptors (all marks), Brenell, etc. Post & Pkg. 5/-. **12 Gns.**

"LINEAR" "DIATONIC." High fidelity 10-14-watt ultra linear Amplifier with integral pre-amp. and tone controls. Post & Pkg. 5/-. **12 Gns.**

"LINEAR" "CONCHORD." A high fidelity 30-watt amplifier incorporating pre-amplifier and tone controls. Post & Pkg. 7/6. **15 Gns.**

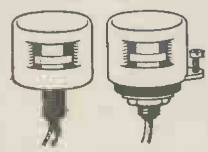
ALL TYPES OF CHASSIS

We hold the largest selection of leading makes including all models ARMSTRONG, EMPRESS, DULCI, etc.
A.M. chassis, L,M,S from **7 Gns.**
A.M./F.M. chassis from **14 Gns.**
A.M./F.M. STEREO from **22 Gns.**

MOVING COIL P.M. SPEAKERS

2½in. 17/6. 3in. and 3½in. 19/6
5in. 14/6. 6½in. 17/6, 8in. 19/6
10in. 29/6. 12in. 29/6
6½in. with transformer ... 21/-
7×4in. Elliptical 19/6
10×7in. Elliptical 32/6
8×5in. Elliptical 25/-
10×2½in. Rectangular ... 27/6

SPECIAL OFFER
HIGH FIDELITY TAPE RECORDER HEADS



A further large purchase enables us to again reduce our price. Leading make, new and unused, upper or lower track RECORD/PLAYBACK, high impedance. Double wound and will reproduce up to 12,000 c.p.s. at 7½ i.p.s. Azimuth adjustments. Output 5 millivolts at 1 Kc. at 7½ i.p.s. ERASE, low impedance.
LASKY'S PRICE
Per pair **39/6** Post 1/3.
Please specify upper or lower track.

SPECIAL FOR OWNERS OF A STAAR "GALAXY"

SERVICE MANUAL for the Staar "Galaxy" 4-spd. Auto-Changer, 1/6 post free.

Good range of Spares for the "Galaxy" available. Call or write stating your needs.

20,000 VALVES. Brand new surplus and imported, also full stocks of B.V.A. valves and C.R. Tubes. List post free.

MICROPHONE BARGAINS

ACOS MIC 39-1. Crystal Stick Microphone for use as a hand, desk stand or floor stand unit for high quality recording, broadcasting and public address work.

LIST £5/5/-.
LASKY'S PRICE Less Stand **39/6**
With Stand 49/6. Post 1/6.

ACOS type 33/1, Crystal hand or table Microphone. Incorporates specially designed acoustic filter. Flat response 30-7,000 c.p.s. Omni-directional. Suitable for tape recording public address, etc. Attractive dark brown plastic case. Brand new in maker's cartons. LIST 50/-. **LASKY'S PRICE 29/6** Post 1/6.

COLLARO high fidelity super sensitive crystal Miniature Hand Microphone. Sensitivity at 1,000 c.p.s. 1.8 millivolts/u.b. Freq. range 30-10,000 c.p.s. LIST 45/-. **LASKY'S PRICE 35/-** Post 1/6.

TAPE DECK OFFERS

COLLARO TAPE TRANSCRIPTOR, Mk. III, fitted with digital counter. Limited quantity only. LIST £22. **LASKY'S PRICE 15 Gns.**
COLLARO Mk. IV **£17/19/6.** Carr. & Ins. 21/-.

TRUVOX TAPE DECKS, Mk. III, 2-speed, 3¾ and 7½ i.p.s. New and unused, in maker's cartons. LIST 22 Gns. **LASKY'S PRICE** Post 12/6 extra. **£16.19.6**

TAPE RECORDER AMPLIFIER for use with Collaro Tape Deck. Manufacturer's surplus, complete with 4 valves and power supplies. Post 3/6. **£7.19.6**

COLLARO 4-spd. Transcription Turntables, 4T200/PX, with Studio trans. p.u. Brand new and unused. LIST £19/10/-. **Lasky's Price** Carr. paid. **£16.19.6**

PICK-UP CARTRIDGES BELOW HALF PRICE!

Your choice of ACOS HGP.59, GARRARD GC2, B.S.R. "ful-fi" TC8, COLLARO Studio O or T, turnover crystal p.u. Cartridges, complete with L.P. and standard styli. All listed at £2/1/7. **LASKY'S PRICE 18/-** Post 1/-.

ACOS GP43 t.o. crystal cartridge complete with L.P. and standard styli 15/-
GARRARD GCE4 ceramic cartridge complete with styli 19/6
GARRARD TOM2 magnetic cartridge. LIST 57/-. **Lasky's Price 25/-**

SEE OVERLEAF FOR MORE NEWS FROM LASKY'S RADIO

LASKY'S RADIO

LASKY'S TRANSISTOR AUDIO AMPLIFIER

MK. II (200/250 milliwatts)

Size 5¼ × 2 × 1¼in., weight 4½ oz. excluding battery. Operates from 6 v. battery. Output imp. 3 ohms.

COMPLETE KIT including 4 transistors, all brand new components, latest T.C.C. miniature condensers, Printed Circuit and full instructions. Post 3/6 **79/6**

With two OC72..................95/-
Full data and circuit diagram 1/-

LASKY'S TRANSISTOR SUPERHET TUNER

For construction on Printed Circuit, size 3¾in. × 3¼in. Uses 3 R.F. transistors, 1 germanium diode, 3 I.F. transformers, Ferrite rod aerial. Operates from 6 v. battery and 1.5 v. cell.

CAN BE BUILT FOR £5.12.9

Post 3/6. Full details on request.

SPECIAL ANNOUNCEMENT!

CAR RADIO

Do you know that you can build a Car Radio with all these star features?

- ★ 12 volt operation
- ★ New hybrid circuit
- ★ Transistor output
- ★ New type Brimar valves
- ★ Printed Circuit
- ★ Tuned R.F. stage
- ★ Medium and long waves
- ★ Permeability tuning
- ★ Small size. Will fit any car.

CAN BE BUILT FOR £12.19.6

using all brand new components, which are also available separately.

A job to be proud of! Call and see a demonstration model working in a car.

Send 1/6 for Instruction Booklet giving full details, illustrations, dimensions, circuit diagram and shopping list.

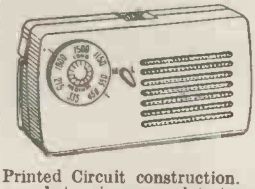
LASKY'S PORTABLE GRAM AMPLIFIER KIT

2 watts. Note small dimensions, approx. 6¾in. × 3¾in., max. height 5in. Uses EL84 output and 6X4 rectifier.

COMPLETE KIT, including valves, printed circuit, full instructions, less Speaker. Carr. 2/6. **49/6**

7in. × 4in. "Elac" Elliptical Speaker, if required, 14/6 extra.

YOU CAN BUILD THIS 6 TRANSISTOR POCKET RADIO FOR £9.19.6

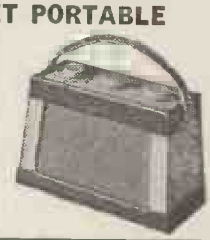


plus 3/6 post

Printed Circuit construction. A FULL medium and long wave superhet using very latest components including 6 transistors, 2¼in. moving coil speaker and inbuilt Ferrite aerial. Handsome cream or coloured plastic case, 5¾ × 3¼ × 1¼in., weight 12 oz. Full assembly instructions supplied.

Demonstrated at either address. All components available separately.

LASKY'S 4-VALVE S/HET PORTABLE



FOR ONLY £7/7/- plus 3/6 carr. and pkg. you can build this battery Portable using all brand new components and valves. PRINTED CIRCUIT, circuit diagram and full instructions supplied. Only batteries extra.
Circuit diagram and full data 1/6.

FOR ONLY £9/9/- plus 3/6 carr. and pkg. you can build this job as a mains and battery Portable using our specially designed build-it-yourself Power Unit for 200-250 v. A.C.

TRANSISTOR PORTABLE

For Construction on PRINTED CIRCUIT 6¾in. × 2½in. using 7 Transistors and 1 germanium diode; 6 v. operation; very low consumption, 200 milliwatts p.p. output; Ferrite rod aerial; fully tunable; choice of 7in. × 4in. elliptical or 3½in. P.M. speaker; choice of cabinet. Circuit diagram and full building instructions supplied.

CAN BE BUILT FOR £9.19.6 Post & Pkg. 3/6

Full data and building instructions available separately, 1/6 post free.

MIDGET T.R.F.

Handsome contemporary design case, overall size 8¼in. wide, 4½in. deep, 5in. high, 2 latest double-purpose valves EBF89 and ECL80, contact cooled rectifier. For A.C. mains 200-250 v. med. and long wave, 5in. P.M. speaker. Plastic cabinet in cream, pastel green, pink, blue.

FULL DATA, instructions, circuit diagram, shopping list, 1/6.

CAN BE BUILT FOR £4.19.6 Post & Pkg. 5/-

CABINET only, as illustrated, 14/- plus 4/6 post and pkg.

SPECIAL OFFER MINIATURE INSTRUMENT SOLDERING IRONS

Famous make, 230/250 v. 25 watts, complete with pencil bit and 3-core flexible lead. Overall length 10in. Tell-tale light in handle shows when current is on.
LIST PRICE 22/6
LASKY'S PRICE **16/6**
Post 1/3

SPECIAL OFFER OF SOLDER

1lb. reels of Ersine 5-core "Savbit" solder. LIST 15/-.
LASKY'S PRICE **10/-**
Post 1/6.

LASKY'S F.M. TUNER

PRINTED CIRCUIT VERSION OF G.E.C. 912 "F.M. PLUS" TUNER FOR HOME CONSTRUCTION

Uses 5 valves, 2 germanium diodes and brand new T.C.C. condensers. The PRINTED CIRCUIT ensures that the I.F. and R.F. amplifiers are extremely stable at maximum gain and results are consistent on all tuners.

CAN BE BUILT FOR (including valves) Post free. **£7.19.6**

G.E.C. FM TUNER BOOK plus our full data and Shopping List, 2/6 post free. All parts available separately.

ALIGNMENT SERVICE available.

TRANSISTORS

AUDIO P.N.P. Junction Types suitable for high gain and low freq. amplifiers, and for output stages up to 250 milliwatts. (Double spot—yellow and green.) **7/6**
3 for 20/-; 6 for 37/6, post free.

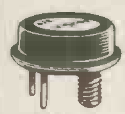
R.F. P.N.P. Junction Type suitable for medium and low freq. oscillators, freq. changers and I.F. amplifiers (1.5 to 8 Mc/s.) **15/-**
(Double spot—yellow and red.)
3 for 40/-; 6 for 75/-.

Special prices for larger quantities.

MULLARD Transistors. OC44 40/-; OC45 35/-; OC70 or OC71 21/-; OC72 or OC73 30/-; OC16 60/-.

BRIMAR Transistors. TS1 or TS2 12/6; TS3 15/-; TS4 27/6; TP1 or TP2 40/-; TJ1 15/-; TJ2 16/6; TJ3 19/6.

"GOLDTOP" POWER TRANSISTORS



All types now in stock, details on request. Example V15/10P as illus., ideal for output stage of car radio, will give approx. 3 watts operating from 12 v. Each 15/-, post free. Output Transformer to suit, correct ratio, matched to 3 ohms, 9/6. Post 1/-. Driver Transformer 9/6, post 1/-.

SPECIAL OFFER! TV CHASSIS

(FOR CALLERS ONLY)

Limited quantity. Famous manufacturer's surplus, factory soiled, complete with 17in. C.R.T. and all valves. 12-channel turret tuning for I.T.V. and B.B.C. Circuit diagram supplied. Do not miss this opportunity! First come, first served!

LASKY'S PRICE **£25**

C.R. TUBE BARGAIN

Special offer of FERRANTI 9in. C.R. Tubes, type T9/3, 4 v. heater, triode, octal base, standard deflection. New and unused. List £12/19/-.
LASKY'S PRICE **59/6**
Carr. & Insur. 12/6.

ALL TYPES F.M. TUNERS

DULCI, QUAD, JASON, LEAK, ROGERS, etc. ALL JASON KITS available from Stock.

CONDENSERS, RESISTANCES. High stability Resistances, Electrolytics. All values and sizes stocked.

SPEAKER COVERINGS. Large stocks of Tygan and "Someweave." Any size piece cut. Samples and prices post free

OPEN ALL DAY SATURDAY
Early Closing Thurs., 1 p.m.
(Both addresses)

LASKY'S (HARROW ROAD) LTD.

42 TOTTENHAM COURT ROAD, W.1.
Nearest Station Goodge Street
MUSeum 2605

370 HARROW ROAD, PADDINGTON, W.9.
(Opposite Paddington Hospital)
LAD 4075 and CUN 1979

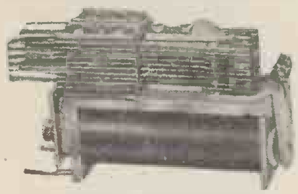
PROMPT POST SERVICE
Please address Mail Orders to Harrow Road.

Wilkinsons EST. 1921 ELECTRONIC BARGAINS BY MAIL

QUANTITIES AVAILABLE ● CALLERS WELCOME

RELAYS P.O. TYPE 3000

BUILT TO YOUR SPECIFICATION QUICK DELIVERY, KEEN PRICES CONTACTS UP TO 8 CHANGEOVER



KEY SWITCHES

PROMPT DELIVERY ALL TYPES UP TO 4co/6co

MINIATURE RELAYS

Siemens High Speed. Sealed.

2.2Ω + 2.2Ω	1 C O	H96A	15/6
500Ω + 500Ω	1 C O	H96D	22/6
1700Ω + 1700Ω	1 C O	H96E	25/-
S.T.C. Sealed.			
700Ω	2 C O	4184GD	19/6
2500Ω	1 make heavy duty	4186EE	22/6
2700Ω	2 C O	4184GE	21/6
G.E.C. Sealed.			
180Ω	2 make 2 break	M1087	19/6
670Ω	4 C O	M1092	21/6
2500Ω	1 C O	M1022	22/6
5000Ω	2 C O	M1052	25/-

All available from stock.

METERS GUARANTEED

F.S.D.	Size	Type	Price
50 Microamps	2½in.	MC/FR	70/-
100 Microamps	2½in.	MC/FR	50/-
500 Microamps	2in.	MC/FR	25/-
500 Microamps	2½in.	MC/FR	37/6
1 Milliamps	2in.	MC/FS	27/6
1 Milliamps	2½in.	MC/FR	35/-
5 Milliamps	2in.	MC/FR	17/6
30 Milliamps	2½in.	MC/FR	12/6
100 Milliamps	2½in.	MC/FR	12/6
200 Milliamps	2½in.	MC/FR	12/6
250 Milliamps	2½in.	MC/FR	12/6
500 Milliamps	3½in.	MI/FR	30/-
5 Amperes D.C.	2½in.	MI/FR	17/6
15 Amperes	2in.	MC/FR	10/6
25 Amperes D.C.	2½in.	MI/FR	7/6
50-0-50 Amp.	2in.	MC/FS	12/6
30-0-30 Amp.	2in.	MC/FR	15/6
20 Volts	2in.	MC/FS	10/6
40 Volts	2in.	MC/FS	10/6

Postage 1/6 extra for above meters.

CROSS POINTER METERS. With 2 separate 100 microamp movements. Brand new. 22/-. Post 2/-.

VARIABLE VOLTAGE TRANSFORMERS

INPUT 230 volts and 115 volts A.C.
OUTPUT INFINITELY VARIABLE. 0-230 volts and 0-270 volts. 9 amperes.

Suitable for bench or panel mounting. Our price £15 only. Cge. 12/6.

BRAND NEW IN MAKER'S CARTONS.

VARIABLE RESISTANCE 140Ω 2.4 amps. in ventilated case, 10×7in., stud type. 35/-. Cge. 7/6.

ROTARY CONVERTERS. Input 12 volt D.C. Output 230 volts A.C., 50 cycles, 135 watts. In fitted case with variable resistance, 0/300 voltmeter, mains switch. The ideal job for television where A.C. mains are not available. £10. Carriage 15/-. Special Connectors 5/- pair.

BATTERIES. 6 v: 125 ampere hours, in metal case for use in pairs with the above converters. £6/10/- each. Carriage 15/-.

SELENIUM METAL RECTIFIERS

Full wave bridge.		Best quality.	
12 v. 1 amp.	8/6	24 v. 1 amp.	13/-
12 v. 2 amp.	13/6	24 v. 2 amp.	24/-
12 v. 3 amp.	16/6	24 v. 3 amp.	28/-
12 v. 4 amp.	20/-	24 v. 4 amp.	36/-

MAINS TRANSFORMERS with correct output tappings, suitable for the above rectifiers to give 12 v. 1 amp., 18/9. 2 amp. 24/-. 4 amp. 29/6. 24 v. 3 amp. 25/-. Post 1/6.

MAINS TRANSFORMER with selenium rectifier fitted on top. From 200-250 v. A.C. mains, 30-40 v. D.C. can be obtained at 1 amp. 27/6. Post 2/6.

VOLTMETERS. 0/300. Moving iron, A.C., 2½in. Flush Round. 25/-. Post 1/6.

MICROAMMETER. 250 F.S.D., 3½in. Flush Round, Sangamo Model S37. Scaled for valve voltmeter, circuit available free. 55/-. Post 1/6.

AVO TEST BRIDGES. 220/240 volt A.C. Measure capacities from 5 pf. to 50 mfd. and resistances from 5 ohms to 50 megohms. Valve voltmeter range 0.1 to 15 volts and condenser leakage test. BRAND NEW. Full working instructions supplied with instrument. £9/19/6. Post 3/-.

SIGNAL GENERATOR TYPE 52A. Input 230 volt 50 cycles, complete with leads, dummy antenna. Brand new in transit case. 6 to 52 Mc/s. inclusive in 4 bands with calibration charts. Coarse and fine attenuators. Int. and ext. mod. Output 0.5 volt to 100 mv, impedance 70 and 100Ω. £10. Carriage 10/-.

WHEATSTONE BRIDGE. 1 to 210 ohms in 1Ω steps with built-in galvo, 4 stud switches, in wood case with spare compartment. Ideal for extending range. 50/-. Post 3/6.

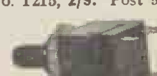
VENTAXIA EXTRACTION FANS. 230 volt A.C. 6in. blades. Ideal for ventilating kitchens, etc. Easy to fix. Silent running. 130/-. Post 3/-.

XPELAIR EXTRACTION FANS. 7½in. blades, with baffle outlet. 190/-. Cge. 5/-.

HEATING ELEMENTS. Flat enclosed type. 230 volt 500 watt. "Bray chromalox." 10×1½in. 7/6. Post 1/6.

OSCILLOSCOPE. Type 43. With 3½in. CRT. 4-6J7, 3-VR54, 1-5Z4, 1-VU120. Brand new with power pack and leads. £10/10/-. Cge. 12/6.

INSPECTION LAMP. Fits on forehead, leaving hands free, battery case clips on belt. 7/6. Post 1/6. Takes E.R. Battery No. 1215, 2/9. Post 9d.



SWITCHES. 1 hole fixing, 3 amp. 250 volt. Single pole changeover. 1/6 each. 12/- doz. £37/10/- per 1,000.

BULKHEAD FITTING. 9in. diam., flat tripod type, suitable for lamps up to 100 watt, complete with pushbar switch lampholder. Ideal for farm buildings, garages, greenhouses, etc. Brand new. 17/6. Post 3/-.

ROOM THERMOSTAT. Adjustable between 45 and 75° Fahr., 250 v. 10 amp. D.C. Ideal for greenhouses. 35/-. Post 2/-.

APQ9 H.F. UNIT. Brand new, contains many valuable components (less photo-multiplier). 90/-. Cge. 7/6.

RACKS—POST OFFICE STANDARD. 6ft. high with U-channel sides drilled for 19in. panels, heavy angle base, 4ft. 10in. in stock.

NIFE BATTERY. Nickel cadmium. 6 volts 75 amp., crated and connected. Alkaline filled. Brand new. £7/10/-. Cge. 15/-.

HEADPHONES. Balance Armature Type DHR. 17/6 per pair. Post 1/6.

HEADPHONES. High resistance 4,000Ω type CHR 12/6 pair. Post 1/6.

HOME INTERCOM

★ ROOM TO ROOM

★ HOUSE TO WORKSHOP

SET No. 5 TELEPHONE HAND SET as illustrated with sound-powered earpiece and battery operated mouthpiece. Simply connect two instruments with twin flex and a 1½ volt battery in series. "Press to talk" button prevents waste of current whilst not in use. Two instruments with cords and plugs. 25/-. Post 2/6.

SET No. 7. Consisting of two P.O. type handsets as illustrated with press button in the handle for ringing bell at other end. The instruments are entirely sound-powered and are supplied with two bells and batteries with full instructions for installing. Simply connect with four wires. 75/-. Post 3/6. Twin flex 4½d. per yard. Single wire in 100 yd. coils at 10/6. Post 1/-. S.A.E. for complete list of ten available sets.

10 AMP BATTERY CHARGER

HERE IS YOUR CHANCE TO PURCHASE A BRAND NEW UNIT WORTH £40! FOR OUR SPECIAL PRICE £17.10.0

Carriage 20/-

Input 200/250 v. A.C. 50 cy. Output 10 amps., 22 volts D.C. Controlled by two 4-position switches for fine and coarse control which enables 6 to 24 volt batts. to be charged. Brand new with 0/12 ammeter. Fused A.C./D.C.

LOUDSPEAKER BARGAINS

BRAND NEW

ELAC 5in. Permanent Magnet. 3 ohms. 9,700 gauss. Only 18/6. Post 1/6. A High Quality Speaker at a Low Price.

AXIOM 150. Double Cone 12in. 15 watts—15 ohms, fully dust-proof. Our Special Offer. £7/19/6. Packing and carriage 7/6. High Fidelity—in maker's cartons.

P.M. SPEAKERS. 10in., in portable case with flex and plug. 50/-. Carr. 5/-.

TANNOY LOUD HAILERS. In slope front wood case, with 180 ohm line transformer and condenser. Speech coil impedance 7.5 ohms. 19/6. Carriage 5/-.

TERMINAL BLOCKS. 2-way fully protected. No. 5C/430. 4/- doz. or box of 50 for 15/-, 3-way 6/- doz., 50 for 22/6, post 1/6.

JACK PLUGS. Cylindrical bakelite screw-on cover. 2 contact. 2/6. 20/- doz.

SOLENOIDS. 12 volt D.C., with 3½in. lever. Very powerful. Ideal for remote control, model railways, etc. 5/- each. Post 1/6.

CATHODE RAY TUBES 2AP1. 25/-. Post 2/6.

CATHODE RAY TUBES 139A. 35/-. Post 3/-.

CATHODE RAY TUBES 5BP1. 55/-. Post 3/6.

TRANSMITTER TUBE 212E. 70/-. Post 3/6.

MAINS MOTORS. Capacitor, 230 volts A.C. 1/40th h.p., 1,400 r.p.m., D.E.S. 55/-. Post 3/-.

GEARED MOTORS. 220/240 volts A.C., 175 r.p.m., torque 15lb. in. Klaxon. £10. Cge. 15/-.

SMALL MOTORS. 12 volts D.C., 3,000 r.p.m. with speed governor in end cap. Size 2×1½in. 12/6. Post 2/-.

L. WILKINSON (CROYDON) LTD.

19 LANSDOWNE RD. CROYDON SURREY

Phone: CRO 0839 Grams: WILCO CROYDON

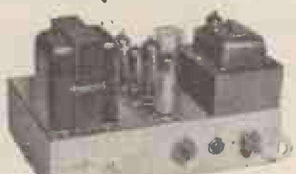
AMPLIFIERS PRE-AMPLIFIERS

COMPLETE KITS OF PARTS FOR THE "HI-FI" ENTHUSIAST

Designed by MULLARD—Presented by US strictly to their specification

MULLARD DESIGNS FOR THE HOME CONSTRUCTOR

THE VERY POPULAR MULLARD "5-10" MAIN AMPLIFIER



Undoubtedly the most successful amplifier yet designed, and used in conjunction with the new Mullard Pre-Amplifier, an undistorted power output of up to 10 watts is obtained. Thoroughly recommended to the "Hi-Fi" enthusiast who contemplates a very high quality home installation. In addition the versatility of the equipment makes it quite suitable for use in small halls, etc. We supply complete to MULLARD'S SPECIFICATION with specified valves and components and including the latest PARMEKO Ultra-linear Output transformer and the Parmeko mains transformer which has power available to drive Radio Tuning Unit.

Price for COMPLETE KIT OF PARTS.......... **£10.0.0**

Alternatively we supply ASSEMBLED and TESTED.......... **£11.10.0**

(Carriage and insurance 5/- extra).

We also offer this "5-10" incorporating the latest PARTRIDGE ULTRA-LINEAR OUTPUT TRANSFORMER for £1/6/- extra.

MULLARD'S NEW 2-STAGE PRE-AMPLIFIER TONE CONTROL UNIT

A completely new design employing two EF86 valves, and in particular designed to operate with the Mullard range of Power Amplifiers, but also perfectly suitable for other makes.

Briefly it incorporates:—

- Equalisation for the latest R.I.A.A. characteristics.
- Input for variable reductance. Magnetic Pick-ups.
- Input for Crystal Pick-ups.
- Input for Tape replay.
  (a) Direct from High Impedance Tape Head.
  (b) From a Tape Amplifier or Pre-amplifier.
- Sensitive Microphone Channel.
- Wide range BASS and TREBLE Controls.
- Attractive Perspex front control panel.
- Our Kit is strictly to MULLARD'S SPECIFICATION

Price, COMPLETE KIT OF PARTS.......... **£6.6.0**

Alternatively we supply ASSEMBLED AND TESTED.......... **£8.8.0**

(Carriage and Insurance 5/- extra).

THE NEW MULLARD "3-3" MAIN AMPLIFIER

Based entirely on the present very popular "3-3" model and designed to operate in conjunction with the new 2-stage PRE-AMPLIFIER (shown here) thus providing all the facilities associated with the more expensive "Hi-Fi" equipment. We recommend it as the IDEAL SMALL HOME INSTALLATION where very high quality is desired at the lower volume level (up to 3 watts).

We supply completely to MULLARD'S SPECIFICATION INCLUDING the latest PARMEKO Output Transformer specified Valves and Components. Has Power available to drive a Radio Tuning Unit.

Price for COMPLETE KIT of PARTS.......... **£7.0.0**

Alternatively we supply ASSEMBLED and TESTED.......... **£8.0.0**

(Carriage and Insurance 5/- extra).

Special Price Reductions WE OFFER

Only NEW HIGH GRADE Components and Mullard Valves are supplied with these kits—we DO NOT use "Surplus or Cheap" components.

(a) THE COMPLETE KIT OF PARTS to build both the "3-3" MAIN AMPLIFIER and the 2-stage PRE-AMPLIFIER-CONTROL UNIT.......... **£12.10.0**

(b) THE COMPLETE KIT OF PARTS to build both the "5-10" MAIN AMPLIFIER and the 2-STAGE PRE-AMPLIFIER-CONTROL UNIT.......... **£15.15.0**

*ALL PRICES QUOTED FOR THE "5-10" ARE SUBJECT TO £1/6/- EXTRA IF THE PARTRIDGE TRANSF IS REQUIRED.

Please enclose S.A.E. if ILLUSTRATED and DESCRIPTIVE LEAFLETS are required . . . alternatively the COMPLETE ASSEMBLY MANUALS containing component Price Lists and practical Drawings, etc., are available at 1/6 each.

(a) THE "3-3" and the 2-STAGE PRE-AMPLIFIER both ASSEMBLED and TESTED.......... **£15.0.0**

H.P. TERMS: DEP. £3 and 12 monthly payments of £1/2/- or DEP. £5 and 12 monthly payments of 18/4.

(b) THE "5-10" and the 2-STAGE PRE-AMPLIFIER both ASSEMBLED and TESTED.......... **£18.18.0**

H.P. TERMS DEP. £3/16/- and 12 monthly payments of £1/7/8 or DEP. £6/6/- and 12 monthly payments of £1/3/1

When ordering please include an extra 7/6 to cover the cost of carriage and insurance

THE NEW COMPLETE MULLARD "5-10" AMPLIFIER

MODEL 510/RC

We offer this popular and very successful design COMPLETE to MULLARD'S SPECIFICATION, but incorporating some improvements in the general layout. HIGH QUALITY REPRODUCTION up to a maximum of 10 watts output. The CONTROL UNIT is separate and completely enclosed; it is normally fitted to the Main Amplifier Chassis as shown in the illustration but, if it is desired to use the unit remote from the Main Chassis, it can be quite easily detached and used up to 2 yards distance. We incorporate SPECIFIED COMPONENTS and NEW MULLARD VALVES. We also give the purchaser the choice of two of the best ULTRA-LINEAR OUTPUT TRANSFORMERS made—first the latest by PARMEKO LTD., and also the latest by PARTRIDGE (£1/6/- extra), which is generally recognised as the best U/L Output Transformer made today and ensures maximum undistorted output and the widest frequency range. We also supply the PARMEKO MAINS TRANSFORMER, and this has extra power available to supply a Radio Tuning Unit amounting to 250 volts at 35 mA. and a separate heater winding giving 6.3 volts 2½ amps. Price COMPLETE KIT OF PARTS (PARMEKO TRANSFORMER) MODEL 510/RC.......... **£11.10.0**

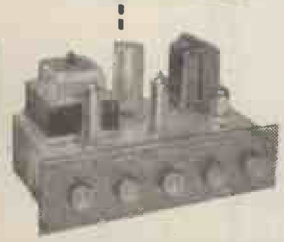
(Plus 6/6 Carriage and Insurance).

Alternatively we supply ASSEMBLED and TESTED (plus 6/6).......... **£13.10.0**

H.P. TERMS: Dep. £2/14/- and 12 monthly payments of 19/10.

Send S.A.E. for ILLUSTRATED LEAFLET or 1/6 for the COMPLETE ASSEMBLY MANUAL.

THE NEW COMPLETE MULLARD "3-3"



A VERY HIGH QUALITY 3-WATT AMPLIFIER PROVIDING EXCELLENT REPRODUCTION AND HAVING AN ATTRACTIVE ENGRAVED PERSPEX FRONT PANEL.

Price for COMPLETE KIT OF PARTS (plus 6/6 carriage and insurance).......... **£7.10.0**

Alternatively supplied ASSEMBLED and FULLY TESTED.......... **£8.19.6**

(Plus 6/6 carriage and insurance).

H.P. Terms deposit £2 and 8 monthly payments of £1.

Developed from the very popular 3-valve 3-watt Amplifier designed in the Mullard Laboratories. Our kit is complete to the Mullard specification including supply of specified components, valves and PARMEKO OUTPUT TRANSFORMER. We also include switched inputs for 78 and L.P. records plus a Radio position. Extra power to drive a Radio Tuning Unit is also available:—

THE COMPLETE ASSEMBLY MANUAL AVAILABLE FOR 1/6.

Please enclose S.A.E. with all enquiries

STERN RADIO LTD. 109 & 115 FLEET ST., LONDON, E.C.4 Telephone: FLEET STREET 5812/3/4

The "NEW" 1959

Stern's "fidelity" TAPE RECORDER

for truly "HI-Fi" *Recordings*

PRICE

£49.10.0

Terms: Dep. £9/18 and 12 monthly payments of £3/12/7 or Dep. £16/10/- and 12 monthly payments of £3/-/6

IT INCORPORATES:

- The latest **COLLARO TRANSCRIPTOR TAPE DECK.**
- The model **HF/TR3 "Fidelity" AMPLIFIER.** (Described below).
- **HIGH QUALITY** 7in. x 4in. P.M. Speaker.
- 1,200ft. reel EMI tape.
- ACOS Crystal Microphone.

BEFORE CHOOSING YOUR TAPE RECORDER YOU SHOULD HEAR THIS MODEL—TRULY "Hi-Fi" RECORDINGS ARE OBTAINABLE and it is comparable to much higher-priced Recorders. **ALTERNATIVELY** Send S.A.E. for **ILLUSTRATED LEAFLET.**

(Plus £1/10/0 carriage and insurance of which £1 is refunded on return of packing case.)

THE LEGS SHOWN IN THE ILLUSTRATION ARE READILY DETACHABLE AND ARE AN OPTIONAL EXTRA AT £1/2/6.

THE MODEL HF/TR3 TAPE AMPLIFIER

Incorporating *3-SPEED TREBLE EQUALISATION by means of the latest FERROXCUBE POT CORE INDUCTOR.*

PRICE for COMPLETE KIT OF PARTS........ **£12/15/-**
FULLY ASSEMBLED AND TESTED.......... **£16/10/-**
HIRE PURCHASE: Deposit £3/6/6 and 12 months at £1/4/2.

A very high quality amplifier based on the very successful Type "A" design completed in the MULLARD LABORATORIES. ONLY NEW HIGH-GRADE COMPONENTS are incorporated including MULLARD VALVES and a GILSON OUTPUT TRANSFORMER . . . other features are: Magic Eye Recording Hand Indicator—Effective Tone Control—Monitoring and Extension Speaker Sockets—has own Power Supply and can be used as independent Amplifier for direct reproduction of Gram Records or from Radio Tuner. Overall size 11 x 6 x 6in.—Truvox—Collaro—Lane—Brenell or Motek Decks—please specify which.
Send S.A.E. for leaflet or 2/6 for the complete Assembly Manual.

THE NEW MULLARD TYPE "C"
TAPE PRE-AMPLIFIER—ERASE UNIT

INCORPORATING THE NEW FERROXCUBE POT CORE PUSH-PULL OSCILLATOR and 3 SPEED TREBLE EQUALISATION by means of the latest FERROXCUBE POT CORE INDUCTOR.

PRICES . . . INCLUDING SEPARATE SMALL POWER SUPPLY UNIT
COMPLETE KIT OF PARTS **£14 . 0 . 0** ASSEMBLED AND TESTED **£17 . 0 . 0**
Deposit £3/8/- and 12 months of £1/4/11. Assembled unit only.
ALSO AVAILABLE EXCLUDING POWER SUPPLY UNIT FOR **£11 . 15 . 0** and **£14 . 10 . 0** respectively. (Carr. and Ins. 5/- extra).
Send S.A.E. for leaflet or 2/6 for Complete Assembly Manual.

WHEN ORDERING PLEASE STATE MAKE OF TAPE DECK TO BE USED

We present this "Hi-Fi" Pre-amplifier strictly to Mullards specification etc. incorporating ONLY NEW HIGH GRADE COMPONENTS and the SPECIFIED NEW MULLARD VALVES. It comprises a COMPLETELY SELF CONTAINED UNIT, all components and valves being contained in a well ventilated Box—Chassis neatly finished in Hammered gold with a very attractively engraved PERSPEX FRONT PANEL.

HOME CONSTRUCTORS
YOU CAN BUILD THIS PORTABLE TAPE RECORDER from £41 . 10 . 0

WE OFFER YOU THIS SELECTION

(a) The PORTABLE CASE illustrated here (£5). 1,200ft. E.M.I. TAPE (£1/15/-). ACOS CRYSTAL MIKE (£1/15/-). ROLA 10in. x 6in. LOUDSPEAKER (£1/10/0) ALL FOR **£9.0.0**

AVAILABLE ON H.P. WITH (b) or (d) below.

(b) The COLLARO MK. IV TAPE DECK (£25) and the HF/TR3 AMPLIFIER Assembled and Tested. FOR **£36.0.0**
H.P. Deposit £7/4/- and 12 months of £2/12/6

(c) As in (b) above, but HF/TR3 supplied as COMPLETE KIT OF PARTS **£32.10.0**

(d) The TRUVOX MK. IV TAPE DECK incorporating Precision Rev. Counter (£30/9/-) and the HF/TR3 AMPLIFIER Assembled and Tested....................................... **£41.10.0**
H.P. Deposit £8/6/- and 12 months of £3/-/10.

(e) As in (d) above, but the HF/TR3 supplied as COMPLETE KIT OF PARTS.................................. **£38.0.0**

(Carriage and Insurance on above quotes 10/- extra)

NOTE: Messrs. Collaro when supplying the MK. IV Deck do not wire up the Deck Switches. We will do this at charge of £1 or supply a Wiring Diagram to the Home Constructor.

TO ADD FULL TAPE RECORDING FACILITIES

To any modern "Hi-Fi" AUDIO AMPLIFIER (such as our Mullard "5-10" and 2 valve Preamplifier) ALL YOU NEED IS . . . THE TYPE "C" PREAMPLIFIER and a TAPE DECK . . . WE OFFER

(a) The COLLARO MK. IV TAPE DECK and the MULLARD TYPE "C" PREAMPLIFIER & Power Unit assembled, tested **£37.0.0**
H.P. Deposit £7/8/- and 12 months £2/14/3.

(b) As in (a) above but the Type "C" supplied as COMPLETE KIT OF PARTS **£34.0.0**

(c) The TRUVOX MK. IV TAPE DECK incorporating Precision Rev. Counter, and the MULLARD TYPE "C" PREAMPLIFIER and power unit assembled and tested............................ **£42.10.0**
H.P. Deposit £8/10/-. 12 months £3/2/4.

(d) As in (c) above but the TYPE "C" supplied as COMPLETE KIT OF PARTS....................... **£39.10.0**

(Carriage and Insurance on above quotes 10/- extra.)

PLEASE ENCLOSE S.A.E. WITH ALL CORRESPONDENCE.

STERN RADIO LTD.

109 & 115 FLEET ST., LONDON, E.C.4

Telephone: FLEET STREET 5812/3/4

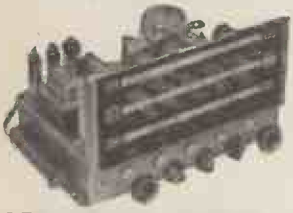
MODERNISE YOUR OLD RADIOGRAM

It is CHEAPER and BETTER VALUE TO REPLACE YOUR OLD CHASSIS and GRAM UNIT

!! RADIOGRAM CHASSIS !!

ARMSTRONG "STEREO TWELVE" - £38.17.0

The most complete unit yet produced for Stereo giving 6 watts high fidelity push-pull output on each channel, 12 watts for monaural. Full VHF band, medium and long wavebands. Stereo and monaural inputs or records, tape and radio and a tape output for stereo and monaural tape recording. Comprehensive matching for all types of crystal pick-ups. The perfect basis for a complete monaural reproducing system or for a complete stereophonic system now or later.

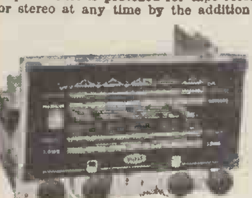


ARMSTRONG "JUBILEE" £30.9.0

An AM/FM chassis with nine valves and two diodes and with push pull output stage providing 6 watts. Full VHF medium and long wavebands with automatic frequency control on FM and ferrite aerial on AM. Tape record and playback facilities. Can be adapted for stereo at any time by the addition of our compact, easy-to-fit converter amplifier.

ARMSTRONG "PB409" - - £29.8.0

A nine valve AM/FM chassis giving 6 watts push-pull output and fitted with attractive piano key selectors. Covers full VHF band, medium, long and short wavebands and an output socket is provided for tape recording from radio and pick-up. Can be adapted for stereo at any time by the addition of our compact easy-to-fit converter amplifier.



DULCI "H4PP" - £29.3.10

An 8 valve AM/FM 4 waveband chassis giving 6 watts ultra linear output. Covers short, long, medium wavebands plus the VHF/FM band and has internal aerial on the medium and long wavebands. Tape outlet incorporated and suitable for 3 to 15 loudspeakers.

DULCI "H3" - £20.17.0

A 6 valve AM/FM chassis giving 4 watts output. Covers medium and long wavebands, on which an internal aerial operates, plus the VHF/FM band. Full AVC on all wavebands and tape outlet incorporated.

NEW HIRE PURCHASE TERMS are available on all above. Illustrated leaflets available—send S.A.E.

AM/FM RADIO TUNING UNITS

Containing own Power Supply Units

ARMSTRONG "S.T.3" - - - £28.7.0

A self-powered high fidelity tuner covering full VHF, medium and long wavebands with automatic frequency control on VHF. Excellent in combination with our MULLARD AMPLIFIERS but the cathode follower stage and variable feedback output control enable this tuner to be used with virtually any amplifier available.

DULCI "H4/T" - - - - £24.19.0

A 4 waveband self-powered high fidelity tuner covering the VHF/FM transmissions plus the long, medium and short wavebands. Excellent performance in combination with our MULLARD AMPLIFIERS and also all high quality designs.

ILLUSTRATED LEAFLET showing recommended HIGH QUALITY LOUDSPEAKERS is available—send S.A.E.

STERN'S FOR STEREO

OUR POPULAR MULLARD MAIN AMPLIFIERS ARE RECOMMENDED FOR USE WITH THE DULCI DUAL CHANNEL STEREO PREAMPLIFIERS

The "STEREO EIGHT" PREAMPLIFIER £23.2.0
(Carr. & Ins. 5/- extra)

The "STEREO TWO" PREAMPLIFIER £9.9.0
(Carr. & Ins. 5/- extra)

Both Preamplifiers can be supplied to correctly operate with our very popular MULLARD "3-3" and "5-10" MAIN AMPLIFIERS (described on page 155). For Stereo reproduction TWO Main Amplifiers are necessary but for normal "Hi-Fi" reproduction the "Stereo Eight" and the "Stereo Two" are perfectly suitable to operate with ONE Main Amplifier and the second Main Amplifier can then be added at any time thus transforming a standard "Hi-Fi" installation over to the Stereo.

WE OFFER PREAMPLIFIERS and AMPLIFIERS AT SPECIALLY REDUCED PRICES.

Send S.A.E. for fully descriptive Leaflets

!! CAR RADIO !!

FOR THE HOME CONSTRUCTOR

We have almost completed the design for a versatile 12 volt Car Radio. Incorporating a PRINTED CIRCUIT with TRANSISTOR output. This has the advantage of low current consumption, does not require a vibrator unit and covers both long and medium wavebands. Size is only 7 x 6 x 2in.

THE COMPLETE KIT OF PARTS WILL BE AVAILABLE LATE APRIL £13.10.0
(Carriage and ins. 5/- extra)

A general assembly Manual will also be available in April. Price 1/6.

!! RECORD PLAYERS !!

The LATEST MODELS are in Stock. Many at REDUCED PRICES!!!
Send S.A.E. for ILLUSTRATED LEAFLET

A FEW CASH BARGAINS

B.S.R. MONARCH UA8 4-spd. Mixer Autochanger with Crystal Pick-up. £6.19.6

The COLLARO "CONQUEST" 4-speed autochanger Studio "O" Pick-up £7.19.6

The latest COLLARO "CONTINENTAL" 4-speed MIXER Autochanger, Studio "C" Pick-up £8.19.6

The COLLARO 4-speed Single Record Player, Studio Pick-up.... £6.19.6

THE NEW B.S.R. model UA12 is in stock. A4 "SPEED" MIXER AUTOCHANGER £8.19.6

UA12 also available incorporating the B.S.R. STEREO Pick-up plays L.P and 78 records.................... £11.17.6

GARRARD RC121/4 4-speed Autochanger fitted with latest Crystal Pick-up £10.10.0

B.S.R. Model TU9 4-speed single record player, complete with separate crystal pick-up £4.10.0

(This high output pick-up is available separately for £1/12/6.)
Carriage and insurance on each above 5/- extra.

HIGH FIDELITY UNITS IN STOCK

The latest GARRARD TRANSCRIPTION MOTOR "301" with Stroboscopically marked turntable.................... £28.0.11

The new GARRARD Model 4HF High Quality Single Record Player fitted with the latest T.P.A. 12 pick-up arm and G.C.8 Crystal Cartridge £19.7.10

As above but fitted with the G.M.C.5 Moving Coil Pick-up and T.P.1 Transformer £27.14.7

GARRARD Model TA/MK II Single Record Player fitted with high output Crystal Pick-up detachable head.................... £9.15.8

The GARRARD T.P.A. 12 TRANSCRIPTION PICK-UP ARM is available separately or with Crystal or Moving Coil Pick-up Heads.

HIRE PURCHASE TERMS available on all units £8/19/6 and over.
Send S.A.E. for Leaflet

SPECIAL CASH ONLY OFFER!!

This very attractive PORTABLE AMPLIFIER CASE together with a good quality GRAM AMPLIFIER and a matched P.M. SPEAKER. ALL FOR ONLY £8.7.6 (plus 7/6 carr. and ins.). The Amplifier consists of a 2-stage design incorporating the 3 modern BVA valves and has separate BASS and TREBLE CONTROLS. The Portable Case will also accommodate almost any make of Autochanger and is attractively finished in Grey colour Rexine—WE ALSO SUPPLY SEPARATELY:—

(a) The 2-stage (plus Rectifier) AMPLIFIER £4 2 6
(b) The PORTABLE CARRYING CASE £3 17 6
(c) 6½in. P.M. SPEAKER 18 9
(Carriage and insurance 4/- extra)

We also have a smaller PORTABLE CASE ideal for Record Players. PRICE ONLY £3/3/- (plus carriage and ins.).

!! HOME CONSTRUCTORS !!

A RANGE OF "EASY TO ASSEMBLE" PREFABRICATED CABINETS

Designed by the W.B. "STENTORIAN" COMPANY for "Hi-Fi" Loudspeaker systems or to accommodate high-quality equipment. The acoustically designed Bass Reflex Cabinets containing the very successful "Stentorian" Speakers give really first-class reproduction and are well recommended. Models are also available to accommodate high-quality Amplifiers, Preamplifiers, Tuning Units, Record Players, etc. All models are very easily assembled, in fact only a screwdriver is required.

Fully illustrated leaflets are available including complete specifications of the various STENTORIAN LOUDSPEAKERS. Please enclose S.A.E.

STERN'S MK II *"fidelity"* F.M. TUNING UNIT

(Plus 5/- carr. and ins.) PRICE £15.0.0
HIRE PURCHASE: Deposit £3 and 12 months at £1/2/-. Incorporates the latest MULLARD PERMEABILITY TUNING HEART and the corresponding MULLARD VALVE LINE UP comprising ECC85, 2 type EF85's (or EF89's), EM84 Tuning Indicator, plus 2 type O.A. 79's Germanium Diodes. A really first-class Tuner very attractively presented and comparable to many offered at much higher prices. Power consumption is only 1.5 amps at 6.3 volts and 25 m/a at 250 volts.

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YOU CAN BUILD THIS TUNING UNIT FOR ONLY............ £11.0.0
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STERN RADIO LTD. 109 & 115 FLEET ST., LONDON, E.C.4
Telephone: FLEET STREET 5812/3/4

RCP MULTIMETERS. A.C. and D.C. volts, 0 to 2.5, 10, 50, 250, 1,000, 5,000; D.C. current, 0 to 1, 10, 100 mA., 0-1 Amps.; Resistance, 0 to 500, 100 K, 1 Meg.; DeciBels, −10 to +69. 1,000 ohms per volt (400 microamps basic). In light oak case 6½ × 6 × 4½in., including lid. Complete with test leads and prods, internal battery, and instruction manual. All BRAND NEW and tested. £5/19/6. Post 3/-.

SELENIUM BRIDGE RECTIFIERS. Funnel cooled. A.C. input 45 v. RMS. D.C. output 30 v. 10 amps. BRAND NEW. Boxed. 45/-. Post 3/6.

DUAL PURPOSE TRANSFORMERS (Gresham). Pri. 230/250 v. Secs. 240-0-240 v. 1.5 amps., 5 v. 12.5 amps. 5 v. 1.75 amps. Ideal for ISOLATING TRANSFORMER, to obtain TWO 240 v. 360 watt lines. Potted, oil-filled, 7 × 7½ × 10½in. high. Wt. 50lb. BRAND NEW. £3/10/-. Carr. 10/-.

ADMIRALTY H.T. TRANSFORMERS. Pri. 230 v. 50 c/s. Secs. 620-550-375-0-375-550-620 v. (620 and 550 v. 200 m/amps., 375 v. 250 m/amps.), plus two 5 v. 3 Amp. rectifier windings. Total rating 278 VA. Upright mtg. Wt. 25lb. Made 1953. BRAND NEW. Original boxes. 45/-. Carr. 5/-.

TRANSFORMER BARGAIN. Input 0-200/250 tapped. Outputs 250-0-250 v. 80 m/amps. 5 v. 2 amps.; 6.3 v. 4.5 amps. Upright mtg. BRAND NEW. Boxed. Ex-Admiralty made 1952. A fine 50 c/s. mains tranny for ONLY 16/6, post FREE.

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AR88D MAINS TRANSFORMERS. Input 110-240 v Output 345-0-345 v. 125 m/amps., 6.4 v., 4.5 amps., 5 v. 2 amps. 4½ × 4½ × 5½in. high. Wt. 12lb. Potted. Tag ends. RCA BRAND NEW. Boxed. 29/6. Post 3/6.

MODULATION TRANSFORMERS. Collins type 20 watts 807 to 807, 8/6 each. Post 1/6.

FERRANTI TYPE, for Tx 36, etc., push-pull 807's to plate and screen modulate push-push 807's, ratio 2 : 1. Fully shrouded. Wt. 6½lb. 17/6. Post 2/6.

RESISTORS

Morgan "T" (½ watt) and "R" (1 watt). Latest types, all BRAND NEW. 100 assorted, 10/-. Post 1/-.

INSTRUMENT TRANSFORMERS. 230 v. A.C. input. Outputs 0-65-130-195 v. 85 m/amps., 6.3 v. 5 amps., 6.3 v. 0.3 amps. Shrouded. Size 3½ x 3½ x 3½in. high. 15/- post FREE.

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SANGAMO-WESTON VOLTMETERS

S61. Dual range 0-5 and 0-100 v. D.C. FSD 1m/A. 3in. scale. Recent manufacture. Ideal for schools. Complete in super quality canvas carrying case, with test prods and leads. **BRAND NEW.** Boxed 27/6. Post 2/6.

MORE METER BARGAINS

RANGE	TYPE	SIZE		PRICE
25 Microamp.	D.C. M/C	2½in	Flush Circ. Scale "Rontgens"	69/6
25 Microamp.	D.C. M/C	2½in.	Proj. Circ. Scale "Rontgens"	59/6
50 Microamp.	D.C. M/C	3½in.	Flush Circ. Scale "Tolerance"	79/6
50 Microamp.	D.C. M/C	2½in.	Flush Circ., scaled 0-100	59/6
100 Microamp.	D.C. M/C	3½in.	Flush Circ. Scale 0-50/0-1,000 v.	62/6
100 Microamp.	D.C. M/C	2½in.	Flush Circular	42/6
1 Milliamp.	D.C. M/C	3½in.	Flush Circular	50/-
1 Milliamp.	D.C. M/C	2in.	Flush Square. Fe/NFe. 1954	22/6
200 Milliamp.	D.C. M/C	2½in.	Flush Circular	10/6
1 Amp. Thermocouple		2½in.	Projecting Circular	6/9
1 Amp. Thermocouple		2½in.	Flush Circular	7/6
4 Amp. Thermocouple		2in.	Flush Square	6/9
300 Volts	A.C. M/I	6in.	Flush Circular. Made 1955	79/6
300 Volts	A.C. M/I	2½in.	Flush Circular	25/-
500 Volts	A.C. M/I	2½in.	Flush Circular	25/-
10 Amperes	D.C. M/C	2½in.	Flush Circular	7/6

METAL RECTIFIERS. Full wave bridge. BRAND NEW. Salford 1 mA., 8/6. 5 mA., 8/6. STC 2 mA., 5/6.

Z MATCH ! Cyldon 250 + 250pFd. split stator double spaced transmitting variables. Ceramic insulation. BRAND NEW, boxed. 19/6. Post 2/6.

WHEATSTONE BRIDGES. Post Office plug-type. 1 to 10,000 ohms. 79/6. Post 3/6.

MEGGERS

Evershed & Vignoles "Wee" Meggers, 500 volts, complete in leather case, with leads. AS NEW. £8/19/6.

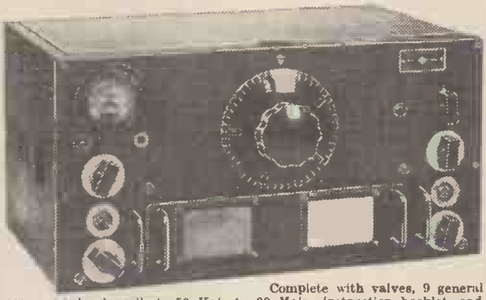
E. & V. Series 2 Meggers. 500 volts, 0-100 Megohms. In leather case. First-class condition. ONLY £14/10/-.

E. & V. BONDING TESTERS. 0-5 ohms at 12 m/amps. max. Hand generator type. In leather case. 79/6.

INSULATION TESTERS. "Record" hand generator type. 0-50 Megohms at 500 volts pressure. Complete in leather case. £7/19/6. Post 4/-.

MINIATURE 373 IF STRIPS. For FM tuner described in "Practical Wireless." Complete with 3 of EF91, 2 of EF92 and 1of EB91. A fresh release enables us to offer these once again. BRAND NEW. Complete reprint of conversion instructions and circuit supplied free, 37/6. OR less valves, 12/6. Post, either 2/6.

HRO SENIOR MODELS



Complete with valves, 9 general coverage plug-in coilsets 50 Kc/s to 30 Mc/s., instruction booklet, and circuit, but less external power supply unit. Table models, as new condition, 21 GNS. Packing and carriage 22/- extra. Send S.A.E. for further details.

HRO POWER PACKS. 115/230 v. A.C. mains input. Tested, and in good condition, 69/6. Post 4/-.

MONITOR TYPE 61

3½in. C.R. Tube. A.C. mains power pack. Very modern design. Ideal for conversion to oscilloscope, full data supplied. Condition as new. £7/19/6. Carr. 15/-.

COLLINS TCS TRANSMITTERS

Cover 1.5-12 Mc/s. (25-200 metres) in 3 bands. Complete with 7 valves: 3 of 12A6 Osc.; 1625 Buffer; 2 of 1625 PA; 1625 Mod. VFO or crystal control, with 4 crystal positions. C/W or R.T. Meters for plate and aerial current. BRAND NEW internally and unused, but externally store soiled. £7/19/6. Carr. 15/-.

R.F. UNITS

RF24. 20-30 Mc/s. 5 switched positions 12/6
RF26. 50-65 Mc/s. Super slow-motion drive.............. 17/6
RF27. 65-80 Mc/s. Super slow-motion drive.............. 22/6
Unboxed, but as new condition. Post 3/6.

MORSE TRAINERS

Two independent valve oscillators (one with pitch control) for one or two operators to practice simultaneously. Has provision for creating "atmospherics." In polished oak case, 12½ × 10 × 8in. Wt. 16lb. Complete with 2 valves, leads, 2 keys, 7-way phone terminal board circuit, and instructions, but less batteries and phones. 12/6. Carr. 7/6. Phones, 7/6 pair.

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COSSOR 343 GANGING OSCILLATORS. An A.M./F.M. signal generator of 70 Kc/s. to 21 Mc/s. in 5 ranges. A.M. modulated 400 c/s., F.M. sweep 0-50 Kc/s. For 100-250 v. A.C. mains. In good clean condition, but may have MINOR faults. £5/19/6. Carr. 7/6.

HICKOCK 1-177 VALVE TESTERS. Checks dynamic mutual conductance, shorts, emission, gas, and noise. For UX4, UX5, UX6, UX7, Octal, Loctal B7G, and Acorn types. Portable in wooden carrying case 15½ × 8 × 5½in. Wt. 13½lb. BRAND NEW. Complete with instruction book and valve testing charts. For 117 v. A.C. 10 gns. Carr. 7/6. Matching auto. transformer for 230 v. A.C.. 12/6.

MULLARD C. & R. BRIDGES. 0.1 ohm to 10 Megohms in 4 ranges; 10 pFd. to 10 mFd. in 3 ranges; Calibrate. Open Bridge, and % range. For 100-250 v. A.C. mains. Tested and guaranteed. £7/10/-. Post 3/6.

TOP BAND R1155's!

A first class 10 valve Communication and D/F receiver, covering 200 Kc/s to 18 Mc/s. (16.2-1,500 m.) in 5 bands. The large scale and superior dual ratio slow-motion drive make tuning easy, and the RF stage and 2 I.F. stages ensure world-wide reception. ALL the receivers we sell have been thoroughly overhauled and completely re-aligned, and are in first class order. **ONLY £12/19/6.**
ALSO available, R1155B, as above, but has 75-200 Kc/s. in place of the trawler band of 100-200 metres. **ONLY £7/19/6.**

A.C. MAINS POWER PACK OUTPUT STAGE. In handsome black crackled steel cabinet to match the receiver. Fitted with 8in. speaker. Just PLUG IN and switch on! Only the finest quality components are used, and we guarantee OUR power packs for 6 months. **Only £6/10/-.** Deduct 10/- when purchasing receiver and power pack together. Send S.A.E. for further details, or 1/3 for 14 page illustrated booklet giving technical data and circuits, etc., which is supplied FREE with each receiver.
Add 10/6 carriage for receiver, 5/- for power unit.

INVICTA LOUDSPEAKERS. Good quality 10in. unit (impedance 3 ohms). In wooden cabinet. 17 × 17 × 6in. Complete with 50ft. lead and jack plug. BRAND NEW. 39/6. Carr. 5/6.

MOVING COIL PHONES. Finest quality Canadian, with chamois ear-muffs and leather-covered headband. With lead and jack plug. Noise excluding and supremely comfortable. 19/6. Post 2/6.

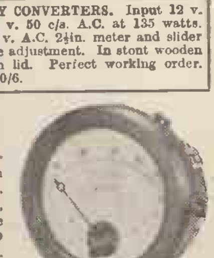
MARCONI LOOP AERIAL type 696. A small, compact, enclosed loop. On swivel mount with degree scale. BRAND NEW. 69/6. Post 2/6. Ideal for R1155, etc.

TX-36 MODULATOR/POWER UNIT. Supplies HT 500 v. 200 m/amps. twice, L.T. 6.5 v. 8 Amps. and bias. Also modulator 3 6C5G, 2 807, and 3 FW4/500 Rects. In oak case 24 × 16½ × 15in., Wt. 120 lb. Circuit supplied. TREMENDOUS BARGAIN. £4/19/6, carr. 15/6 Eng. & Wales.

D.C./A.C. ROTARY CONVERTERS. Input 12 v. D.C. Output 230 v. 50 c/s. A.C. at 135 watts. Fitted with 0-300 v. A.C. 2½in. meter and slider resistor for voltage adjustment. In stout wooden carrying case with lid. Perfect working order. £9/19/6. Carr. 10/6.

FERRANTI VOLTMETERS N5.

0-300 volts, 25-100 c/s. Moving iron 6in. scale. Fl. mtg. Hermetically sealed, grade IN. Made 1955. BRAND NEW. Boxed. 79/6, post 3/6.



R.S.C. A.10 ULTRA LINEAR 30 WATT AMPLIFIER

HIGH FIDELITY PUSH-PULL UNIT EMPLOYING SIX VALVES. EF86 EF86, ECC83, 807, 807, GZ34. Tone Control Pre-amp. stages are incorporated. Sensitivity is extremely high. Only 12 millivolts minimum input is required for full output. **THIS ENSURES THE SUITABILITY OF ANY TYPE OR MAKE OF MICROPHONE OR PICK-UP.** Separate Bass and Treble controls give both "lift" and "cut" with ample tone correction for long playing records. An extra input with associated vol. control is provided so that two separate inputs such as "mike" and gram, etc., etc., can be simultaneously applied for mixing purposes. **AN OUTPUT SOCKET WITH PLUG IS INCLUDED FOR SUPPLY OF 300 v. 20 mA. and 6.3 v. 1.5 a. FOR A RADIO FEEDER UNIT.** Price in kit form with easy-to-follow wiring diagrams. Only **11 Gns.** Cover as illustrated 18/9 extra. Carr. 10/-

Type 807 output valves are used with High Quality Sectionally wound output transformer specially designed for Ultra Linear operation. Negative feedback of 20 D.B. in main loop. **CERTIFIED PERFORMANCE FIGURES ARE EQUAL TO MOST EXPENSIVE UNITS AVAILABLE.** Frequency response ± 3 D.B. 30-20,000 c/cs., Tone Controls ± 12 D.B. at 50 c/cs., + 12 D.B. to − 6 D.B. at 12,000 c/cs., Hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish blue hammer. Overall size 12 × 9 × 9in. approx. Power consumption 150 watts. For A.C. mains 200-250-250 v. 50 c/cs. Outputs for 3 and 15 ohm speakers. **EQUALLY SUITABLE FOR THE CONNOISSEUR OR FOR LARGE HALLS, CLUBS or OUTSIDE FUNCTIONS. IDEAL FOR USE WITH MUSICAL INSTRUMENTS SUCH AS STRINGBASS, ELECTRONIC ORGAN, GUITAR, etc. FOR DANCE BANDS, GARRISON THEATRES, etc., etc.** We can supply Microphones, Speakers, etc., at keen cash prices or on terms with amplifiers.

Or Factory built with 12 months' guarantee **£13/19/6. TERMS ON ASSEMBLED UNITS. DEPOSIT 24/9** and 12 monthly payments of 24/9.

EXPORT ENQUIRIES INVITED.

LINEAR LT/45 HIGH QUALITY TAPE DECK AMPLIFIER

COMPLETE WITH POWER PACK and OSC. STAGE. Suitable for Collaro, Lane, Truvox, Brenell, etc., etc. State make of Deck when ordering. Chassis size 12-7-3in. Overall size 12-7-6½in. For 200-250 v. 50 cc/s. A.C. mains. Output for standard 2-3 ohm speaker. Only 15 millivolts input required for full recording. Only 2 millivolts minimum output required from recording head. Magic Eye recording level indicator. Provision for feeding P.A. amplifier. Negative feed-back equalisation. Linear frequency response ± 3 D.B. 50-11,000 c/cs. Facilities for recordings at 15in., 7½in. or 3¾in. per second. Automatic equalisation at the turn of a knob. When switching from record to playback position automatic demagnetisation of heads is assured. Separate gain and output controls. Valves type ECC83, ECC83, EL84, EZ80, EM34. Output 4 watts. Unit supplied with maker's 12 months' guarantee.

12 GNS. Ready for use Carr. 7/6. Or Dep. 22/3 and 12 payments 22/3.

Leaflet 6d. Special offer LT/45. Collaro Tape Transcriptor, Studio Microphone, reel or tape and 6½in. or 7 × 4in. speaker, **29½** gns. Carr. 10/-.

All ULTRA LINEAR 12-14 WATT AMPLIFIER

NEW 1958 DESIGN HIGH-FIDELITY PUSH-PULL AMPLIFIER WITH "BUILT-IN" TONE CONTROL PRE-AMP. STAGES

Two input sockets with associated controls allow mixing of "mike" and gram. as in A10. High sensitivity. Includes 5 valves, ECC83, ECC83, EL84, EL84, 5Y3. High Quality sectionally wound output transformer specially designed for Ultra Linear operation, and reliable small condensers of current manufacture. **INDIVIDUAL CONTROLS FOR BASS AND TREBLE "Lift" and "Cut."** Frequency reponse ±3 D.B. 30-30,000 c/cs. Six negative feedback loops. Hum level 60 D.B. down **ONLY 23 millivolts INPUT** required for **FULL OUTPUT.** Suitable for use with all makes and types of pick-ups and microphones. Comparable with the very best designs. For **STANDARD or LONG PLAYING RECORDS.** For **MUSICAL INSTRUMENTS** such as **STRING BASS, GUITARS, etc. OUTPUT SOCKET** with plug provides 300 v. 30 m.a. and 6.3 v. 1.5 a. For supply of a **RADIO FEEDER UNIT.** Size approx. 12-9-7in. For A.C. mains 200-250 v 60 c/cs. Output for 3 and 15 ohms speakers. Kit is complete to last nut. chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied. Only **8** Gns. Carr. 10/-. (Or factory built 45/- extra.)

If required louvred metal cover with 2 carrying handles can be supplied for 18/9. **TERMS ON ASSEMBLED UNITS. DEPOSIT 18/9** and 12 monthly payments of 18/9. Send S.A.E. for illustrated leaflet detailing Ready-to-assemble Cabinets, Speakers, Microphones, etc., with cash and credit terms.

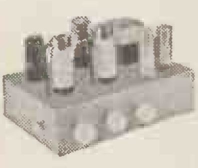
COLLARO JUNIOR 4 SPEED RECORD PLAYER

with separate pick-up having dual point sapphire stylus. Brand new, cartoned. For 200-250 v. A.C. mains only. Only £4/10/-. Post 3/6.

LG3 MINIATURE 3 WATT GRAM. AMPLIFIER

For 200-250 v. 50 c.p.s. A.C. mains. Overall size only 6¼ × 4¼ × 2¾in. Fitted vol. and Tone Control with mains switch. Designed for use with any kind of single player or record changing unit. Output for 2-3 ohm speaker Guaranteed 12 months. Only **55/9**

R.S.C. A5 4-5 WATT HIGH GAIN AMPLIFIER



A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high-fidelity pick-up heads in addition to all other types of pick-ups and practically all mikes. Separate Bass and Treble controls are provided. These give full long playing record equalisation. Hum level is negligible being 71 D.B. down 15 D.B. of negative feedback is used. H.T. of 300 v. 26 mA. and L.T. or 6.3 v. 1.5 a. is available for the supply of a Radio Feeder Unit or Tape Deck pre-amplifier. For A.C. mains input of 200-230-250 v. 50 cc/s. Output for 2-3 ohm speaker. Chassis is not alive. Kit is complete in every detail and includes fully punched chassis (with baseplate) with the blue hammer finish, and point-to-point wiring diagrams and instructions. Exceptional value at only **£4/15/-** or assembled ready for use 25/- extra, plus 3/6 carriage. Or Deposit 22/- and five monthly payments of 22/- for assembled unit.

R.S.C. A7 3-4 WATT QUALITY AMPLIFIER

A highly sensitive 4-valve amplifier using negative feedback and having an excellent frequency response. Pre-amplifier and Tone Control stages are incorporated with separate Bass and Treble Controls giving full tone compensation for long playing records. Suitable for any kind of pick-up including latest high fidelity types. H.T. of 250 v. 20 mA. and L.T. 6.3 v. 1 a., available for supply of Radio Feeder Unit, etc. ONLY 40 millivolts input required for full output. Fully isolated chassis with baseplate. For A.C. mains 200-250 v. 50 cycles. Output for 2-3 ohms speaker. Complete kit of parts, point-to-point wiring diagrams and instructions. Only **£3/15/**, carr. 3/6 or factory built 25/- extra.

COLLARO AC/4/564 4 Speed Single Players £6/19/6. Carr. 4/6. **PORTABLE CABINETS.** Two tone rexine. Will take AC/4/564 Amplifier and Speaker Size inside 14¾ × 13¾ × 6¼, 47/9. Post 4/6.

ACOS HIGH FIDELITY PICK-UPS. GP54 with HGP59/52 cartridge. Dual point sapphire stylus. Cream finish. A fortunate purchase enables us to offer these at approx. half price. Only **35/9**

PORTABLE CABINETS. Inside measurements 17 × 12¾ × 8½in. high. Clearance above baseboard 5¾in. Below 2½in. Attractive design. Two tone rexine covering. Carr. 5/-. Only **69/6**

SPECIAL OFFER. Above cabinet, LG3 amplifier, 6½in. speaker and B.S.R. UA8 Autochanger. **13** gns. Carr. 10/-.

LINEAR L45 MINIATURE 4/5 W. QUALITY AMPLIFIER. Suitable for use with Garrard B.S.R. or any other record playing unit and most microphones. Total negative feedback 12 D.B. Separate Bass and Treble controls. For A.C. mains input of 200-250 v. 50 c.p.s. Output for 2/3 ohm speaker. Three miniature Mullard valves used. Size only 6 × 5 × 5½in. high. Chassis fully isolated from mains. Guaranteed 12 months. Only £5/19/6. Or Deposit 22/- and 5 monthly payments of 22/-. Send S.A.E. for leaflet.

PLESSEY DUAL CONCENTRIC 12in. P.M. SPEAKERS

(15 ohms), consisting of a high quality 12in. speaker of orthodox design supporting a small elliptical speaker ready wired with choke and condensers to act as tweeter. This high fidelity unit is highly recommended for use with our A11 or any similar amplifier. Rating is 10 watts. Gauss 12,000 lines. Price only £5/17/6. Or Deposit 10/6 and 12 monthly payments of 10/6.

LINEAR "DIATONIC" 10-WATT HIGH FIDELITY AMPLIFIER. Incorporating pre-amp. For A.C. mains input 200-230-250 v. 50 c.p.s. A compact attractively finished unit with two separately controlled inputs and outputs for 3 and 15 ohms speakers. Separate Bass and Treble controls. Five latest type miniature Mullard valves. Only 12 Gns. Send S.A.E. for leaflet and credit terms.

P.M. SPEAKERS

2-3 ohm 2½in. Rola **17/9.** 5in. Goodmans **17/9.** 7 × 4in Goodmans Elliptical **19/9.** 6½in. Rola **19/9.** 8in. Rola **19/9.** 8in. Goodmans **21/9.** 10in. R.A. **28/9.** 10 × 6in. Elliptical Goodmans **29/9.** 12in. Plessey **29/11.** 12in. Plessey 3 or 15 ohms, 10 watts, 12,000 lines, **59/6.**

SUPERHET RADIO FEEDER UNIT

Design of a high quality Radio Tuner Unit (specially suitable for use with any of our Amplifiers). A Triode Heptode F/changer is used. Pentode I.F. and double Diode Second Detector, delayed A.B.C. is arranged so that A.V.C. distortion is avoided. The W. Ch. Sw. incorporates Gram. position. Controls are Tuning, W. Ch. and Vol. Output will load most Amplifiers requiring 500 mV. input depending on Ae location. Only 250 v. 15 mA. H.T. and L.T. of 6.3 v. 1 amp. required from amplifier. Size of unit approx. 9-6-7in. high. Send S.A.E. for illustrated leaflet. Total building cost is **£4/15/-.** Point-to-point wiring diagrams and instructions 2/6.

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Personal Shoppers to 5 and 7 County Arcade, Briggate, Leeds, I.
Mail Orders to 29-31, Moorfield Road, LEEDS, 12.

Terms: C.W.O. or C.O.D. No. C.O.D. under £1. Postage 1/9 extra on all orders under £2 2/9 extra under £5 unless carriage charge stated. Full Price List 6d. Trade supplied. Open to callers: 9 a.m. to 6 p.m. Wednesday until 1 p.m. S.A.E. please with all enquiries.

C.R.T. ISOLATION TRANSFORMERS

For Cathode Ray Tubes having Heater/Cathode short circuit and for C.R. Tubes with falling emission.
Type A. Low Leakage windings. Optional Boost 25% and 50%. Tapped mains primaries.

2 volt	12/6 each	
4 volt	12/6 each	with Tag.
6.3 volt	12/6 each	Panel and
10,8 volt	12/6 each	Solder Tag
13.3 volt	12/6 each	

OUR LATEST SUPERIOR PRODUCT. Type A2.
High Quality. Low capacity, 10/15 pf.
Optional boost 25%, 50%, 75%, 16/6 each.
Type B. Mains input. Low Capacity. Multi Ontput 2, 4, 6.3, 7.3, 10 and 13 volts. Optional boost 25% and 50%. Suitable for all Cathode Ray Tubes, 21/-.

RESISTORS. All preferred values. 20% 10 ohms to 10 meg., ¼ w. 4d.: ½ w., 4d.; 1 w., 6d.; 1½ w., 8d.; 2 w., 1/-.
HIGH STABILITY. ½ w., 1%, 2/-. Preferred values 100Ω to 10 meg. Ditto 5%, 9d. to 5 meg., 10%, 6d. to 10 meg.

WIRE-WOUND RESISTORS 25 ohms—10,000 ohms: 5 watt 1/3; 10 watt 1/6; 15 watt 2/-.
15,000 ohms—50,000 ohms 5 w., 1/9; 10 w. 2/3

WIRE-WOUND POTS. 3 w. Pre-set Min. T.V. Type Knurled Slotted knob. All values 25 ohms to 25 K. 3/- ea., 30 K., 50 K., 4/-. Ditto Carbon Track 30 K. to 2 Meg., 3/-.

WIREWOUND POTS. 4 w. Standard size Pots., 2¼in. Spindle High Grade. All Value 100 ohms to 50 K., 5/6; 100 K., 6/6.
W/W EXT. SPEAKER CONTROL 10Ω, 3/-.

O/P TRANSFORMERS. Heavy Duty 50 mA., 4/6. Multi-ratio push-pull, 7/6. Miniature 3V4, etc., 4/6. Hygrade Push-pull 10 watts, 15/6. MULLARD "510" 6k or 8k 30/-.
L.F. CHOKES 15/10H 60/65 ma., 5/-. 10H 85 ma. 10/6. 10H 150 ma. 14/-. 5H 250 ma. 16/6.

MAINS TRANSFORMERS 200/250 v. A.C.

STANDARD 250-0-250, 80 mA., 6.3 v. 3.5 a. tapped 4 v. 4 a. Rectifier 6.3 v. 1 a. tapped, 5v. or 4 v. 2 a. Ditto 350-0-350	22/6
MINIATURE 220 v. 20 mA., 6.3 v. 1 a.	10/6
MIDGET, 250 v. 45 mA., 6.3 v. 2 a.	15/6
SMALL, 250-0-250 100 mA., 6.3 v. 3.5 a.	19/6
STANDARD, 250-0-250, 65 mA., 6.3 v. 3.5 a.	17/6
HEATER TRANS. 6.3 v. 1½ a. 7/6. 3 amp.	10/6

ALADDIN FORMERS and cores, ¼in. 8d.; ⅜in. 10d.
0.3in. FORMERS 5937/8 and Cans TV1/2. ⅜in. sq. × 2⅜in. and ⅝in. sq. × 1⅜in. 2/- complete with cores.
SLOW MOTION DRIVES. Epicyclic ratio 6 : 1, 2/3.
TYANA. Midget Soldering Iron. 40 w. 16/9.
FAMOUS MAKE INSTRUMENT IRON, 25 w., 17/6.
MAINS DROPPERS. 3 × 1¼in. Three Adj. Sliders, .3 amp. 750 ohms., 4/3. .2 amp., 1,000 ohms, 4/3.
LINE CORD. .3 amp., 60 ohms, per foot, .2 amp., 100 ohms. per foot, 2 way, 6d. per foot, 3 way, 7d. per foot.

CRYSTAL MIKE INSERT by Acos 6/6

Precision engineered. Size only ⅞ × 3/16in. Bargain.
ACOS CRYSTAL DESK MIKE, 33-2, switched, 35/-.

MIKE TRANSF. 50 : 1. 3/9 ea.; 100 : 1 Potted, 10/6.
LOUDSPEAKERS P.M. 3 OHM. 2½in. and 5in., 17/6
6in. × 4in. Rola, 18/-. 7in. × 4in. Goodmans 21/-
10in. × 6in. Rola 27/6. 8in. Plessey, 19/6
6½in. Rola, 18/6. 10in. R.A., 30/-.
4in. HI-FI TWEETERS, 25/-. 12in. Plessey, 30/-.
12in. Baker 15 wt. 3 ohm and 15 ohm models 105/-. 12in. 15 ohm. Plessey 10 wt. with Tweeter, 97/6.

I.F. TRANSFORMERS 7/6 pair

465 kc/s. slug tuning miniature can 2½ × 1 × 1in. High Q and good bandwidth. By Pye Radio. Data sheet supplied.
Wearite M800 I.F. Miniature 465 kc/s. 12/6 pair.
Wearite 550 I.F. Standard 465 kc/s. 12/6 pair.

CRYSTAL DIODE G.E.C. 2/-. GEX34, 4/-. 40 Circuits, 3/-.
H.R. HEADPHONES, 4,000 ohms., brand new, 16/6 pair.
SWITCH CLEANER Fluid, squirt spout, 4/3 tin.
TWIN GANG CONDENSERS. 365 pf. Miniature, 1⅜in. × 1½in. × 1¾in., 10/-. .0005 Standard with trimmers, 9/-; less trimmers, 8/-. Midget, 7/6; Single 50 pf., 2/6; 100 pf., 7/-. Solid Dielectric 100, 300, 500 pf., 3/6.
VALVE HOLDERS. Pa. int. Oct., 4d. EF50, EA50, 6d. B12A, CRT, 1/3. Eng. and Amer. 4, 5, 6, 7 and 9 pin, 1/-.
MOULDED Mazda and Int. Oct. 6d., B7G, B8A, B8G, B9A, 9d. B7G with can, 1/6; B12A, 1/3. B9A with can, 2/6.
CERAMIC, EF50, B7G, B9A, Oct., 1/-. B7G with can, 1/9.
SPEAKER FRET. Gold Cloth 17in. × 25in., 5/-, 25in. × 35in., 10/-. Expanded metal, Silver 15⅝in. × 9½in., 2/-.
Tygan 54in. wide, 10/- ft. 27in. wide. 5/- ft. Samples.
WAVECHANGE SWITCHES.

2 p. 2-way, 3 p. 2-way, short spindle	2/6
5 p. 4-way, 2 wafer, long spindle	6/6
2 p. 6-way, 4 p. 2-way, 4 p. 3-way, long spindle	3/6
3 p. 4-way, 1 p. 12-way, long spindle	3/6

Wave change "MAKITS" 1 wafer. 8/6; 2 wafer 12/6; 3 wafer 16/-: 4 wafer 19/6; 5 wafer 23/-; 6 wafer 26/6.
TOGGLE SWITCHES. S.P., 2/-; D.P. 3/6; D.P.D.T., 4/-.
MORSE KEYS, good quality 2/6.

GOLTOP TRANSISTORS

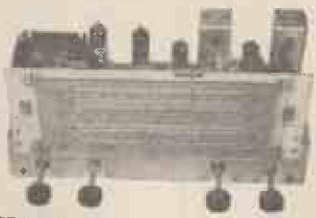
Product of the Pye Group
JUNCTION TYPE P.N.P.
Complete Data Supplied.

AUDIO V.10/15a suitable for high gain and low frequency amplifiers, and for output stages giving up to 250 milliwatts in push pull. PRICE 10/-

R.F. V.6/R2 suitable for oscillators, frequency changers and I.F. amplifiers cut off frequency 3 Mc/s. average. PRICE 18/-

Power V15/10P, up to 10W with heat sink 20/-.

1959 RADIOGRAM CHASSIS FINEST VALUE



THREE WAVEBANDS
S.W. 16 m.—50 m.
M.W. 200 m.—550 m.
L.W. 800 m.—2,000 m.

FIVE VALVES
LATEST MULLARD
ECH 42, EF41, EBC41, EL41, EZ40

12 month Guarantee. A.C. 200/250 v., 4-way switch. Short-Medium-Long-Gram. A.V.C. and Negative Feedback. 4.2 watts. Chassis 13½in. × 5½in. × 2¼in. Glass Dial 12½ × 5¾in. horizontal or 10 × 4½in. vertical. 2 Pilot Lamps. Four Knobs, Walnut or Ivory, aligned and calibrated. Chassis isolated from mains.

BRAND NEW £9.10.0 Carr. 4/6

TERMS: Deposit £5/5/- and 5 monthly payments of £1.
MATCHED SPEAKERS 8in., 17/6; 10in., 25/-; 12in. 30/-.

★ GARRARD 4-SPEED RECORD CHANGERS RC121/D MKII MODELS ★

Brand new and fully guaranteed 12 months.

AUDIO PERFECTION

Designed to play 16, 33, 45, 78 r.p.m. Records 7in., 10in., 12in. With plug-in. NORMAL HEAD.

OUR PRICE **£10.15.0** each. Post Free.
Optional Plug-in STEREO HEAD £2 extra.

★ COLLARO ★ HIGH-FIDELITY AUTOCHANGER

Latest Model
4-SPEEDS—10 RECORDS
With Studio "O" pick-up
BRAND NEW IN MAKER'S BOXES
OUR PRICE **£7.19.6** post free

B.S.R. MONARCH UA8 4-SPEED AUTOMATIC RECORD CHANGERS

Brand new and fully guaranteed 12 months.
OUR PRICE **£6.19.6** post free
STEREO MODEL UA12, £11/17/6.

AUTOCHANGER ACCESSORIES

Suitable player cabinets (uncut boards) ... 49/6
Amplifier player cabinets with cut boards 63/-
2 valve amplifier and 6½in. speaker for above 72/6
3 valve amplifier and 6½in. speaker for above 95/-
Wired and tested ready for use.

EXCEPTIONAL OPPORTUNITY

COLLARO 4-speed MODEL 4/564 Single Player, heavyweight turntable and lightweight Studio O Pick-up with turnover Xtal mounted on baseplate. Autostop fitted.
OUR PRICE **6gns.** Carr. 4/-
Amplifiers Player Cabinets, 45/-.

★ GARRARD 4-SPEED SINGLE RECORD PLAYER 4SP ★

£8 AUDIO PERFECTION POST FREE

De luxe Cabinet with amplifier and 6½in. speaker £6/15/-, or complete kit £14/10/-.

Teletron Transistor Pocket Radios

Designers' Specified Kits
COMPANION PRINTED CIRCUIT 3
Local station receiver kit, 4½x3x1½in. **£4.19.6**
3 Mullard or Goltop transistors; plans 6d.

Transidye Superhet Six 6 × 4 × 1½in.

T.C.C. Printed Circuit, internal Ferrite aerial, Rola loudspeaker, push-pull output. All parts, cabinet and 6 Mullard or Goltop transistors.
£11.19.6 Plans, etc., 9d.
No surplus reject transistors supplied

THE HI-GAIN BAND 3 PRE-AMP.

Cascode circuit using Valve ECC84. 17db gain. Kit 29/6 less power; or 49/6 with power pack kit. Plans only 6d.
Also Band I version same Prices.

Volume Controls

Midget size:
Long spindles. Guaranteed 1 year. All values 5 K. ohms to 2 Meg.
No Switch 3/- D.P. Sw. 4/9
Linear or Log Tracks

80 ohm CABLE Coaxial

Semi-air spaced Polythene insulated ¼in. dia. Stranded core. Ideal Band III 9d. yd. Losses cut 50%.

FRINGE QUALITY AIRSPACED .... 1/6 yd.

COAXIAL PLUGS	1/-	DOUBLE SOCKET	1/3
SOCKETS	1/-	OUTLET BOXES	4/6

BALANCED TWIN FEEDER per yd. 6d. 80Ω or 300Ω.
TWIN SCREENED BALANCED FEEDER 1/6 yd., 80 ohm.
TRIMMERS, Ceramic, 30, 50, 70 pf., 9d. 100 pf., 150 pf., 1/3. 250 pf., 1/6. 600 pf., 750 pf., 1/9. Phillips. 1/- ea.

ALUMINIUM CHASSIS. 18 s.w.g. Plain, undrilled with 4 sides, riveted corners and lattice fixing holes, with 2½in. sides, 7 × 4in., 4/6; 9 × 7in., 5/9; 11 × 7in., 6/9; 13 × 9in., 8/6; 14 × 11in., 10/6; 15 × 14in., 12/6; and 18 × 16 × 3in., 16/6.

BLACK CRACKLE PAINT. Air drying, 3/- tin.
P.V.C. CONN. WIRE, 8 colours, single or stranded, 2d. yd.
NEON MAINS TESTER SCREWDRIVERS. 5/-.
CORED SOLDER RADIOGRADE 3 yds. 9d. ¼lb. 2/6.
PAXOLIN SHEET, 8in. × 10in., 1/6. ION TRAPS 5/-.

"GEVAERT GEVASONOR"

50% Extra Long Play Plastic Tape, 1,700ft. Reel 35/-, 850ft. Reel 21/-.

SUPERIOR 1,200ft. 7in. Plastic Tape 21/-
Spare Reels Plastic, all sizes 3/- ea.

"INSTANT" Bulk Tape Eraser, 200/250v. A.C. For any make and size of tape. 27/6.

SENTERCEL RECTIFIERS. E.H.T. TYPE FLY-BACK VOLTAGES. K3/25 2 kV., 5/-; K3/40 3.2 kV., 7/-; K3/45 3.6 kV., 7/6; K3/50 v. 4 kV., 8/-; K3/100 8 kV., 14/6. 50 c.p.s. Voltage 30% of above.
MAINS TYPE. RM1, 125 v., 60 mA., 5/-; RM2, 100 mA., 6/-; RM3, 120 mA., 8/-; RM4, 250 v. 275 mA. 16/-.
MINIATURE CONTACT COOLED RECTIFIERS. 250 v. 50 mA., 7/6; 60 mA., 8/6; 85 mA., 9/6.
COILS. Wearite "P" type, 3/- each. Osmor Midget "Q" type adj. dust core from 4/- each. All ranges.
TELETRON. L. and Med. T.R.F. with reaction. 3/6.
FERRITE ROD AERIALS. M.W., 8/9: M. & L. 12/6.
T.R.F. COILS A/HF 7/- pair. H.F. CHOKES, 2/6.

JASON F.M. TUNER COIL SET, 26/-. H.F coil, aerial coil. Oscillator coil, two I.F. transformers 10.7 Mc/s., Detector, transformer and heater choke. Circuit and component book using four 6AM6 2/-. Complete kit with Jason Calibrated dial and 4 valves, £6/15/-.
Mercury Switched FM Tuner 5 valve Kit, £8/19/6.
Mullard 3-3 quality Amplifier. Ready built. £7/17/6.

CONDENSERS. New Stock. .001 mfd. 7 kV. T.C.C., 5/6. Ditto 20 kV., 9/6; 100 pf. to 500 pf. Micas, 6d.; Tubular 500 v. .001 to 0.1 mfd., 9d.; .05 .1 1/-; .25 1/6; .5 1/9; .1/350v., 9d.: 0.1 mfd., 2,000 v., 3/6; 0.01 mfd., 2,000 v. 1/9.
CERAMIC CONDS. 500 v. .3 pf. to .01 mfd., 9d.
SILVER MICA CONDENSERS. 10% 5 pf. to 500 pf.. 1/-; 600 pf. to 3,000 pf. 1/3.
CLOSE TOLERANCE (±1pf.) 1.5 pf. to 47 pf., 1/6. DITTO 1% 50 pf. to 815 pf 1/9; 1,000 pf. to 5,000 pf., 2/-.

NEW ELECTROLYTICS. FAMOUS MAKES.

TUBULAR		TUBULAR		CAN TYPES	
1/350 v.	2/-	64/350 v.	5/6	8/500 v.	3/-
2/450 v.	2/3	100/25 v.	2/-	16/500 v.	4/-
4/450 v.	2/3	250/25 v.	2/6	32/350 v.	4/-
8/450 v.	2/3	500/12 v.	3/-	100/270 v.	5/6
8/500 v	2/9	8+8/450 v.	4/6	2,500/3 v.	4/-
16/450 v.	3/6	8+8/500 v.	5/-	6,000/6 v.	5/-
16/500 v.	4/-	8+16/450 v.	5/-	8+16/500 v.	7/-
32/450 v.	5/6	8+16/500 v.	5/6	32+32/350 v.	4/6
25/25 v.	1/9	16+16/450 v.	5/6	50+50/350 v.	7/-
50/25 v.	2/-	16+16/500 v.	5/-	64+120/350 v.	11/6
50/50 v.	2/-	32+32/350v.	4/6	100+200/275 v.	12/6

FULL WAVE BRIDGE SELENIUM RECTIFIERS. 2, 6 or 12 v. 1½ amp., 8/9; 2 a., 11/3; 4 a. 17/6.
CHARGER TRANSFORMERS. Tapped input 200/250 v. for charging at 2, 6 or 12 v. 1½ a., 15/6; 2 a., 17/6; 4 a., 22/6. Charger circuit free. AMPMETERS, 4 a. and 5 a., 14/6.

All boxed VALVES 90 day guarantee

1R5	8/6	6L6G	10/6	EA50	1/6	EZ81	11/6
1S5	8/6	6N7M	7/6	EABC80	10/6	E1148	1/6
1T4	8/6	6Q7G	10/6	EB91	6/6	HABC80	12/6
2X2	2/6	6SA7	10/6	EBC33	8/6	HVR2A	7/6
3S4	8/6	6SJ7M	10/6	EBC41	10/6	MU14	10/6
3V4	8/6	6SN7	10/6	EBF80	10/6	P61	6/6
5U4	8/6	6V6G	7/6	ECC84	12/6	PCC84	12/6
5Y3	8/6	6X4	7/6	ECF80	11/6	PCF80	11/6
5Z4	10/6	6X5	7/6	ECF82	11/6	PCF82	11/6
6AM6	8/6	787	10/6	ECH42	10/6	PCL82	11/6
6BE6	7/6	12AH8	10/6	ECL82	12/6	PEN25	6/6
6BH6	10/6	12AT7	10/6	EF39	7/6	PL82	10/6
6BW6	10/6	12AU7	9/6	EF41	10/6	PY80	10/6
6D6	7/6	12AX7	9/6	EF50	5/6	PY81	10/6
6F6	7/6	12BE6	9/6	EF50	8/6	PY82	10/6
6H6	3/6	12K7	8/6	Sylv.		SP61	5/6
6J5	6/6	12Q7	8/6	EF80	10/6	UBC41	10/6
6J6	7/6	35L6	9/6	EF92	5/6	UCH42	10/6
6J7G	8/6	35Z4	9/6	EL32	5/6	UF41	10/6
6K6GT	6/6	80	10/6	EL84	10/6	UL41	10/6
6K7G	5/6	807	6/6	EZ40	10/6	UY41	10/6
6K8G	8/6	954	1/6	EZ80	9/6	U22	10/6

RADIO COMPONENT SPECIALISTS

OUR ONLY ADDRESS
337 WHITEHORSE RD., WEST CROYDON

THO. 1665. Buses 133 or 68. S.R. Stn. Selhurst. P. & P. 1/-, over £2 free. C.O.D. 1/6. (Export C.W.O. post extra.) (Wed. 1 p.m.). Catalogue 6d.

GEIGER COUNTERS—BRAND NEW

LIGHT — ROBUST — RELIABLE

Ratemeter 1048A (currently in use at Harwell Nuclionics Div.) designed to detect and measure variations in gamma-ray intensity such as concentrations of radio-active minerals and estimates of uranium and thorium content of geological specimens. The radiation detector is a G.104 low voltage Geiger Müller tube, which has an effective cathode area of approx. 90 sq. CMS and triggered at a rate of about 90 per minute by cosmic and gamma rays emitted by radio active potassium and minute traces of uranium and thorium in ordinary soil and rock, the readings being measured on a 50 microamp meter. The electronic amplifying circuits employ cold cathode trigger valves. Working battery life is approx. 2,000 hours. Instrument is housed in a tough plastic case and hermetically sealed and all components, etc., have been I.S.C. Tech. C. approved. Size 8¾ x 8 x 3½in., weight 6½lb., supplied with canvas carrying case. Fully guaranteed.

ONLY **£7.10.0** P. & P. 7/6.

LEAD ACID ACCUMULATORS (unspillable). 2 volts 16 A.H. Ideal for 6 volts and 12 volts supply. Brand new original cartons. Size 4in. x 7in. x 2in. **5/6** each. P. & P. 1/6
3 for 15/- P. & P. 3/6
6 for 27/6 P. & P. 5/–

12 VOLTS 10 WATT AMPLIFIER. Complete with internal dynamotor. 2-6L6s push-pull, 2-6N7. Incorporating mike and gram inputs, speaker outputs, tone and volume controls. Size 12½ x 6½ x 8in. Sprung mounted. ONLY £8/10/-. Carr. 10/-.

RECTIFIER BARGAINS. Mains (doubler) 300 volts per section at 120 M.A. 5/- each. P.P. 1/6. Two (full wave) for 8/-. P.P. 2/-.

CONTROL BOX B.C.602. Complete push-button control box. 4 position and on/off, with dual coloured indicators for instant channel check. In black crackle case 5½in. x 3½in. x 1¾in. Bargain price 5/- each. P. & P. 1/6. Two for 8/-. P. & P. 2/6.

VIBRATOR PACKS. 12 volt input 300 volts output at 150 mA. consists of 12 volt vibrator, 4 metal rectifiers, chokes and smoothing condensers. ONLY 25/-, carriage 7/6.

Also 6 v. input 230 v. output at 100 mA, complete 4-pin vibrator, OZ4 rectifier. Fully smoothed 25/- each. P. & P. 3/6.

WESTINGHOUSE J.50 PENCIL RECTIFIERS. 500 v. 5 mA., 3/6. P. & P. 1/-.

MICROPHONES — BRAND NEW. Throat magnetic, 4/6; No. 8 carbon with switch, 6/6; No. 7 moving coil, 8/6.

SOLDERING IRON. Instrument type 230 to 250 volt A.C. 25 W. with neon indicator. Only 16/6. P. & P. 1/6.

SPECIAL VALVES. 813 70/-; 829 30/-; 832 35/-; 866A 13/6.

WESTON 1 AMP. H.F. METERS. 2in. circular. Brand new, 5/6. P. & P. 1/-.

T.C.S. RECEIVER 1.5 to 12 Mc/s. 7 valve super-het, built like a dream. 12SK7-R.F., 12SA7 Mixer, 12A6 Oscillator, 12SQ7 Detector, AVC- BFO- 1st AF, 12SK7-I.F.s. The 12A6 final puts 1.4 watts into 500 ohms with an input modulated only 30%. Panel controls: R.F. Gain, A.F. Gain, CW pitch, band-switch, mod-CW switch, power switch, ground and aerial posts, MO or crystal frequency switch, speaker jack, card holder to log 30 stations, hand vernier tuning knob turning a large etched calibrated plate behind hair lined window, anti back lash gears used. Excellent condition. £8/10/-. Carr. 15/-.

H.R.O. SENIOR RECEIVERS

Total frequency coverage is 50 Kc/s-30 Mc/s, obtained by inserting coil sets of which 4 sets are supplied with every receiver. Incorporates 9 valves, 2 R.F., 2 I.F. and 2 audio amplifiers. Crystal gate with crystal phasing control. Variable selectivity. Effective tuning scale of 12 feet. R.F. and L.F. gain controls. Signal strength meter. B.F.O. on/off and pitch control. H.T. and "S" meter on/off switch. Phone jack and loudspeaker terminals. Black crackle cabinet. 17½in. x 9in. x 12in. deep. Fully tested and guaranteed. Complete with 110 volt or 6 volt (state which preferred) power pack.

ONLY .... £16.19.6 Carr. 20/6.

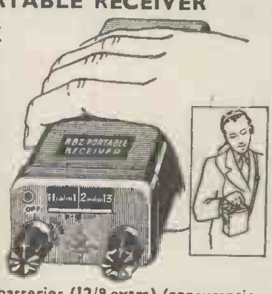
WIRELESS STATION NO. 19

Complete station comprising Transmitter/Receiver 2-8 Mc/s. 12 v. supply unit, Aerial, Variometer, control box, headphones, microphone and all leads, circuit and instruction book.

S.A.E. for full details .... £9 Carr. 20/-.

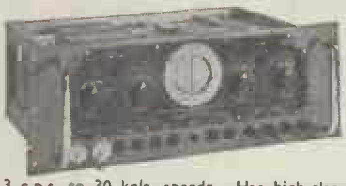
R.B.Z. PORTABLE RECEIVER

Covering 5 to 13 Mc/s. The most compact receiver ever produced for the U.S. forces. Only 9in. x 2¾in. x 1¾in. weighing 30 oz. 5 valve permeability tuned super het receiver. (2)—I.T.4 (1)—I.R.5. (1)—I.S.5. (1)—I.L.4. On/off gain and frequency controls. Supplied complete with headphones, aerial, matching battery container, canvas carrying case with strap, and 55-page instruction book. Operates from standard dry batteries (12/8 extra) (consumption 5.5 mA). Brand new in original cartons. Fully guaranteed and ready for immediate operation.



ONLY ....£5 P. & P. 5/-.

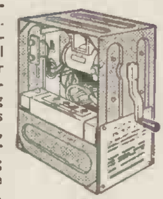
COSSOR OSCILLOSCOPE



A truly magnificent first-grade L.F. oscilloscope incorporating a hard valve time base, speeds 1–5–40 milliseconds, easily extended for a few shillings to 3 c.p.s. to 30 kc/s. speeds. Has high-class amplifier with fine and coarse gain controls. Brightness and focus controls, X & Y shifts. 115 v. and 230 v. mains power pack fully fuse protected. Employs 2¾in. tube ACR 10. Size 19in. x 7in. x 12in. Only 28 in stock so first come first served. Genuinely cost £59 each.

OUR PRICE .... £14 Carr. 15/-.

POWER SUPPLY UNIT No. 5. Contains Hand Generator giving 6 v. output with overload cut-out, ideal to boost a flat car battery; 6 volt Vibrator Pack giving 3 volts and 150 volts with output leads, plugs, etc., for Army 38 and 18 sets; battery box for three 2 v. accumulators. This is a fully portable and multi-purpose power supply unit. BRAND NEW. ONLY 30/- carr. paid.



PYE 10in. EXTN. SPEAKER. 3Ω in magnificent oak cabinet. Complete with 36ft. lead and plug. Ideal for Hi Fi and stereo. Brand new, 45/-. Carr. 5/-.

HEADPHONES — BRAND NEW. American chamois padded moving coil 100 ohms, 25/-. U.S.A. lightweight. Type H.S.30, 15/-. Dynamic D.L.R.5, 8/6. Low resistance 120 ohms 6/6. P. & P. 1/6 on each.

TRANSMITTER B.C.625. Covering 100 to 156 Mc/s. 4-channel crystal controlled, using 6G6 osc., 12A6 harm. ampl. 832 harm. ampl. and driver, and 832 R.F. output plate—modulated by P–P 12A6s which are transformer coupled to 6SJ7 speech amp. Supplied with circuits and operating gen. Only 25/-. P. & P. 5/-.

HOOVER ROTARY TRANSFORMER. 11.5 v. input, 490 v. output and 6 v. input 230 v. output at 65 mA. 27/6.

AERIAL VARIOMETERS. These magnificent instruments will enable you to receive maximum signal strength on all Short Wave receivers. Precision calibrated control. Complete with connection details. 12/6. P. & P. 2/6.

ARMOUR RECORDING WIRE. U.S.A. top quality on original reels, length 3,700 yd. 8/6. P. & P. 1/6.

POCKET VOLT TEST METER. Two D.C. ranges 0–250 v. and 0–15 v. Complete with test prods. Brand new. Very limited quantity. ONLY 10/6. P. & P. 1/6.

TEST SET 16/APN. Used for alignment and calibration of Altimeters. Has internal vibrator supply. Audio Generator 60–1,200 cycles, cavity tuned wavemeter 400–460 Mc/s. Complete with 6 valves, 1 mA Meter and all cables. A very fine instrument. ONLY 40/-. Carr. 10/-.

CANADIAN TELEPHONE SETS

Latest release! Brand new fully portable telephones with built-in hand generator, ringing device, hand telephone, morse key, buzzer and indicator lamp to give speech or morse reception over distances up to three miles by simply connecting twin wire and batteries to two sets. Housed in portable transit case 12 x 9 x 7½in. We offer two complete sets at the ridiculous price of only 60/- plus carriage 10/-.

Relda Radio Ltd.

87, TOTTENHAM CT. RD., LONDON, W.1.
32A, COPTIC STREET, LONDON, W.C.1.

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Send 1/- (plus 3d. post.) Now For Our **TERRIFIC** Catalogue

BUY IT FROM LONDON'S LEADING STOCKISTS

ESTABLISHED 1943

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Special Offer 1

MAINS TRANSFORMER
550-0-550 v., 150-200 mA., 6 v. 3 a., 4 v. 3 a., 100 and 200 v. primary **30/-**

Special Offer 2

MAINS TRANSFORMER
350-310-p-310-350 v., 220 mA., 6.7 v. 5 a., 6.3 v. 3 a., 6.3 v. 1 a., 5 v. 3 a., 6. v. 3 a., 6.3 v. 1 a. Potted 50/-

CHOKES
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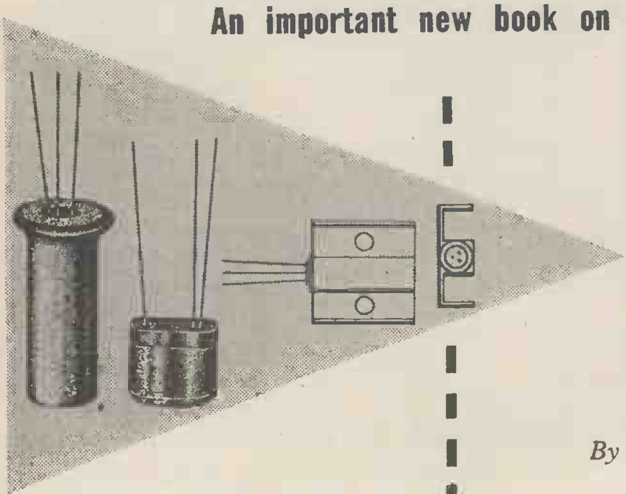

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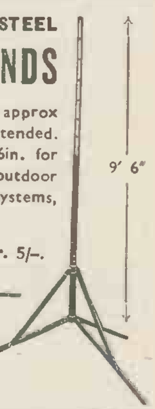

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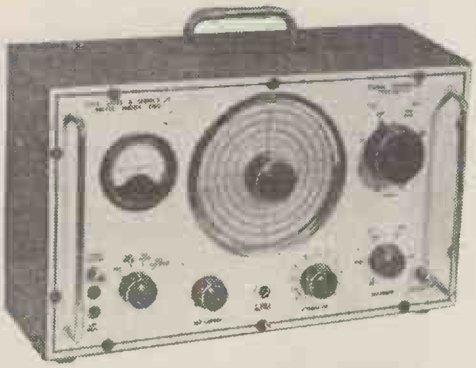

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Known in the U.S.A. as a "Transtat," these are high-quality, heavy-duty units of unusual construction with twin large-contact-area carbon bushes traversing the exposed twin windings carried on separate robust cores to vary the output over 75 to 120 volts. In neat black crackle box with helical traversing gear. Input 115 v. 400 c/s. Maximum current 6 amps.

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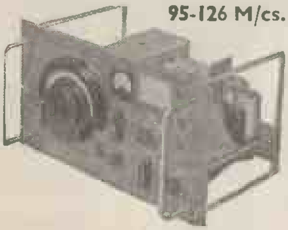

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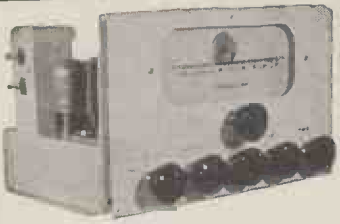

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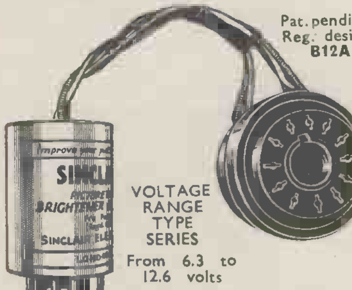

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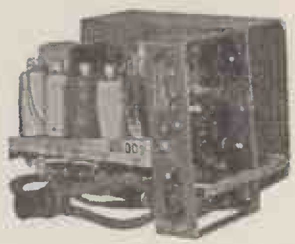

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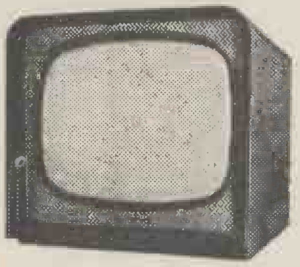

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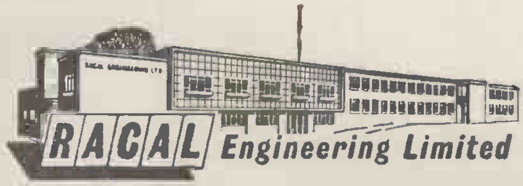

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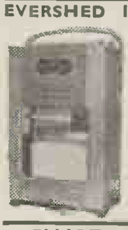

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TS-13 SIGNAL GENERATOR WITH SELF-CONTAINED WAVEMETER AND POWER MONITOR. Range 9305 to 9445 Mc/s. Internal pulsing. Peak Power output 50 microwatts.

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AM/FM stereo chassis, 6w output, only £20. —Bel Sound Products, Marlborough Yard, N.19. [0182

AM/FM radiogram chassis sep. B. & T., 6 valves, £10; Mullard 20-watt amplifier, complete BVA valves, £10; 10-watt Hi-fi amplifier, £10; 10-watt amplifier incl. pre-amp., cover and carrying handle, twin input, 2v/c A.C., £14.—Hardaker & Co., 300, Kensington St., Bradford, 8, Yorkshire. [8411

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MODERN American communication receiver, superhet, for 2 meters; also all-band mobile outfit, Elmac, etc.—Box 2121. [8402

HRO Rx's, etc., AR88, CR100, BRT400, G209, S640, etc., etc., in tock.—R. T. & I. Service, Ashville Old Hall, Ashville Rd., London, E.11. Ley. 4986. [0053

AMERICAN equipment, brand new and inexpensive, receivers Bendix RA10, Command R28/ARC5, R3/ARR2X, Loran APN4, R7/APS2 radar, etc.—List from Jasper, 42, West Bar, Sheffield, 3. [8420

PHILIPS model 704A 20in projection TV turret tuner, £12/10; Sonobuoy with mains unit, £6; Denco FM tuner kit, £4; Ferguson FM/AM tuner, £6/10; Mullard optical unit, £2/10.—Hall, 24, Nevern Mansions, Warwick Rd., S.W.5. Fremantle 9631. [8413

JASON F.M. Tuner, £10; Ever Ready portable, £8; 7w. stereo Amp., 2 speakers, £10; 4-speed mixer changer with stereo cartridge, £9; multi-range testmeter, 25/-; crystal mic., 25/-; 12in P.M. 8 tweeter in cabinet, 95/-; 3w. amp., ideal stereo, £3.—Box 2240. [8419

TV RECEIVERS—SURPLUS AND SECONDHAND

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MARCONI Q magnification meter, excellent condition, complete with coils, in perfect and accurate working condition; offers.—Box 1831. [8376

FOR sale: B.C.221 and calibration book, impedance bridge, type 2, 10.SB/253, 1155 and power pack, test set type 210 A.M. 10S/16002; signal generator, type 30.10S/65.—Box No. 2202. [8409

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TAPE decks: Wearite, Brenell, Truvox, Bradmatic, Dulci-Harting. Amplifiers and tuners: Leak, Quad, R.C.A., Dynatron, and Dulci. Microphones: Resio, Lustraphone, Philips, Acos, Grampian, etc. All tapes and accessories. Audio service department and recording studio. HIRE purchase facilities available.
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OUR April recommendation, a Unimixer, 3-way mixing unit, see p. 197, to go with the tape recorder you buy from us.—Sound News. [0131

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FOR SALE AND WANTED ADVERTISEMENT FORM TURN TO PAGE No. 197

GRAMOPHONE AND SOUND EQUIPMENT—SURPLUS AND SECONDHAND

ONLY from us! Famous make stick mike, listed 5gns., only £2/14; save 15/- on 7in. L.P. Geveart tape, 35/-; 5in L.P. Geveart, listed 28/-. only 19/6; 7in. 1,200ft. Ferotape. ex-M.O.S., listed 42/-, only 25/-; 5¾in. 250ft. for Grundig, etc., 19/6; many other tape bargains—our list will save you ££'s! Outstanding secondhand tape recorder bargains from Ferrograph to Walter; all new recorders supplied; we buy for cash or exchange recorders, Hi-fi equipment, radios, cameras, etc; specialist repair service.—E. C. Kingsley & Co., 132, Tottenham Court Rd., London, W.1. Eus. 6500. [0320

TAPE RECORDING, ETC.

RENDEZVOUS RECORDS offer comprehensive 78/LP tape to disc recording facilities. —Leaflet from 19, Blackfriars St., Manchester. 3. [8168

TAPE to film . . . film to tape . . . your 16mm film striped and recorded.—Edric Films, Ltd., 34/36 Oak Tree End Way, Gerrards Cross, Bucks. (Tel. Gerrards Cross 2908.) [0124

TAPE to disc service, brand new cutting equipment, all speeds: 45s-78s and L.P.s. satisfaction guaranteed; keenest prices; s.a.e. for full details.—Sunderland Sound Services, 28, Viewforth Terrace, Fulwell, Sunderland. Tel. 57032. [8282

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WANTED, BC610 Hallicrafters, ET.4336 transmitters, BC312 receivers, BC221 frequency meters and spare parts for all above; best cash prices.—P.C.A. Radio, Beavor Lane, Hammersmith, W.6. [0079

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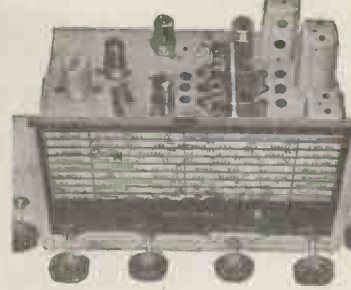

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APPLICATIONS are invited for the post of Electronic Engineer (Senior Technician grade) in the newly established Medical Research Council Neuropharmacology Research Group at the Medical School, Birmingham. The person appointed will be required to repair and maintain electrophysiological and to develop and construct electronic equipment for use in research projects. Starting salary will be dependent on qualifications and previous experience.—Applications, in writing, to The Director, Neuropharmacology Research Group, The Medical School, Birmingham, 15, from whom further particulars may be obtained. [8320

ELECTRONICS Engineer.

MAJOR British engineering concern in Sudan requires Electronics Engineer, preferably sing.e, with previous experience in undertaking the installation and servicing of electro-acoustic, electro-medical and radio-telecommunication apparatus; he will also be responsible for training Sudanese mechanics and supervising the activities of a workshop engaged in servicing radios, tape recorders, etc; the position offers commercial opportunities with commensurate promotion and prospects; free passage, annual home leave after first two-year contract, free accommodation, contributory pension scheme.—Write Staff Manager, Gellatly, Hankey & Co., Ltd., Dixon House, 1, Lloyds Ave., London, E.C.3. [8389

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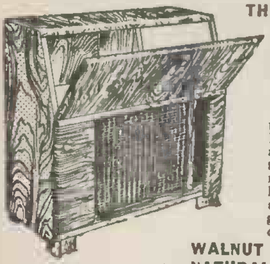

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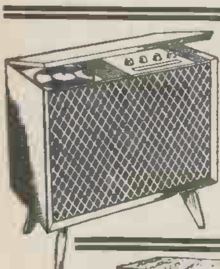

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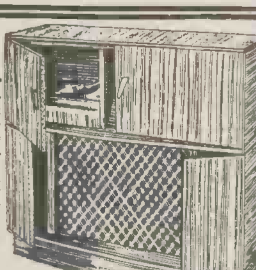

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This cabinet can accommodate almost any combination of Radio-Feeder Amplifier Control, Motor Units and Loudspeaker System. There is ample storage space. Available in finest walnut or mahogany veneer and polished. Has pneumatic lid stay and castors.

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(B) Cinema Technician (M3C/49952/WF).

SALARY scale (including inducement addition) for post (A) is £810 rising to £1,716 a year, and for post (B) £810 rising to £1,530 a year. Commencing salary according to experience. Clothing allowance £45. Gratuity at rate £100/£150 a year. Free passages for officer and wife. Assistance towards cost of children's passages and grant up to £288 annually. Liberal leave on full salary. Candidates for post (A) must be capable of taking charge of the maintenance and repair of (i) mobile cinema vans and all equipment therein, and (ii) public address equipment. They should have proved organising ability. Candidates for (B) must have had good practical experience of workshop procedure in all types of mechanical and electronic repairs to 16mm Bell & Howell sound projectors and public address equipment. They must also be fully conversant with all types of test equipment to carry out such repairs. Knowledge of working of generators an advantage.

WRITE to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote the reference shown against the desired post. [8417

"A" licensed radio engineer required; good salary.—Apply Chief Engineer, Morton Engineering Services, Ltd., Croydon Airport, Surrey. [0251

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A GOOD understanding of radar systems and circuitry is essential for staff positions offering salaries up to £850.
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TELEVISION engineers first-class, experienced men required immediately for field service; competence and efficiency will be rewarded with a salary in the range of £700-£950 p.a., and a permanent position.—Apply at once to The Secretary, Leytonia Radio, Ltd., Head Office, 784-8, High Rd., Leyton, E.10. [8375

ELECTRONIC engineer with electro-mechanical background reqd. by an expanding company to apply experience in field of airborne transmission systems; substantial four figure salary offered to a versatile man.—Write details to Personnel Manager, Vactric (Control Equipment), Ltd., 19-21, Brunel Rd., London, W.3. [8414

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GRADUATE radio engineer possessing flair for editorial work required by leading journal, good command of English essential, interesting position with good prospects open to successful candidate between ages 22-30; salary about £650+ per annum, according to qualifications and experience.—Applications, in confidence, to Box 1826. [8377

LABORATORY assistant required for lab. engaged on the development of electrical components; test room routine and experience of workshop practice desirable; excellent prospects for advancement, in expanding company.—Rivlin Instruments, Ltd., Doman Road, Yorktown Industrial Estate, Camberley, Surrey. Tel. Camberley 2507/2508. [8372

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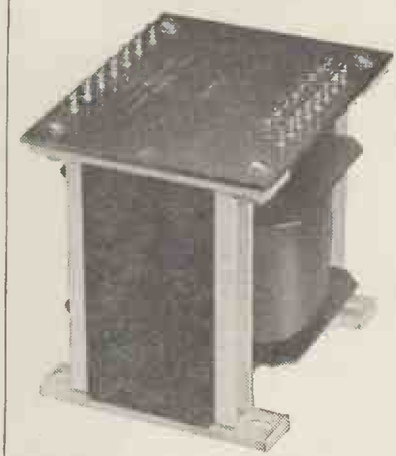

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OVERSEAS.—Oil Exploration Company with world-wide seismic parties offers permanent career to electronic technicians; maintaining and operating field equipment; men prepared to accept responsibility and to live in camp conditions, academic qualifications to H.N.C. or equivalent essential and genuine practical experience to this standard; liberal home leave. —Box 6478. [0331

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A. B. METAL PRODUCTS, Ltd., require additional technical respresentatives for their Special Component Products Division; it is essential that applicants should have good connections in the Instrumentation and Electronics field; write stating qualifications and experience to The Sales Manager, 17, Stratton St., London, W.1. or telephone for interview Grosvenor 7131. [5388

PHILIPS ELECTRICAL, Ltd., (Medical X-ray Division) require Engineers for the service and installation of X-ray equipment. Experience in this field desirable but candidates with O.N.C. (electrical) or electronics experience would be considered for training; applications giving full details should be addressed to the Personnel Officer, Philips Electrical, Ltd. (Medical X-ray Division), 45, Nightingale Lane, Balham, S.W.12. [8386

A MODERN factory on the North East coast requires a development engineer; preference will be given to men who have attained H.N.C. standard and had experience on the design of electronic equipment suitable for mass production.—Write in confidence giving full details of age, qualifications and experience to the Personnel Manager, British Ferrograph Recorder Co., Ltd., Simonside Works, South Shields. [8367

ELECTRO-MECHANICAL engineer to design and carry through to production, small electrical components; adequate technical knowledge together with a practical outlook and the ability to get things done; opportunity to make substantial contribution to the expansion of a growing company wih generous financial reward.—Rivlin Instruments, Ltd., Doman Road, Yorktown Industrial Estate, Camberley, Surrey. Tel. Camberley 2507/2508. [8373

A PHYSICIST or engineer is required for development work on a wide range of acoustic problems including ultrasonic pulse transducers, electro-acoustic filters and ultrasonic flaw detection, the applicant must have a good academic record and a thorough background of experience in this or allied fields; he must be capable of initiating work and carry it through without close supervision; a progressive salary will be paid and pension scheme is in operation.—Please send details immediately to Glass Developments, Ltd., Sudbourne Rd., S.W.2. [8391

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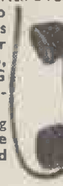

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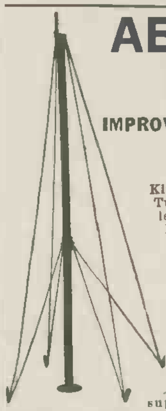

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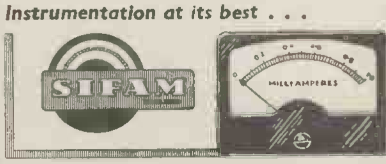

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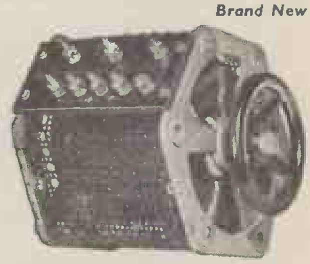

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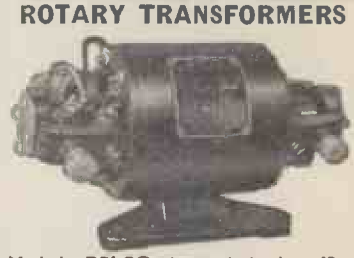

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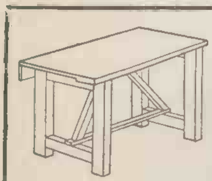

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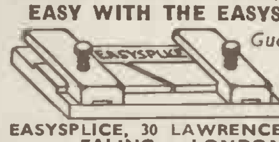

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