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Wireless World

ELECTRONICS, RADIO, TELEVISION

MARCH 1961

Managing Editor:

HUGH S. POCOCK, M.I.E.E.

Editor:

F. L. DEVEREUX, B.Sc.

Assistant Editor:

H. W. BARNARD

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VOLUME 67 No 3.

PRICE: TWO SHILLINGS

FIFTIETH YEAR
OF PUBLICATION

Iliffe Electrical Publications Ltd. *Managing Director:* H. S. Pocock, M.I.E.E.
Dorset House, Stamford Street, London, S.E.1

Please address to Editor, Advertisement Manager, or Publisher as appropriate

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PUBLISHED MONTHLY (4th Monday of preceding month) by ILIFFE ELECTRICAL PUBLICATIONS LTD., Dorset House Stamford Street, London, S.E.1. Telephone: Waterloo 3333 (65 lines). Telegrams: "Ethaworld, London-SEL." *Annual Subscriptions Home and Overseas*, £1 15s. 0d. *Canada and U.S.A.*, \$5.00. Second-class mail privileges authorized at New York, N.Y. BRANCE OFFICES: BIRMINGHAM: King Edward House, New Street. 2. Telephone: Midland 7191. COVENTRY: 8-10, Corporation Street Telephone: Coventry 25210. GLASGOW: 62, Buchanan Street, C.1. Telephone: Central 1265-6. MANCHESTER: 260, Deansgate, 3 Telephone: Blackfriars 4412. NEW YORK OFFICE: U.S.A.: 111, Broadway, 6. Telephone: Digby 9-1197.

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Television Standards—a World Problem ?

WHILE the Pilkington Committee collects evidence and behind closed doors sifts and digests the formidable mound of material which must by this time have accumulated, extra-mural arguments about the future of broadcasting, and in particular television in the U.K., pursue their inconclusive course.

The R.I.C. has now said that we should not change from 405 lines. We agree and have already given our reasons both at the time some of the European stations were changing to 625 and again last July when commenting on the T.A.C. Report.

The I.T.A. says we *should* change to 625 lines, but not yet. The best time to change, it says, would be when the country is adequately covered by a three-programme service on 405 lines in Bands I and III and "everything would be running smoothly and easily." After duplication of all three services on 625 lines in Bands IV and V the 405 lines services would cease, after an interim period of duplication. This would have the advantage of avoiding the need for dual-standard receivers, but, as the I.T.A. statement says, it does not "avoid the absurdity that, if we change the national line system, we must approach the point at which we have emptied our best television frequencies in Bands I and III of all television."

The B.B.C. disagrees in detail, but not in principle as far as line standards are concerned. It would like to see the uncommitted channels in Band III used to extend the area covered by the existing 405-line B.B.C. and I.T.A. programmes, and four programmes established on 625 lines in Bands IV and V to duplicate existing services and to start new ones. Like the I.T.A. proposals this would enable a changeover to be made without dual-standard receivers, but would be just as wasteful of the available frequency spectrum over a long period.

Whatever the wishes of the corporations, authorities, manufacturers and dealers may be it is the needs of the home viewer which should ultimately prevail. Is he dissatisfied with television because the picture quality is inadequate, and if so is this due to too few lines? 819 and 625 lines obviously give better resolution than 405 lines, but in a talk, say, on the finer points of Nottingham lace the disadvantage of the 405-line system can quite easily be overcome by moving the camera a little closer. Does the line structure distract when the picture size is too large? It always will. The remedies in order of

cost are to be satisfied with a smaller tube, to use optical or electronic methods of elongating the spot or to go to colour, in which the interstices between lines are very conveniently filled.

Is the variety of television programmes restricted because of the difficulty of international exchange, and if so will a change to 625 lines result in any significant increase in the amount of fresh material? Taking a near-sighted view there would be an immediate improvement in the facility of exchange with those countries which use the currently popular 625-line standard (but not Belgium where positive modulation and a.m. sound are used). There would also be an improvement in picture quality compared with off-the-tube standards conversion (though this is quite acceptable, even with present-day methods, which may be expected to improve).

But by the time we can be overtaken by a possible change in line standards the whole outlook will have been radically changed by satellite communications and the possibility of programme exchange not only with Europe and Asia but with the Americas. Standards conversion will then still be necessary, for it is extremely unlikely that America will change from 525-lines; still less that it will change its power supplies from 60 to 50c/s in order to standardize the television field frequency.

The convenience of a common standard is desirable when the immediacy of a transmission is important, i.e. when the exchange is made in "real time" as it would be expressed in computer jargon; but it is not *essential*, and parallel camera systems and links could be used to supply pictures on several standards if the occasion warranted it. When the transmission is over long east-west distances "real time" has its disadvantages as listeners to "big-fight" commentaries in the early hours already know. If a delay of an hour or two is permissible or even desirable, then fast jet aircraft and magnetic tape recording will fill the bill, and before colour comes in these methods may well be superior to either standards conversion or long distance relays with their phase distortion problems.

Against the background of developments which are already upon us the 405/625 squabble seems to us to be quite insignificant. Let us sit tight and look beyond our noses before we move from our present position. Nibbling at this problem will do much damage and little good.



Physical Society Exhibition

NEW ELECTRONIC EQUIPMENT AND TECHNIQUES

WHILE much pure research was exhibited, the accent this year was on over-the-counter equipment. Much more thought is being devoted to the presentation of measurement readings, and performance claims generally are much tighter. Electronics is penetrating further and further into the medical laboratory, and reliability is now a *sine qua non*.

Overcrowding was once again a cause for complaint and one questions the necessity for sales staff rather than engineers to be in attendance on the stands.

TEST AND MEASUREMENT

THE invasion by the transistor of fields of circuit design formerly dominated by the thermionic valve continues apace, particularly in equipment employing switching circuits, such as high-speed counters. More attention is being paid to the appearance of equipment and "ergonomics" (the relationship of men and machines) is playing a greater part in the panel layout of recently-designed instrumentation.

Voltage and Current Measurement.

An extremely sensitive d.c. valve millivoltmeter was shown by Marconi Instruments. The Marconi TF1093 was designed primarily as a pH meter, but is equally suitable for use as a millivoltmeter over the range 0-1400pH. Extreme stability with wide changes in supply voltage, is, to some extent, due to the use of a valve-controlled transductor which holds constant the current through the primary of the mains transformer.

A change of 15% in mains voltage results in a change of only 0.2% in pH or millivolts reading. The transductor has the advantage that, unlike a saturated reactor, it is not dependent on mains frequency.

The General Radiological type N138 is capable of measuring currents as small as 10^{-13} A. The input current is applied to an extremely high value feedback resistor which is connected between the grid of the electrometer input stage and a

cathode-follower output. The amplifier maintains the input end of the feedback resistor at "virtual earth," so that the output of the amplifier is equal to the voltage across the resistor. The impedance at the output end of the resistor is that of the cathode-follower, and is sufficiently low to allow the use of a moving-coil meter. Stability with mains variations is obtained by the use of a constant-voltage transformer to feed the valve heaters. As the instrument is intended for use with ionization chambers, a polarizing voltage is provided as an output.

In the Tinsley type 5401 Automatic Potentiometer, the circuit is self-balancing, and is controlled by a pulse generator, the frequency of which is set by the error voltage obtained from a photocell galvanometer amplifier. The potentiometer

adjusts to within the nearest (lower) $10\mu\text{V}$, the setting being indicated on a four-figure in-line read-out. The remainder, up to $10\mu\text{V}$, is shown by a drum recorder, which enables very small variations to be observed directly.

A true r.m.s. voltmeter was shown on the stand of the National Research Development Corporation. The unknown input, in the range d.c.-30Mc/s, is applied to a bridge rectifier, the output of which is fed, via an emitter-follower, to a square-law detector composed of point-contact diodes. The instantaneous current value at the output of the detector is now proportional to the square of the input voltage. This output is fed to an R-C network which derives the mean value of the current. A further chain of diodes now perform a reversal of the process occurring in the detector, the output being proportional to the square root of the mean current, or the root-mean-square of the input voltage. The overall transfer characteristic is linear and the output may be measured on a digital voltmeter. As the law of a diode does not change with temperature, but only the ratio of current to voltage, any temperature changes in the two sets of diodes cancel out and the scale remains linear.

Digital measurement of direct voltages is facilitated by the Racal Voltage-to-Frequency convertor SA503. When a varying voltage is applied to a junction diode, the width of its depletion layer and hence its capacitance, varies accordingly; if the diode is in an oscillator circuit, the frequency will then vary in proportion to the d.c. voltage. In this instrument, the outputs of a fixed oscillator and of a voltage-variable one are mixed, the output of the mixer being zero when the input is short circuited, and 10kc/s when 1V d.c. is applied. The output is shaped into pulses which may be counted.

Frequency Measurement. A high proportion of frequency meters are

digital in form and employ transistor counting decades with an upper speed limit of 10Mc/s, although the Airmec 298 will count at speeds up to 20Mc/s.

A novel design is the Venner TSA3338. This is basically a 1Mc/s counter with the usual gating facilities. However, the input is frequency-changed in two mixing stages down to 1Mc/s or less. Both internal oscillators are crystal-controlled, and are varied in frequency automatically by a stepping-switch until the final difference frequency lies within the range of the counter. The stepping-switch also indicates on the display which local oscillator frequency is in use; the whole measurement is, therefore, automatic and direct reading.

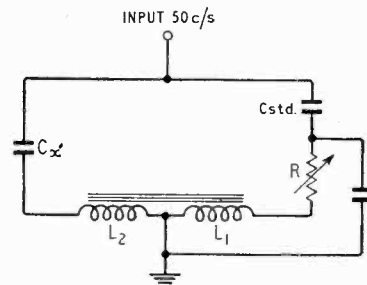
An ancillary unit for use with the Marconi 10Mc/s valve counter is the Decoder TF1392. This unit, with plug-in accessories, provides outputs, translated from the binary form of the decade outputs, which are suitable for the operation of printers, graphical pen recorders and an in-line read-out panel. The decoding process is effected by relay matrices operated by the decoder outputs via valve amplifiers.

Frequency Standards are in greater demand as development work on stable sources proceeds. One such standard is the 16kc/s GBR transmitter at Rugby, which is controlled by the MSF standard. Two exhibits, one a joint example by the N.P.L. and Post Office Engineering Departments, the other a "private enterprise" method adopted by Glass Developments (who are developing an ammonia maser and timing chain) demonstrated ways of comparing GBR with a local "standard."

The N.P.L. exhibit received the 16kc/s signal, multiplied it to 96kc/s and mixed it with a locally-generated 4kc/s, giving 92kc/s and 100kc/s. The 100kc/s signal was fed into a modulator-comparator driving indicating and recording instruments.

The Glass Developments comparator, on the other hand, received the 16kc/s signal, passed it through a gate to eliminate the beginning and end of the keyed pulses (which could give anomalous results), and fed it as brightness modulation to a c.r.t. The local 5Mc/s oscillator was divided down to 80kc/s, modified to produce quadrature (90° phase difference) signals and used as x and y deflection for the c.r.t., where it produced a rotating trace brightened once each cycle of GBR. If the relationship between the 5Mc/s signal and GBR changes this is displayed by a rotation of the spot produced on bright-up (the local timebase is then running "fast" or "slow"). One rotation of the bright-up in three hours represents an accuracy of 1 part in 10^9 so that smaller errors are easily observed.

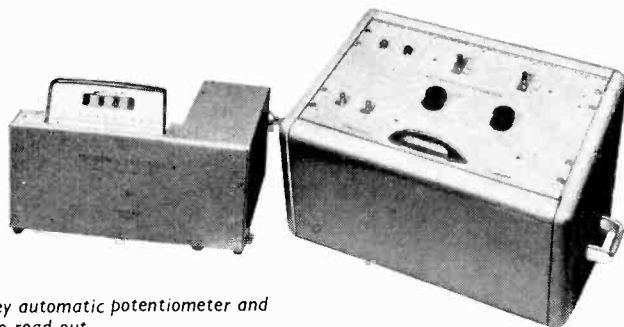
Inductance and Capacitance Measurement. Direct-reading of Q and inductance of iron-cored inductors, with or without direct current flowing is made possible by the Furzehill B810A Incremental Inductance Bridge. The internal measuring frequency is 50c/s, but the bridge is



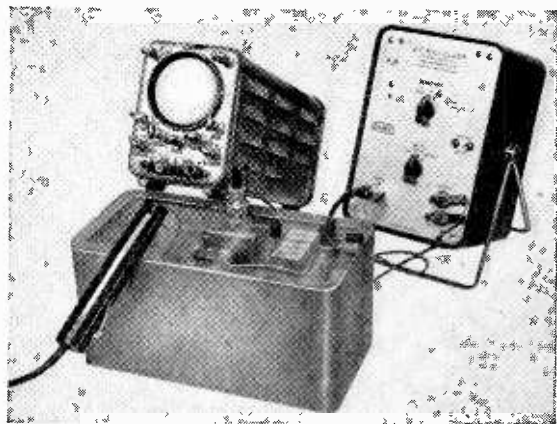
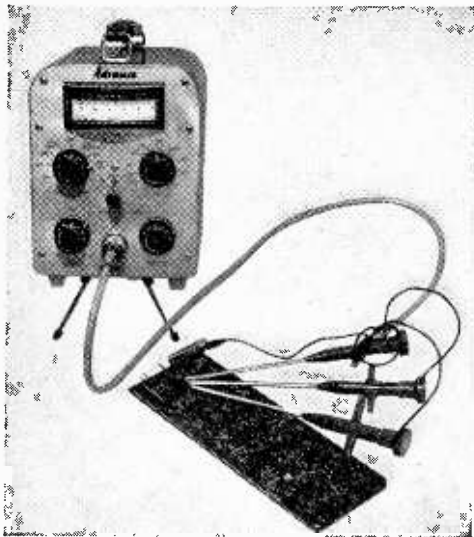
A.E.I. (Manchester) inductively coupled bridge for dielectric loss measurement.

designed to work with external excitation of frequencies between 25c/s and 3kc/s. The circuit is that of a Hay bridge, the standard capacitor being a high-quality polystyrene type. The null indicator is a logarithmic meter, facilitating rapid balancing by means of the reactance dial, which is calibrated in inductance, and the resistance balance control which is calibrated in resistance. Q is calculated from the bridge frequency and the resistance balance setting.

An inductively-coupled dielectric-loss bridge is described by A.E.I. Research, for the measurement of $\tan\delta$ in the range 0.0003 to 0.03. The bridge is balanced when the ampere-turns in L_1 are equal to those in L_2 , i.e., when C_x is equal to C_{std} , which is variable.



Tinsley automatic potentiometer and in-line read-out



Advance in situ transistor tester.

Dawe A.C. Milliclam and pick-up probe.

If the dielectric loss of C_x exceeds that of C_{std} , R is adjusted for balance. To obtain the value of R very precisely, a battery and metering circuit are connected across it. The current through R is held constant at 1mA, and the voltage is then proportional to $\tan\delta$.

The Fluxgate magnetometer elements shown on the stand of Kelvin-Hughes are a means of measuring the strength of a spatial magnetic field. Two wires of high permeability material are wound with excitation windings, through which sufficient alternating current is passed to cause partial saturation of the wires. The two wires, side by side, are also wound with a common secondary winding. E.m.f. induced in the secondary winding in the absence of a magnetic field is nil, as the two induced voltages are equal and opposite. However, if the Fluxgate is placed in a magnetic field, which has a component along its axis, the saturation of the two wires becomes asymmetrical, and an e.m.f. is induced in the secondary at twice the frequency of the wire excitation current. This e.m.f. is directly proportional to the magnetic field.

Square Wave and Pulse Generators. 100-V pulses with a rise time of less than one millimicrosecond are produced by the Cossor 1097. This is achieved by a high-pressure mercury relay, working at a frequency of 45-120 p.p.s. Pulse width is governed by the length of 52Ω coaxial cable used as the delay element, a socket being provided for this connection on the front panel. Alter-

natively, a CR network connected in place of the coaxial cable will produce a pulse width of $2.6\mu\text{sec}$. A button-operated switch provides a single pulse output.

Accuracy of pulse repetition frequency is a feature of the Fleming crystal-controlled pulse generator 1478A. The p.r.f. generator is a 100kc/s crystal oscillator, the output of which is divided to provide five switched repetition rates. The highest-speed divider is a trochotron magnetic beam-switching tube, the remainder being EIT tubes. Bursts of pulses, $2\mu\text{sec}$ wide and with a rise time of $0.1\mu\text{sec}$, are available, and a visual self-checking facility is provided.

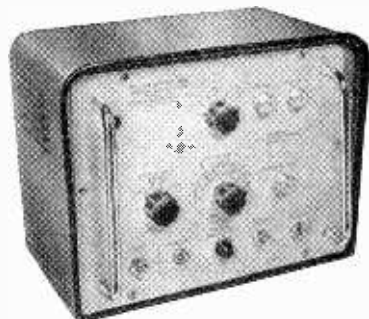
Oscilloscopes. The trend in oscilloscope design seems to be towards a basic instrument with a high potential performance, with facilities for a range of plug-in units designed to fulfil a specific function.

Two new plug-in units for use with the EMI WM16 oscilloscope extend the Y amplifier performance. Type 7/6 facilitates the viewing of two inputs either separately or algebraically added, the rise time being 16 millimicroseconds in each case. Type 7/5 increases the sensitivity of the Y amplifier to 5mV/cm maximum; the bandwidth is reduced, at the maximum gain setting, to 5c/s-25Mc/s (a.c.-coupled). The gain is continuously variable between attenuator settings on both units.

To extend the flexibility of their 1076 oscilloscope, Cossor have introduced several plug-in units. High gain and facilities for differential viewing of two channels are features

of the 1081 and 1080 respectively, while 1082 and 1083 enable the start of the timebase to be delayed with respect to the triggering pulse, or a "bright-up" spot to be superimposed on the trace to indicate the delay. The units contain, in effect, two timebases; the trigger pulse initiates the run-down of one, which, on reaching a predetermined level, triggers the second, which is the one that appears on the screen. Model 1082 will delay the sweep by 10 seconds maximum, while 1083 provides a calibrated, high precision delay up to 50msec. Model 1085 plug-in unit provides for dual-channel viewing by means of chopped or alternate sweeps.

Examination of current waveforms without the necessity for breaking the circuit is facilitated by the Dawe 618 A.C. Milliclam. The waveform-carrying conductor forms the primary of a transformer, the secondary of which is provided by the probe assembly winding. The output of the probe is fed to a transistor amplifier, the output of which may be



Cossor millimicrosecond pulse generator.

viewed on an oscilloscope. Currents of a few hundred μA may be measured at frequencies from 7c/s to 1Mc/s, and direct current up to 5 amperes has no effect on accuracy.

Pulse-Amplitude Analyser. When the absolute count rate obtained from a scintillation counter used in radioactive material studies is not required to be known accurately, the relatively low speed of operation and long "dead-time" of the conventional "kicksorter" can be a disadvantage. With this in mind the Atomic Energy Research Establishment have developed an electronic grey-wedge pulse-amplitude analyser.

The amplitude of each pulse at the output of the scintillation counter is proportional to the energy of the gamma ray producing it. The pulse is applied to the horizontal deflection system of an oscilloscope, where it deflects the spot an amount proportional to the energy of the gamma ray. The horizontal deflection is

held constant while the spot is deflected vertically by a sweep circuit; the brightness of the spot is meanwhile decreased linearly from bottom to top of the screen. The brightness of any part of the screen, which is governed by the relative spacing of successive vertical lines and the varying sweep brightness, is now a measure of the distribution of energy of the gamma rays, and a high contrast photograph will show a sharply defined density boundary.

Transistor Tester. Beta is directly obtained from the dial of the Advance TT1 Transistor Tester. Collector current is initially set to the required figure (indicated on the meter), after which an uncalibrated balance control is adjusted until the meter reads zero. Operation of a switch now changes the collector current by a fixed increment of 0.5mA, whereupon a calibrated bias control restores the balance. Current gain is read from this control.

DISPLAY DEVICES

THE last few years have seen the fairly widespread introduction of digital indicators in place of the cathode-ray tube and the meter.

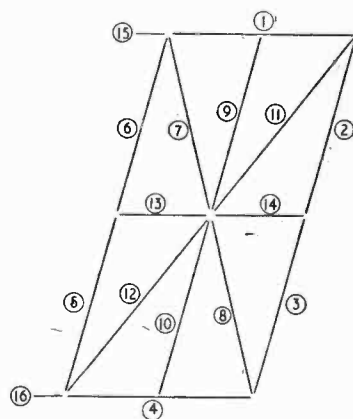
Digital Indicator (Type S.462) shown by Sangamo-Weston, is intended principally as a read-out indicator for transistor counting decades. It consists of a moving-coil meter movement with a transparency carrying the numerals 0-9 mounted on it. The transparency moves in an optical system and the numerals are projected on to a screen. Counter decade outputs may be mixed in a five-resistor network and applied to the movement to provide discrete steps corresponding to the number of input pulses received by the decade.

Electroluminescent Display for millimicrosecond pulses was shown by G. V. Planer. This consists in its simplest form of a row of electroluminescent areas connected in sequence to a delay line. When pulses are inserted from opposite ends of the line they travel towards each other producing, when and where they coincide, illumination of the phosphor. One example demonstrated had the delay line and row of "dots" folded up to form a rectangular panel: another application of a modification of this type could be used, for instance, for pro-

ducing a television type of display with two delay lines on the x and y axes.

Electroluminescence is also used in an arrangement by Ericsson to display any letter of the alphabet or figure. Sixteen strips of a luminescent panel called the Phosptron have individual connections and, by selecting the leads, fair representation of the desired letter or figure can be made: "5" for instance would use 1, 6, 13, 8, 4; similarly "R" would employ 1, 2, 14, 13, 6, 5 and 8.

Post-deflection Acceleration of the electron beam in a cathode-ray tube is often used to increase trace brightness without incurring the loss of sensitivity that would result from an increase of final-anode potential. P.d.a. can lead to trace distortion,

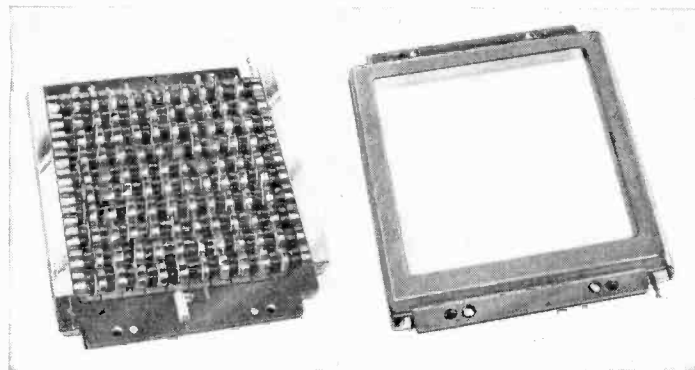


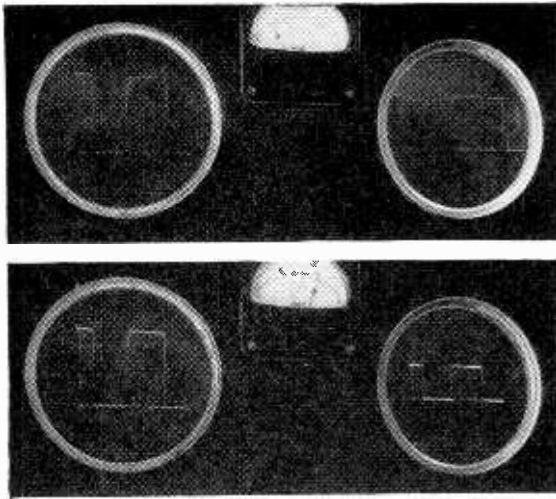
Simplified diagram of layout of Ericsson "Phosptron" electroluminescent letter and figure indicator.

though, and this limits the screen area. Interaction between the p.d.a. field and the deflection field is one cause of the distortion, and, to reduce this interaction 20th Century Electronics have introduced in their S5AB-800 tube an isolating mesh connected to the third anode and placed between the deflector plates and the screen: thus the p.d.a. field extends only to this mesh. G.E.C., in their experimental tube Type LD603, have placed a mesh about an inch behind the screen and the effect of this was demonstrated by the LD603 and an ordinary spiral p.d.a. tube, side by side, with the e.h.t. varying between four and 10kV. An increase in usable screen area of over two times is achieved.

C.R.T. Beam-blanking during time-base flyback is usually accomplished

Delay line coils (left) at back and screen (right) of millimicrosecond electroluminescent display by G. V. Planer.





G.E.C. LD603 c.r.t. (left) with p.d.a. mesh behind screen compared with ordinary p.d.a. tube (right) at 3kV e.h.t. (upper pair) and 10kV (lower), with same deflection waveforms. Note that lens action reduces image size on the ordinary tube (right) but not on the LD603.

by applying a brilliance-reducing potential to the cathode or grid. However, in a new c.r.t. by Sylvania-Thorn the beam can be extinguished by a blanking waveform at or near earth potential, a small deflection system between the first and second anodes. When the blanking potential is applied the beam is deflected out of line with the rest of the electrode structure and does not reach the screen.

Glass-fibre Face-plates for c.r.t.s may obviate the use of cameras for

the photography of traces, reducing the equipment needed to a light-tight box containing a roll of sensitive paper. Shown by Ferranti, the face-plate is made up of many axially-aligned fibres of glass of high refractive index in a support of low refractive index. The action of the fibres is to "pipe" the light produced at the phosphor to the front of the screen; then, to produce a sharp record, it is necessary only to hold a sheet of sensitized paper against the tube face. Normally this would give a blurred image.

COMPUTERS

ALTHOUGH few general trends in this field were noticeable, a number of new detailed developments were seen, for example in storage.

Prediction of the Future value of signals whose component frequencies have an upper maximum limit was demonstrated by Wayne Kerr. The prediction system is based on the fact that, if there is a maximum frequency present in a signal, there is also a maximum rate (depending on the signal amplitude) at which present changes in the signal can themselves alter. If frequencies only up to a certain maximum value are present in a signal, changes in the signal level which are being produced by these frequencies can then be extrapolated into the future with reasonable accuracy for a time equal to the reciprocal of pi times the maximum frequency. The possible time and amplitude errors in the predicted change increase with increasing frequency up to about 30% in amplitude and rather less in time at the maximum frequency. Since in many industrial processes the

maximum frequency in the measured quantities is limited by "inertia" to a low value, this system should be useful in process control.

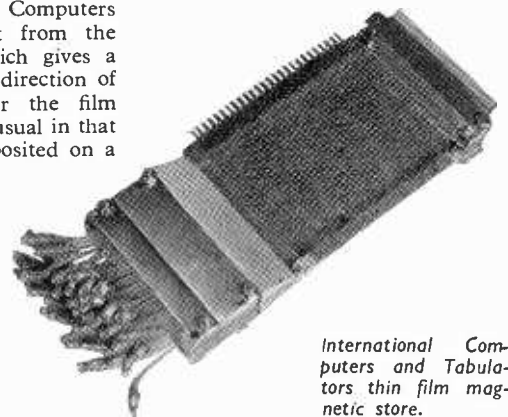
Magnetic Thin Film Computer Stores in an improved form were shown by International Computers and Tabulators. Apart from the use of a new alloy which gives a smaller variation of the direction of easy magnetization over the film area, these stores are unusual in that the magnetic film is deposited on a metallic (aluminium) rather than an insulating surface. It has been found that the write currents induce eddy currents in the aluminium which double the magnetic field produced in the film for a given write current. This effect can be used either

to improve the signal-to-noise ratio for a given write current or alternatively, to reduce the write current for a given signal-to-noise ratio.

By the use of two write fields at right angles rather than in parallel, the whole range of the B-H curves can be made use of rather than only their maximum values. This greatly reduces the tolerances which must be maintained on the write fields and currents. The use of two write fields at right angles also allows field strengths to be used which are well below the levels which produce gradual interference (walkdown) between adjacent areas of the film.

Multi-Track Heads for recording as many as forty tracks on $\frac{1}{4}$ -in wide magnetic tape were shown by the physics department of the Northern Polytechnic. Each head is made up of a number of close mica-spaced silver strips across the edges of which a very fine silver wire is soldered. This wire corresponds to the head "gap" and the head of each track consists of an adjacent pair of silver strips and the part of the silver wire between these strips.

Symbol Writing at High-speed on magnetic tape is possible by using a set of the multi-track heads shown by the physics department of the Northern Polytechnic and described immediately above. By making use of wedge-shaped heads with their thin ends across the tape, a number of such multi-track heads can be stacked together along the tape length. Letters can then be written in as magnetization of the tape by feeding a pulse to the appropriate heads and gaps to form the appropriate letter shape. Such magnetization can be made visible by passing the tape through an ultrasonically agitated suspension of fine iron powder. A writing speed as fast as



International Computers and Tabulators thin film magnetic store.

1 μ sec/symbol is possible by means of this method.

Tunnel Diode pair connected in series to form a sensitive current-amplitude or time discriminator was shown by the Royal Radar Establishment. A voltage is applied across the two (identical) diodes which is only sufficient to maintain one diode on the high-voltage positive-resistance part of its characteristic and the other on the low-voltage part. A

current of less than 1 μ A into or out of one of the two diodes will then determine which diode is switched to the high- and which to the low-voltage part of its characteristic. Since the diode pair is only sensitive to such currents during the time in which the voltage is applied, it can also be used as a time discriminator, in which case its sensitivity is 20×10^{-9} sec. The use of such a discriminator in a computer store read-out circuit was demonstrated.

On the other hand the splitting of a nucleus leaves a track of emitting particles, thus sufficient photons are released for both tubes to be excited.

Measurement of the reduction in gauge of strip metal in a rolling mill is difficult because of the high speed and irregularities in the movement of the strip. However, comparison of the speed of the before and after rolling is one possible method and B.I.S.R.A. were demonstrating a technique for measurement of strip speed by coincidence.

Two spots of light are incident in line upon the strip surface at a known mutual displacement in the direction of travel. The light reflected from the strip varies as surface imperfections occur and the same variation will be experienced at the second spot of light after a time depending on the strip speed. Photo-cells convert the reflected light to electrical waveforms and that from the "upstream" cell is delayed by a mechanism such as a tape recorder so that it coincides with the waveform from the "down-stream" cell. Coincidence was detected by subtracting one signal from the other and adjusting the delay for minimum output. The combination of known distance and time give strip speed.

Industrial Television:—The remote observation of dangerous processes by television is a well-known technique; however, a development by Cawkell probably makes the use of television worth while even where no danger is involved, but where the speed of an operation is too rapid to allow proper inspection. The "Telerelescope" is a modification, to form a picture monitor, of an oscilloscope using a storage tube. Designed for operation on 405- 525(60c/s)- or 625-line systems, the monitor can be set to store one to four fields of the image on its 10-cm c.r.t. and retain them until the picture is no longer required. As a pulse can be used to give the "re-write" instruction, a form of slow-motion display could be arranged.

Detection of surface flaws in tinplate strip is another new idea for industrial TV. Developed by the British Iron and Steel Research Association, this method employs a rotating mirror synchronized with the movement of the strip to "arrest" the strip movement and present a stationary picture to the television camera. By storing images taken by the camera and displaying them side by side it may be possible to "compress" the view of a long strip into a relatively small picture.

INDUSTRIAL ELECTRONICS

SOME time ago "automation" by the use of electronics was hailed as the second industrial revolution. But this was only the application of electronic techniques to the instrumentation and control of small individual functions. Now, however, genuine overall automatic control of whole complex plants is being developed and the next few years should see the emergence of products made entirely without human intervention.

Comprehensive Control Systems for industrial plants which use computers to adjust processes to the optimum condition for maximum profit depend on a prior knowledge, for programming, of all the factors affecting the running of the plant and, what is more important, the laws that relate these factors to the whole. As the plant becomes more complex either over-simplification has to be made to allow programming or a rather different type of control system has to be used, one which will adapt itself by "trials," as does a human operator, to changed conditions. At the N.P.L. research into self-adaptive control systems is being done and an analogue model of such a system was shown on the D.S.I.R. stand. Relatively simple, so that mathematical analysis of the "process" and results could be carried out without too much difficulty, the model was of a third-order system—that is, only three independent variables were employed. The three variables were represented by integrators in cascade, each having negative feedback loops completed via the earlier stages. Each loop was varied by a motor-driven potentiometer which was activated when a difference occurred between overall output and input. So that the effect of each variable can be detected, identifying test signals at different frequencies were applied: the components of the test signals in the error signal operated the individual motors. It was possible to apply several laws such as straight \pm limits or error squared to the error detector and random disturbing influences from a variety of sources could be used to affect the system.

Coincidence or Correlation Techniques were demonstrated in apparatus developed by both Isotope Developments and the British Iron and Steel Research Association, although the mode of application was rather different.

When measuring the radiation given off by a radioactive substance it is sometimes mixed with a liquid phosphor, placed in a small transparent cell and the scintillations produced by each discrete radiation-emitting event are counted by means of a photomultiplier. However, thermal noise gives a count in the region of 1,000/sec at room temperature: thus it would be difficult to register accurately less than, say, 1,000 scintillations per second. Cooling the photomultiplier (and the specimen) can reduce the number of noise pulses that could be confused with scintillations and thus enables a higher sensitivity to be realized; but the operation can be difficult.

Isotope Developments achieve in their apparatus a minimum rate of 1 count/sec. Two photomultiplier tubes are used; their outputs, after amplification, are clipped to reject pulses that are smaller than would be given by a scintillation, compared for coincidence and gated yet again to eliminate pulses that are too large. In this way noise is discriminated against as is phosphorescence (the glow of the phosphor after it has been exposed to light). The light from phosphorescence is produced by discrete changes of energy within the phosphor emitting at a time only one photon which can go only to one photomultiplier: coincidence is not achieved and the pulse is rejected.

BIOLOGICAL ELECTRONICS

ELECTRONIC equipment is becoming more and more widely adopted in medical research and practice, as, in many cases, it represents the only possible tool for the evaluation of the minute and inaccessible phenomena encountered. An example is equipment used for electro-oculography, which is a technique whereby minute changes in skin potential of areas near the eye may be amplified and used to record eye movements.

E.M.I. have developed a high-gain, dual-channel, d.c.-coupled amplifier for this purpose, the complete equipment being known as "EMMA"—Eye Movement Measuring Apparatus. High stability is achieved by the use of an electromechanical chopper followed by a.c. amplification. That this is necessary is evident when it is known that changes of less than $100\mu\text{V}$ must be observed on standing skin potentials of 100mV . Backing-off potentials are provided to eliminate these standing voltages.

A very flexible electronic stethoscope was shown by Faraday Electronic Instruments. The output of either one or two microphones is applied to a 3-stage amplifier using sub-miniature valves, which were chosen for their high input impedance and low-noise characteristics. Frequency response controls may be adjusted to restrict the upper or lower frequency range, to concentrate the operator's attention on the phenomenon under examination. For instance, heart sounds, which are mainly low frequency, may be excluded when respiration, consisting mainly of high frequencies, is being studied. Two outputs are provided, affording facilities for two operators, or to operate recording or visual monitoring equipment.

To eliminate dependence on human subjects in breathing study,

the Research Department of Anaesthetics of the Royal College of Surgeons has developed an electronically-controlled breathing simulator. The simulator consists of pistons driven by a servo linkage from a velodyne speed control system. The required respiratory waveform is supplied by a transparent disc function generator mounted on the linkage shaft. A positive voltage, derived from the function generator on the grid of a balanced servo-amplifier, causes the current through the field coils of the split-field d.c. servo motor, one of which is in each anode of the amplifier, to vary differentially and the armature to rotate. The armature is fed from a constant current source. As the motor rotates a tacho-generator coupled to the linkage shaft produces a potential which opposes the original input to the amplifier. The amplifier is balanced, and the motor stationary, when the two voltages are equal and opposite about earth, with the result that the motor speed, which is proportional to the resultant positive voltage on the input, follows the waveform from the function generator.

COMMUNICATIONS

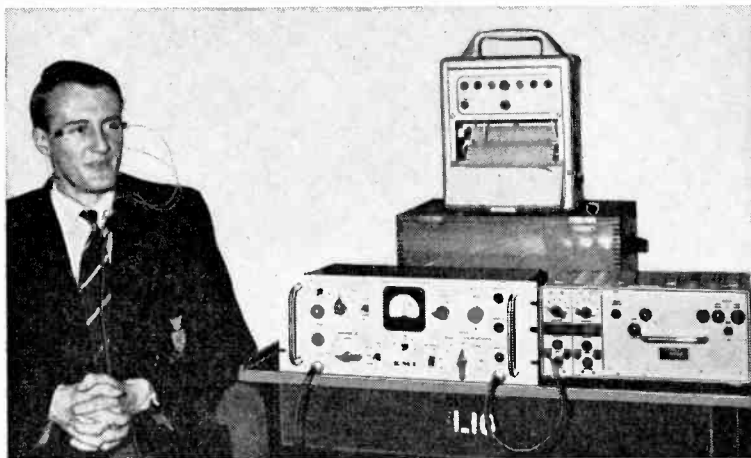
IT is sometimes said that, for "steam" radio, development is com-

plete. How wrong this point of view is can be seen from this year's exhibition where a new method, which promises great advantages, for s.s.b. generation, was seen.

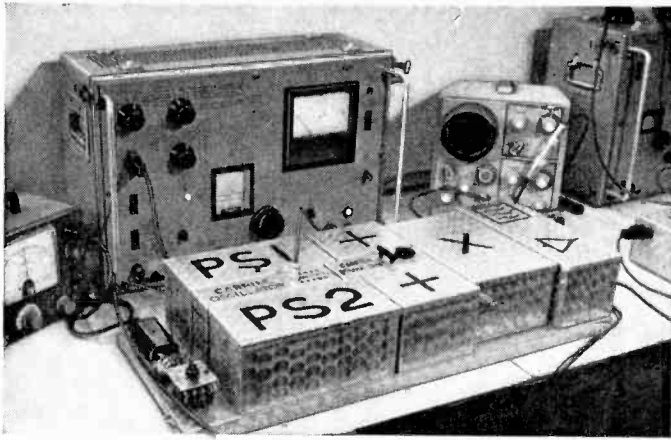
New S.S.B. Generation method developed by W. Saraga of A.E.I. uses only one multiplier-modulator stage compared with the more usual two. Summarizing previous methods briefly, it could be said that they depend either upon the use of filters to remove the unwanted sideband which is very near the wanted sideband, or on "outphasing" by which two suppressed-carrier signals are generated on "carriers" in phase quadrature (90° relative phase) with modulation in phase quadrature. On combining these two d.s.b. signals, one pair of sidebands adds, becoming the output s.s.b. signal, and the other pair cancels.

The new method requires one a.f.-band 90° phase-shifter, and adds the quadrature a.f. components to quadrature carriers, which, as these can be at a constant frequency, need not be difficult to produce. The a.f.-plus-carrier components then pass into a single multiplier (ring modulator) whose output consists of the wanted s.s.b. signal, the product of the quadrature a.f. and the product of the quadrature carriers; the unwanted a.f. and carrier components are very easily eliminated by a simple filter as their limits are represented by twice the highest a.f. and twice the carrier, respectively. For a change of sideband from upper to lower or *vice versa* it is necessary only to reverse a quadrature source—usually the carrier. The filter will, of course, pass both upper and lower sidebands without attenuation.

A.f. Spectrum Analyser shown by the P.O. Engineering Department produces spectrogram of speech with only a very small time delay: normally these displays are produced by analysis by filters splitting up the spectrum to be examined; but as the accuracy required is increased—that is, the bandwidth of individual filters is narrowed—or flexibility in choice of bandwidth is wanted, the apparatus quickly becomes too complex. The G.P.O. machine overcomes this problem by sampling the 0 to 3.3kc/s incoming speech at $150.5\mu\text{sec}$ intervals: these samples are then converted to a parallel six-bit code and fed into torsional wire delay lines $150\mu\text{sec}$ long, arranged so that the information circulates. The digits are thus spaced $0.5\mu\text{sec}$ apart in the



Eye-movement measuring equipment by E.M.I.



Demonstration model of new s.s.b. modulator, set out in block diagram form. PS1 and 2 are a.f. phase-shifting networks; +, adding stages; x, multiplier; at right-hand end is simple output filter. (Harlow Research Laboratory, A.E.I.)

lines (the first digit entered will have been round once and $0.5\mu\text{sec}$ on its second circuit when the next input is applied) and make three hundred circuits (taking 45msec) before being cancelled by the writing-in of new information. The signals in the lines are operated on by a digital-to-analogue converter which thus produces an analogue of the original signal at 300 times its original rate. This high-frequency analogue is heterodyned with an oscillator whose frequency is varied in synchronism

with the vertical deflection signal to the display c.r.t. A single filter, whose characteristics may be adjusted readily, sets the bandwidth to be examined and the resultant signal, after envelope detection, is used to brighten the trace of the c.r.t. The horizontal deflection of the c.r.t. spot is a linear sweep of a convenient time: thus the display represents frequency vertically and time horizontally with brightened patches indicating by their position the presence of a particular band of frequencies.

MICROWAVES

ONE of the main trends in this field, towards broader bandwidths, led this year more to new broadband components rather than, as in some previous years, to new wide band generators.

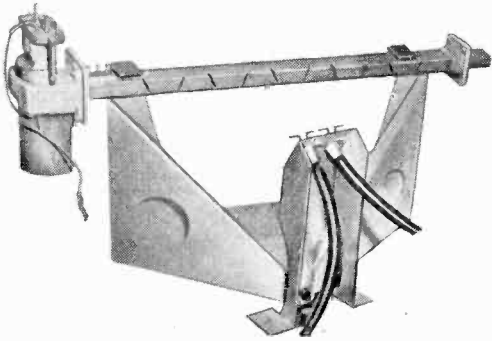
Waveguide Transmission is normally under conditions in which only one mode can be propagated or, alternatively, as in the low-loss systems now being investigated, in oversize guides in which several hundred modes can be propagated. In this latter case, unwanted interfering modes are readily produced at any slight discontinuity in the guide, and the problems of eliminating these unwanted modes have not yet been satisfactorily solved. Decca Radar showed that a useful, though not as great, reduction in the loss can still be produced by using a somewhat less oversize guide in which only a few modes can be propagated. Elimination of the unwanted modes is then possible by relatively-simple methods.

Radar Performance Monitor shown by Elliott enables the overall performance of the whole radar system to be observed. In this monitor the output from the radar aerial is received by a monitor aerial, attenuated by a total amount which can be varied to correspond to various path losses, and displayed on a c.r.t. At the same time, the radar pulse voltage is delayed by the path delay time and then used to trigger a separate microwave oscillator to produce a simulated reflected pulse. The simulated reflected pulse level is made equal to the actual reflected pulse level by comparing the simulated reflected pulse with the path-attenuated transmitted pulse on the monitor c.r.t. The simulated reflected pulse is then fed back along

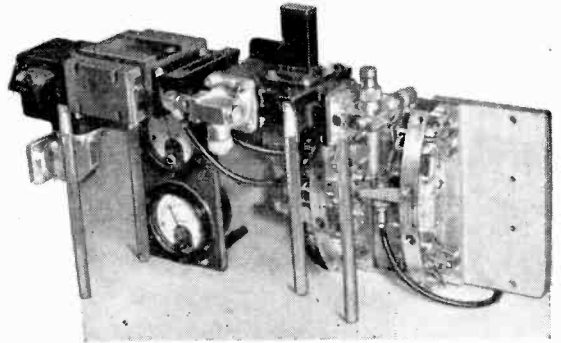
the path followed by the transmitted pulse via the monitor aerial to the radar's aerial. Since the simulated reflected pulse is made to follow the same path as the transmitted pulse, the simulated reflected pulse is attenuated by the path loss before reception by the radar's aerial. Observation of the simulated reflected pulse on the radar display then allows the overall performance of the whole radar system to be checked.

Radar Beam Position indication is usually obtained by coupling an electromechanical transducer to the aerial array. This has disadvantages—backlash may affect accuracy—new arrangements, too, preclude this mechanical measurement because the beam may be moved by non-mechanical means, altering phases in the aerial feeds, for instance. By placing two stationary probe dipoles in the near field of the aerial and measuring the phase difference between them a pulse-by-pulse statement of beam position may be achieved (Elliott).

Microwave Frequency Control system shown by Elliott employs a reference cavity resonator at one end of which is a moving-iron diaphragm. This diaphragm is vibrated at an audio frequency so as to modulate the cavity resonant frequency at the same audio frequency. A sample of the microwave frequency to be controlled is fed into the cavity where it is amplitude modulated at the audio frequency. This amplitude-modulated microwave signal is fed to a phase-sensitive rectifier and the resulting audio modulation output amplified and rectified. The rectified modulation voltage is used to change the frequency of the microwave source so as to reduce to a minimum the rectified modulation and thus the audio modulation produced by the cavity. The microwave source frequency has then been made equal to the mean cavity resonant frequency. The reference cavity resonant frequency is temperature compensated simply by means of a plunger which is moved by a temperature-sensitive bimetal strip, rather than by making the reference cavity of a low expansion coefficient material. In this way the cavity resonant frequency change for a temperature change of 100°F may be reduced to one part in 5×10^7 . By means of this frequency-control system short- and long-term stabilities may be obtained which are better than one part in 10^7 and 10^6 respectively.



Radar beam position indication by phase measurement (Elliott). Photograph shows dipole probes near slotted-waveguide aerial.



G.E.C. Hirst Research Centre broadband ferrite switch.

Parametric Amplifier for u.h.f. using a variable-capacity diode was shown by Marconi. This consisted simply of a length of X-band guide containing a strip with the diode mounted at its centre. The strip is arranged to be half a wavelength long at the signal frequency, and an odd number of half wavelengths long at the X-band pumping frequency. Both the signal and pump frequencies are propagated in the guide, and an amplified output at the sum of these two frequencies is produced by the variable-capacity diode. This amplified output is converted back to u.h.f. by mixing it with the pump frequency in a second diode further down the guide. In this amplifier the down frequency conversion loss can be made much less than the up conversion gain.

Ferrite-swept Klystron shown by Decca Radar incorporated a ferrite rod at the end of its tuning cavity. By varying the current in a coil placed round the ferrite, its permeability can be altered. This alters the reflection phase shift at the end of the cavity, and thus the effective cavity length. By means of this method electronic tuning over 300Mc/s at X-band (9,000Mc/s) is possible.

Travelling Wave Tube Limiter shown by S.T.C. makes use of the normal saturation in the output/input characteristic of the t.w.t. A useful feature of this method of limiting is that gain is provided at low input levels.

Coaxial Microwave Components are being increasingly used to replace waveguide components so as to secure greater bandwidths. Some shown by Decca Radar cover a range as large as from 1 to 12kMc/s.

Decca Radar also showed a

narrower-band coaxial phase shifter in which the normal straight inner conductor was replaced by a helix nearly as large as the outer conductor. To alter the phase a hollow dielectric cylinder is moved between this helix and the outer conductor. The electrical length, and thus the phase shift produced, change nearly linearly with movement of the dielectric cylinder. This component may be made relatively short.

A coaxial variable directional coupler shown by Elliott consisted of two sections of coaxial line joined together at their outer walls by a longitudinal slot. The two centre conductors are replaced by strips which can be rotated about one edge. The relative power coupled from one line to the other may be varied smoothly from -6dB to -40dB by rotating the two strips so as to move their free edges from their closest to their farthest possible separation.

Broadband Ferrite waveguide components were shown by the G.E.C.

In a rotator the output was sampled in two planes of polarization by two crystals. The difference between the output of the two crystals is taken, amplified, and fed back to the ferrite magnetizing current in such a way as to correct the rotation of the plane of polarization produced by the ferrite. By this means a relatively constant rotation over a 15% bandwidth can be produced. A somewhat similar technique was also used in a broadband switch.

Waveguide High-power Loads shown by Morganite Resistors consist of tapered hollow wedges whose openings are made accurately equal to the inside waveguide dimensions. The load material (called Termlode) can be manufactured with different attenuation characteristics covering a total range of 200 to 1, and sections with different attenuation characteristics can be combined to give a uniform heat dissipation along the wedge.

SEMICONDUCTORS

A HIGH speed of development continues in the field of semiconductors—each year we record at this exhibition some of the devices and manufacturing techniques evolved in the past year; but, on looking back, these often appear entirely disconnected from each other—developments that occurred during the year were “too old” to be shown at the next exhibition.

Boff Diode, like the tunnel diode, is a device that can be used for fast waveform shaping and switching. Unlike the tunnel diode, though, it is a passive device and can work at considerably higher powers, typically 0.5A switched in $2\mu\text{sec}$. Plessey demonstrated a Boff diode, switching power into a short-circuited line.

In an ordinary semiconductor junction, carrier storage results after the junction has been switched off by reversing the supply, in a gradual

decay of the current output: this is usually made as short as possible by making the carrier lifetime short. In the Boff diode, however, a long carrier lifetime is chosen and the carriers are made to “congregate” near the junction by the application of a drift field which is achieved by grading the materials forming the junction. On reversal of the supply polarity, current will flow practically unabated from the junction, and then stop suddenly, instead of dying away.

Binistor is the name used by G.E.C. to describe a four-layer pnpn structure with leads attached to each layer. The normal controlled rectifier can be switched on by an external pulse, but, like the thyatron, the main current flow has to be interrupted to switch it off. The Binistor, however, can be switched both on and off by application of control pulses—as demonstrated, some 50mA at 45V was switched in 0.2 μ sec by 2mA pulses.

Regrown Diffused silicon-transistor manufacturing technique developed by G.E.C. shows promise for reducing the difficulty of making silicon devices, and at the same time increasing the usable "yield" of transistors from a batch. A small block of silicon has placed upon it smaller blocks heavily doped with arsenic (n-type material) and boron (p-type material) and the whole is heated from above until only a part of the original silicon block remains unmelted. On cooling, the heavily doped materials re-crystallize (in a pyramid shape) on to the block to form a single crystal of, as the arsenic is made predominant, n-type material. Then, during baking at high temperature, boron diffuses from the n-type material to form a p-layer between the silicon and n-material. This layer can be very thin and controlled accurately. The remaining block is cut into small bars, each of which has the required transistor structure.

Epitaxial Transistors have a low bottoming voltage combined with the high collector-breakdown potential and h.f. advantages of diffused construction. The ordinary diffused transistor is made by taking a wafer of high-resistivity material, which has to be of reasonable thickness for mechanical strength, and diffusing impurities into it to form base and emitter regions. Naturally, the high resistivity of the collector region results in a high bottoming voltage.

The epitaxial technique starts off with a low-resistivity wafer (hence

low bottoming voltage) and the high-resistivity collector region is allowed to crystallize from a vapour, as a thin layer with the same crystal orientation as that of the wafer. S.T.C. use, for germanium transistors, ger-

manium iodide vapour, whereas Texas Instruments were showing epitaxially-made transistors using silicon. Further stages in the manufacturing process are similar to those used for diffused-base transistors.

OTHER INTERESTING EXHIBITS

WE conclude with a number of items which do not fit neatly into the foregoing groups but which interested us and which seem worth recording.

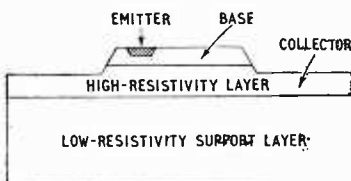
Electron-beam Alignment: One of the problems associated with the use of beams of high-energy electrons or ions is that of ensuring that the beam is properly focused and travelling in the right direction, say along the axis of a comparatively narrow tube. Observation of the beam with a fluorescent screen cannot be employed as incidence of the beam upon a surface could produce dangerous amounts of radiation. A technique developed at the Physics Department of Reading University overcomes the difficulties very simply. A diaphragm with a central hole and two insulated metallic quadrants is introduced into the apparatus so that the hole lines up with the designed beam direction and the beam is caused to rotate with constant angular speed by means of applied deflecting field: for an electron beam horizontal and vertical deflection coils fed with two sine waves having a 90° phase relation could be used. In two quadrants the beam will pass and in the other two it will strike the plates producing an output from them, which is displayed upon a c.r.o. synchronized with the rotating scan. If the beam is off-centre then its time of travel between or across the plates will be different, so producing asymmetrical waveforms. Similarly, as the focus of the beam is improved the time it takes to move on to or off a plate is reduced, thus the waveform becomes more "peaky". By adjusting for a spiky, symmetrical waveform, correct beam alignment and focus is achieved from a remote, safe point: it is then necessary to switch off the deflection.

Another beam-alignment problem is encountered when setting up high-resolution c.r.t.s. If the electron beam emerges from the gun other than along the axis of the magnetic fields of focus and scan coils then distortions (usually defocusing and astigmatism) can occur. Thus to correct for the manufacturing tolerances either the focus coil and, possibly, the deflector coils have to be offset, or restoring influences applied with small magnets. A procedure devel-

oped by E.M.I. shows promise of reducing the labour involved: for this the focus coil is energized with a.c. of a value such that the spot is focused at the peaks of the a.c. As the direction of the current is reversed two separated focused and one defocused spots (when the current is zero) will appear unless the beam alignment is correct. Adjustment for coincident spots centred in the defocused spot rapidly gives optimum focus.

Cold-Cathode Trigger Tubes suffer from a power limitation because ion bombardment of the cathode causes damage which results in "whiskers" of cathode material growing on the trigger electrode, so affecting the level at which the tube "fires." Mullard have found that, by using a tubular cathode (formed from helically wound flat strip) with the trigger electrode near a tab at one end of the tube, the discharge moves into the tube and, once inside, stays there with a lower cathode voltage drop than the open construction entails. The trigger electrode does not "foul up" and the power handling capacity is improved with maximum permissible peak currents some three times those of the conventional tube.

Analogue of Furnace for firing ceramics has been used by Morgan Crucible to determine optimum design factors rather than an extensive and time-consuming series of calculations which have to be modified again and again as design work is carried on and the original "guesstimates" prove inaccurate. In the analogue, electrical quantities represent the various parameters: for example charge represents heat; voltage, temperature; capacitance, thermal capacity; conductance, thermal conductivity. Trigger circuits detect changes in "temperature" and alter the parameters of "heat input" and "loss" and the time scale is compressed so that 1sec on the analogue represents half-an-hour of real (kiln) time.



Simplified diagram of section through epitaxial transistor.

WORLD OF WIRELESS

Car Radio Licences

A DOMESTIC broadcast receiving licence permits the licensee to use "one or more portable sound or television broadcast receiving sets provided that . . . any such set is operated by a battery wholly contained within the set and is not permanently installed in any premises, vehicle, vessel or other place." So far as car radio is concerned this has in the past been interpreted in the summary of regulations published in the *Wireless World* Diary by the phrase "a separate licence is needed for a set fitted permanently in a motor car."

When asked recently to approve the Diary summary as is done periodically, the phrase was modified by the Post Office to read "a separate licence is needed for a set fitted in a motor car or connected to the car battery." When we questioned the modification we were told it is "a clarification of intention" and not a change in licence regulations. This makes it quite clear that a portable set which when used in a car is plugged into an amplifier unit powered from the car battery and not from its self-contained battery (as is now done by some manufacturers to give improved output) the set needs a separate licence.

P.A. Show

THE object of the Association of Public Address Engineers is "to promote and protect the interest of public address and its *allied services*" (our italics). The Association is, therefore, featuring at its annual exhibition in March a display showing the advantages of using television with p.a. for gatherings where the audience is accommodated in more than one hall.

The show is being held on March 8th at the King's Head Hotel, Harrow-on-the-Hill, Middx., and will be open from 11.0 to 6.30. Tickets are obtainable free from exhibitors (listed below) or direct from the A.P.A.E., 394 Northolt Road, South Harrow, Middx.

Audix
Antone
C.T.H. Electronics
Chapman Ultrasonics
E.M.I. Electronics
Film Industries
G.E.C.
Lustraphone
Magenta BVC
Pamphonic Reproducers
Philips

Rendar Instruments
Reosound Engineering
Resosound
S.T.C.
Shure
Tellux
Vortexion
H. Warren
Westrex
Whiteley Electrical
C. T. Wright

Components Show

AT the Radio and Electronic Components Show, which opens at Olympia on May 30th, more than 250 exhibitors—an increase of nearly 50% on 1959—will occupy an area four times as large as previous shows organized by the Radio & Electronic Component Manufacturers' Federation. Admission to the Exhibition, which will remain open for four days, will cost 5s.

Satellite Communications

THE Post Office's decision to "go ahead with the erection of a ground radio station with a large steerable aerial system for satellite communication tests" was announced on behalf of the P.M.G. at the annual dinner of the Telecommunications Engineering and Manufacturing Association. Teams of specialists from the U.S.A. and this country have recently exchanged visits and discussed plans for tests of transatlantic satellite communications.

"Space" Technology

TWO symposia being organized by the British Interplanetary Society are of particular interest to readers of *Wireless World*. The first is a one-day programme of eight papers on communications satellites presented by specialists from both this country and the U.S.A. The meeting will be held in the Council Room of the Federation of British Industries, 21 Tothill Street, London, S.W.1, on May 12th, from 10.0 to 5.0. The registration fee for non-members is 1 gn.

The second symposium is a three-day meeting arranged primarily to bring together scientists and engineers from Western Europe to discuss the possibility of formulating a joint programme of space research. This, the first European Symposium on Space Technology, will open on June 26th and will also be held at the F.B.I. The registration fee is 5 gn.

Registration forms and programmes for both meetings are obtainable from The British Interplanetary Society, 12 Bessborough Gardens, London, S.W.1.

Electronics in North East

N.E. ENGLAND'S first exhibition devoted exclusively to electronic engineering opens at Newcastle-upon-Tyne on February 28th for three days. Organized by the North East Industrial and Development Association it is being held at the City Baths Hall. The exhibitors include: Burgess Products Co.; Derritron; Electricals (Laboratory); Elliott Bros.; Farnell Instruments; Sir Howard Grubb, Parsons & Co.; Heywood & Co.; Imhof; Joyce, Loebel & Co.; Marconi Instruments; Measuring Instruments (Pullin); Microwave Instruments; Morganite Resistors; Mullard; Murray Swanson & Co.; Research and Control Instruments; Solartron; Southern Instruments; Tyne Tees Television; Wayne Kerr Laboratories; and Welwyn Electrical Laboratories.

A number of colleges in the Region are providing a combined display featuring educational facilities in electronic engineering.

The exhibition opens at 2.0 on the first day and at 10.0 on succeeding days. It closes each day at 8.30. Admission 6d.

N.R.D.C. Report

EXPERIMENTAL work based on a proposal by Dr. D. Gabor for the direct generation of electricity by a thermionic method is one of many projects mentioned in the Report and Statement of Accounts for the year July 1st, 1959 to June 30th, 1960 of the National Research Development Corporation (H.M. Stationery Office, 1s 6d). Income from royalties during the period rose to £259,000 compared with £182,000 in the previous year, and expenditure was £427,000 with forward commitments of £739,000 for further developments of, for instance, fuel cells and Hovercraft which are being actively pursued. Sir William Black (chairman) in introducing the report said, "The wit of our brilliant research scientists is of no value to the nation if it is not quickly turned to industrial use. It is the object of the N.R.D.C. to do just this. . . ."

Trader Year Book

CONDENSED specifications of current sound radio and television receivers and tape recorders; valve and c.r.t. base connections; transistor types and connections; and field-strength contour maps of U.K. television stations are but a few of the features of the 1961 edition of the "Wireless & Electrical Trader Year Book." First published in 1925 the Trader Year Book has become the *vade mecum* of the radio dealer and indeed of the radio industry in general. All the features which experience has shown to be the most useful have been retained and brought up to date; one of the most useful of these being the directory of manufacturers' addresses. Prepared by our associate journal *Wireless & Electrical Trader* it is published by Iliffe Books Ltd., price 15s (postage 1s 6d).

IN BRIEF

British Association.—The Kelvin lecturer for the annual meeting of the British Association, which will be held in Norwich from August 30th to September 6th, is Professor D. J. E. Ingram whose subject will be connected with micro-wave radio. Dr. Ingram, who was appointed professor of physics at the University College of North Staffordshire in 1959, was previously reader in the electronics department of the University of Southampton.

Railway Telecommunications.—A conference on railway modernization is being organized jointly by the Institutions of Civil, Mechanical and Electrical Engineers, for May 3rd and 4th at the Institution of Civil Engineers, Great George Street, London, S.W.1. One of the five main papers is signal engineering and telecommunications and will be presented by J. F. H. Tyler, chief signal and telecommunications engineer, S. Region, British Railways.

A.S.L.I.B.—The annual conference of the electronics group of the Association of Special Libraries and Information Bureaux will be held at Ashridge College, Berkhamsted, Herts., from April 21st to 23rd. At this the group's third conference papers will cover both librarianship and information work with special reference to the field of electronics. Further particulars are obtainable from: N. E. C. Isotta, Ministry of Aviation, T.I.L.2., First Avenue House, High Holborn, London, W.C.1. The fee is £7.

T.E.M.A. Awards For Apprentices.—For the fourth year the Telecommunications Engineering and Manufacturing Association has held a competition for the three best final year apprentices of their member-firms. The prizes, to the value of £25, were awarded to the following at the Association's annual dinner on February 15th: P. G. C. Young, B.Sc., graduate-in-training with G.E.C.; Peter Hunt, Dip. Tech., student apprentice with A.T.E.; and E. T. Lamb, technician apprentice with Ericsson.

Dover's permanent low-power television station was brought into service on February 1st. The transmitter, which shares a site near Swingate with an Air Ministry station, operates in channel 2 with vertical polarization. It is equipped with an 0.5kW vision transmitter supplied by S.T.C. The station will later be equipped for v.h.f. sound broadcasting.

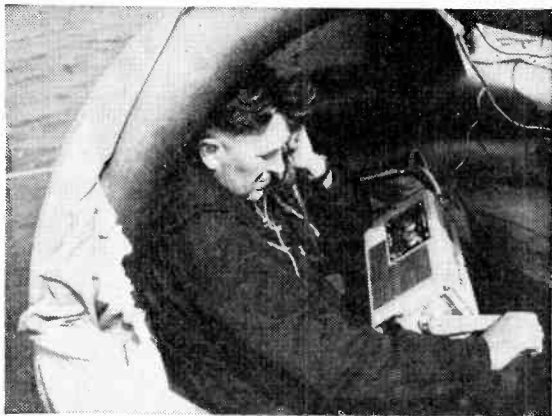
Soviet television receivers adapted to receive 405-line transmissions will be demonstrated at the Soviet Industrial Exhibition which is being held at Earls Court, London, from July 7th to 29th. Capital equipment as well as consumer goods in the radio and electronics fields will be among the 12,000 or more exhibits planned for the nine sections of the exhibition.

"Applications of Analogue Computers" is the title of a two-day symposium to be held at Loughborough College of Technology on April 10th and 11th. It is being organized jointly by the departments of electrical, mechanical, aeronautical and chemical engineering. The fee for the course, accommodation and meals, is 5½ gn.

Brit.I.R.E. Membership.—The annual report of the British Institution of Radio Engineers for 1959/60 records that on March 31st last the Institution had an effective membership of 6,332 which shows a growth of almost 1,000 in the past five years.

"The Satisfied User," a 30-minute sound colour film illustrating some of the uses to which the ICT1200 series of computers is being put, is available on loan from International Computers and Tabulators Ltd., Publicity Division, 149 Park Lane, London, W.1.

Soviet Production.—The number of television sets manufactured in the U.S.S.R. last year totalled 1.7M which was a 35% increase on the previous year's figure. There was a 3% increase in the number of sound receivers bringing the total to 4.2M.



"Lifeline", a new portable transmitter-receiver for inflatable liferafts is strapped to the knees of the operator and is powered by a hand-driven generator. The set, which is produced by Clifford and Snell and marketed by Marconi International, is pretuned to the international R/T distress frequency (2182 kc/s) and can be used either for speech or to radiate an automatic two-tone alarm signal.

Personalities

Air Vice-Marshal Sir Leslie Dalton-Morris, K.B.E., C.B., Air Officer Commanding-in-Chief, Signals Command R.A.F. since 1959, has been appointed Air Officer Commanding-in-Chief, Maintenance Command with the acting rank of Air Marshal. Sir Leslie, who was knighted in 1959, has been a signals specialist throughout his Service career. He was Deputy Chief Signals Officer, Fighter Command, during the Battle of Britain. In 1944 as Chief Signals Officer, Bomber Command, he headed a team of specialists working on radio counter-measures operated by Bomber Command. Prior to commanding No. 90 Signals Group, which was raised to Command level in 1959, he was Assistant Chief of Air Staff (Signals). Earlier he commanded the R.A.F. Central Signals Establishment. He is 54. Sir Leslie's successor at Signals Command is Air Vice-Marshal **W. P. G. Pretty, C.B., C.B.E.**, who has been Director General of Organization at the Air Ministry since October, 1958. In 1944 he was appointed deputy-director of radar in the Air Ministry. The following year he became Chief Signals Officer, Fighter Command, and in 1951 was appointed Director of Electronics Research and Development (Air) at the Ministry of Supply. Air Vice-Marshal Pretty is 51.



A.V.-M. W.P.G. Pretty

N. A. Twemlow, M.B.E., who is a director of a number of companies in the Pye group, has been appointed to the board of E. K. Cole Ltd., and **W. M. York, commercial director of E. K. Cole Ltd.** becomes a director of Pye Ltd. Mr. Twemlow was for a short time with Ekco before he joined Pye in 1934. Mr. York, who has been with Ekco since 1932, is also a director of Radio Industry Exhibitions Ltd.

Hector V. Slade, M.B.E., T.D., J.P., managing director of the Garrard Engineering and Manufacturing Company, has joined the board of Plessey International Ltd. It will be recalled that Plessey recently acquired Garrard. Mr. Slade, who is 44, joined Garrard in 1935 and became managing director in 1957. He is chairman of the council of the Radio and Electronic Component Manufacturers' Federation.

R. J. F. Howard, a director of Lancashire Dynamo Electronic Products Ltd. (a member of the Metal Industries group), has been appointed director of marketing for the group and will be primarily concerned with the group's electrical companies. He remains a non-executive director of Lancashire Dynamo Electronic Products and also joins the board of five other M.I. subsidiaries. He received his initial training with Harries Thermionics and was for some years with the Mullard organization where he was latterly concerned with industrial applications of valves. In 1945 he joined the development staff of the English Electric Company and two years later was appointed chief engineer of British Electronic Products (now Lancashire Dynamo Electronic Products). He is 40.

W. M. Chapman-Walker, C.B.E., M.V.O., M.B.E., who has been associated with Aerialite Ltd. for some years as a member of its London organization, has become a director. He was the first managing director of the programme organization, Television Wales and the West, and is joint general manager of the *News of the World* organization. He represents Aerialite and Television Wales and the West on the board of Wire-
vision Ltd.

Air Vice-Marshal W. E. Oulton, C.B., C.B.E., D.S.O., D.F.C., has retired from the Royal Air Force after 32 years' service and joined the board of E.M.I. Electronics Ltd., as director responsible for Ministry work. He played a prominent part in setting-up the London Air Traffic Control Zone in 1946 and helped to create the first international air traffic control organization in post-war Europe.

J. B. Webb, A.M.I.E.E., is appointed head of the valve section of the B.B.C.'s Transmitter Department in succession to **H. S. Walker, M.B.E., A.M.I.E.E.**, who has retired. Mr. Walker joined the British Broadcasting Company in 1922 as engineer-in-charge of the Bournemouth transmitter. Mr. Webb, who joined the B.B.C. in 1934, was for some time in the engineering secretariat but since 1953 has been an engineer in the section of which he now becomes head.

R. D. A. Maurice, Ing-Dr., Ing.E.S.E., A.M.I.E.E., is appointed assistant head of the B.B.C.'s Research Department in succession to **A. B. Howe, O.B.E., M.Sc., M.I.E.E.**, who recently retired after 36 years' service with the Corporation. Dr. Maurice joined the Research Department in 1939 and became head of the receiver and measurement section in 1943. Since 1958 he has been head of the television group.

Dudley Saward, O.B.E., who is 47, has joined the board of Bush Radio as managing director designate. He recently resigned from the managing directorship of Texas Instruments Ltd., which he joined on its formation in 1956, but has remained a director. Mr. Saward, who was Chief Radar Officer, Bomber Command, during part of the war, was for some time after the war manager of navigation and telecommunications for British European Airways.



D. Saward



J. C. G. Bell

J. C. G. Bell has been elected to the board of Rank Cintel as managing director designate. Mr. Bell, who is 51, served in the R.A.F. during the war and was in charge of air navigation research and development at the Ministry of Supply. He joined the Sperry Gyroscope Company in 1945 and since 1959, until he recently left to join Rank Cintel, had been director and manager of the Brentford division of the company.

O. S. Puckle, M.B.E., M.I.E.E., of timebase fame, has retired from E.M.I. where for the past five years he has been chief lecturer and has travelled extensively overseas lecturing on the company's products. He joined the company in 1948. His industrial career began at Standard Telephones and Cables. This was followed by a period with Marconi's where at one time he was concerned with experimental work on 75cm transmission. He then joined A. C. Cossor where he worked for many years with L. H. Bedford mainly on television research and later on the development of radar receivers.

Charles P. Ginsburg, vice-president of the Ampex Corporation of California and manager of the Corporation's advanced development, has been awarded the Valdemar Poulsen gold medal by the Danish Academy of Technical Sciences, for his "guiding spirit and principal participation in the development of the 'video tape' recorder." This is the seventh award of the gold medal, named after the Danish scientist, since its introduction in 1939 when Poulsen himself received it on his 70th birthday.

Frank S. Richmond, who has been a director of A. H. Hunt (Capacitors) since 1939, retired at the end of the year. He originally joined the company in 1928. He relinquished the position of deputy managing director and sales director two years ago but remained on the board as an executive director.

J. Maurice, managing director of Lustraphone Ltd., has been nominated president of the Association of Public Address Engineers for 1961/62. The election of officers takes place on March 8th, the date of the Association's annual exhibition.

Two appointments are announced by Fortiphone Ltd.: **J. A. Steel** becomes manager, hearing aid and machine division; and **I. W. Rae**, manager, components division. Mr. Steel was previously with Plessey for 10 years, the last four of which were spent with Plessey Nuclonics as production manager. Mr. Rae was previously a production manager at Elliott Brothers and was at one time with the G.E.C.

N. Girton has been appointed manager, home sales, and **C. R. Russell** manager, export sales, by the M-O Valve Company. Mr. Girton joined the company in 1950 and became engineer-in-charge of the u.h.f. and microwave valve manufacturing section. In 1959 he was appointed assistant manager (home sales). Mr. Russell went to Wembley Research Laboratories, now the Hirst Research Centre, of G.E.C. in 1947 where he has been particularly concerned with the company's microwave programme.

Albert Lowe, managing director of International Aeradio (Pakistan) Ltd., since its formation in 1949, has retired. His radio career began in 1918, when he joined the Marconi Marine Company as a wireless operator. He went to Imperial Airways as radio operator in 1933 and was for some time B.O.A.C. signals superintendent, Far East.

R. D. Stafford, A.M.I.E.E., works director of Cawkell Research and Electronics, Ltd., now a subsidiary of Simms Motor and Electronics Corporation, has been appointed chief engineer of Cawkell's Industrial Division. **R. Reeves**, A.M.I.E.E., is appointed chief engineer, special products division, and **D. Parker**, B.Sc., senior engineer, special services. Cawkell's Research and Development Division is now at 99, Uxbridge Road, London, W.5, next door to the development laboratories of the associate company, Dawe Instruments, Ltd.

P. G. A. H. Voigt, who has been in Canada since 1950, has joined the Telecommunications and Electronics Branch of the Canadian Government's Department of Transport. The Department regulates radio operation in Canada as does the Post Office in this country.

Having regrouped its Aeronautical Division (of which **Dr. B. J. O'Kane** is manager) in new premises at Basildon, Essex, Marconi's have made the following appointments:— **F. Wheeler**, formerly sales and contracts manager has been appointed deputy manager; **G. P. Parker**, A.M.I.E.E., deputy chief air radio engineer (development) since 1957, becomes manager, engineering co-ordination; **G. E. Beck** becomes chief engineer, navigational aids; and **L. R. Mullin**, chief engineer, airborne communications. Other new appointments are:— **J. H. Gill**, service manager; **E. Swinney**, systems manager; **B. J. Infield**, sales manager; and **C. A. R. Mackley**, contracts manager.

The I.T.A. has appointed engineers-in-charge at three of its new transmitters. **Henry N. Salisbury**, Assoc.-Brit.I.R.E., to Caldbeck, near Carlisle; **Kenneth Archer**, Assoc.Brit.I.R.E., to Caradon Hill, Cornwall; and **George W. Stephenson**, Grad.I.E.E., to Stockland Hill, Devon. Mr. Salisbury, who is 32, was with the B.B.C. for 14 years before joining the Authority in January, 1958. Mr. Archer, 36, joined the Authority in August, 1959, and Mr. Stephenson, 36, in April, 1958, both after 18 years with the B.B.C.

Peter E. M. Sharp, A.C.G.I., B.Sc.(Eng.), A.M.I.E.E., general manager of Westrex Company Ltd., which he joined last year, has been appointed a director of the company. Immediately prior to joining Westrex he was for some time personal assistant to the managing director of the Troughton and Young group of companies.

C. A. P. Cannon, who has been with Measuring Instruments (Pullin) Ltd. for 21 years, has become general manager and is appointed to the board. He was for some time production manager prior to his appointment last year as assistant to the managing director.

M. Esterson is manager of the newly-formed high-power klystron division of the English Electric Valve Co. This division has been formed to co-ordinate work previously done in separate divisions.

T. M. A. Lewis, B.Sc., author of the article on a record equalizer on page 121, graduated at the Imperial College of Science and Technology (where he read mathematics) in 1959. He has since been a graduate apprentice at the guided weapons establishment of English Electric Aviation Ltd. at Stevenage. He is 23.

Major William Logan, general sales manager of Avo Ltd., has been appointed to the board of the company, and will assume the responsibilities of sales director.

OBITUARY

George G. Blake, M.Sc., F.Inst.P., M.I.E.E., well known to "old timers" as author of the reference book "History of Radio Telegraphy and Telephony," died in Sydney on January 16th. For many years prior to going to Australia he was radiographer to several hospitals. Between 1940 and 1945 he was in the Physical Laboratory of the University of Sydney where he later taught for a few years.

Hamish Kirkwood, secretary of the Association of Dry Battery Manufacturers since 1951, died on January 19th aged 54. Since 1957 he had also been secretary of the Accumulator Manufacturers' Association and of the British Starter Battery Association.

News from Industry

"Space" Consortium.—British Space Development Company has been formed by a consortium of eight companies "to bring together a representative cross-section of that part of the industry which is interested in the development and exploitation of space for commercial purposes." The eight participating companies are A.E.I., Associated Television, B.I. Callender's Cables, Decca Radar, de Havilland, Pye, Rank Organization and Rolls-Royce. Sir Robert Renwick was prime mover in the formation of the company and Grp. Capt. D. Saward (Rank), Grp. Capt. E. Fennessy (Decca) and J. Brinkley (Pye) have been appointed as an organizing committee.

Marconi-Itek Agreement.—A five-year agreement has been signed by Marconi's and the Itek Corporation, of Cambridge, Mass., allowing Marconi's to manufacture in the U.K. more than 1,000 types of Hermes frequency-selective crystal filters produced by Itek Electro-Products Company. Marconi's will be able to market these in all countries of the "western world" except the United States. Itek Electro-Products Company was formed last November as a result of the merger between the Itek Corporation and Hermes Electronics Company.

Industrial electronic control equipment designed and manufactured over the past 15 years by Lancashire Dynamo Electronic Products Ltd. is to be manufactured in the United States by Emerson Electric Manufacturing Company, of St. Louis, Missouri. The agreement also provides for a reciprocal flow of "know how" between the two companies and the exchange of personnel for training.

Facsimile equipment designed by Alden Research Foundation, of Westboro, Mass., will be manufactured in this country by Redifon Ltd. The agreement between the two companies also provides for Redifon to develop the sales of Alden automatic "order-write" and banking systems throughout the U.K.

Elac Electronic Components Ltd. has been formed as a subsidiary of Electro Acoustic Industries Ltd., to develop and manufacture components other than loudspeakers and kindred acoustic products. P. W. Pannell, previously chief television component engineer of Electro Acoustic Industries, has been appointed technical director of the new company.

Admiralty Station.—The major part of the receiving equipment at the Admiralty receiving station at Forest Moor, near Harrogate, Yorkshire, was supplied by Marconi's. The equipment includes a considerable number of triple- and double-diversity receivers (some for s.s.b. operation), telegraph recording units and electronic aerial exchange equipment.

Thermionic Products (Electronics) Ltd. have supplied the first of their new transistor multi-channel recorders for the Ronaldsway (Isle of Man) airport. The recorder's $\frac{1}{2}$ -in tape provides for eight communication channels, a time signal reference channel and a reserve channel for emergency use.

Naval Radar.—The Kelvin Hughes 14/12 radar is being installed in the smaller vessels of the Royal Navy. It will incorporate a few additional features to make it suitable for Naval use and will be known as Type 975.

COMPAC.—Cable and Wireless have placed an order worth £10M with Submarine Cables Limited and another worth £9M with Standard Telephones and Cables Limited for cable and equipment for COMPAC, the trans-Pacific telephone cable to be completed in 1964. Submarine Cables will supply 5,875 miles of cable, 93 repeaters and the deep-sea housings for all the 335 repeaters in the project, and S.T.C. 2,800 miles of cable, 242 submerged repeaters and the 38 submerged equalizers.

Bendix-Ericsson.—What was the instrument division of Ericsson Telephones Limited forms the basis of a new company, Bendix Ericsson U.K. Ltd. It is operating from High Church Street, New Basford, Nottingham. (Tel.: Nottingham 75115.)

Airfield Surveillance Radar.—An order for a substantial number of Cossor moving-target radars for installation at R.A.F. airfields in this country and abroad has been placed with the company by the Ministry of Aviation.

Allegro Sound Equipment is the new name adopted by P.A.R. Electronics Co., 7 Avery Row, London, W.1 (Tel.: Mayfair 9910), manufacturers of the Allegro tape recorder. P. A. Rispoli, founder of P.A.R. Electronics, is managing director.

Grundig.—The grand total of Grundig products manufactured in Germany since 1947 now exceeds 10M. This total comprises 6.2M radio receivers (including portables), 1M radio gramophones, 1M television sets, 2M tape recorders and dictating machines and 50,000 measuring instruments.

Dupol plastic film capacitors, which are manufactured in Italy by Ducati, are now being marketed in the U.K. by W. Greenwood (London) Ltd., of 677, Finchley Road, London, N.W.2. (Tel.: Swiss Cottage 3383.)

Zenith.—More than one million television receivers were produced and sold during 1960 for the second successive year by the Zenith Corp. of Chicago.

OVERSEAS TRADE

Australia.—Ferranti have established a computer office at 65 Queen's Road, Melbourne. W. R. Arnott, an Australian, is in charge of the office, where initially a Sirius computer is to be installed, and assisting him is Keith Nicol from the U.K.

Television Cameras.—Twelve E.M.I. image orthicon cameras and associated equipment are being supplied to the Canadian General Electric Co. who have been awarded a C\$500,000 contract to provide equipment for Montreal's new television station, CFTM-TV.

Canadian Agents.—Alma Components Ltd. have appointed Associated Electronic Components Limited, of 1560 Avenue Road, Toronto 12, Ontario, to be their agents for precision wirewound resistors in Canada.

Marine Equipment.—Five large new turbine tankers being built in Sweden for Mobil Tankships Company Ltd., of Bermuda, are to be fitted with radio equipment and radar supplied by Associated Electrical Industries.

Accurate Record Equalizer

TRANSISTOR STEREO PICKUP PRE-AMPLIFIER CIRCUIT

By T. M. A. LEWIS*, B.Sc., A.R.C.S.

THE unit to be described is intended for use with high-quality magnetic pickup cartridges, and features unusually-accurate equalization for the standard microgroove recording characteristic. The signal-to-noise ratio is of high-fidelity standard and the total harmonic distortion is extremely low. Two of the pre-amplifiers can be used with stereophonic cartridges, provided the battery is decoupled so that cross-talk is minimized.

The specifications to which the unit was designed are:—

- (1) Power supply 18V.
- (2) Noise introduced by unit to be negligible under listening conditions.
- (3) Equalization accuracy better than ± 1 dB from 20c/s to 20kc/s.
- (4) Total harmonic distortion $\leq 0.1\%$ at 100mV r.m.s. output.
- (5) Gain at 1kc/s to be within ± 0.5 dB of unity voltage gain when feeding a load $\leq 50k\Omega$.

As the results show, these specifications were achieved or bettered. The specification on equalization accuracy would seem unusually strict, but since the better magnetic cartridges available today have a frequency response which is flat within ± 1 dB from 30c/s to 15kc/s, it was thought worth while to aim for an equalization accuracy at least as good as that in specification (3). As far as the distortion figure is concerned, this would seem to be the accepted standard for high-fidelity reproduction.

Equalization.—Before describing the circuit, it is proposed to describe how the equalization is

effected. The standard playback characteristic (B.S. 1928: 1960 and R.I.A.A.) can be written as the transfer function

$$f(j\omega) = \frac{K(1 + j\omega T_2)}{(1 + j\omega T_1)(1 + j\omega T_3)} \dots \quad (1)$$

where ω is angular frequency ($2\pi f$), K is the gain at zero frequency, $T_1 = 3,180\mu\text{sec}$, $T_2 = 318\mu\text{sec}$, and $T_3 = 75\mu\text{sec}$.

Since it is necessary to use feedback to reduce distortion, the possibility of including the equalization components in the feedback loop was investigated. The type of feedback used was determined by the requirement that the unit should present a load of not less than $50k\Omega$ to magnetic cartridges.

Two types of feedback are shown, in block form, in Figs. 1(a) and 1(b).

In Fig. 1(a), the closed loop gain will be Z_1/Z_2 and accurately defined, provided the open loop gain A is high, and that $Y_1 + Y_2 + Y_{in} \ll AY_1$, where Y_1 , Y_2 and Y_{in} are the admittances corresponding to Z_1 , Z_2 and R_{in} respectively. The closed loop input impedance will be approximately Z_2 since Point B is a virtual earth. Thus Z_2 must be greater than $50k\Omega$, which means that R_{in} must be of the order of $50k\Omega$. This can be achieved with an emitter follower, and this would be followed by a common-emitter stage to provide voltage gain. However, the open loop gain, as provided by just this one transistor, would not be sufficient to ensure accurate definition of the closed loop gain. Thus, without resorting to more than two transistors per channel this type of feedback is unsuitable.

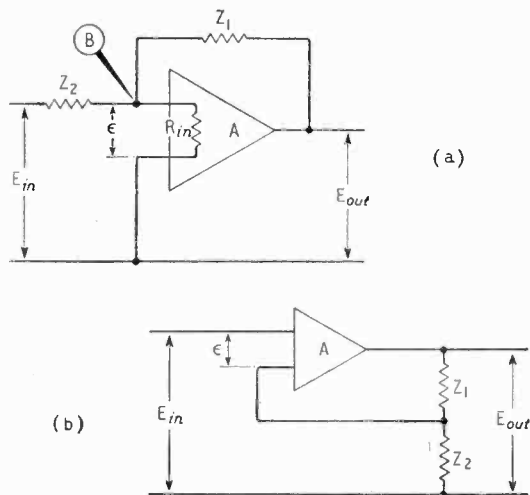
In Fig. 1(b) the closed loop gain will be $1 + Z_1/Z_2$ and will be accurately defined when the open loop gain is high. This being series feedback, the closed loop input impedance will be high enough to provide the correct loading for magnetic cartridges. The magnitude of the closed loop gain is always greater than unity, whereas the transfer function of equation (1) approaches zero as the frequency approaches infinity. Therefore, this type of feedback cannot provide the complete transfer function specified in equation (1). However, bass equalization is specified by the transfer function

$$f_b(j\omega) = \frac{K(1 + j\omega T_2)}{(1 + j\omega T_1)}$$

where K , T_2 , T_1 and ω are as before, and use of the network shown in Fig. 2 will produce the above transfer function.

Referring again to Fig. 1(b) then, provided that the signal current in Z_1 is very nearly equal to that in Z_2 and provided the open loop gain A is high compared with the maximum value of the gain $G(j\omega)$ when feedback is applied (a function of

Figs. 1 (a) and (b). Two types of feedback amplifier.



* English Electric Aviation Ltd.

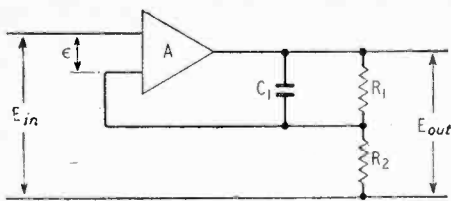


Fig. 2. Feedback amplifier providing bass equalization.

frequency), then $G(j\omega) = 1 + Z_1/Z_2$ to a high degree of accuracy.

In Fig. 2, Z_1 becomes R_1 in parallel with C_1 and Z_2 becomes R_2 . Thus

$$Z_1 = \frac{R_1/j\omega C_1}{R_1 + 1/j\omega C_1} = \frac{R_1}{j\omega T_1 + 1}$$

where $T_1 = R_1 C_1$

Therefore,

$$\begin{aligned} G(j\omega) &= 1 + \frac{R_1}{R_2(j\omega T_1 + 1)} \\ &= \frac{R_2(j\omega T_1 + 1) + R_1}{R_2(j\omega T_1 + 1)} \\ &= \left(1 + \frac{R_1}{R_2}\right) \left[\frac{1 + j\omega T_1 \left(\frac{R_2}{R_1 + R_2}\right)}{1 + j\omega T_1} \right] \end{aligned}$$

This is of the form

$$G(j\omega) = K \frac{1 + j\omega T_2}{1 + j\omega T_1}$$

where $T_2 = T_1 \frac{R_2}{R_1 + R_2}$ and $K = 1 + R_1/R_2$.

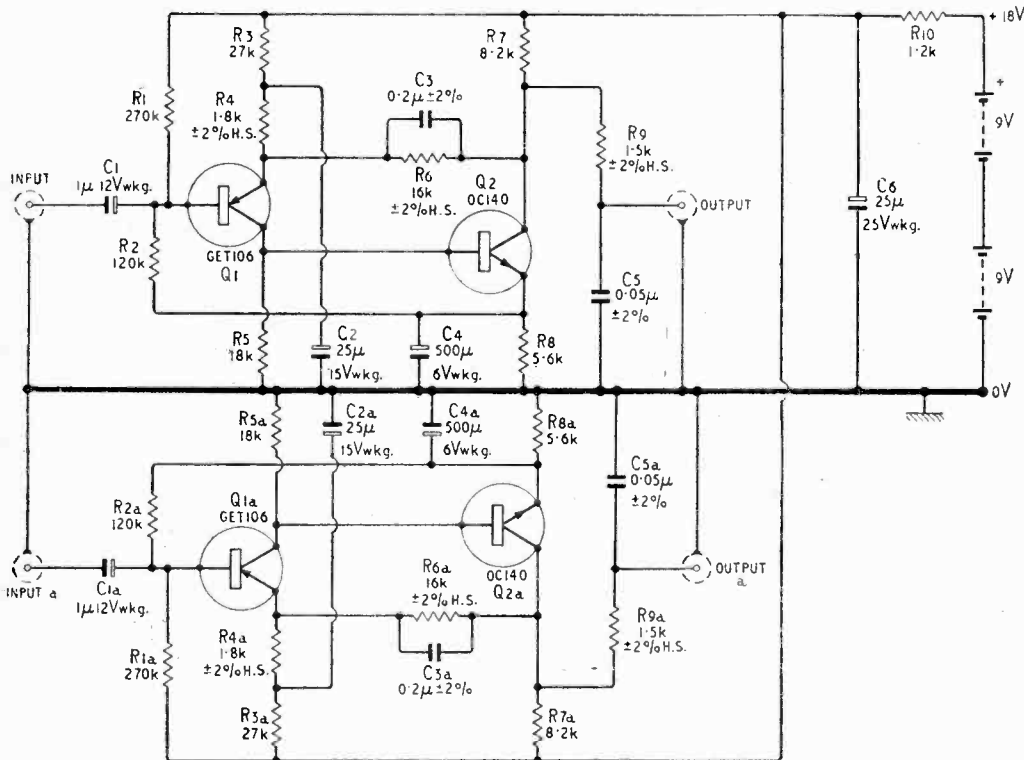
Thus if $T_1 = 3,180 \mu\text{sec}$, and $T_2 = 318 \mu\text{sec}$, then $G(j\omega) = f_b(j\omega)$. Thus bass equalization can be incorporated in the feedback loop.

In the circuit of Fig. 3, the components corresponding to R_1 , C_1 and R_2 in Fig. 2, are R_6 , C_3 , and R_4 respectively (and R_6a , C_3a , and R_4a for the other channel).

Treble equalization is accomplished by a simple C-R network (formed by C_5 and R_9 in Fig. 3) with a time constant of $75 \mu\text{sec}$, which is equal to the specified time constant. This C-R network is outside the feedback amplifier, and the time constant will not be materially affected by the low output impedance of the amplifier. The load on the output may be as little as $50k\Omega$ without affecting equalization accuracy.

It should be pointed out that the accuracy of equalization depends on component tolerances as well as the amount of feedback.

Circuit Details.—The circuit diagram of two pre-amplifiers is shown in Fig. 3. The transistors used are Q_1 , GET 106, a p-n-p low-noise transistor; and Q_2 , OC140, an n-p-n transistor. A p-n-p and n-p-n combination is used to facilitate direct coupling



Figs. 3. Circuit diagram of a stereo pickup pre-amplifier providing equalization for fine-groove records. All resistors are $\frac{1}{4}W$, $\pm 10\%$ (H.S. means high stability) and all capacitors $\pm 20\%$ unless otherwise shown. The GET106 may be replaced by an OC44, OC45 or XA102, but with a slightly higher noise level. The OC140 may be replaced by an OC139, but with more distortion.

TABLE 1: EQUALIZATION ACCURACY

Frequency c/s	20	30	40	50	60	80	100	150	200	300	500	700	1,000
Error dB	-0.1	0	0	0	0	+0.1	-0.1	0	0	0	0	0	0

Frequency kc/s	1.5	2	3	4	5	6	7	8	10	12	14	16	18	20
Error dB ...	0	0	0	-0.1	-0.1	-0.2	-0.2	-0.2	-0.1	-0.1	+0.1	+0.1	+0.2	+0.2

between the stages. The direct coupling avoids the low-frequency attenuation and phase shift associated with a coupling capacitor, thereby reducing the possibility of motorboating. Bass and treble equalization are accomplished separately; bass equalization within the feedback loop, and treble equalization outside. The d.c. conditions are stabilized by two d.c. feedback paths.

The battery supply is decoupled by R10 and C6, so that cross talk is minimized. (Alternatively, the units may be operated from separate power supplies.)

Input Circuit.—The first stage stands at approximately 300μA under quiescent conditions, and the collector-base potential is approximately 3.5V. These conditions result in close to optimum operation of the GET 106 as far as noise level is concerned.

Although the input may be applied between the base of Q1 and earth, it is possible to make the input connection such that much more cable capacitance may be tolerated. In this case, the cable will be double screened and is connected as follows:—

- (a) Outer screen: Between cartridge "earth" and earth on pre-amplifier.
- (b) Inner screen: Left unconnected at cartridge end and connected to emitter of Q1 at other end.
- (c) Inner wire: Between cartridge "live" and input to pre-amplifier.

These connections considerably reduce the effect of the cable capacitance, and enable longer cables to be used.

The reason for the reduction of the effect of cable capacitance is as follows. The cable capacity consists of two capacities in series, one between signal wire and inner screen, C_a say, and one between inner screen and outer screen, C_b say. The voltage across C_a is very small compared with the input voltage (being ϵ in Fig. 1b), and therefore its effect is much reduced. The voltage across C_b will be approximately the same as the input voltage, but instead of being associated with an input impedance of 100 kΩ, C_b is now connected to the low impedance point at the emitter of Q1 (compare the impedance at the cathode of a valve).

If C is the effective cable capacitance, and L the inductance of the cartridge windings, then there will be a peak in the output at a frequency which is approximately $1/2\pi\sqrt{LC}$, if the input impedance of the pre-amplifier is so high that the resonant circuit formed by L and C is underdamped. But C, the effective cable capacitance, is now very small, and with usual values of L, the peak in the response will occur at a frequency well above audibility, and the output will fall off thereafter.

D.C. Conditions.—The potential at the first base

is set by the potential-dividing chain of resistors R1, R2, and R8, which take approximately 30μA from the supply. By defining the potential in this manner, d.c. negative feedback is applied from the emitter of Q2 to the base of Q1, thus stabilizing the collector current of Q1. By using static complementary symmetry, direct coupling between Q1 and Q2 is achieved, whilst maintaining the correct potentials so that the feedback from collector of Q2 to the emitter of Q1 may be direct coupled.

The unit should in general be capacitively coupled into the succeeding amplifier, but the capacitor need not be larger than 0.5μF, provided that the load is not less than the recommended lower limit of 50kΩ. (The load will be the input resistance to the next amplifier.)

Performance.—The performance of the pre-amplifier is shown in Tables 1 and 2.

Table 1: Equalization Accuracy.—This was measured using average samples of the transistors specified, and Table 1 shows that the accuracy was ± 0.2dB from 20c/s to 20kc/s. (This accuracy may be more conveniently expressed as ± 2 centi-

Table 2: Miscellaneous Tests and Measurements

- (1) A large amplitude signal at 0.1c/s caused very little ringing or overshoot.
- (2) When a square wave of 5V peak-to-peak at 20kc/s was applied at the input the output showed no trace of ringing or overshoot.
- (3) A resistor of 560Ω was placed in series with the battery supply, and the equalization, even at bass frequencies, was completely unaffected.
- (4) A load of 3,300pF at the output caused an attenuation of 1dB at 20kc/s.
- (5) Input impedance: 75kΩ at audio frequencies.
- (6) Output impedance: 1.5kΩ at audio frequencies.
- (7) Maximum input at 30c/s, before clipping: 200mV r.m.s. Maximum input at 15kc/s, before clipping: 760mV r.m.s.
- (8) Total consumption (2 pre-amplifiers): 2.6mA.
- (9) Equalization accuracy completely unaffected when unit was at 60°C for one hour.
- (10) The clipping level was reduced by 1dB under the conditions of (9).
- (11) When the supply was reduced to 7.5V, equalization accuracy was ± 0.6dB, and the total harmonic distortion, measured at 3.5kc/s and 100mV r.m.s. output, was ≤ 0.05%.
- (12) Cross talk between the units was better than 55dB below 100mV r.m.s. at audio frequencies.
- (13) The measured gain of the unit at 1kc/s, feeding a 56kΩ load, was + 0.1dB relative to unity voltage gain.

bels!) The accuracy was also measured using transistors different to those specified, having current gains of 15 and 30 for Q1 and Q2 respectively, and was found to be within $\pm 0.5\text{dB}$ from 20c/s to 20kc/s. It should be noted that these values of current gain are lower than the manufacturer's published lower limits for the transistors specified. As noted previously, the accuracy of equalization depends upon the tolerances of R4, R6, R9, C3 and C5.

Distortion.—The distortion was measured at 3.5kc/s because a filter was available which attenuated the signal at 7kc/s by 70dB relative to the signal at 3.5kc/s. Thus a signal of 3.5kc/s with very little harmonic content was available. The distortion output of 100mV r.m.s. was unmeasurable, so the figure at 150mV r.m.s. output was measured, and found to be less than 0.015% total harmonic. When the output is 150mV r.m.s. the input is approximately 300mV r.m.s. which is of the order of ten times the peak output available from a magnetic cartridge and a microgroove disc at 3.5kc/s.

Table 2: Miscellaneous Tests and Measurements.—Results (1) and (2) show that the pre-amplifier is very stable. Result (3) shows that the unit's performance will not deteriorate as the battery ages (i.e. as its internal resistance gets higher). Result (6) indicates that screened cable up to 15 feet in length may be used at the output. Result (7) shows that the pre-amplifier will handle signals from a typical magnetic cartridge at well below clipping level. Results (9) and (10) show that the unit is unaffected by temperatures of up to 60°C (which is 140°F). Result (11) shows that the performance is but little affected by the supply voltage in the range 7.5 to 18V.

Noise.—To measure noise levels of better than -60dB with respect to 100mV r.m.s. requires a very sensitive valve voltmeter. The most sensitive valve voltmeter available had a full-scale deflection of 1mV r.m.s., and when the input of the pre-amplifier was terminated with a 600Ω wirewound resistor, the noise level did not register.

Listening Tests.—The unit was tested in conjunction with a Decca "ffss" stereophonic cartridge, an SME arm, and Leak power amplifiers, and the quality was clean and smooth throughout the audio range. The unit did not introduce audible noise when connected to the above equipment. Even when the supply was decreased to 3V, the difference in quality was only just noticeable.

Construction.—The layout is not critical, and the results should be within the design specifications in all cases. (In fact, the equalization accuracy should always be better than $\pm 0.5\text{dB}$ from 20c/s to 20kc/s.) When two pre-amplifiers are built for a stereophonic cartridge, then the signal-carrying wires of the separate pre-amplifiers should not cross or come near to one another, so that cross-talk is minimized. Also, as shown in the circuit diagram, the battery should be decoupled via R10 and C6 so that cross-talk due to an impedance in the battery, which is common to both channels, is less likely to occur.

The frequency response of the pre-amplifier may be made flat by omitting C3, C5 and R9, in which case the voltage gain will be 10 at all audio frequencies. The output impedance will then be close to zero, and the input impedance will remain at about 75 kΩ.

The pre-amplifier would seem to satisfy every requirement for reproduction of the highest standard and the equalization accuracy is better than in any amplifier known to the author.

Credit is due to D. A. Smith, late of English Electric Aviation Ltd., for helpful suggestions during the design of the unit.

Industrial Groups—V

AT the annual general meetings of both Camp Bird Ltd. and its associates Hartley Baird Ltd., shareholders asked if a list of companies within each group could be included in future annual reports. These suggestions were readily accepted by the respective chairmen, John Dalgleish (Camp Bird) and A. W. M. Hartley. As it will be nearly a year before effect can be given literally to these requests, we feel we may be doing a service to readers by publishing a list of companies in the Camp Bird Group of which Hartley Baird is a member.

Camp Bird is an old-established mining company with interests in Colorado and Canada but during the past few years its operations have been widened considerably and the group of nearly 40 companies now includes manufacturers of electrical, electronic, plastics and mechanical equipment and cold-forging plant.

John Dalgleish, the present chairman and managing director, joined the group when his company, Sapphire Bearings Ltd. was acquired. Sapphire Bearings, which was started in East London in 1952 with one machine for grinding sapphire tips for gramophone styli, became in three years "the largest sapphire engineering factory in the world." Its title was changed to E.V. Ltd. but is now operating as Electronic Reproducers (Components) Ltd.

Four years ago the Hartley Baird Group was acquired by Camp Bird. It was in 1954 that Baird Television Ltd. was amalgamated with the Hartley group of companies and the group became known as Hartley Baird. It continued for some time to produce domestic television receivers with the trade name Baird, but it will be recalled that Hartley Baird recently sold Baird Television Ltd. to Radio Rentals who now use the trade name Baird for their sound and television receivers.

We conclude this very brief and abridged history of the Camp Bird Group with some figures from the 1959-60 accounts. The group's share capital and reserves total £3,879,786. Its fixed assets are £2,296,417. The 1959-60 trading profit was £295,323 compared with £366,345 the previous year. The group, however, incurred a consolidated loss of £163,028 (after taxation and the transfer of £278,898 to capital reserve) against the previous year's profit of £272,151. The group's present constitution is:—

Camp Bird	Limit Tools & Gauges
Camp Bird Finance	A. Prince Industrial Products
Camp Bird Industries	Rubber Plastics
Camp Bird Investment Trust	Tenaplas
Camp Bird Mining	Vending Supply & Service
Camp Bird Securities	West European Industries
Cold Forging	
Coolers & Venders	Hartley Baird
Creston Electric	Baldwin, H. J., & Co.
Electronic Reproducers	Baldwin Central Products
Electronic Reproducers	Baldwin Durawire Cable Co.
(Components)	Baldwin Engineering
Grahams Trading Co.	Equipments
Hanworth Engineering (Aircraft)	Duratube & Wire
Inductoforce	Hartley Installations
Kelly Acoustics	National Rejectors
Lambert & Son (Eastcheap)	Salopian Industries (Metals)
Limit Engineering Group	Thermat
Limit Manufacturing Co.	Waldogram Properties
Limit Sales	Wireohms (Universal)

Transatlantic Radiotelegraphy

By A. M. HUMBY,* M.I.E.E.

PRESENT PERFORMANCE AND FUTURE PROSPECTS

EARLY experiments with very low frequencies led to the establishment in 1907 of the first commercial transatlantic radiotelegraph circuit, the two terminals being Clifden in Ireland and Glace Bay in Canada.

Due to the very long wavelengths involved (several thousands of kilometers) the efficiency of the aerial was low, its dimensions being necessarily relatively small. In consequence, despite the use of transmitters of several hundreds of kilowatts, the effective radiated power was often too small to produce a signal at the distant receiving terminal of sufficient strength to overcome interference from the high level of atmospherics experienced on these wavelengths. It will be appreciated that sharply directive receiving aerials designed to discriminate against such interference are impracticable on very low frequency systems. Nevertheless a worthwhile improvement of signal-to-interference ratio was frequently obtained by the use of suitably spaced Bellini-Tosi aerials associated with the radio receiving site.

Transmission was by Morse code at an average speed of about 20 words per minute, the precise speed being frequently adjusted (using the Z code) by quite small amounts throughout the day and night to suit the changing conditions of reception (e.g., ZSS3 = send 3 words per minute slower). The field strength of the signal and atmospherics were, as now, subject, independently, to diurnal and seasonal variations, and atmospherics also exhibited diurnal and seasonal changes in their predominant direction of arrival. On very rare occasions automatic reception at 50, or more, words per minute was possible—such occasions were probably coincident with the appearance of solar flares, the effects of which, we now know, may significantly increase the D-region ionization, and thus increase the intensity of v.l.f. sky-wave propagation. Unfortunately atmospherics from distant sources may also increase in intensity under such conditions.

By 1924 the number of long-distance low-frequency radio stations was about 50, but despite the high degree of technical efficiency reached by that date the proportion of world traffic carried by radiotelegraphy was extremely small.

Operation at High Frequency.—By 1926, however, a revolutionary change had taken place in that the short-wave (i.e., high frequency) beam system had been proved and introduced commercially. Transmitters of about 20kW in power enabled telegraph speeds of up to 300 words per minute to be recorded over extreme distances of the earth, and commercial circuits were set up in the United Kingdom to work with Australia, Canada, India and South Africa.

The use at the transmitter of highly directional aerials (made practicable by the use of high fre-

quencies) enabled the signals to be concentrated in the required direction thereby significantly increasing the effective radiated power. The use at the receiver of similar aerials resulted in a considerable improvement in signal-to-interference ratio, except of course when the direction of arrival of the desired and undesired signals was substantially similar.

Within two or three years several hundred high frequency stations had been set up, and the whole world became linked up by long-distance radiotelegraph channels. Analyses of circuit performance and frequency usage, and their subsequent correlation with solar, magnetic and other data materially assisted the development of long-distance radiotelegraphy disclosing, for example, that the optimum frequencies on any given route were critic-

*Royal Naval Scientific Service.

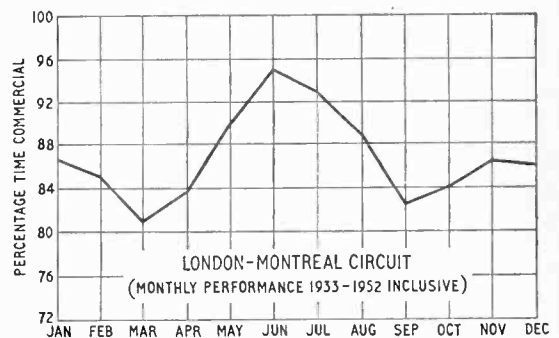


Fig. 1. Average monthly performance over the London-Montreal radio circuit for the years 1933 to 1952 inclusive.

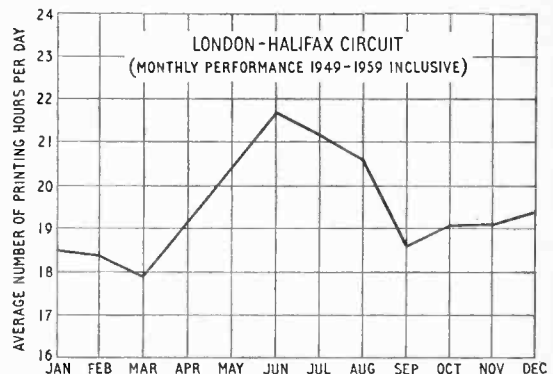


Fig. 2. Similar data to Fig. 1 over London-Halifax radio circuit for the years 1949 to 1959 inclusive.

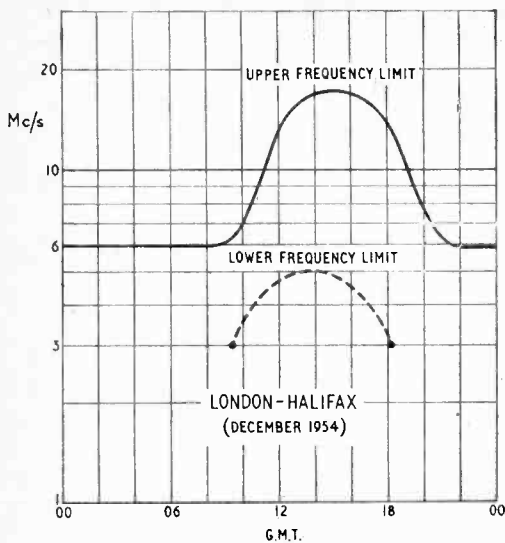


Fig. 3. Upper and lower usable frequency limits over the London-Halifax radio circuit for December 1954; year of minimum solar activity.

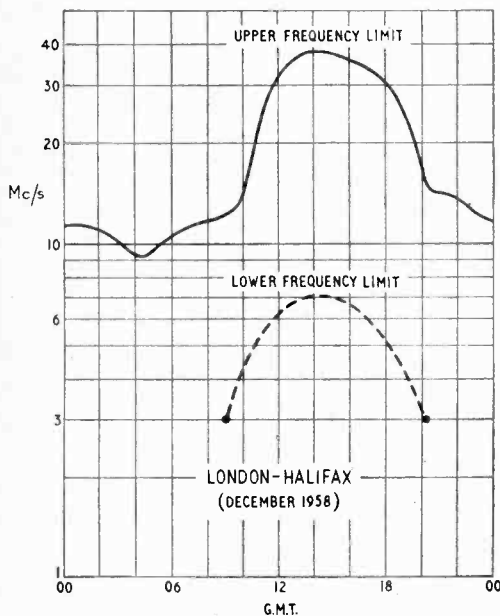


Fig. 4. Similar data to Fig. 3 but for December 1958; year of maximum solar activity.

ally dependent upon the epoch of the 11-year solar cycle, for any given time of day and season.

It very soon became apparent that, apart from solar-cycle considerations, certain circuits such as the transatlantic (the great circle paths of which pass close to, or through, the auroral zone) may be seriously disrupted at times of high magnetic activity, for example at the equinox periods. Figs. 1 and 2 depict the monthly performance, averaged over the number of years, of a London/Montreal and a London/Halifax circuit respectively, and it

will be noted that the circuit efficiency in each case was reduced to low values during the above periods, deterioration on each circuit being somewhat worse in March than in September.

In these days the upper and lower frequency limits for the operation of any circuit at any given season and time of day may be forecast within a fairly high degree of accuracy, and it is clear from such forecasts that the range of useful frequencies for a given season is considerably less in solar minimum years than in solar maximum years. See, for example, Figs. 3 and 4 which compare such data for the month of December in 1954 (solar minimum) with the same month in 1958 (solar maximum). The effect of a large magnetic storm is to severely restrict the frequency band as forecast for normal conditions; in consequence should a peak of magnetic activity coincide with low values of solar activity, such as in 1952¹ (solar minimum was in 1954) widespread interruptions to circuit operation would occur^{2,3}.

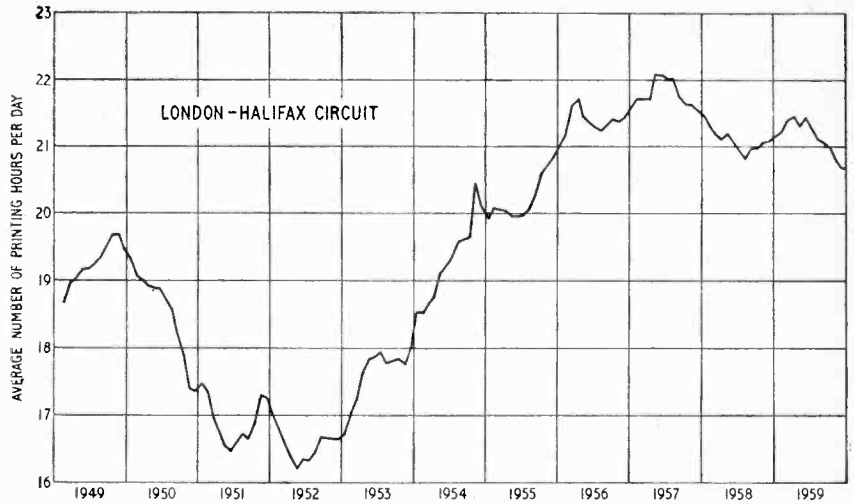
The extent to which the transatlantic route may be affected by such a coincidence of high-magnetic and low-solar activity may be estimated from Fig. 5 which shows that the average number of printing hours per day of the London/Halifax circuit mentioned earlier in this article was as low as 16½ for the 12 months ending May, 1952, as compared with over 22 hours for the 12 months ending May, 1957. Data for each individual month of the former period is shown in Fig. 6 from which it will be noted that the worst month was March, 1952, when the average number of printing hours per day fell to 12½. The diurnal change in performance for this month (of high-magnetic and low-solar activity) is compared in curve B, Fig. 7, with that for March, 1959, curve A, Fig. 7 (a month of low-magnetic and high-solar activity).

The well-known 27-day recurrence tendency of magnetic disturbance, so characteristic of solar minimum years, was the main contributory factor to the difficulties experienced in transatlantic communication during the 12 months ending May, 1952. This recurrence tendency is illustrated in Fig. 8 which plots magnetic activity in rows of 27 days each. In such a diagram, January 10th, 1952, for example, is directly over February 6th, 1952, and the 27-day interval represents one complete rotation of the sun. Presumably very active solar areas were continuously erupting streams of particles which swept across the earth for several solar rotations.

A substantial improvement in the performance of transatlantic radiotelegraph circuits operating in the high-frequency band can be effected by the introduction of a relay station so sited that the two legs of the system are directed away from the zone of auroral activity. Ascension Island and Barbados have proved to be suitable locations for such a relay station.⁴ However, in the case of severe magnetic storms unacceptable interruptions to traffic handling may still occur despite the use of a relay station. A recent example was the unusually intense storm of 1st/2nd April, 1960, which severely affected a considerable number of high-frequency circuits for periods varying from 24 to 36 hours.

Recent Developments and Future Trends.—Experience over the past few years has shown that a chain of stations operating by means of ionospheric and tropospheric scatter suffers significantly less inter-

Fig. 5. Twelve-monthly running average performance over the London-Halifax radio circuit for the years 1949-1959 inclusive.



ruption than the conventional direct, or relay, high-frequency link. In scatter systems of this type a small amount of the radio-wave energy is scattered from regions well above the earth's surface to areas beyond the transmitter horizon, the exact mechanism of propagation, however, being still not completely understood.

Largely because of signal-to-interference considerations ionospheric scatter systems operate normally in the 30-to-40-Mc/s band with transmitter output powers of the order of 50 to 100kW, associated with directive aerials, usually of the "corner reflector" type. The channel capacity is often limited to about four telegraph and one telephone channels, and the range of operation is from about 500 to 1,300 miles.

Tropospheric scatter systems, on the other hand, have a useful frequency range of from about 200 to 5,000Mc/s, and a channel capacity of many tens of telephone, or hundreds of telegraph, channels. They frequently operate with transmitter powers of some 20kW, or more, associated with 30- to 60-ft diameter dish" aerials. The range of operation however is often restricted to about 200 or 300 miles, but the

LONDON-HALIFAX CIRCUIT
(MONTHLY PERFORMANCE JUNE 1951-MAY 1952)

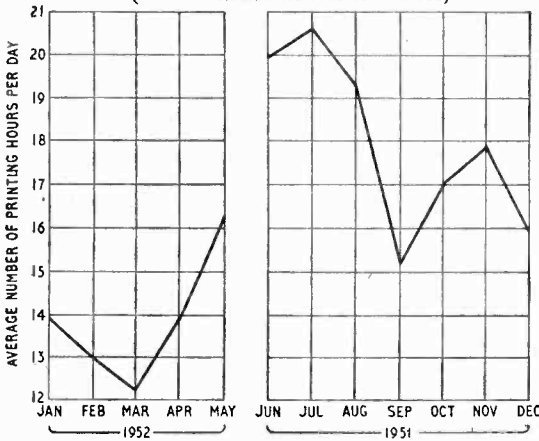
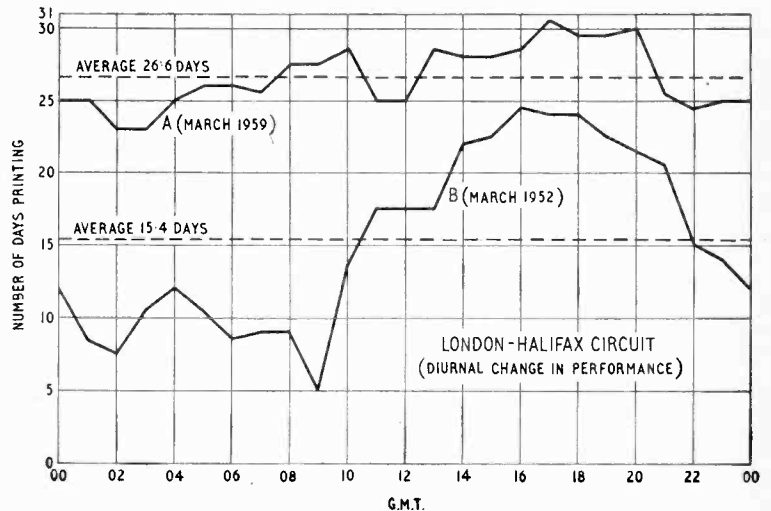


Fig. 6. Monthly average performance over the London-Halifax radio circuit from June 1951 to May 1952.

Fig. 7. Curves comparing diurnal changes in performance over the London-Halifax radio circuit for March 1952 and March 1959.



performance of well-engineered systems is usually very high. Under certain conditions, notably over sea routes, the above range may be extended to some 600, or more, miles.

With ionospheric scatter systems problems may sometimes arise from the occurrence of Sporadic-E reflections (and of F-layer reflections at times of very high-solar activity). In addition, circuit performance may be adversely affected by solar flares. For example, as a result of the big solar flare of February 23rd, 1956, measurements of signal strength of five ionospheric scatter circuits in high geomagnetic latitudes showed that abnormally high absorption was present during the sunlit hours of the next three

or four days⁵. As a result widespread interruptions to circuit operation occurred.

The demands for transatlantic radio-communication continue to increase, and it is now generally believed that satellite communications, using frequencies between about 1,000 and 10,000Mc/s, may well offer the best means for satisfying such demands. Indeed, transmission of radio signals between the earth and artificial earth satellites and other space objects is now an established fact. However, the need for extensive field trials is stressed before definite conclusions may be reached as to the practicability of obtaining signals sufficiently free from distortion and interference to meet the modern demands for continuously reliable high-speed multiplex telegraphy and data transmission.

The period 1963 to 1966 is likely to be one of extreme difficulties on the conventional high-frequency circuits; such difficulties may be even more pronounced than those of 1952 to 1955 (referred to earlier in this article) on account of the ever increasing volume of traffic and number of users.

Progress in space research has been truly phenomenal in the past few years, so much so in fact that satellite communication systems have been stated to be "just around the corner!" Time alone will show whether, or not, such systems may alleviate the inevitable difficulties with which the radio engineer responsible for high-frequency transatlantic radiotelegraphy will be faced about two or three years hence, difficulties at least of the order of those indicated in Figs. 6 and B of Fig. 7.

Acknowledgements.—The author wishes to thank Miss S. S. Aucken and B. W. Smith of the Royal Naval Scientific Service for their assistance in the presentation of the data in this article.

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AUDIO FESTIVAL

TICKETS for the Audio Festival and Fair, which is being held at the Hotel Russell, London, from April 6th to 9th, are obtainable free from audio and radio dealers; the Festival Director, 42, Manchester Street, London, W.1; or from the editorial offices of *Wireless World*. Applicants are asked to enclose a stamped addressed envelope. The Festival will be open each day from 11.0 to 9.0, but on the first two days admission up to 4.0 is restricted to holders of trade tickets which are issued to *bona fide* dealers and members of the industry.

There will be about 70 exhibitors at the show, most of whom will have demonstration rooms as well as stands. About 10% of the exhibitors are from overseas.

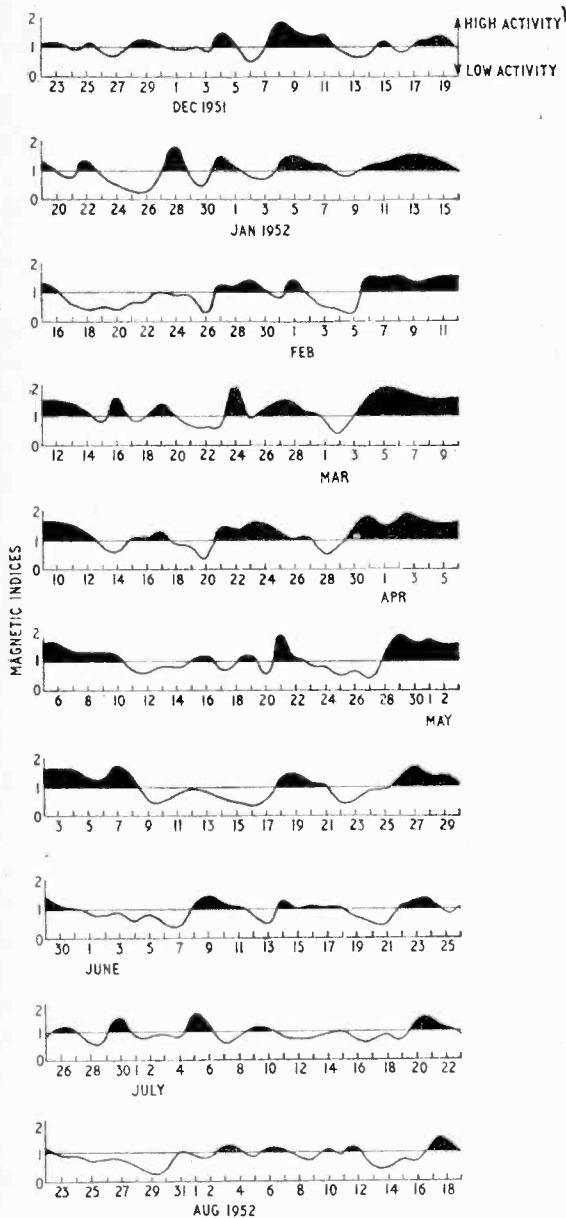


Fig. 8. Monthly magnetic activity during the solar low activity year 1952.

Applications of Frequency-Sweep Oscillators

2.—DIFFERENTIAL AND DERIVATIVE TECHNIQUES

By R. BROWN

(Continued from page 61 of the February 1961 issue)

AS has already been mentioned, the oscillator output always varies during the sweep. Even with the most careful design this variation cannot be reduced to less than about $\pm 0.1\text{dB}$, and with many instruments the output variation is considerably greater than this. This sets the limit to the accuracy with which any piece of equipment can be aligned using a direct amplitude/frequency display.

Differential Measurements

It is possible, however, using what are called differential methods², which display the difference between input and output of the equipment, to see variations in the amplitude/frequency characteristic which are as small as 0.01dB . Alternatively, differential methods will allow the use of a much cheaper instrument, having a large output variation with frequency, for precision applications.

The block diagram of a suitable set-up is shown in Fig. 8. This type of measurement technique is particularly suitable for the examination of the flat (or normally flat) top of the pass-band of the equipment under test. Both the input and the output of the equipment under test are monitored using two detectors. For best results both detectors should work at the same voltage level, so an attenuator should be included and adjusted to bring the overall gain of the amplifier-attenuator combination to unit. The output from these two detectors are then combined in a differential amplifier, whose output will be the difference between signals applied to the input and output probes. This difference signal can be amplified and then displayed on the oscilloscope. If, at any frequency, the gain of the equipment under test varies from that value for which the attenuator was set, there will be an output signal from the differential amplifier. Measurements thus made are independent of the degree of flatness of the output of the frequency-sweep oscillator.

First Derivative of Amplitude/Frequency Characteristic

In some applications where the direct display of the amplitude/frequency characteristic does not provide sufficiently accurate information to allow of the correct alignment of the equipment under test, an alternative method to differential measurements may be used. An example of this type of application is the alignment of the f.m. discriminators used in wideband multi-channel links. In order that the crosstalk between channels in such a link is kept to a minimum, it is essential that the centre

portion of the discriminator characteristic is linear, possibly within about 0.1dB . It would be rather difficult to see such small departures from linearity on a conventional amplitude/frequency display; if a display of the first derivative of the amplitude/frequency characteristic is produced, then such small departures from linearity can be easily seen.

Such a display can be produced with the aid of a composite signal, which consists of a frequency-swept signal additionally modulated in frequency at a much higher rate with a small deviation. Such a signal can be produced by mixing the output from a frequency-sweep oscillator with the output from a f.m. signal generator³.

How this signal can then be used to display the first derivative of the amplitude frequency characteristic can be seen from Fig. 9, which shows the characteristic of a typical wideband f.m. discriminator. The level of the modulation frequency in the output from the discriminator will, at any one point, depend upon the slope of the discriminator characteristic at that point: the greater the slope, the higher the level of the modulating frequency in the output. If the discriminator has been adjusted so that its characteristic is linear over the centre portion then the level of the modulation frequency in the output will remain constant as the frequency is swept across this band. Any departures from linearity will, however, show up as variations in the level of the modulation frequency. The output from the discriminator can, of course,

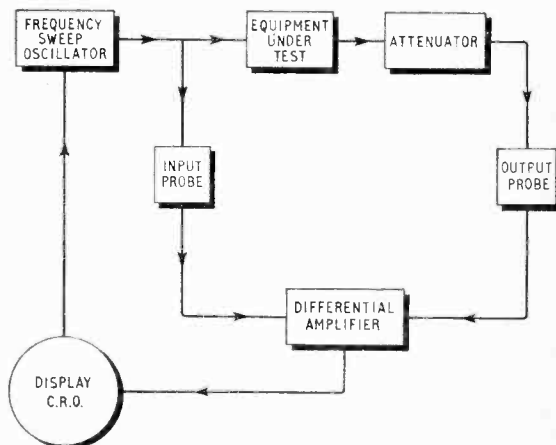


Fig. 8. Apparatus set up for differential measurements which overcome difficulties due to variations of oscillator output.

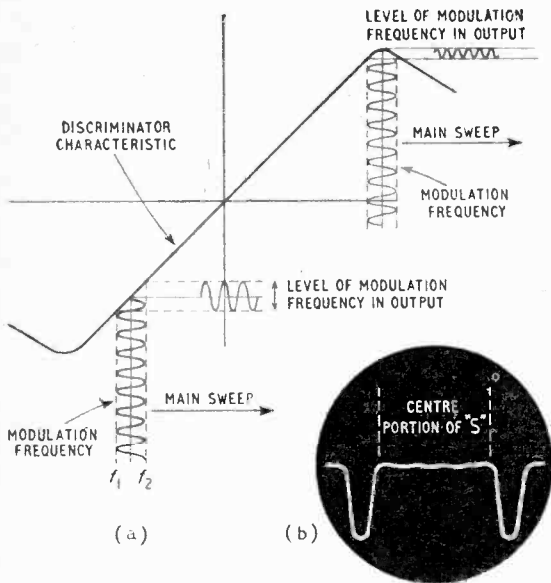


Fig. 9. (a) Production of first derivative of f.m. demodulator characteristic ("S"-curve) showing effect at two different points in the sweep and (b) display produced on c.r.o.

be amplified before being displayed, and in this way very small variations in discriminator linearity can be shown.

The display will, of course, show the average slope of the discriminator characteristic between f_1 and f_2 . The closer together f_1 and f_2 are made, that is, the narrower the deviation of the f.m. signal generator, the more accurate the display. The narrower the deviation, however, the lower the signal to noise ratio in the output, and the choice of deviation must be a compromise between accuracy and signal-to-noise ratio. There is a commercial instrument available which makes use of this technique, and in this instrument the deviation chosen is $\pm 150\text{kc/s}$ at 20kc/s .

The display can be calibrated by altering the level of the modulation in the output. The voltage displayed is proportional to the level of the modulation frequency in the output, so lowering this level in steps of, say, 0.2dB allows calibration lines at these levels to be drawn on the graticule of the display oscilloscope. The block diagram of the complete test arrangements for displaying the first derivative of the amplitude/frequency characteristic is shown in Fig. 10. Although the display of the derivative an f.m. discriminator characteristic has been described, this technique can be used to measure small non-linearities in many other types of characteristic. The transfer characteristics of valves and transistors are an example.

Phase Frequency Characteristic

In many applications, such as linear bandpass pulse amplifiers and amplitude-limited f.m. systems, the conditions for optimum operation are not that the amplitude/frequency characteristic should be flat, but that the phase/frequency characteristic should vary linearly with frequency. It is rather difficult to display the phase/frequency characteristic

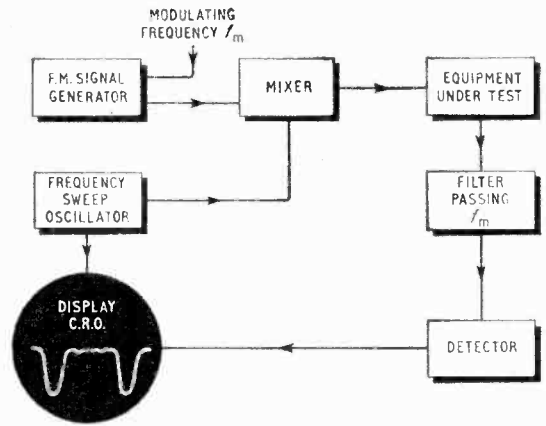


Fig. 10. Apparatus for display of first derivative of amplitude/frequency characteristic.

directly, and in modern amplitude-limited f.m. systems, the quality requirements are such that significant distortion can be introduced by curvature of the phase/frequency characteristic which would not be detectable on such a display. It is, however, possible to display the group delay of the system, or alternatively to display the second derivative of the phase/frequency characteristic of the system. Such a display will provide all the information necessary for accurate alignment.

Group-delay Measurements

The basic arrangement for the measurement of group delay by point-by-point methods is shown in Fig. 11. The r.f. output from the signal generator at a frequency ω (c/s) is amplitude modulated by the output from the l.f. oscillator. This l.f. oscillator has a sinusoidal output at a frequency p (c/s). The amplitude modulated signal is passed through the network under test, and demodulated. The phase of the demodulated l.f. signal p is compared with the phase of the l.f. oscillator output in a phase meter. The indicated phase difference will depend upon the group delay time of the network at the frequency ω .

In Fig. 12 is shown the phase/frequency characteristic of a typical network. For small values of p the phase shift of each sideband relative to the carrier frequency will be proportional to the slope of the phase/frequency characteristic at the frequency ω , and it will be equal to $p \cdot d\phi/d\omega$. The phase of the l.f. signal from the demodulator will also be shifted by this same angle. The phase meter will, therefore, indicate a phase difference $\Delta\phi$ where:—

$$\Delta\phi = p \cdot d\phi/d\omega = p\tau \quad \dots \dots \dots (4)$$

τ (secs) is the group delay at the frequency ω . Radians are the units for ϕ .

Thus if the frequency of the signal generator output is varied over the passband of the network under test, then any change in the group delay will produce a corresponding change in the reading of the phase meter. This reading will be directly proportional to the group delay, and hence the meter can be calibrated directly in group-delay-time units, usually millimicroseconds.

The main difficulty with this type of measurement

is that of sensitivity. This becomes more and more a difficulty as the accuracy of measurement is increased. From Fig. 12 it can be seen that the group delay actually measured is the average group delay between $(\omega - p)$ and $(\omega + p)$. To obtain the maximum possible accuracy, the value of p should be as small as possible. Unfortunately, the final value of phase shift measured by the phase meter is directly proportional to p , and this can be very small for high accuracy systems. As an example, using a frequency of 50kc/s for p , a group delay variation of 1μ s corresponds to a phase variation of only 0.017° . The phase-difference output with point-by-point measurements is, of course, a direct voltage or current and stable amplification of this signal is difficult.

Sweep Technique.—If the signal generator is replaced with a frequency-sweep oscillator and the phase meter with a device which will give a voltage or current output proportional to phase difference, then the usual sweep oscillator advantages of saving in time and skill will be obtained. There will now be an output signal which is proportional to phase difference and, as it is an alternating-current signal it is easy to amplify. There is, however, a disadvantage to the use of the swept-oscillator technique, a disadvantage which largely cancels out the advantage of having an easily amplified alternating-current output. This is that the bandwidth of the measuring circuits has to be very considerably increased. It can be as low as 1c/s for point-by-point methods; but may have to be increased to several thousand cycles for sweep-oscillator measurements so producing a considerable increase in the noise level. The level of the a.c. phase-difference signal will be proportional to the frequency of the modulating signal, p , and so by increasing p the signal to noise ratio can be increased; but this will, of course, be at the expense of accuracy. There are several instruments available commercially, and in these a frequency of 100kc/s has been chosen as the best compromise between noise level and accuracy.

The output from the demodulator will now consist of a p -frequency signal whose phase will vary as the frequency of the swept oscillator sweeps across the passband of the network under test. This output can be fed into any conventional phase detector and thence displayed on an oscilloscope. As a reference p -frequency signal is available from the i.f. oscillator a detector of the monode type (EQ80) is suitable. Some form of limiter stage preceding the phase detector will help to reduce the effects of noise.

Detector Distortion—Some means of maintaining constant the level of the i.f. signal at the detector diode is usually necessary. In most applications of this method of measuring group delay the demodula-

tor used will be part of the equipment under test and will be followed by video-frequency stages. The demodulator will give a certain amount of coupling between the video and i.f. stages and the displayed characteristics of the i.f. stages will depend to some extent on the degree of coupling. With wideband i.f. circuits the level of the signal is usually quite low and, consequently, the demodulator does not work over the linear portion of its characteristic. As a result the coupling between the video and i.f. stages will depend upon the level of the signal. Hence the characteristics of the i.f. stages and, therefore, the phase shift of the frequency p will vary with different signal level. This variation in phase shift will be interpreted on the display as a change in group-delay time and errors will be recorded. This effect is not serious, however, as, for any given signal level and to a first approximation, the phase shift will not vary significantly over the frequency band of the equipment. Measurements made at different signal levels will thus give group-delay characteristics which are of identical shape; but which are shifted vertically by amounts depending upon the signal level. The absolute value of the

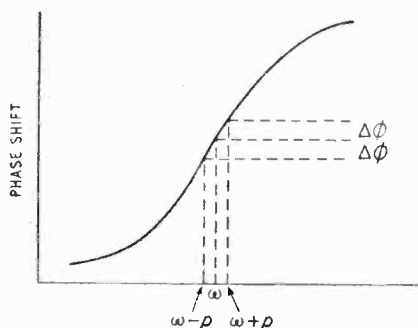


Fig. 12. Phase shift/frequency characteristic for a network, showing principle of group-delay measurements.

group delay is not important for most purposes—the important thing is how the value varies over the frequency band—and any constant shift in the group-delay characteristic can be ignored.

This effect is, of course, also apparent when making point-by-point measurements but here it is possible to connect a meter to read the level of the direct component of the demodulator diode output. The signal-generator output can then be adjusted at each frequency to give a constant reading. With a frequency-sweep test, this adjustment of diode signal level must obviously be done automatically and this can be achieved by the use of the direct component of the diode output to control the gain of a variable- μ amplifying stage connected between the frequency-sweep oscillator output and the input of the equipment under test.

If a valve with a suitable I_a/v_u characteristic is chosen for the control amplifier position, then the control voltage can be made roughly proportional to the logarithm of the gain of the equipment under test. This control voltage can then be displayed on the second beam of the oscilloscope used to display the group delay, which will give a simultaneous display of the group-delay and amplitude/frequency characteristics. This technique is particularly useful when the equipment under test is a filter

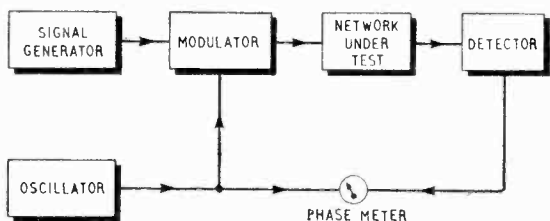


Fig. 11. Point-by-point measurements of group delay. The signal generator is, of course, an ordinary manually tuned type.

Display Calibration.—This can be done by switching a phase-shifting network in the path of either the comparison frequency signal to the phase detector, or in the path of the demodulated frequency- p signal. If we call the fixed phase shift introduced $\Delta\phi$, the result of switching it into circuit will be to move the whole displayed delay curve vertically over a distance corresponding to a delay equal to $\Delta\phi/p$.

Calibration of the amplitude scale may be carried out with the aid of the swept-oscillator attenuator; but the frequency axis presents difficulty, for active frequency markers which pass through the equipment under test cannot be used. This is because the marker output frequency, as well as the swept-oscillator output frequency, will be modulated by the frequency- p signal. The input voltage of the equipment under test will thus consist of two carrier frequencies, each with two sidebands (assuming only one marker is used). As a result of the beating which will occur between the swept-frequency carrier with its sidebands and the marker carrier with its sidebands a number of extra frequency- p components will be produced at discrete frequencies of the swept signal. At each of these discrete frequencies the extra frequency- p component will cause a sudden phase shift in the detector output, a phase shift which will show up as a shift in the displayed delay characteristic. A number of markers will thus be displayed, instead of a single marker. If active markers are used, they will have to be of the kind which does not pass through the equipment under test: alternatively passive markers may be used.

Derivative Display of Phase/Frequency

The phase/frequency characteristic of a network can be adjusted to vary linearly with frequency with the help of a display of the second derivative of the phase/frequency characteristic. If this characteristic does vary linearly with frequency over the required bandwidth then the second derivative of the characteristic will be zero over the same band (Fig. 13).

The second derivative can be displayed quite

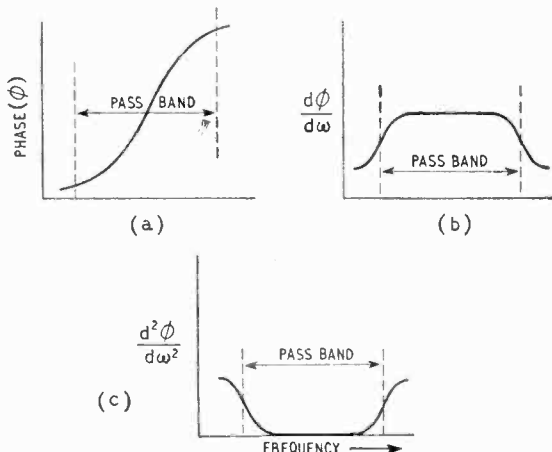


Fig. 13. (a) Example of a phase/frequency relationship compared with (b) its first derivative and (c) second derivative.

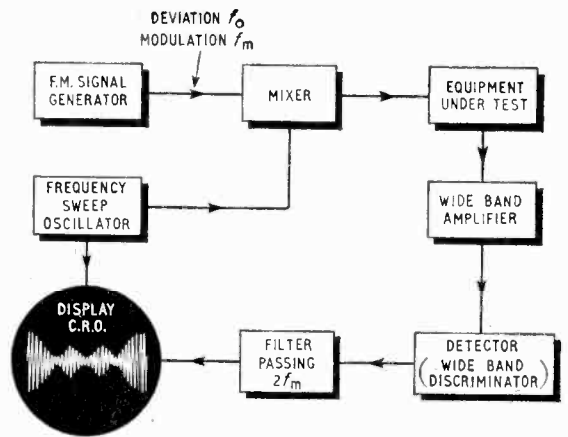


Fig. 14. Equipment arranged to display the second derivative of phase/frequency characteristic.

easily by making use of the fact that if a frequency-modulated signal is passed through a network, then the amount of second-harmonic distortion of the modulating frequency introduced by the network will be proportional to the second derivative of its phase/frequency characteristic⁵. The relationship can be expressed in the following manner:—

$$|D_2| = \frac{1}{2} \omega_a \Delta \Omega |d^2\phi/d\omega^2|_{\omega = \Omega} \dots \dots \dots (5)$$

where D_2 is percent. second harmonic distortion in the output: i.e. $D_2 = 100$ (level of 2nd harmonic in output/level of fundamental in output)

$$\omega_a = 2\pi f_m \text{ where } f_m \text{ is modulating frequency in c/s.}$$

$$\Delta \Omega = 2\pi f_o \text{ where } f_o \text{ is the deviation frequency in c/s.}$$

and $|d^2\phi/d\omega^2|$ = absolute value of the second derivative of the phase/frequency characteristic at the carrier frequency.

Here $\omega/2\pi$ is the frequency deviation, that is, the width of the phase/frequency characteristic occupied by the frequency-modulated signal (c/s). ϕ is the difference in network phase shift between the upper and lower limits of frequency deviation (radians).

Thus a display of the second-harmonic distortion of an f.m. signal passing through the network on one axis and frequency on the other axis will present quantitatively the data concerning the phase-curve curvature in the frequency band of interest.

If the output from a swept oscillator is combined with the output from a f.m. signal generator, the composite signal produced is suitable for use in a display of this sort. In Fig. 14 is shown the basic arrangement. Outputs from the frequency-swept oscillator and the f.m. signal generator (which has a frequency deviation f_o at a modulation frequency f_m) are combined in a mixer, and the output from the mixer is fed in to the equipment under test. The output from the equipment under test is fed into a wideband low-distortion discriminator whose output will consist of the modulation frequency f_m and, if there is any curvature of the phase/frequency characteristic, the harmonics of the modulation frequency. The modulation frequency f_m and third and higher harmonics are removed by a suitable filter, and the second harmonic of f_m is

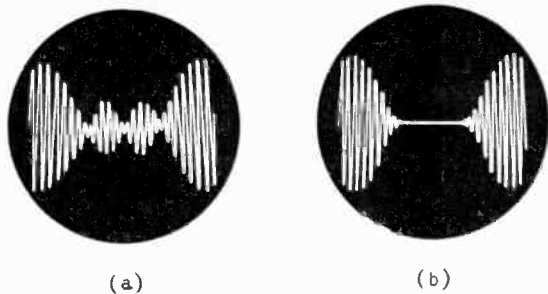


Fig. 15. Two typical second-derivative displays obtained with the equipment shown in Fig. 14. (a) shows the type of trace resulting from an amplifier that has been aligned to give a flat-topped amplitude/frequency characteristic, whilst (b) is the display given by an amplifier which has a phase/frequency characteristic varying linearly with frequency.

passed to the y-amplifier of the display oscilloscope. The timebase of the oscilloscope is locked to the sweep of the frequency-sweep oscillator. A phase-adjusting network is included between the timebase of the swept oscillator and the timebase of the oscilloscope. Also an amplifier is usually required between the equipment under test and the discriminator.

The phase-adjusting network enables the displayed waveform to be produced in the correct relationship with the horizontal deflection voltage applied to the oscilloscope; i.e. it can be made to appear on the "portion" of the sweep waveform responsible for its generation. Such a network may be necessary whenever the equipment being tested introduces an appreciable delay.

The filter must be adjusted to avoid excessive ringing as a result of the fast-changing levels; but at the same time it must provide sufficient selectivity to suppress adequately both the modulation frequency and its third harmonic. An attenuation of about 60dB for the modulation frequency is required.

There are certain precautions to be observed.

As with group-delay measurements the loading on the equipment being tested should not depend upon the i.f. level. If this effect is present, then some form of automatic level control will have to be included. The network under test should precede any limiting stages so that, for instance, the phase of the output voltage is determined before limiting and there should be no noticeable regeneration in the equipment being tested. The distortion produced by the discriminator and other pieces of test equipment should, of course, be negligible over the frequency band of the equipment under test.

Provided that these precautions are taken, the results compare well with the results achieved with other methods. Some typical oscillograms are shown in Fig. 15.

The frequency-sweep generator can be used for impedance matching: it is also invaluable for the adjustment of filters and display of their characteristics. These applications will be dealt with in the final part of this article.

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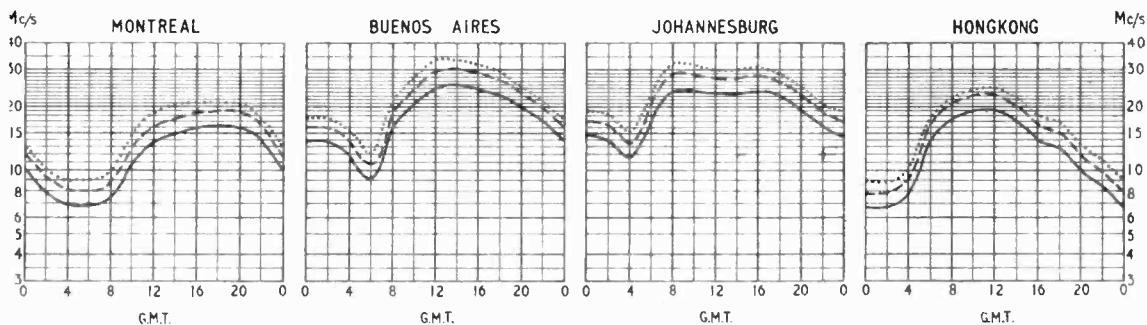
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(To be concluded)

SHORT-WAVE CONDITIONS

Prediction for March



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

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

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

SATELLITE TRACKING

Minitrack Station at Winkfield

THE Minitrack system of satellite tracking makes use of a number of teleprinter-linked stations in various parts of the world. At the new British station at Winkfield (Berks.) satellite positions are measured using two interferometers. (Basically, an interferometer consists of two pairs of spaced aerials. Signals from a radiating object are received at slightly different times at the two aerials of each pair owing to their spacing. From the time [or phase] differences for the two pairs, the two angular co-ordinates in space of the radiating object may be determined.)

At Winkfield each interferometer consists of two pairs of aerial systems placed at diagonally opposite corners of a square. Each aerial system consists of eight colinear slot aerials, and all the slot aerials in one interferometer lie in the same direction. This gives both interferometers a response which is narrow in the vertical plane through the line of their slot aerials, and broad in the vertical plane at right angles to this line. The slot aerials in one interferometer lie N and S and in the other E and W, so that the directivity patterns of the two interferometers are at right angles. According to the actual angular position of a satellite, the interferometer with the most suitable directivity is used for making measurements.

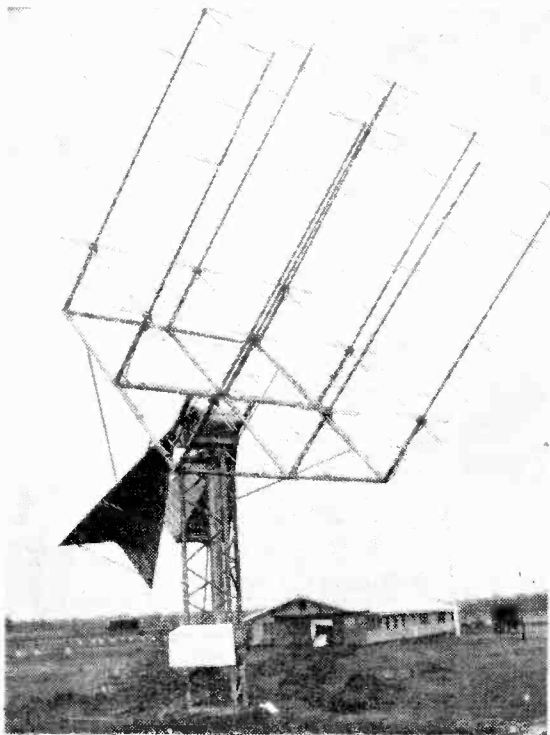
Since the element of each interferometer are spaced about fifty wavelengths apart, the phase difference between them nearly always exceeds 360 degrees. This introduces ambiguities in the satellite's angular position

which are resolved by measuring the phase differences between five single slot aerials (called ambiguity aerials), which are much closer together.

The phase difference between two signals is measured by converting them to intermediate frequencies differing by exactly 100c/s. This is done by means of two oscillators which also differ in frequency by 100c/s, this difference being phase-locked to a standard 100c/s signal. The two signal intermediate frequencies beat together to produce a 100c/s output whose phase then represents the phase difference between the two received signals. Corresponding points on the waveforms of this 100c/s output and the standard 100c/s signal are used to gate on and off a 100kc/s oscillator. The number of 100kc/s oscillations produced is then proportional to the phase of the 100c/s output.

At Winkfield there is also an aerial system for receiving data transmitted from satellites, and for transmitting signals to the satellite to alter its operation (for example, to make it transmit any recorded data). This aerial system consists of eighteen eight-element Yagis divided into nine pairs. In each pair of Yagis corresponding elements are placed at right angles to receive signals polarized in either of two directions at right angles. To receive circularly-polarized radiation, the outputs from the elements of each pair are added. The nine pairs of Yagis are mounted in a three-by-three array which can be oriented in any direction in space. The centre pair of Yagis in this array is used for transmission, and the remaining eight for reception.

Both these and the interferometers are designed for the 136-137Mc/s band which has been recently allocated for satellites by international agreement. (There are, however, as yet no satellites transmitting on this frequency.) At Winkfield there is also an aerial for receiving data transmitted on the currently-used frequency of 108Mc/s.



Aerial for receiving satellite data transmissions.

CLUB NEWS

Barnet.—At the March 28th meeting of the Barnet and District Radio Club R. C. Hills (G3HRH) will talk about aerials. The club meets on the last Tuesday of each month at 8.0 at the Red Lion Hotel.

Birmingham.—Mullards are providing a programme of films for the meeting of the Slade Radio Society on March 10th at 7.45 at the Bennett Hall, Y.M.C.A., Snow Hill. Admission is by ticket obtainable from M. D. Fowler, 25 Crossway Lane, Birmingham, 22B. At the meeting on the 24th D. Wilson will talk on his visit to Moscow. This meeting and the normal fortnightly meetings are held at 7.45 at the Church House, High Street, Erdington.

Cleckheaton.—The March meetings of the Spen Valley Amateur Radio Society include a lecture by Philips entitled "Audio in practice" on the 1st and a talk on electronics in the carpet industry on the 15th. The club meets at 7.30 at the Labour Rooms.

Leeds.—Subscriber trunk dialling will be discussed by H. E. Hulbert (G3BDR) at the March 1st meeting of the Leeds Amateur Radio Society. On the 28th M. Scargill will give a talk entitled "Radar systems illustrated." The club meets each Wednesday at 7.45 at the Swarthmore Education Centre, 3 Woodhouse Square.

Rhyl.—Meetings of the Flintshire Radio Society will in future be held on the last Monday of each month at the Bee Hotel. Details of forthcoming meetings are obtainable from L. W. Barnes, 1 Bryn Coed Park, Rhyl.

Ionosphere Review: 1960

DECLINING SUNSPOT ACTIVITY FORCING GREATER USE OF LOWER RADIO FREQUENCY

By T. W. BENNINGTON*

SINCE February/March 1958 the average solar activity has been decreasing, and throughout 1960 the decrease, as indicated by the 12-month running average of the sunspot number, continued at a relatively steady rate. At the end of the year, the value of this index of the solar activity was still, however, of the order of 110, which is a pretty high sunspot number, and one at which the ionization levels in the various ionospheric layers are still relatively high. However, though during the early part of 1960 the highest frequencies normally used for long-distance communication were the most efficacious, there was a definite tendency during the latter part for lower frequencies to become of most use, at least over certain circuits.

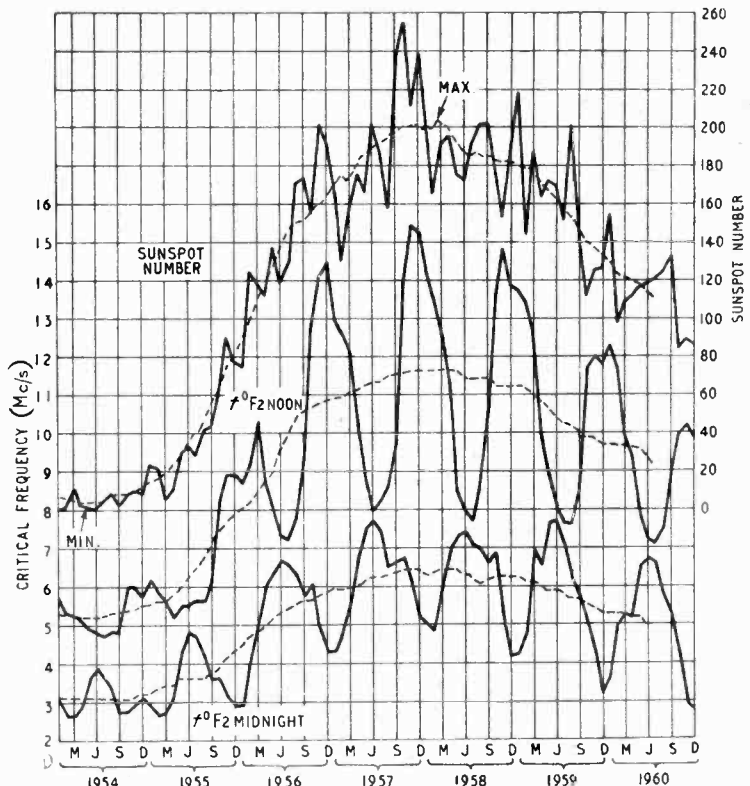
Course of the Sunspot Cycle.—In the graphs are plotted data which will serve to indicate how conditions have varied over the past few years. The upper graph is a plot of the sunspot numbers (indicative of the degree of solar activity) and the two lower graphs give the noon and midnight F2-layer critical frequencies as measured at the D.S.I.R. station at Slough (indicative of the level of F2 ionization). The full lines in each graph give the monthly mean, or median, values, and the dashed lines show the 12-month running average of these, and thus indicate the average conditions and the general variation in each quantity.

The monthly values of sunspot number have, since early in 1958, fluctuated widely but with a gradually decreasing tendency which, by the end of 1960, brought the value down to 86. The decrease in the 12-month running average was, during the latter part of 1958, very slow, but then became accentuated and has continued at a more or less steady rate ever since. Incidentally the downward slope of the running average sunspot curve may, in fact, be far from a smooth one. Though the average duration of a sunspot cycle is just over eleven years (which would place the minimum about 1965) those cycles of which we have record have lasted from just over nine years to nearly 14 years. So it will be gathered that predic-

tion of the future shape of the curve, and of the time of sunspot minimum, is a very speculative business. What is more or less certain, however, is that for several years to come the average sunspot number will have a relatively low value and the critical frequencies of the ionospheric layers will also be low, which situation will not be a good one for long-distance communication.

During the summer of 1960 the noon critical frequency was, it is seen, not greatly lower than that for the maximum year, but at the end of the year it was much lower than during the previous winters. The midnight critical frequency was considerably lower during the summer of 1960 than during the previous year, and at the end of the year it fell to

*Research Department, British Broadcasting Corporation.



Variations in sunspot activity with corresponding variations in ionospheric conditions, 1954 to 1960 inclusive.

exceptionally low values. Thus, towards the end of 1960, the general decrease in critical frequencies from those obtaining at sunspot maximum was becoming quite considerable.

Usable Frequencies.—In practice it was found that, in spite of the reduction in ionization, the 26-Mc/s broadcast frequency held up surprisingly well as a daytime working frequency throughout the year over certain circuits running in southerly directions from this country. Over more northerly circuits, however, 21Mc/s became the highest usable daytime frequency in April, May, August and September, and 17Mc/s in June and July. For example, over the North Atlantic circuits the highest receivable frequencies averaged about 39Mc/s at the beginning of the year, decreased to not much above 20Mc/s during the summer, and increased again to a little over 30Mc/s in the autumn. The highest receivable night-time frequencies increased to about 16Mc/s in the summer, but decreased towards the end of the year to values of the order of 11Mc/s, being then considerably lower than during the previous winter. The general tendency, in practice, was for the working frequencies to be considerably lower, both by day and night, at the end of the year than at the beginning, and for the higher frequencies to be usable for shorter periods over those circuits where they remained usable at all.

Ionospheric and Magnetic Disturbances.—There were less sudden ionospheric disturbances during 1960 than was the case during the previous two years, this decrease being associated with the decrease in sunspot activity, which gives rise to such disturbances. On the other hand the number of magnetically and ionospherically disturbed days was greater than during the previous two years. The solar particles which cause these disturbances upon arrival in the earth's atmosphere do not always emanate from sunspot regions, but, during the de-

clining phase of the sunspot cycle, appear to take the form of long-lived streams which come from solar regions where there is no visible sign of activity. The particle streams thus sweep across the earth's orbit once during each 27-day solar rotation, and produce ionospheric disturbances which tend to recur at 27-day intervals. There are indications that such a disturbance occurred from 3rd to 7th September 1960, and has recurred at approximately 27-day intervals ever since.

The Coming Year.—During 1961 solar activity is expected to go on decreasing so that, by the end of the year, the 12-month running average sunspot number may have fallen to a value (applicable to an epoch six months back) of about 80. It is likely that, in these circumstances, the 26-Mc/s band will, after about March, fail as a daytime frequency over all circuits. Over southerly circuits the best daytime frequency will probably be about 17Mc/s during the summer months, and 21Mc/s from September onwards. Over more northerly circuits daytime frequencies during the summer months may be as low as 15Mc/s, rising to about 17Mc/s about September. As to frequencies usable during the deep night period these may rise to 11Mc/s during the summer months, but next winter 9 or 7Mc/s will almost certainly be the highest frequencies usable, and perhaps even lower frequencies will be necessary over northerly circuits.

Thus, during 1961 the decline in solar activity is likely to be really effective in forcing the greater use of lower frequencies, with all the disadvantages which that implies. However, there is always the hope that in the future the situation may be somewhat relieved by the establishment of some new type of regular long-distance communication, such as that which might be effected in the v.h.f. or higher frequency bands by way of active or passive satellites.

BOOKS RECEIVED

Radio Construction and Repairs, by W. Oliver. Presents advice to the beginner in radio construction and servicing, starting with basic matters such as the avoidance of electric shock and making up a tool kit. It provides practical hints in dealing with the various circuits and mechanical features found in modern radio sets.

Pp. 128; Figs. 23. Price 10s 6d. W. Foulsham and Co. Ltd., 2-5, Old Bond Street, London, W.1.

R.S.G.B. Amateur Radio Call Book, 1961 edition: compiled and published by the Radio Society of Great Britain, New Ruskin House, Little Russell Street, London, W.C.1. Based on the record of call signs issued to amateurs by the Radio Services Department of the G.P.O., the book provides an up-to-date list of amateur radio stations in Great Britain, Northern Ireland and the Channel Isles. Useful additional material in the 1961 edition is a list of affiliated radio societies and clubs with addresses and list of international amateur radio prefixes. Price is 4s (post 4s 6d).

Service Valve Equivalents, 2nd edition: compiled by G. C. Fox and published by the Radio Society of Great Britain, New Ruskin House, Little Russell Street, London, W.C.1. The CV list of Service valves is considerably extended and now includes c.r. tubes and semi-conductors. Additional lists identify early Army, Navy and R.A.F. types with CV numbers and there is a

list of U.S. Signal Corps VT numbered valves with equivalents. Price 2s (2s 6d by post).

Paramètres Hybrides des Transistors, by J.-P. M. Seurot. Puts forward the case for hybrid parameters in transistor circuit design. The author discusses the theory of four-terminal networks in general, and transistor applications in particular, and goes on to demonstrate the use of hybrid parameters in the design of a typical high-frequency amplifier stage. Pp. 32; Figs. 23. Editions Chiron, 40, Rue de Seine, Paris-6^e. Price 8.80 NF.

Masers, by Gordon Troup. One of the Methuen series of Monographs. An exposition of present knowledge on the theory of amplification and oscillation by stimulated emission. The description of the basic effect is approached from both the thermodynamic and quantum mechanical viewpoints, while a large part of the discussion is closely linked to the science of microwaves. Amplifier and oscillator systems and their performances are described, and chapters on experimental systems and possible applications are included. Appended are discussions on the quantum-mechanical treatment of the harmonic oscillator and on the theory of paramagnetic ions in a crystal field and a steady magnetic field. Pp. 168; Figs. 20. Methuen and Co., Ltd., Publishers, 36, Essex Street, Strand, London, W.C.2. Price 13s 6d.

LETTERS TO THE EDITOR

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

Colour Television

YOUR Editorial in the January issue gives small credit to the motives behind the B.B.C. proposal to introduce a small service of colour television on the 405-line system. While we would not claim always to be immune from the desire to use a beautiful toy, this is certainly not cause and effect in the present case. Colour television using an N.T.S.C. form of signal has been accepted by most of the countries participating in the work of the C.C.I.R., and transmissions on this basis are already regularly put out in the U.S.A., U.S.S.R. and Japan. The B.B.C. experiments to which you refer demonstrated that, on 405 lines, this form of signal would give an excellent picture, and the B.B.C. wants to introduce a limited service of colour as a natural development of our experimental transmissions of the past five years. We started television in this country, and we do not want to be behind the rest of the world in colour.

It is not true to say that the B.B.C. has backed the shadow mask tube. Of course, we have made use of it as it is the best tube yet available. But it is not an inherent part of the N.T.S.C. form of signal, and other types of tube, when they become available, could operate on this system. Acceptance of an N.T.S.C. signal would in no way limit the development of other, and possibly better, types of colour tube.

HAROLD BISHOP,

Director of Engineering,

London, W.1. British Broadcasting Corporation.

Stereophonic Broadcasts

MR. GOTCH, in his letter in the January issue, has very rightly pointed out a weakness of stereophonic broadcasts using an a.m. TV sound transmitter for the right-hand side, in that many listeners will find the signal-to-noise ratio poor compared with that of the left-hand side received on v.h.f. There are, of course, other weaknesses. For example, broadcasts can only be made during free time of both the B.B.C. television network and one of the sound networks; also, the system is not compatible, since a properly balanced reproduction cannot be obtained when listening to one of the channels alone. It is natural, therefore, that there should have been a number of proposals in the U.S.A. and on the Continent, as well as in the U.K., for multiplex systems which can modulate two audio signals on to a single f.m. transmission, in such a way as to provide acceptable reproduction for the monophonic listener. However, all these systems have the disadvantage that they cannot maintain the present high standard of signal-to-noise ratio throughout the same service areas.* We cannot put two signals in place of one on an existing transmitter without paying a price in terms of a considerable reduction in the service area for stereophonic reception and an unacceptable reduction in the case of the ordinary listener. The contraction of the service area results from an increased level of interference due to the ignition systems of cars and to transmissions from other stations on the same or adjacent radio channels.

The problems of stereophonic broadcasting using a multiplex system are not only quite difficult on the radio side, but exacting requirements are imposed on other

* B.B.C. Engineering Monograph No. 29, "A Summary of the Present Position of Stereophonic Broadcasting," by D. E. L. Shorter and G. J. Phillips.

parts of the transmission network. It is for this reason that the B.B.C. is co-operating with other members of the European Broadcasting Union in a study programme covering transmission systems and other problems of stereophonic broadcasting. While everyone would wish for a system that has no penalties, stereophonic broadcasting appears at the present time to be a costly matter in radio frequency channels as well as in other directions. The present stage of development is one of careful examination and comparison of the various proposals in the laboratory.

The present arrangement for the B.B.C. transmissions of stereophony is so clearly one that could not be used for a regular service that there is no danger that the public would buy special receivers for it. If, however, experimental transmissions were made using a system which appears suitable for regular transmissions, then the public might buy receivers designed for this system only, and the eventual introduction of some other system that could more nearly satisfy the various requirements would be prejudiced. There is, therefore, a strong argument for continuing the present arrangement, even with its shortcomings, at least until the technical problems are nearer a solution than they appear to be at present.

G. J. PHILLIPS,

Tadworth, Surrey. B.B.C. Research Department.

Nodal Analysis

MANY of us will have appreciated F. R. B. Jones's articles on Nodal Analysis (November and December issues, 1960) but may have found difficulty through the author's use of the same symbols for different quantities. It was of little importance in the section of Part 2 on transistors where the Y-parameters of the transistor and of the whole circuit were intermingled in a happy ambivalence, but some of us may not have noticed that the i_a of the opening equations is not the same quantity as that i_a of, say, Fig. 2(b), and in consequence the description of Fig. 3 may then have turned us away in despair. If so, then a second look would be well worth while.

The difficulty hinges on the discrepancy between the primal equation and the equation for node 2; the left-hand sides are equal, but on the right-hand sides we find in one i_a and in the other zero, yet we are assured that i_a is not zero.

Now reconsider the primal equation:

$$g_m v_a + g_a v_a = i_a$$

In it i_a is the resultant of two opposing currents, for v_a is negative, but in Fig. 2(b) i_a is identified with the grid-controlled component, $g_m v_a$, whereas it should designate the current flowing into Y_1 . If we apply the same principle to Fig. 3, i_a becomes zero and the discrepancy between the primal and nodal equations disappears, for they are in fact the same equation. The nodal equation is only true for $i_a = 0$; if i_a has a value other than zero, say $y_a v_a$, then the nodal equation becomes

$$g_m V_1 + (g_a + y_a) V_2 = 0$$

and the current, i_a should appear in Fig. 3 as a load current.

If the readers who fell at this fence now find they can clear it, they will find the rest of the course straightforward and rewarding.

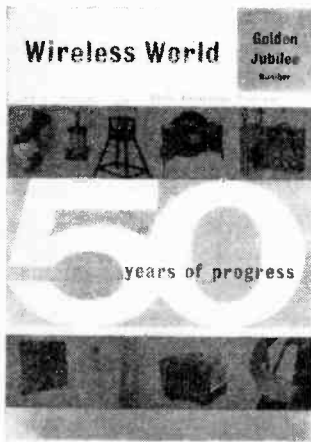
London, N.W.11

F. G. BALCOMBE

The author replies:

The difficulty to which Mr. Balcombe refers is in par

The First 50 Years



Our next issue marks the completion of the first 50 years of publication.

The enlarged April number, in addition to the normal coverage of technical articles and news of the month, will contain a 20-page illustrated review of progress over the past 50 years. This will record the outstanding events in the progressive understanding of principles and in the history of their applications in communications and electronics.

due to the unavoidable differences between the conventions of mesh and nodal analysis.

If we confine our mesh analysis of the valve to the output circuit, Fig. 2(a) in the December issue we have only one current, i_a , which can be regarded as either generator current or load current, although the term "anode current" does link it with the generator.

In a set of nodal equations the right-hand terms, I_1, I_2, \dots, I_n , conventionally signify the currents fed to the various nodes by external constant-current generators. For example, in the equivalent two-node network for a valve, I_2 would represent current supplied by an external generator connected between the anode and reference point. This generally occurs only in non-linear mixing circuits, and so is of no interest to us.

When we convert our constant-voltage valve to the constant-current form shown in Fig. 2(b), the generator current becomes $g_m v_g$. In the static case (no load) all this current flows out through g_a and by Kirchhoff these two currents, from a nodal standpoint, equal zero, since they are equal and one is flowing into the node and the other out. I_2 is thus zero, as we would expect.

If we now introduce a load, the generator current $g_m v_g$ remains constant, but the total shunt impedance decreases, and with it v_a . $g_a v_a$ will therefore be smaller and the difference between it and $g_m v_g$ will be the load current. If this load current is termed i_a , we can indeed write $g_m v_g + g_a v_a = i_a$, for—as Mr. Balcombe states— v_a is negative and the two left-hand terms are subtractive. This interpretation may be helpful to students, but I think they should also clearly understand that this i_a (the load current) is not the conventional I_2 of the basic nodal equation.

Television Standards

IF Britain adopts the 625-line system as used in Europe, the choice of intercarrier sound frequency will present a problem. Should we use 5.5 Mc/s as in Western Europe, 6.5 Mc/s as in Eastern Europe, or a new value such as 6 Mc/s? I suggest two intercarrier frequencies of 5.5 and 6.5 Mc/s, one carrying TV sound and the other a sound-radio programme. In each area u.h.f. coverage of at least three television and three sound programmes ("Home," "Light" and "Third") could then be achieved, the advantage of a stable intercarrier i.f. being obtained for sound-radio reception as well as for TV sound.

Provided that the receivers were equipped to accept either sound channel with or without picture, they

would operate anywhere in Europe. Also our intercarrier frequency for TV sound could easily be changed from 5.5 to 6.5 Mc/s, or *vice versa*, if either frequency were to become the international standard in the distant future.

Ewell, Surrey.

J. S. SINGLETON

Horizontal and Vertical Definition

THE start of a picture element where the brightness signal undergoes a step function can only be placed with infinite certainty on the receiver screen if the bandwidth of the connecting circuits is infinite. Since in practice the bandwidth is finite, the raster example put forward by Mr. R. C. Whitehead in your January, 1961, correspondence columns is not a practical one. All the bandwidth available is used in passing information occurring along a very few lines, say, two or three, for the whole picture.

On January 8th, the B.B.C., I know not whether by accident or design, dressed its Showtime Dancers in striped tights, giving about critical definition during the programme. The result was rather startling on the receiver I happened to be watching. The stripes were just visible when the girls' pretty limbs were vertical, when the distinguishing information was along the line. As the dance progressed the stripes were presented at greater inclinations to the vertical, and became clearer, the more inclined, being clearest when the stripes were horizontal.

The performance of the set seems to satisfy a large number of people who have access to other receivers.

Harwell, Berks.

J. D. HILL

Screen Size

NOTING the reference by "Diallist" (December, 1960, issue) to our larger screens and to picture loss in the screen corners, I would call attention to a recently published paper on this topic in the November, 1960, "Radio Fall Meeting" issue of the *I.R.E. Transactions of the Professional Group of Broadcast and Television Receivers*. The paper, "Benefits of a New Aspect Ratio for Television," written by Mr. W. D. Schuster of Sylvania and myself, both questions the current propriety of the 4:3 aspect transmission standard in the U.S. and advocates even squarer corners for picture tube screens than on present 19in and 23in expansions of the 17in and 21in faceplates (approximately 5:4 aspect ratio).

As this item of aspect ratio directly influences equipment saleability, it also relates to frequency spectrum utilization, sweep power consumption and reliability as well as costs.

A request has been made to have the 4:3 aspect transmission standard reviewed by an appropriate committee.

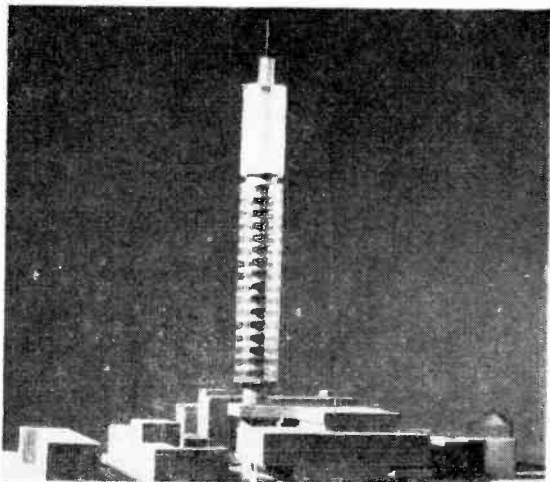
It is understood that the British transmissions were at one time on 5:4 aspect, dropped in favour of accommodating film with no loss, on early sets.

Both Britain and the U.S. might beneficially compromise on a standard which could combine 525 line, 60 field transmission (6 megacycle channel) with 5:4 aspect transmission to accelerate international signal exchange. This would raise detail resolution in American sets and do the least damage to the currently good resolution possible with British transmission channel-width and fewer lines, and slower frame scan, if single sideband is included in the above "compromise" proposal.

It is difficult to maintain "best" theoretical viewing distances here—my teenage daughters and their contemporary friends have for over 7 years preferred to sit within elbow-reach of a 27in screen. No one feels that the picture is "too large," even at such close quarters, or at more "proper" separation.

CHARLES E. TORSCH,

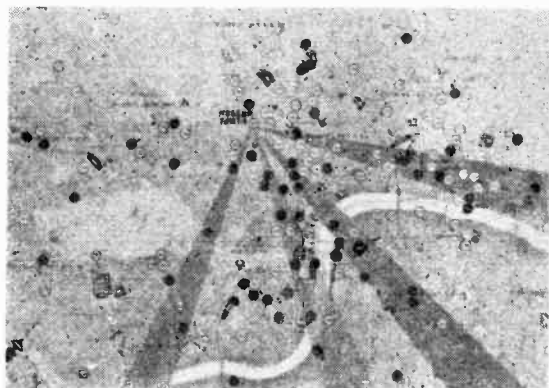
Chief Television Engineer, Rola Company.
Cleveland, Ohio, U.S.A.



500-FT RADIO TOWER

LONDON'S NEW LANDMARK

Model of the radio tower which will dominate London's skyline.



Dots represent existing or proposed buildings in London which would obstruct signals from the present mast. The shaded segments indicate possible radio links.

"WE shall have to ask the architects of - - - House to leave a hole through the building on the 10th floor so that our signals will continue to have an uninterrupted line-of-sight path." This somewhat facetious remark of an engineer at the Museum Exchange—nerve centre of the G.P.O.'s microwave links—epitomizes the position with which the Post Office has been faced for some time with the increasing number of tall buildings being erected in London. To increase the number of cable links sufficiently to carry even the foreseeable growth in the number of television and trunk telephone links would mean ripping up miles of London streets. To overcome the problem, therefore, a 500-ft tower is to be built at the Museum Exchange in Howland Street, London, W.1, to replace the lattice mast on the roof of the building which has an effective height of only 180 feet. This was erected when the original London-Birmingham television link was installed in 1949.

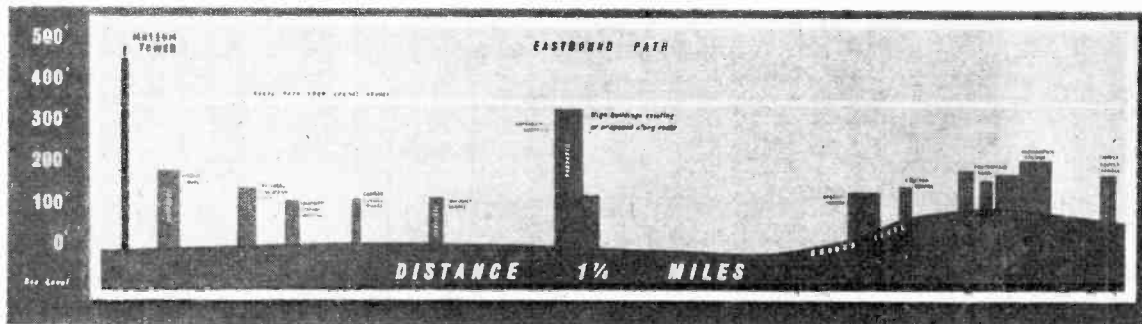
It is hoped to have the new tower, which will be 50ft in diameter, in operation by the middle of 1964. It is to be built alongside and in conjunction with a four-storey extension to the present buildings and will be sited to avoid obstructing paths of radio links from the existing mast.

The upper section, from 355 to 470ft, will house the aerials and this section will be surmounted by an observation gallery to which the public will have access

by high-speed lifts. The 15 floors below the aerial section will house the transmitting and terminal equipment.

In addition to being the focal point for the Post Office trunk telephone service the Museum Exchange is also the switching centre for the inter-connection of the B.B.C.'s radio and television network, the I.T.A. network of transmitters and the numerous independent television studios in the London area.

The P.M.G. says that the tower will meet the Post Office's foreseeable needs for radio links for the next 40 years. For example, it is expected that by 1980 there will be 24 radio-telephone links, each capable of carrying 960 telephone channels. This number could be doubled in the following 20 years without reducing the proposed 100 or more television outlets.



Typical radio path eastwards from the lowest aerial on the proposed tower which, as is shown, would just clear the highest proposed building in that direction.

Elements of Electronic Circuits

23.—Squares and Square Roots

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

CIRCUITS can be made up which produce outputs proportional to either the square or the square root of the input. Naturally, the multiplying arrangements described in last month's issue could be used for square production by the connecting together of the two inputs; but for square-rooting a different technique has to be used.

Square-producing Circuits

An important group of square-producing circuits makes use of the approximately parabolic shape of mutual characteristics of valves. For a triode or

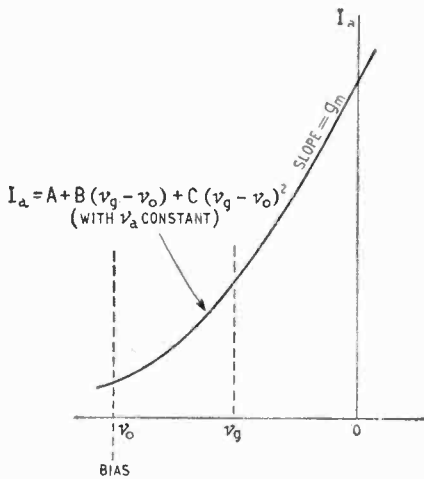


Fig. 1.

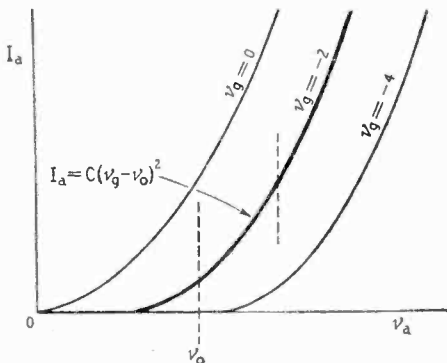


Fig. 2.

pentode one suitable curve is the I_a/v_g characteristic, with v_a held constant (Fig. 1).

The series $I_a = A + B(v_g - v_0) + C(v_g - v_0)^2 + D(v_g - v_0)^3 \dots$ etc. represents the true form of this curve where A, B, C, etc., are valve constants and v_0 is a reference voltage from which measurements are taken.

It is possible to find valves with characteristics to which the terms higher than the square term make relatively small contributions. Assuming that we can neglect higher order terms than the square term the series becomes:—

$I_a = A + B(v_g - v_0) + C(v_g - v_0)^2$. Note the presence of the linear term $B(v_g - v_0)$.

Accuracy is increased if the range of operation of the grid voltage is restricted to confine the squaring to the part of the curve that most closely matches the desired form.

For the triode the series is also applicable for a specific anode load; but there is no such restriction in the case of a pentode which has mutual characteristics almost independent of v_a even when v_0 varies widely.

The anode characteristics (I_a/v_a with v_g held constant) of some triodes are of approximately parabolic form, i.e. $I_a = C(v_a - v_0)^2$ and can therefore be used as square-producing devices. Characteristics are illustrated in Fig. 2.

Removing the Linear Term.—Compensation can be applied to remove the linear term $B(v_g - v_0)$ from the I_a/v_g series, thus permitting operation near the vertex of the parabola, i.e. $v_g = v_0$.

Fig. 3 shows a square-producing circuit with a compensating network (R_2 and R_3 are much greater than R_1). The linear term $B(v_g - v_0)$ in the valve

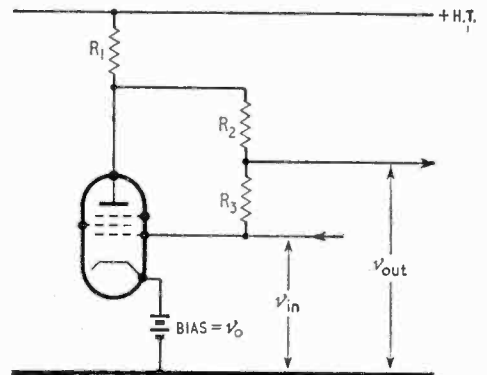


Fig. 3.

equation will result in the appearance at the valve anode of an amplified (depending on R_1) and inverted version of the input voltage, as well as the square term. If the gain of the valve is one and $R_2 = R_3$ the linear term from the valve and the input will be equal and opposite and will cancel each other at the junction of R_2, R_3 , leaving the square term. If the required value of R_1 is such that the gain is other than unity, adjustment of R_2, R_3 will restore cancellation.

Valves for Squaring.—As the mutual conductance $g_m = dI_a/dv_g$ (i.e. the slope of the mutual characteristic), it follows from differentiation of the I_a series with respect to grid voltage (no further than the square term) that, for a suitable "squaring" valve, g_m must be a linear function of grid voltage. Reference to graphs of valve characteristics will therefore indicate the suitability or otherwise of a valve for the squaring application.

Push-pull Circuits.—(Fig. 4). If we define the input voltage to valve V1 as $v_{in} = v_g - v_0$ then $I_{a1} = A + Bv_{in} + Cv_{in}^2 + Dv_{in}^3 + Ev_{in}^4 \dots$ etc. Now suppose we drive an identical valve V2 with the same input voltage but opposite in sign ($-v_{in}$) then $I_{a2} = A - Bv_{in} + Cv_{in}^2 - Dv_{in}^3 + Ev_{in}^4 \dots$ etc. As I_{a1} and I_{a2} flow through a common resistor R the common anode voltage will be $v_{ht} - R(I_{a1} + I_{a2}) = v_{ht} - 2(A + Cv_{in}^2 + Ev_{in}^4 \dots)$. Note the cancellation of the odd-power terms when the anode current components are added.

It is assumed that the even-power terms Ev_{in}^4 and higher are small enough to be ignored, then with a.c. inputs v_{out} will be of the form $v_{out} = -2RCv_{in}^2$. In other words, v_{out} will vary as the square of the input voltage.

Square Roots

Let us now turn to circuits which provide an output voltage proportional to the square root of the input voltage. Again, valve characteristics can be employed.

Valve Characteristics.—If the anode voltage of some types of pentode is varied, the anode current changes in such a way that it approximately represents the square root of the anode voltage. Fig. 5 illustrates for a pentode typical anode characteristics from which operating conditions can be selected to roughly conform with the law:—

$$v_a = kI_a^2 \text{ or } I_a \propto \sqrt{v_a}$$

A circuit which makes use of this property is shown in Fig. 6. The pentode, V2, has its anode voltage controlled by the cathode follower, V1. Varying v_{in} and hence v_{2a} causes the anode current of V2 to vary as $\sqrt{v_{2a}}$. As this is the current through V1 the voltage developed at the anode of V1 by R (i.e. v_{out}) will vary as $\sqrt{v_{2a}}$ and hence as $\sqrt{v_{in}}$. This method is rather inaccurate as the square-root law usually holds only over a small range of the characteristic.

Another direct method which will give an approximate result is to use the I_a/v_g characteristic of a triode, i.e. $I_a = A + Bv_g + Cv_g^2 \dots$ discussed in the section on squaring circuits. If we now make I_a the independent variable and v_g the dependent variable, neglecting the linear term Bv_g , v_g is

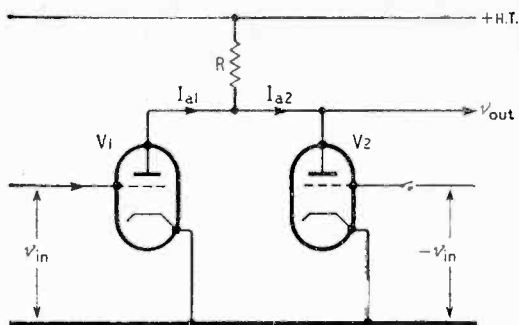


Fig. 4.

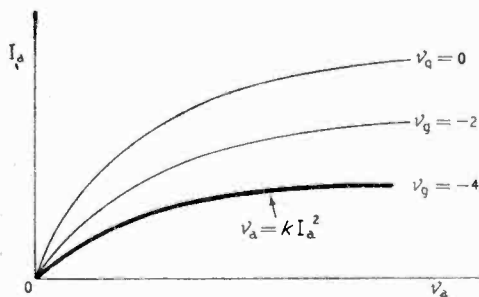


Fig. 5.

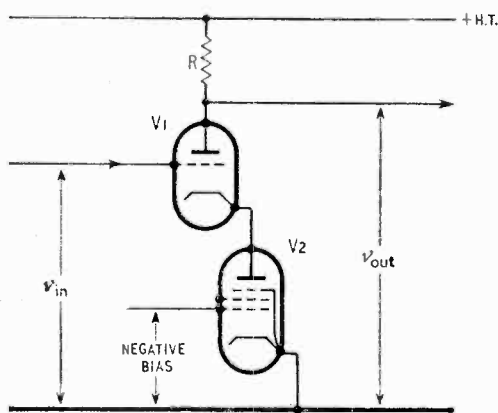


Fig. 6.

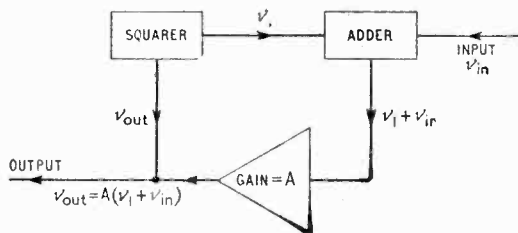


Fig. 7.

approximately proportional to $\sqrt{I_a}$. Inaccuracies arise in this method due to the difficulty in eliminating the linear term Bv_g .

Accurate Method.—An important method which is used in some computers involves an adding circuit together with feedback via a high-gain amplifier. The feedback makes the output of a squaring circuit equal to the input signal whose square root is wanted. If the output of the squarer is equal to the input to be "rooted," then the input to the squarer must be the desired square root.

In Fig. 7 let v_{in} be the input, the square root of which is desired, i.e. it is required to derive the result $v_{out} = \sqrt{v_{in}}$.

The equations are:—

$$v_1 = -kv_{out}^2 \quad \dots \quad (1)$$

(from the squarer)

$$v_{out} = A(v_1 + v_{in}) \quad \dots \quad (2)$$

(from the amplifier)

substituting in (2) for v_1 we have

$$v_{out} = A(-kv_{out}^2 + v_{in})$$

Hence

$$v_{out} + Akv_{out}^2 - Av_{in} = 0$$

rearranging, we have

$$Akv_{out}^2 + v_{out} - Av_{in} = 0 \quad \dots \quad (3)$$

Equation (3) is of quadratic form $ax^2 + bx + c = 0$, for which the solutions are given by:—

$$x = \frac{-b \pm \sqrt{(b^2 - 4ac)}}{2a}$$

substituting from Equation 3 above:—

$$v_{out} = \frac{-1 \pm \sqrt{(1 + 4A^2kv_{in})}}{2Ak}$$

$$\text{or } v_{out} = -\frac{1}{2Ak} \pm \sqrt{\left(\frac{1}{4A^2k^2} + \frac{4A^2kv_{in}}{4A^2k^2}\right)}$$

$$= -\frac{1}{2Ak} \pm \sqrt{\left(\frac{1}{4A^2k^2} + \frac{v_{in}}{k}\right)}$$

If the gain (A) of the amplifier is very high, $1/A$ becomes very small so that the equation reduces to:—

$$v_{out} = \pm \sqrt{(v_{in}/k)}$$

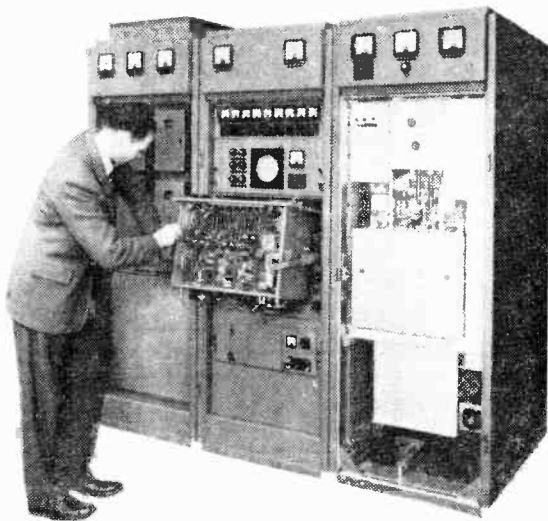
which is the result required. The constant k can be made equal to one.

BORDER TELEVISION

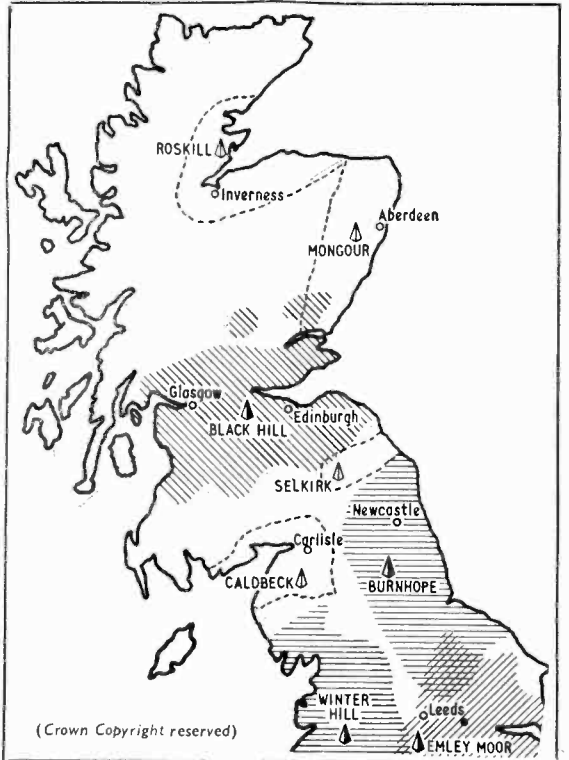
THE I.T.A. has placed orders with Marconi's for the transmitters for the two television stations which are to serve the Anglo-Scottish border area. The main transmitter, which with its 16-stack quadrant array on a 1,000-ft mast will give a vision e.r.p. of 100kW in the direction of maximum radiation, will be at Caldbeck, near Carlisle. The site is 1,000ft above sea level. Caldbeck will operate in channel 11 with horizontal polarization.

The associated station will be at Selkirk where the signals radiated from Caldbeck will be picked up and fed to vision and sound translators and re-radiated in another channel (yet to be decided). Selkirk will have a vision e.r.p. of 25kW.

The approximate service areas of these two stations, which will be operated by Border Television Ltd., are



Marconi 4-kW vision transmitter with sub-modulator withdrawn for test purposes. Two of these transmitters are being installed at Caldbeck



Predicted service areas for four new I.T.A. stations in Scotland and northern England

shown dotted on the map giving service areas of existing I.T.A. stations. Caldbeck is planned to come into service this summer and Selkirk at the end of the year.

The predicted service areas of the two stations planned for north-east Scotland are also shown on the map. The Mongour station, which will have a maximum vision e.r.p. of 400kW, is scheduled for service this autumn and the Roskill transmitter (10-50kW e.r.p.) a few months later.

Permanent Magnet Circuits

By "CATHODE RAY"

THE reason for my choice of subject this month is that last month's—Electricity Direct from Heat—leads helpfully into it. I hasten to assure new readers (if any) that failure to have read it is not a fatal handicap. In fact, those who did read it are probably busy wondering what on earth it had to do with permanent magnets. Apart from one passing mention of a permanent magnet as a component of a briefly described device, nothing—directly. But we shall see.

To prevent disappointment I must also disclaim any intention of explaining in detail why permanent magnets—or any other kind—are magnetic, beyond mentioning that all matter is potentially magnetic because the protons and electrons that form its main ingredients are electric charges and are in continuous motion, and electric charges in motion are electric currents, and electric currents cause magnetic fields. These tiny fields normally tend to cancel one another out because of their random distribution. In a small number of substances (called ferromagnetic) they can be made to cooperate to produce a strong magnetic field so long as they are held in formation by a current flowing through a surrounding coil. When the current is switched off, heat vibrations tend to restore the original chaos. The extent to which this happens depends on the particular material; in those suitable for permanent magnets the greater part of the magnetism is retained, and quite a strong reverse field is needed to restore it to zero.

However, our subject is permanent magnet circuits. *Permanent* magnet circuits; because although most of the books on electrical engineering and on electricity and magnetism explain quite clearly the principles of electromagnets and how to calculate the number of ampere-turns to produce a given flux in a given gap, the corresponding information on permanent magnets is usually less satisfactory or even entirely absent. Considering the vast

number of permanent magnets used in loudspeakers, gramophone pickups, meters and television focusing, this is quite surprising.

All the treatises I have come across draw an analogy between electric circuits (which, with the aid of Ohm's law, etc., one is supposed to understand) and magnetic circuits. This may immediately cause a misunderstanding in the minds of beginners, who are aware that a certain amount of power is needed to maintain the flow of current in an electric circuit (unless, of course, they have had a look at the end of the book and read about Kammerlingh Onnes and superconductivity) and conclude that power is needed to maintain the flow of flux (what is flux if it doesn't flow?) in a magnetic circuit. Sure enough, power is needed to energize an electromagnet. So a permanent magnet appears from the start as a mystery.

This is because the electric/magnetic analogy is being wrongly used. The power supplied to an electromagnet (after the initial building up of the field by an amount of energy that is returned to the circuit on switching off) is occupied solely in overcoming the resistance of the circuit. If it were not for that resistance, no e.m.f.—and therefore no power—would be needed, just as no current—and therefore no power—is needed to maintain an electric field between the plates of a capacitor. The everlasting currents started in resistanceless lead rings at very low temperatures by Onnes and his followers are accompanied in the usual way by magnetic fields, although no e.m.fs are present. If the fields needed power to sustain them, the currents would quickly die away.

Correctly used, the analogy is very helpful, for magnetic circuits have their "Ohm's law" and "Kirchhoff's laws", as we shall see. The important thing is to make sure that the quantities compared are the ones that truly correspond.

In a d.c. circuit in which all the resistances are

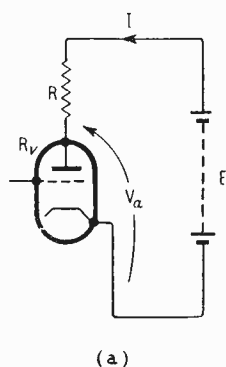
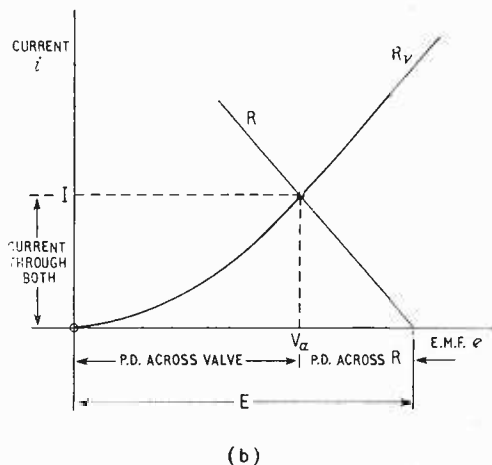


Fig. 1. (a) Simple valve circuit with load resistance R . (b) is the familiar load-line graphical method of finding the current I and anode voltage V_a .



linear (i.e., they obey Ohm's law, in the sense that they are independent of the amount of current) it is simple to calculate the current that will flow when a given e.m.f. is applied, or vice versa. When part of the resistance depends on the current in a manner that can be stated as an equation, it is a little more complicated, but can still be done by algebra. When the relationship between resistance (or voltage) and current can be stated only as a graph, then the calculation has to be done graphically.

I am assuming we can all do this in the familiar situation of a valve in series with a linear resistance, as in Fig. 1(a). If the e.m.f. (e) applied to the valve is varied and the corresponding current is plotted, we get the familiar anode characteristic curve marked R_v in Fig. 1(b). R_v actually stands for the valve's anode d.c. resistance (at a fixed grid bias), which of course is equal to e/i at any point. The question is, which point represents the situation when a total e.m.f. E is applied through a linear or ohmic resistance R ? This is answered by plotting current against voltage for R too; not in the usual way from the zero point, as for R_v , but backwards from the point representing E on the e scale. The justification for the backward plotting is that the voltage concerned is what must be subtracted from E to find the particular anode voltage required, V_a . In this case (though not with all valves, as we saw when studying tunnel diodes in the August 1960 issue) the two lines have only one point in common, which represents I and V_a , the only values of i and e that fulfil the conditions of the circuit. The voltage across R is of course $E - V_a$.

Next, let us look at the magnetic analogue of this electrical circuit, Fig. 2(a). Corresponding to the current I is the flux Φ , represented by the dotted lines. In spite of its name, nothing really flows, so in this respect flux is unlike current, but for the present purpose that doesn't upset the analogy. This flux is caused by a total magnetomotive force M , applied as a current through a coil. The magnetic analogue of resistance is reluctance. The flux passes "in series" through an air section of the circuit with a linear reluctance S_a , and a magnet with a non-linear reluctance S_m . The procedure for finding Φ is the same as for I : ϕ is plotted

against F for magnet and air in turn, back to back as for R and R_v , and the intersection shows Φ and also the magnetic p.d. across both parts of the circuit (Fig. 2(b)).

By now the bright boy of the class will inevitably have put up his hand to ask why, if one can measure F and ϕ , one doesn't do it for the whole set-up shown in Fig. 2(a) and arrive at Φ at one go, instead of taking a lot of extra trouble to measure them for the magnet and air separately at a sufficient number of values to plot curves of them both. Well, of course, if one were given a particular electromagnet and wanted to find how much flux it would produce with a given current through the coil, one would adopt the bright boy's suggestion. It would apply to the valve in Fig. 2 as well, in similar circumstances. But the circuit designer (electric or magnetic) doesn't try innumerable ready-made combinations until he is lucky enough to find one that does what he wants. He designs on paper, calculating the value of R that best suits the valve having the most likely-looking curve. In the magnetic example he usually has even more freedom, being able to vary the dimensions of the material to suit his requirements. It would be silly to be obliged to have a different S_m curve for every possible size and shape of magnet; what is needed is a single curve that applies to that material in general.

This sort of thing hardly works with valves; we cannot (unless we are going to order vast quantities) tell the maker we would like a valve with characteristics similar to his type XYZ but with the current scale multiplied by $1\frac{1}{2}$. The resistance of homogeneous materials is much simpler, being proportional to the length (l) and inversely as the cross-sectional area (a). The only other factor is the resistiveness of the material itself—its resistivity (ρ), which is the resistance of a piece with unit l and unit a . In symbols,

$$R = \rho \frac{l}{a} \quad \dots \quad (1)$$

Given ρ , we can easily calculate dimensions of a resistor for any required resistance. If the resistivity is non-linear, we must have a graph of it, and to suit the change from resistance to resistivity, it must

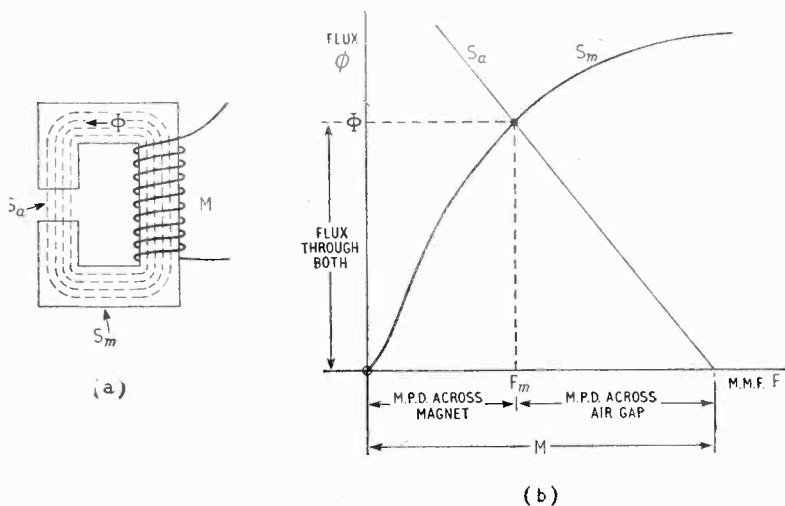


Fig. 2. Magnetic analogue of Fig. 1. The flux Φ corresponds to current I , m.m.f. to e.m.f., and reluctance (S) to resistance.

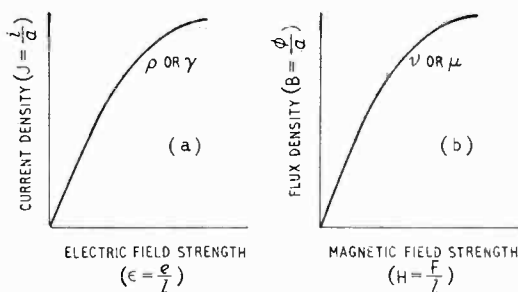


Fig. 3. (a) To transform the current/voltage graph of a resistor into a general one for its resistive material, the current is divided by the cross-sectional area of the resistor, and the applied voltage is divided by the length. (b) is the magnetic analogue, well known as a B/H curve.

show current *per unit area* (i.e., current density) plotted against e.m.f. *per unit length* (i.e., electric field strength). Fig. 3(a) is such a graph, marked ρ to correspond with R_v in Fig. 1(b), and perhaps even more appropriately γ , which is the symbol for conductivity, $= 1/\rho$, because that is what is indicated by the slope of the graph.

There is even better ground for adopting this modified form of graph for ferromagnetic materials, which are invariably non-linear. Fig. 3(b), the magnetic analogue of (a), is the familiar B/H curve of commerce and should need no explanation except to mention that ν is the symbol for reluctivity ($= H/B$) which is the reciprocal of the much better known permeability, μ . The equation corresponding to (1) is therefore

$$S = \nu \frac{l}{a} \text{ or } \frac{1}{\mu} \frac{l}{a} \dots \dots (2)$$

Given this B/H curve for any material, any desired flux can be obtained by multiplying B by a , and the corresponding F by multiplying H by l . If a core consists of several sections in series, each with a different a and l , their separate magnetic potential drops can be calculated and added together to give the total m.m.f. required to maintain the desired flux throughout. In practice it is seldom quite so simple, because magnetic circuits have no insulator appreciably better than air, which usually allows a significant amount of flux leakage; but I must dodge that complication by declaring it to be outside the scope of this article.

By this time some of the dimmer boys may be putting up their hands, wanting to know how ϕ and F are measured. I must dodge the question about ϕ too, but F is calculated rather than measured. This raises the question of units, and I am counting on us all being sufficiently progressive to work in m.k.s. units, even magnetic ones. The unit of m.m.f. is (surprisingly to the older generation) the ampere. In an electromagnetical context it is commonly called the ampere-turn, because it is the *total* current linked with the magnetic circuit. The unit of H is therefore the ampere (or ampere-turn) per metre (of magnetic circuit length). The unit of flux is the weber, which is equal to 10^8 "lines" or maxwells. The unit of B is therefore the weber per square metre (of magnetic circuit cross-sectional area).

If there are any non-progressive (i.e., c.g.s.) readers, they will be wondering how we are managing

to retain their simple relationship $B = \mu H$ and yet calculate H without any 0.4π —and what about the 10^9 ? It must be admitted that all the untidy factors have been swept under the carpet, the carpet in this case being μ . Instead of being 1 for vacuum, as in the c.g.s. system, it is $4\pi/10^7$. This apparently shabby practice might seem to reflect no credit on the m.k.s. system. This is not the place to justify the m.k.s. system, but in my opinion it would be worth its awkward values of μ and ϵ even if it had no other advantage than confining arbitrary constants to those two things. Even some dirt under a couple of carpets may be tolerable if one can rely on there being none anywhere else.

A more pertinent criticism might be to inquire whether I had forgotten that the title—a long while since, by now—was *Permanent Magnet Circuits*. I'm sorry if anyone has tired of waiting for it and has left us, but the persistence of the survivors is about to be rewarded. Most of the work has by now been done, and in response to a pre-arranged growl from an accomplice who says, "What about when there is no applied m.m.f.?" I have only to

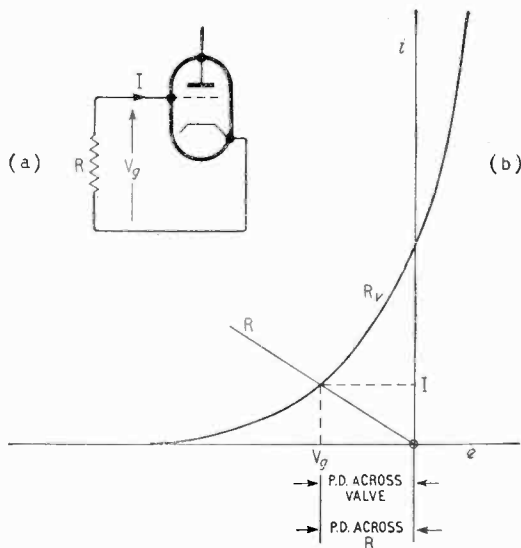


Fig. 4. (a) is the electrical analogue of a permanent magnet—a circuit in which some current flows even though there is no applied e.m.f. (b) is the same type of curve as in Fig. 1.

point back to its analogue which we considered last month at considerable length—Fig. 4. For the benefit of those who missed that, this time I'm showing the diode formed by the cathode and *grid* of a valve, since that is a rather better known example of the fact that thermionic current can occur even when the applied e.m.f. is zero. Compare the graph with Fig. 1(b), imagining E to shrink to zero, carrying with it the R line. No change in principle is involved; calculation of the current and p.d. (the previous two p.d.s now coincide) proceeds exactly as before.

This peculiarity of a valve as a resistor, shown by its i/e curve entering the region to the negative side of the current axis, may gain importance in the future, as we saw last month, but in the whole realm of electronics it has hitherto been a minor detail. Not

so its magnetic analogue. Permanent magnets—to mention one thing—would be impossible without it. A characteristic of all ferromagnetic materials is that when they have once been magnetized they retain some of their magnetism after the m.m.f. has been cut off. It is shown by the familiar “hysteresis” curves such as Fig. 5. Beginning from zero, the magnetism is first increased as shown by the upward arrow. When the applied field has been restored to zero, B is found to have a value B_r , the “residual flux density,” which in “soft” materials is near zero (a) but in “hard” materials, suitable for permanent magnets, is a large percentage of the maximum (b). The amount of reverse field needed to demagnetize it completely is the “coercive force,” H_c . The values of B_r and H_c depend on the degree to which the material was first magnetized; the particular values when it was magnetized to saturation are called its “remenance” and “coercivity” respectively. These are the important values, which we shall be using.

For permanent magnets we are interested in the “second quadrant,” corresponding to Fig. 4, which therefore has its analogue in Fig. 6, which in turn should be compared with its energized magnet counterpart in Fig. 2.

We have now reached “the end of the beginning” and can concentrate on applying our principles to practice. From this point of view, Fig. 6 has one attractive feature: it directly shows Φ , the flux in the circuit, which is usually what one is after. It can be varied from zero up to Φ_r by varying the slope of the S_a line. A horizontal line means an infinite reluctance, which allows no flux—a magnetic open-circuit, in fact—while a vertical line means zero

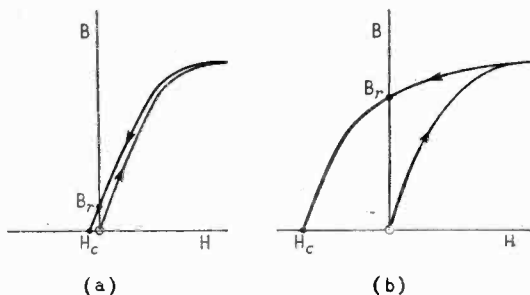


Fig. 5. Curves showing the results of increasing and decreasing the magnetizing force applied to (a) a “soft” (b) a “hard” ferromagnetic material.

reluctance, a closed gap and circuit. Neither of these extremes is of any use, of course. The best utilization of the magnet must be at some intermediate position, like the optimum load line in a valve circuit. Whatever it is, it will fix both the amount of flux and the dimensions of the gap. But those are just the things one is usually given as already fixed, with the request that we find the smallest and cheapest magnet that will fulfil them. Fig. 6(b), which refers to a particular magnet and shows what can be done with it, puts the cart firmly before the horse.

We have already studied how to rectify this situation: obtain a general curve (B against H) for the most likely material; use the load-line technique on it to find the most efficient magnet-to-gap dimension ratio; and then work out the actual magnet

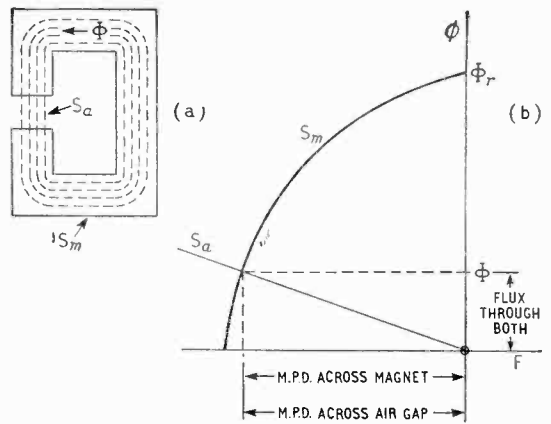


Fig. 6. This permanent magnet circuit and curve compares with the electromagnet circuit and curve in Fig. 2, and the electrical analogue in Fig. 4.

dimensions to give the required total flux in the given gap.

The first thing, then, is to convert Fig. 6(b) into the B/H form by dividing ϕ by a_m , the cross-sectional area of the magnet (assumed constant throughout its length) and dividing F by l_m , the length of the flux path in the magnet. In practice we just write to magnet material makers and ask for B/H curves for their products. The left-hand half of Fig. 7 is a typical sample—except perhaps for the units (I’m afraid the ferromagnetic industry is a pocket of resistance to m.k.s. units). Some readers may feel more at home if they multiply the B scale by 10,000 and label it “gauss,” and the H scale by $4\pi/1000$ and label it “oersteds.” Anticipating a little, they should also multiply the —HB figures by 40π .

At this stage we take note of the magnetic analogues of Kirchhoff’s laws. Because flux can’t just vanish anywhere, and we have in Fig. 6 (neglecting any by-passing of the gap via the surrounding air) only one continuous circuit loop, the flux must be the same everywhere around it. I.e.,

$$\Phi = B_m a_m = B_a a_a$$

$$\therefore a_m = a_a \frac{B_a}{B_m} \dots \dots \dots (3)$$

The second law states that the total potential drop around any complete circuit is zero:

$$H_m l_m + H_a l_a = 0$$

$$\therefore l_m = l_a \frac{H_a}{-H_m}$$

and because $H_a = B_a/\mu_a$ and μ_a is practically the same as for vacuum— $4\pi/10^7$ —this becomes

$$l_m = l_a \frac{B_a \times 10^7}{4\pi(-H_m)} \dots \dots \dots (4)$$

Multiplying (3) and (4) together gives the volume of the magnet:

$$a_m l_m = a_a l_a \frac{B_a^2 \times 10^7}{4\pi(-H_m B_m)} \dots \dots \dots (5)$$

So the volume of magnet metal required is directly proportional to the volume of the air gap and to the square of the flux density therein. And for given values of them it is least when $-H_m B_m$ is most. For any point on the B/H curve (Fig. 7), $-H_m B_m$ is

found by multiplying the co-ordinates of that point, and this product can be plotted against B in the vacant space to the right of the B axis, giving a bulge-shaped curve. Its maximum stands out—not a mile, in this case, but enough to show that the most economical B_m is 0.5. The corresponding $-H_m$ is 23,000.

If one is too lazy or short of time to plot the $-H_m B_m$ curve, one can usually get very near it in a few seconds by completing the rectangle with B_r and H_c as corners (shown chain-dotted) and drawing its diagonal to cut the B/H curve at the working point X. As a matter of fact, the makers of the material are usually helpful enough to state the optimum B_m and H_m , thereby rendering all effort superfluous.

Just to see how things work out, let us take an example. Suppose an air gap 0.2cm by 3 sq cm is to be filled with 0.8 Wb/m^2 (= 8,000 gauss or lines per sq cm) by means of an alloy having the B/H curve shown in Fig. 7.

$$\text{From (3) } a_m = 3 \frac{0.8}{0.5} = 4.8 \text{ sq cm}$$

(Centimetres are admittedly more convenient for magnet dimensions of this order, and one can safely use them in these m.k.s. equations as long as the scale multiplier occurs on both sides so that it cancels out.)

$$\text{From (4) } l_m = 0.2 \frac{0.8 \times 10^7}{4\pi \times 23,000} = 5.5 \text{ cm}$$

It appears, then, that all we have to do, given the optimum B_m and H_m figures from Sheffield, is put them and the given gap data into two simple formulae and we get the magnet dimensions. In real life there are some complications.

A magnet of these stubby proportions will have to be connected to the air gap by means of low-reluctance pole pieces. But that is as obvious as saying that a generator should be connected to its load by low-resistance leads. Then—especially with such a large B_m —there will be some “fringing” around the gap, and flux leakage elsewhere. That is usually taken care of by a factor based on experience of similar magnet systems. If there have been no similar magnet systems it is necessary to make some rather tricky calculations, or perhaps use an analogue tank. There are also other complications which it

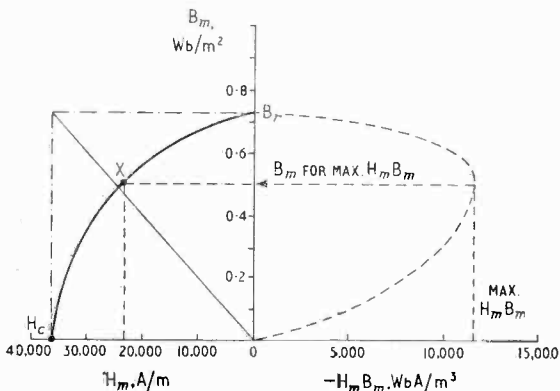


Fig. 7. Generalizing Fig. 6(b) by the process illustrated in Fig. 3 gives the left-hand part of this diagram. The right-hand part is constructed for finding the B_m and H_m giving the maximum value of $-H_m B_m$.

would be out of place to consider in what is intended to be a framework of theory serving as a first approximation in design.

Our study should however enable us to tackle cases where there is some m.m.f. coming from a coil, assisting or opposing the permanent magnet. The starting point for the air-gap line in Fig. 6 would have to be to the right or left, respectively, of zero, by an amount equal to the m.m.f.

Sometimes such an m.m.f. is an unwanted stray field. It is obviously important that a moving-coil meter, for example, should not have its magnet permanently altered. Suppose it comes under the influence of an external field that opposes its own, so that the working point is moved downward from X in Fig. 8 to Y. When this influence is removed the *status quo* is not restored. Owing to hysteresis, the return curve to the gap line is from Y to Z,

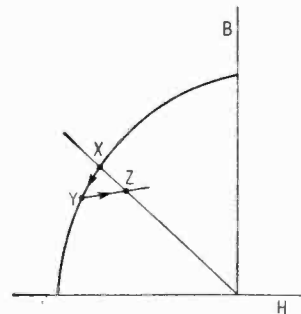


Fig. 8. What happens if a permanent magnet originally working at point X is demagnetized to point Y. The recovery is to another point, Z.

which is far enough from the original X to cause serious error in the meter readings. To avoid this, such magnets are aged by submitting them in advance to demagnetizing fields stronger than they are likely to experience after calibration. Subsequent variations take place along a relatively flat curve such as YZ.

This also shows why it is not a good idea to take a permanent magnet circuit to pieces. Doing so generally introduces a relatively large reluctance in series, which makes the gap line move close to the horizontal, bringing the working point low down so that the value of B is much reduced. When the system is reassembled, much of the original magnetism is likely to have been lost. If possible, the magnet should first be short-circuited; but that needs care, for if the iron shorting piece is drawn against the magnet violently the resulting shake-up is liable to demagnetize it considerably.

This is where the ceramic permanent-magnet materials described as recently as last December* come in. Their remanence is much lower than in the best metallic magnets, so they are not so suitable for providing very high flux densities, but their coercivity is several times greater than almost any others, so the B/H curve is very flat compared with the one in Fig. 7, for example. They are therefore suitable for high-reluctance gaps, and even if the magnet system is taken to pieces it suffers little permanent demagnetization. For the same reason, coupled with very high resistance, they are virtually immune from undesirable effects due to a.c. fields. And the materials are relatively cheap. Ceramic materials have become familiar as magnetic cores in place of iron; now it looks as if they will become familiar as permanent magnets.

* By J. W. Bunn and J. Harrison, Dec. 1960, p. 595.

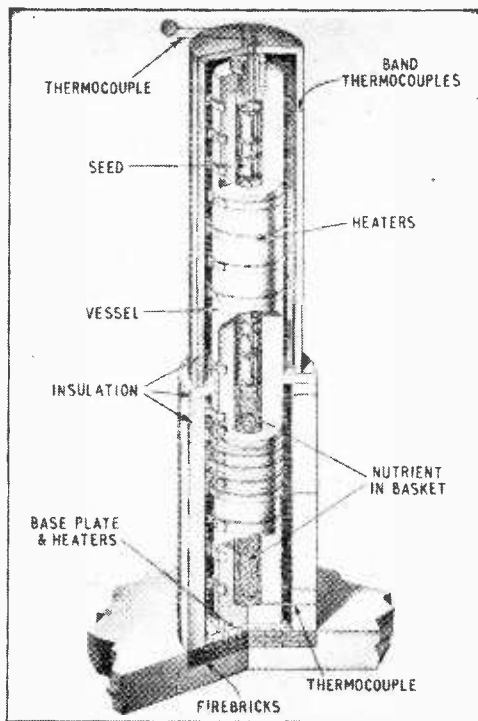
SYNTHETIC QUARTZ CRYSTALS

MASS production of synthetic quartz crystals is now in full swing at the Western Electric's new Merrimack Valley Works, Mass., U.S.A.

The new factory grows good-quality quartz crystals from natural quartz chips, using as a basis a "seed" crystal of the shape and configuration which will produce a mother crystal of the best size and shape for the most economical slicing into communications-type crystals. It is estimated that the yield of usable crystals per pound of synthetic quartz is about two-and-a-half times that obtainable from the best natural quartz crystals.

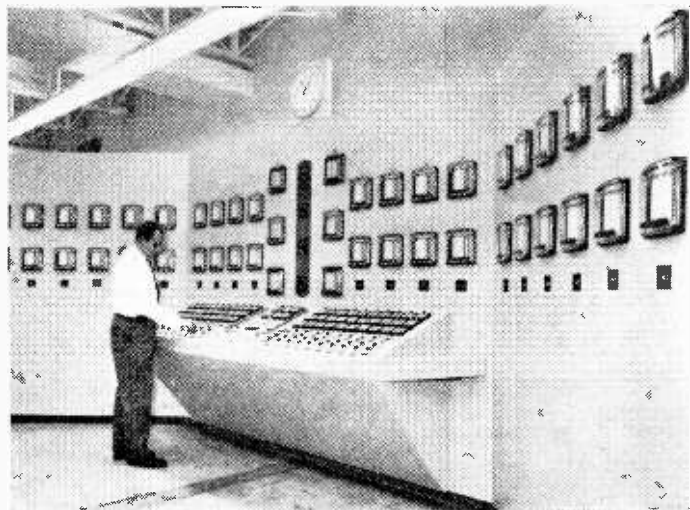
The hydrothermal process is used and depends on the maintenance of a critical temperature differential between the upper and lower regions of an autoclave-type growing vessel. This vessel has to withstand temperatures of the order of 700°F and pressures up to about 25,000 lb per square inch. In the upper portion of the autoclave is suspended a string of seed plates and in the lower, or hotter region, is the "nutrient" consisting of quartz chips in an alkaline solution. Under heat and pressure the small pieces of quartz dissolve and the nutrient is carried by convection to the cooler upper part of the growing chamber where the lower temperature super-saturates the nutrient, causing the dissolved quartz to deposit on to the seed plates in single crystal form. It takes about three weeks to grow a string of synthetic crystals.

The cut-away illustration shows the main features of the autoclave growing vessels of which about a score are at present in use. They are about 10ft long, 6in inside diameter and about 12in overall outside diameter and they are made of chromium-molybdenum steel which has good corrosive resistance properties and great strength at high temperatures. Each chamber has to withstand a high-temperature pressure of about 350 tons, so for safety reasons they are buried in cavities below floor level and further protected by large tubular shields, some of which can be seen in the background of one of the illustrations. Another illustration shows the extent of the control panel from which the entire process of growing the crystals is automatically controlled.



Cut-away drawing showing the principal features of the autoclave vessels employed for growing synthetic quartz crystals.

The entire process of growing quartz crystals at Western Electric's Merrimack Valley Works is controlled automatically. This control console and panel reflects the scale of the undertaking.



A string of synthetic quartz crystals being removed from the growing chamber.

Hand Soldering of Printed Circuits

By DR. W. RUBIN*, B.Sc., A.R.I.C.

THE introduction of printed circuits into radio and television assembly has not only raised fundamental changes in design but has imposed new criteria for the soldering of components.

Many factories have actively investigated the pros and cons of the automatic soldering of printed circuit boards in which components are inserted in the boards either by hand or by machine. Production lines have been established which involve the minimum amount of handling of the boards during automatic soldering processes.

Unfortunately, no automatic process appears to be 100% reliable due to the varying degrees of oxidation which may be present on the leads of the components which are mounted on the boards. Consequently, it is the practice for all boards to be inspected after they pass through an automatic soldering bath and any "doubtful" joints are then hand soldered. Operatives undertaking this work can, after a certain amount of experience, determine which joints are unsatisfactory and it is very important that only trained operatives are used in this work because it is much more difficult to determine a dry joint on a printed circuit board than one in the conventional wired chassis.

If it is essential to use components which have been in stock for varying periods and which have the leads oxidized or tarnished in varying degrees, it is advisable either to re-tin all leads prior to insertion in the boards or solder each joint by hand. Although this may appear to be a long process compared with passing the boards through a solder bath, an experienced operative can solder boards by hand extremely rapidly and he or she will invariably compensate for the varying degrees of oxidation when applying the cored solder simultaneously with the iron.

When prototype printed circuit assemblies are being undertaken, or limited production runs are being manufactured, hand soldering is usually adopted because it avoids the necessity for making special jigs for taking the boards through the solder bath. Furthermore, hand soldering is invariably undertaken when the home constructor is engaged upon the production of a printed circuit assembly.

It cannot be stressed too strongly that the choice of the most suitable cored solder and soldering iron is most important when work of this kind is being done.

It should be emphasized that in no circumstances should separate acid or greasy fluxes be used. Obviously, a soldering iron having a very large bit is unsuitable for this type of work, and miniature irons are now available which possess a good bit temperature despite their small size. With these small irons it is absolutely essential that the bit is kept in good condition and this will be much more easily achieved on long runs if a copper-loaded alloy, such as Savbit, is used as this alloy minimizes the absorption of copper from the bit of the iron into

the solder alloy. For the small user and the electronics handyman, this argument need not apply and a 60/40 tin/lead cored solder would be suitable.

The gauge of alloy is important because the amount of solder used on the joint should not be excessive and should lead to a relatively flat fillet of solder around the joint, giving it a neat appearance and at the same time avoiding unnecessary application of heat to the board. Generally, a size not thicker than 18 s.w.g. should be used. For the soldering of small printed circuit boards it has been found in practice that a diameter as fine as 22 s.w.g. is probably the most suitable and this gauge has been adopted by many of the specialist instrument manufacturers. The use of a fine gauge solder ensures that there will be a minimum of flux residue and this is important as too great an excess of flux leads to an untidy looking soldered circuit board, apart from the fact that too great an excess might flow and cover adjacent printed wires, which is not considered to be good practice, as although the flux has a high resistivity the specified electrical properties of the laminate on the board might be affected.

The choice of flux is therefore also of primary importance, for not only must it allow for ease of soldering but any residue must be non-corrosive and non-conducting. Ersin 362 Flux, which is available in either Savbit, or 60/40, Alloys, and which meets the relevant D.T.D. and B.S. Specifications for these properties, is suitable and is used extensively for the soldering of printed circuit boards. When applied with a miniature iron, 22 s.w.g., 5-core, 362 Savbit No. 1 Alloy, does not overheat the circuit board and cause any subsequent damage such as could be caused by loss of adhesion of the copper wiring to the laminate. When additional solder is being applied to a dip-printed circuit board to re-solder defective joints, 18 s.w.g. can be used.

Copper Absorption

As the Savbit No. 1 Alloy incorporates a small percentage of copper, its use will prevent copper from the board being absorbed into the solder. When a straight tin/lead alloy is used for this purpose, a small percentage of copper may be taken from the board and thus lead to variations in the thickness of the circuit and so affect the conductivity of the wiring.

The enthusiast who has never previously undertaken the soldering of printed circuit boards need have no fear that equipped with the correct type of iron and suitable solder, he will be unable to undertake efficient and rapid soldering of printed circuit boards, but if he is using components of varying storage life and some of them are old, then it may be necessary to clean the wires first because some of them may have become contaminated or seriously oxidized in storage. In assembling wired

*Chief Chemist, Multicore Solders Ltd.

circuits, such oxidation can usually be overcome by applying the flux-cored solder to the joint with the iron for a slightly longer period than is necessary with the wires of a clean component. If the iron is applied for an extended period to printed circuit boards, the printed wire may well become separated from the laminate.

As the flux residue is non-conductive and non-corrosive it is not essential that it be removed for equipment which will be used under normal working conditions in this country, and if this is the case it would be advisable that the board be previously lacquered with a preservative coating before soldering is undertaken, to prevent subsequent tarnishing or discoloration of those parts of the copper wiring which will otherwise be unprotected. Some Govern-

ment specifications for equipment which may be used under exceptional circumstances call for the removal of flux residue or its over-coating with protective coating. Where it is essential to remove the flux residue the boards can be treated with solvents such as alcohol or toluene, leaving the board free for the application of a recommended final treatment.

Providing all the above factors are duly taken into account, even the unskilled operative should be able to make sound joints on printed circuit boards with confidence, but it must always be remembered that the correct materials and equipment are even more important when undertaking this type of soldering than the normal wire-to-tag joints.

MARCH MEETINGS

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

LONDON

1st. Brit.I.R.E.—Inaugural meeting of Television Group address by L. H. Bedford at 5.30 at the London School of Hygiene, Keppel Street, W.C.1.

1st. I.E.E. and R.Ae.S.—Discussion on "The training of 'electrical' and 'electronic' engineers for the aircraft industry" opened by G. S. Bosworth at 6.0 at the Royal Aeronautical Society, 4 Hamilton Place, W.1.

1st. British Kinematograph Society.—"The design of new television studios" by P. H. Treadgold at 7.30 at the Central Office of Information, Hercules Road, S.E.1.

3rd. I.E.E.—Discussion on "The clinical value of E.E.G. recording" and "Present trends in general purpose E.E.G. recorders" opened by H. B. Morton and H. R. A. Townsend at 6.0 at Savoy Place, W.C.2.

6th. I.E.E.—"An investigation of the usefulness of back-scatter sounding in the operation of h.f. broadcasting services" by E. D. R. Shearman at 5.30 at Savoy Place, W.C.2.

7th. I.E.E.—"The automatic control of machines for assembling mechanical components" by A. V. Hemingway and R. L. Dressler at 5.30 at Savoy Place, W.C.2.

9th. Radar and Electronics Association.—"Air traffic control" by A. Field at 7.30 at the Royal Society of Arts, John Adam Street, W.C.2.

10th. Television Society.—"Colour television camera problems" by I. J. P. James at 7.0 at the Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, W.C.2.

14th. I.E.E.—Discussion on "New routes into national certificate and technician courses" opened by H. W. French at 6.0 at Savoy Place, W.C.2.

15th. I.E.E. Graduate and Student Section.—"Space research" by Prof. Sir Harrie Massey at 6.30 at the Institution of Civil Engineers, Gt. George Street, S.W.1.

16th. Brit.I.R.E.—"Transistorized tape recorders" by S. Wellton at 5.30

at the London School of Hygiene, Keppel Street, W.C.1.

17th. Institute of Navigation.—"The long-term plan for air traffic control" by Capt. V. A. M. Hunt at 5.15 at the Royal Geographical Society, 1 Kensington Gore, S.W.7.

17th. B.S.R.A.—"The artist on the record" by R. Threlfall at 7.15 at the Royal Society of Arts, John Adam Street, W.C.2.

22nd. Brit.I.R.E.—Discussion on "The future of high speed storage systems" at 5.30 at the London School of Hygiene, Keppel Street, W.C.1.

23rd. Television Society.—"Underwater television in marine biology" by Dr. H. Barnes at 7.0 at the Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, W.C.2.

24th. R.S.G.B.—"Mobile operation and its problems" by N. A. S. Fitch at 6.30 at the I.E.E., Savoy Place, W.C.2.

27th. Brit.I.R.E.—Symposium on "Electronic instrumentation for cardiac surgery" at 3.0 at the Post-Graduate Medical School, University of London, Hammersmith, W.12.

29th. Brit.I.R.E.—Symposium on "Electronic instrumentation for nuclear power stations" at 3.0 at the London School of Hygiene, Keppel Street, W.C.1.

ARBORFIELD

13th. I.E.E. Graduate and Student Section.—"The work of the B.B.C. with particular reference to transmitters" by R. W. Leslie at 7.0 at the Unit Cinema, 3 (Tels.) Training Bn., R.E.M.E.

BARNESLEY

8th. I.E.E.—"Radiocommunication in the power industry" by E. H. Cox and R. E. Martin at 7.0 at the Town Hall.

BEDFORD

21st. I.E.E.—"Silicon controlled rectifiers" by R. G. Hibberd at 7.0 at the Swan Hotel.

BIRMINGHAM

6th. I.E.E.—Discussion on "This house deplores the present rate of world expenditure on space research, while many problems of extreme poverty and sickness still exist on an international scale" at 6.30 at the James Watt Memorial Institute.

15th. Television Society.—"Science on television" by A. J. Garratt at 7.0 in the New Physics Lecture Theatre, the University.

22nd. Brit. I.R.E.—"A pulse time multiplex system for stereophonic broadcasting" by G. D. Browne at 6.15 at the University.

23rd. I.E.E.—Discussion on "The integration of industrial and academic training" opened by E. C. Merrick at 6.0 at the College of Technology, Gosta Green.

27th. I.E.E.—"New amplifying techniques" by Professor C. W. Oatley at 6.0 at the James Watt Memorial Institute.

BOURNEMOUTH

22nd. I.E.E.—"Radiocommunication in the power industry" by E. H. Cox and R. E. Martin at 6.30 at the Grand Hotel.

BRISTOL

14th. Television Society.—"Training in television servicing" by G. C. Barker at 7.30 at the Hawthorns Hotel, Woodland Road, Clifton.

15th. Brit.I.R.E.—"Airborne servo system for throttle control" by D. W. Thomasson at 7.0 at the School of Management Studies, Unity Street.

CAMBRIDGE

2nd. I.E.E.—"Engineering and the brain" by R. L. Gregory at 8.0 at the Cavendish Laboratory.

13th. I.E.E.—Discussion on "The broadening of university engineering and science courses" opened by Professor H. E. M. Barlow at 6.30 at the Technical College.

23rd. I.E.E.—"Advances in semiconductor devices and circuits" by Dr. J. Evans and T. H. Walker at 8.0 at the Cavendish Laboratory.

CARDIFF

8th. Brit.I.R.E.—Discussion on "The radio and electronics industry of South Wales" at 6.30 at the Welsh College of Advanced Technology.

13th. I.E.E.—"Silicon power rectifiers" by A. J. Blundell, A. E. Garside, R. G. Hibberd and I. Williams at 6.0 at South Wales Institute of Engineers.

29th. Society of Instrument Technology.—"Feed back" by R. S. Medlock at 6.45 at the Welsh College of Advanced Technology.

COVENTRY

21st. I.E.E.—"Bridging the Atlantic" by A. H. Mumford at 6.30 at the Herbert Lecture Theatre.

DERBY

16th. Society of Instrument Technology.—"Recent developments in industrial electronics" by E. Metcalf at 7.15 at the Derby & District College of Technology, Kedleston Road.

EDINBURGH

7th. I.E.E.—"An oscillating synchronous linear machine" by Dr. E. R. Laithwaite and R. S. Mamak at 7.0 at the Carlton Hotel.

8th. Brit.I.R.E.—"High speed pulse techniques" by E. Wolfendale at 7.0 at the Department of Natural Philosophy, The University, Drummond Street.

14th. I.E.E.—Discussion on "Digital transducers" at 7.0 at the Carlton Hotel.

21st. I.E.E.—Faraday Lecture on "Transistors and all that" by L. J. Davies at 7.30 at the Usher Hall.

28th. I.E.E.—"The potentialities of artificial earth satellites for radio-communication" by W. J. Bray at 7.0 at the Carlton Hotel.

FARNBOROUGH

7th. I.E.E. Graduate and Student Section.—"D.C. amplifiers" by H. Kehmajian at 6.30 at the Technical College.

21st. I.E.E.—"Recent research in thermionics" by Dr. G. H. Metson and Miss E. Macartney at 6.15 at the Technical College.

22nd. Brit.I.R.E.—"The design of a long range single sideband airborne equipment" by P. D. Adams and T. E. Wynne at 7.0 at the Technical College.

GLASGOW

9th. Brit.I.R.E.—"High speed pulse techniques" by E. Wolfendale at 7.0 at the Institution of Engineers and Shipbuilders, 39 Elmbank Crescent.

13th. I.E.E.—Discussion on "Digital transducers" at 6.0 in the Royal College of Science and Technology.

25th-26th. I.E.E.—Symposium on "The instrumentation and control of nuclear reactors" at The Chesters, Bearsden.

HULL

21st. I.E.E.—"The transmission of news film over the transatlantic cable" by C. B. B. Wood and I. J. Shelley at 6.30 at the Lecture Theatre, Y.E.B. Offices, Ferensway.

KIDSGROVE

6th. I.E.E.—"The future of 'electronics' and 'electronics' in aircraft and guided missiles" by Viscount Caldecote at 7.0 at the English Electric Co.

LEEDS

14th. I.E.E.—Discussion on "Refresher and post-graduate courses for electrical engineers" opened by Professor G. W. Carter at 6.30 at the Electrical Engineering Department, The University.

LEICESTER

2nd. I.E.E.—Faraday Lecture on "Transistors and all that" by L. J. Davies at 7.15 at the De Montfort Hall.

20th. Television Society.—"Colour television" by L. C. Jesty at 7.30 in Room 104, the College of Technology and Commerce, The Newarke.

LIVERPOOL

15th. Brit.I.R.E.—"Flight simulators" by D. J. Mauchel and R. Marvyn at 7.0 at the Adelphi Hotel.

MALVERN

20th. I.E.E.—"Radio communications by means of satellites" by Dr. A. W. Lines at 7.30 at the Winter Gardens.

23rd. Brit.I.R.E.—"Magnetic film storage" by Dr. A. C. Moore at 7.0 at the Winter Gardens.

MANCHESTER

2nd. Brit.I.R.E.—"Some typical uses for electronic data processing systems" by C. W. Blaxter at 7.0 at the Reynolds Hall, College of Technology.

15th. I.E.E.—"The potentialities of artificial earth satellites for radio-communication" by W. J. Bray at 6.15 at the Engineers' Club, Albert Square.

20th. I.E.E.—Discussion on "Experimental methods with particular reference to transistors" opened by V. H. Atree at 6.15 at the College of Science and Technology.

22nd. I.P.R.E.—"Telemetry" by

J. E. P. Hunt at 7.30 at the Central Hall, Oldham Street.

MIDDLESBROUGH

1st. I.E.E.—Hunter Memorial Lecture on "The application of electronics to the electricity supply industry" by Dr. J. S. Forrest at 6.30 at the Cleveland Scientific and Technical Institution.

NEWCASTLE-UPON-TYNE

6th. I.E.E.—"Performance of semiconductor devices for instrumentation" by C. Hilsum at 6.15 at the Rutherford College of Technology, Northumberland Road.

8th. Brit.I.R.E.—"V.H.F. a.m./f.m. transistor receivers" by H. A. Heins at 6.0 at the Institute of Mining and Mechanical Engineers, Neville Hall, Westgate Road.

20th. I.E.E.—"New amplifying techniques" by Professor C. W. Oatley at 6.15 at the Rutherford College of Technology, Northumberland Road.

23rd. I.E.E.—Faraday Lecture on "Transistors and all that" by L. J. Davies at 7.0 at the City Hall.

READING

20th. I.E.E.—"The development of Eurovision" by M. J. L. Pulling at 7.15 at the George Hotel, King Street.

SOUTHAMPTON

14th. I.E.E.—"Analogue to digital converter techniques and their applications" by K. L. Smith at 6.30 at the University.

16th. I.E.E. Graduate and Student Section.—Discussion on "Electrical engineering education and training" at 6.30 at the University.

CONFERENCES AND EXHIBITIONS

The following additions should be made to the lists of conferences and exhibitions published in our January and February issues.

May 15-17	International Television Equipment Exhibition (Television Festival Committee, 8 Grand-Rue, Montreux, Switzerland).	Montreux
May 16-18	Avoidance of Collision at Sea and in the Air by Land-based Aids (Convention) (Institute of Navigation, c/o Royal Geographical Society, 1 Kensington Gore, London, S.W.7.)	Diüsseldorf
May 17-21	International Television Symposium (International Telecommunication Union, Berne, Switzerland)	Montreux
June 12-15	International Exhibition of Electronics, Nuclear Energy, Radio, Television and Cinematography (Rassegna Internazionale Elettronica, Nucleare e Teleradiocinematografica, Via della Scrofa 14, Rome)	Rome
June 26-28	European Symposium on Space Technology (British Interplanetary Society, 12 Bessborough Gardens, London, S.W.1.)	21 Tothill Street, London, S.W.1.
July 9-14	International Bio-Medical Electronics Conference (Dr. A. Rémond, 131 Boulevard Malesherbes, Paris 17)	New York
Aug. 30-Sept. 6	British Association for the Advancement of Science annual meeting (Secretary, B.A.A.S., 19 Adam Street, London, W.C.2.)	Norwich
Sept. 11-19	International Congress of Navigation (Permanent International Association of Navigation Congresses, 60 rue Juste Lipse, Brussels, Belgium)	Baltimore
Sept. 25-30	Irish Television and Radio Show (Castle Publications Ltd., 38 Merrion Square, Dublin).	Dublin
Oct. 2-4	I.R.E. Canadian Convention (I.R.E. Canadian Convention, 1819 Yonge Street, Toronto 7)	Toronto

RANDOM RADIATIONS

By "DIALLIST"

Well Done, R.I.C.

CONGRATULATIONS to the Radio Industry Council on its memorandum to the Pilkington Committee. I couldn't agree more with what they say. As they point out, it must be many years before the millions of TV receivers in use in this country are worn out. The Government has given an undertaking to continue the use of the present 405-line standard and not to make sets obsolete before their time. Suppose the change is envisaged, say, 15 years ahead; no one can possibly say what improvements in TV transmission and reception will be made in that time and it would be futile to commit ourselves to a 625-line standard, which may be out of date before it gets going. The point has been made that if we went to 625 lines, we'd be able to export sets to European countries; but that cuts both ways, for they'd be able to dump their surplus sets on us. I don't envy the members of the Pilkington Committee their job, for they're expected to be both wise men and prophets—and whatever they recommend is certain to be fiercely criticized.

France Won't Change Her Definition

SOME weeks ago French lay papers were suggesting that France was about to scrap her 819-line system

and change over to 625 lines. It wasn't a bit true. What *may* happen is this. The present transmitters will stay as they are and it is proposed that a new chain of stations should be built to provide a second programme on 625 lines. Since the latter system is in use in other European countries, engineers of the R.T.F. believed that the relaying of outside programmes would become easier and trials have proved that this is the case. Manufacturers say that it won't be too difficult or costly to provide viewers with a switch, enabling the change from one programme to the other to be made when required (as is already done in Belgium where both standards are used). Despite all rumours I'm sure that there'll be no abandonment of the 819-line definition for the first programme, for the French are proud of it—and justifiably so. When the second programme will come along I don't know.

Noise Abatement and P.A.

THE Noise Abatement Act of 1960 has restricted public address loudspeaker activities to some extent and that's not altogether to be deplored, for they could be and sometimes were a real nuisance if mishandled. Under the Act public address equipment may not be operated on any highway between nine o'clock in the evening and eight o'clock the following

morning. There are, however, some sensible exceptions to this rule. Police, fire brigades and ambulances are not affected and there is no restriction on the use of loudspeakers on the highway in cases of emergency. The use of p.a. on the highway for advertising any entertainment, trade or business is prohibited at all times, except that it may be used on a vehicle carrying perishable food-stuffs to inform the public that they can be bought from the vehicle; but it must be operated so as to give no reasonable cause for annoyance. The whole thing seems to me to be sound common sense and I trust it'll help to lessen the plague of noise which has been inflicted on us for too long now.

A Sound Scheme

IT'S good to read that an approval scheme for domestic electrical appliances is now under way. In conjunction with the British Standards Institution, groups of manufacturers have set up the British Electrical Approvals Board for Domestic Appliances. The tests are to be twofold: the first object is to ensure that apparatus is safe when it is sold; the second, to see that it is likely to remain so in use. All approved articles are to carry an easily recognizable mark, which will be the purchasers' safeguard against shoddy, potentially dangerous stuff, of which far too much has found its way into the shops, a good deal of it being of foreign origin. Once the approval mark becomes widely known—and that shouldn't take long—people who know nothing of electricity will be able to buy with confidence. Naturally you can't make regulations to prevent fools from being fools and I suppose that whatever is done there'll be some accidents, particularly in homes where the husband has the do-it-yourself-even-if-you-know-nothing-about-it mentality.

Television Forges Ahead

THE B.B.C. has two TV transmitters due to get to work this year, the satellites at Llandrindod Wells and Redruth. Next year's programme is much more extensive, for it should see the opening of no fewer than eleven. By

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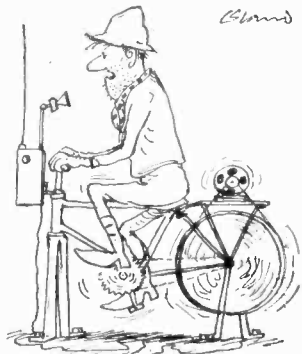
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the end of next year the B.B.C. will have 48 stations in service. The I.T.A. plans another five or six transmitters for this year and one or two next. If all goes according to schedule, it will have 21 transmitters at work by the beginning of 1963. Thus there'll be 69 stations handling the two services and all but the most difficult and most sparsely populated parts of the country should obtain reception of one or both programmes. That's pretty good going when you think that when the B.B.C. television service was restarted after the war, in 1946, the only station we had was the original Alexandra Palace set-up. I don't suppose that 100% of our homes will ever be covered, for some are in remote, hilly places, but we're getting very near that figure.

Shaking Up Mussels

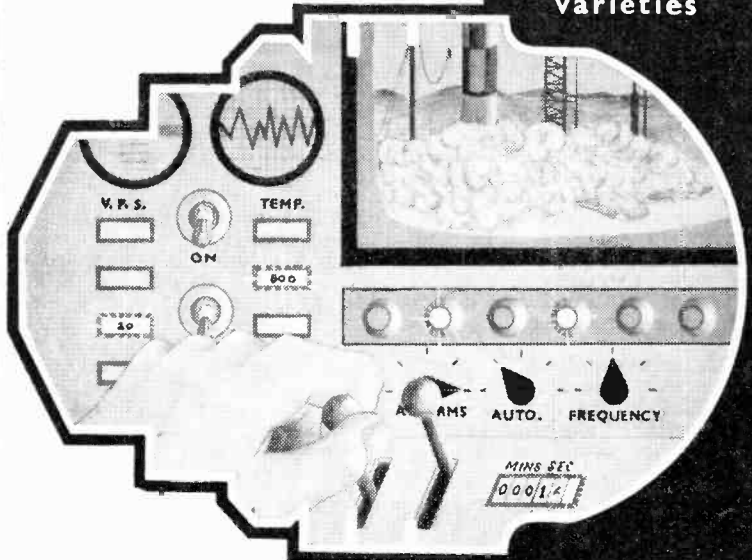
MUSSELS are, or can be, an expensive nuisance at nuclear power stations, which use large quantities of sea water for cooling purposes. They like to settle down in the culverts leading to pump suction chambers and no completely effective deterrent has yet been found. Chlorination of the water discourages them, but it's a costly business and it only works if applied when the mussels are too young to have formed shells. But according to a paper read recently at the Institution of Mechanical Engineers there is evidence to show that they don't like being bombarded by ultrasonic pulses. At the Blyth A power station 14 oscillators have been installed in the culverts, down which they shoot 1 msec pulses at a frequency of 28kc/s. To find out just how far this bombardment really is effective, four experimental culverts are being installed at Blyth and the results of pulse bombardment will be carefully checked.



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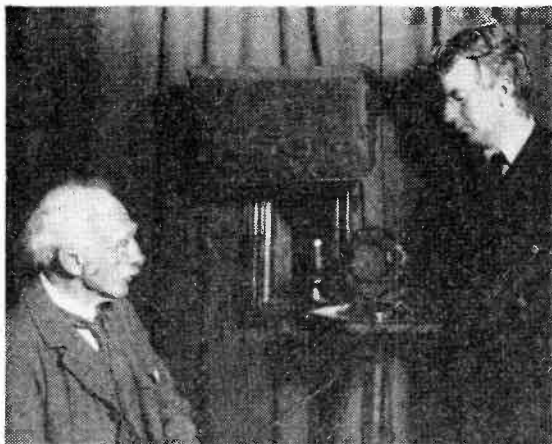
30-Hard Lines

LAST September I drew attention to what I supposed to be an error in the B.B.C.'s "Scrapbook for 1910". I was very rightly rebuked by Vernon Harris, its producer, in a letter to the Editor (October issue) in which he pointed out that "Scrapbook" records not only the happenings but also the errors of the times. What I thought was a B.B.C. mistake was a commonplace erroneous opinion of 1910 which was deliberately put into the mouth of a girl at a ball.

This technique of putting an error of the times into the mouth of a participant in the Scrapbook is a highly ingenious one which was used again in the "Scrapbook for 1931"

Later in the programme, Mr. Grisewood was made to tell us quite accurately that Jack Payne's television broadcast of August 15th, 1931, was the very first one from a B.B.C. studio. This might make it seem that I am splitting hairs and that the truth is that there was no television in our homes until the latter part of 1931.

The full truth is, of course, that by the time 1931 dawned, the B.B.C. had been transmitting TV programmes regularly for well over a year and quite a number of us had television receivers—or televisions as we used to call them—in our homes. But although the B.B.C. had been transmitting television regularly since September 30th, 1929, on normal



From my scrapbook. Sir Ambrose Fleming inaugurating, in the presence of J. L. Baird, the B.B.C.'s 30-line television service on Sept. 30th, 1929

broadcast on January 16th. But I was very greatly amused to hear a silly popular error put into the mouth of Freddie Grisewood, the narrator.

Such a well-informed man as Mr. F. G. must have stuck his tongue in his cheek and ground his teeth in annoyance—no mean feat—as he gave utterance to the words laid down for him in the script, which told us there was no television in our homes in 1931. It was certainly hard lines on Mr. Grisewood—even if there were only 30 of them—to put this error of the times into his mellifluous mouth.

Of course there is no denying that this error was a very widespread one in that year but it would, I think, have sounded better if it had been voiced by a silly girl of the type who acted as the stooge for the 1910 popular error rather than by a man having the same initials and degree of intelligence as myself.

broadcasting wavelengths, it had been garnering them from extramural sources, chiefly, of course, the Baird studios.

Torsometer

I HAVE previously registered astonishment that big firms spend vast sums on developing a highly specialized piece of apparatus to serve a certain limited need, and yet fail to see that a much larger field of use for the apparatus lies almost under their noses.

I noticed a case in point at the recent physics exhibition where the well-known optical firm of Barr & Stroud were exhibiting a dendrometer to measure the vital statistics of a tree and, in particular, its girth at various heights of the trunk. The instrument's *modus operandi* was a modification of that employed in a

range-finder such as is used by artillerymen and photographers.

It is obvious to me that the same piece of apparatus could also be used to measure without her knowledge, a girl's girth at various loci on her torso which, of course, constitute what are usually known as a woman's vital statistics.

It may be asked who on earth wants to measure a girl's vital statistics without her knowledge? Personally I think there are quite a number of people, as this firm would find if it marketed its dendrometer in a slightly more compact form and under another name such as torsometer.

Among potential users would be theatrical agents who would find it very useful to give prospective chorus girls the once-over without their knowledge.

A Pommy in N.Z.

THE brief article in the October issue entitled "A 'Kiwi' at Earls Court," interested me greatly as the author's experiences were, *mutatis mutandis*, parallel to my own nigh on forty years ago. I, too, arrived in England from New Zealand just in time to see the Radio Show—actually the very first one, at the Horticultural Hall.

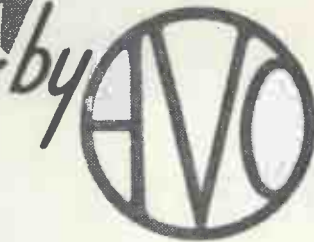
The most interesting part of his article to my mind was his statement that seeing the sign "Overseas Visitors," he walked in and sat down in the select overseas visitors' lounge. I flatter myself that I can imitate a New Zealand accent well enough to deceive the attendants at Earls Court and if there be any genuine "Kiwis" there I am sufficiently well acquainted with the main N.Z. towns not to betray myself. Even to this day I have a moving-coil loudspeaker (Magnavox horn type) and an electric razor bought in 1922 from a shop at the corner of Willis and Manners Streets in Wellington, the N.Z. capital. I recollect that corner so well; "Perretts Corner" it was called after the name of the shopkeeper whose establishment was there.

Next year, therefore, will see me safely ensconced in the overseas visitors' lounge instead of on the hard workhouse seats provided in the hall for us natives. After all, there will really be no deception as nowadays I am a genuine "Kiwi," my wings having long since been clipped by marriage.

Why Xtal?

CAN anybody tell me why the word crystal is sometimes abbreviated to xtal? We sometimes write xmitter as an abbreviation for transmitter because the "x" is "a cross" (a St. Andrew's one) and the Latin word trans means "across". But xtal beats me. Is the first letter x or the Greek chi?

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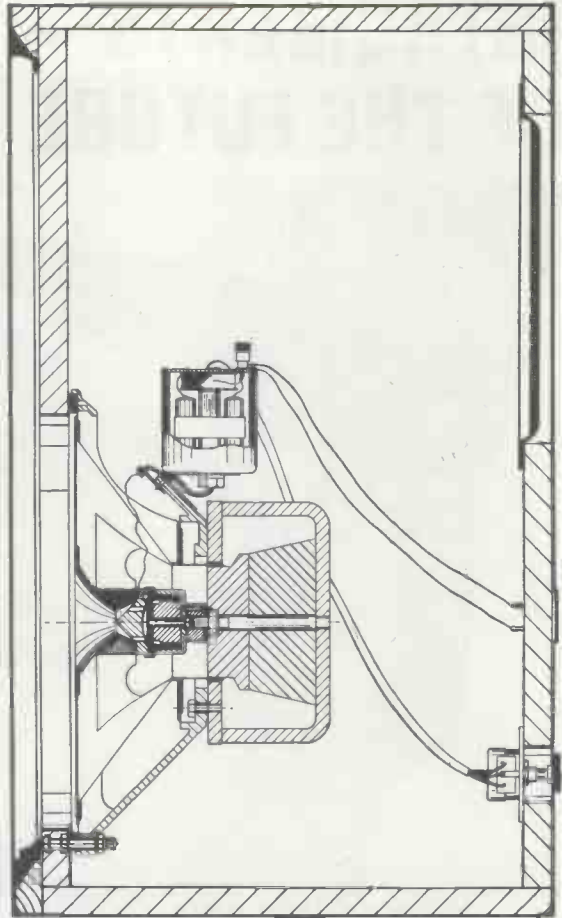
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ABRIDGED DATA

Characteristics	E810F	E55L
V_a	120V	125V
V_{g_2}	150V	125V
V_{g_3}	0V	0V
V_{g_1}	-1.9V	-2.0V
I_a	35mA	50mA
I_{g_2}	5mA	10mA
g_m	50mA/V	45mA/V
$\mu_{g_1-g_2}$	58	38
r_a	70k Ω	20k Ω
r_{g_1}	500 Ω	1000 Ω
	(f=100 Mc/s)	(f=50 Mc/s)

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Capacitances (unshielded)

C_{a-g_1}	40mpF	110mpF
C_{in}	16pF	18pF
C_{in} (working)	25pF	28pF
	($I_k=40mA$)	($I_k=60mA$)
C_{out}	3.5pF	4pF
Valve Base	B9A	B9D

* For more detailed information please write to the address below or telephone LANGHAM 6633.

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GOVERNMENT AND INDUSTRIAL VALVE DIVISION

Mullard Limited,
Government and Industrial Valve Division

MULLARD HOUSE, TORRINGTON PLACE, LONDON, W.C.1

THE LATEST

DUBILIER

DEVELOPMENT

Tantalum Electrolytic Capacitors

ACTUAL SIZE

TYPE TF (FOIL)**TYPE TS** (SOLID)

THE FACT THAT high quality electrolytic capacitors can be made with tantalum has been known for many years. The practical development of this particular type of capacitor has been accelerated by the exacting demands for capacitors having exceptionally good characteristics for use in electronic circuits. The following types are available:—

TYPE TF

The plain or etched foil types which are of comparable construction to the well-known dry aluminium electrolytic capacitor and known as "Foil Type Tantalum Capacitors." These foil type units are suitable for standard circuitry where a size limitation exists requiring high capacitance at up to 150V with wide temperature and/or long shelf life characteristics.

TYPE TS

The solid type, in which the anode is a formed tantalum wire or, more usually, a sintered pellet of compressed tantalum powder encased in a semiconductor and housed in a container fitted with wire lead terminations. This type is most suitable where it is undesirable to have any liquid component present and where exceptionally long shelf life, extremely small dimensions and operation at temperatures beyond the capacity of the foil type is essential. The peak operating voltage of the solid type is, at present, limited to 35 volts.

The characteristics of Tantalum Capacitors differ from the conventional types of electrolytic capacitors, in the following respects:

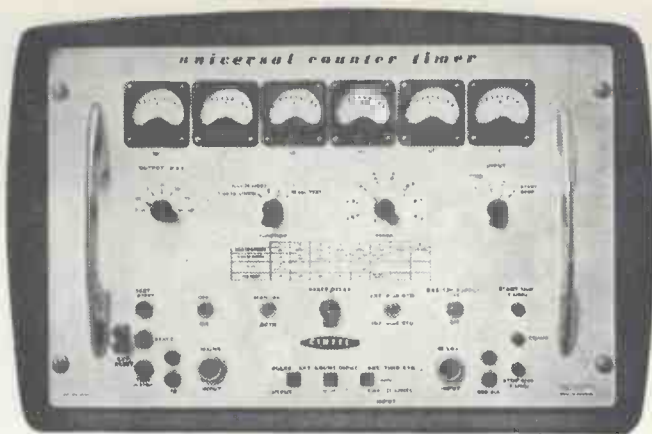
- 1 They are smaller.
- 2 They have a lower leakage current and lower power factor, i.e. a maximum of 10% for foil type and 5% for solid type.
- 3 They have considerably extended shelf life, with the added advantage of being operated over a much wider temperature range: for example certain types are suitable for operation over the range of -80°C. to $+85^{\circ}\text{C.}$
- 4 As tantalum capacitors are inherently resistant to chemical attack, the risk of internal corrosion is eliminated and the fact that there are no riveted, crimped or stitched metal-to-metal connections is an additional insurance against risk of open-circuit failures in service.

Catalogue TC 560, giving a full description of these capacitors, is available upon request.

DUBILIER CONDENSER COMPANY (1925) LIMITED, DUCON WORKS, VICTORIA ROAD, NORTH ACTON, LONDON W.3

Tel: Acorn 2241. Grams: Hivoltcon London Telex. Telex: 25373. Cables: Hivoltcon London.

Transistorized UNIVERSAL COUNTER TIMER



Frequency Measurement

Random Counting

Frequency Division

Time Measurement

Frequency Standard

This fully transistorized portable equipment provides for a wide range of time and frequency measurement as well as facilities for counting, frequency division and the provision of standard frequencies. The facilities available are briefly listed below:

TIME/UNIT EVENT (1 LINE): For the measurement of the time interval between two occurrences in a continuously varying electrical function in the range $3\mu\text{sec}$ to 1sec. The time for 1, 10 or 100 such events can be measured.

TIME/UNIT EVENT (2 LINE): For time measurement in range $1\mu\text{sec}$ to 2777hrs. of any interval defined by a positive or negative going pulse in any combination.

EVENTS/UNIT TIME: For frequency measurement in range 30c/s to 1Mc/s over period of 0.001, 0.01, 0.1, 1 or 10secs. Crystal accuracy ± 2 parts in 10^6 /week. For mains or 12Vd.c. operation.

Full technical specification available on request.

RANK CINTEL LIMITED

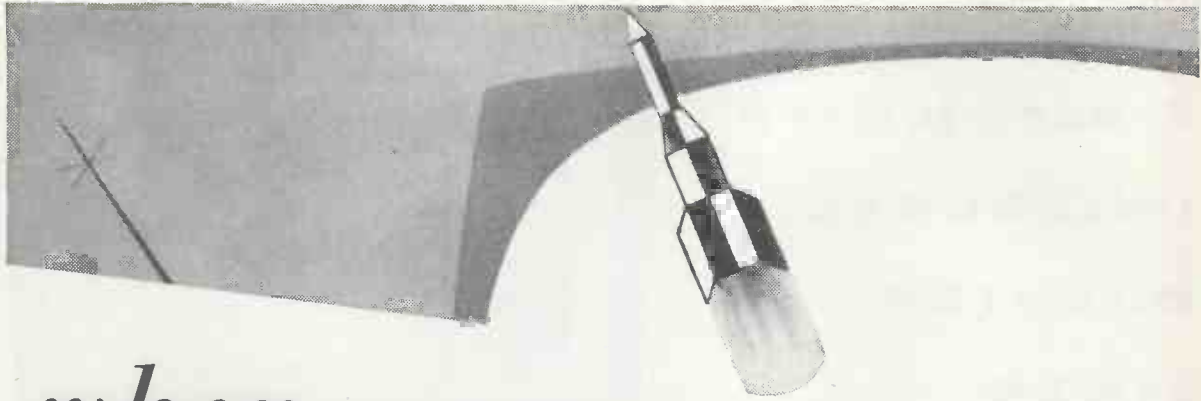
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HITHER GREEN 4600

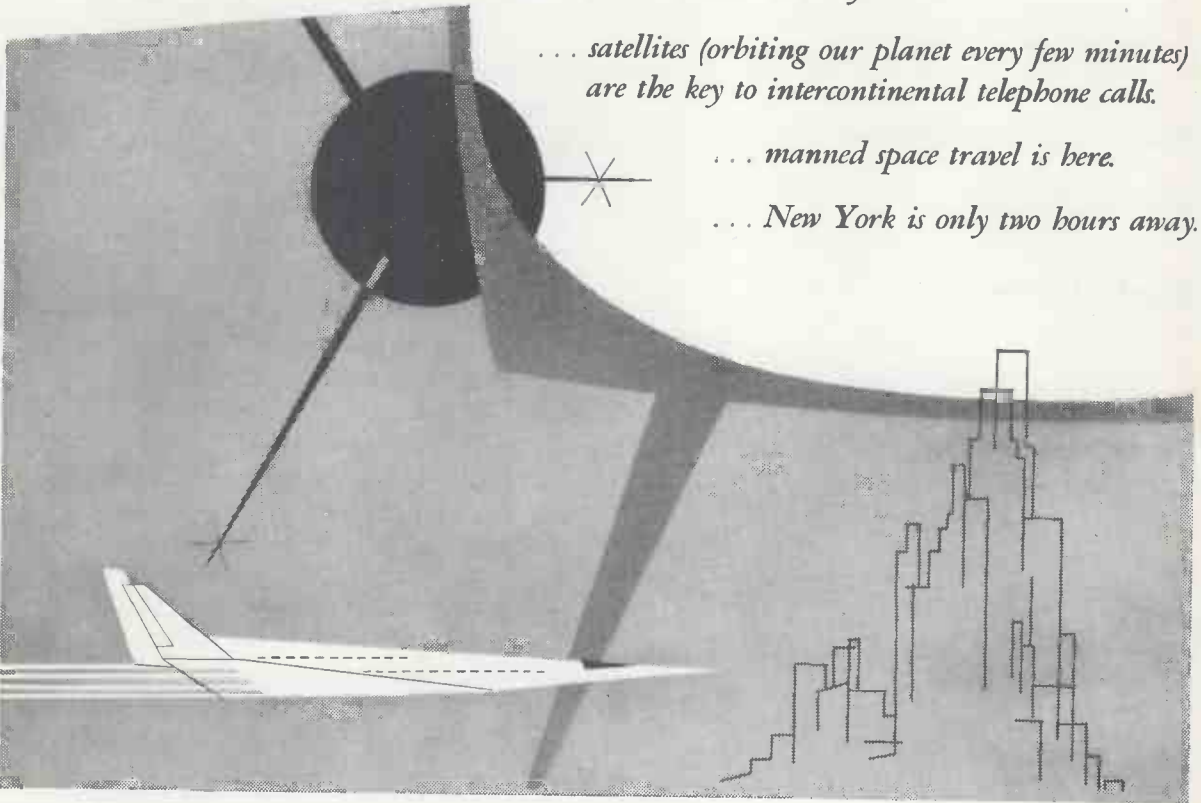


Sales and Servicing Agents: Atkins, Robertson & Whiteford Ltd., Industrial Estate, Thornliebank, Glasgow

McKellen Automation Ltd., 122 Seymour Grove, Old Trafford, Manchester 16; Hawnt & Co. Ltd., 112/114 Pritchett Street, Birmingham 6



when . . . there is colour television in every home.



. . . satellites (orbiting our planet every few minutes) are the key to intercontinental telephone calls.

. . . manned space travel is here.

. . . New York is only two hours away.

then . . . **SUFLEX** capacitors will be playing their part as they are today—doing whatever they are meant to do . . . and doing it well.

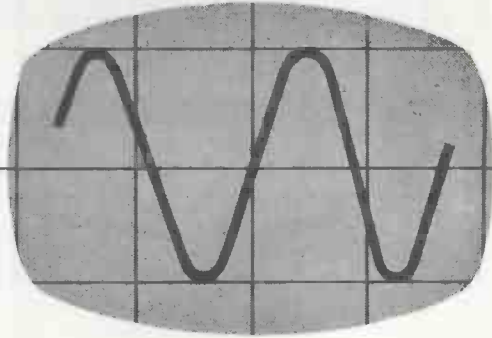
SUFLEX Polystyrene Capacitors can be made smaller, pF for pF, than any other condenser of comparable performance. Write now for full details and prices to: SUFLEX LTD., 54 UXBRIDGE RD., EALING, W.5. Tel: EALing 7733

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VOLTAGE



by *Advance*

THE CVH RANGE

Advance constant voltage transformers are available in the CVH range with low harmonic distortion in the output waveform, ideal for use with precision equipment sensitive to power frequency harmonics, and also with all equipment requiring a constant voltage sinusoidal input.

In most applications the harmonic distortion present in the output waveform will not exceed 3%. Under the most unfavourable conditions this figure will not rise substantially above 5%. When used with a rectifier to provide a d.c. supply, the characteristics of the system are identical to the normal mains source and particularly close regulation of the output is obtained.

VOLSTAT

- CONTINUOUS AND AUTOMATIC STABILIZATION
- RAPID RESPONSE TIME
- CURRENT LIMITING CHARACTERISTIC
- COMPACT DESIGN
- NO MOVING PARTS
- NO ROUTINE MAINTENANCE

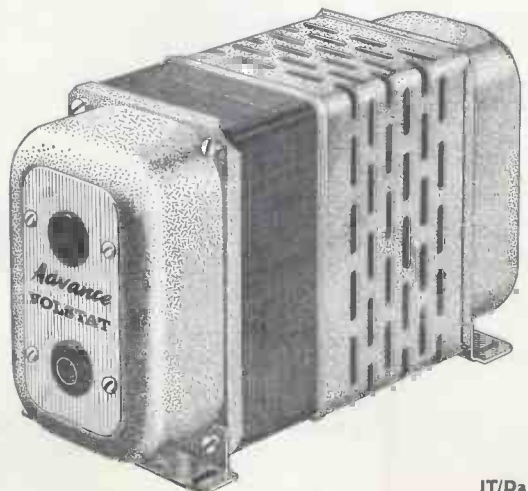
Type	I/P V Range	O/PV r.m.s.	Watts	p.f.	Net Price in U.K.
CVH60A	190-260 50 ~	240	60	1.00	£10 10
CVH125A	190-260 50 ~	230	125	1.00	£17 0
CVH420A	190-260 50 ~	230	420	1.00	£37 0
CVH750A	190-260 50 ~	230	750	1.00	£68 0
CVH1500A	190-260 50 ~	230	1,500	1.00	£99 0
CVH3000A	190-260 50 ~	230	3,000	1.00	£185 0
CVH6000A	190-260 50 ~	230	6,000	1.00	£355 0

Full details in Folder M1 available on request

Advance COMPONENTS LIMITED

MAINS STABILIZATION DIVISION

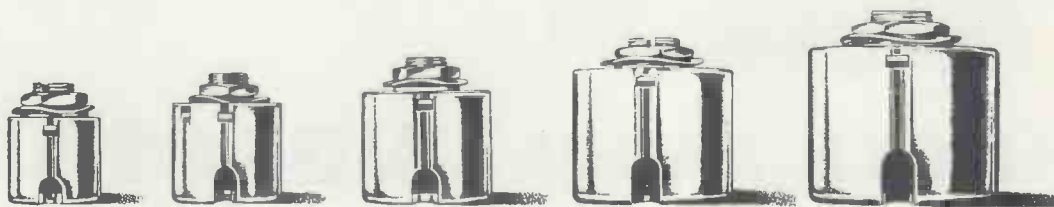
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NEW VINKOR SERIES

Covers frequencies from 100 Kc/s to **2** Mc/s



A new series of Vinkor adjustable pot cores has now been developed by Mullard for use in the frequency range 100 kc/s to 2 Mc/s. This series is in addition to the highly successful group already widely used for frequencies between 1 kc/s and 200 kc/s.

The world's most efficient pot core assembly, the Mullard Vinkor gives a choice of 3 permeabilities and has exceptionally high performance and stability.

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ADJUSTABLE POT CORE ASSEMBLIES



MULLARD LTD., COMPONENT DIVISION, MULLARD HOUSE, TORRINGTON PLACE, W.C.1.

MC1 (C)

So easy to build



so easy to use

6 W STEREO AMPLIFIER KIT



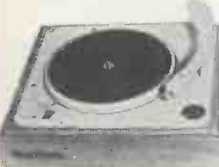
Model S-33
A versatile high-quality self-contained STEREO/MONAUURAL Amplifier with adequate output for a living room. Can be used to convert a favourite (monaural) radiogram into a stereo-radiogram. 3 watts per channel; 0.3% distortion at 2.5 w/chnl.; 20 dB N.F.B., inputs for Radio (or Tape) and Gram., Stereo or Monaural; Ganged controls. Sensitivity 200 mV. £11.8.0

HI-FI SINGLE CHANNEL AMPLIFIER KIT Model MA-12



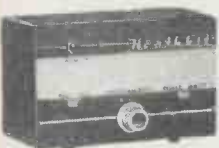
A compact high fidelity power amplifier (including auxiliary power supply). 12 watts output. Wide frequency range and low distortion. A variable sensitivity control is fitted enabling it to be used with an existing amplifier in a stereophonic system. Other applications include sound reinforcing systems, transmitter modulators, for use with tape recorders, also as a general purpose laboratory amplifier. £9.19.6

TRANSCRIPTION RECORD PLAYER Model RP-1U



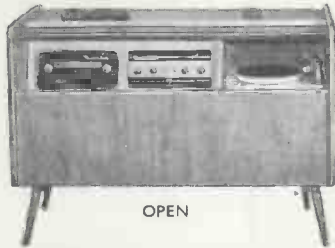
With 4-spd. A.C. motor unit and Stereophonic Pick-up completely assembled on plinth. High performance at low cost. This attractive Transcription Record Player incorporates many new features which make it suitable for all types of recordings on discs. It has the new Collaro RP.594 unit with the Ronette Stereo Pick-up and gives excellent results on stereo or mono (16, 33, 45 L.P. or 78 r.p.m.) gramophone records. £12.10.0

STEREO-HEAD BOOSTER KIT Model USP-1



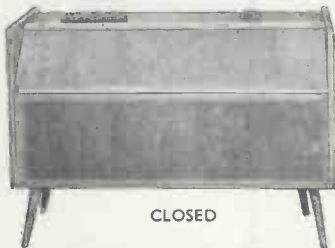
Hi-Fi Stereo Pre-Amplifier for low-output Hi-Fi P.U.s. Input 2 mV. to 20 mV. Output adjustable from 20 mV. to 2 V. 40-20,000 c/s. Also suitable as low-noise R.C.-Coupled high-gain monaural amplifier. £5.19.6

GLOUCESTER STEREO CABINET KIT



OPEN

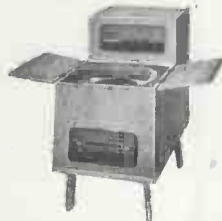
Specially developed to meet the varying needs of different homes. It will house Tape Deck and/or Record Player, F.M. Tuner and Stereo Amplifier. In addition, for the convenience of those to whom space is an overriding consideration, it is possible to house speaker systems at each end. For this purpose a loudspeaker kit, comprising two 4in. plus 8in. speaker systems, balance unit, speaker grille, cutting template, padswag and mounting details is also available. Neutral hardwoods have carefully been selected so that the finished product can be stained and polished to individual choice. There is storage space for records, etc., also for power amplifiers. Dimensions: length 46 1/2 in., height 30 in., depth 21 in.



CLOSED

Mk. I for Tape Deck or Record Player £15 18 6
Mk. II for both T/D and R/P..... £17 8 6

CHEPSTOW EQUIPMENT CABINET KIT



Specially designed for those whose floor space is at a premium. Will house Record Player, FM Tuner, Stereo Amplifier and additional power amplifiers where needed. An upper deck is available for the self-powered stereo amplifiers to ensure maximum heat dissipation. Veneered and left in white for finishing to personal taste. Overall dimensions are 35 in. x 18 in. x 33 in. high. £10.10.0

Deferred Terms available on all orders above £10.

HI-FI STEREO AMPLIFIER KIT Model S:88



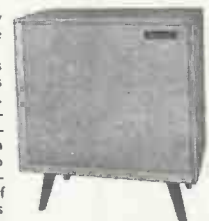
Gives 16 w. output (8 per channel with 0.1 per cent. distortion at 6 w. per channel). It has ganged controls, STEREO/MONAUURAL gram, radio and tape recorder inputs and push-button selection as well as many other first class features well above its price range. In two-tone grey metal cabinet with a golden surround and fittings. Also ultra-linear push-pull output. £25.5.6
Basic sensitivity 20 mV. (2 mV. available 20/- extra).

HI-FI SPEAKER SYSTEM KIT Model SSU-1



Ducted-port bass reflex cabinet, "in the white." Frequency response to 40-16,000-c/s. Power rating 25 watts. Matched speaker units 8in. high flux (12,000 lines) with hyperbolic cone and 4in. wide angle dispersion type for higher frequencies. With legs £11/12/6..... £10.5.6

COTSWOLD SPEAKER SYSTEM KIT



This acoustically designed enclosure measures 26 x 23 x 15 1/2 in. and houses a special 12in. bass speaker with 2in. speech coil, elliptical middle speaker together with a pressure unit to cover the full frequency range of 30-20,000 c/s. Its polar distribution makes it ideal for really Hi-Fi Stereo. Delivered complete, with speakers, cross-over unit, level control, Tygan grille cloth, etc. Left "in the white" for finish to personal taste, all parts are pre-cut and drilled for ease of assembly. £19.18.6

STEREO CONTROL UNIT KIT Model USC-1



Incorporates all worthwhile features for high fidelity stereo and mono. Push-button selection, accurately matched ganged controls to ±1 dB. Negative feedback rumble and variable low-pass filters. Printed circuit boards. Accepts inputs from most tape heads and any stereo or mono-pick-up. £17.19.6

TAPE DECKS now available as "packaged deals" with other equipment. Details on request.

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excellent

5in. OSCILLOSCOPE KIT



Model O-12U
Laboratory quality at utility oscilloscope price and ease of assembly make this kit of outstanding value. Vertical frequency response 3 c/s to 5 Mc/s., ± 1.5 dB. -5 dB, sensitivity 10 mV. per cm. at 1 kc. Horizontal frequency 1 c/s. to over 400 kc/s. (± 1 dB, up to 200 kc/s.). The Heath patented sweep circuit functions from 10 c/s to 500 kc/s. In five ranges giving five times the usual sweep of other scopes.

In addition it has exceedingly short re-trace and rise times and electronically stabilised power supply. Included is a 48-page instructional Manual. **£34.15.0**

ELECTRONIC SWITCH KIT Model (Oscilloscope Trace Doubler) S-3U



This extremely useful, low priced device will extend the use of your single-beam oscilloscope for duties otherwise only in the province of the double-beam tube.

In short, at a nominal cost, the Heathkit Model S-3U will give you the advantages of a double (or other multiple) beam 'scope, while retaining all the advantages of your present single-beam instrument.

Hitherto an electronic switch of this nature, permitting the simultaneous observation of two signals on the screen of a single-beam C.R.T. oscilloscope, has cost nearly as much as the 'scope itself. **£9.18.6**

RESISTANCE-CAPACITANCE BRIDGE KIT Model C-3U



Measures capacity 10pF to 1,000 μ F, resistance 100 Ω to 5 megohms and power factor. 5-450 v. test voltages. Safety switch provided. **£7.19.6**

AUDIO SIGNAL GENERATOR KIT Model AG-9U



10 c/s. to 100 kc/s., switch selected. Distortion less than 0.1%. 10 v. sine wave output, metered in volts and dB's. **£19.3.0**

AUDIO VALVE MILLIVOLTMETER KIT Model AV-3U

Very sensitive. High stability. 1 mV. to 300 V. A.C. 10 c/s to 400 kc/s. **£13.18.6**

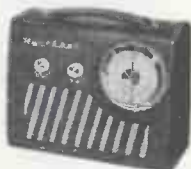
MULTIMETER KIT Model MM-1U

Provides wide voltage, current, resistance and dB ranges to cover hundreds of applications. Sensitivity 20,000 ohms/volt D.C. and 5,000 ohms/volt A.C. Ranges: 0-1.5V. to 1,500V A.C. and D.C.; 150 μ A to 15A D.C.; 0.2 Ω to 20M Ω ; 4 μ in. 50 μ A meter. **£11.8.6**

DECADE CAPACITOR KIT Model DC-1U

Capacity values 100 μ F to 0.111 μ F in 100 μ F steps. Precision silver-mica capacitors and minimum loss ceramic wafer switches ensure high accuracy. **£5.18.6**

TRANSISTOR PORTABLE RADIO KIT Model UXR-1



Presented in elegant real hide case with tasteful gold relief. Can be assembled in 4 to 6 hours, and you have a set in the top flight of transistor portables. Pre-aligned I.F. transformers, printed circuit and a 7in. x 4in. high-flux speaker. **£14.18.6**

HI-FI F.M. TUNER



Tuning range 88-108 Mc/s. Flywheel tuning. Attractive Plastic Front Panel in two-tone grey with golden trim, surround and motif. Thermometer type visual tuning indicator. Pre-aligned I.F. transformers (eliminates adjustment). Three I.F. Stages. Wide-band low distortion. Ratio Detector. Complete R.F. Unit, wired, tested and pre-aligned (ready for mounting to chassis). Printed circuit for I.F. Amplifiers and Ratio Detector, for ease of assembly. No alignment necessary after assembling. Built-in power supply. Output sockets for stereophonic adaptor (for stereo transmission when available).

TUNER UNIT Model FMT-4U (incl. 16/11 P.T.) with 10.7 Mc/s. I.F. output **£3 2 0**

I.F. AMPLIFIER Model FMA-4U complete with case and valves **£10 10 6**

Sold separately Total **£13 12 6**

CAPACITANCE METER KIT Model CM-1U

This Direct-Reading Capacitance Meter is a very low priced, time-saving instrument which is so useful that it should be part of the general equipment of every electronic laboratory and production line. Easily built in a few hours. 0-100 μ F, 0-1,000 μ F, 0-0.01 μ F, 0-0.1 μ F. The meter has 4 $\frac{1}{2}$ in. scale and can be used by an unskilled operator after a few minutes' instruction. **£14.10.0**



2 $\frac{1}{2}$ in. SERVICE OSCILLOSCOPE KIT Model OS-1

Light, compact, portable, for service engineers. Printed circuit board for easy construction. Wt. 10 $\frac{1}{2}$ lb. Size 5in. x 8in. x 1 $\frac{1}{4}$ in. long. **£18.19.6**

POWER SUPPLY UNIT KIT Model MGP-1

Compact, general purpose unit suitable for FM Tuners, Tape Recording Amplifiers and general Laboratory use. Input 100/120 v., 200/250 v., 40-60 c/s. Output 6.3 v., 2.5 A. A.C.; 200, 250, 270 v. 120 mA. max. D.C. **£4.9.0**



AUDIO WATTMETER KIT Model AW-1U

This popular meter is used in many recording studios and broadcasting stations as a monitor as well as for servicing purposes. Dissipation rating up to 25 w. continuous, 50 w. intermittent. **£13.18.6**

VALVE VOLTMETER KIT Model V-7A

The world's most popular valve voltmeter, with printed circuit and 1 per cent. precision resistors to ensure consistent laboratory performance. It has 7 voltage ranges measuring respectively d.c. volts to 1,500 and a.c. to 1,500 r.m.s. and 4,000 peak to peak. Resistance measurements from 0.1 ohm to 1,000 M ohms with internal battery. D.C. input impedance is 11 Megohms and dB measurement has a centre-zero scale. Complete with test prods, leads and standardising battery. **£13.0.0**



R.F. PROBE KIT Model 309-CU

This complete probe kit will extend the frequency range of the V-7A Valve Voltmeter to 100 Mc/s. and will enable useful voltage indication to be obtained up to 300 Mc/s. **£1.5.6**

• Deferred Terms available on all orders above £10. •

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Model DX-40U



Covers all amateur bands from 80 to 10 metres. Power input 75 watts C.W. 60 watts peak controlled carrier phone. Output 40 watts to aerial. Provision for V.F.O. Filters minimise T.V. Interference. **£29.10.0**

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to our range of kits

AMATEUR TRANSMITTER KIT
Model DX-100U



The world's
most popular

"Ham" T.X. Kit

- Completely self-contained, compact "Ham" Transmitter.
- Built-in, high stable VFO and all Power Supplies.
- TVI: Careful design has reduced TVI to a minimum by use of effectively screened frequency-generating stages and pi tuned circuits at the input and output of the PA stage, and by 11 chokes and pi network filters to all outlets from the cabinet. No fewer than 35 disc-ceramic by-pass capacitors help to achieve the exceptional stability and high-performance for which this Transmitter is noted.
- The KT88 high-level anode and screen modulator stage gives over 100 watts of audio from less than 1.5 mV. input.
- Adjustable drive and clamp control ensure that valves are only driven sufficiently to maintain the required output.
- Keying on CW is via the VFO and buffer amplifier cathodes; the other RF valves are biased beyond cut-off. When zero-beating the TX with incoming signals, the exciter stages only may be run without the final amplifier being switched on.
- Provision has been made for remote control operation.
- VFO slow-motion drive is very smooth and back-lash free. ● VFO or Crystal control.
- Covers all Amateur bands up to 30 Mc/s. phone or CW **£78.10.0**

BALUN COIL UNIT KIT
Model B-IU



Useful transmitter accessory. Will match unbalanced coaxial lines, used on most modern transmitters, to balanced lines of either 75 or 300Ω impedance. Can be used with transmitters and receivers without adjustment over the frequency range of 80 through 10 meters, and will handle power inputs up to 200 watts. **£4.4.6**

TAPE AMPLIFIER UNITS
Models TA-IM and TA-IS

This Combined Tape Record/Replay Amplifier is available in both monophonic and Stereophonic models. Model TA-IM can be modified to the stereo version with modification kit TA-IC.

TA-IM £16/14/-; TA-IS, £22/4/-; TA-IC, £6.



4-wave TRANSISTORISED PORTABLE RADIO
Model RSW-1

Using 7 latest type transistors and three diodes this highly sensitive set is specially designed for Short and Medium wave-bands (200-550, 90-200, 18-50 and 11-18 m.). In solid leather case fitted with retractable whip aerial. **£20.18.6**



MATCHED HI-FI STEREO KIT

4-speed Transcription Record Player Model RP-IU	£12 10 0
6 w. Hi-Fi Amplifier, Model S-33.....	£11 8 0
Twin Stereo Speaker Systems Model SSU-I....	£20 11 0
Total cost if purchased separately.....	£44 9 0

YOURS for **£42.10.0**

if all ordered together, or £8/8/- deposit and 9 monthly payments of £4/3/-. Pedestal speaker legs £2/14/- optional extra.

PERSONAL TRANSISTOR RADIO KIT
Model UJR-1



Operated by a 4.5V. torch battery, this sensitive dual-wave head-phone set is a fine introduction to electronics for young and old. In Polystyrene moulded plastic case which accommodates battery (and amplifier if added). **£2.16.6**

Additional Amplifier Stage Model UJR-IS will enable the UJR-1 to work a loudspeaker under favourable conditions. 16/6 extra.

R.F. SIG. GENERATOR
Model RF-IU

Provides extended frequency coverage on six bands from 100 kc/s.-100 Mc/s. on fundamentals and up to 200 Mc/s on calibrated harmonics. **£11.11.0**

GRID-DIP METER
Model GD-IU

Functions as oscillator or absorption wave meter. With plug-in coils for continuous frequency coverage from 1.8 Mc/s. to 250 Mc/s. **£9.19.6**



Two Additional Plug-in Coils Model 341-U extend coverage down to 350 kc/s. With dial correlation curves, 15/-.

TRANSISTORISED GRID-DIP METER
Model XGD-I

Similar to GD-IU. Fully transistorised with a frequency range **£9.18.6** of 1.75 to 45 Mc/s.

VARIABLE FREQUENCY OSCILLATOR KIT
Model VF-IU

Specially designed to meet the demand for the maximum possible flexibility from an amateur Transmitter which would otherwise be subject to certain limitations imposed by crystal control. For all Amateur Bands 160-10 metres. Ideal for Heathkit DX-40U and similar transmitters..... **£10.12.0**
Price less valves £8/19/6.



"Wireless World" report

of the Radio Hobbies Exhibition on page 28 January issue says:—

"... transistors have made an enormous impact on the amateur... but this year sees the first introduction of a commercial communications receiver using them. The Heathkit "Mohican" was certainly the centre of attraction among the kits on Daystrom's stand:"

Write for details of the forthcoming "MOHICAN" GENERAL COVERAGE RECEIVER KIT.....Model GC-1U **£38.15.0**

Please send me FREE CATALOGUE (Yes/No).....
Full details of Model(s)

NAME
(Block Capitals)

ADDRESS

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All prices include free delivery in U.K.

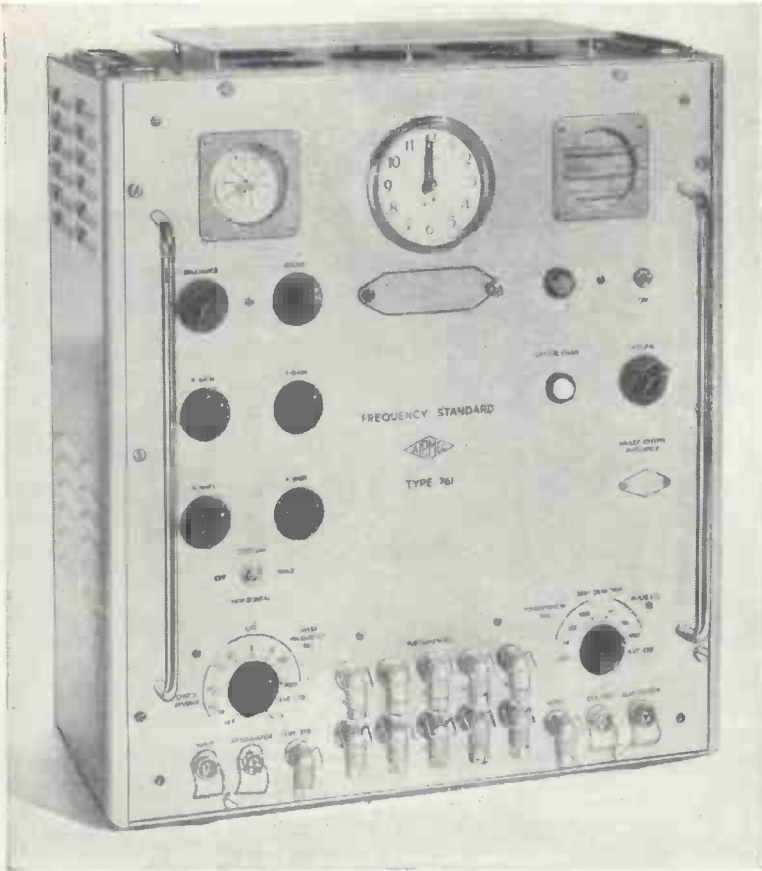
★ Visit our STAND at the MARCH L.P. FESTIVAL, Norbreck Hotel, Blackpool. MARCH 3rd. — 5th. ★

● Deferred Terms available on all orders above £10 ●

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DEPT. W.W.3, GLOUCESTER, ENGLAND

THE WORLD'S LARGEST-SELLING ELECTRONIC KIT-SETS



FREQUENCY STANDARD

TYPE 761

in instrumentation...

Airmec

makes most things...
better

AIRMEC LIMITED
HIGH WYCOMBE · BUCKS
Telephone: High Wycombe 2501/7

FUNCTION

Provides an excellent crystal controlled frequency and time standard of small size and moderate cost. The short term frequency stability of better than 1 part in 10^6 obtainable upon installation improves with time and correct treatment up to a working stability approaching 1 part in 10^7 .

OPERATION

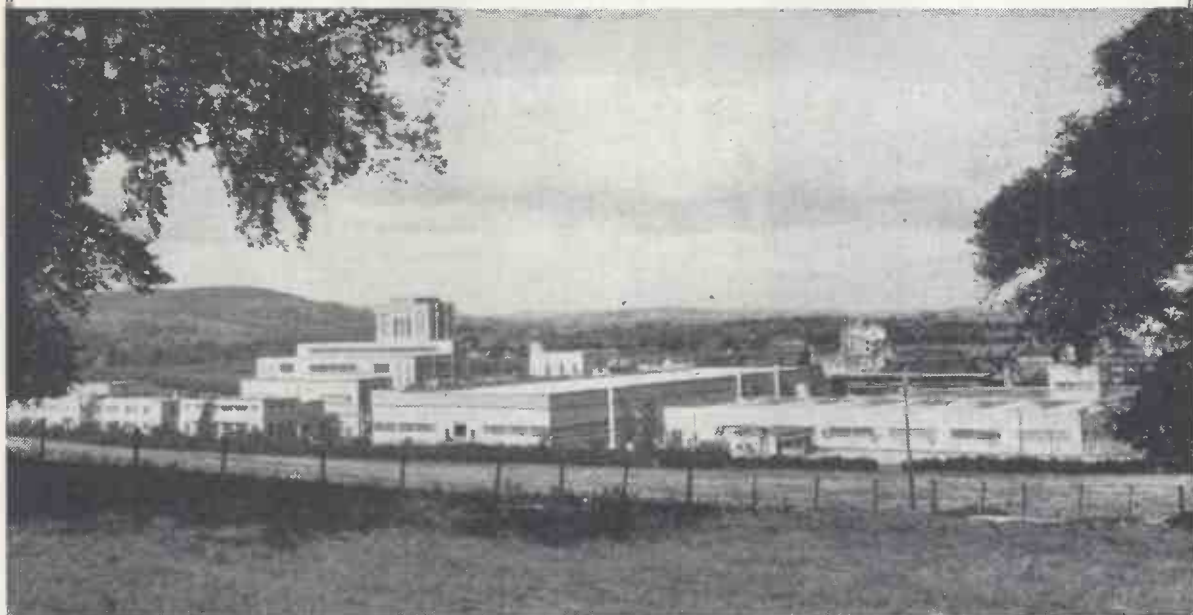
Sinusoidal and pulse signals are produced at five standard frequencies, the pulse waveform being rich in harmonics. The instrument includes both an Oscilloscope and Heterodyning Circuit as independent facilities and is therefore extremely flexible in operation.

FEATURES

- 100 kc/s crystal housed in an oven controlled at 70° C.
- Standard signals provided at 100 c/s, 1 kc/s, 10 kc/s, 100 kc/s, and 1 Mc/s.
- Identification of an unknown signal by Lissajous figure or beam modulated circular trace.
- Beat output available from a plug on the front panel.
- Suitable for rack mounting.

IMMEDIATE DELIVERY

More 'Melinex' in 1961



I.C.I. build new plant to produce 2,000 tons of 'Melinex' film per year

IN JANUARY 1961, a new 'Melinex' polyester film plant will start production at Dumfries with a rated capacity of 2,000 tons/year. I.C.I., who are the sole manufacturers of polyester film in this country, have been selling 'Melinex' for some years. The demand has increased rapidly and I.C.I. have been allowing imports of American and Continental film to supplement their limited production. The new plant will remove the necessity for such imports.

More and more firms are appreciating the outstanding properties of 'Melinex' film. Its unusual clarity and strength (both mechanical and electrical) combined with its great dimensional stability and resistance to heat and chemical action, are improving a very wide range of products throughout industry.

Where 'Melinex' film is now being used:

- The Electrical Industry**—in coils, capacitors, cables, recording tapes and loudspeakers.
- Drawing Offices**—as a flexible, durable and dimensionally stable drafting film.
- Display**—in metallised form for tinsel and as coloured tapes and panelling.
- The Book Trade**—for protecting covers and as a base for hot stamping foils.
- Footwear & Leather goods**—in metallised form for shoes and fashion accessories.
- The Food Industry**—for improving the sales appeal of goods and for 'boilable' packs.

The range of uses for this versatile film will widen considerably in 1961. If you would like further information or wish to discuss a possible application for 'Melinex' film, please write to I.C.I. Their Technical Service staff will be pleased to give advice and technical assistance.

'Melinex'

'Melinex' is the registered trade mark for the polyethylene terephthalate film manufactured by I.C.I.



IMPERIAL CHEMICAL INDUSTRIES LIMITED · LONDON · S.W.1

MODEL 5G-5"



MODEL 6G-6½"



MODEL 58C-8"x5"



MODEL 8C-8"



POPULAR REPLACEMENT SPEAKERS

For the guidance of the trade and public we publish below a list of the most popular ELAC replacement loudspeakers.

We have made this selection from our wide range of speakers as they cover practically all the requirements of the replacement trade.

The new prices are now operative.

POPULAR REPLACEMENT MODELS

Type	Ref	Flux	Retail Price	Purchase Tax
5in.	5G	6500 g	20/6	6/7
6½in.	6G	6500 g	21/6	6/11
7 x 4in.	47G	6500 g	20/6	6/7
7 x 3in.	37G	6500 g	20/6	6/7
8 x 3in.	38G	6500 g	20/6	6/7
8 x 5in.	58C	8500 g	24/6	7/10
8in.	8C	7000 g	25/6	8/2

All loudspeakers have Standard 3 Ohm impedance. Higher impedances can be supplied at an extra cost of 3/- plus 1/- Purchase Tax.

Please write for leaflets and further details.

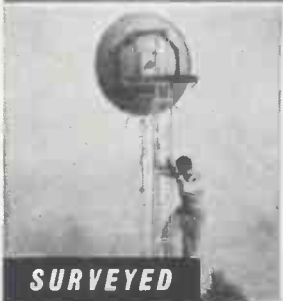
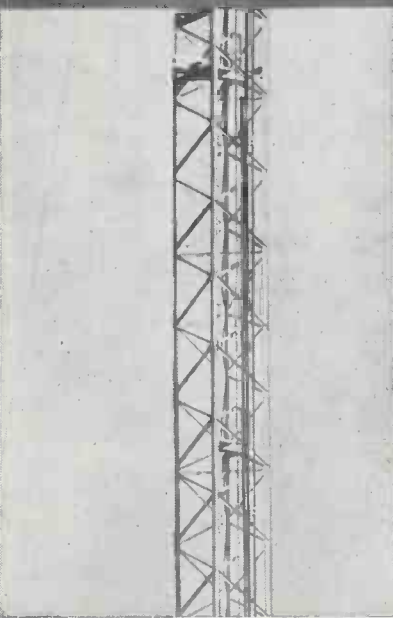


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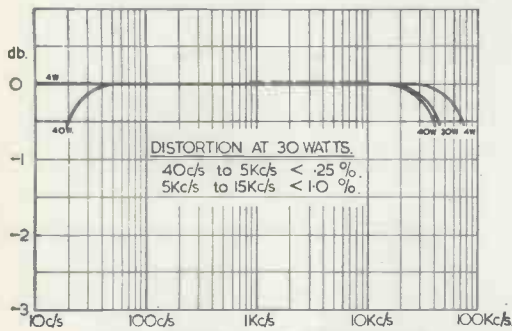
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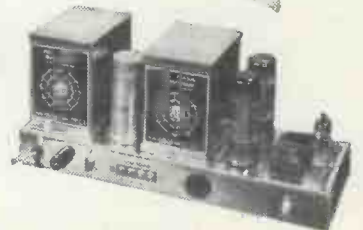


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3×2½in. rectangular case, scale numerals shifted by lever which may be coupled to range switch by cord or lever, giving positions "Set-zero": 0-3, 0-30, 0-300. Easily recalibrated and adjustable to centre zero 25-0-25 μ A. Makes 20,000 opv. multimeter. Multirange scales V- Ω -Ma/shunts and multipliers available.

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Available punched to take one or two meters as illustrated and with all fixing screws, etc., for 50 μ A meter. S.A.E. for detailed lists.



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ONE METER **19'6** (plus 6d. post)

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10 Watt. ALL-TRANSISTOR AMPLIFIER 12v. D.C.

New 1961 design, for P.A./gramo., etc. 2 inputs mic/gram, volume and tone controls, outputs 3-8-15 ohms; 100 c/s-10 kc. response, max. consumption only 1.25 amps. Size 7¼ × 5½ × 3½in. In kit form £10/10/-, or wired and tested £12/15/-, post paid.

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We have available (for export only) large quantities of Transmitters and Transmitter Receivers as follows. Full descriptions and prices available on request. Our prices are a small fraction of the original cost.

Type	Frequency	Application	Emission	Control	Power	Operation
B.44	60-90 Mc/s	Mobile Transceiver	AM	Crystal 1 Channel	3w	12 v. D.C.
46	3.6-9 Mc/s	Walky-Talky	AM or CW	Crystal 3 Channel	1.5w	Dry Batteries or 6 or 12 v
75C	100-156 Mc/s	Base Station	AM	Crystal 1 Channel	50w	200-250 v. 50 c.
ART13	1.5-18 Mc/s	Aircraft or Fixed Station	AM or CW	Master Osc.	200w	24 v. D.C.
TA24J	1.5-15 Mc/s	Fixed Station	AM or CW	Crystal 8 Channel	100w	24 v. D.C.
SW11B	3-22 Mc/s	Fixed Station	CW	Master osc. or crystal	6 to 7kV	400/440 v. 3 ph. 50 c.
No. 19 Mk. III	2-8 Mc/s	Mobile Transceiver	AM or CW	Master osc.	8w	12 or 24 v. D.C.
88	38-43 Mc/s	Walky-Talky	FM	Crystal 4 Channel	1w	Dry Batteries or 6 or 12 v.
ET4336	2-20 Mc/s	Base Station	AM or CW	Master osc. or Crystal	250 to 350w	200-250 v. 50 c.
1935	100-124 Mc/s	Mobile Transceiver	AM or CW	Crystal 4 Channel	5w	12 or 24 v.
1936	124.5-156 Mc/s	Mobile Transceiver	AM or CW	Crystal 4 Channel	5w	12 or 24 v.
1985	100-124 Mc/s	Mobile Transceiver	AM or CW	Crystal 10 Channel	5w	12 or 24 v.
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Other material available includes a large range of transmitting and receiving valves, 500,000 crystals including 3,000 different frequencies. BC221 Frequency Meters. Instrument Wire of all types. Spares for T.C.S. Transmitters and Receivers. 110-150 v. 50 c. 1/6th H.P. Motors. APN4 Indicators and Receivers. DLR5 Headphones. Relays, 3,000 types and others, Mains Transformers, various types including (1) 6.3 v. 4 a., (2) 6.3 v. 2 a., (3) 1,000 v. 20 m/a., etc. Type 4A Mine Detectors. P.O. Push Button Switches.

MAGNETIC AMPLIFIER AND SERVO ACTUATOR. Complete unit in aircraft type aluminium case 8 x 12 x 5in., 4 control-loop magamp (gains 24 : 12 : 6 : 6) with Carpenter and slave relays operates 24 v. D.C. 1/75 h.p. reversible servomotor with gearbox and lead-screw to give linear movement 100 lb. through lin. Easily adapted for Education and all control systems. Requires few watts 10.5 or 115 v. 400 c/s. Fully filtered for R.F. MAGAMP unit only 63/-. Complete amplifier 105/-. 24 v. Actuator 55/-. Miniature Dynamotor with 12 v. input and 10.5 v. output for above, price 25/-.

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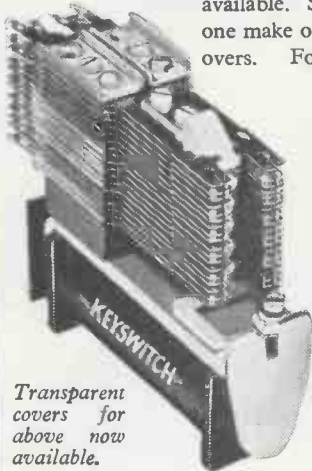
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The best known and most useful relay available. Spring sets allow from one make or break to 12 changeovers. For minute or heavy switching. Sensitivity down to 20 milliwatts. Adjustable for critical timing, fast or slow operation. Standard or Tropical finish. Special adaptations can be supplied.



Transparent covers for above now available.

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Plug-in facilities in addition to all the versatility and well-established, reliable features of the world's best known relays.

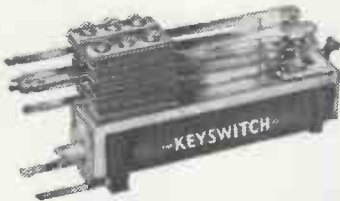
- ★ Positive contact between male and female pins.
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SOCKETS AND FITTINGS ARE AVAILABLE FROM STOCK for immediate assembly of units.

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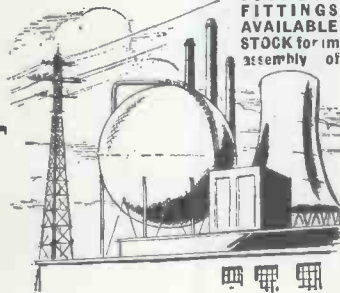
Operation AC or DC Switching or Signal Current AC or DC 5 to 500 micro-amps Transfer switching current 10 amps. or 500 v.



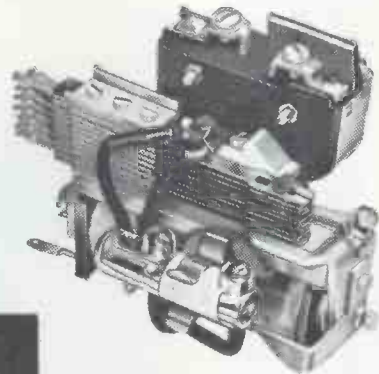
MINOR TYPE '600' (Fitted with double pole changeover for 250 volts, 2 amps.)

Ideal for simple switching operations where lightness, compactness and economy are prime considerations. When fitted with contacts similar to those of the "B.P.O. 3000" type it is faster in operation and release.

Available free on request, unique calculator provides full relay specifications.



This relay incorporates 15 amp. Micro Switch; 5 amp. Mercury Switch and standard 0.3 to 8 amp. contacts.



RELAYS FOR ALL PURPOSES can be manufactured to customers' requirements for:—

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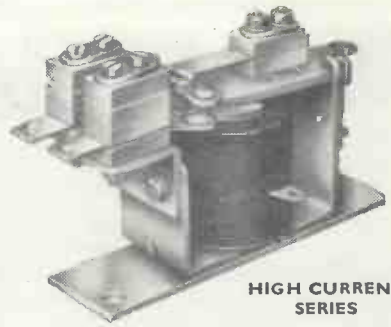
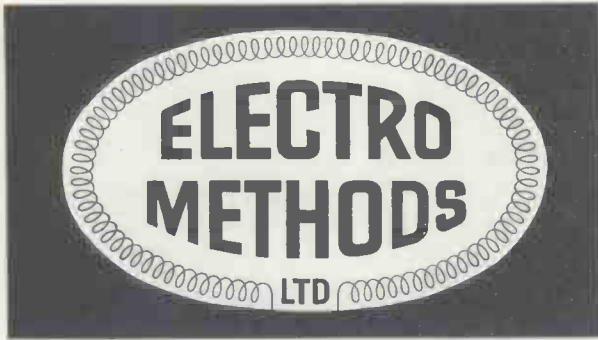
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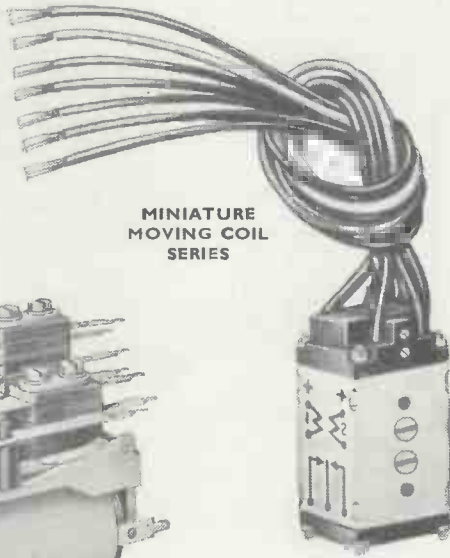
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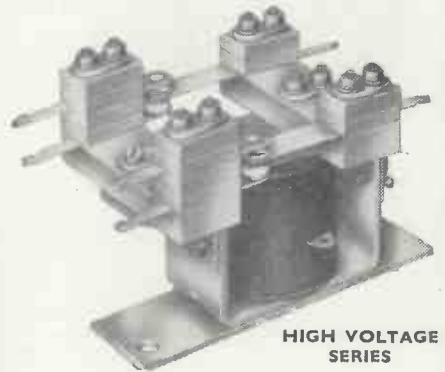
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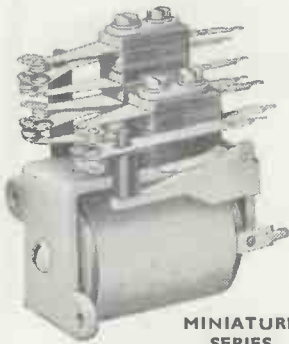
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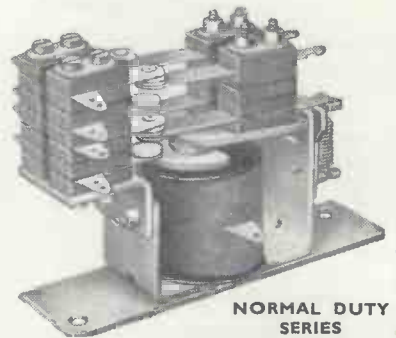
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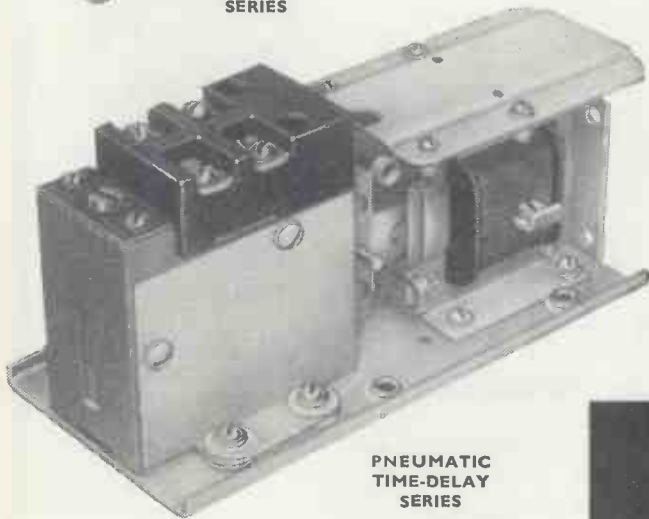
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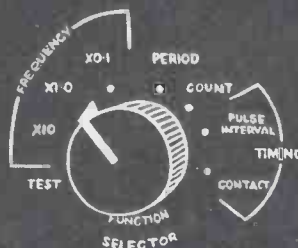
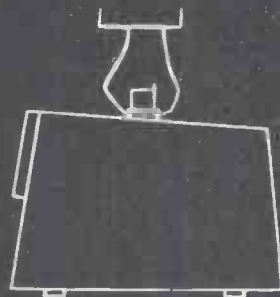
The treble-3-six is proof that Venner gives a high technical performance AND versatility at low cost.

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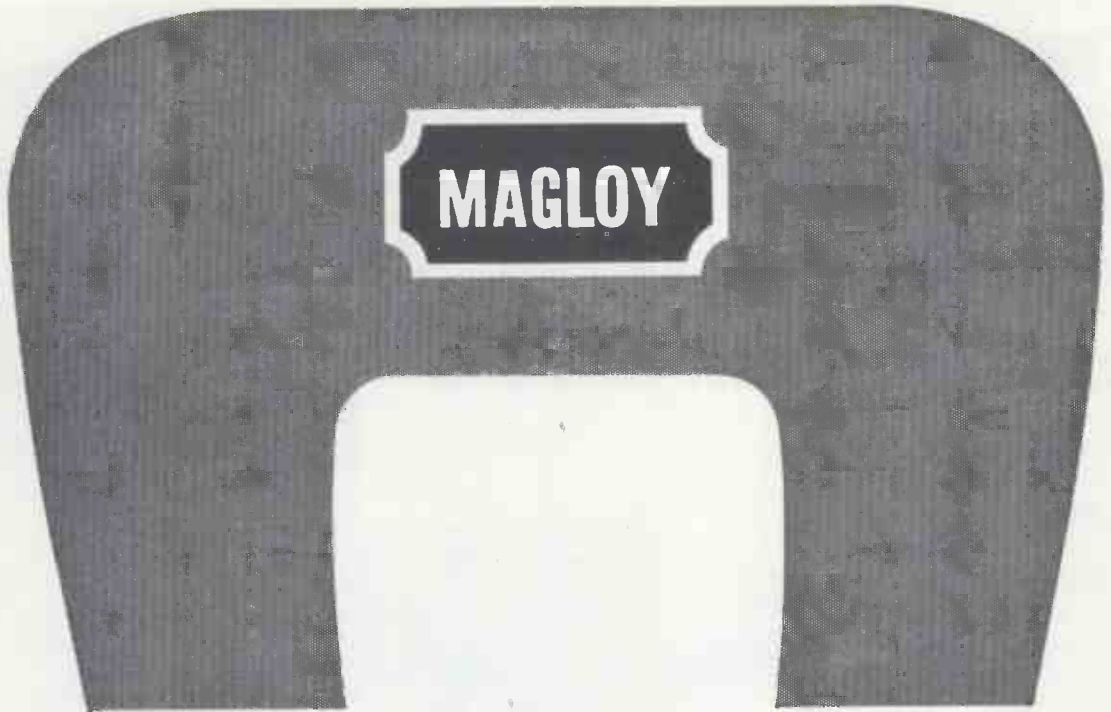


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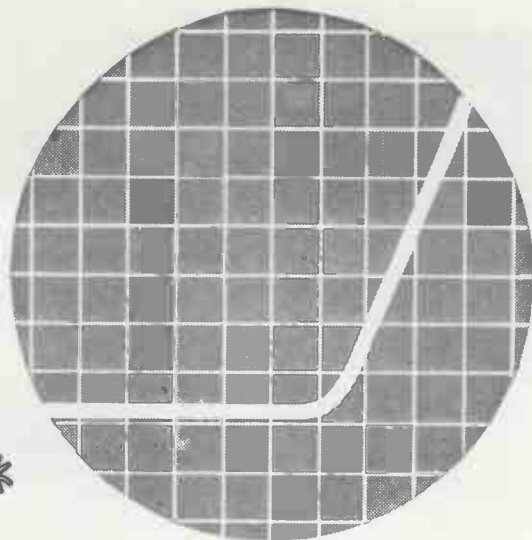
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“O.K.—it’s an ordinary characteristic but what isn’t so ordinary is that we have got definition of this valve’s performance. Definition in a special way that is. For instance, we know just what ‘spread’ we can expect in every batch that is delivered, and we have an indication of the spreads that we can expect over life.

This information is a tremendous help when you’re designing equipment that’s got to be reliable and you get it on Mullard Special Quality valves. You get this information because of the work they put in at their quality and test laboratories; with it you can design circuits that allow for possible valve variations and so achieve standards of equipment dependability that might otherwise not be possible.

Closely controlled characteristics are a feature of some Mullard Special Quality valves—others have a particularly long life expectation and some are designed for application where physical shock and vibration are likely to be experienced; some even have a combination of these features.”

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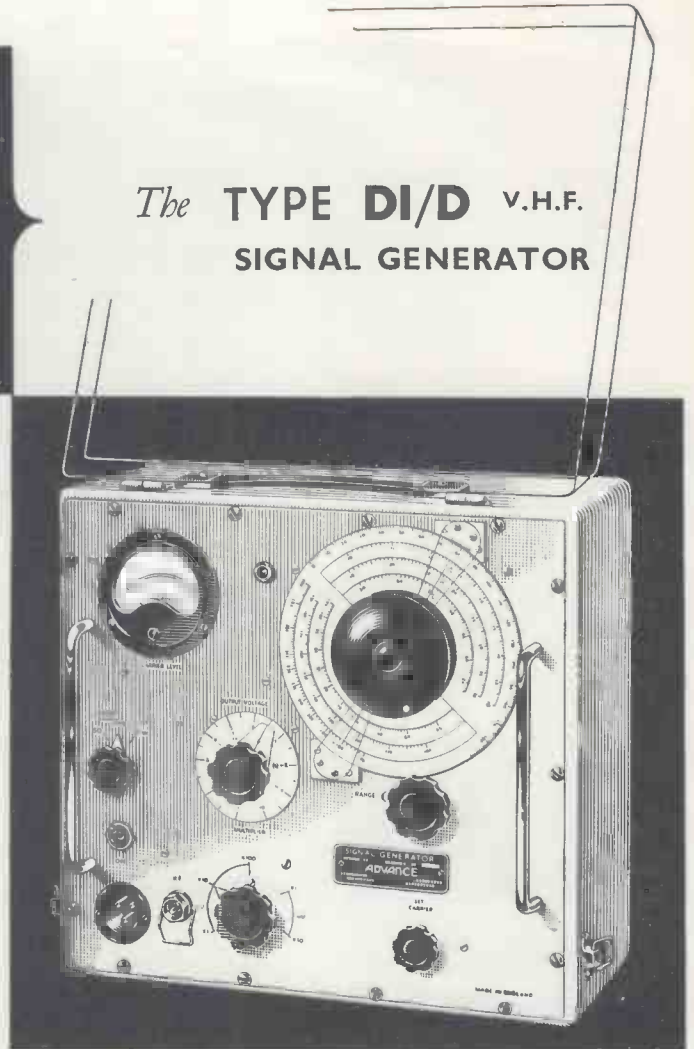
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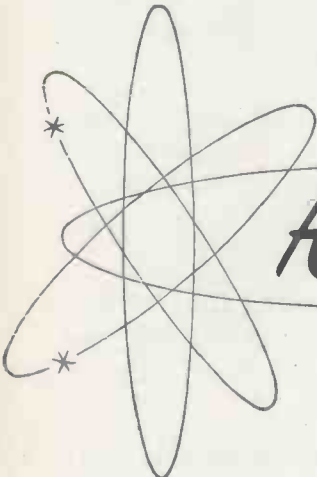
Full technical details in leaflet W43

The TYPE D1/D V.H.F. SIGNAL GENERATOR



Both the D1/D and DIP/2 are now available with an output impedance of 50 ohms.

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THE ADVANCE TYPE DIP/2 V.H.F. SIGNAL GENERATOR

This model is a special version of the D1/D designed for the alignment of narrow band communication receivers, and incorporates:—

- Crystal Modulator, eliminating spurious frequency modulation.
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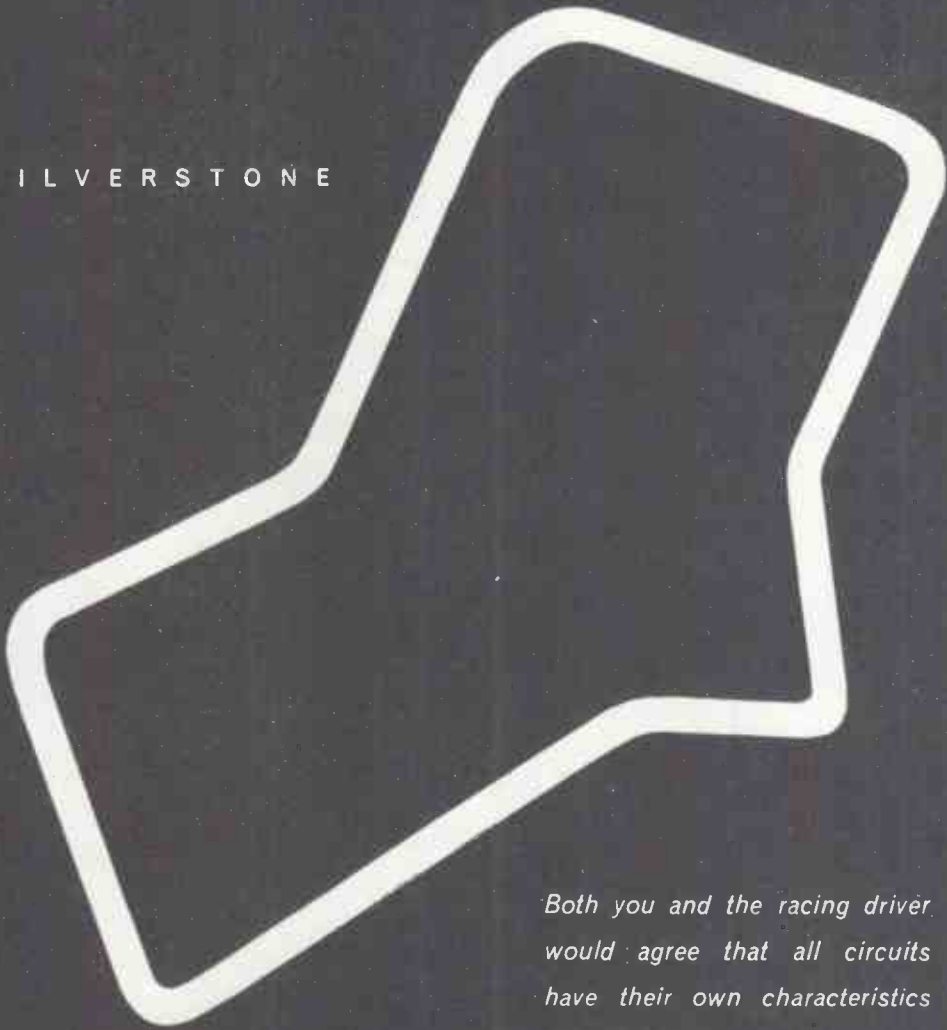
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have their own characteristics
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3 & 4 PORT CIRCULATORS, SWITCHES AND MODULATORS

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SOUND SPECTROMETER SPM 1



A Sound Spectrometer conforming fully with the international requirements of the Rapallo Convention, the Advance SPM1 provides for the accurate and rapid measurement and analysis of noise from any source. A compact and light-weight instrument, self-contained with its own battery power supply and sensitive microphone, the SPM1 is truly portable and well adapted to a wide range of applications involving the measurement and calculation of:

- ★ SOUND LEVEL AND NUISANCE VALUE
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- ★ BACKGROUND NOISE AND SPEECH LEVEL
- ★ ACOUSTIC AND VIBRATION INVESTIGATIONS AND ANALYSES

SPECIAL FEATURES INCLUDE

- ★ Built-in meter for monitoring sound pressures from +20dB to +150dB and "loudness" at three "weightings"
- ★ Jack for connection of headphone for aural monitoring
- ★ Choice of eight filters covering the range 20 c/s to 12,000 c/s
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THE ESSENTIAL INSTRUMENT FOR ALL ACOUSTIC INVESTIGATIONS

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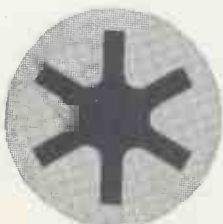
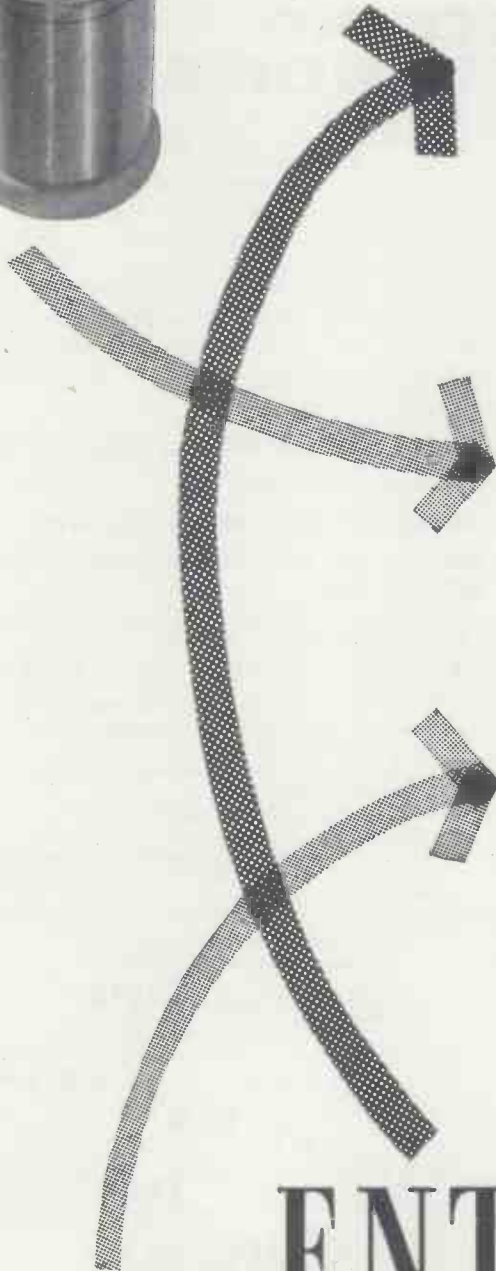
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Waveform monitoring facilities can be incorporated in both existing equipment and new designs with extreme ease and economy with the ETEL cathode ray tube 1CP31.

The tube itself is inexpensive and the associated circuitry required is very simple. The operating voltage is so low that in most equipment suitable connection to existing H.T. lines is all that is required. Beam focusing is fully automatic and auto-bias is quite adequate.

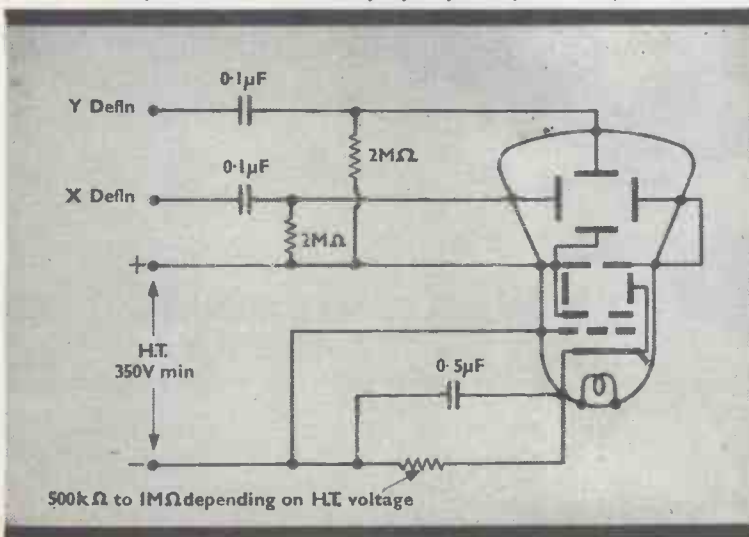
Space problems rarely occur when the 1CP31 is used—it is only 4½ inches long and fits a normal B8G octal socket.

If you are interested in the simplest and most economical method of waveform monitoring write to the address below for further details.

ABRIDGED DATA

V_h	=	6.3V
$v_{h-k}(pk)$	max. =	±250V
$V_{a_1+a_3}$	min. =	350V
S_x	=	$\frac{95}{V_{a_3}}$ mm/V
S_y	=	$\frac{110}{V_{a_3}}$ mm/V

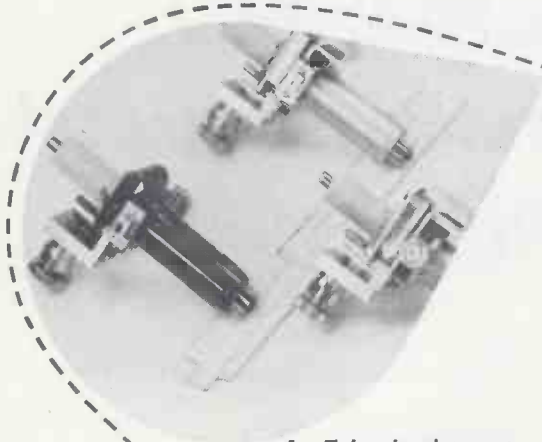
(The green medium persistence phosphor used by E.T.L. has now been designated F31. It is exactly the same as the E.T.L. phosphor previously called P1.)



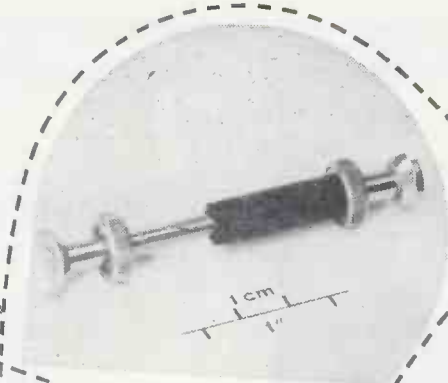
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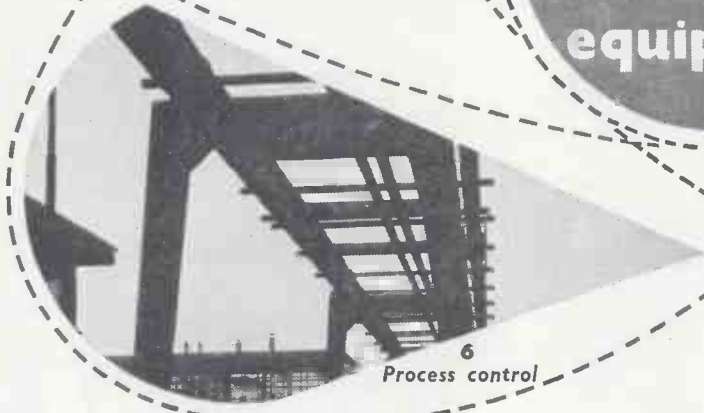


1 Tube development



2 Solid state physics

3 cm 8 mm
 4 mm 2 mm
**microwave
 equipment**



6 Process control

PHILIPS *electronic measuring*

Detailed information on microwave components will be gladly supplied on request.

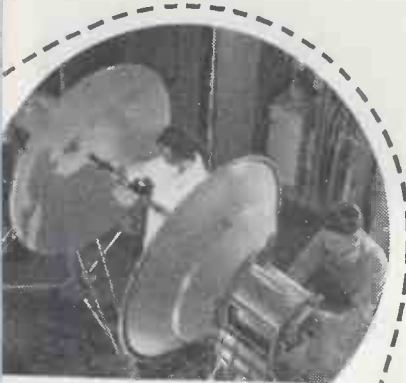
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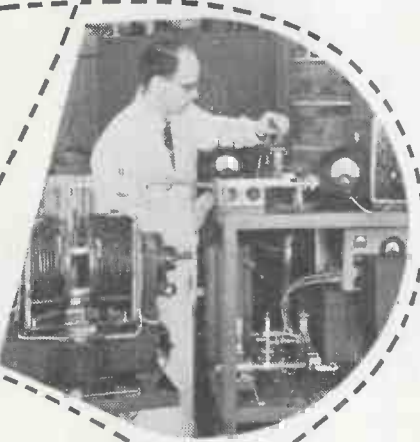
SIX SOUND REASONS WHY

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3 Telecommunication



4 Physics



Chemistry

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50 cm Permits M.T.I. elimination of permanent 'clutter'.

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50 cm Switches into instant operation.

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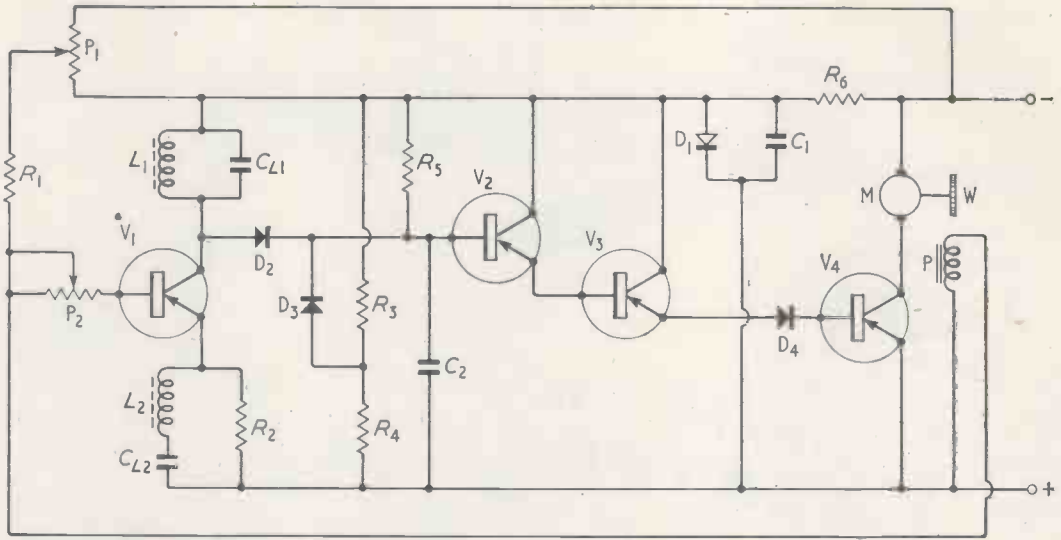


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Speed Control of D.C. Motors

This article in the February issue of **ELECTRONIC TECHNOLOGY** deals with the automatic speed control of small d.c. motors of the type used in portable tape recorders. The authors describe two complete systems, both using transistor circuits, which are each capable of providing a d.c. motor with a speed performance equal to or better than that of an a.c. synchronous motor. Details of the system are given along with circuit diagrams.

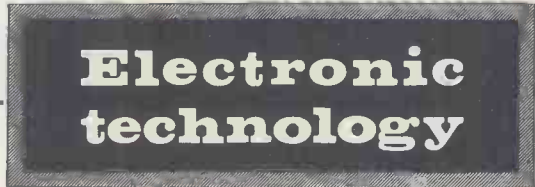
**ARTICLES
IN THE MARCH ISSUE
INCLUDE:**

TELEMETRY SIGNALS FROM SPUTNIK III

In this article, the author describes the equipment used for transcribing telemetry signals from Sputnik III from magnetic tape on to 35-mm film. The resultant record is in raster form showing successive keying cycles one under another. In addition, the telemetry encoding system used in the satellite is described, and the results of the analysis of two transits are discussed.

BARKHAUSEN NOISE IN TRANSFORMER CORES

While it is not suggested in this article that Barkhausen noise in transformers is of importance in all applications, there are those where it is the limiting factor. The author discusses the effect and shows how noise may be isolated and measured. Furthermore, it is shown that transformers can be operated and designed for minimum-noise contribution.



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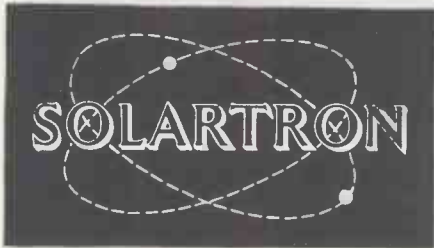
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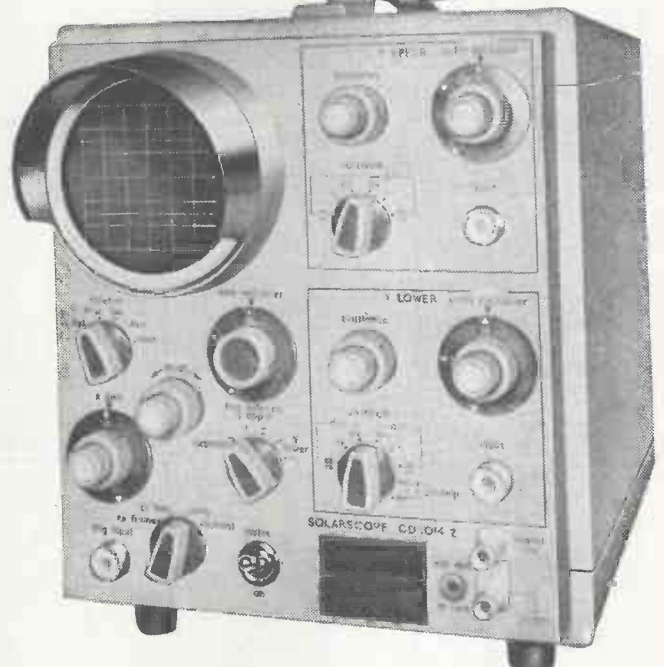
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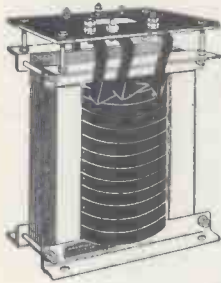
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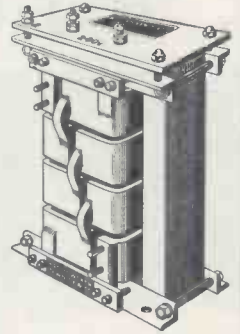
TRANSFORMERS



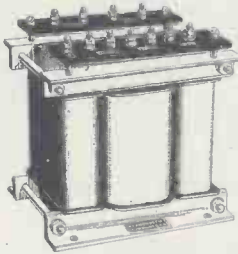
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110 V	10 A	... £15
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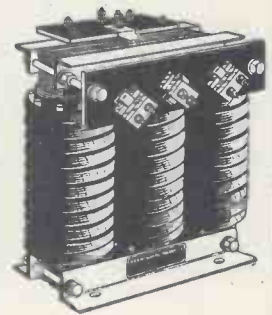
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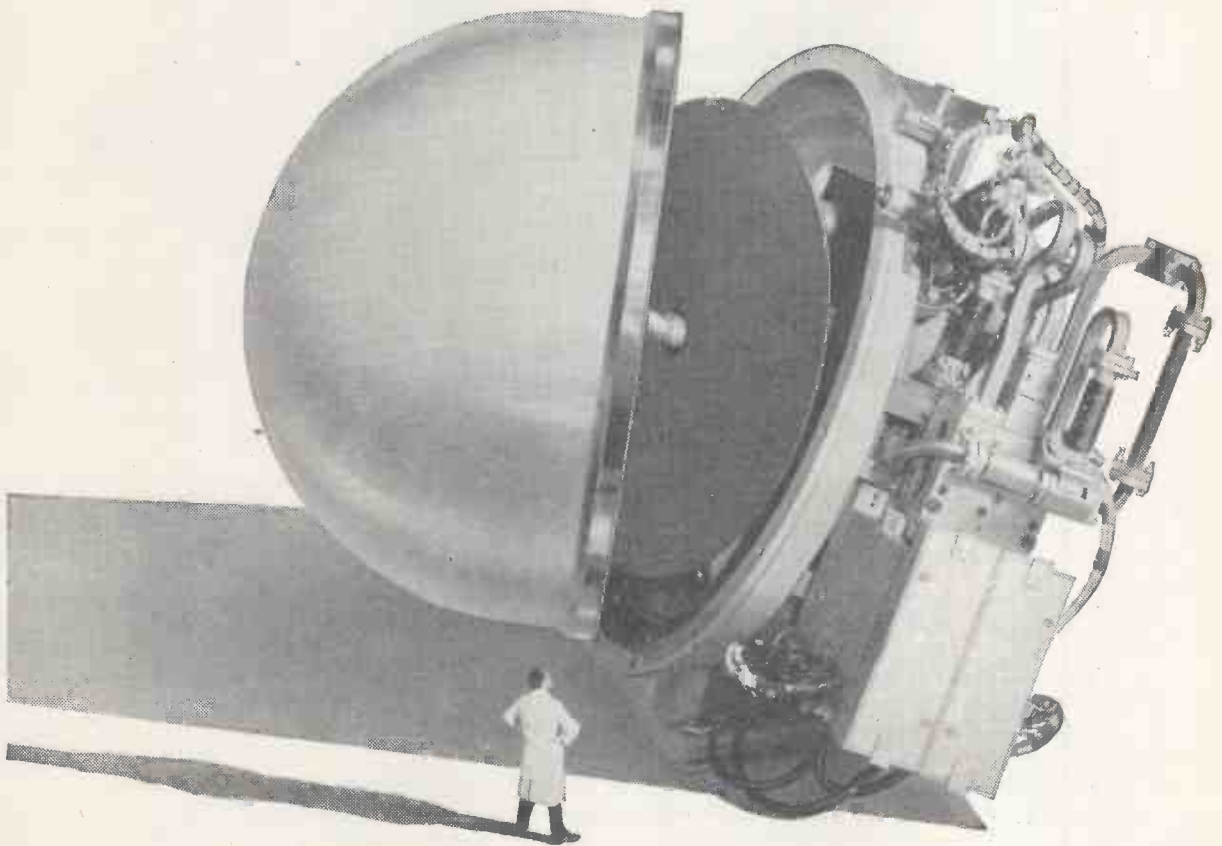


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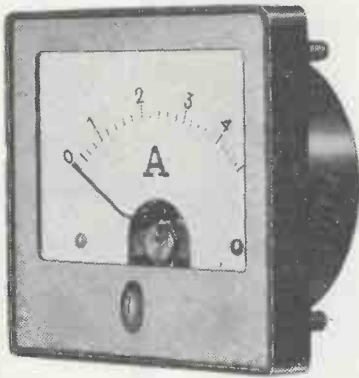
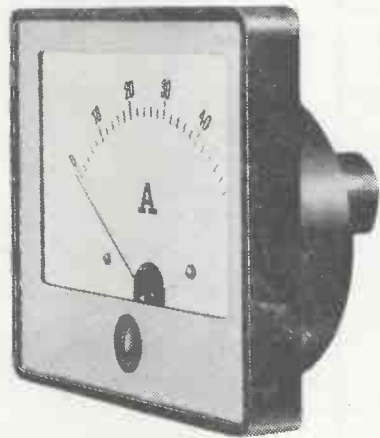
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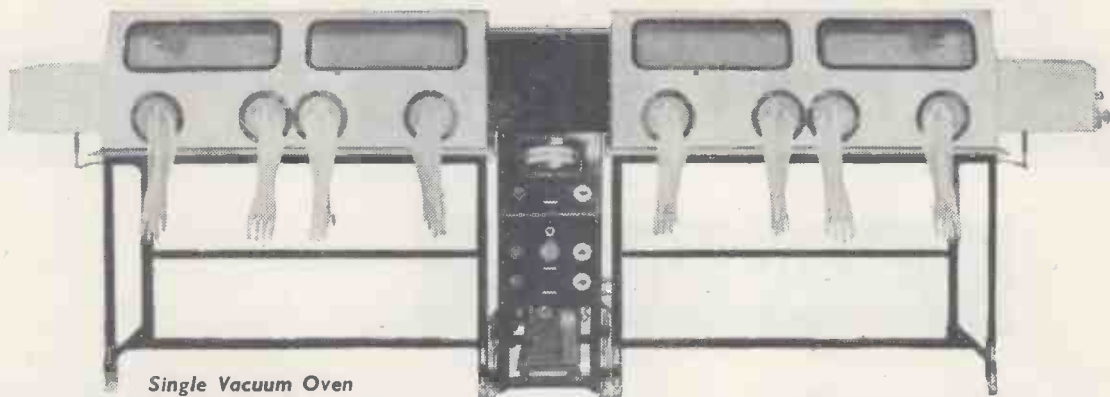
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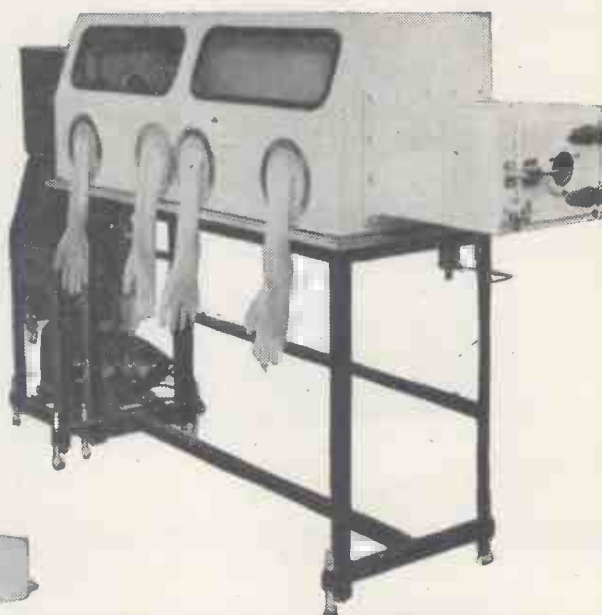
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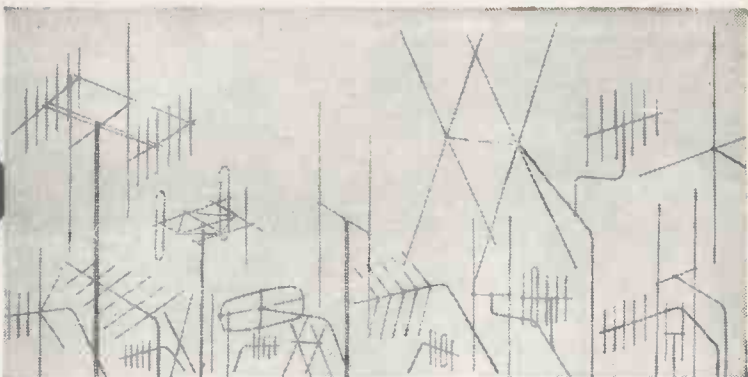


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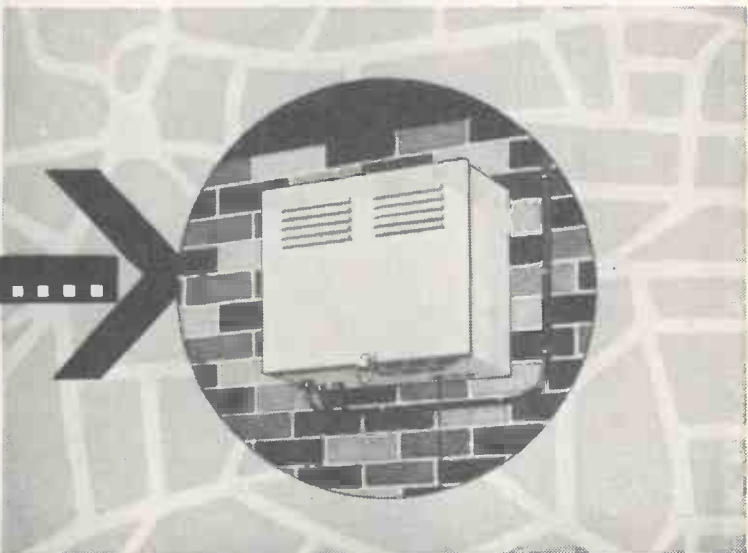
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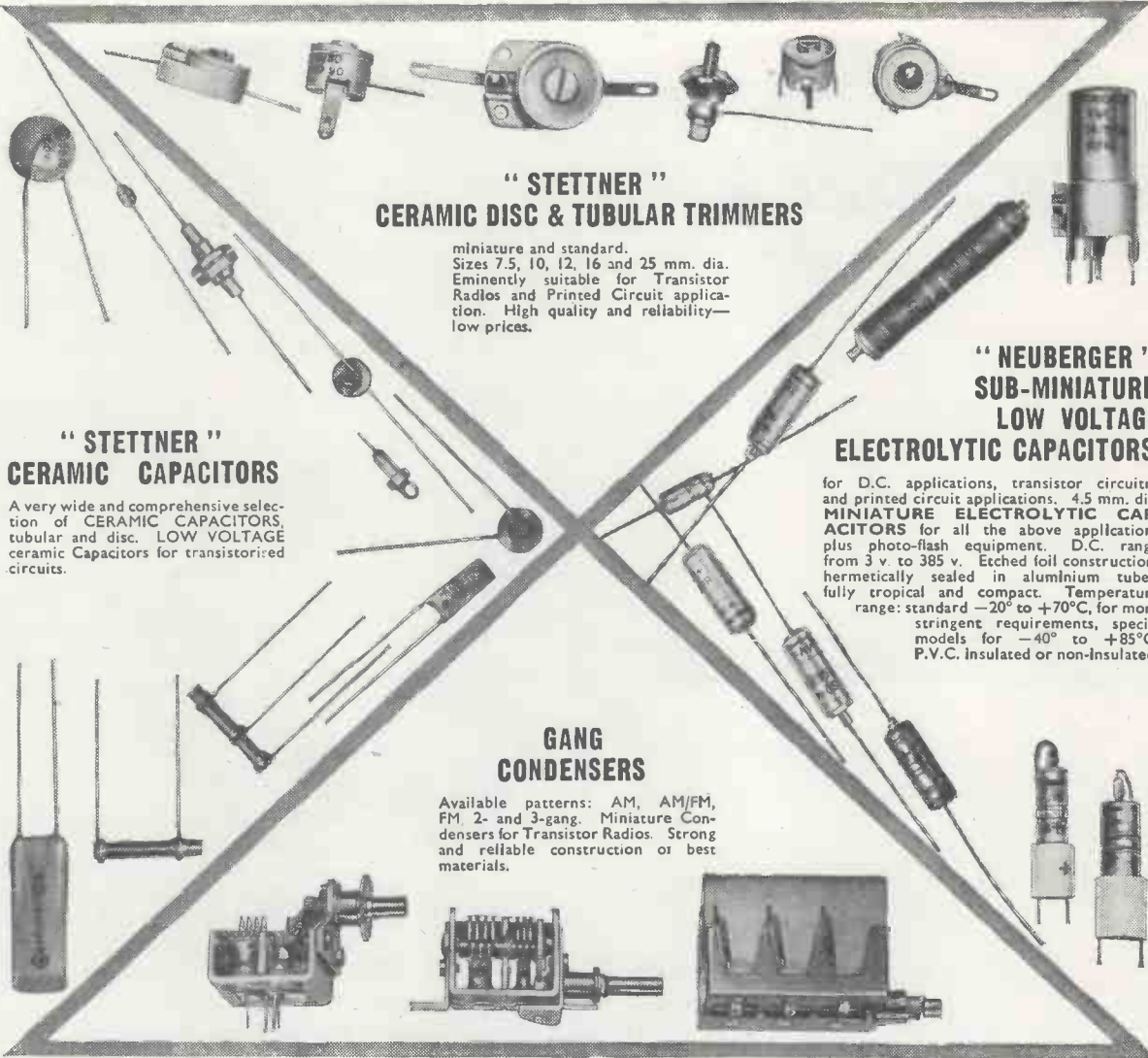
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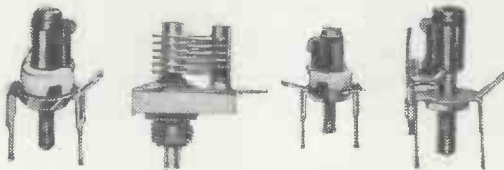
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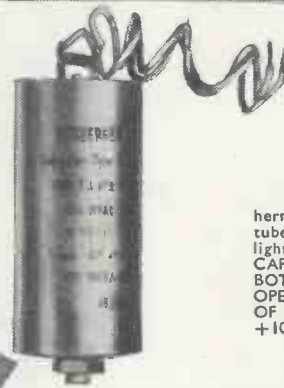
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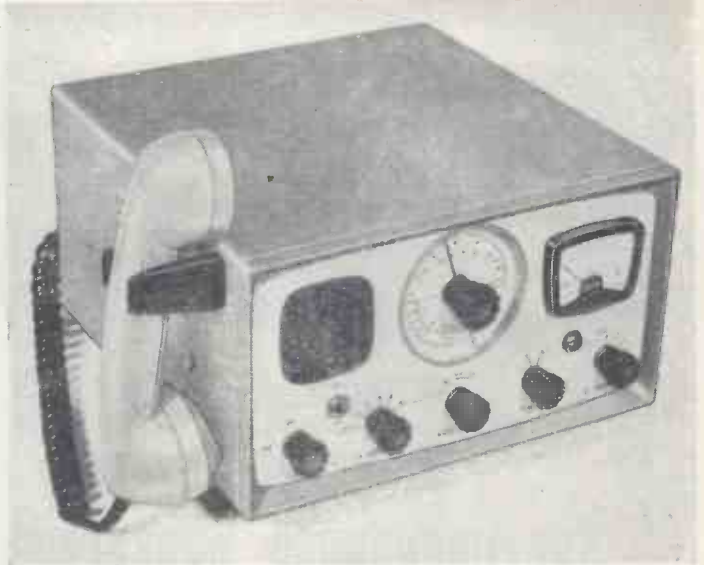
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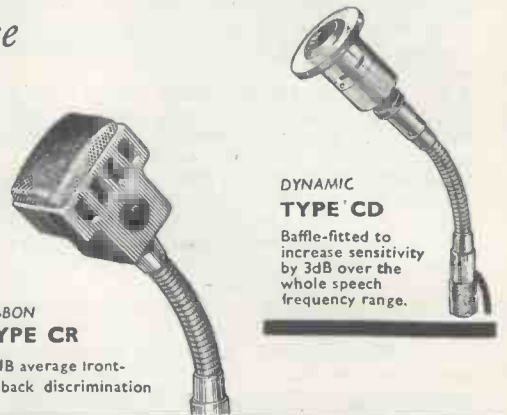
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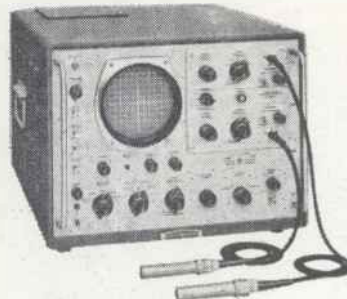


Photo 185 A

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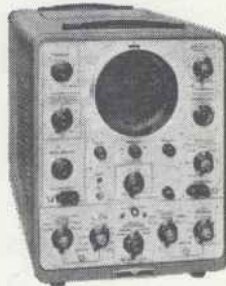


Photo 150 A

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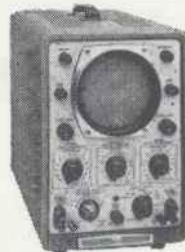


Photo 120 A

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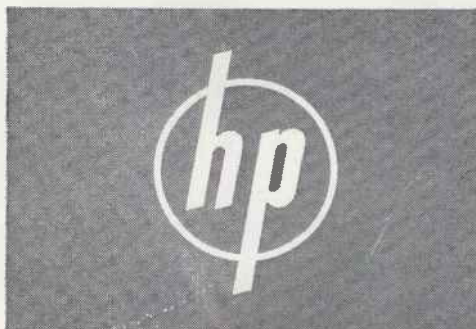
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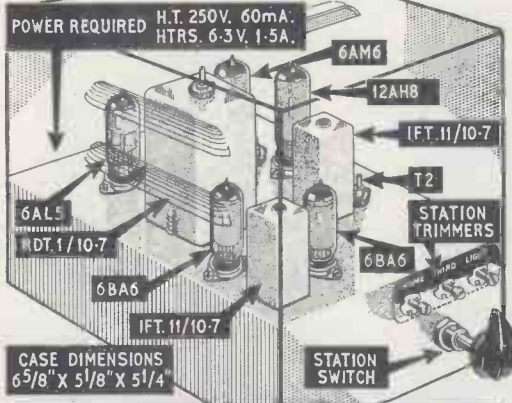
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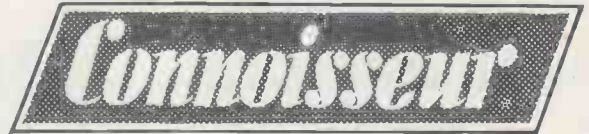
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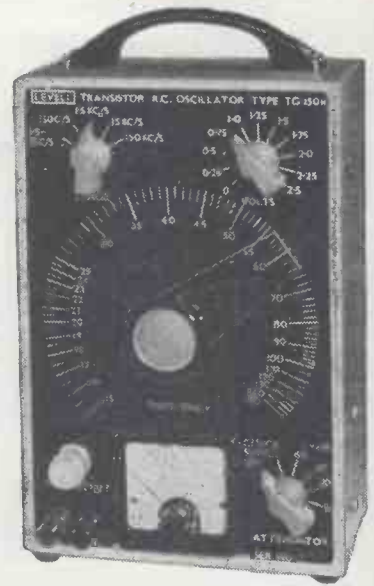
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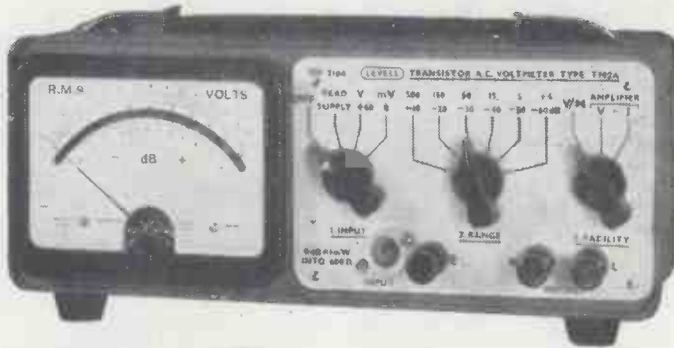


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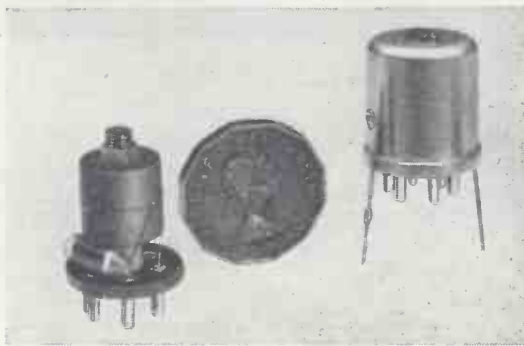
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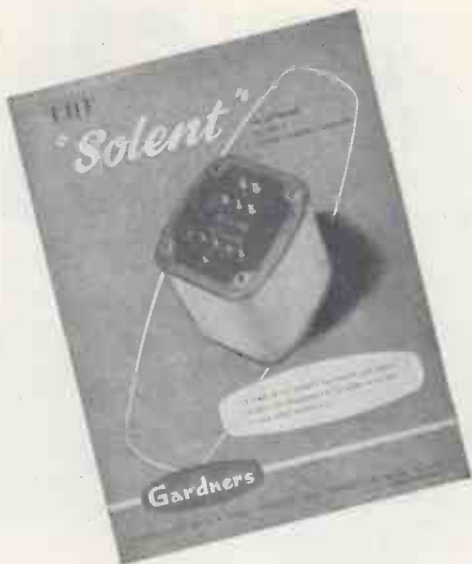


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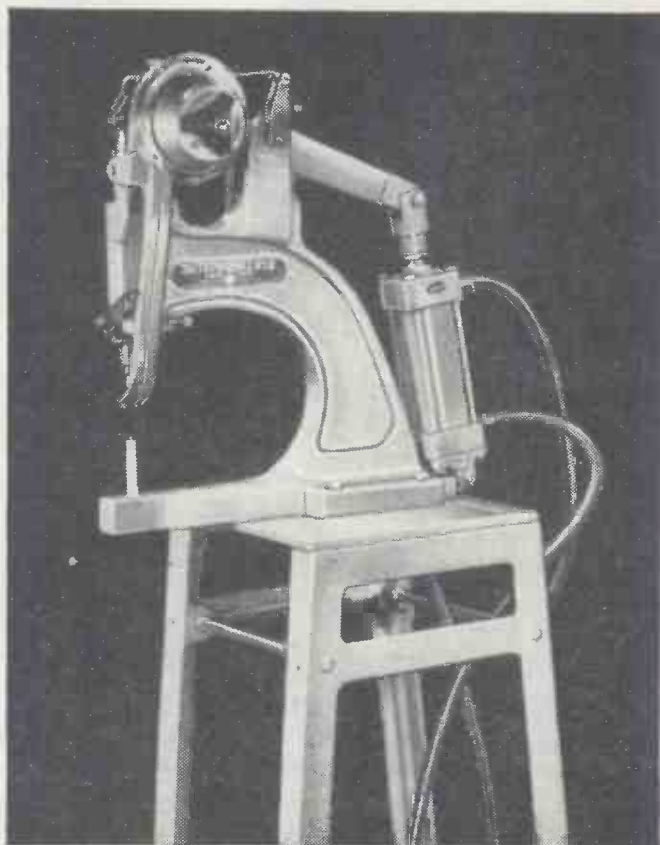
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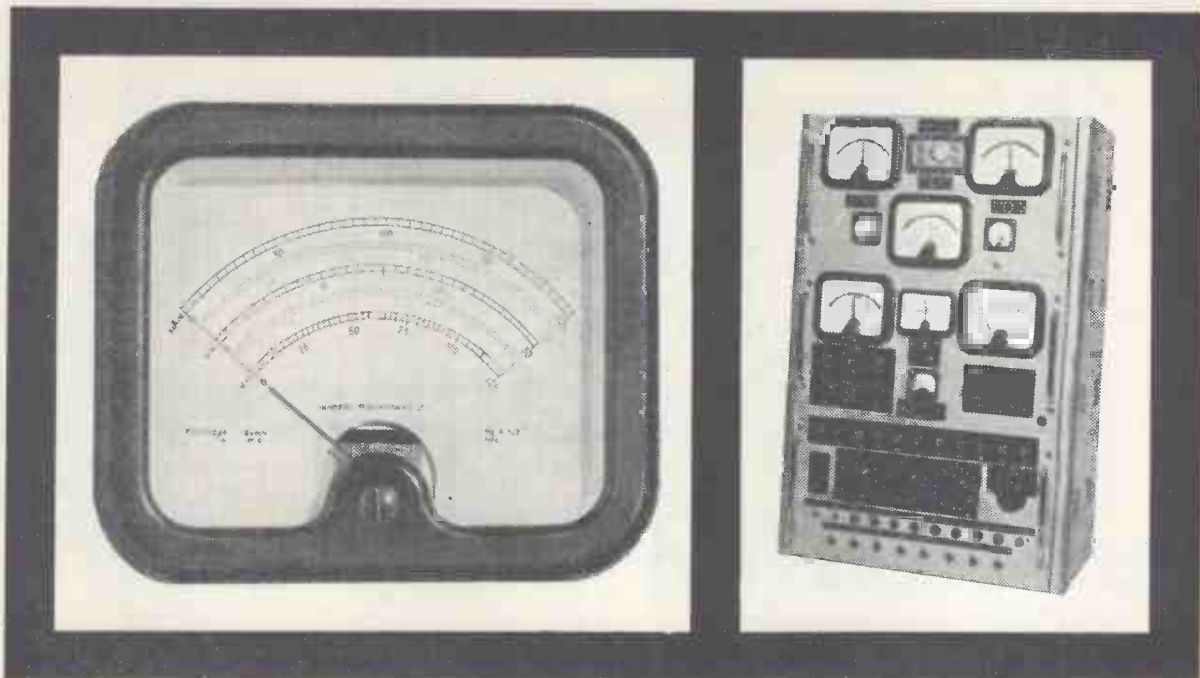
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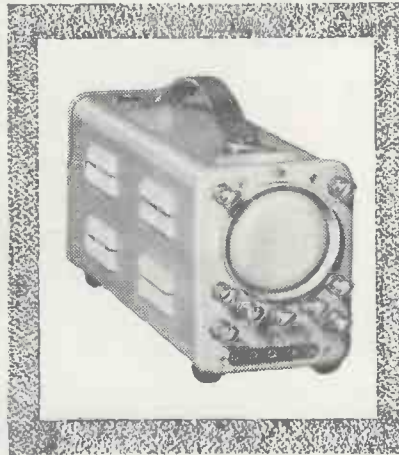
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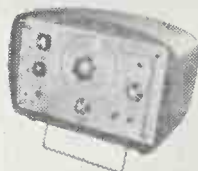


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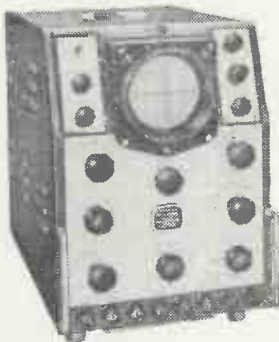
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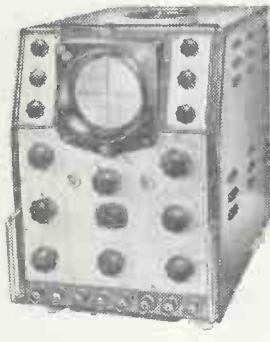


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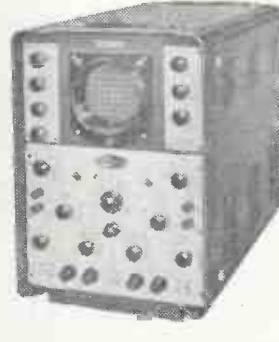
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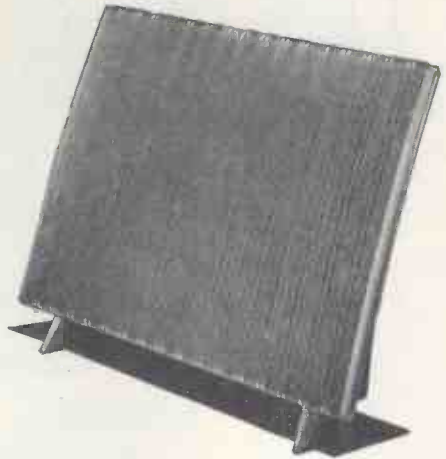


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MODEL L10 HIGH FIDELITY 10 WATT AMPLIFIER

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All inputs 500k. Plus 10pfd.

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+9 d.b. to -9 d.b.
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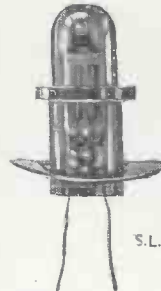
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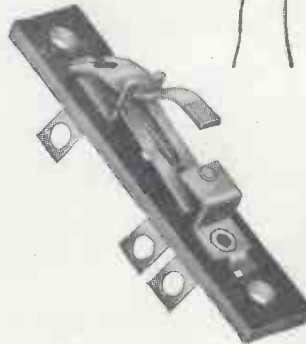
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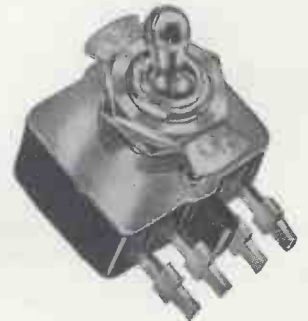
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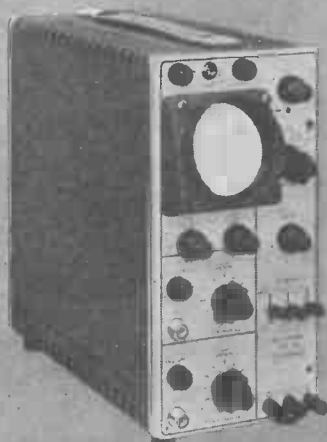
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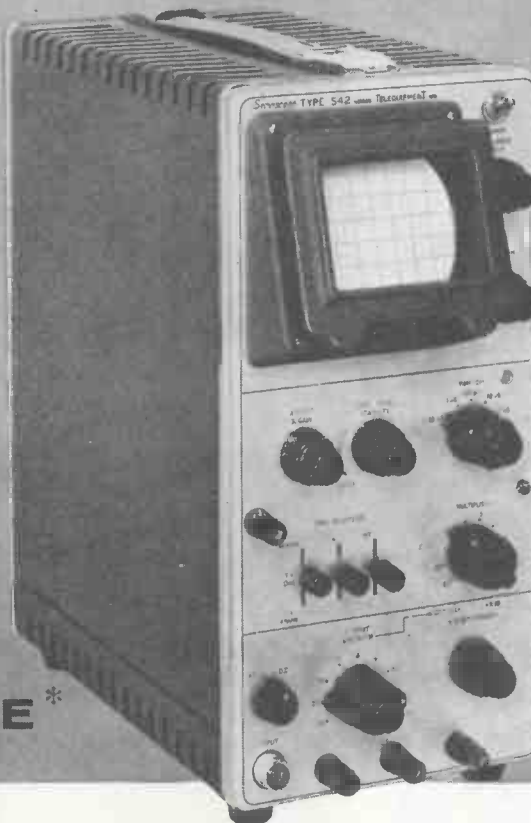
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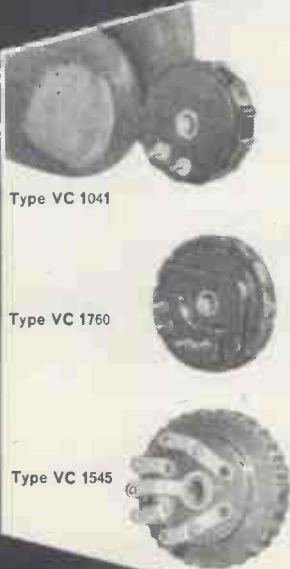
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Type VC 1041

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Overall power handling of track	100 mW
Insulation resistance:	
Between switch and potentiometer (switch "on")	100 MΩ at 100v DC
Between switch contacts (switch "off")	10 MΩ at 100v DC
Initial resistance	0.1% } typical figure given for a
Final resistance	5% } 200 KΩ control
Switch DC contact resistance	Not greater than 8 mΩ
Switch contact rating	150 mA at 50v
Noise level	Not greater than 270 microvolts at 1 microamp DC. Typical figures for 200 KΩ track
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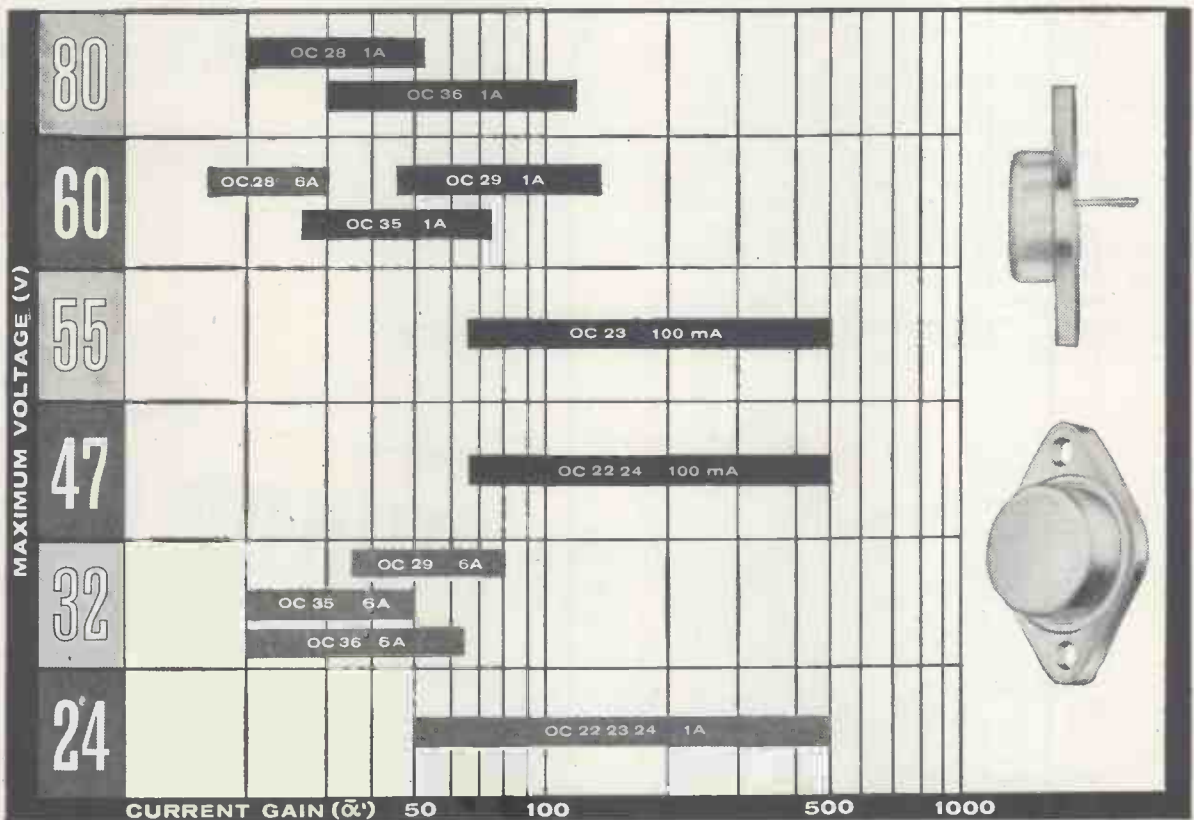
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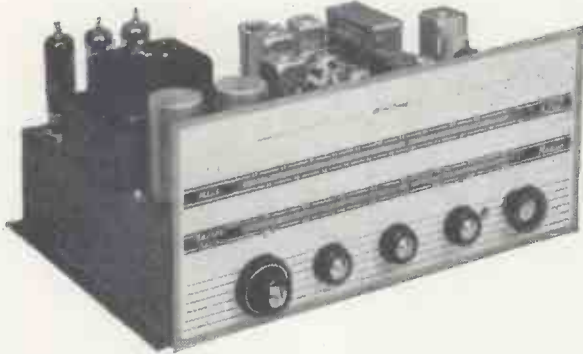
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Full VHF and medium bands ● Inputs for tape recording and playback ● Alternative pickup inputs ● Booster Unit available for low output pick-ups ● Input for possible future stereo radio ● Separate bass and treble controls and dual volume control for ease of balancing ● Free instruction booklet with every model.

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A new and improved version of the famous Stereo-Twelve. A total of 16 watts output is available from the two 8 watts push-pull amplifiers. VHF, with automatic frequency control, and medium and long bands. Inputs for recording and playback and for stereo radio if required in the future. Booster units are available for low output pick-ups, both mono and stereo.

See our advertisement on page 167 for details of our mono chassis.

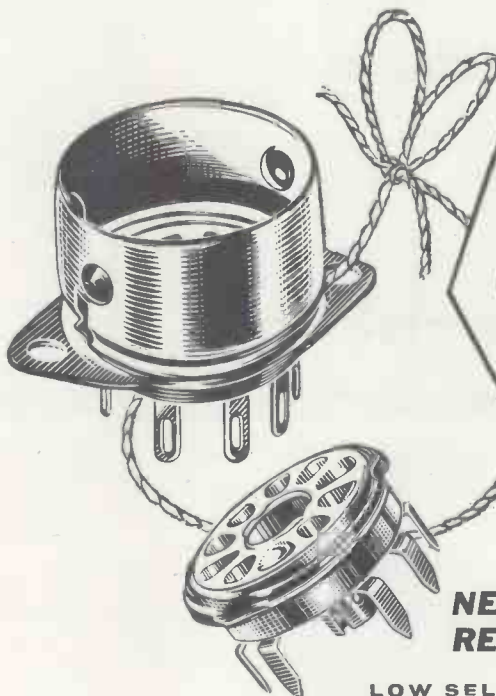
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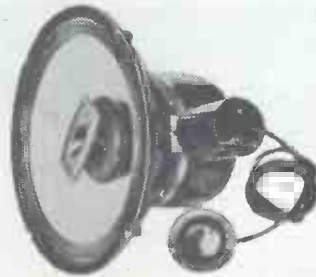
TRIAXIOM 212 — 12 inch.

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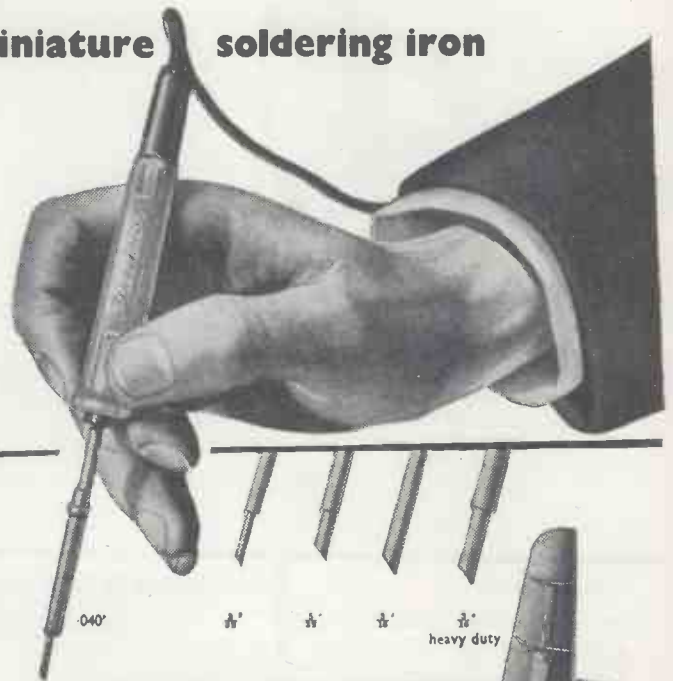
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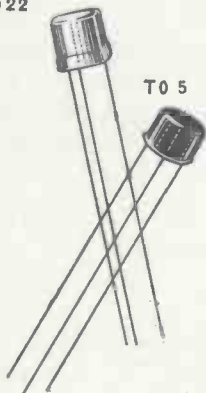
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T022

T05



ACTUAL SIZE

SPECIFICATIONS	VERY HIGH SPEED $f_{c0} = 15 \text{ Mc/s}$ upwards	HIGH SPEED $f_{c0} = 7-14 \text{ Mc/s}$	MEDIUM SPEED $f_{c0} = 3-8 \text{ Mc/s}$
HIGH CURRENT (500mA) (Core Drivers etc)	NKT 101	NKT 102	NKT 103
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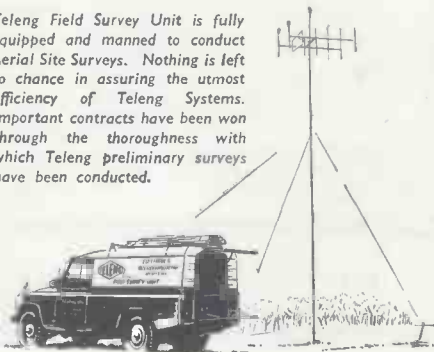


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Heater Voltage (volts)	V_h	6.3
Heater Current (amps)	I_h	0.3

TENTATIVE RATINGS AND DATA

Maximum Design Centre Ratings

Anode Dissipation (watts)	$P_a(max)$	2.5*
Screen Dissipation (watts)	$P_{g2}(max)$	0.8*
Anode Voltage (volts)	$V_a(max)$	250
Screen Voltage (volts)	$V_{g2}(max)$	250
Heater to Cathode Voltage (volts rms)	$V_{h-k}(max)$ rms	150†
Control Grid to Cathode Resistance (megohms)	$R_{g1-k}(max)$	0.6‡

*With grid to cathode resistance not exceeding 10 kΩ.

†From cathode to higher potential heater pin.

‡With $P_a(max) = 2$ W; $P_{g2}(max) = 0.5$ W; and assuming a common anode and screen decoupling resistance < 2.2 kΩ $\pm 10\%$.

Inter-Electrode Capacitances (pF)§

Input Capacitance	C_{in}	8.8
Output Capacitance	C_{out}	2.6
Grid 1 to Anode	C_{g1-a}	0.006
Grid 1 to Grid 3	C_{g1-g3}	0.1
Grid 1 to Grid 2	C_{g1-g2}	2.0
Grid 1 to Cathode	C_{g1-k}	6.2
Grid 2 to Anode	C_{g2-a}	0.15
Grid 3 to Anode	C_{g3-a}	0.47

§Measured in fully shielded socket, without can.

TYPICAL OPERATION

Anode Voltage (volts)	V_a	170
Screen Voltage (volts)	V_{g2}	170
Self Bias Resistance (ohms)	R_k	150
Anode Current (mA)	I_a	10
Screen Current (mA)	I_{g2}	2.7
Mutual Conductance (mA/V)	g_m	15
Inner Amplification Factor (g_1 to g_2)	μ_{g1-g2}	65
Equivalent Grid Noise Resistance (ohms)	R_{eq}	370

Input Loss at 38 Mc/s (Pins 1 and 3 strapped) (kΩ)	$r_{g1-k}(w)$	8.5
Working Input Capacity** Measured at 38 Mc/s (pF)	$C_{in}(w)$	13.7

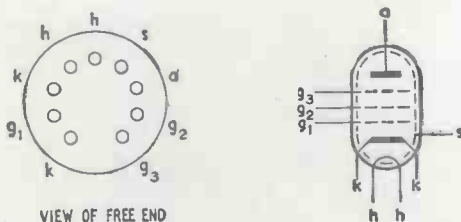
Change in Input Capacity produced by biasing valve to cut-off. Measured at 38 Mc/s (pF)	$\Delta C_{in}(w)$	3.4
---	--------------------	-----

Figure of Merit†† (Valve only) (Mc/s)	375
Effective Figure of Merit (Valve and Circuit) (Mc/s)	220

**Inter-electrode capacity with holder capacity balanced out.

†† Given by $\frac{g_m \times 10^3}{2\pi \sqrt{C_{in}(w) C_{out}}}$ see "Aspects of Design" No. 1 for further details. (Wireless World July 1958.)

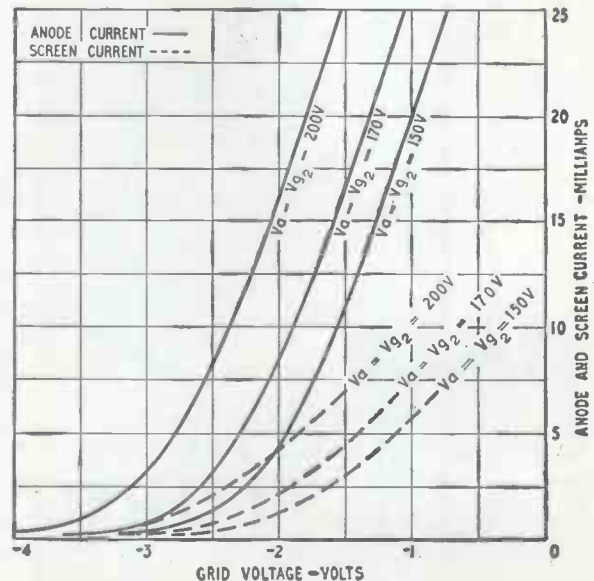
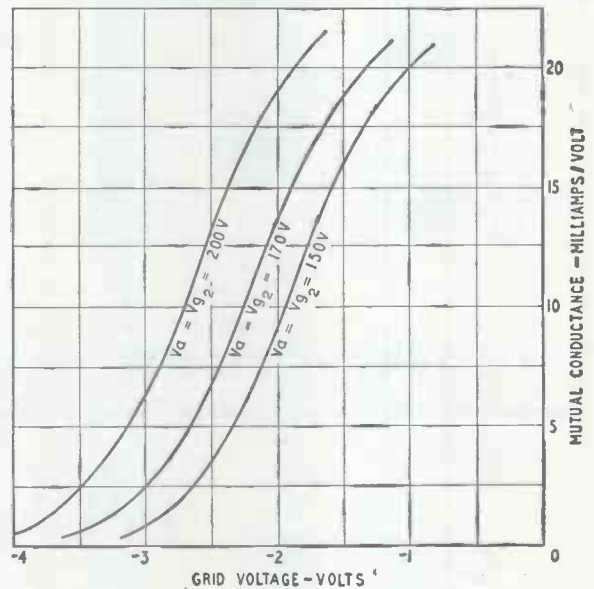
Base: B9A (Noval) Mounting Position: Unrestricted



Maximum Dimensions (mm)	
Overall Length	56
Seated Height	49
Diameter	22.2



Tentative Characteristic Curves of Ediswan Mazda Valve Type 6F24



Associated Electrical Industries Ltd
 Radio and Electronic Components Division
 Technical Service Department
 155 Charing Cross Road, London, W.C.2
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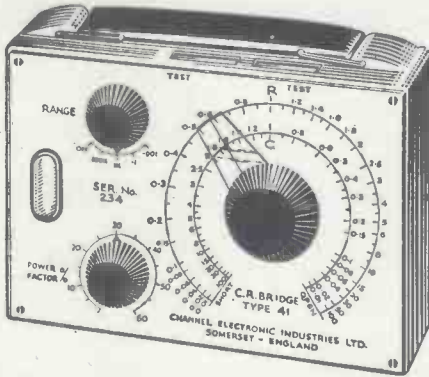
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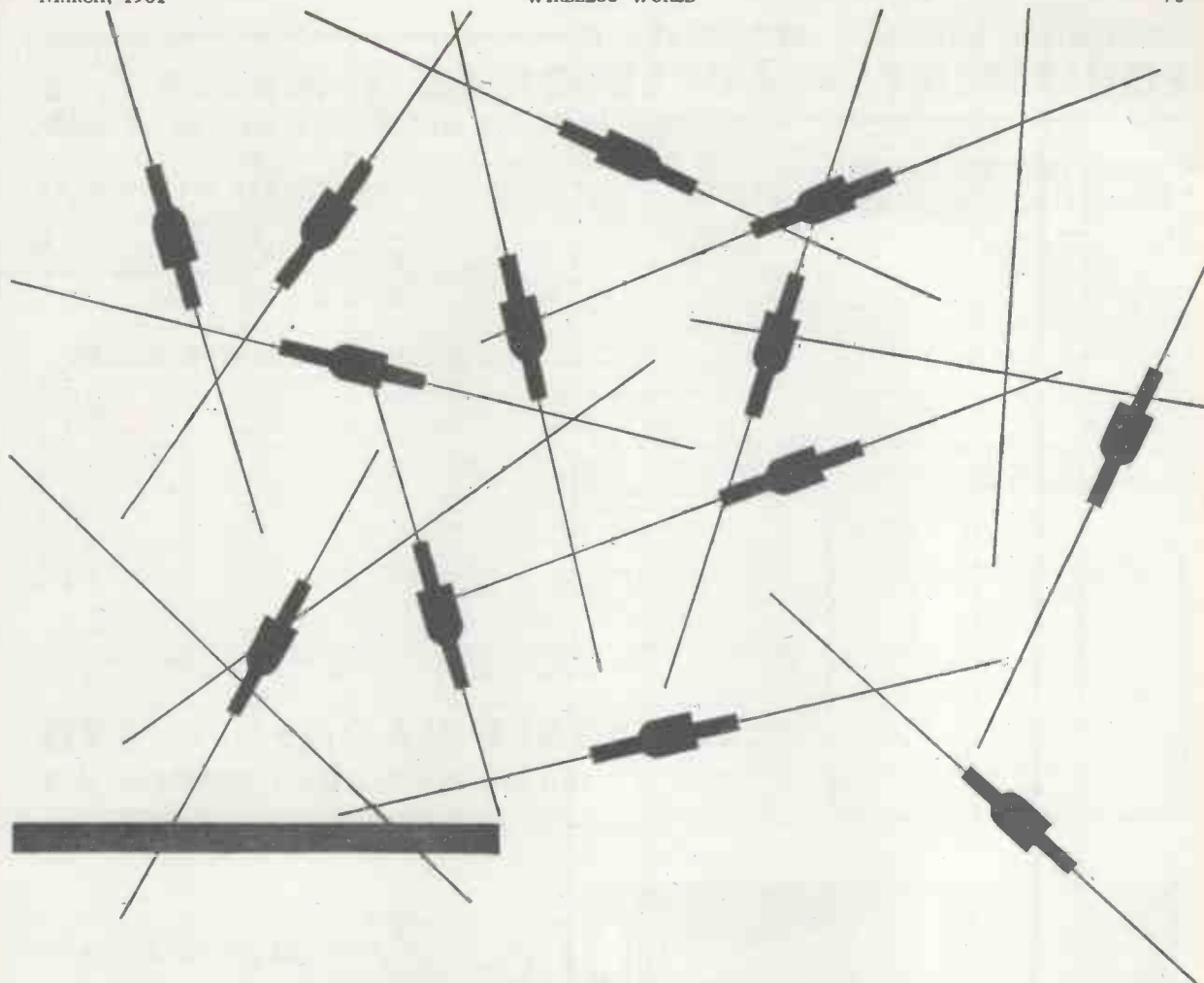
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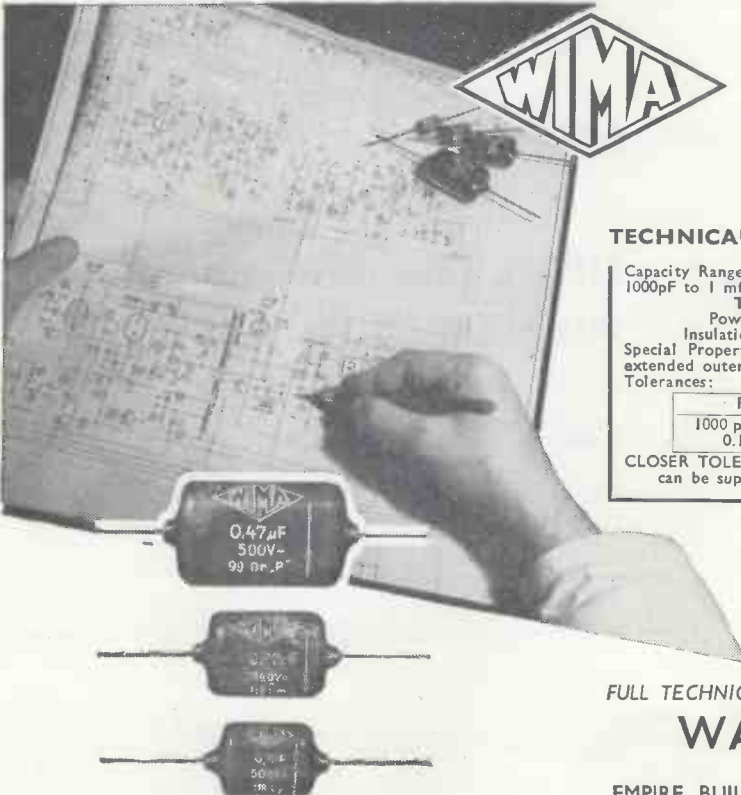
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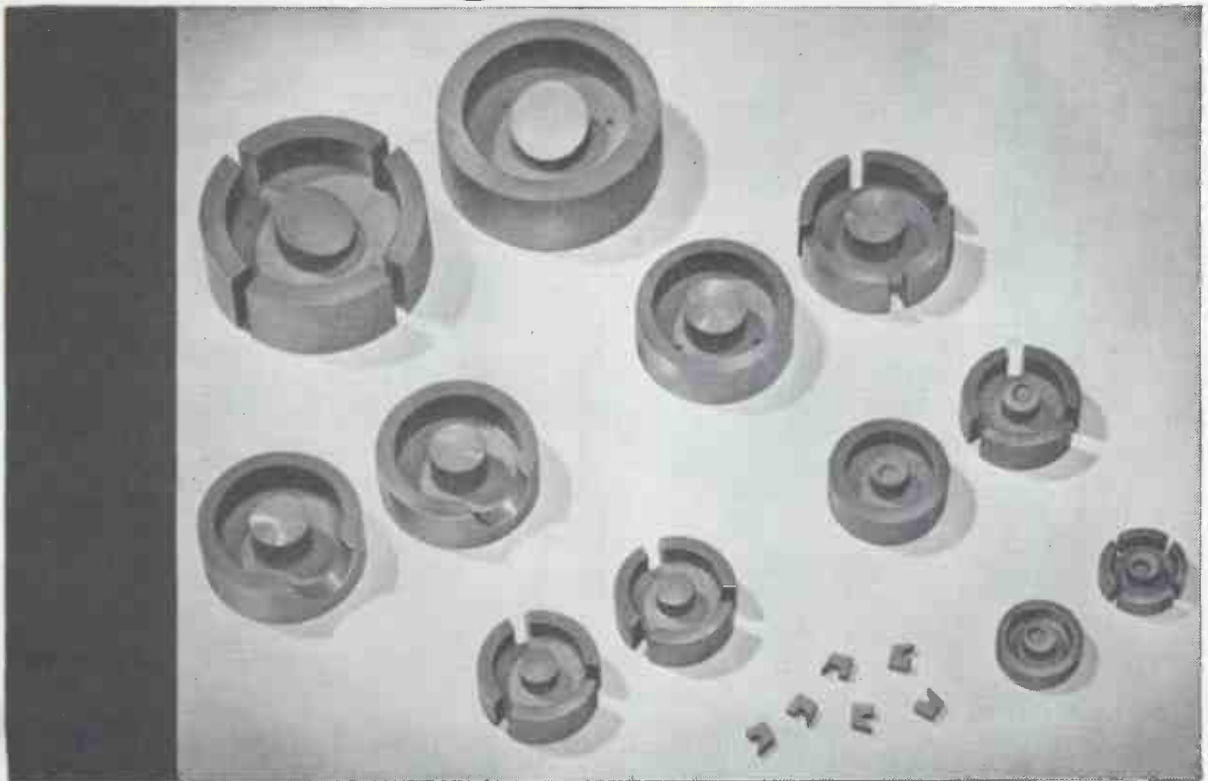
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Z530021	2	2M	1.3 v.	10 6
Z530022	2	1M 1B	1.3 v.	12 6
Z530023	2	2B 2M	1.3 v.	12 6
Z530024	40	2M	6 v.	12 6
Z530025	40	1M 1B	6 v.	12 6
Z530026	40	2B 2M	6 v.	15 0
Z530027	180	2M	12 v.	17 6
Z530028	180	1M 1B	12 v.	17 6
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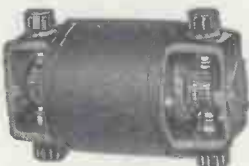


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Input 11.5 v.
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Input 11.5 v.
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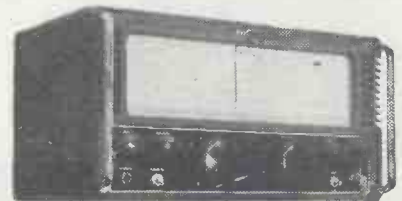
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S.104/1K	25	35	6.3
S.105/1K	20	30	27
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* Flying Lead Version

Ask for application report MS/117



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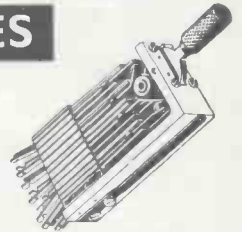
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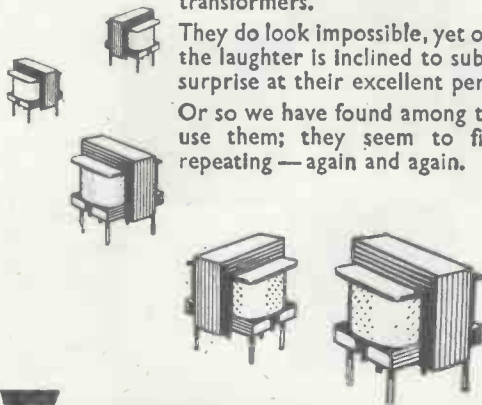
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± 3 dba. Tracking
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Complete with Mono
head. 17 gms. Stereo
head 1 gm. extra.

JUST RELEASED! GARRARD AUTO-TURNABLE TYPE "A"

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A transcription Record Player with provision for automatic use, if desired. Perfect playing from both Stereo and Mono records.

£21.7.8 (with G.C.8 cartridge)



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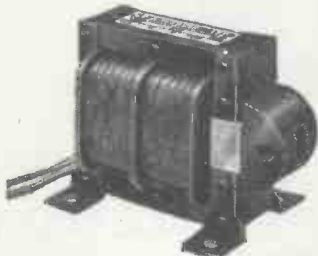
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— TO JEDEC OUTLINES

Types TK200A & TK250A

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Type TK200A



Type TK250A

Characteristics	f_T Common emitter gain-frequency product at $I_C = 20\text{mA}$, $V_{CE} = 9\text{V}$, $f = 20\text{Mc/s}$	50 Mc/s min
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	I_{CBO} Collector-to-base leakage current at $V_{CB} = 9\text{V}$, $I_E = 0$	1 μA max
Outline	JEDEC TO-3	
Ratings	$V_{CB\text{ max}}$ with emitter open circuited or reverse biased	40V
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	$V_{CE\text{ max}}$ with base open circuited	20V
	$V_{BE\text{ max}}$ reverse direction	6V
	$I_{C\text{ max}}$	0.5A
	Power dissipation in a heat sink	10W max
	Junction temperature	150°C max
	Storage temperature	150°C max

Characteristics	f_T Common emitter gain-frequency product at $I_C = 20\text{mA}$, $V_{CE} = 9\text{V}$, $f = 20\text{Mc/s}$	50 Mc/s min
	V_{CES} Collector-to-emitter saturation voltage at $I_C = 100\text{mA}$, $I_B = 12.5\text{mA}$	1.6V max
	I_{CBO} Collector-to-base leakage current at $V_{CB} = 9\text{V}$, $I_E = 0$	1 μA max
Outline	JEDEC TO-9	
Ratings	$V_{CB\text{ max}}$ with emitter open circuited or reverse biased	40V
	$V_{CE\text{ max}}$ with base-emitter junction reverse biased	40V
	$V_{CE\text{ max}}$ with base open circuited	20V
	$V_{BE\text{ max}}$ reverse direction	6V
	$I_{C\text{ max}}$	0.25A
	Junction temperature	150°C max
	Storage temperature	150°C max

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Maximum emitter/base voltage (volts)	12	12	10
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($V_{ce} = 4V, I_c = 750\text{ mA}$)	—	15	—
($V_{ce} = 4V, I_c = 1.5\text{ A}$)	—	—	10
Average f_{α} ($V_{cb} = 28V, I_c = 5\text{ mA}$) (Mc/s)	1.5	—	—
($V_{cb} = 28V, I_c = 5\text{ mA}$) (Mc/s)	—	1.25	—
($V_{cb} = 12V, I_c = 100\text{ mA}$) (Mc/s)	—	—	1

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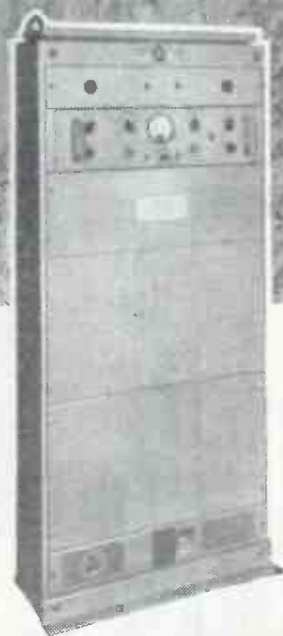


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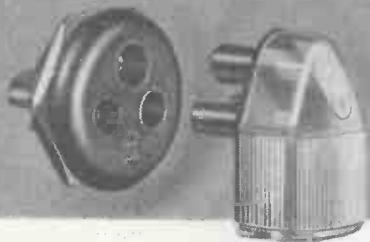
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Iron is the principal constituent, amounting to 70-90% of the whole, although there are specialised stainless alloys (not steel) for very high temperature applications, where it forms only a few per cent of the total content. Carbon, without which these alloys would not rank as steels, usually accounts for no more than 0.5%, but chromium, which is chiefly responsible for its stainless property, represents anything from 6 to 25% of the ingredients. Its presence in sufficient quantity in a state of solid solution alters the properties of the surface film of oxide, which is always present on all metals; unlike iron, it forms a self-sealing film which prevents the penetrative development of corrosion.

The higher the chromium rating, the wider is the ability to resist different forms of corrosion, but beyond a certain level its presence deprives the steel of its characteristic amenability to hardening and tempering by heat treatment unless additional ingredients are added. Nickel is the chief of these, being usually used in concentrations up to 12%, but minute traces of other metals, rarely exceeding 1% in aggregate, are employed to vary the characteristics, improving the toughness, ductility, machinability, or resistance to weld decay, etc.

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Aspects of design

32

NOISE IN THE RF STAGE OF TELEVISION TUNERS

This is No. 32 in the series of articles dealing with advanced problems in circuit design published by The Ediswan Mazda Applications Laboratory. No. 33 will appear next month. We shall be pleased to answer queries arising from this or other articles. Reprints of the first twenty-four articles, in booklet form, are available on request.

GENERAL

Any emission in a thermionic valve contains a shot noise component due to the random departure from the cathode, and arrival at the anode, of the electrons comprising the emission current. This noise is constant over any selected frequency band, B, throughout the whole frequency spectrum and has a mean-square value proportional to (B) and the total d.c. emission current. For temperature-limited emission the mean square noise current is given by $i_k^2 = 2eI_kB$, where e is the electron charge, I is the current, and B is the bandwidth.

Thus, for the cathode current: $i_k^2 = 2eI_kB$ (1)
 and for the anode current: $i_a^2 = 2eI_aB$ (2)

With space-charge-limited emission the presence of a reservoir of electrons in the cathode space-charge produces a marked smoothing-out of the random emission variations, resulting in a reduction of the shot noise given by Eqns (1) and (2) by a factor Γ^2 (termed "gamma-squared" and lying typically in the range 0.08 to 0.2). The space-charge also influences the division of noise current between any collecting electrodes, so that the noise current, as given by Eqn (2), is reduced by the factor $[1 - (I_k/I_k)(1 - \Gamma^2)]$.

Thus, in the case of a tetrode where I_{k2} is the screen current:

$i_k^2 = 2eI_kB\Gamma^2$ (3)
 $i_a^2 = 2eB [(I_a^2\Gamma^2/I_k) + (I_a I_{k2}/I_k)]$ (4)

In noise calculations it is generally convenient to regard the valve as being noise-free, and the noise currents, due to electron fluctuations, as being replaced by an equivalent voltage generator applied to the grid-cathode input circuit. The magnitude of this voltage can be related to Nyquist's formula for the thermal noise produced in a resistance. This is:—

$v^2 = 4KTB$ (5)

where K = Boltzmann's constant; T = Absolute temperature; B = Bandwidth; R = Resistance.

In the case of the valve, R may be replaced by R_{eq} , the magnitude of an equivalent grid-circuit resistance which will provide the same noise current as that produced by the electron emission. Thus, when assessing the noise performance of a valve in its associated circuit, it is usual to derive an equivalent circuit in which each resistance, R_i , is placed in series with a noise voltage generator of magnitude $v^2 = 4KTBR$ or, alternatively, in parallel with a noise current generator of magnitude $i^2 = 4KT/R$. Where a number of individual noise sources appear in parallel the latter alternative is more convenient, and is adopted here (see Fig. 1).

Using Eqns (4) and (5) the equivalent grid-noise resistance of a tetrode may be written:—

$R_{eq} = (2e/4KT) [(I_k\Gamma^2/g_k^2) + (I_a I_{k2}/g_m I_k)] = R'_{eq} + R''_{eq}$ (6)

where $g_m = \frac{\partial I_a}{\partial V_{g2}}$ and $g_k = \frac{\partial I_k}{\partial V_k} \approx g_m \frac{I_k}{I_a}$

R'_{eq} , involving $I_k\Gamma^2/g_k^2$, can be regarded as being due to the reduced shot noise in the cathode current, while R''_{eq} , involving $I_a I_{k2}/g_m I_k$, can be regarded as due to the partition of noise between the anode and screen electrodes. Thus, if a tetrode is to be used in low-noise applications, it is desirable to keep R'_{eq} , and hence the screen current, as low as possible.

FREQUENCY EFFECTS

As the frequency of operation increases, two major feedback effects become apparent. First, signal and noise voltages developed across the finite cathode lead inductance are fed back to the grid circuit by the grid-cathode capacitance. This feedback effect can be represented by a shunt resistance, R_t , across the valve input (Fig. 1), so placed that only the shot noise component of cathode current is reduced by this feedback, while the partition noise represented by R'_{eq} remains unaffected.

The second feedback effect is due to the finite time of electron transit in the valve. The electron current, crossing the grid plane, induces a current in the grid electrode which, obviously, couples into the input circuit. At low frequencies the effect is mainly capacitive and merely adds to the "cold"

grid-cathode capacitance. As the frequency increases the transit-time effect makes this contribution become increasingly resistive, and this can be represented as a damping resistance, R_t , in the equivalent circuit of Fig. 1. Just as the electron current has a shot noise component, so also has the induced grid current, the magnitude of which can be represented by an equation similar to Eqn (5) by substituting a resistance equal to R_t working at five times room temperature.

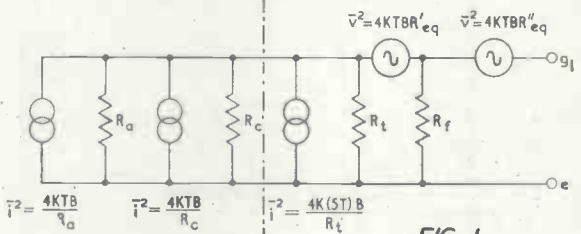


FIG. 1

In Fig. 1, R_a is the aerial radiation resistance referred to the valve grid circuit. R_c represents the effective dynamic resistance of the input tuned circuit. Shunted across each of these resistances are their respective noise current generators. Hence those contributions to noise arising from the resistances and generators to the left hand side of the vertical dotted dividing line of Fig. 1 cannot, for a given bandwidth and temperature, be reduced. The contribution arising from the resistances and generators on the right hand side can be reduced by the valve designer and considerable attention has been given to improving the noise performance of valves for the input stage of television tuners.

LOW NOISE VALVES FOR TELEVISION TUNERS

To reduce shot-noise the aim has been to increase the mutual conductance per milliamp of anode current, by reducing the g1-k gap, by using a grid wire of smaller diameter with increased turns-per-inch, or by a combination of both methods.

The induced grid noise, arising from transit-time effects will also be reduced by using a smaller g1-k gap. In addition, a shorter transit-time can be obtained by operating the valve at the highest possible cathode current-density before the shot noise begins to increase as the condition of temperature-limited, rather than space-charge-limited, emission is approached.

The need for keeping the screen current low has already been mentioned, and its importance can be emphasised by inserting typical values into Eqn (6).

In a modern tetrode, where the screen current is normally about 25% of that of the anode current, Eqn (6) gives:—

$R_{eq} = 170\Omega + 210\Omega = 380\Omega$

However, when the ratio of I_{k2}/I_a is reduced to 10%

$R_{eq} = 170\Omega + 90\Omega = 260\Omega$

that is, the equivalent resistance is now only 1.5 times greater than that for a triode having the same cathode current and slope. This reduction of screen current can be taken still further, with a corresponding reduction of R_{eq} .

A limit is usually reached at a point where further reduction of screen current, achieved by opening the pitch of the screen electrode, leads to an increase of a-g1 capacitance, which may be unacceptable on the grounds of operating stability.

An example of the application of the foregoing is the Ediswan Mazda 30F27 RF tetrode in which modern frame-grid construction is employed, together with a screen-to-anode current ratio as low as 12%, and good a-g1 screening.

The next "Aspects of Design" article will deal with the use of the 30F27 in a tuner circuit.

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Radio and Electronic Components Division
 Technical Service Department
 155 Charing Cross Road, London, W.C.2
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EDISWAN MAZDA 6F25

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Heater Current (amps)	I_h	0.3

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Anode Dissipation (watts)	$P_a(max)$	2.5
Screen Dissipation (watts)	$P_{g2(max)}$	0.5
Anode Voltage (volts)	$V_a(max)$	250
Screen Voltage (volts)	$V_{g2(max)}$	250
Heater to Cathode Voltage (volts rms)	$V_{h-k(max)rms}$	150*
Resistance Control Grid to Cathode (megohms)	$R_{g-k(max)}$	1

*From cathode to higher potential heater pin.

Inter-Electrode Capacitances† (pF)

Input Capacitance	C_{in}	8.5
Output Capacitance	C_{out}	2.7
Grid 1 to Anode	C_{g1-a}	0.006
Grid 1 to Grid 3	C_{g1-g3}	0.1
Grid 1 to Grid 2	C_{g1-g2}	1.8
Grid 1 to Cathode	C_{g1-k}	6.0
Grid 2 to Anode	C_{g2-a}	0.19
Grid 3 to Anode	C_{g3-a}	0.45

†Measured in fully shielded socket, without can.

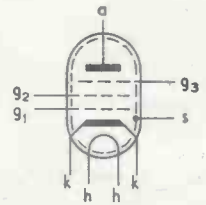
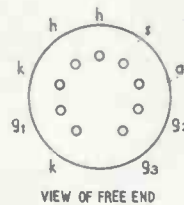
TYPICAL OPERATION

Supply Voltage (volts)	V_b	200
Anode Voltage (volts)	V_a	170
Screen Voltage-Initial (volts)	V_{g2}	90
Screen Resistor (kΩ)	R_{g2}	39
Cathode Bias Resistor (ohms)	R_k	100
Anode Current (mA)	I_a	11.5
Screen Current (mA)	I_{g2}	2.8
Inner Amplification Factor (g_1 to g_2)	μ_{g1-g2}	35
Mutual Conductance (mA/V)	g_m	12.5
Grid Voltage for Mutual Conductance = 1.25 mA/V (volts)		-5.5



Base: B9A (Noval)

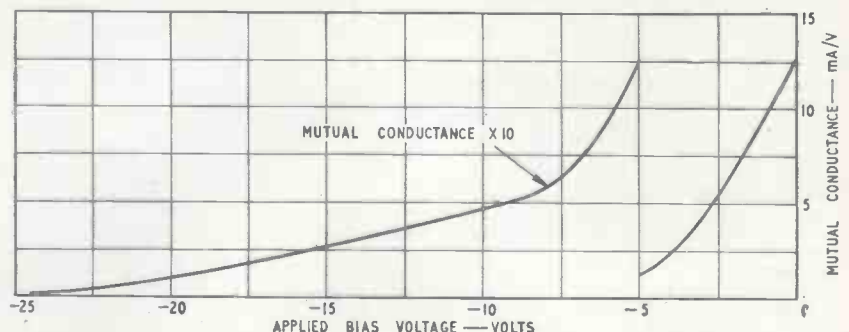
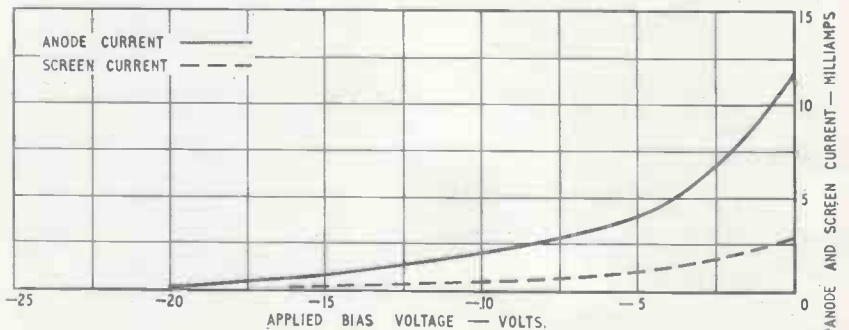
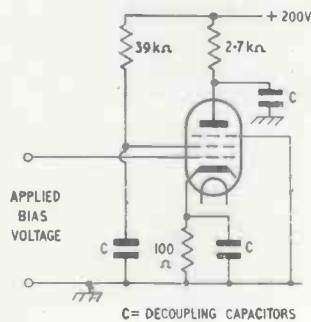
Mounting Position: Unrestricted



Tentative Characteristic Curves of Ediswan Mazda Valve Type 6F25

RISING SCREEN CHARACTERISTICS

TEST CIRCUIT



Maximum Dimensions (mm)

Overall Length	56
Seated Height	49
Diameter	22.2

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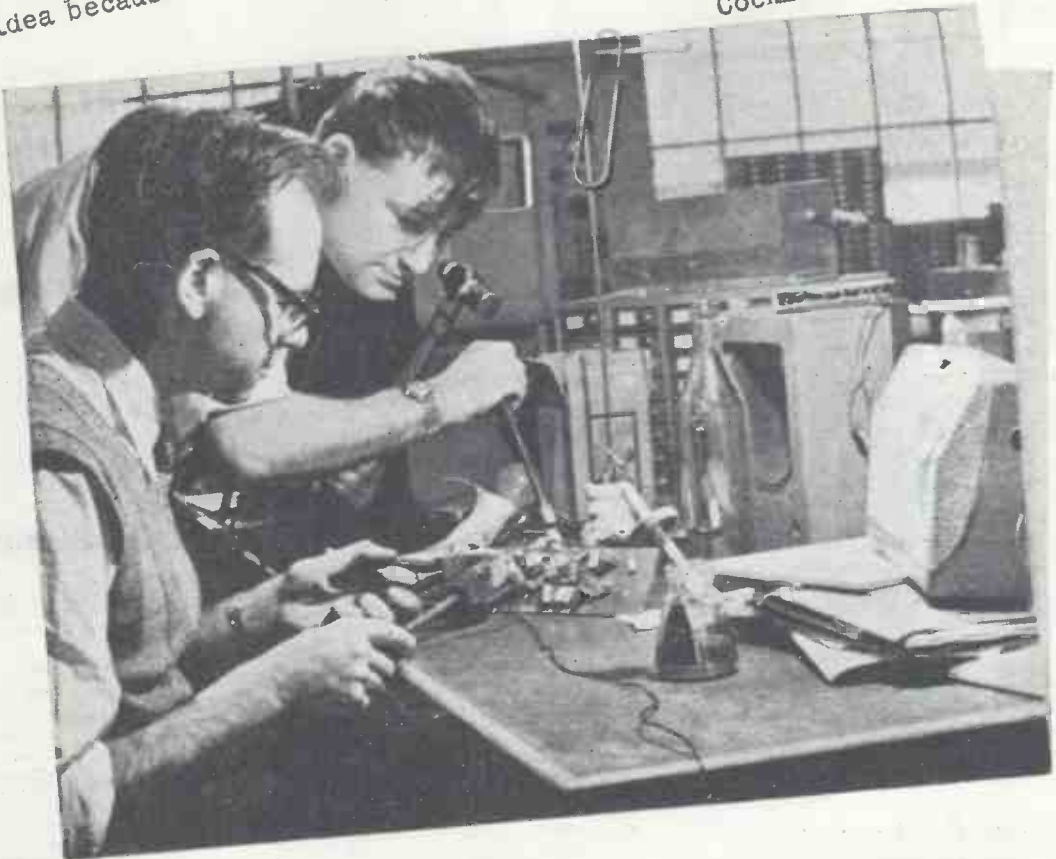
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Dear Sirs,

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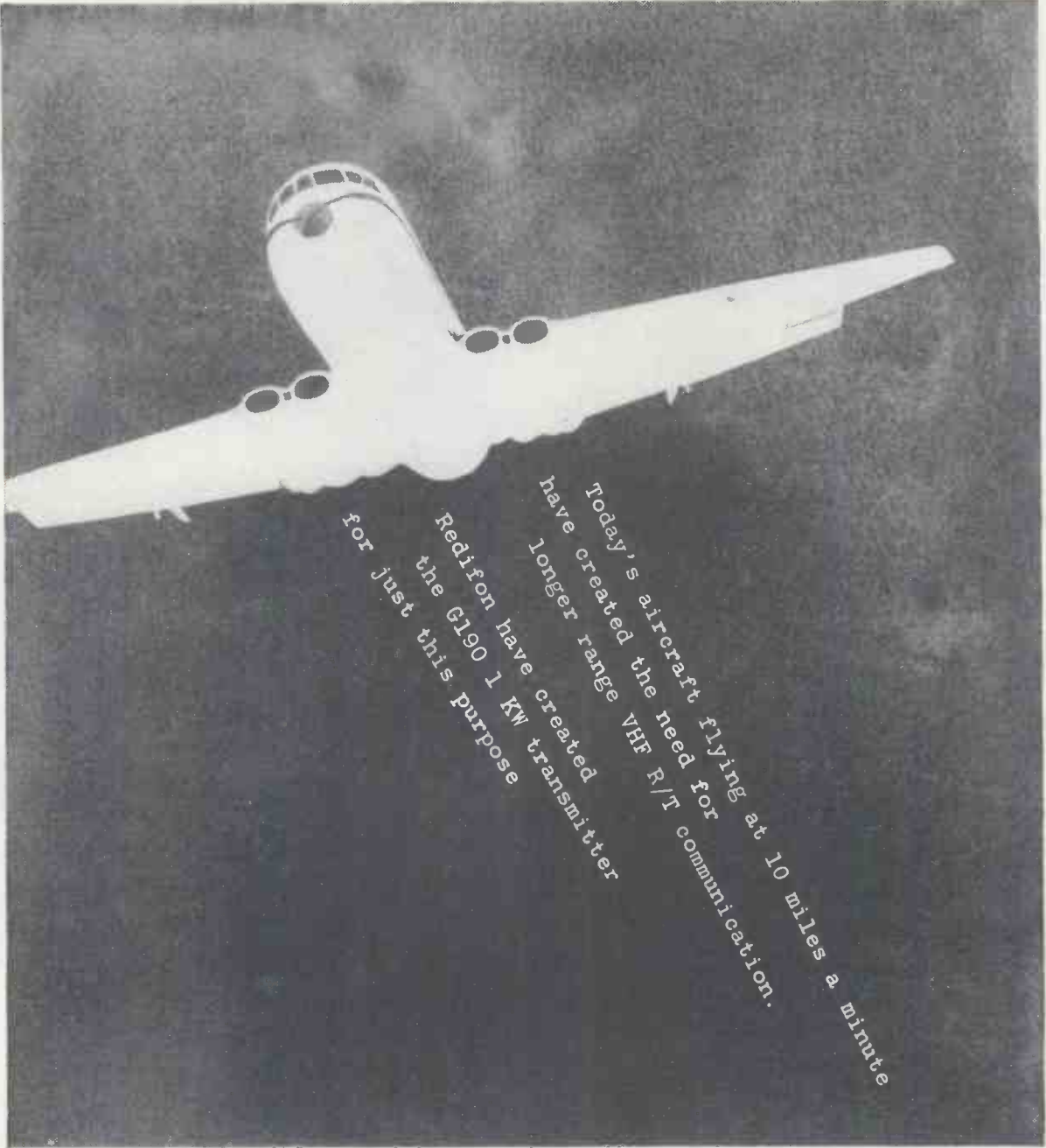
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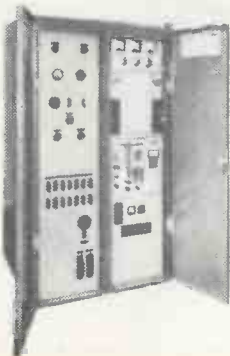
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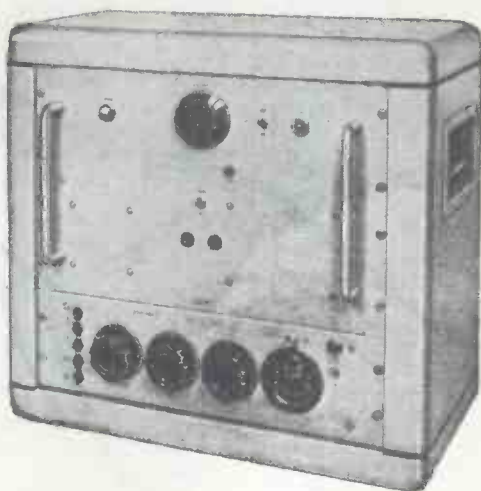
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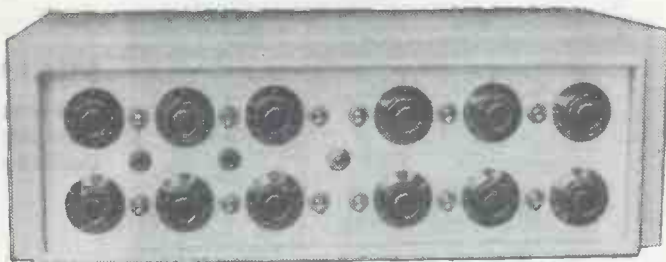
Size 18 x 7½ x 9½ in. deep.

Price of standard model £49.

The 12-way electronic mixer has facilities for mixing 12 balanced line microphones. Each of the 12 lines has its own potted mumetal shielded microphone transformer and input valve, each control is hermetically sealed. Muting switches are normally fitted on each channel and the unit is fed from its own mumetal shielded mains transformer and metal rectifier.

Also 3-way mixers and Peak Programme Meters. 4-way mixers and 2 x 5-way stereo mixers with outputs for echo chambers, etc. Details on request.

12-WAY ELECTRONIC MIXER

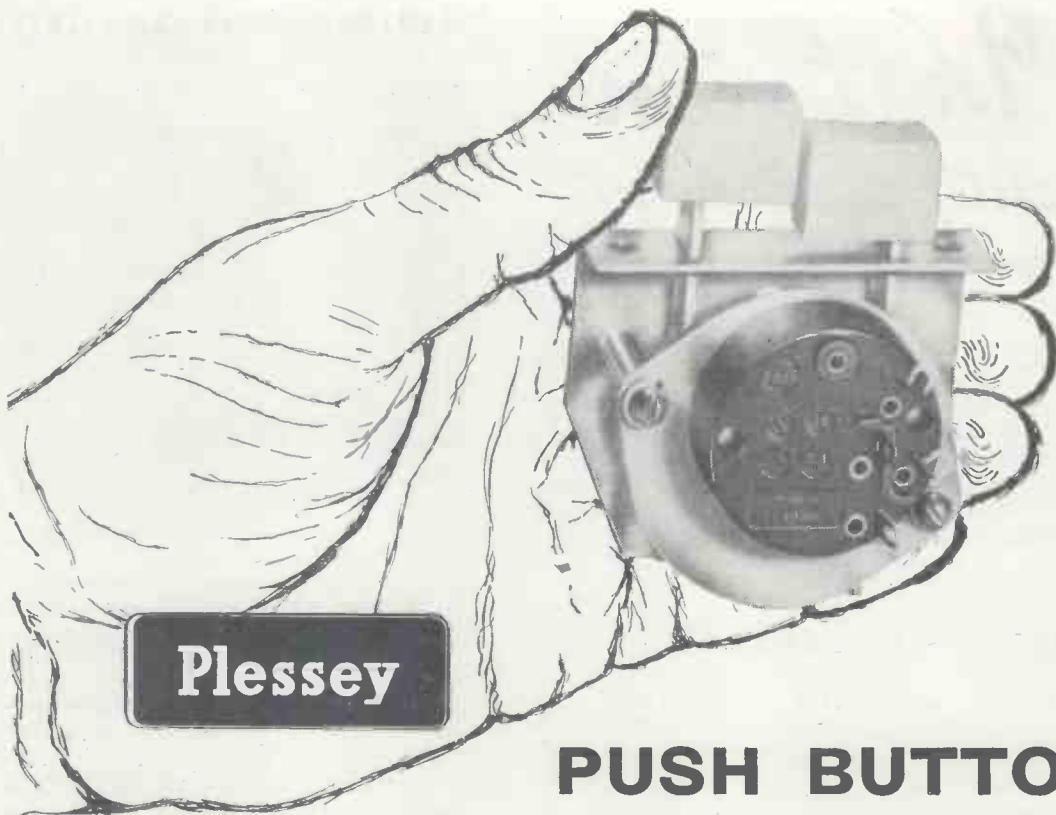


Full details and prices of the above on request

VORTEXION LIMITED, 257-263 The Broadway, Wimbledon, London, S.W.19

Telephones: I.I.Erty 2814 and 6242-3

Telegrams: "Vortexion, Wimble, London."

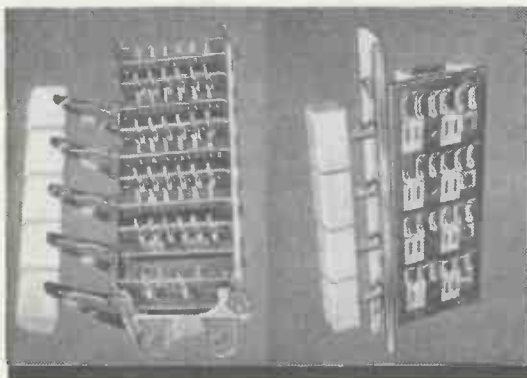


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A whole range of PB and PK switches is provided by Plessey to meet the contemporary requirement in TV, radio and audio equipment design. And whether you plan to employ the one or the other, you will find a suitable Plessey switch with the shape of key or button you prefer—in the colour of your choice.

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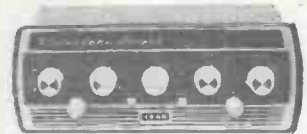


Television history was made at night, at 10 p.m. to be exact, when a 45-second "live" Commercial was flashed across Europe from race-track to the screens of Britain's network within four hours of Stirling Moss winning the Monaco Grand Prix.

A telephone interview with the winning driver was recorded over land lines from Monte Carlo to the A.B.C. Studios, while photographs were wired to Fleet Street and rushed by motor-cycle to Teddington.

For permission to reproduce this picture of the editing of the interview we are indebted to The Dunlop Rubber Company Limited and Charles F. Higham Limited, their Advertising Agents, and to A.B.C. Television Limited, in whose Teddington Studios the photograph was taken.

Evidence in Camera



Of interest not only for its story, this picture has provided (quite unintentionally) striking evidence of the reputation enjoyed by LEAK. It is a typical incident of the use of LEAK equipment by professional audio engineers in broadcasting and recording studios throughout the world, who choose LEAK for quality of performance and reliability. Does *your* installation measure up to these standards? If it does not, your LEAK Dealer can help you. The prices of LEAK studio quality equipment are made possible only by world-wide sales.



The new LEAK Varislope Stereo pre-amplifier (Illustrated above) incorporates facilities which make it the most comprehensive pre-amplifier presently available.

PRICE £25

We shall be pleased to send you a copy of Thomas Heintz' review of this "Remarkable new control unit for stereo" reprinted from "Records and Recording."

Whether you are for Monaural or Stereo, LEAK equipment offers you the best of either. These suggestions may help you.

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Varislope III Pre-Amplifier
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Model 39/1, this is ideal for tape or general amplifiers, complete with screened lead 39/6, plus 1/- post.

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12in. Hi-fidelity loudspeaker. High flux permanent magnet type with standard 3 ohm speech coil. Will handle up to 12 watts. Brand new by famous maker. Price 32/6, plus 3/6 post and insurance.

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E.H.T. SEALER. Apply with soldering iron. Stops corona discharge, etc. 2/6 per stick.

POLYTHENE TAPE. 2in. x 10 thou, for E.H.T. insulation up to 25 kv. 5/- per 12ft. roll.

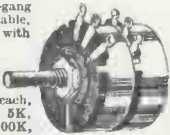
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Hi-Fi Snip Infinite Wall Baffle

Nicely veneered and polished. Corner fitting (attaches to picture rail). Takes up no floor space. Given really fantastic results with only low-priced 8in. speaker. Fitting for tweeter. Only 45/- each, carriage and insurance 3/6.



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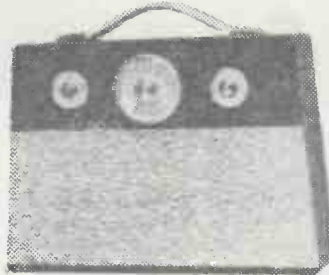
Stout board construction these drawers are ideal for small parts. Supplied complete with simple erection instructions. 1/6 each or 12 drawers each 6x2 1/2 x 6 1/2 in., 13/6, post 2/-.



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CAR RADIO PORTABLE

There's nothing to compare with this so don't buy your portable until you have heard this one—call at any branch for demonstration—you will be well satisfied—why not earn spare time cash making them up for your friends?



NOTE THESE FEATURES

- ★ 400/500 mw. Output Push-Pull.
- ★ 6 First Grade Transistors.
- ★ Latest Type Superhet Circuit.
- ★ Medium and Long Wave.
- ★ Internal Ferrite aerial hz wound.
- ★ High "Q" coils.
- ★ Latest type printed circuit with components plan.
- ★ Slow motion tuning.
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- ★ High flux elliptical speaker.
- ★ Size 11 x 8 x 3in. approximately.
- ★ Easy to follow instructions.
- ★ 12 months' guarantee all components.
- ★ No technical knowledge required.
- ★ Service available at moderate charges.

ORDER IN CONFIDENCE

Money returned in full if parcel not up to expectation and returned unassembled. Price complete, less battery £9/19/6. Battery 3/6 plus carriage and insurance 7/6.

TRANSISTOR POCKET RADIOS

The Moulded Cabinet illustrated is used for six results-proved circuits all of which cover the long and medium waves but do not require aerial or earth—truly portable.

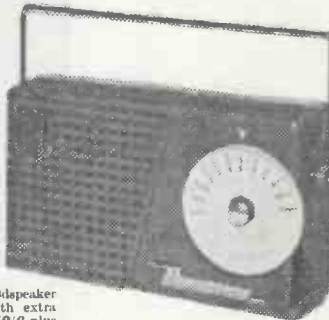
The Secret Three. This is an earphone model for private listening, ideal for hikers, etc., uses two special transistors in a reflex circuit and germanium diode—complete with miniature push into car type earphone 37/6 plus 2/- post and ins.

The Pocket Four. A loudspeaker model as above but with extra high gain audio stage 52/6 plus 2/6 post and ins.

The Pocket Five. As above but with extra A.F. stage—feed back control—and other refinement for weak reception areas, 67/6 plus 2/6 post and ins.

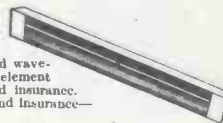
The Push-Pull 7. As pocket five but with 2 more transistors in a push pull moving coil speaker stage—really big output £51/17/6 plus 3/- post and ins. The Superhet 7. As P.P.7 but a superhet with printed circuitry £29/19/6 plus 3/6 post and ins.

Send S.A.E. for free booklet of these Circuits. Demonstrations at all branches—only first grade transistors used—batteries not included in above prices.

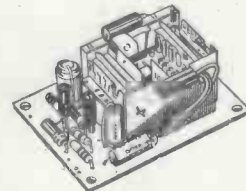


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2 x CX71's direct coupled cascade drive to 2 precision matched OC74's in Class B push-pull provide up to 1 W. undistorted output from 5 mV. in at 1.5 K-ohm. Frequency response, 60-180,000 c/s ± 3 dB. Overall size 3 x 2.2 x 1.2in. 92/6. Post and ins. 2/6.

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1 mA.-100 mA.-500 mA. D.C. current resistance 0-2000 ohms 012 megs.

Size approx. 5in. x 3in. x 2 1/2in. Price 69/6 plus 2/6 post and ins.



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SB 305 20-30 M/cs	9/-
SB 331E 40-50 M/cs	15/-
AMERICAN 2N1727 100-150 M/cs	12/6
AMERICAN 1T832 400-600 M/cs	25/-
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1 Pole 3 Way	1/6
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3 Pole 3 Way	1/6
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6 Pole 3 Way	3/6
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- Transistor holder 1/6 each.
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- Superhet 6 all first grade includes matched pair 45/-.
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- Diodes 1/-, sub-miniature 2/6.
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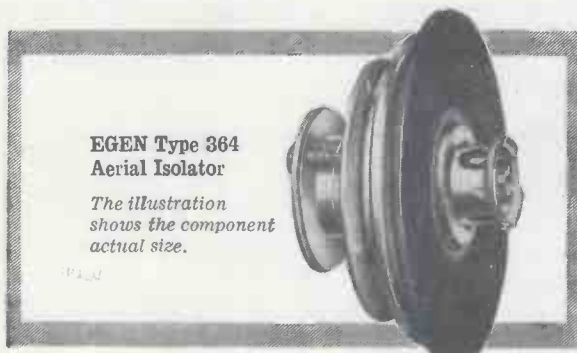
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The illustration shows the component actual size.

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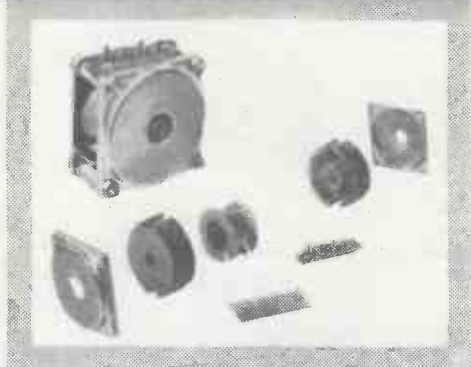
WPS 57

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Adjustable Ferrite Cores

TYPICAL ADJUSTMENT CURVES

The graph plots the percentage change in inductance (% ΔL) against the number of turns of the adjusting core for four different Gecolite assemblies: GA 132, GA 176, GA 131, and GA 106. Each assembly has two curves, labeled A and B. Curve A generally shows a lower percentage change in inductance compared to curve B for the same number of turns. The x-axis ranges from 1 to 12 turns, and the y-axis ranges from 0 to 18% ΔL.



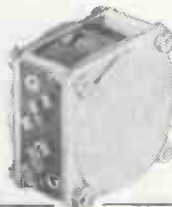
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Write for Data Sheet 592.

A range of non-adjustable cores is also available. **Data Sheet 591.**

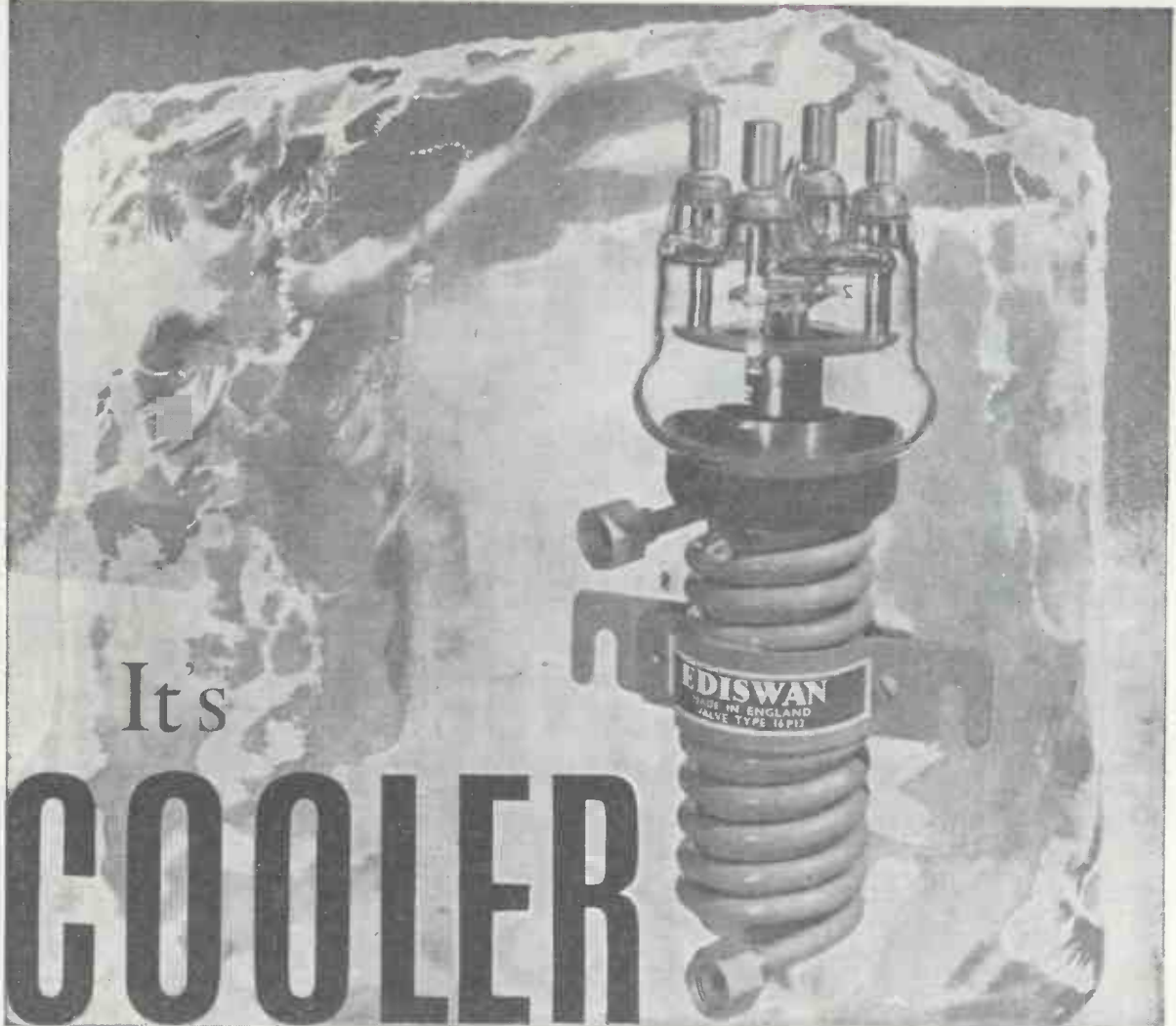


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Filament voltage (volts)	V_f	5.0	8.0
Filament current (amps)	I_f	32.5	26.0
Maximum anode voltage (kV)	$V_{a(max)}$	6.0	8.0
Maximum anode dissipation (kW)*	$P_{a(max)}$	0.6	3.0
Maximum operating frequency (full rating) (Mc/s)	$f_{(max)}$	1.5	1.5
Maximum RF power output (kW)	P_{out}	2.5	7.5

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* Other valves with anode dissipations up to 6 kW will be available shortly.

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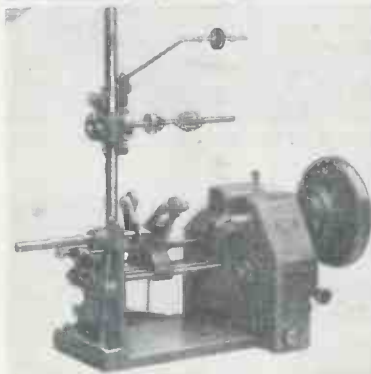
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brings out
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Even the most expensive recorder will only give its best performance if a good quality, reliable microphone is used.

In the DP4, with a uniform wide frequency response from 50 c/s to 15,000 c/s, Grampian have developed an outstanding, moderately priced instrument which will please the most exacting recordist.

The DP4 is equally suitable for Public Address, Broadcasting, Call Systems, etc.

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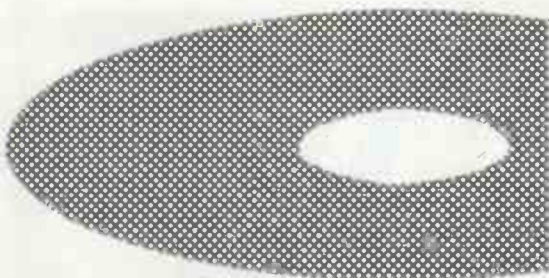
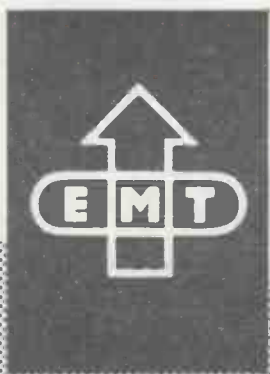
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Turntable Diameter	13 inch
Wow and Flutter, peak to peak	max. 0.1 %
Dimensions	15. ³ / ₁₆ x 19. ¹ / ₄ inch
Depth	6. ³ / ₁₆ inch
Weight	22 lbs
Power requirements	220 volts, 50 cps, a. c.
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Power consumption	approx. 20 watts



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BRAND NEW, FOUR-SPEED TRANSCRIPTION TURNTABLE

Younger brother of the excellent model EMT 930 well-known to most broadcast stations of the world. The new EMT 940 has also two turntables in one, a heavy flywheel as main turntable and a light plexiglass cover for instantaneous starting and stopping by means of a mechanical brake.

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Wearite 4A	£36 10 0	\$105
Wearite 4B	£41 10 0	\$119
Brenell Mk. V	28 gns.	\$84
Brenell Stereo Deck	£33 16 0	\$101
Brenell Pre-Amp. and Amp.	£24 0 0	\$69

Microphones by Lustraphone, Reslo, Acos, Simon, etc.

PLEASE NOTE—Prices subject to alteration in accordance with any which may be made by manufacturers at time of receipt of order.

● **TAPES BY ALL LEADING MAKERS**

★ **SPEAKER SYSTEMS**

Quad Electrostatic	£52 0 0	\$149
Wharfedale SFB/3	£39 10 0	\$113
Wharfedale Coaxial 12	£25 0 0	\$156
Wharfedale Golden 10	£8 14 11	\$18
Tannoy 12in. Monitor	£30 15 0	
Tannoy 15in. Monitor	£37 10 0	
WB. 1016	£7 12 3	\$16
Goodmans AL.120	£29 10 0	\$84
Goodmans AL.100	£23 10 0	\$67
Goodmans Triaxiom	£25 0 0	\$72
Goodmans 300	£11 5 9	\$32
Goodmans 400	£16 17 0	\$46
Kelly Ribbon Mk. II	£10 10 0	\$30
B. J. Tweeter complete	£5 5 0	\$11

★ **MOTORS AND PICK-UPS**

Decca Stereo P.U.	£21 0 0	\$45
Lenco GL60 Trans. Unit	£28 19 2	\$62
Lenco GL58/R, Stereo P.U.	£29 3 10	\$62
Garrard 301	£22 7 3	\$54
Garrard 4HF/Stereo P.U.	£19 17 7	\$41
Garrard TA/Mk. II	£9 15 8	\$22
Connoisseur Motor Type 'B'	£27 16 1	\$63
Connoisseur, 2 sp. Motor	£16 3 1	\$36
Golding 700	£9 14 9	\$21
Ronette DC284	£4 3 5	\$9

★ **AMPLIFIERS & TUNERS**

Quad 22-Control Unit	£25 0 0	\$73
Quad II Amplifier	£22 10 0	\$65
Leak Stereo 20 Amp.	£30 9 0	\$87
Leak Point One Pre-Amp.	£21 0 0	\$60

Rogers Junior Stereo	£28 10 0	\$81
Rogers Master Stereo Unit	£35 0 0	\$100
Quad FM Tuner	£28 17 6	\$70
Chapman AM/FM	£29 8 0	\$75

Enquiries for all items by firms mentioned in this advertisement invited.

BINSON "ECHOREC"

Distributed exclusively by Modern Electrics (Retail) Ltd. For superimposing controlled echo on to any audio signal. Compact, fully portable instrument, with three working channels, echo interval is variable, swell and other effects are obtainable.

ABRIDGED DESCRIPTION

- Three inputs and outputs.
- Push-button channel selection for 1, 2 or 3 channels.
- Controls for echo intervals, volume of echo, swell effect, volume level on input channels, etc.
- Complete with fitted carrying case, leads, plugs. A.C. mains.

Professional Discounts

140 gns. \$420 Leaflet on request. Trade enquiries invited

BINSON "BABY ECHOREC"

Similar to above but for single channel working. 80 gns. \$240

ATTENTION!

Ecrivez nous en francais S.V.P.
Schreiben Sie uns bitte auf Deutsch.
Escribanos en español por favor.

MODERN ELECTRICS (RETAIL) LTD.

We carry extensive up-to-date stocks of equipment, components and accessories by Britain's leading makers. Enquiries dealt with by return.

164 CHARING CROSS ROAD, LONDON, W.C.2
(3 shops from Tottenham Court Road Station Underground)
Tel: TEM 7587 & 00V 1703 Cables: MODCHAREX, LONDON

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as easy as—ABC

Special Stencils—like this electrical one—are just part of the wide UNO range. everyone can use

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A. West & Partners Ltd.
684, Mitcham Road, Croydon, Surrey

Type 3000* and Magnetic Latching (Remanence) Relays

STEVENAGE RELAYS LTD

D. G. I. TYPE APPROVAL NOW GRANTED FOR OUR RANGE OF RELAYS

Certificate Nos. HIGH VOLTAGE 1178, 1179 LOW VOLTAGE 1287

- Magnetic latching and release by impulse
- Silver, Platinum or Elkonite spring set configurations
- Coil values to customer's requirements
- Fully tropicalised or standard finish to A.I.D. release

Fast delivery on both prototype and normal production

STEVENAGE RELAYS LTD

A MEMBER OF THE **Sanders** GROUP OF COMPANIES

GUNNELS WOOD ROAD · STEVENAGE · HERTS.
Telephone: Stevenage 981. Telex: 82159 Sanders, Stev.
Ask for further details of our full range of Relays and Relay Kits.

★ **RANGER-3** ★

3-TRANSISTORS 2-DIODES

PERSONAL POCKET RADIO WITH FULL TUNING OF AMATEUR "TOP BAND" AND MEDIUM WAVE (120 to 500 Metres)



- First grade transistors.
- No external aerial or earth.
- Calibrated dial.
- Volume control.
- Personal earphone for quality output.

Size 4 1/8 x 3 x 1 1/4 in.

NO EXTRAS TO BUY EVERYTHING SUPPLIED. ALL COMPONENTS

AFTER SALES SERVICE **79/6** P. & P. 1/6.

● New Illustrated Booklet **FREE** on request.

6-TRANSISTOR RADIO

Size 3 x 2 1/4 x 1/2 in.

● **THE WORLD'S SMALLEST RADIO with Speaker**

FITS INTO VEST POCKET OR PURSE

Complete with Batteries, Leather Case, Earphone, in Presentation Box.


- All your favourite stations including Luxembourg.
- Superhet Circuit with Push-Pull output on 2in. speaker.
- 540 to 1600 kc/s coverage.

BUILT AND READY TO USE



CASH OR C.O.D.

12 gms Reg. Post Free.

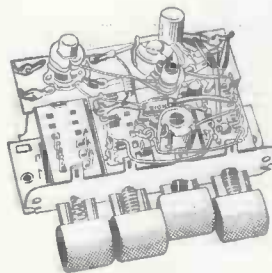


VALVES & TUBES

TRANSMITTING RADIO AND TV VALVES, TUBES AND INDUSTRIAL TYPES. NEW FREE LIST ON REQUEST.

Bulk order enquiries invited for all types.

SEVEN TRANSISTOR SUPERHET MEDIUM, LONG AND SHORT WAVE



(Units can be used for other circuits)

UNIT 1 (illustrated) Press Button Osc/Mixer stage. OC170 Transistor. S.W. 5.9 to 13 Mc/s; MW 510 to 1620 kc/s; LW 150 to 275 kc/s. Printed circuit. Size 3.4 x 2.1 x 1.8in. Output 465 Kc/s I.F. PRE-ALIGNED AND TESTED. 90/3. P. & P. 1/-.

UNIT 2 465 kc/s I.F. Amplifier, 2-OC169 Transistors. Double tuned I.F.T.'s. Diode Detector, A.V.C., etc. Printed circuit, Size 3 1/2 x 1 1/2 x 1 1/2 in. Ready to use. PRE-ALIGNED AND TESTED. 92/6. P. & P. 1/1-.

UNIT 3 4 Transistors, 1 watt Audio Amplifier, 60-1600 c/s ±3dB. 5mV input for 1 watt. 2-OC71, 2-OC74 Transistors. Printed circuit. Size 3 x 2.2 x 1.2in. Ready to use. 92/6. P. & P. 1/1-.

SUNDRIES (FOR ABOVE UNITS) 8 x 1/2 in. M.L.S. Ferrite Aerial and Coils. 12/6. 176pF + 176pF Tuner, 9/6. 2-15 pF Trimmers, 1/- each. 7 x 4in. 3 ohm Speaker, 20/- OR 9 x 6in. Cels., 25/-.

FULLY ILLUSTRATED BOOKLET SHOWING INTER-CONNECTION OF ABOVE 2/6

THE "CONTESSA"



PROFESSIONALLY DESIGNED: PROFESSIONAL PERFORMANCE: SIMPLE TO BUILD

6-TRANSISTOR MEDIUM AND LONG WAVE SUPERHET ● PORTABLE AND CAR RADIO ●

SPECIFICATION:

- ★ Peak output 425 mW Push-Pull
 - ★ 6 "Top Grade" Ediswan Transistors
 - ★ New type Printed Circuit with all component positions clearly marked
 - ★ Equally sensitive on Medium and Long Wave Bands.
 - ★ High "Q" internal Ferrite aerial with car coupling coil
 - ★ Step by Step fully illustrated instructions
 - ★ Clearly calibrated dial with station names and slow motion tuning
- Full instruction details, double tuned IFT's, AVC. Packaged components. Attractive two-colour cabinet, plus many other features.

- Inclusive price of all parts complete in every detail.
- No Extras to buy
- After Sales Service.
- No technical knowledge required
- Call for Demonstration anywhere—
- All parts available separately—
- No extra cost

£11.10.0
P. & P. 3/6.

Continental or Local Stations anywhere—

ILLUSTRATED LEAFLET WITH DETAILS AND PRICES FREE ON REQUEST.

- No Extras to buy
- After Sales Service.
- No technical knowledge required
- Call for Demonstration anywhere—
- All parts available separately—
- No extra cost

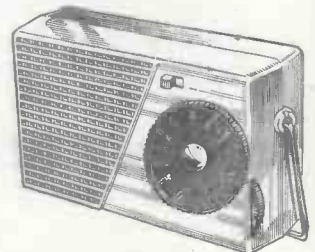
We specialise in components for the Home Constructor. Valve or Transistorised; from Radio Control to Amplifiers, Test units to Transmitters.

THE "PW" 6-TRANSISTOR POCKET SUPERHET

Full, Medium and Long Wave Tuning

- ★ Printed circuit with all components marked
- ★ 6 MATCHED MULLARD TRANSISTORS
- ★ Built-in Ferrite Aerial
- ★ 150 mW Output Push-Pull
- ★ Quality 2 1/2 in. Speaker
- ★ Size 5 1/2 x 3 x 1 1/2 in.

- Easy construction with fully illustrated building instructions
- Excellent performance



FREE LEAFLET WITH PRICES ON REQUEST

TOTAL COST OF ALL NECESSARY ITEMS **£9.19.6**
No extras to buy.

★ **BABY-SITTER** ★

Leaflet on request

ALL TRANSISTOR PORTABLE BABY OR INVALID ALARM



- BATTERY OPERATED
- 100% SAFE

Amplifier unit placed in any room required. Completely assembled with Battery and Microphone, ready to use. **£5.10.0** P. & P. 2/6.

- BATTERY LIFE 3 to 4 months
- FULLY PORTABLE

Battery operated Push-Pull Circuit with 5in. Speaker. Output: Low impedance. Input enables it to be used over any distance with up to 3 microphones.

★ Microphone is placed within 6 feet of baby; twin flex is taken to any room required.

● **SUPER-3** ●

PERSONAL POCKET RADIO

- ★ Medium Wave Tuning
- ★ Three Transistors and Diode.
- ★ 9 Months' Battery Life for 4d.



- ★ Simple to Build
- ★ After Sales Service
- ★ Ideal for Beginners

Personal Earphone Output for Quality Listening

BUILT-IN FERRITE ROD AERIAL

FREE Diagram on Request

Total cost of all necessary items with earphone, battery and transistors, etc. **37/6** P. & P. 1/6
All parts sold separately

QUARTZ CRYSTALS

FOR TRANSMITTING RADIO CONTROL OSCILLATORS, ETC. Free List on Request ALL TYPES FOR ALL PURPOSES

FROM **5/-** EACH



Bulk Order Enquiries Invited

● **COMING SHORTLY** ●
7-TRANSISTOR AM/FM PORTABLE TO BUILD YOURSELF FIRST AGAIN ●

HENRY'S RADIO LTD.

DEPT. W/W, 5 HARROW ROAD, EDGWARE ROAD, PADDINGTON, LONDON, W.2.
Opposite Edgware Road Tube Station. PADDINGTON 1008/9. OPEN MONDAY to SAT. 9-6. THURS. 1 o'clock

COMPLETE ILLUSTRATED LEAFLETS OF ALL HOME CONSTRUCTION UNITS
FREE ON REQUEST.

Matched Sets of Transistors

● SPECIAL OFFERS—FULLY GUARANTEED ●

- | | |
|---|--|
| <p>1. 6 Mullard Transistors and Diode</p> <p>1—OC44 ONLY
2—OC45
1—OC71
2—OC72
and
1—OA81
or with 2—OA81, 62/6</p> <p>60/- PER SET</p> | <p>2. 6 Mullard Transistors and Diode—1 watt output</p> <p>1—OC44 ONLY
2—OC45
1—OC81D
2—OC81
and
1—OA81
or with 2—OA81, 65/-</p> <p>62/6 PER SET</p> |
| <p>3. 6 Ediswan Transistors and two Diodes</p> <p>1—XA102 ONLY
2—XA101
1—XB103
2—XC101
and
2—Diodes</p> <p>57/6 PER SET</p> | <p>4. 4 Mullard Transistors for 1 watt amplifier</p> <p>1—OC71
1—OC81D ONLY
2—OC81
with Cooling Clips
Capable of 1 watt Push-Pull</p> <p>49/6 PER SET</p> |

ALL THE ABOVE TRANSISTORS ARE 1st GRADE AND SELECTED FOR PERFORMANCE



TRANSISTORS From 3/6 each

SEND FOR NEW FREE LIST WITH DATA AND USES

FULLY GUARANTEED

We can supply a Transistor for every need!

9.72 Mc/s IF STRIP

- 2-EF92 Valves
- 3-EF91 Valves
- 1-EB91 Valve

32/6 P.P. 1/6

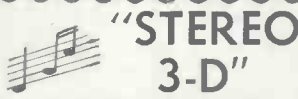


BRAND NEW WITH DIAGRAM

BC221 FREQUENCY METER
125 kc/s to 20 Mc/s: Three Valve Crystal controlled Oscillator. Battery operated. Complete with Calibration Charts and Handbook.

£16 FREE CARRIAGE

NEW CONDITION WITH HANDBOOK.



STEREO RECORD PLAYER AMPLIFIER

New high-gain circuit with full tone, balance and volume controls. Can be used with all types of records as well as stereo.

- ★ 2 WATTS PEAK PER CHANNEL
- ★ ECC83; 2-ECL82 VALVES
- ★ MAINS 110/250V A.C.

Complete with speaker sockets, calibrated dials, etc. 97/6

BUILT AND TESTED P.P. 2/-

★ ★ COLLARO 4-SPEED STEREO AUTO-CHANGER, ideal for use with above amplifier, £7/10/-, P.P. 3/6.

★ ★ 9 x 6in. large magnet Elac speaker, for use with STEREO 3-D, 37/- pair. P.P. 1/6.

Crystal Microphones

- ACOS 39-I. Stock Microphone with screened cable and Stand (List 5 gns.), 39/6. P.P. 1/6.
- ACOS 40 Desk Microphone with screened cable and built-in Stand (List 50/-), 19/6. P.P. 1/6.
- ACOS 45 Hand Microphone with screened lead, very sensitive, 29/6. P.P. 1/6.

931A (27M1)

(CV 2696)

PHOTO MULTIPLIER

Brand new, original cartons.

60/- P.P. 1/-
Base 2/-

Also: Special purpose 931A-CV337 Base 2/- each. 80/-

MARCONI NO. 19 SET CRYSTAL CALIBRATOR

6-Valve Crystal Controlled Oscillator. 10 kc/s. 100 kc/s and 1 Mc/s. New Modulator. Unused with Handbook. 79/6, P.P. 2/6.

DECCA AMPLIFIER

As supplied in the well-known Deccamatic III. Uses ECL82 valves, full range tone and volume controls. Size 8½x3½x3in. P.P. 2/6. 59/6

● IDEAL FOR PORTABLE RECORD PLAYER ●

8 x 6in. CELESTION SPEAKER for use with above. 25/- P.P. 1/-.



ADDRESS

HENRY'S RADIO LTD.

● ACKNOWLEDGED THE SPECIALISTS ●

- ★ TRANSISTORS
- ★ QUARTZ CRYSTALS
- ★ VALVES & TUBES

- ★ MINIATURE & STANDARD COMPONENTS

A SHORT LIST FROM OUR VAST STOCK

COSSOR "TRAVELLER'S FRIEND" 4 TRANSISTOR POCKET RADIO

Complete kit of parts to build this wonderful set. Size 6 x 3½ x 1½in. Weight 17 oz. Printed circuit, ferrite aerial, 2in. speaker. Original price 18 gns.

£7-19-6 Complete P. & P. 2/6.

CRYSTAL DIODES

General Purpose GEX00, each 1/-, per doz. 9/-. All other types in stock. All types of Sub min. Condensers and Resistors. Send S.A.E. for our List of All Components.

LABGEAR AUDIO POWER OUTPUT METER

Build this wonderful meter in an evening. Two ranges: 25 mW-1 W and 1 W to 10 W. Accuracy 5%. Complete kit.

£2-19-6 P. & P. 2/-.

TAPE DECKS

COLLARO STUDIO TAPE TRANSCRIBER 3 motors, 3 speeds 1½, 3½, 7½. Push button controls. LIST PRICE 16 GNS.

£12-19-6 P. & P. 3/6.

TRANSISTORS

P.N.P. Junction types.

AUDIO, suitable for high gain and low freq. amplifiers, and for output stages up to 250 milli-watts. Double spot—yellow and green

Each 5/-

R.F. suitable for medium and low freq. oscillators, freq. changers and I.F. amplifiers (1.5 to 8 Mc/s.). Double spot—yellow and red.

Each 7/6

Type TS1. Suitable for all audio applications. Post 6d.

Each 3/6

One dozen 35/- post free

Special prices quoted for large quantities.

AVANTIC STEREO PHONIC HI-FI AMPLIFIERS—

AT ALMOST HALF LIST PRICE WHILE EXISTING STOCKS LAST. BRAND NEW IN MAKER'S CARTONS—100—250 VOLTS—SMALL DEPOSIT SECURES.

PL6/21 10 WATT MONAURAL AMPLIFIER AND COMBINED PRE-AMPLIFIER CONTROL UNIT

5 Inputs. Size 14½in. wide, 9in. deep, 4in. high, 8½in. deep. LIST PRICE £29/8/-

19 GNS. CARR. & INS. 7/6.

SPA11 STEREO AMPLIFIER AND PRE-AMPLIFIER

Twin 10 watts output, 3-dimensional Monaural reproduction by combining both channels, 3 inputs for each channel. Size 14½in. wide, 4in. high, 8½in. deep. LIST PRICE £29/8/-

19 GNS. CARR. & INS. 7/6.

STEP 11 STEREO PICK-UP PRE-AMPLIFIER UNIT

Size: 7½ x 4½ x 2½in. LIST PRICE £6/16/6

£4-19-6 CARR. & INS. 7/6

RECORD CHANGERS

B.S.R. U.A.8 complete with latest "ful-fi" cartridge

£6-19-6

STEREO

£7-19-6

COLLARO CONQUEST 4 Speed auto

£7-19-6

GARRARD RC120 4 Speed auto

9 GNS.

COLLARO JUNIOR 4 speed Single Play Complete with Arm and P.U.

£3-15-0

P. & P. 3/6.

Garrard TA Mk. II. Wired for Stereo, plug in head, 4 speed single play.

£8-9-0

P. & P. 3/6.

VERDIK TAPE RECORDERS

First class Tape Recorders using the famous Collaro transcription deck. 3 speed 1½—3½—7½ I.P.S. Mic. and Radio inputs. 7in. x 3½in. internal speaker. Valve line up ECC83, ECL82, EM84. Wow and Flutter 0.15% total at 7½in/sec. Size width 15½in. depth 6½in., height 6½in., weight 28lb. LIMITED STOCK ONLY.

Model S22 2-Track

32 GNS.

Model S44 4-track

39 GNS.

CARR. & INS. 21/-.

8 WATT AMPLIFIER

This superb 8 watt amplifier made by well known manufacturer, ready for your Hi-Fi cabinet. Spec.: 2 EL84, 12AX7 and E281 push pull output Separate Bass and Treble controls on panel with extended lead. SPECIAL BARGAIN

WHILE STOCKS LAST. P. & P. 3/6. £4-15-0



SP21/2

STEREO PRE-AMPLIFIER CONTROL UNIT Twin channel. Designed primarily for use with two DL7 35 Power Amplifiers. Six inputs for each channel. LIST PRICE £28/10/-

£16-19-6 CARR. & INS. 7/6.

WIRECOMP ELECTRONICS

378 HARROW ROAD, LONDON, W.9. TEL.: CUNNINGHAM 9530

Hours of business: 9 a.m. to 6 p.m. Open all day Saturday

Opposite Paddington General Hospital. Buses 18B & 36 pass the door.

RCA AR88D RECEIVERS

One of the most renowned American Communications Receivers ever manufactured. Widely used by all the Armed Services to maintain World-wide Communications and Monitoring Posts under all conditions. Employs 14 valves, and has 6 switched overlapping wave bands for complete coverage. Refinements include Mechanical Band Spread with Logging Scale, Automatic or Manual Volume Control, Automatic or Manual Noise Limiter, BFO with pitch control, RF and AF Gain Controls, Variable HF Tone Control, Variable Selectivity with Crystal Filter, Aerial Trimmer, Choice of Head-phones or Speaker. Has internal mains power pack for nominal 115-230 volts A.C. In Black Cracked Case size 19 1/2 in. W. x 11 in. H. x 19 1/2 in. D. Thoroughly reconditioned, immaculate in appearance, and in perfect working order. Covers 500 kc/s-32 Mc/s, price (add carriage 30/- and 50/- deposit on returnable transit case). **£45** S.A.E. brings illustrated descriptive leaflet.

R1155 RECEIVERS

The famous Bomber Command Receiver known the world over to be supreme in its class. Covers 5 wave ranges: 18.5-7.5 Mc/s. 7.5-3.0 Mc/s. 1,500-600 kc/s., 600-200 kc/s., 200-75 kc/s. and is easily and simply adapted for normal mains use, full details being supplied. All sets thoroughly tested and in perfect working order before despatch, and on demonstration to callers. Fitted with latest type Super Slow Motion tuning assembly. Have had some use, but are in excellent condition. **ONLY £9/19/6**. **A.C. MAINS POWER PACK OUTPUT STAGE** in black metal case to match receiver, enabling it to be operated immediately, by just plugging in, without any modification. Fitted with 8in. P.M. speaker **£6/10/-**. **DEDUCT 10/- IF PURCHASING RECEIVER AND POWER PACK TOGETHER**. Send S.A.E. for illustrated leaflet, or 1/3 for 14-page booklet which gives technical information, circuits, etc., and is supplied free with each receiver. Add carriage 10/6 for Receiver, 5/- for Power Unit.

POWER UNITS TYPE 234



Primary 200/250 v. 50 cycles. Outputs of 250 v. 100 m.A., and 6.3 v. 4 amps. Fitted double smoothing. For normal rack mounting (or bench use) having grey front panel size 19in. x 7in. **ONLY 59/6** (carriage, etc., 7/6). Or fitted with 2 1/2 in. A.C. volts output meter, 79/6 (plus carr. as above).

CARRYING CASES, solid leather. **SLIGHTLY USED**. Internal dimensions 8 1/2 in. H. x 8 1/2 in. W. x 4 1/2 in. D. Fitted lock and key, and shoulder strap. Ideal for Test Instrument, Camera and accessories, etc. **ONLY 25/-** (postage 2/-).

BC 342 RECEIVERS. A few only of these famous American sets covering 1.15-18.0 Mc/s. in six bands. Internal 115 v. A.C. Mains pack. A super receiver in first-class condition and perfect working order. **ONLY £25** (carriage 15/-).

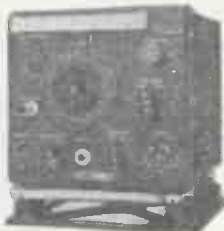
HRO MAINS POWER UNITS. A.C. Input 115/230 volts. Output D.C. (fully smoothed) 230 volts 75 m.A., and 6.3 volts 3.5 amps. Complete in black cracked case **ONLY 59/6**.

12-WAY SCREENED CABLE. In 10ft. lengths, fitted with plugs, originally made for No. 19 Wireless Set. **UNUSED. ONLY 15/-** per lead.

P.M. SPEAKERS. 3in. 19/6. 6 1/2 in. 17/6. 8in. 21/- 12in. 29/6.

SPRAGUE CONDENSERS. Metal cased wire ends. New. .01 mfd 1,000 v. and 1 mfd., 500 v. 7/6 per dozen. Special quotes for quantities.

HETERODYNE FREQUENCY METERS TYPE LM14



Frequency range 125-20,000 kc/s. in 2 bands. This is the United States Navy Model of the well-known BC221 Frequency Meter, but has many additional features which increase its usefulness. Voltage stabilisation circuits and Crystal control ensure extreme accuracy, and in addition it is fitted with an Internal Modulation switch to allow use as a Signal Generator. Size only 8 1/2 in. x 8 in. x 8 1/2 in. Full information on request.

UNIVERSAL VOLT-OHM-MILLIAMETER

Reads A.C. and D.C. Volts up to 1,000 in 5 ranges at 1,000 o.p.v., D.C. Current (3 ranges) to 500 m.A. Resistance readings to 200 Kohms in 2 ranges. Basic movement 300µA sensitivity. Easily read open scale. Dimensions 5 1/2 in. x 3 1/2 in. x 2 1/2 in. Beautifully made, and fully guaranteed. Complete with leads, prods and internal battery. **ONLY 59/6**



BC 221 FREQUENCY METERS

Similar specification to LM 14 Frequency Meter below, but does not have internal modulation or voltage stabilising circuits. Complete with original calibration book, crystal, valves, and instruction book. Used, but in very good condition. **ONLY £16**. Illustrated descriptive leaflet available on request.

DOUBLE BEAM OSCILLOSCOPE TUBES

Type CV 1596 equivalent to Cossor 09D as used in oscilloscopes by Cossor (339 series). Hartley and Erskine (13 series). Listed at £12/10/-. Our price **£2/19/6** (carriage 5/6). *Brand new in makers' crates.*

METERS

F.S.D.	SIZE AND TYPE	PRICE
25 microamps	D.C. 2 1/2 in. Proj. circular	59/6
50 microamps	D.C. 2 1/2 in. Flush circular	59/6
50 microamps	D.C. 3 1/2 in. Flush circular	80/-
100 microamps	D.C. 2 1/2 in. Flush circular	39/6
1 milliamp	D.C. 2 1/2 in. Flush circular	30/-
1 milliamp	D.C. 3 1/2 in. Flush circular	50/-
200 milliamper	D.C. 2 1/2 in. Flush circular	12/6
20 amps	D.C. 2 1/2 in. Proj. circular	7/6
40 amps	D.C. 2 1/2 in. Proj. circular	7/6
5 amps	D.C. 2 1/2 in. Flush square	12/6
300 volts	A.C. 2 1/2 in. Flush circular	25/-
500 volts	A.C. 2 1/2 in. Flush circular	25/-

HIGH FREQUENCY A.C. VOLTMETER

A First Grade Moving Iron Instrument with 6in. Mirror Scale, reading up to 150 volts A.C. at 400 and 1,200-2,400 cycles. In substantial Oak case with removable lid, overall size 8 1/2 in. x 8 1/2 in. x 5 1/2 in. Recently made for the Air Ministry, by Everett Edgcumbe, and in perfect order. Brand New & Unused. **ONLY 27/10/-**. Can also be supplied for 50 cycles, use either 0-150 or 0-300 volts.



POWER UNIT TYPE 3. Primary 200/250 volts A.C. 50 cycles. Outputs of 250 volts 100 m.A., and 6.3 volts 4 amps. Fitted double smoothing and 2 meters to read H.T. current and voltage. For normal rack mounting (or bench use) having grey front panel. Size 19in. x 7in. **BRAND NEW. ONLY 79/6** (carriage 7/6).

INTERCOM. TELEPHONE SET. Two pairs of Brand New Headphones connected to Breast Microphones, with leads, etc., in fitted carrying cases. Supplied with 4 1/2 volt battery, 10 yards twin flex, and full instructions for connecting to make super intercom. **ONLY 27/6**. (Post 3/6). Extra flex 3d. per yard.

10,000 OHMS PER VOLT TESTMETER. This latest Cabby model is a handy pocket sized tester 5 1/2 x 3 1/2 x 2 1/2 in. Reads low D.C. voltages at 10,000 ohms per volt, up to 10,000 v. A.C. and D.C. at 4,000 o.p.v. Resistance to 20 mega. D.C. current to 250 milliamperes and also Decibels. Complete with Test Leads, Batteries and Instruction Book. **ONLY 28/10/-**.

12 VOLTS AMERICAN DYNAMOTOR. Delivers 220 volts at 100 milli. Size 5 1/2 x 8 1/2 in. diameter. Ideal for running Radio and Electric Shaver etc., from car battery. **ONLY 32/6**.

MARCONI SIGNAL GENERATOR TF 1440/7. Coverage 85 kc/s.-2.5 Mc/s. and 8 Mc/s.-70 Mc/s. Complete, and in AS NEW CONDITION. **ONLY £95**.

AMPLIFIER N24



Utilises 4 valves, 1 each 5Z4G, 6V6G, 6J7G, 6J5G and high quality components such as "C" Core Transformers and Block Paper Smoothing Condensers. A.C. Mains Pack for nominal 110 x 230 volts. Provision for 600 ohms or High Impedance Input. Output to 600 Transformer. Output approximately 4 watts. Designed for Standard Rack Mounting, having grey front panel size 19in. x 7in. All connections to rear panel, front having "On/Off" Switch. Gain Control, Indicator Light. Fuses and Valves Inspection Panel. **BRAND NEW IN MAKER'S PACKING. ONLY £41/9/6** (carriage 10/6).

Cash with order please, and print name and address clearly
PLEASE ADD POSTAGE OR CARRIAGE COSTS ON ALL ITEMS

HARRIS ELECTRONICS (LONDON) LTD.

Radio Corner, 138 Gray's Inn Road, London, W.C.1. Phone: TERMINUS 7937

Open until 1 p.m. Saturdays.

We are 2 mins. from High Holborn (Chancery Lane Station) and 5 mins. by bus from King's Cross.

G.W. SMITH & CO

(RADIO) LIMITED

Phone: GERRARD 8204/9155
Cables: SMITHEX LESQUARE

3-34 LISLE STREET, LONDON, W.C.2

SELENIUM L.T. METAL RECTIFIERS

Full wave, bridge connected. All new and guaranteed.



12/18 v. 1 amp. 4/3	12/18 v. 10 amp. 22/6
12/18 v. 2 1/2 amp. 6/9	24/36 v. 1 amp. 9/6
12/18 v. 4 amp. 9/9	24/36 v. 2 amp. 13/6
12/18 v. 5 amp. 12/6	24/36 v. 6 amp. 22/6
12/18 v. 6 amp. 13/6	24/36 v. 10 amp. 45/-
	24/36 v. 15 amp. 47/6

Please add postage.

L.T. TRANSFORMERS. For charging or models. All 200/250 volt primaries. 3.5, 9 or 17 volt 1 amp., 9/9; 3.5, 9 or 17 volt 2 amp., 14/3; 3.5, 9 or 17 volt 4 amp., 16/6; 9 or 17 volt 6 amp., 26/-; 3, 4, 5, 6, 8, 10, 12, 15, 18, 20, 24 or 30 volts 2 amps, 18/6; Ditto but 4 amp., 30/-. Please add postage.

PLESSEY 24-VOLT D.C. PUMPS



Self lubricating, capacity 60 g.p.h. at 30 lb./sq. in. Will operate O.K. on 12 v. $\frac{1}{2}$ BSP inlet/outlet union. Only 15/6 each. P/P 2/6.

CARPENTER RELAYS

570 ohm coils. Side stable single changeover contacts. Brand new boxed, 12/6 each. P/P 1/3.



PORTABLE PRECISION VOLTMETERS

Brand new moving iron instruments by famous manufacturer. Housed in polished teak case, Bin. mirror scale. 2 ranges, A.C. or D.C. 0 to 160 v. and 0 to 320 v. Accuracy within 2%, £5/19/6 ea. P/P 3/6.



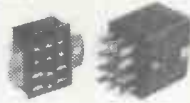
SPARES KITS FOR CR.100 RECEIVERS
Contains 15 valves; 2—DH63; 2—X66; 2—KT63; 2—U50; 7—KTW61. Condenser and resistor packs, pots, toggle switch, output transformer, etc. All brand new, 59/6. P/P 3/6.

FIELD TELEPHONES TYPE F.

Ideal for all intercom. systems, house, office, building sites, etc. Generator bell ringing, 2 line connection. Supplied complete with batteries and wooden carrying case, fully tested. £4/19/6 pair. P/P 5/-.



PAINTON MINIATURE JINES PLUGS AND SOCKETS



All new and unused.
2 pin 2/6 pr. 12 pin 5/6 pr.
4 pin 3/6 pr. 18 pin 7/6 pr.
6 pin 4/- pr. 24 pin 8/6 pr.
8 pin 4/6 pr. 33 pin 10/6 pr.
Please add postage.

MULTI-RANGE TESTMETER BARGAIN



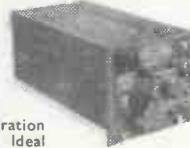
Imported, brand new and guaranteed. 1,000 ohm/volt A.C./D.C. Volts D.C.: 10, 50, 250, 500, 1,000 v. Volts A.C.: 10, 50, 250, 500, 1,000 v.

Current D.C. 1 mA., 100 mA., 500 mA. Resistance: 2,000 ohms and 200,000 ohms. Supplied complete with all instructions and test leads. Price 59/6 each. P/P 2/6.

MARCONI TF-373 UNIVERSAL IMPEDANCE BRIDGES. Reconditioned to maker's specification. 0-100 H., 0-100 mfd., 0-1 megohm., 0-100 Q, each on 5 ranges at 1,000 c/s. £35 each.

MARCONI TF-329 "Q" METERS. Range 0 to 500 Q. Frequency 50 kc/s to 50 Mc/s. Reconditioned to maker's specification. £65 each.

ARB AMERICAN RECEIVERS



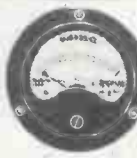
Frequency coverage on 4 bands 195 kc/s to 9.05 Mc/s continuous. Operation from 24-volt D.C. Ideal for boat or car. Precision vernier drive. Valve line-up: 12SA7, 4—12SF7, 12A6 and 991. Supplied fully tested and checked, £10/19/6 each. P/P 7/6.

BRAND NEW MEDRESCO HEARING AIDS



Supplied fully tested and complete with ear-piece, leads and battery pouch. Incorporates 3 sub-miniature valves and sensitive crystal microphone. Only 32/6 each. P/P 1/-.

VALVE VOLTMETERS No. 2. A laboratory instrument at a fraction of cost. Five ranges A.C. and D.C. 1.5 v., 5 v., 15 v., 50 v. and 150 volts. Operation 200/250 volts A.C. Supplied as new, fully tested and complete with internally mounted H.F. probe. £17/10/- each. P/P 10/-.



BRAND NEW Boxed 100 MICROAMP METERS. Standard 2 1/2 in. flush panel mounting. Scale calibrated 0-100 microamps. 42/6 each. P/P 1/3. Also available 3 1/2 in. panel mounting 62/6 each.

COLLARO STUDIO TAPE TRANSCRIPTORS



Latest 1961 model. 3 speeds 1 1/2, 3 1/2 or 7 1/2. Fitted with 3 separate motors, digital counter, press button switching, provision for fitting extra stereo head. Supplied

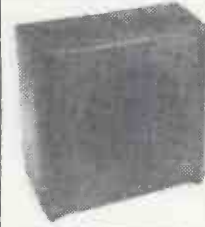
brand new and guaranteed complete with spare 7 in. spool. £12 each. P/P 3/6.

COAXIAL PLUGS AND SOCKETS

All new and unused. Large stocks available. Type 1. Films and Equipment, 2/6 per pair. Type 2. Miniature Pye, 2/6 per pair.



R.C.A. LOUD-SPEAKERS



High quality Bin. 3 ohm. speaker housed in black crackle metal case to match AR-88 or H.R.O. receivers. Supplied brand new and boxed, 45/- each. P/P 3/6.

R.C.A. PLATE TRANSFORMERS. Primary 200/250 volts 50 cycles. Secondary 2,000/1,500/1,000/2,000 volts 500 milliamps. Supplied brand new and boxed, £6/10/- each.

PARMEKO TABLE TOP TRANSFORMERS



Input 230 volt 50 cycles. Output 620/550/375/300/375/550/620 volts 250 mA., 5 volt 3 amp., 5 volt 3 amp. Size 6 1/2 in. x 6 1/2 in. x 5 1/2 in. Brand new and boxed, 45/- each. P/P 3/6.

7.5 K.V.A. AUTO TRANSFORMERS

115/230 volts. Brand new and boxed, ex-U.S.A. £45 each. P/P 10/-.



MINIATURE EARPIECES



Available high (Crystal) or low (5 ohm) impedance. Ideal for transistor receivers, etc. Supplied brand new complete with lead and jack and plug. Only 7/6 each complete. P/P 9d.

LOOK! THOUSANDS OF BARGAINS AVAILABLE WHICH WE ARE UNABLE TO ADVERTISE. IT IS WORTH YOUR WHILE TO PAY US A VISIT

HIGH FIDELITY RECORDING TAPES
Bargain prices. All new and guaranteed.

3in. long play 225ft.	6/-
5in. std. play 600ft.	12/-
5in. long play, 900ft.	16/-
5½in. long play, 1,200ft.	19/6
7in. std. play, 1,200ft.	19/-
7in. long play, 1,800ft.	29/-
7in. double play 2,400ft.	49/6

PLASTIC SPARE SPOOLS. All new.
5in. 2/- ea., 5½in. 2/3 ea., 7in. 2/9 ea.
BRAND NEW PLASTIC SPOOL CONTAINERS
5in. 1/6 ea., 5½in. 2/- ea., 7in. 2/3 ea.
Please add postage.



MINE DETECTOR No. 4A

Will detect ferrous or non-ferrous metals. Complete, as new in transit cases. Supplied fully tested with instructions.
39/6 each, carriage 10/-, batteries 8/- extra

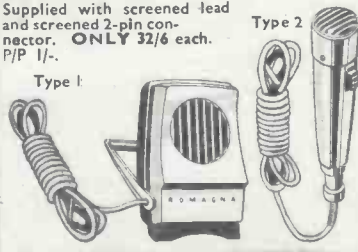
METER BARGAINS

20 microamp D.C. M/C flush rd.	2½in.	69/6
25 microamp D.C. M/C proj. rd.	2½in.	59/6
50 microamp D.C. M/C proj. rd.	2½in.	49/6
100 microamp D.C. M/C flush rd.	2½in.	42/6
100 microamp D.C. M/C flush rd.	3½in.	62/6
200 microamp D.C. M/C proj. rd.	2½in.	29/6
300 microamp D.C. M/C flush rd.	2½in.	29/6
1 milliamp D.C. M/C flush rd.	2½in.	25/-
1 milliamp D.C. M/C flush sq.	4in.	69/6
30/0/30 milliamp D.C. M/C flush	2½in. rd.	9/6
15 amp. 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/C rectifier flush rd.	2½in.	25/-
300 volt A.C. M/I flush rd.	2½in.	25/-
500 volt A.C. M/I flush rd.	2½in.	25/-
1,500 volts electrostatic proj. rd.	2½in.	25/-

Postage extra.

CRYSTAL MICROPHONES
Brand new and guaranteed.

Type 1. Hand or desk type with screened lead. **ONLY 15/6** each. P/P. 1/-.
Type 2. High fidelity stick type, metal cased and fitted with switch. Supplied with screened lead and screened 2-pin connector. **ONLY 32/6** each. P/P 1/-.



SANGAMO WESTON STANDARD VOLT METER
Range 0/30 v. D.C. 1000 ohms per volt. Correct to B.S. 89 Pr. limits 6 inch mirror scale, £25 each. 3/6 P. & P.

SUB-STANDARD I.F. OSCILLATORS
3 ranges covering 445-485 kc/s. Crystal controlled fitted with precision variable attenuators. Brand new, £15 each, 10/- carriage.

NATIONAL H.R.O RECEIVERS

Senior model, table mounting. Supplied complete with full set of 9 coils covering 50 kc/s. to 30 mc/s. All receivers are fully tested and aligned. Price 21 gns. Carriage 10/- extra. Power units are also available at an extra cost of 59/6 each.

AVO SIGNAL GENERATORS

Frequency coverage 95 kc/s to 40 mc/s. Ideal for all general radio work. Supplied fully tested and checked £7/19/6 each. P/P 3/6. Operation is from 2 v. and 60 v. batteries but original Avo mains units can be supplied at 19/6 each extra.



PHOTO VOLTAGE AMPLIFIERS

These special units contain a 1 microamp Tinsley galvanometer and a double selenium photo electric cell. Brand new £9/19/6 each. P/P 7/6.

FIELD TELEPHONE TYPE L.

Generator bell ringing, 2 line connection. Supplied fully tested, complete with batteries. 59/6 each. P/P. 3/-.

AMPHENAL CHASSIS UNITERS

All new and unused. Available with 15 or 18 pins. Both types 3/6 per pair.

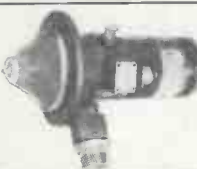


HALLICRAFTER 6 VOLT VIBRATOR POWER SUPPLIES. Housed in grey metal case and supplied with all necessary connectors etc. Made for SX28, S27, S36 receivers. Output 300 volts 170 ma., fully smoothed. Supplied new and boxed, 29/6 each. P/P 3/6.

SOUND POWERED TELEPHONE HANDSETS

Make simple Intercom system. No batteries required. Just connect together with twin flex. Brand new only 15/- per handset. P/P 1/6. Suitable twin flex 2½d. per yd.

24 VOLT D.C. FUEL PUMPS.
Perfect condition, 15/6 ea. P/P. 2/6.



RECORD CHANGERS AND PLAYERS



B.S.R. Monarch UA8 4 speed record changers, £6/12/6 each.
B.S.R. Monarch UA8 Stereo 4 speed record changers, £6/12/6.
B.S.R. UA14 Stereo 4 speed record changers, £7/10/- each.
Collaro Junior 4 spd. single players, £3/15/- ea. POST EXTRA.

1,000 WATT MAINS ISOLATION TRANSFORMERS. 230 volt primary, 230 volt secondary. Ex-Admiralty heavy duty type. New boxed, £5 each. Carriage 10/-.

AR.88 WAVECHANGE SWITCHES. 8 banks, 6 positions, complete with all screens. New, boxed, 17/6 each. P/P 2/6.

BC. 221 HETERODYNE FREQUENCY METERS

125 kc/s to 20 Mc/s As new condition. Supplied complete with valves, crystal and calibration charts.



Only **£16** each P/P 7/6.

Also available less calibration charts only £9/10/0 each.

ALUMINIUM CHASSIS

18 swgs, four sided and with reinforced corners. 6 x 4 x 2½in. 3/6; 10 x 7½ x 2½in. 5/3; 7½ x 5½ x 2½in. 4/6; 11½ x 7½ x 2½in. 6/-; 13½ x 9 x 2½in. 6/9. Post extra.

HALLICRAFTER S-27 RECEIVERS

FM/AM, 27-143 Mc/s. operation 110/230 A.C. Supplied reconditioned and in perfect order £27/10/- each, carriage £1, also available S36A receivers ditto as above but no S meter. £25 each.

24 AMP. VARIAC TRANSFORMERS. Primary 230 volts. Adjustable secondary from 185 to 250 volts at 24 amps. Can also be used in reverse, £12/10/- each. P/P 10/-.

MUIRHEAD CELL TESTERS

Brand new. Incorporates a 6in. scale 3 amp. D.C. meter and variable rheostat for controlling current. Only 32/6 each. P/P 3/6.



POWER UNIT TYPE 234A. Input 200/250 volt. Output 250 volt 150 ma., fully smoothed and 6.3 volt. 5 amp., 19 inch rack mounting chassis 59/6 each, carriage 7/6.

GW. SMITH & CO. (RADIO) LIMITED
Phone: GERRARD 8204/9155
Cables: SMITHEX LESQUARE
3-34 LISLE STREET, LONDON, W.C.2

LASKY'S RADIO

SAVE POUNDS! ORDER BY POST IF YOU CANNOT CALL

FAMOUS MAKES HI-FI EQUIPMENT
GREATLY REDUCED! Last Few! Hurry!

MICROPHONE BARGAINS

The "Diana," High impedance moving coil mike with unique magnetised table base. Response 30-15,000 c.p.s. Ideal for tape recorders. List 4 Gns. Lasky's Price **55/-** Post free.



ACOS CRYSTAL STICK MIKE Type M.C.39/1, complete with cable. Listed at £5/5-. Lasky's Price **39/6** Post free.

MINIATURE moving coil dynamic microphone, incorporating switch and complete with pocket clip. As used for the "Fi-Cord" **35/-** Post 1/6.

STEREO AMPLIFIER KIT

Twin 4 watt (or 8 watt monaural), employing two ECL82 and E280 rect. valves, double-wound mains transformer, etc. Separate panel with bass, treble and volume controls. Indicator lamp, push button on/off switch, elegant gold/cream knobs. Kit comprises two Amplifier Units and one Power Unit, all 5in. x 2in. in size. Fully assembled ready to be wired together. Kit is priced without Loudspeaker so that you can choose the type and size you prefer.

LASKY'S PRICE

Kit complete with new Mullard valves, full data, circuit diagram, assembly instructions and suggested layout.

56/- Post 5/-.

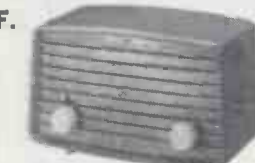
SPECIAL OFFER OF SPEAKERS WITH THIS KIT

Two 5in. for 20/-.
Two 6x4in. 25/-.

Suitable cabinets available to callers.

LASKY'S MIDGET T.R.F.

Handsome contemporary design case, overall size 8½in. wide, 4½in. deep, 5in. high. 2 latest double-purpose valves EBF80 and ECL80, contact cooled rectifier, 5in. P.M. speaker. For A.C. mains 200-250 v. med. and long wave, neat plastic cabinet in cream and pastel colours. FULL DATA, instructions, circuit diagram, shopping list, 1/6.



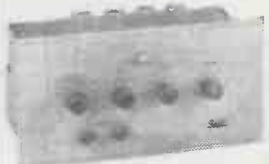
CAN BE BUILT FOR **£4.19.6** Post & Pkg. 5/-.

ALL TYPES OF CHASSIS

ARMSTRONG, DULCI, EMPRESS, etc. A.M. (1, m., s.) from... 7 Gns. A.M./F.M. from... 14 Gns. A.M./F.M. STEREO from 22 Gns.

SAVILLE STEREO & MONAURAL

For 200-250 v. A.C. main. New and fully guaranteed. Few only.



SAVILLE STEREO Pre-Amplifier and Control Unit. Uses two EF86 and two ECC81 valves. Separate controls, bass and treble, balance and switched selector for various inputs. List £15. Lasky's Price **8 Gns.** Post 3/6.



SAVILLE TWENTY

Main Amplifier and Power Unit. 20 watts nominal, 30 watts peak from "C" core distributed load stage. Freq. range: 34 c/s to 30,000 c/s ± 1 dB at 20 watts. Distortion at 1,000 c/s and 20 watts < 0.1%. Mains transformer will sustain 100% overload continuously. Power supplies for Tuner: 300 v. 50 mA. 6.3 v. 2.5 amp. 4 valves: 2 EL34 push-pull, ECC81, GZ34. List £27.

Lasky's Price **£14.19.6**

Carr. 9/6.

SPECIAL COMBINED OFFERS One Saville Twenty Amplifier and one Saville Pre-Amplifier and Control Unit, if purchased together, **20 Gns.**

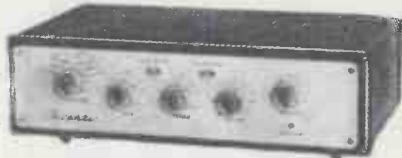
STEREO

Two Amplifiers and one Pre-Amplifier, purchased together, **32 Gns.**

Carr. & Ins. 12/6.

AVANTIC MONAURAL AMPLIFIER

For 200-250 v. A.C. mains. New and fully guaranteed. Very few left. Call or order without delay.



PL6/21. 20-watt MONAURAL AMPLIFIER and combined pre-amplifier control unit. Freq. response 40 c/s-15 Kc/s. ± 1dB. 5 inputs. Size: 13½in. wide, 8½in. deep, 3½in. high. LIST £29/8-. LASKY'S PRICE **19 Gns.** Carr. & Ins. 7/6.

SP21/2 Stereo Pre-Amplifier Control Unit. twin channel. Freq. response 40 c/s-15 Kc/s. LIST £28/10/-. Lasky's Price **£16.19.6** Carr. & Ins. 7/6.

SPA11 Stereo Amplifier and Pre-Amplifier. Twin 10 watts output. 3 inputs for each channel. LIST £29/8/-. LASKY'S PRICE **19 Gns.** Carr. & Ins. 7/6.

HI-FI SPEAKER SYSTEM

SPECIAL OFFER. Limited quantity only. ELAC Hi-Fi Speaker system comprising 10in. bass unit (woofer), 8x6in. enclosed middle range unit, and 4in. tweeter. LASKY'S PRICE, complete **49/6** Post 3/6.

TWO MATCHED SETS FOR STEREO **£5** post paid.

Units available separately:

10in. Bass Unit 27/6. Post 2/6.	8x6 Middle Unit 15/6. Post 1/6.	4in. Tweeter 12/6. Post 1/6.
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TAPE DECK & TAPE OFFERS

LIMITED NUMBER ONLY

The well-known MOTEK K10 Deck with push-button controls, 3 motors, 3-speed (1½, 3½, 7½ i.p.s.), rev. counter. Freq. response better than 40-12,000 c/s. at 7½ i.p.s. 2-tone grey finish. Listed at £22.

LASKY'S PRICE **£9.19.6**

Carr. and Ins. 7/6

Suitable case, callers only, 39/6.

GOLLARO STUDIO TAPE TRANSCRIBTOR.

3 motors, 3 speed 1½, 3½, 7½ i.p.s., takes 7in. spools. Push-button controls.

Lasky's Price complete with Tape and Spool **£12/19/6.**

Carr. & Ins. 12/6.

HIGH FIDELITY TAPE RECORDER HEADS

Leading make, new and unused. Upper or lower track. RECORD/PLAYBACK. high impedance. Double wound and will reproduce up to 12,000 c.p.c. at 7½ l.p.s. Azimuth adjustments. Output 5 millivolts at 1 Kc. at 7½ i.p.s. ERASE, low impedance. LIST £4 PAIR.

LASKY'S PRICE, per pair **29/6**

Post free.

Please specify upper or lower track.

SPECIAL OFFER!

Set of 4 heads (upper and lower track) **49/6**

PLASTIC TAPE SPOOLS

3in. 2/9	5in. 2/9	7in. 2/9	8½in. 5/6
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7in. Metal Spools, 1/9 each.

Post extra.

GOLLARO TAPE TRANSCRIPTOR

Mk. IV, fitted digital counter. List £25. Lasky's Price **£16/19/6.** Carr. & Ins. 12/6. Tape extra.

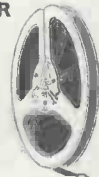
TAPE RECORDER PRE-AMPLIFIER

For use with Gollaro Studio Transcripator. Size 11½ x 5 x 3in. Uses 3 valves, tuning indicator, contact cooled metal rectifier. Incorporates mike/grm/radio inputs, ext. l.s. jack, superimposing switch. Complete with matching knobs (Gold/Black). Lasky's Price **9 Gns.**

Post 3/6.

SPECIAL OFFER OF TAPE

Famous make P.V.C. base on latest type plastic spools. Brand new, boxed and guaranteed, 1,200ft. on 7in. spool. **20/-**



1,800ft. on 7in. spool	32/6
1,200ft. on 5½in. spool	21/-
850ft. on 5½in. spool	16/6

SCOTCH PLASTIC TAPE 1,200ft. on 7in. spool **25/-**

M.S.S. LONG PLAY TAPE

1,800ft. on 7in. spool	39/6
1,200ft. on 5½in. spool	29/6
850ft. on 5in. spool	25/6
220ft. on 3in. spool	7/11

Post: 1 spool 1/6.

Orders over 60/- post free.

ALL MAKES OF TAPE. Long Play, Double Play and American "MYLAR."

RADIO · TELEVISION · HI-FI · ELECTRONICS · RECORDERS

4-SPD AUTO-CHANGERS

New and Unused in Maker's Cartons



- B.S.R. type UA8 £6 19 6
 - B.S.R. UA8, stereo £7 19 6
 - B.S.R. UA12, stereo £7 19 6
 - B.S.R. type UA14 £7 19 6
 - COLLARO Conquest, wired for stereo, with monaural p.u. £6 19 6
 - As above, Stereo £7 19 6
- Post on all above 5/-

**DRASTIC STOCKTAKING
REDUCTION TO CLEAR!**



Last few! "LIGHT" TAPE RECORDER for A.C. mains 200/250 v. Brand new and unused in maker's cartons. 2-speed, 3 $\frac{1}{2}$ and 7 $\frac{1}{2}$ i.p.s., twin track, 60 min. playing time at 3 $\frac{1}{2}$, 30 min. at 7 $\frac{1}{2}$. Inputs for mike and tuner, 5in. speaker, smart duo-tone blue/grey carrying case, 12 $\frac{1}{2}$ x 9 $\frac{1}{2}$ x 7 $\frac{1}{2}$ in. Weight approx. 6 $\frac{1}{2}$ lb.

SPECIAL CLEARANCE PRICE

£15.19.6

Carr. & Ins. 15/-

NOTE: Complete with 5in. spool of tape, empty spool, crystal hand mike and radio jack, absolutely ready for use. WORTH DOUBLE.

LIMITED QUANTITY ONLY.

**LASKY'S
RADIO**

STEREO ADAPTOR

CONVERTS ANY RADIOGRAM TO GIVE STEREOPHONIC REPRODUCTION

2-valve Amplifier using EF80X and EL84 metal rectifier (full-wave bridge). Mains voltage 195-250, 50/60 c.p.s. Ganged volume control and ganged tone control.

CAN ALSO BE USED AS A SINGLE-END AMPLIFIER.

LASKY'S PRICE complete with printed circuit, circuit diagram, full service data and 2 new 59/6 valves. Post & Pkg. 3/6.

AMPLIFIER BARGAIN

6-watt, employing 4 valves: EX80 rect., ECC83, feeding two E184 in push-pull. Separate control unit with bass, treble and volume controls. Size of chassis: 4 $\frac{1}{2}$ x 4 $\frac{1}{2}$ x 12in. Complete with 4 new Mullard valves.

LASKY'S PRICE **85/-**
Post 4/6.

GRAM AMPLIFIER

Uses two valves, ECL82 and EZ80 find separate mains transformer to minimise hum. Incorporates Elac 8x5in. loudspeaker with output transformer mounted. Size of printed circuit 4 x 3 x 2 $\frac{1}{2}$ in.

Lasky's Price **59/6** Post 3/6.

MINIATURE POCKET TRANSISTOR RADIOS

Large selection of various well-known makes at money-saving prices. Call and select or write for latest Bargain List.

TRANSISTOR RECORD PLAYER

CAN BE BUILT FOR

£9.19.6

Carr. free



6 v. operation. For all L.P. and standard records. All components available separately.

AMPLIFIER

300 milliwatts push-pull output, using two OC71 and two OC72 transistors. Fully assembled, 79/6. Knobs 3/6 extra.

LOUDSPEAKER

30 ohms, 7x4in. elliptical matched to Amplifier, 25/-.

3-SPEED TURNTABLE

6 v., with rubber mat and speed adjustment, complete with t.o., crystal cartridge and two sapphire stylo. 79/6.

CARRYING CASE

As illustrated, handsome two-tone finish. 17in. deep, 14in. wide, 5 $\frac{1}{2}$ in. high. Well made and finished. 49/6. Batteries extra.

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RC.88 STEREO	£12 19 6
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Auto start and stop. Complete with pick-up and crystal cartridge.
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ACOS HGP.59 or HGP.37 turnover, crystal cartridge with L.P. and standard styli. List 39/7.
Lasky's Price 18/- post free.

ACOS 73-1A STEREO. List 52/6.
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LASKY'S F.M. TUNER
PRINTED CIRCUIT VERSION OF G.E.C. 912 "F.M. PLUS" TUNER FOR HOME CONSTRUCTION
CAN BE BUILT FOR **7 Gns.** (including valves)
Post free. Details on request.

THE 'VANCOUVER'
3-TRANSISTOR POCKET RADIO
Employs 3 transistors plus germanium diode, on printed circuit size 3 $\frac{1}{2}$ x 4 x 1in. Tunable over medium and long waves. Built-in Ferrite rod aerial.
CAN BE BUILT FOR **39/6** Post 1/6.
Circuit diagram and step-by-step instructions, 1/6 (free with parcel).



P.M. SPEAKERS
3 $\frac{1}{2}$ in. 4in. 5in. 6 $\frac{1}{2}$ in. 8in. 10in.
17/6 19/6 14/6 16/- 16/6 25/-
12in. 27/6. **ELLIPTICAL:**—
7x4 9x6 10x2 $\frac{1}{2}$ 10x6 10x7
14/6 22/6 25/- 25/- 25/-
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TAPE RECORDER OFFER!**

Complete Tape Recorder using Collaro Studio 3-speed deck, 1 $\frac{1}{2}$, 3 $\frac{1}{2}$, 7 $\frac{1}{2}$ i.p.s. Twin track with pause control, rev. counter, latest type electronic recording indicator. Superimposing switch, volume and tone controls, 7 x 4 loudspeaker. 4 watts output. Takes 7in. spools.
In contemporary design carrying case, 9 $\frac{1}{2}$ x 16 x 16in. Brand new, fully assembled, ready for use.



LASKY'S PRICE
COMPLETE WITH MIKE
TAPE AND SPOOL **29 Gns.**
Carr. & Ins 25/-

LIMITED QUANTITY ONLY
NEW AND UNUSED 17" TV CHASSIS



200-250 v. A.C./D.C. Complete with 13 new Brimar valves, latest Fireball turret tuner covering all channels bands I and III (i.f.33-38 Mc/s.). Ferroxcube line output transformer and wide angle 90° scanning coils, ion trap, latest electrostatic focus. All first quality components Overall dimensions 8x15 $\frac{1}{2}$ in.

Valve line-up:
3 PCF80, 1 PCC84, 3 B6W7, 1 PCL84, PCL82, PY82, PL81, PY83, EY51.

LASKY'S PRICE **£18.19.6** Carr. & Ins. 7/6.

BRAND NEW BRIMAR 17in. C.R. TUBE, C17SM. 3-amp. heater, electrostatic focus. 12 months' guarantee.
LIST 10 gns. Lasky's Price £6/19/6. Carr. & Ins. 12/6.

SPECIAL COMBINED OFFER. **£23.19.6** Carr. & Ins. 19/6.
CHASSIS & NEW BRIMAR C.R.T.

A few cabinets available to callers.

"LINEAR" AMPLIFIERS
"DIATONIC" 10-14 watts 12 Gns.
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L45 4-5 watt Amplifier... 25/19/6
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GARRARD 4HF, stereo or monaural, complete with plug-in head **£18.9.0**
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Also Lenco, Connoisseur, etc.

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LASKY'S RADIO

G.R. TUBE BARGAINS NEW AND UNUSED



FERRANTI. 12in. types T12/44 or 9in. type T9/3 4 v. heater.

LASKY'S PRICE 49/6
Carr. & Insur. free.

FERRANTI 17in. type TR17/10, 6.3 v. 3 amp. heater. Brand new and unused.

LASKY'S PRICE £6.19.6
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16in. **METAL CONE**, famous make, type T901/A, 6.3 v., 0.3 amp. heater. **£6.9.6**
Carr. & Insur. 21/-.

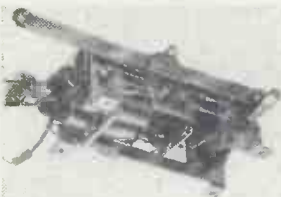
17in. 90 degrees G.R. TUBES

Seconds but in perfect working order and guaranteed.
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Type	From	& Ins.
12in. round	£5 10 0	12/6
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CAR RADIO COIL PACK (Superhet, I.F. 465 Kc/s)



As used in many famous makes car radios. A permeability tuned Coil Pack covering medium and long wavebands, with tuned R.F. stage and complete with dial and pointer. Needs no ganged condenser. Its compact construction and small size, 7 1/2 x 5 x 1 1/4 in. enables it to be used in the smallest of car radios.

LASKY'S PRICE 49/6
With circuit diagram and full data. Post 2/6.

20,000 VALVES IN STOCK
Mullard, Brimar, G.E.C., Mazda, Cossor, E.M.I. Philips, Pinnacle, Telefunken, etc. Send for our latest Valve List.

SUB-MIN RESISTORS, 1/4th watt, most values available. Each 3 1/2d. Per doz. 2/6.

CONDENSERS, RESISTANCES. High stability Resistances, Electrolytics. All values and sizes stocked.

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EVERYTHING FOR HOME CONSTRUCTOR & SERVICEMAN MANY BARGAINS IN MULTI-TEST METERS

All new and guaranteed unused.



The **KAPURA** MdI. **U1. MULTI-RANGE TEST METER**, incorporating 3in. rectangular meter.

Sensitivity: 1,000 ohms per volt A.C. and D.C.

Ranges: (A.C. and D.C.) 0-10-50-250-500-1,000 v. D.C. current 0-100-500 m/a. 0-1 m/a. (used at 0-10 v. range).

Resistance: 1-2,000 ohms (centre 24 ohms). 100-200,000 ohms (centre 2.4 k.).

Size: 5in. x 8in. x 2 1/2in. Weight: 22 ozs.

Fully guaranteed. **LASKY'S PRICE** 59/6
Complete with test leads. Post & Pkg. 3/6

AN/20. Famous make pocket, size 18-range multi-test meter for amateur or service engineers 5,000 ohms per volt A.C. and D.C. with accurate linear scales for the lower A.C. range. In black leatherette-covered case. 3 1/2 x 3 1/2 x 1 1/2 in. deep. LIST 9 gns.

LASKY'S PRICE 99/6
Post 3/6. Leads 3/6 extra.



AN/27. Accurate, highly sensitive 27-range Test Meter by famous maker. 5,000 ohms per volt A.C. and D.C. In

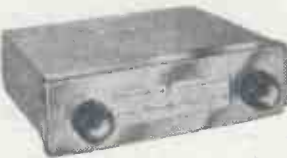
black-leatherette-covered wood case, 7 1/2 x 9 1/2 x 3 1/2 in. deep, with carrying handle and ample room for small tools as well as leads. An ideal multi-range meter for all general purposes. LIST 15 gns.

LASKY'S PRICE £8/19/6
Post 5/-.

Leads, 7/6 extra.

VERY LIMITED QUANTITY

LABGEAR A.F. POWER METER KIT. Two ranges: 25 milliwatts to 1 watt; 1 watt to 10 watts. Accuracy 5% and matched for 3, 15 and 600 ohms. Dimensions: 4 1/2 x 6 1/2 x 3 1/2 in. **COMPLETE KIT** with clear step-by-step instructions, circuit, data. **59/6** Post 1/6.



LASKY'S CAR RADIO CAN BE BUILT ABSOLUTELY COMPLETE FOR £11/19/6
Post free.

- ★ Small size. Will fit any car.
- ★ 12 volt operation.
- ★ New Hybrid circuit.
- ★ Transistor output.
- ★ New Type Brimar valves.
- ★ No vibrator 12 volt H.T. & L.T.
- ★ T.C.C. Printed Circuit and Condensers.

- ★ Tuned R.F. stage.
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 - ★ 7in. x 4in. elliptical speaker.
- Instruction Booklet giving full details, illustrations, dimensions, circuit diagram and shopping list 2/6 (returned if you order).

SEND FOR LASKY'S COMPONENTS CATALOGUE OVER 100 ILLUSTRATED PAGES, SIZE 8 x 5 1/2 in.

Price 2/- Post 6d. Latest 12-page BARGAIN BULLETIN included free.

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★ 12-CHANNEL TURRET TUNERS ★

Large selection, many by famous makers such as Cydon, Brayhead, Plessey, Cossor, etc., all I.F.s. New and unused. Let us quote you for the model required. Examples: 33-38 mc/s., 29/6, 6-9 mc/s., 59/6. 9-14 mc/s., 59/6, 14-26 mc/s., 59/6.

TRANSISTORS

P.N.P. Junction types.

AUDIO, suitable for high gain and low freq. amplifiers, and for output stages up to 250 milliwatts. Double spot—yellow and green. Each 5/-

R.F. suitable for medium and low freq. oscillators, freq. changers and I.F. amplifiers (1.5 to 8 Mc/s.). Double spot—yellow and red. Each 7/6

Type T51. Suitable for all audio applications. Post 6d. 3/6

One dozen 35/- post free.

Special prices quoted for large quantities. Enquiries invited.

0044 15/-; 0045 15/-; 0070 8/6; 0071 8/6; 0078 15/- (Matched Pair 30/-); 0079 13/-; 0010 54/-.

EDISWAN MAZDA TRANSISTORS. The very latest types: XE 102 10/-; XB/103 10/-; XC/101 12/6; XA/101 15/-; XA/102 17/6.

SPECIAL OFFER. Set of 7 Ediswan Transistors: XA/101, XA/102, 2 XB/102; XB/103, 2 matched XC/101. Price 59/6.

CRYSTAL DIODES. General Purpose 0.1X00, each 1/- Per doz. 9/- All other types in stock.

"GOLTO" POWER TRANSISTORS

All types in stock. Example: V15/10P. Ideal for output stage of car radio, will give approx. 3 watts operating from 12 v. Each 15/-, post free. Multi-tube Output Transformer for above, correct ratio, matched to 3 ohms. 9/6. Post 1/-.

Driver Transformer, 9/6. Post 1/-.

MINIATURE EARPHONES FOR POCKET TRANSISTOR RADIOS

High quality and remarkably sensitive, giving clear reproduction of music as well as speech. Lightweight and comfortable to wear. Supplied complete with transparent ear-insert. 3ft. cord, sub-miniature jack and socket. Fully guaranteed.

MdI. **GR.5.** Crystal Earpiece, high imp. 12/6
MdI. **MR-4.** Magnetic Earpiece, low imp. 10/-
Post free.

SUB-MIN. COMPONENTS FOR TRANSISTOR RADIOS

As used in the smallest Japanese pocket transistor radios. Coils, Loudspeakers, I.F. transformers, Ganged Condensers, etc., now available from stock at lowest prices. Also in stock, all T.S.L. transistorised Miniature Units.

OPEN ALL DAY
SATURDAY

Early Closing
Thurs., 1 p.m.

(Both addresses)

SEE OVERLEAF FOR MORE NEWS FROM LASKY'S RADIO



CRYSTAL CALIBRATOR No. 10
A crystal controlled heterodyne wave-meter covering 500 Kc/s. to 10 Mc/s. (Harmonics up to 30 Mc/s.) Requires 300 V. 15 mA. and 12 V. 0.3 A. D.C., but can be easily modified for 120 V. and 1.4 V. working. Size 7 x 7 1/4 x 4 in. Good condition, complete with valves, crystal, instruction manual and circuit. **ONLY 59/6.** Post 3/6. This item available complete as above.

BRAND NEW and with spare set of valves. £4/10/-, post 3/6.

CANADIAN CRYSTAL CALIBRATOR. Uses double crystal and multi-vibrator circuit to give "pips" at 1 Mc/s., 100 Kc/s. and 10 Kc/s. Incorporates Modulator. With book. **79/6**, post 2/6.

TRANSMITTER TYPE 36. A complete 50 watt TX for phone or CW. Covers 10-40 Mc/s. (10-15-20m.) Crystal or stabilised VFO. Push-pull 807's plate and screen modulate parallel 807's. Tested and ready to plug into AC mains. Complete with 16 valves, handset, operating instructions and circuit. Wooden cabinets may be somewhat damaged. **£15.** Carr. England and Wales £2.

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 1/6.

MATCHING TRANSFORMER (for Hi impedance) i.e. for HRO, CR100, etc., with standard jack plug, 4/6.

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.

"C" CORE TRANSFORMERS. Pri. 230 v. 50 c.p.s. 510-0-510 at 275 mA. 375-0-375 at 83 mA. 6.3 v. at 9 A. 6.3 v. at 2A. (twice), 6.3 v. at 1A. (twice), 6.3 v. at 1.5A. 6.3 v. at 0.5A. 5 v. at 3A. 6.3 x 6 x 7 1/2 in. high. Weights 25 lb. Removed from equipment but in perfect condition. **32/6.** Carr. 5/6.

ADMIRALTY HT 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/-.

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 3 1/2 x 3 1/2 x 3 1/2 in. high. **15/-.**



TRIPLET METER MOVEMENT

This article consists of a basic 400 microamp meter movement mounted on a Bakelite panel 5 1/2 x 2 1/2. The dial is scaled as a 15 range Testmeter. A circuit and parts list of the original instrument is supplied.

BRAND NEW. Boxed. 35/-, post paid.

QQVO6-40 37/6
PVI-35 32/6, 2D21 7/6, OC3 6/-, PT15 12/6, CV51(Y65) 5/-, 6F33 5/-, 2050 W. 7/6, 5126 £10, 5670 5/-, FW4/500 7/6. **BRAND NEW** in individual cartons. Bulk enquiries invited.

CANADIAN RECEIVER No. 52
1.75-16 Mc/s (19-170 m.) in three wavebands R.F., Mixer, Sep. Osc. 2 I.F.'s, Det/A.V.C., 1st Audio, Output, BFO (10 valves), plus a 3-valve dual Crystal Calibrator. Controls: R.F. Gain, L.F. Gain, Crash Limiter, C.W. Filter, Variable Selectivity, Slow and Fast Tuning and Osc. Vernier Tuning. Man. or A.V.C. BFO pitch control. Internal 3in. speaker and valve check meter. Power supply required 160 v. H.T., 12 v. L.T. Data and Circuit supplied. A really excellent receiver, £8/19/6, carr. 15/6. Power supply Unit, 59/6, carr. 5/6.

SEARCH RECEIVERS
Type AN/APR4. Covers 38 to 1000 Mc/s. with 3 Plug-in R.F. Heads. TN 16 (38-95 Mc/s.), TN 17 (74-320 Mc/s.) and TN 18 (300-1000 Mc/s.). Self-contained power supply for 115v. 50-2,600 c.p.s. Thoroughly reconditioned as new. In 100 per cent. mechanical and operational order. **£100.**

MARCONI CR100
Still one of the finest surplus communication receivers. Ready for immediate use on A.C. mains. Of new appearance, completely overhauled and in perfect working order. Later model with noise Limiter, **£25.** Carr. England and Wales 30/-. Send S.A.E. for full details.

RECEIVERS R-1155B
A first-class 10-valve Communications receiver, covering 75 Kc/s. to 18 Mc/s. (1.62-4,000 m.) in 5 bands. The large scale and superior dual ratio slow-motion drive make tuning easy and the R.F. stage and 2 I.F. stages ensure world-wide reception. All the receivers we sell have been thoroughly overhauled, completely realigned and are in first-class working order. **ONLY £9/19/6.**

A.C. MAINS POWER PACK OUTPUT STAGE. In handsome black crackled steel cabinet to match the R-1155. Fitted with RCA 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 unit together. Send S.A.E. for further details or 1/3 for 10-page illustrated booklet giving technical data and circuits etc. (Free with each receiver). Add 10/6 carriage for receiver, 5/- for power unit.

RCA AR-88 SPEAKERS
A high quality 3 ohm unit fitted into heavy gauge black crackled steel cabinet, size 10 1/4 x 11 1/4 x 6 in. Fitted with rubber feet and 6ft. lead. Ideal for extension speaker. CR 100, etc. In original cartons. **BRAND NEW, 45/-.** Post 3/6.

MINIATURE 373 IF STRIPS. 9.72 Mc/s. For FM tuner described in "Practical Wireless." Complete with 3 of EF91, 2 of EF92 and 1 of EB91. A fresh release enables us to offer these once again. **BRAND NEW.** Complete reprint of conversion instructions and circuit supplied free. **27/6.** OR less valves 12/6. Post, either, 2/6.

LOUD-HAILER EQUIPMENT
IDEAL FOR CROWD CONTROL, FACTORIES, FETES, ETC. CONSISTS OF 4 SPEAKER UNITS AND CONTROL UNIT. COMPLETE WITH MICROPHONE, HEADPHONE AND SPARES. OPERATES FROM 12 VOLTS D.C. (OR 6 VOLTS A.C. WITH SLIGHTLY REDUCED OUTPUT) CONSUMING ONLY 3 AMPS. OUTPUT POWER 8 WATTS. ALL TESTED AND WORKING, BUT SLIGHTLY SOILED. A GENUINE BARGAIN. **£4/18/6.** CARRIAGE 25/6.

T.C.C. VISCONOL CONDENSERS. 8 mfd. 800 v. D.C. wkg. at 71 deg. C. CP152V. Size 3 x 1 1/2 x 5 in. high. **BRAND NEW.** Boxed 8/6 each, post paid. 4 mfd. 600 v. wkg. CP 130T, 4/6 each, post paid.

MINIATURE RELAYS (ALL BRAND NEW AND BOXED)
G.E.C., sealed, wire ends, 670 2M2B H/D M1095 8/6
G.E.C., sealed, wire ends, 670 Ω, 2 H/D makes, M1099 ... 15/-
G.E.C., sealed, wire ends, 5,000 Ω 2 c/o., plat., M1052 17/6
Siemens High Speed, 1K+1K Ω, 1 c/over 10/6

GIANT COMPONENT PARCEL
Contains 100 1/2 and 1 watt resistors, 50 Hi Stab resistors, wire wound resistors, carbon and W/W pots, 100 capacitors (mica, paper, Sprague, bias, variable, etc.), valveholders, tag strips, metal rectifiers, sleeving etc. All components are unused. **GUARANTEED VALUE, 25/-** plus 2/6 post.

CHARLES BRITAIN (Radio) LTD.
11 UPPER SAINT MARTIN'S LANE
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Near Leicester Sq. Station. (Opposite Thorn Day House)
Shop Hours: 9-6 p.m. (9-1 p.m. Thursdays). Open all day Saturday.

BC221 FREQUENCY METER
125 kc/s. to 20 mc/s.
£16/-/-

This crystal controlled heterodyne frequency meter is too well known to need further description. Those we offer are complete with correct individual calibration books and are carefully tested and guaranteed. Condition is very good.

CALLERS' CORNER

We have a large number of items which are remnants of lines previously advertised. The quantities remaining are either too few to warrant a further advert, or the articles may be slightly incomplete or require some servicing. We aim to dispose of these at give away prices.

Examples:—Multimeters from 50/-. A.C. mains power packs from 10/-. Valve testers from £5. Receivers from 50/-.

DON'T MISS THIS CHANCE

MARCONI IMPEDANCE BRIDGE. Type TF373. Measures, L, C & R at 1,000 Cycles. Accuracy 1%. 0-100Ω; 0-100μF; 0-1MΩ each in 5 ranges. Power Factor and "Q." Guaranteed **£5.**

HALLICRAFTER VIBRAPACK. Input 6 v. output 300 v. at 170 mA. Designed for 5X28 or 5Z7. Size 6 1/2 x 7 x 7 in. **BRAND NEW, BOXED. 29/6.** Carr. 3/6.

PHILIPS RADIATION MONITOR. Type 1092C. A portable self-contained instrument for measuring radio-activity, uses the Mullard MX-115 Geiger counter tube, and is scaled 0-10 milli-Rontgens per hour. Supplied complete with carrying haversack. **BRAND NEW. £17/10/-.** Carr. 5/-. Other types of radiation monitoring equipment in stock.

MARCONI TF987/1 NOISE GENERATORS. Range 100 Kc/s. to 200 Mc/s. Determines noise factor of AM and FM receivers. Fully stabilised H.T. supply A.C. mains operation. Brand new and in original boxes. **£15.** Carr. 7/6.

HEAVY DUTY SLIDER RESISTORS. 1.25Ω 20 A., 12/6, post 3/6. 1Ω 12 A., 8/6. **PRECISION RESISTORS.** A Megohm. 1% 1 watt wire wound, Ex-U.S.A. **BRAND NEW. 10/6** per dozen.

D.C./A.C. CONVERTERS. Input 12 v. D.C. Output 230 v. 50 c/s. A.C. at 135 watts. Fitted with 0-300 v. A.C. 2 1/2 in. meter and slider resistor for voltage adjustment. In stout wooden carrying case with lid. Perfect working order. **£9/19/6.** Carr. 10/6. 24 v. Input 230 v. A.C. 50 c/s. 100 watts output. In grey metal case. **BRAND NEW. 92/6.** Carr. 7/6.

SANGAMO WESTON ANALYSER E772. A useful multi-range meter. Thoroughly overhauled and in perfect working order. For full details see previous adverts. **£7/10/-.** Carr. 4/6.

MICROAMMETERS

R.C.A. 0-500 microamps. 2 1/2 in. circular flush panel mounting. Dials are engraved 0-15, 0-600 volts. As used in the American version of the No. 19 set. **BRAND NEW.** Boxed. 15/-.
American 0-100 microamps. 2 1/2 in. square flush panel mounting. **BRAND NEW.** Boxed. 42/6.

MULTIMETERS

1,000 Ω/Volt A.C. and D.C. volts 0-10, 50, 250, 500 and 1,000. D.C. current 0-10, 0-100 mA. Ohms 0-2,000, 0-200K. Bakelite case size 5 1/2 x 3 1/2 x 2 1/2 in. Fully guaranteed with test leads, prods and internal battery. **59/6**



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and MAIL ORDER SERVICE

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PRECISION AM/FM SIGNAL GENERATOR CT12



Highly stable, laboratory standard, Services Test Oscillator of modern ruggedised design in fully sealed cast case 12 x 11 x 8in. Operating from 110-115 v., 220-250 v. mains, or 12 v. D.C., it covers 85 kc/s to 32 Mc/s in seven directly calibrated bands with high-ratio slow-motion tuning.

FACILITIES:

- Variable RF carrier and AM and FM modulation levels, with calibration level shown on meter.
- Variable FM deviation from 0 to 35 kc/s (FM coverage 2 to 32 Mc/s).
- Variable output from 10,000 to 1 μ v. in 50 switched steps of precision attenuator (also calibrated in dB).
- Seven miniature B7G valves: 4 EF91 television pentodes, EL91, QS150/15 for

- stabilised HT, EZ90 rectifier, and 12 volt non-synchronous vibrator. A.C., D.C., and HT fuses.
- Co-axial output load with 75 and 7.5 ohm terminating pad, A.C. and D.C. mains leads, spare fuses, etc., stowed in lid.
- High level modulation output from separate terminals.

NEW, GUARANTEED, £27.10.0
at the remarkable price of
(carriage 15/- England and Wales).

RF EHT POWER UNIT 846

A small, very neat, lightweight unit of most modern construction providing 1000 volt DC from rectification of self-generated AC. Unit employs a 6C4 oscillator and an EY51 EHT rectifier and incorporates its own HT and EHT smoothing. Requires only 12 or 24v DC for filaments and 250 volts of raw AC to provide the EHT for an oscilloscope etc. Unit also contains a 616 arranged as an independent multi-vibrator with its inputs and outputs connected to a Breeze multi-socket on front panel. Size: 4½ x 5½ x 5½in.

Brand New, complete with valves and circuit . . . **25/-** post paid.



MAINS TRANSFORMERS

200-250 volt 50 c/s. post paid

Type	Price
1. 250-0-250 at 70mA. 6.3v. at 2A. 4v. at 2A.	10/-
2. 300-0-300 at 70mA. 6.3v. at 2.5A. 5v. at 2A.	10/6
3. 350-0-350 at 120mA. 6.3v. at 3.5A. 5v. at 2A.	17/6
4. 350-0-350 at 300mA. 6.3v. at 8A. 5v. at 2A. plus 4v. at 2A. and 6.3v. at 2A.	27/6
5. Filament only: 6.3v. at 4A.	8/-

WALKIE-TALKIES Type 46

This is a later type than those previously available. A really serious job of sound design, crystal controlled, 10 mile range, transmitter and receiver covering any one frequency between 4125 and 7100 kcs in 25 kcs steps with standard crystal supplied—or any spot frequency between 3600 and 9000 kcs with special crystal supplied to order. Brand new, complete with headphones, throat mic., whip-antenna, plugs and leads. Size: 12 x 4 x 6½in. Weight 8½lb.

Price, with standard crystal . . . **£3/10/0** carriage paid
with chosen spot frequency crystal . . . **£7/15/0** carriage paid
Batteries required: 150, 15, and 3 volts. Transistorised converter to operate from 6v. or 12v. D.C. . . . **£8/10/0** extra

Cold Cathode Trigger Tubes

A sub-miniature cold cathode valve developed by Ericsson primarily for computer work, these GTR.120W tubes have great possibilities in a number of experimental electronic automatic control circuits. They have an Anode-Cathode running voltage of 95 to 140 at 4.5 mA, and at 290 anode volts require a trigger current of only 250 microamps to cause the anode to take over the discharge. Typical ionization time=90 microseconds. They will withstand up to 310 v. with zero trigger voltage without self-igniting.



Supplied complete with full performance data in original packs of 100 at the Special Price of **£5** per 100 post paid.

ETCH-YOUR-OWN PRINTED CIRCUIT SETS 21/-

Each contains over 60 sq. in. of laminated board and sufficient chemicals to make dozens of printed circuits, plus comprehensive instruction book giving advice and examples on translating theoretical circuits into layouts ready for etching. High-quality materials—completely safe to handle—carefully prepared to ensure fine definition and uniform results without laboratory control.

NOMATRON DECADE COUNTER TUBES



STC Type G10/241 latest type cold cathode, gas-filled, single pulse, uni-directional decade counter which illuminates numerals on tube face. Operating range—20 kc/s. Cathode output 40 volts, 3.7 mA. HT supply 310 v. plus. Applications include: tachometers, counting and batching, frequency and time measurement, direct operation of electro-magnetic relays, sequential monitoring of up to 10 different waveforms, etc. Brand New, complete with special base and instructions. **32/6** post paid.

VENNER TIME SWITCHES



Type T.S.2, first grade precision time switches as supplied to G.P.O. Comprises absolutely silent, self starting, 250 volt 50 c/s synchronous clock mechanism totally enclosed in heavy gauge brass case. Central drive takes detachable dial that revolves to operate sensitive on and off trips for external mains operated circuit. Self contained clock is easily detachable from rear mounting panel (self starting down to 80 v. and keeps running down to 15 v.). Brand new, in original packings, and with dial and adjustable stops. **37/6** post paid

TELEVISION OSCILLOSCOPE

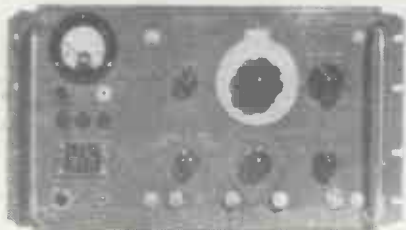
Release of a small quantity of the latest version of the well known APN-4 Indicator Unit from the American Loran Airborne radio navigation system. This provides a golden opportunity to make a serious television servicing and development tool as described in the *Wireless World*. This is a nice looking piece of equipment with a really businesslike inside. Steel, double-decked chassis with fully screened 5CP1 tube in the centre, all high-grade capacitors and resistors, separate tag boards and layout diagrams for individual sections, etc. Modern circuit technique centred around one type of valve (14 of 6SN7 double-triodes and 8 of 6H6, plus three 6E7 and one 6SJ7), and RCA. 100 kcs Crystal. Brand New, with W.W. Circuit for conversion **£6.10.0**



CRYSTALS 2,800 to 9,800 kc/s

British 10X Type. ½in. pin spacing.
Huge range of frequencies from 2,000 kc/s-9,800 kc/s.
All Ham Band frequencies 8/6 each. Other frequencies 6/6 each.
Orders under £2, P. & P. 1/6, over £2, post free.

PRECISION SIGNAL GENERATOR CT53. A modern laboratory standard instrument still in current use



FEATURES

- Vernier tuned, Triple screened, 6-Band coil turret covering 8.9 to 300 Mc/s with 72 ohm output from 100 mV down to 1 μ V.
- Precision decade ladder and silver slide wire attenuator calibrated in voltage and 0-90db.
- Variable carrier level monitored by cathode follower and VTVM.
- CW or modulated 30% by 1,000 c/s Sine or Square wave (variable mark/space ratio).
- External mod. by sine wave from 50 c/s to 10 kc/s. or pulses down to $\frac{1}{2}$ μ Sec.
- Seven B7G Valves, Potted "C" core transformers, Paper capacitors, Stabilised H.T.
- Selected spare oscillator, pre-aged spare monitor, 100 μ A meter.
- Mains, H.T., Bias and Filament supplies fully RF-filtered.
- Combined cabinet/rack mounting case, Pressure sealed, Desiccator, Panel Mains voltage adjustment, Triple fused, in fact, "the lot"

Offered straight from Service use, complete with calibration book, cables, circuit diagram and principal technical information, checked serviceable and fully guaranteed.

£17.10.0

Plus 15/- for careful packing and carriage

BEAM-ECHO AVANTIC KITS

S.P.A.11 combined stereo control unit and power amplifier complete to the last nut and bolt, with specially prepared assembly instructions, full circuitry and wiring diagrams, plus a full copy of the handbook. **ONLY A FEW LEFT. — £11 plus 7/6 carriage.**



High Quality Power Pack

Admiralty Rectifier Unit Design 95, totally enclosed in heavy gauge attractive light grey case size 11 $\frac{1}{4}$ in. high x 6in. wide x 14in. deep. Admiralty ratings: transformer 400-0-400 at 50mA, 6.3 v. at 1 Amp, 5 v. at 3 Amp for 5U4G. Insulation tested to 3 kV. Two 350 ohm 20 henry 80 mA chokes; Two 4 μ F at 600 v. ceramic terminal square canned paper smoothing capacitors. Double pole mains switch, two 2A fuses and two spares all in screw-in holders on front panel. 3-pin 250 v. 50 c/s

mains input, and 3-pin output with matching plug on short screened cable providing 400 v. D.C. and 6.3 v. A.C. with common earth. An unusually neat, attractive, high quality unit. Brand New, still boxed

for only **50/-** carriage paid.

Brand New, Individually Tested, Fully Guaranteed

LOW-VOLTAGE, HALOGEN-QUENCHED, GEIGER-MUELLER TUBES 25/- post free

Working voltage 400-450. Highly sensitive. Effective length 11.8 cm. Background count 90/minute. Response 30,000 counts/minute. 80-volt plateau. Standard British 4-pin base, stainless iron electrode. Ideal for basic experimentation and instructional demonstration. Circuits of simple all transistor and conventional valve counter circuits supplied on request with each tube.



VARIABLE SPEED HYDRAULIC GEARBOX

This specially made oil-filled casing houses an hydraulic torque conversion unit originally precision made by Westinghouse from high quality materials for the U.S. Government at an acquisition cost exceeding £150 each. Highly suitable for lathe head drive, workshop variable speed power take-off, etc.

Basically the unit is a back-to-back mounted, oil submerged, variable displacement hydraulic pump (input shaft) feeding a reversible hydraulic motor (output shaft) so that variation of the pump displacement by manual control gives very fine selection of output speed from zero up to 6% below input speed while a changeover valve in the supply lines to the motor provides instantaneous reverse at any speed. Recommended input speed 500-1,000 r.p.m., maximum power 1 $\frac{1}{2}$ h.p. Both shafts $\frac{1}{2}$ in. dia. with Woodruff key. Tested and fully guaranteed, supplied complete with technical data and performance curves for the remarkable price of £16 only, carriage paid.

ANTENNA INDICATOR

Remote indication to within 1° on precision instrument type flush fitting black crackle indicator with 3in. dial calibrated in 2° steps plus the four cardinals. Simple D.C. wiring (6-30 volts) from specially wound potentiometer in sealed die-cast housing with $\frac{1}{4}$ in. drilled spindle transmits accurate signal of horizontal or vertical bearing. Brand New, Post Free, 35/-

POST FREE SNIPS

- Double pole knife changeover switch on porcelain base. 2 for 5/-
- Pyrex Aerial Insulators. Four 3in. OR one 8in. 7/6
- U.S.A./British co-ax. adaptors. Four for 5/-
- Neons. Ten 115 volt for 12/6; Six 80 volt for 7/6
- G.P.O. electro-mechanical counters. 0-9999 7/6
- Bulgin Type M microswitches, new 4 for 11/6

B.C. 221 FREQUENCY METER

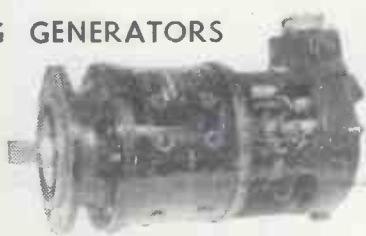
125 kc/s to 20 Mc/s WITH CALIBRATION BOOK in first-class working order, £19 10s. carr. 10/-.

CATHODE RAY TUBE

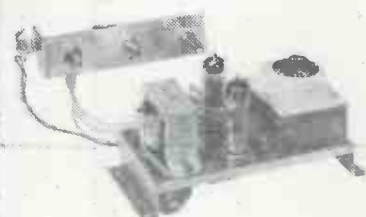
VCR 139. (Cossor 23D Equiv.). 2 $\frac{1}{2}$ in. dia. Tube. New in original cartons. 17/6 Post Paid.

200 amp WELDING GENERATORS

Relatively small, but really heavy-duty aircraft quality six-pole shunt-wound self-excited generator with six interpoles delivering 30 volts at up to 200 amps. Requires 8/10 h.p. between 600 and 3,300 r.p.m., clockwise or anti-clockwise rotation according to position of changeover links. Are very successfully driven from tractor take-off pulley or the like. 13in. long, 7in. dia. Weight 57 lb. **£6.15.0** Carriage paid (U.K. only).



8 WATT HI-FI PUSH PULL AMPLIFIER



Separate control panel 6" x 1 $\frac{1}{2}$ ". Volume/On-Off switch, Bass and Treble Boost controls and Pilot light. Amplifier Chassis 3 $\frac{1}{2}$ in. x 8in. x 4in. 2 x ECL82 in Push-Pull. Output transformer matched 3 and 15 ohms. 110-220-240V. A.C. with 6 \bar{x} . mains lead. All units guaranteed ready for installation.

£5.10.0 plus 5/- Carriage

PROOPS

BROTHERS LTD., 52 Tottenham Court Road, London, W.1.
Head Office and mail order enquiries LANgham 0141
Shop hours 9 a.m. to 6 p.m. Thurs. 9 a.m. to 1 p.m. **OPEN ALL DAY SATURDAY**

CLYNE RADIO LTD.



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NORTH 6295/16/7

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Open: Tottenham Court Rd., and
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Our advantageous H.P. and Credit
Sole Terms are available on any single
item over £5. Your enquiries invited.
Please print your name and address!!

CLYNE RADIO ELECTRONIC ORGAN



Fibre Glass
Console
now available

Readers will no doubt be pleased to know that our working model of this amazing organ for home construction, may be heard and seen at our Hi-Fi Showroom in Tottenham Court Road, W.1. For the benefit of constructors all components, key-boards, chokes, etc., are available ready made. Full constructional details are available in book form at 15/- plus 1/6 p. and p. We shall be happy to forward a complete price list on receipt of a stamp. Please address all organ enquiries for the attention of Mr. L. Roche.

CLYNE CATHODE RAY OSCILLOSCOPE for Home Construction

(37)

A recent addition to our comprehensive stocks of quality equipment for the constructor. This is an exceptionally sound and robust instrument of the most versatile type, that will be a boon to the seriously minded amateur, serviceman or constructor. Specifications: 8-Range Time Base, switched from 20 c/s to 160 Kc/s. Y-Plate Amplifier has a sensitivity of 50 mV. and frequency response of 20 c/s to 600 Kc/s with a gain of 150. A calibrating voltage of 6.3 v. 50 c/s. is provided. Employs ECR30 2 1/2 in. Cathode Ray Tube and 4 valves: 2/ECF80, 1/EF91, 1/6XS. Controls: X-shift, Y-shift, Focus, Width, Brilliance. ON/OFF. Time Base Frequency (Fine), Time Base Frequency (Coarse), Sync. Selector. Sync. Amplitude. Y-input Selector. X-input Selector. Amplifier Gain. Operates from 200/250 v. A.C. Mains. All required components for the construction of this wonderful instrument, including comprehensive assembly instructions, available at a SPECIAL INCLUSIVE PRICE OF ONLY £12/19/6, plus 3/- c. and p. Attractive engraved ivoryine front panel, optional extra at only 10/6. Just arrived! Portable carrying case at 45/- extra.



THE NEW LOOK RAMBLER PORTABLE

This wonderful little Medium and Long wave battery superhet incorporates IR5, IT4, IS5, 3V4 miniature valves. 5in. speaker and frame aerial. Housed in smart two-tone Red/Grey cabinet. All required components at the NEW LOW PRICE OF £6/19/6, plus 2/6 p. & p. or with the latest low consumption "96 range" valves at the NEW LOW PRICE OF £7/7/-, plus p. & p. Uses all-dry batteries AD35 (1/6), B126 (9/-). Full descriptive instruction book, itemised price list, diagrams, etc., available separately at 1/6 post free.

(2) MAINS UNIT FOR ABOVE.
Fits into battery compartment. A.C. 200/250 v. All required components at ONLY 47/6 plus 1/6 p. & p. or assembled and tested at £3/5/- plus p. & p. (Also suitable for many other portables.)



NEW LOOK ECONOMY FOUR



(3 & 4)

Our very popular three-valve plus rectifier mains T.R.F. receiver is now available with a new De Luxe cabinet with polished Walnut finish and Cream trimming (as illustrated). Brief Spec.: Valve line-up 6K7, 6I7, 6V6 and contact cooled rectifier. Ready drilled chassis, good quality 5in. loudspeaker, Special Denco Coils Covers Medium and Long Wavebands. Overall dimensions: 12in. x 6in. x 5in. high A.C. 200/250 v. Simple construction with guaranteed results. Easy to follow practical and theoretical diagrams supplied. All necessary components, down to the last nut and bolt, are offered at a SPECIAL INCLUSIVE PRICE OF £5/10/-, plus 5/- p. & p. Instruction book available separately 1/6, post free. Also available with plastic cabinet in IVORY or BROWN if preferred at ONLY £5/5/-, plus p. & p.

RADIO JACK

Covers local medium wave stations variably tuned. Compact self-contained unit requiring only connection to aerial (no power supplies reqd.) for 1st class reception when used in conjunction with your tape recorder or high gain amplifier. All necessary parts available at a special inclusive price of only 19/6. P. & P. 1/6.

AUDIO GENERATOR AG10.

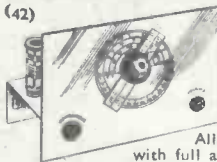
Covers from 10 c/s to 100 Kc/s in four ranges. Max. output 10 volts. Min. output 100 microvolts. Square wave output with excellent rise time makes this generator very



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useful for checking all Audio equipment. Housed in Attractive metal shelf mounting case 11 1/2" x 6 1/2" x 5 1/2" high. All necessary components including valves, £14/5/-, plus 3/6 P. P. Fully descriptive booklet with assembly instructions 2/- post free.

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SUPER I-VALVE SHORT-WAVE RADIO

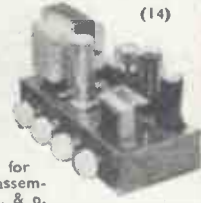
World-wide coverage at most reasonable cost. Covers 40-100 metres with the coil supplied. Can be extended to cover 10-100 metres. Provision is also made for the addition of two extra valve stages. Employs the famous Acorn-type 954 valve.

All necessary components can be supplied complete with full assembly instructions at ONLY 35/- plus 2/- p. & p. Send 2/- for point-to-point wiring diagram and price list.

THE R.C. 3/4 WATT AMPLIFIER

Compare the advantages. Treble bass AND middle controls. For crystal or magnetic pick-up. A.C. Mains 200/250 v. Valve line-up: 6V6GT, 6SG7 metal, 6X5GT. Negative feedback. Built on stove enamelled steel chassis, measuring only 8in. x 4in. x 1 1/2in. Four engraved cream knobs are included in the price of the complete kit with all necessary practical and theoretical diagrams at £4/5/- only, plus 2/6 p. & p. or Instruction Book fully illustrated for 1/- post free. This amplifier can be supplied assembled, tested and ready for use at £5/5/-, plus p. & p.

(14)



VISIT OUR FULLY EQUIPPED
HI-FI SHOWROOM
AT TOTTENHAM COURT ROAD FOR
DEMONSTRATIONS OF THE LATEST
HI-FIDELITY EQUIPMENT
BY ALL LEADING MANUFACTURERS

We stock equipment of Quality by all leading makers: i.e., Leak, Quad, Armstrong, Dulci, Ferrograph, Reflectograph, Vortexion, Tannoy, Linear, Wharfedale, Grundig, Goodmans, W.B., Rogers, Garrard, Lenco, B.T.H., Pamphonic, Simon, Brenell, Collaro, Telefunken, Hi-Cord, etc., etc. A full range of high quality cabinets to suit all purposes is on show, i.e., "RECORD HOUSING," "W.B.," "A.D.," etc. Enquire about our interesting part-exchange scheme for personal callers. H.P. Available.

THE "WAVEMASTER" 7-TRANSISTOR LUXURY PORTABLE

400 MILLIWATTS OUTPUT

To build yourself Medium and Long waves—Push-Pull Superhet A.V.C. Perfect Car Radio reception. Size 10in. x 6½in. x 4½in. at base tapering to 4in. at top. Very attractive two-tone grey Vynide covered cabinet with black and gold printed escutcheon plate, cream and gold knobs, handle and cabinet fittings. ★ Weight—complete with long-life 7½ volt battery—4½lb. ★ Mazda high-grade transistors throughout. ★ High-Flux 7in. x 4in. Elliptical Speaker. ★ Slow motion tuning. ★ Co-axial socket at rear for direct connection to Car Radio Aerial. ★ Improved reception by use of seven-section plated telescopic aerial disappearing into Cabinet when closed, 34in. above Cabinet when fully extended.



(43)

Construction simplified by Bakelite chassis board with the following components already mounted: I.F. Transformers (3). Oscillator Coil, Trimmer Bank, Output Transformer, Interstage Transformer, Aerial Brackets and Earth Bar. **SPECIAL INCLUSIVE PRICE** for all required components, full assembly instructions—nothing more to buy—is £10/19/6 plus 3/6 P. & P. Alignment service available. Full assembly instructions and individually priced parts list, all of which are available separately, 2/6, post free.

TO BUILD YOURSELF

ALL PARTS AVAILABLE SEPARATELY

"PRACTICAL WIRELESS" POCKET SUPERHET

All required Components for the complete Osom version as described in November issue of "Practical Wireless" now available at special inclusive price of £9/19/6 complete, including Printed Circuit and Osom booklet. Overall size 5½in. x 3in. x 1½in., 6 transistors, 2½in. P.M. Speaker. All items available separately, send stamp for list.

	All required components at special inclusive price	P. & P.	Instruction Book and itemised price list available separately
(1) New Look "RAMBLER" all dry s'het portable. NEW LOW PRICE	£6 19 6	2/6	1/6
(2) "RAMBLER" Mains Unit (suits most portables)	£2 7 6	1/6	9d.
(3) "ECONOMY FOUR" T.R.F. Mains Receiver	£5 5 0	2/6	1/6
(4) "ECONOMY FOUR" with New Look Cabinet	£5 10 0	2/6	1/6
(5) "FAMILY FOUR" (our new T.R.F. Receiver	£3 19 6	2/6	1/6
(7) Standard JASON F.M. Tuner FMT1	£6 15 0	2/6	2/-
(8) Fringe area JASON F.M. Tuner FMF	£7 15 0	2/6	2/-
(9) JASON "MERCURY 2" Switched F.M. Tuner plus ITA/B.C. Sound	£10 10 0	2/6	3/6
(11) JASON "ARGONAUT" AM/FM Chassis	£15 5 0	2/6	2/-
(12) JASON "ARGONAUT" AM/FM Tuner	£13 19 6	3/6	2/-
(13) F.M. Power Pack (suitable for most tuners)	£1 17 6	1/6	1/-
(14) R.C. 3/4 watt Amplifier (with Bass, Middle and Treble controls)	£4 5 0	2/6	1/-
(15) 2-amp. Battery Charger	£1 16 6	2/6	3d.
(16) R.C. Transistor/Crystal Receiver ('phones extra)	£1 1 0	1/3	3d.
(17) R.C. Super Transistor/Crystal Rec. (ditto)	£1 7 6	1/3	3d.
(18) R.E.P. 1-valve Battery Receiver	£2 2 0	2/-	9d.
(19) "CRY-BABY" ALARM (Baby Alarm)	£3 12 6	2/6	1/-
(20) MULLARD 510 Amplifier (printed circuit) Ultra Linear Version	£9 9 0	3/6	1/6
(21) MULLARD 510 as above plus input selector and spare power supplies	£11 10 0	3/6	2/6
(22) "DE-LUXE" Printed Circuit Superhet	£7 19 6	3/6	1/6
(23) "DE-LUXE" with New Look Cabinet	£3 4 6	3/6	1/6
(24) JASON J.T.V. 2 Tuner	£13 19 6	3/6	2/6
(25) RADIO JACK	19 6	1/6	6d.
(26) MULLARD TYPE "C" Tape pre-amp	£12 9 6	3/6	2/6
(27) JASON Will Wobblur	£14 19 0	3/6	3/6
(28) JASON Valve Voltmeter EM10 (23 ranges)	£18 10 0	3/6	2/6
(29) NEW JASON F.M. TUNER FMT2 with built-in power supplies and cabinet	£8 19 6	3/6	2/6
(30) NEW JASON FRINGE F.M. TUNER FMT3, as above	£10 19 6	3/6	2/6
(32) R.C. Super Personal Portable 1-valve (phone extra)	£1 15 0	2/6	2/-
(33) R.C. Super Personal Portable 2-valve (phone extra)	£2 1 0	2/6	2/-
(34) R.C. TRANSETTE 2-Transistor Personal Portable	£3 9 6	2/6	2/-
(35) JASON EVEREST 6-Transistor 2-wave Portable	£13 19 9	3/6	3/6
(36) JASON EVEREST 7-Transistor 2-wave Portable	£15 18 9	3/6	3/6
(37) CLYNE Cathode Ray Oscilloscope	£12 19 6	5/-	10/-
(38) Compact Multi-range Test Meter	£2 19 6	1/6	1/6
(39) CAR RADIO, Printed Circuit, 5-valve S'het. NEW LOW PRICE	£11 19 6	3/6	2/6
(40) JASON Audio Generator AG10	£14 5 0	0	3/6
(41) JASON Oscilloscope OG10	£22 10 0	5/-	3/6
(42) Super SHORT WAVE RADIO, 1 valve	£1 15 0	2/-	2/-
(43) "WAVEMASTER" 7-Transistor Luxury Portable	£10 19 6	3/6	2/6
(44) "GOLD STAR" De-Luxe 1-valve Portable	£1 17 6	2/6	1/6
(45) "PAGEBOY" 2-Transistor Pocket Portable ('phone extra)	£1 12 6	1/6	2/-

Instruction Books which contain full description, easy-to-follow practical wiring diagrams theoretical diagrams itemised price lists, etc., are free of charge with all parcels but may be purchased separately as shown above.

PLEASE NOTE—A selection of the above items are described more fully in this advertisement!!

PRINTED CIRCUIT CAR RADIO

(for Home Construction). We are proud to be able to offer this New type Car Radio employing up-to-the-minute circuitry, special 12 volt valves and transistorised out-put stage. The highest degree of sensitivity is assured by the incorporation of Permeability Tuning and a tuned R.F. Stage. Covers Medium and Long Wavebands. **NO VIBRATOR PACK IS REQUIRED.** This is a really compact receiver that will fit any car. Comprehensive assembly Instructions are provided with all necessary components, including valves and transistor at a Special New Low inclusive Price of Only £11/19/6 plus 3/6 P. & P. Instruction booklet with itemised price list, full description dimensions, etc. available separately at 3/6 post free.



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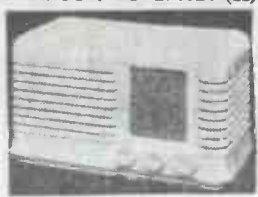
TURN OVER FOR MORE CLYNE BARGAINS

CLYNE RADIO LTD. THE COMPONENT SPECIALISTS

18 Tottenham Court Road, London, W.1.
162 Holloway Road, London, N.7.
99 Cheapside, London, E.C.2.

THE CLYNE RADIO "DE LUXE" PRINTED CIRCUIT SUPERHET (22)

A new two-wave band (L and M) Superhet using the latest miniaturised valves: E C H 8 1, EF85 and ECL80, plus cooled



Rectifier. Incorporates Ferrite Rod Aerial and is of unit construction. Exceptional sensitivity and selectivity. Outstanding performance and quality T.C.C. condensers throughout. Easily constructed in one evening. Brown or ivory Bakelite or wooden Walnut finish cabinet. A.C. mains 200/250 v. All necessary components at special inclusive price of £7/19/6 plus 3/6 P. & P. Instruction Book with itemised price list available separately at 1/6 post free. Also available in De Luxe Cabinet (as "Economy Four" at 5/- extra).

NEW! "PAGEBOY" 2-TRANSISTOR POCKET PORTABLE

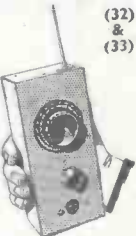
Completely portable—NO EXTERNAL AERIAL OR EARTH REQUIRED. This is an amazing little receiver with built-in aerial and small enough to be held in the palm of the hand. Medium wave reception at wonderful volume. No fiddly tuning!—condenser tuned! Supplied with drilled chassis and colour coded components. Easily assembled with the aid of the easy-to-follow assembly instructions provided. Total cost of all necessary components, including transistors, wiring wire and even solder **ONLY 32/6** plus 1/6 P. & P. Battery 3/- extra. Ardente type deaf-aid earpiece complete with cord and plugs extra at 12/6. Parts price list and Easy Lay-out Plans 2/- post free. Callers welcome to hear this set demonstrated at any of our branches. Our reputation is your guarantee.



(45)

SUPER PERSONAL PORTABLE.

A wonderful little set you can take anywhere. Ideal for camping, etc. Detachable aerial rod supplied. Covers Medium waveband 200-500 metres. Can be built in approx. 1 hour. All necessary components available at the following **SPECIAL INCLUSIVE PRICES**: 1-valve version **ONLY 35/-** plus 2/- P. & P. Super 2-valve version **ONLY 41/-**. Plus 2/- P. & P. Send for point-to-point wiring diagram and parts price list 2/- post free. Extra for use with the above DLR5 balanced armature headphones, 7/6 pair.



(32) & (33)

"FAMILY FOUR"

(5) Our supersensitive T.R.F. Receiver for home construction. Covers Long and Medium Wavebands, is housed in very smart plastic table cabinet in Brown or Black. For A.C. mains 200/250 v Comprehensive assembly instructions provided, including practical and theoretical diagrams, which are easy to follow and will enable you to complete this receiver which will be the envy of your friends. **ALL NECESSARY COMPONENTS ONLY 79/6**, plus 2/6 P. & P. Instruction book available separately if you wish to study before purchase at 1/6 post free.



★ MORE CLYNE RADIO BARGAINS ★

RECORD PLAYERS

Full range at usual competitive prices. Interesting H.P. facilities E.M.I. 4-SPEED STEREO/MON-
AURAL SINGLE RECORD UNIT. Complete with Stereo Head and Sapphire Styl. Brand New and Fully Guaranteed. ONLY £6/19/6 plus 3/6 P. & P.
LATEST GARRARD MODEL 210. Four-speed manual or automatic. 10in. and 12in. records of same speed can be mixed in any order, wired for stereo, attractive white colour scheme. Price 10½ gns. plus 3/6 P. & P.
LATEST B.S.R. UA14. 4-speed. Attractive appearance. Wired for stereo. Fully guaranteed. £7/19/6, plus 3/6 P. & P.
**B.S.R. UA8 STEREO/MON-
AURAL.** Few only at £7/19/6, plus 3/6 P. & P. Brand new Guaranteed.
B.S.R. UA8. Monaural only, £6/19/6, plus 3/6 P. & P.
ACOS GP73-2A: Turnover cartridge for Stereo and Monaural Standard and L.P. Few only at 29/6, also GP67-3 Mono at 18/-. Both plus 9d. P. & P.
GOLDRING 580 CARTRIDGE. In MPH2 shell. Few only at special price of 99/6 post free.

CABY UNIVERSAL TEST METERS

These pocket-size multi-range test meters are of excellent quality and cover all the most useful ranges (A.C. Volts, D.C. Volts, resistance and current). Supplied complete with test rods, instruction book and batteries.
Model A.10 (2,000 ohms per volt) £4/17/6
Model B.20 (10,000 ohms per volt) £6/10/-, Plus P. & P. 3/6 on ea. Fully detailed and illustrated leaflet available on request.

CATHODE RAY TUBES. Unrepeatable offer! 17in. MW 43/69 by leading British Manufacturer. Brand new in original cartons. Not regunned. Full 12-month guarantee. Limited quantity at £7/10/- each only, plus 10/- P. & P. Send stamp for comprehensive Valve and Tube List.
METERS. Large selection of panel mounting meters at competitive price. Send stamp for new list now ready.

ANOTHER PORTABLE CABINET! Ex leading manufacturer's battery portable attache type case. Attractive two-tone grey rexine finish. Size closed 13½in. x 9½in. x 3½in. Complete with fittings and handle. Including Medium and Long Wave frame aerial which fits in lid. Limited quantity only at bargain price of 19/6 plus 2/- P. & P. Brand new.

DEAF-AID TYPE EARPIECES. Ardenite Standard magnetic type complete with lead and plug. Only 12/6. P. & P. 1/-.

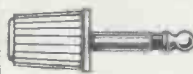
MINIATURE CRYSTAL DEAF-AID TYPE EARPIECE. Supplied with ear insert. 3ft. lead, sub-miniature jack plug and socket at 8/- only, plus 1/- P. & P.

E.M.I. FULL FREQUENCY SPEAKER. Size 13½in. x 8in. A further small quantity available. 3 ohm speech coil. 39/6 only, plus 2/- P. & P.

12in. BAKERS SELHURST LOUSPEAKER. 15 ohms, 15 watt 30-14,000 cps. Brand new, £4/10/-, P. & P. 3/6.

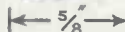
12in. RICHARD ALLAN P.M. LOUSPEAKER. 3 ohm speech coil. Brand new. ONLY 32/6 plus 2/6 P. & P.

VIBRATOR PACKS. Limited quantity of both 6 volt and 12 volt types available. Output 300 volt. 100 m/a. Fully smoothed. Brand new ex-Govt. surplus. Price 35/- ea., plus 2/6 P. & P. Please specify input voltage required.



SUB-MINIATURE TWO-WAY JACK PLUGS & SOCKETS

Smallest yet available
3/6 per pair. P. & P. 6d.



SUB-MINIATURE SLIDER SWITCH

Two-pole two-way ONLY 2/6 EACH. P. & P. 6d.

● Wholesale and manufacturer quantity enquiries invited on both of the above new items.

★ TAPE RECORDER CONSTRUCTORS ★

TELEPHONE PICK-UP COIL. Designed to feed into the microphone input of either a tape recorder or any high gain amplifier. Easily attached to telephone by rubber suction attachment. The coil is electrostatically shielded to minimise hum pick-up. When positioned on telephone this model is more than adequate for a fully modulated tape recording. Brand new complete with 5ft. shielded cable. ONLY 14/-, P. & P. 1/6.

COLLARO TAPE PRE-AMPLIFIER AND BIAS OSCILLATOR. Complete with power pack for use with Collaro Mk. IV deck. 4 valve plus EM81 magic eye. 110-240 v. A.C. Input sensitivity: microphone socket 5 m/v., auxiliary socket 500 m/v. Speed equalisation switch gives compensation at all 3 speeds. Full wiring instructions included. List price £21. Limited quantity only at £15/19/6. P. & P. 5/-.

LATEST COLLARO STUDIO TAPE TRANSCRIBOR. 3 motors, 3 speeds, 1½, 3½, 7½ i.p.s., takes 7in. spools. Push-button controls, £12/19/6 plus 5/- P. & P. Usual H.P. facilities.

LATEST B.S.R. "MONARDECK." Single speed Tape Deck. Takes 5½in. spools—3½ i.p.s. At only £8/5/- plus 5/- P. & P.
TAPE RECORDER AMPLIFIER. Suitable for use with either of the above Tape Decks, and most other types. For A.C. mains, 4 watts output, 40-12,000 CPS at 7½ i.p.s. ±3 db. Facilities for superimpose. Valves: 6BW6, ECL82, 12AX7, EM84, and contact cooled metal rectifier. Radiogram input, microphone input, monitor facilities (can be used as straight through amplifier), volume control and separate treble and bass controls. Chassis measurement 4½ x 3 x 4½in. Supplied complete with attractive grey/blue esctuchon plate finished in black and gold. Circuit diagram and connecting instructions included. Price £11/5/- only, plus 3/6 P. & P. If purchased with either of the above decks, both items post free!

ATTRACTIVE TWO-TONE PORTABLE CARRYING CASE. Suitable for above amplifier and Collaro, Studio deck. Limited quantity only at 79/6 plus 3/6 P. & P.

MIC 45-1 Acos latest flat pistol-grip crystal microphone. Attractive black and gold finish. OUR PRICE 29/6 plus 1/- P. & P. **ACOS MIC 39-1.** Crystal stick microphone. List price 5 gns. Our price 39/6 plus 1/6 P. & P. **MIC 40.** General-purpose crystal microphone with desk stand. Our price 25/- only plus 1/6 P. & P. **M.C. 24.** Imported, crystal, attractive streamlined polished metal case, incorporates muting switch. List price 64/- OUR PRICE 42/- only. 1/- P. & P.

SUPER MAGNETIC RECORDING TAPE SPECIAL!!!

Famous American FerroDynamics "BRAND FIVE"



An enthusiast's "must." Brand new (NOT SUB-STANDARD) High grade Acetate Base, 5in. 600ft. 16/-, 5in. 900ft. 18/6, 5½in. 1,200ft. 23/6 7in. 1,200ft. 25/-, 7in. 1,800ft. 35/-, Extra quality Mylar Dupont. 3in. 300ft. 13/-, 5in. 1,200ft. 37/6. 7in. 1,800ft. 44/-, 7in. 2,400ft. 60/-, Each on plastic spool. All Post free. Trade enquiries invited.

PLASTIC TAPE SPOOLS. Best quality. 3in. 1/6, 5in. 2/-, 5½in. 2/3, 7in. 2/6. **PLASTIC SPOOL CONTAINERS** for spool sizes 5in. 1/6, 5½in. 2/-, 7in. 2/3. Any single item plus 6d. P. & P. Orders over £1, post free.

LANGUAGE COURSES ON TAPE!

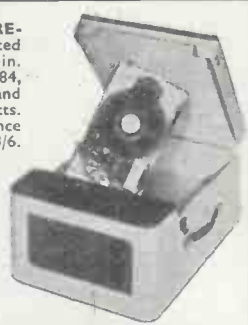
Complete Elementary Course in French, Italian, German or Spanish. Phrase book supplied. 5' long play tape, 55 minutes at 3½ i.p.s. Price ONLY 29/6 per course, Post Free!

EXTRA SPECIAL OFFER !!

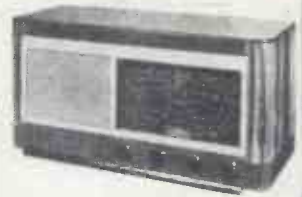
A small three-valve **PORTABLE RECORD PLAYER AMPLIFIER** mounted on baffle 12 x 7in., with High Flux 6½in. Loudspeaker. Valve line-up ECC83, EL84, EZ80. Incorporates separate bass and treble controls. Max. output 3 watts. Will match all types of high impedance pick-up. Ready to use, £5/12/6. P. & P. 3/6.

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, £39/6, plus 5/- P. & P.

NOTE. If both items purchased together they will be supplied at a special inclusive price £87/6, plus 6/6 P. & P.



FRUSTRATED EXPORT. Not repeatable! L.L. M. and S.W. **SUPERHET RECEIVER.** Manufactured by McCarthy for export. At present for operation on 6 volts, but conversion details supplied free.



Valve line-up: 6K8G, 6K7G, 6Q7C, 6F6G, 6X5G and 6 volt 4-pin non-synchronous vibrator. 8in. P.M. Speaker, 4 watts output, P.U. socket, Ext. L.S. socket, etc. Tone control. Fitted in polished wood cabinet, size 21½in. x 10½in. x 10½in. These cabinets are slightly soiled owing to storage, but each is guaranteed unused, in serviceable condition, tested prior to despatch. Price £5/19/6 only plus P. & P. 7/6, plus 27/6 for A.C. Mains Conversion Components if required. **OUTSTANDING BUY!**

TRANSISTORS!!!

SURPLUS P.N.P.
RED SPOT (Audio/Experimental Application) 3/6 ea.
WHITE SPOT 5/- ea.
R.F. up to 2.5 Mc/s. 5/- ea.
OCI69 VHF P.N.P. JUNCTION TRANSISTOR. Drift-type, Alpha cut-off frequency 80 Mc/s. 18/- ea. Attractive discounts for bulk purchases. The above is a selection only. Full range in stock by all leading manufacturers. Let us have your enquiries. (ALL POST FREE.)

LOUDSPEAKERS. EX. CHASSIS

As new guaranteed perfect, by leading manufacturers. 5in. high flux, 9/6; 6½in. 10/6; 8in. 13/6; also 10in. with O/P transformer (5,000 ohms), 17/6. All 3 ohm speech coil, also 8in. available, in attractive cloth covered cabinet, ideal for extension speaker, 22/6. Each item plus 1/6 P. & P. Complete list of new speakers on request. **No. 38 AFV WALKIE-TALKIE.** A wonderful offer. This famous transmitter unit, with relay operated SEND/RECEIVE switch covering 7.4-9 Mc/s band, range approx. 5 miles. Good condition. ONLY 22/6, plus 2/6 P. & P. per unit (LESS ACCESSORIES). Quantity export inquiries welcomed. **AERIAL TUNING UNIT ZA0841** This well made ex-W.D. unit contains a host of useful components including: 1 mA. 2in. flush round M/C meter, 1 mA. Westinghouse full-wave meter rectifier. 5-pole 5-way heavy-duty silver plated wavechange switch. 3in. dia. silver plated rotary tuning indicator, 350 pF tuning condenser with insulated coupler and 3½in. calibrated dial (0-180 deg.) etc., etc. Contained in strong metal carrying case 9in. x 9in. x 8in. with hinged lid. ONLY 27/6, plus 5/- C. & P.

WIRING WIRE.

5 coils 10 yds., each coil, in different colours, contained in cellophane bag, 5/-, plus 9d. postage.

"PIFCO" INSTRUMENT BIT SOLDERING IRON with integral Stand and built-in Spot-light for illuminating work 200/250 v. ONLY 22/6. P. & P. 1/6.

SOLDER. New boxed 1 lb. reels, 16 S.W.G. 50/50 at 8/6 only, plus 1/- P. & P.

TRANSFORMER SPECIAL. Superior quality half-shrouded drop thro' mains transformer. Input 200/250 v. Output 350-0-350 v. 80 mA.; 6.3 v. 3 amps. 5 v. 2 amps. Ex-equipment but guaranteed O.K. ONLY 9/6, plus 1/- P. & P.

R.F.26. Variable tuning. Brand new in sealed carton. ONLY 22/6, plus 2/- P. & P.

THE COMPONENT SPECIALISTS

ALSO SEE PREVIOUS PAGES

CLYNE RADIO LTD.

18 Tottenham Court Road, London, W.1.
162 Holloway Road, London, N.7.
99 Cheapside, London, E.C.2.

C.R.T. BOOSTER TRANSFORMERS

For Cathode Ray Tubes having Heater/cathode short circuit and for C.R. Tubes with failing emission. Full installation instructions supplied.

Table listing C.R.T. booster transformer specifications: Type A, Low Leakage windings, Optional Boost 25% and 50%. Tapped mains primaries. 2 volt, 4 volt, 5.8 volt, 10.8 volt, 13.3 volt.

OUR LATEST SUPERIOR PRODUCT. Type A2. High Quality. Low capacity. 10/15 pf. Optional boost 25%, 50%, 75%. Type B. Mains input. Low capacity. Multi-Output 2, 4, 6.3, 10 and 15 volts. Optional boost 25% and 50%. Suitable for all Cathode Ray Tubes 21"-

RESISTORS. All preferred values. 90% 10 ohms to 10 meg. 1/4 w., 4d.; 1/2 w., 4d.; 1 w., 6d.; 1 1/2 w., 9d.; 2 w., 1/-.

WIRE-WOUND POTTS, 3 w. Pre-set Min. T.V. type. Knurled Slotted knob. All values 10 ohms to 25k. 3/- ea., 30 K., 50 K., 4/-.

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. Push-pull 20 w. 6/- or 8 k. 30/6.

MAIN TRANSFORMERS 200/250 v. A.C. STANDARD 250-0-250, 80 mA., 6.3 v. 3.5 a.

ALADDIN FORMERS and cores, 1/4 in. 5d.; 1/4 in. 10d. 0.3in. FORMERS 5937 or 5 and 1/4 in. Gans TV1 or TV2.

CRYSTAL MIKE INSERT by Acos 6/6. Precision engineered. Size only 1/4 x 1/4 in.

MIKE TRANSF. 50-1, 3/9 ea., 100-1 Potted 10/6. 100/6.

I.F. TRANSFORMERS 7 1/2 pair 465 kc/s, slug tuning miniature can 1 1/4 x 3/4 in. High Q and good band width.

CRYSTAL DIODE G.E.C., 2/-, 6HX34, 4d., 40 Circuits 3/-. H.R. HEADPHONES, 4,000 ohms, brand new, 15/- pair.

WAVELENGTH SWITCHES 2/6 5 p. 4-way, 2 wafers, or 3 p. 11-3 wafers, long spindle 6/6 2 p. 6-way, or 4 p. 2-way, or 4 p. 3-way, long spindle 3/6 3 p. 4-way or 1 p. 12-way, long spindle 3/6

THE HI-GAIN BAND 3 PRE-AMP Cascade circuit using Valve ECC84. 17db gain. Kit 29/6 less power; or 49/6 with power pack. Plans only 6d.

RADIO COMPONENT SPECIALISTS. POSTAL SERVICE 4/-, OVER £2 FREE. C.O.D. 1/6. (EXPORT C.W.O. POST EXTRA.) Wed. 1 p.m.

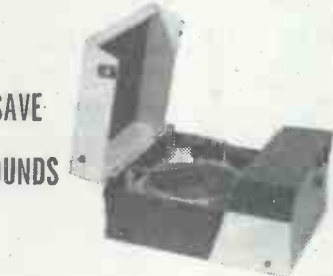
ARMSTRONG AF208 AM/FM RADIOGRAM

CHASSIS PRICE 22 GNS. CARRIAGE FREE

- Full VHF Band (87-108 M/cs) and Medium Band, 187-570 m. 7 Valves. 5 watts Output. 15dB Negative Feedback. Separate wide range Bass and Treble Controls. 2 Compensated Pick-up Inputs. Frequency Response 30-22,000 c.p.s. ±2dB. Tone Record and Playback Facilities. Continental Reception of Good Programme Value.

For 3, 7 1/2 and 15 ohm speakers The AF208 is the most economically priced chassis Armstrong have ever produced and, in doing so, the aim is to bring traditional Armstrong quality and design to a larger circle of enthusiasts than ever before.

MONARCH RECORD PLAYER



SAVE POUNDS BUILD IT YOURSELF using 4-SPEED BSR

MONARCH AUTOCHANGER U. A. 8 READY BUILT 3W. AMPLIFIER HANDSOME PORTABLE CASE HIGH FLUX 6in. LOUDSPEAKER FULL INSTRUCTIONS supplied

Total Price Carr. and ins. 5/-. £12. 10. 0

RECORD PLAYER BARGAINS



- 4 Speed Autochangers, BSR, U.A.8 Stereo or Monaural £6 15 0 Collaro Model 457 £7 19 6 Garrard Model 210 £10 10 0 4 speed Single Valves, EMI Stereo or Monaural £6 19 6 Garrard TA Mk. II £8 8 0 Garrard 4 HF Transcription £17 19 6 Garrard Stereo Heads £2 extra.

AUTOCHANGER ACCESSORIES Suitable player cabinets (tuncat board) 49/6 Amplifier player cabinets with cut boards 63/6 2-valve amplifier and 6in. speaker for above 79/6 Ready mounted on baffie 12in. x 7in., 3in. deep.

GYLDON TURRET TUNELER

L.F. 33/38 meas., complete with frame-grid valves. 30C1 and 30L15. (LT 16v. 3a.) With coils for channels 1 to 5 & 8 to 11. Latest model, Brand new price, 45/-. operating data & circuit supplied, ideal for "P.T." Olympic.

Table listing GYLDON TURRET TUNELER specifications: VOLUME CONTROLS, 80 Ohm Cable Coaxial, Midget size, Long spindle, Guaranteed 1 year. All values, 5 K. ohms up to 2 Meg. No switch. D.P. 5/6 3/4 Linear or Log. Tracks.

ALUMINIUM CHASSIS 18 s.w.g. Plain, un drilled, with 4 sides, riveted corners and lattice fixing holes with 2in. sides 7x4in. 4/6; 9x7in. 4/6; 11x7in. 6/9; 13x9in. 8/6; 14x11in. 10/6; 15x14in. 12/6 and 18x16x3in., 16/6.

BLACK CHACKLE PAINT. Air drying, 3/- tu. P.V.C. CONN. WIRE, coloured, single or stranded 2d. LEON MAINS TESTER SCREWDRIVERS, 5/- CORED SOLDER RADIOGRADE, 4d. vid., 1lb. 5/- FAXOLIN 1/18in. x 8in. x 10in., 1/6. 10N TRAPS 5/-

AMERICAN MAGNETIC RECORDING TAPE FERRODYNAMICS "BRAND FIVE"

Table listing AMERICAN MAGNETIC RECORDING TAPE specifications: 5in. 600 feet, 16/- MYLAR DUPONT, 5in. 900 feet, 18/6 Super High Fidelity, 5in. 1,200 feet, 23/6 Double P...

RECTIFIERS, 6M1, 5/-; 6M2, 6/-; 6M3, 6/-; 6M4, 16/-; 6M5, 20/-; 6C3, 27/6; 14A85, 17/6; 14A100, 21/-; MINIATURE CONTACT COOLED RECTIFIERS, 250 v. 50 mA., 7/6; 60 mA., 8/6; 85 mA., 9/6; 200 mA., 21/-; 300 mA., 27/6; Full Wave 75 mA. or 250 mA., 15/-.

JASON F.M. TUNER COIL SET, 29/-. H.F. coil aerial coil. Oscillator coil two I.F. transformers. 10.7 Mc/s. Detector transformer and heater choices. Circuit and component book, using four 6AM6 2/6. Complete kit FM/T with Jason Calibrated dial and 4 valves, 265/-. New Jason Cabinet FM/T, £2 extra.

CONDENSERS. New Stock. .001 mfd. 7kV. T.C.C., 5/8; 20 kV. 9/6. 1 mtd. 7 kV. 9/6. 100pf. to 500 pf. Micas, 6d. Tubular 500 v. 0.001 to 0.05 mfd., 9d.; 0.1, 1/6; 0.25, 1/6; 0.5 1/8; 0.1/350 v., 9d.; 0.1/500 v., 10d.; 0.1 mfd., 2/6. 2,000 v., 3/6; 0.001 mfd., 2,000 v., 1/9. 500 pf. to 20 kV., 9/6.

CLOSE TOLERANCE (± 1%) 2 pf. to 4 pf., 1/6. DITTO 1 1/2 pf. to 8 1/2 pf., 1/9; 1,000 pf. to 2,000 pf., 2/6. TRIMMERS. Ceramic 30, 50, 70 pf., 5d.; 100 pf., 6d.; 1/3, 250 pf., 1/6. 500 pf., 750 pf., 1/9. PHILIPS, 1/1- ea.

NEW ELECTROLYTICS. FAMOUS MAKES

Table listing NEW ELECTROLYTICS: TUBULAR CAN TYPES, 1/350 v. 2/-, 2/3 100/25 v. 2/-, 4/450 v. 2/3, 250/25 v. 2/6, 8/450 v. 2/3, 500/12 v. 3/-, 8/500 v. 2/3, 8+8/450 v. 3/6, 16/450 v. 3/-, 16/500 v. 3/-, 32/450 v. 3/9, 16+16/450 v. 4/3, 25/25 v. 1/9, 50/50 v. 2/-, 32+32/350 v. 4/6.

FULL WAVE BRIDGE SELENIUM RECTIFIERS. 2.6 or 12 v. 1 1/2 amp., 8/9; 2 a. 11/3; 4 a., 17/6; 6 a., 22/6.

CHARGER TRANSFORMERS. Dapped input 200/250 v.

charging at 2, 6 or 12 v., 11 a. 15/6; 2 a., 27/6; 4 a., 22/6. Charger circuit free. AMMETERS, 4 a., and 8 a., 13/6.

Table listing CHARGER TRANSFORMERS and VALVES: NEW and boxed VALVES 90 day guarantee, 1B5 7/6, 6L6G 10/6, EASO 1/6, EY71 1/6, 1A5 7/6, 6NTM 6/6, 6BC80 8/6, EY86 1/6, 1T4 6/6, 6Q7G 7/6, 6BD9 6/6, HARCO80 12/6, 2X2 3/6, 68A7M 6/6, 6BC33 6/6, HVY2A 2/6, 384 7/6, 68Y7M 6/6, 6BC41 8/6, 6U7A 9/6, 3V4 7/6, 68N7 6/6, 6BF30 10/6, PVI 3/6, 5U4 7/6, 6VGG 6/6, 6BC54 9/6, 6PC54 9/6, 5Y3 7/6, 6X4 7/6, 6CF50 9/6, 6CF80 9/6, 5Z4 9/6, 6X5 5/6, 6ECH42 10/6, PCL82 11/6, 0A6M 5/-, 12A6 7/6, 6CL90 10/6, 6PN25 6/6, 6BE6 7/6, 12AT7 8/6, 6CL82 10/6, 6PL32 10/6, 6BE6 9/6, 12AU7 8/6, 6BF30 5/6, 6P40 7/6, 6BD6 9/6, 6X7 9/6, EF41 9/6, 6Y81 9/6, 6BE 6/6, 12BA6 8/6, 6PF50 5/6, 6PY2 7/6, 6PC6 7/6, 12BE6 8/6, 6F90 8/6, 6BP1 9/6, 6EGHT 6/6, 12K7 8/6, 6F96 14/6, 6BC41 9/6, 6J5 5/6, 12Q7 6/6, 6F92 5/6, 6U42 9/6, 6J5 5/6, 35L6 9/6, 6L82 5/6, 6U41 9/6, 6B7G 6/6, 35Z4 7/6, 6B7G 9/6, 6U41 9/6, 6K6GT 6/6, 80 9/6, 6L84 8/6, 6U41 8/6, 6K7G 5/-, 807 5/6, 6Z4 5/6, 6U2 2/6, 6K9G 7/6, 954 1/6, 6Z80 7/6, 6U2 7/6.

PREMIER RADIO

23 Tottenham Court Rd., London. W.1. Tel: MUSEum 3451/2



THE PREMIER TRANSISTORISED BABY ALARM

79/6 Plus 3/- P. & P. Battery extra 3/3 (Ever-Ready PP9 9 volt or equiv.)

The answer to the modern Parents' problem for "Baby Sitting," this extremely efficient Unit is completely safe, being battery operated, its portability enables you to place the Master Unit in any part of the house. Extra Microphones may be used in different rooms without impairing the efficiency of the Unit. It is the most economical Unit of its kind and will run on one Battery for approximately two months of continuous day and night use. It is housed in an attractive bakelite Cabinet in either Ivory or pastel blue. The price includes one Microphone, extra Microphones can be supplied at 12/6 and Microphone Lead at 5d. per yard.



The SUPER 60

6-Transistor Battery Receiver
MAY BE BUILT FOR **£9.15.0** Plus 1/4 P. & P.
Ever-Ready PP10 Battery Extra 11/-.
P. & P.

- STAR FEATURES:-**
- ★ Six 1st grade Mullard Transistors and one Diode.
 - ★ Internal Ferrite Rod Aerial.
 - ★ 7in. x 4in. Elliptical Speaker.
 - ★ Printed Circuit.
 - ★ 500 mW Push-pull Output.
 - ★ Full medium and long waveband coverage.
 - ★ Calibrated Direct Drive Dial Drive Assembly.



★ Full point-to-point instructions supplied.
★ Dimensions 18in. x 7 1/2in. x 5 1/2in.

The Receiver is housed in an attractive contemporary mahogany finished cabinet trimmed with gilt, supported by gilt stands. The Receiver will operate for months on one 9-volt long-life battery. Instruction Book separately at 2/6 p.p.

TAKE ADVANTAGE OF THESE

DRAMATIC PRICE REDUCTIONS

AVANTIC SPAII Stereophonic Amplifier. Technical details: power output (each channel) 10 watts peak, L.S. impedance, 4, 8 and 16 ohms. 6-position input selector, bass, treble, volume on/off controls, stereo reverse switch, phase reverse switch, stereo balance control, P.U. balance control. Dimensions 14 1/2 x 8 1/2 x 4in. Original price 28 Gns. P. & P. 7/6. **OUR PRICE 19 Gns.**

AVANTIC PL621 20-watt monaural Amplifier, frequency response 10 c/s-30 Kc/s. 1 bb. L.S. impedance, 4, 8 or 16 ohms. Dimensions 14in. x 8 1/2in. x 7 1/2in. Original price 29 Gns. P. & P. 7/6. **OUR PRICE 19 Gns.**

AVANTIC STEPII. Stereophonic Magnetic Pick-up Amplifier Unit. Price £4/4/-.

SPECIAL BARGAIN OFFER

THE PERFECT STEREO SYSTEM
Two DL7/35 power amplifiers original cost **OUR PRICE 47 gns**
One SP21 Stereo control unit £91 - 10 - 0

Brief specifications:
DL7/35. Power output 54 watts peak; L.S. impedance 4, 8 or 16 ohms. power inputs 105-250 v. Valve line-up GZ34, 2-EL34, ECC83, EF86. Dimensions 14 1/2 x 9 x 8 1/2in. Original price 30 gns.
SP21. 6 inputs for each channel, bass, treble, volume control, on/off stereo/3D/reverse stereo switch, stereo phase switch, low pass filter. Power requirements 6.3 v. at 1.3 A., A.C. 350 v. at 5 mA. D.C. dimensions 14 1/2 x 9 x 4in. Original price £28/10/-.

All this equipment is Brand New and in manufacturer's original sealed cartons. Full descriptive literature available.

THE Petite PORTABLE

MAY BE BUILT FOR **£7.7.0** P. & P. 3/-.

Batteries extra.
H.T. 10/- (Type B126) or equivalent.
L.T. 1/6 (Type AD 35) or equivalent.

- High Q frame aerials.
- High sensitivity on both wavebands.
- Medium and long wave superhet circuit.
- Instruction book 1/6.
- Size only 8 x 8 x 4 1/2in.
- Weight including batteries 5 1/2lb. ● 4 valves of the economy type.

BATTERY ELIMINATOR

Housed in two containers which are to replace AD 35 and B126 Batteries.

MAY BE BUILT FOR **37/6** Plus 2/- P. & P. Only suitable for use with DK96 Series valves.

STEREO ADAPTOR

Why not convert your Record Player or Radiogram to stereo with this easy to install Stereo Conversion Unit complete and ready to install giving an out- **£2.19.6** Plus 2/- p.p. of 3 watts. P. & P.
STEREOPHONIC PICK-UP CARTRIDGES AVAILABLE, 35 - post paid.

TUNERS FOR THE HOME CONSTRUCTOR BY 'JASON'

JASON JTV2. T.V. SOUND & F.M. complete with Tuning Tuner and Case, less Valves, £14/19/-, plus 3/6 P. & P. Valves £1/12/-. Instruction Book available separately 3/6.

JASON FMT3. F.M. Tuner with Twin Limiters, sensitivity 5 microvolts, complete with Case and Power Supply, £9/19/- Less Valves, plus 3/6 P. & P. Valves £2/13/-. Instruction Book available separately 2/6.

JASON MERCURY 2. Switched Tuner for F.M. and T.V. Sound, less Valves and Power Supply, £10/14/-, plus 2/6 P. & P. Valves £1/4/6. Instruction Book available separately 3/6.

Power Supply Kit, suitable for above £2/14/-, plus 2/- P. & P.

THE VICEROY QUALITY CRYSTAL MICROPHONE. A good-quality crystal Microphone for the discerning enthusiast, finished in polished steel with Muting Switch and detachable lead. Price 42/-, P.P. 1/6.

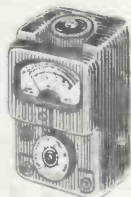


WHY NOT DO IT YOURSELF!

SUPERHET may be built for **£7. 7. 0** Plus 3/- P. & P.
T.R.F. may be built for **£5. 10. 0** Plus 3/- P. & P.

These two receivers use the latest type circuitry and are fitted into attractive cabinets 12 x 6 1/2 x 5 1/2in., in either walnut or ivory Bakelite or wood 1/- extra. Individual instruction books 1/- each, post free.

OUTSTANDING BARGAIN OFFER



The Kapura Model UI Multi-meter for only **59/6** (complete with Test Leads). P & P. 2/6.

A truly efficient Meter for the enthusiast: sensitivity 1,000 ohms per volt. A.C. and D.C. ranges 4AC/DC: 0-10-50-250-500-1,000 v. D.C. current 0-100-500 mA, 0-1 mA. (at D.C. 0-10 v.). Resistance 1-2,000 ohms (centre 24 ohms), 100-200 K. (centre 2,400 ohms). Size 5in. x 2in. x 2 1/2in. Brand new in manufacturer's original boxes.

THE 'MID-FI'

A NEW DESIGN **4 1/2 WATT AMPLIFIER KIT** MAY BE BUILT FOR **95/-** Plus 3/- P. & P.



A new circuit for the home constructor requiring a good quality medium-powered Amplifier for reproduction of Records or F.M. Broadcasts. Technical Specifications: separate bass and treble controls. Valve line-up 12Y60, E184, E230. Voltage adjustment for A.C. mains from 200-250 volts, 3 or 16 ohms impedance. Negative feedback. Size 7 x 3 x 2 1/2in., overall height 5in. Silver-hammered finished Chassis.

FOR THE BEGINNER

A 2-transistor, medium wave, receiver, ideally suited for the young enthusiast or the beginner. Operating on two pen torch batteries.

Simple to construct, with full instructions supplied. No headphones required. Complete set of components, including plastic case. **27/6** plus 1/4 P. & P. Batteries extra.



THE MODEL V7M4 VALVE FILAMENT TESTER

Will instantly check the filaments of all Radio and T.V. Valves, Tubes and Dial Bulbs. Will also give an accurate circuit continuity test and also has built-in 7 and 9 valve straighteners. Size 5 1/2 x 3 1/2 x 1 1/2in. Price 30/- with Battery, post paid.

GABY MODEL B20 MULTI-METER

DC/V 0-0.5 v. 0-2.5 v. (2K-Ω/V).
DC/V 10-50-250-500-1000 v. (4K-Ω/V).
AC/V 10-50-250-1000 v. (4K-Ω/V).
DC/MA 0-100 microamps (500mV).
DC/MA 0-2.5-25-250 mA (250mV).
OHMS, 2K-20 meg.

COMPLETE WITH TEST LEADS—
PRICE **£6/10/0** plus 2/- P. & P.

GABY MULTI-METER A-10

DC/V 10-50-250-500 1kΩ (2KΩ/V).
AC/V 10-50-250-500-1kΩ (2KΩ/V).
Ranges: DC/MA 0.5-25-250 (250mV).
OHM 0-10 KΩ-1MΩ.

COMPLETE WITH TEST LEADS P. & P. 2/6. **£4/17/6**

PREMIER RADIO

23 TOTTENHAM CT. RD., W.1. Tel. Museum 3451/2
309 EDGWARE ROAD, W.2. Tel. Paddington 6963

Visit our large and comprehensive Hi-Fi showrooms

The 'Magnaphon'



A truly top quality and versatile Tape Recorder at a price well below the original cost. Incorporating the latest Collaro 3-speed Studio Tape Deck.

- ★ Volume and Tone Control for recordings.
- ★ Volume and separate Bass and Treble Controls for replay.
- ★ Facilities for monitoring.
- ★ Output 4 watts.
- ★ Separate Output Sockets for Amplifier and Extension Speaker.
- ★ Mixing Facilities.
- ★ Housed in attractive red and beige two-tone Cabinet with detachable lid.

★ Fully guaranteed and supplied complete with the following accessories:—
Price £32.0.0
Good quality Crystal Microphone with Lead and Jack Plug fitted, 5 1/2" Reel of Standard Tape and Spare Reel, spare Lead fitted with Jack Plug and Wander Plugs for recording from Radio.

Plus 21/- P. & P.

TAPE DECKS

LATEST BSR MONARDECK. Single speed 3 1/2 i.p.s. Will take 5 1/2 in. spools. £8/19/6. P. & P. 5/-.

COLLARO STUDIO TAPE TRANSCRIPTOR. 3 speeds 1 1/2, 3 1/2, 7 1/2 i.p.s. 3 motors. Push-button controls. Will take 7 in. spools. £12/19/6. P. & P. 7/6.

TAPE RECORDER AMPLIFIER specially designed to match the Collaro Studio Tape Deck. £10/19/6. P. & P. 4/-, Size 1 1/4 x 5 x 3 1/2 in., uses 3 valves, magic eye, contact coated metal rectifier. Incorporates mike/gram/radio inputs, ext. l.s. jack, superimposing switch, with matching knobs.

RECORDING TAPE

By well-known manufacturers, brand new, boxed and fully guaranteed.

- 1,800 ft. on 7 in. spool 32/6
 - 1,200ft. on 5 1/2 in. spool 22/6
- P. & P. 1/- per spool.

AMERICAN C.B.S. RECORDING TAPE

Brand new, fully guaranteed and with Leader Tape:—
600ft. on 5 in. Spool 17/6
1,200ft. on 5 1/2 in. Spool 25/-
1,800ft. on 5 1/2 in. Spool D.P. 47/-
1,200ft. on 7 in. Spool 25/-
1,800ft. on 7 in. Spool L.P. 35/-
Plus 1/- per Spool P. & P.

First Again!! "THE PREMIER TR/2"

Once again, Premier is first, with another magnificent offer. Introducing the "TR/2" the latest and cheapest addition to our range of popular Recorders.

- Star features:
- ★ Latest BSE Tape Deck, with interlocking device to prevent accidental erasure.
 - ★ Single speed 3 1/2 in. per sec.
 - ★ Playing time 5 1/2 in. std. tape—1 1/2 hours. L.P. tape—2 hrs. 8 mins.
 - ★ Volume on/off and tone control.
 - ★ Power output 3 watts.
 - ★ Input sockets for Microphone, Radio/ Gram.
 - ★ Extension speaker socket.



PRICE including Microphone, Tape and Spare Spool **19 Gns.** Plus 15/- P. & P.

SINGLE PLAYERS

Collaro Junior 4-speed Player complete with Pick-up	£3 15 0
Garrard 4SP 4-speed Player, complete with Pick-up and automatic stop	£6 19 6
Garrard TA Mk. 2, 4-speed Player, wired for stereo, with plug-in Head	£8 10 0
Phillips AG2009, 4-speed Player, with diecast turntable and Microlift, wired for stereo	£10 10 0

P. & P. 3/6 on above units.

RECORD CHANGERS

BSR UA8, 4-speed	£6 19 6
BSR UA8, 4-speed with stereo cartridge	£7 19 6
Collaro Conquest, 4-speed Changer	£7 19 6
Collaro RC457, latest type 4-speed changer	£8 10 0
Garrard RC111 3-speed Changer	£7 19 6
Garrard RC120 Mk. 2, 4-speed	£8 19 6
Garrard RC121/AD, 4-speed	£9 19 6
Garrard RC121 Mk. 2, 4-speed, wired for stereo and with plug-in Head	£10 19 6

P. & P. 5/- on above units.

TRANSCRIPTION UNITS

Garrard 301	£22 7 3	Garrard 4HF (Stereo)	£19 4 8
Garrard 301 (Strobe turntable)	£23 18 4	Garrard 4HF (GC8)	£18 9 8

P. & P. 7/6 on above units.

FOR BARGAINS

MS. RADIOPOST CO.

MAIL ORDER SPECIALISTS

Please quote Dept. M.O.W.W.

36 WINCANTON RD., HAROLD HILL, ROMFORD

HYSTERESIS BLOWER MOTORS

Manufactured by SMITHS Aircraft Instrs. Type: HM1/4. 115 volts 400 cycles. Removed from New Automatic Pilot equipment but in perfect condition.

ONLY 60/- each

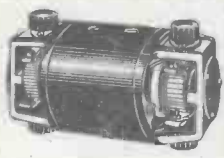
Type HM/14/1, 115 volts 400 cycles. 50/- each. New.



SENSITIVE RELAY: Miniature type. 250 ohms. D.P.D.T. 12 v. D.C. 2 oz. Overall size 1 x 1 1/4 x 1 in. Has adjustable armature tension spring. Will operate on less than 1 m/a. Suitable for all model radio control. Brand New. 15/6 each.

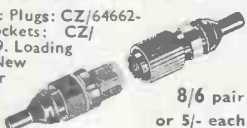
ROTARY TRANSFORMERS TYPE HT.31.

Input: 11.5 volt. Output: 250 volt at 120 mA. Ex-Units but tested, 35/- ea. Type HT.32. Input: 11.5 volt. Output: 490 volt at 65 mA. New, in cartons, 20/- ea.



PLESSEY E.H.T. CONCENTRIC CONNECTORS

Types available: Plugs: CZ/64662-CZ/64658. Sockets: CZ/64661-CZ/64659. Loading 7 to 10 KV. New and unused. For Radar Stations, T.V. Link-ups and atomic research applications.



8/6 pair or 5/- each

MINIATURE MODEL MOTOR

(Not Ex-Govt.). Removed from Transistor Tape Recorders and in perfect condition. 3 to 12 volts. Dual spindle, fully reversible, protected bearings. Approx. 3/4,000 r.p.m. Size: 2 1/2 in. long x 1 in. wide. Spindle: 1/8 in. x 1/16 in.



Only 9/6 each

TRANSDUCERS. Dismantled from Radio Altimeters. This is a moving coil unit with powerful magnet, coil imp. 5 ohms, also fitted is a ceramic cover divided in 2 and silver plated forming the moving vane, cap. about 5-50 P.F. Has possibilities as a Tweeter unit, 7/6 each.

VISUAL INDICATORS

Type 10 Q/4. New. Containing 2 high grade meter movements—30 microamps and 750 microamps, for converting to Multi-meter and exposure meter. Incl. 2 neon lamps and holders 17/6 each.



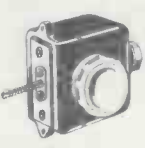
PANEL FUSEHOLDER ASSEMBLY

ZA/US 1054. American pattern. Will take standard cartridge fuses. New. 2/6 each or 6/- pkt. of 3.



LANDING LAMP MOTOR.

A.M. Ref. 5U/3294 12 or 24 volt reversing motor. Complete with magnetic brake. 1 1/2 in. x 1/2 in. spindle with worm drive. Extremely powerful. Ht. 2 1/2 in. x width 2 in. x depth 3 in. (with spindle 4 1/2 in.). New 21/- each.



HEADPHONE AND MICROPHONE ASSEMBLY No. 1.

Moving coil. As used on W.S. No. 19. New and packed 21/- complete assembly.

8 FOOT WHIP AERIALS. Supplied in 2 sections, No. 1 and 2 ZA/26800 and 26286. Each section collapsible down to 1ft., with retaining wire through each section. Ideal also for Radio Control, fishing rod or pennant mast. 7/6 complete. New.

TERMS: C.W.O. or 7 days approved accounts. All our goods are guaranteed new or in working order. Money refunded in full if not absolutely satisfied. Orders despatched same day. No postal or packing charges. (C.O.D. 1/9 extra. Carriage extra Ireland and countries outside U.K.)

R.S.C. A10 ULTRA LINEAR 30 WATT AMPLIFIER

HIGH FIDELITY PUSH-PULL UNIT EMPLOYING SIX VALVES BPS6, EF86, ECC83, 807, 807, GZ34. Tone Control Pre-Amp. stages are incorporated. Sensitivity is extremely high. Only 12 millivolt minimum input is required for full output. THIS ENSURES THE SUITABILITY OF ANY TYPE OR MAKE OR 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, 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. Or Factory built with 12 months' guarantee £13/19/6. TERMS ONLY.



11 gns. ON ASSEMBLED UNITS. DEPOSIT 31/9 and 9 monthly payments of 31/9.
Over an illustrated Type 807 output valves are used with High Quality Sectionally 18/9 extra. Wire 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/s. Tone Controls ± 12 D.B. at 50 c/s. ± 12 D.B. to - 6 D.B. at 12,000 c/s. hum and noise 70 D.B. down. Good quality reliable components used. Carriage finish brass hammer. Overall size 12 x 9 x 9 1/2 in. approx. Power consumption 150 watts. For A.C. mains 200-250 v, 50 c/s. 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 STRING BASS, ELECTRONIC ORGAN, GUITAR, etc. FOR DANCE BANDS, GARRISON THEATRES, etc., etc. We can supply Microphones, Speakers, etc., at cash prices or on terms with amplifiers. EXPORT ENQUIRIES INVITED.

Full Range of Linear High Fidelity Amplifiers Always in Stock. GLSA Miniature 3 Watt Gram Amplifiers
For 200-250 v. 50 c.p.s. A.C. mains. Overall size only 11 1/2 x 2 1/2 in. Fitted Vol. and Tone Control with mains switch. Designed for use with any kind of single player or record changer unit. Output for 3-ohm speaker. Guaranteed 12 months. Only 59/6.

R.S.C. AS 4-5 WATT HIGH GAIN AMPLIFIER
A highly sensitive 4-valve quality amplifier for the home, small clubs, etc. Only 50 millivolt 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 makes. 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. 20 mA, and L.T. of 6.3 v. 1.5 A. is available. Carriage supply of Radio Feeder Unit or Tape Deck pre-amplifier. For A.C. mains input of 200-250 v. 50 c/s. Output for 2-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. TRANSFORMERS. Fully Guaranteed, Interleaved & Impregnated. WE CAN QUOTE FOR SPECIAL OR STANDARD TYPES IN ANY QUANTITY. OUR FACTORY HAS SUPPLIED LEADING EQUIPMENT MANUFACTURERS AND GOVT. DEPTS. FOR 15 YEARS.
MAINS TRANSFORMERS. Primarys 200-250-250 v. 50 c/s. FULLY SHROUDED UPRIGHT MOUNTING.
250-0-250 v. 60 mA., 6.3 v. 2 a., 5 v. 2 a., 24-3-3in. 17/11
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. 27/11
300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. 27/11
350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. 27/11
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a. 33/11
425-0-425 v. 200 mA., 6.3 v. 4 a., ct. 5 v. 3 a. 49/9
450-0-450 v. 250 mA., 6.3 v. 4 a., 5 v. 3 a. 59/9
TOP SHROUDED DROP-THROUGH TYPE
260-0-260 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a. 16/11
250-0-250 v. 100 mA., 6.3 v. 3.5 a. 19/9
250-0-250 v. 100 mA., 6.3 v. 2 a., 6.3 v. 1 a. 21/9
350-0-350 v. 80 mA., 6.3 v. 2 a., 5 v. 3 a. 19/11
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. 25/9
300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. 25/9
300-0-300 v. 130 mA., 6.3 v. 4 a., ct. 6.3 v. 1 a. suitable for Mullard 510 Amplifier 29/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a. 25/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a. 29/9
425-0-425 v. 200 mA., 6.3 v. 4 a., 5 v. 3 a. 47/9

ELIMINATOR TRANSFORMERS
120 v. 40 mA., 5.0-5 v. 1 a. 14/9
90 v. 15 mA., 6.0-6 v. 250 mA. 9/11
FILAMENT TRANSFORMERS
6.3 v. 1.5 a. 5/9
6.3 v. 2 a. 7/9
4.0-6.3 v. 2 a. 7/9
12 v. 3 a. or 24 v. 1.5 a. 17/9
AUTO (Step Up/Step Down) TRANSFORMERS
50-80 watts 110-120 v./220-250 v. 11/9
150 watts 110-120 v./200-250 v. 27/9

OUTPUT TRANSFORMERS
Midget Battery Pentode 06:1 for 3S4, etc. 3/9
Small Pentode 5,000Ω to 3Ω 3/9
Standard Pentode 5,000Ω to 3Ω 5/9
Standard Pentode 8,000Ω to 3Ω 5/9
Push-pull 8 watts 6V6 to 3 ohms 8/9
Push-pull 8 watts EL84s to 15 ohms 8/9
Push-pull 10-12 watts 6V6 to 3Ω or 15Ω 16/9
Push-pull 10-12 watts to match 6V6 to 3-5-8 or 15Ω 17/9
Push-pull EL84 to 3 or 15 ohms 10-12 watts 17/9
Push-pull Ultra Linear for Mullard 510 27/9
Push-pull 15-18 watts, sectionally wound, 6L6, KT66, etc., for 3 or 15 ohms 23/9
Push-pull 20 watt high-quality sectionally wound, 6L6, KT66, etc., or 3 or 15Ω fully shrouded 47/9

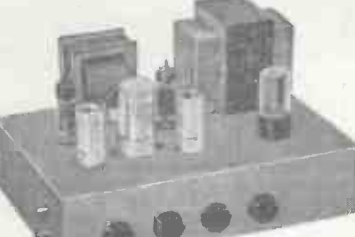
MICROPHONE TRANSFORMERS
120:1 High quality, clamped 6/9
120:1 High quality Mu metal screened 8/9
SMOOTHING CHOKES
250 mA., 5 H., 100Ω 11/9 80 mA., 10 H., 350Ω 5/6
150 mA., 7-10 H., 250Ω 11/9 60 mA., 10 H., 400Ω 4/11
100 mA., 10 H., 200Ω 8/9 1 amp. 0.5Ω L.T. type 6/6

PARMEKO MAINS TRANSFORMERS. Fully shrouded.
500-0-500 v. 120 mA., 6.3 v. 4 a., 5 v. 3 a. 31/9

R.S.C. (MANCHESTER) LTD. MANCHESTER, LEEDS & BRADFORD
Open to callers at the following branches—
5-7 County (Mecca) Arcade, Leeds, 1.
54-56 Morley Street (above Alhambra), Bradford.
8-10 Brown Street (Market St.), Manchester, 2.
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 stated. Trade supplied. Post order to: Mail Order Dept. 29-31 Moorfield Road, Leeds, 12.

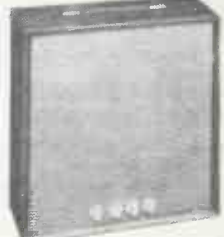
HIGH FIDELITY 12-14 WATT AMPLIFIER TYPE A11

PUSH-PULL ULTRA LINEAR OUTPUT "BUILT-IN" TONE CONTROL PRE-AMP STAGES



Two input sockets with associated controls allow mixing of "mike" and gram, as in A.10 High sensitivity. Includes 5 valves: BOC83, 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 response ± 3 D.B. 30-30,000 c/s. 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 mA. and 6.3 v. 1.5 A. For supply of a RADIO FEEDER UNIT. Size approx. 13.9-in. For A.C. mains 200-250 v. 60 c/s. Output for 3 and 15 ohm speakers. Kit is complete to last out. Chassis is fully punched. Full instructions and point-to-point wiring 8 Gns. Carr. diagrams supplied. (Or factory built 45/- extra.) ONLY 10/- If required louvred metal cover with 3 carrying handles can be supplied for 18/9. TERMS ON ASSEMBLED UNITS. DEPOSIT 24/3 and 9 monthly payments of 24/3. Send S.A.E. for illustrated leaflet detailing ready-to-assemble Cabinets, Speakers, Microphones, etc., with cash and credit terms.

R.S.C. PORTABLE GUITAR AMPLIFIERS



JUNIOR 5 WATT. High Quality Output. Separate Bass and Treble "cut" and "boost" controls. Sensitivity 15 mv. High Flux 6in. /speaker. Input sockets for Radio/Tape or Gram Pick-up and Mike /Instrument Pick-up. Handsome strongy made cabinet (size approx. 14 x 14 x 7in.). Finished in attractive and durable polychrome and fitted carrying handle. Carr. 7/6. Or Deposit £1 and nine monthly payments 21. Send S.A.E. for leaflet.

SENIOR 10 WATTS. High-Fidelity Push-Pull output. Separate Bass and Treble "cut" and "boost" controls. Twin separately controlled high gain inputs so that two instruments such as Guitar and String Bass can be used at the same time. Two Loudspeakers are incorporated in 12in. P.M. for Bass notes and 1 7 x 4in. elliptical for Treble. Cabinet is well made and finished as for 15 Gns. Plus 10/- carr. H.P. TERMS. DEPOSIT 33/9 and 9 monthly payments 33/9. Both models for 200-250 v. A.C. mains.

COLLARO CONTINENTAL 4 SPEED DE LUKE MIXER AUTO-CHANGERS WITH TX88 Transcription Cartridge for standard and L.P. records. For normal 200-250 v. A.C. mains. Few only at unrepeatable price of £10/19/6. Carr. 4/6.

COLLARO CONQUEST 4-SPEED AUTO-CHANGERS. With studio pick-up with turnover head. Latest model for 200-250 v. A.C. mains. £6/19/6. Carr. 4/6.

B.S.R. MONARCH AUTO-CHANGERS. Type USA. 4 speed T/O Pick-up with sapphire stylus £3/19/6. Carr. 4/6.

Any of the above supplied with T/O stereo/monaural head for £1 extra.
COLLARO JUNIOR. 4-speed Single Players with Hi-Fi T/O crystal pick-up head, £3/19/6.

LOUDSPEAKER IN POLISHED WALNUT FINISHED CABINET. Gauss 12,000 lines. Speech coil 3 ohms or 15 ohms. Only £4/19/6. Carr. 5/-. TERMS: DEPOSIT 11/- and 9 monthly payments of 11/-.

12in. 20 WATT 15,000 line /speakers 15 ohms in Cabinet finished as above. Size 18 x 18 x 8in. £7/19/6 or Deposit 17/9 and 9 monthly payments of 17/9.

ACOS HGP59 Hi-Fi Crystal Cartridges. (Turnover type with sapphire stylus.) Standard replacement for Garrard and Collaro. Only 19/9. B.S.R. Ful-Fi 19/9. Garrard GC2 19/9. Acos Stereo/monaural 49/9.

ACOS HIGH FIDELITY PICK-UPS. GP64 with HGP59/52 Cartridge. Turnover sapphire stylus cream finish. Limited number at approx. half price. Only 35/9.

R.C.A. TRANSCRIPTION PICK-UPS. Variable Reluctance type for standard and L.P. Records. Normal price approx. £14. Limited number-brand new perfect at £3/19/6.

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 All or any similar amplifier. Rating is 10 watts. Gauss 12,000 lines. Price only £5/19/6. Or Deposit 13/9 and 9 monthly payments of 13/9.



HEAVY DUTY EX GOVT. SELENIUM RECTIFIERS

With large square aluminium cooling fins. 12 v. 15 amp. F.W. (Bridge). Limited number. 19/6.

EX. GOVT. MAINS TRANSFORMERS

All 200-250 v. 50 c/s. input. Pr. 0-110-200-230-250 v. 275-0-275 v. 100 mA., 6.3 v. 7 a. 5 v. 3 a. 22/9 250 v. 60 mA. 6.3 v. 2 a. 10/11 6.3 v. 2 a., 6.3 v. 1 a., 6.3 v. 2 a., 6.3 v. 0.5 a., 5 v. 3 a., 6.3 v. 5 a., 5 v. 6 a., Potted 27/9 340-0-340 v. 90 mA., 700-0-700 v. 100 mA., Potted 27/9 AUTO 500 watts 0-215-220-225-230-235-240 v. Carr. 7/6 50 watts, 0-110/120/230/250 v. 8/11

MICRO-AMMETERS

500 Micro-amp. Sealed in Decibels. Diameter 3 1/4 in. Flush mounting. 49/6 0-50 micro-amp. Diameter 2 1/4 in. approx. Sealed 29/6 0-100. Flush mounting 13/9 METER RECTIFIERS 0-5 mA. 13/9

EX. GOVT. CASES

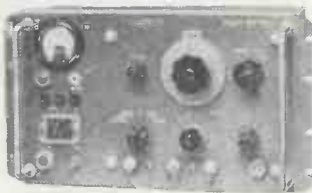
Well ventilated, black crackle finished, un drilled cover. Size 14 x 10 x 8 1/2 in. high. IDEAL FOR BATTERY CHARGER OR INSTRUMENT CASE. COVER COULD BE USED FOR AMPLIFIER. Only 5/9, plus 2/9 post.

FIELD TELEPHONES



Complete including bell. Suitable for office, warehouse, factory or outdoor communications. Operate with small dry battery lasting many months. Supplied complete in wooden carrying case. Only 59/6 Carr. 5/9 each.

WAYNE KERR SIGNAL GENERATORS, TYPE CT53



8.5 to 300 megacycles. Output 1 micro-volt to 10 millivolts. Five position switched attenuator. Variable multiplier 1 to 10, calibrated 0-20 db. C.W. square wave and sine wave outputs. Vernier tuned, 6 Band Call Turret, Potted "C" core transformers. Stabilised H.T. All voltage supplies including mains, R.F. filtered. External mod. by sine wave from 50 c.p.s. to 10 k/c.p.s. or pulses down to 1 µsec. Complete with all valves and charts.

SUITABLE FOR ALIGNING T.V. and V.H.F. RADIO. For 200-250 v. A.C. mains. Beautifully made to very high standards. Worth over £100. Very 17 Carr. 15/- limited number available at only 17 GNS.

EX. GOVT. SMOOTHING CHOKES

60 mA. 10 h. 400 ohms 3/11 150 mA. 10 h. 100 ohms 10/11 80 mA. 20 h. 900 ohms 5/11 120 mA. 12 h. 100 ohms 9/9 100 mA. 5 h. 100 ohms 3/11 200 mA. 5-10 h. 100 ohms 11/9 100 mA. 10 h. 100 ohms 6/9 250 mA. 5 h. 30 ohms 10/9

VOLTMETERS

0-300 v. A.C., 50 c.p.s. Diameter 2 1/4 in. approx. M.I. Only 16/9

VARLEY 2 v. 14 A.H. EX GOVT. ACCUMULATORS

New Boxed. Only 5/9 each, 3 for 15/-, plus 3/6 carr.

PRACTICAL WIRELESS SUPER SIX POCKET PORTABLE

6 Transistor Superhet Radio. Full constructional details etc. 1/6. All required parts including attractive plastic case and dial, printed circuit and first grade transistors. Only £9/19/6

V.H.F./F.M. A.M. 4 WAVEBAND RADIO RECEIVERS

Complete in beautiful veneered Walnut cabinets. Covers normal Short, Medium and Long wavebands plus V.H.F. Brand new and covered by usual 12 months guarantee. For 200-250 v. 50 c.p.s. A.C. mains 12 1/2 Carr 10 GNS.

RADIOGRAM CABINETS

For callers only. Console type size. Beautiful traditional design. Worth £25 at least. Only 12 gns. Suitable AM/FM 3 waveband chassis £12/19/6. Table model type. Polished walnut finish 29/6. SPECIAL OFFER OF ABOVE CONSOLE CABINET and CHAIRSIN. 4-SPEAKER AUTOCHANGER and 8in. SPEAKER. A really exceptional opportunity. Only 31 1/2 GNS.

RELAYS

Carpenter's Type Poised 2 x 9,500 turns at 1,665 ohms. 13/9. Miniature Moving Coil Differential Type. Single pole 2-way, or centre stable. Two coils each 350 ohms. Minimum operating current 400 micro-amps, nominal 400 micro-amps, maximum 8 milliamps. Two-way contact current 100 mA. at 5 v. A.C. or D.C. Size approx. 1 1/2 x 3/4 in. 13/9. Miniature type G.E.C. 670 M1092 sealed, wire ends, 4 colours, platinum. 12/9.

MULTI-METERS

CARY A10 Basic meter, sensitivity 155 micro-amps. A.C. and D.C. Ranges. £17/6. CARY B130. Sensitivity up to 10,000 ohms per volt A.C. and D.C. £3/10. TAYLOR MODEL 127A. 20,000 ohms per volt. 20 Mega. 20 flanges. £10. S.A.E. will bring leaflet on any of above.

Open to callers at following branches:

- 5-7 County (Mecca) Arcade, Bridgate, Leeds, 1. 54-56 Morley Street (above Alhambra Theatre), Bradford. 8-10 Brown Street (Market St.) Manchester, 2.

R.S.C. (Manchester) LEEDS, BRADFORD and MANCHESTER Ltd.

Mail Orders to Head Office and Warehouse, 29/31 Moorfield Road, Leeds, 12. For Terms see double page advert., pages 122 & 123.

BENTLEY ACOUSTIC CORPORATION LIMITED The Valve Specialists 38 CHALCOT ROAD, LONDON, N.W.1

Telephone: PRIMROSE 9090 Nearest Underground: Chalk Farm

EXPRESS POSTAL SERVICE! ALL ORDERS DESPATCHED SAME DAY AS RECEIVED. TELEPHONE AND TELEGRAM ORDERS FOR CASH ON DELIVERY SERVICE ACCEPTED UP TO 3.30 P.M.

Table with multiple columns listing electronic components such as resistors, capacitors, and tubes with their respective values and prices.

Terms of business—Cash with order or C.O.D. only. Post/Packing charges 1d. per item. Orders over £3, post free. C.O.D. 3/6 extra. Any parcel insured against damage in transit for 6d. extra. We are open for personal shoppers. Mon.-Fri. 8.30-5.30. Sat. 8.30-1 p.m.

Latest catalogue of over 1,000 different valves, also metal rectifiers, volume controls, electrolytic condensers, transistors, germanium diodes, valve holders, and Elvac miniature valves, with full terms of business, price 6d.

All valves boxed, fully guaranteed, and new manufacturers' stock or government stores surplus. First-grade goods only, no seconds or rejects. Please enquire for any type not listed. S.A.E. please.

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 2½ in. tube ACR 10. Size 19in. x 7in. x 12in. FEW ONLY AT £10/10/- Carr. 15/-.

TELEPHONE PICK-UP COILS

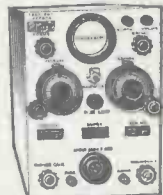
MODEL FC-8 Induction Pick-up coil enabling conversations to be picked up without tapping of wires or special telephone circuits. Simply place telephone on the pick-up platform and connect lead to the input of any medium gain amplifier or direct to any tape, disc, or wire recorder. Brand new complete with 5ft. shielded cable.



Relda Pick-up Coils require no Electrical connections—offer virtually unlimited use.

ONLY 16/- P. & P. 1/6

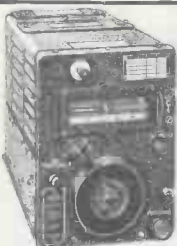
OSCILLOSCOPE MODEL 74



This basic scope represents one of the finest buys we have ever made. Contains Brilliance, Focus, Gain and 2-speed time base controls. Separate X plate terminals. Signal generator modulated at 2 freqs. over 150-255 Mc/s. Complete with 12 valves. VCR 139A tube, internal A.C. power pack and complete circuit and technical details. ONLY 97/6. Carr. 12/6.

PRECISION SIGNAL GENERATOR MODEL SWO-300, 150 Kc/s-300 Mc/s.

An outstanding instrument specially designed to cover the wide frequency range from 150 kc/s-300 Mc/s, which covers all the requirements of equipment in general use. Specifications—FREQUENCY RANGE: 150 kc/s-150 Mc/s. on fundamentals (6 bands). 150 Mc/s-300 Mc/s on harmonics. CALIBRATION ACCURACY: within ±1 per cent. MODULATION: Internal and external. ATTENUATION: To -40 db. OUTPUT: Facilities for high and low. POWER SUPPLY: Internal 230 v. A.C. ACCESSORIES: Test leads and instruction manual. Size 7in. x 10in. x 5in. Only £14/19/6. P. & P. 5/6. FULLY GUARANTEED.



COMMAND TRANSMITTERS

Complete with all Valves, Crystal etc.
3-4 Mc/s.....45/-
4-5.3 Mc/s.....45/-
5.3-7 Mc/s.....45/-

COMMAND RECEIVERS

6-9.1 Mc/s.....60/-
Post & Packing 3/6 each.

BC-221 HETERODYNE CRYSTAL CONTROLLED FREQUENCY METERS

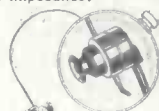
Freq. range: 125 kc/s to 20 Mc/s. Calibration: Individual Calibration Books with numerous Crystal Check points. Accuracy: 0.01% or 25 cycles. Power Supplies: 6 v. and 135 v. batteries. Size 14" x 10½" x 9½". Weight 43 lbs.

Offered for the first time at the ridiculous price of only £25 CARR PAID

AMERICAN LIGHTWEIGHT HEAD SET

They're High and Low Impedance!

These H.S.30 phones are the smallest used by U.S. Air Force. 250Ω imp. using soft rubber miniature ear moulds for maximum music and voice reproduction of the finest quality. Supplied free is a small transformer unit with cord and plug which steps impedance up to 4,000Ω.



ONLY 15/- P. & P. 2/6

PORTABLE TRANS/RECEIVER SETS

ONLY 60/- EACH P. & P. 4/-
2 for £8 post free.
Batteries 20/- Per Set

Designed for reliable voice inter-communication operating up to 10 miles depending upon obstructions and elevation. Covers the whole frequency range between 7.4-9 Mc/s. and is fully tunable on both Transmitter and Receiver. Operates from standard dry batteries 3 v. E.T. and 120 v. E.T. Incorporates 5 valves: R.F. Amplifier, I.F. Amplifier, Second Detector, Output and Power Amplifier. Supplied complete with all accessories comprising dynamic sound powered headphones, electro magnetic super-sensitive microphone, etc. aerial, junction box, battery connection details and full circuit diagram.

AERIAL VARIOMETERS



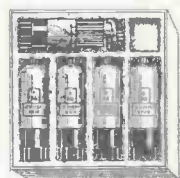
These magnificent instruments will enable you to receive maximum signal strength on all short wave receivers. Precision calibrated control. 12/6. P. & P. 2/6.

POCKET VOLT TEST METER



Two D.C. ranges: 0-250 v. and 0-25 v. Complete with test leads and leather case. Very limited quantity. Only 12/6. P. & P. 1/6.

SPARE VALVE KIT



Here's a gift for all 36 and 18 set owners! Case containing 4 ARP12 and 1 ATP4 valves.

Only 10/- P. & P. 2/6.

U.S.A. BC 312 RECEIVERS.

9-valve Superhet Receiver plus Rectifier with built-in 12 v. D.C. Power Supply. Panel tunable on ckt. and 2 R.F. stages give 0.5-1.5 μv sensitivity for 10 M.W. output. Phase controllable crystal filter gives selectivity. Best bandwidth and logging. Vernier knob as 90:1 and fast knob 25:1 ratio. Log scale and the band being tuned appear on dial (1.5-18 Mc/s on 6 Bands). 6C5 oscillator 470 kc/s above B.F. on three 3 bands, below on upper 6L7 mixer, 2-6K7 I.F.A., 6R7 det., A.V.C. 1st A.F. 6C5 pitch controllable oscillator, 6F6 and 6W4 rectifier. Gain control is R.F. on M.V.C., A.F. on A.V.C. Power supply is removable as a unit for Marine or Mobile use. With crystal valves and manual.

FEW ONLY AT £20 Carr. 20/-

CRYSTAL MIXE INSERTS



1" dia. 70-6000 c/s response. Brand New Only 6/6 P. & P. 6d.

ACCUMULATORS. 2 volts 16 A.H. (unspillable). Ideal for 6 and 12 volt supply, etc. Brand new. Original cartons. Size 4in. x 7in. x 2in., 5/6 each. P. & P. 1/8, 3 for 15/- P. & P. 3/6. 6 for 27/6. P. & P. 5/-.



R.C.A. AR-88 RECEIVERS

SPECIFICATION: Range: 73-550 kc/s and 1.48-30.5 mc/s. Power Supply: 110/260 v. A.C. Power Output: 2.5 W. into 2.5 or 600 ohm line or H.I. Headphones. Sensitivity: From 15 to 2.5 μv per 500 mW. Image Ratio: From 1,000,000 at 60 kc/s to 200 at 28 Mc/s. Circuit: Two R.F. stages (6SG7); Oscillator (6J5); Frequency Changer (6SA7); Three I.F. stages (6SJ7); A.V.C./Detector (6H6); Noise Limiter (6-6); Audio Amplifier (6SJ7); Power Output (6K6); B.F.O. (6-5); Voltage Regulator (VR-150); Rectifier (5Y3); I.F.—455 kc/s. Size: 19½ x 11 x 19½in. FULLY GUARANTEED. Model AR-88 L.F., £37/10/- Carr. 50/- FEW ONLY!

VARIABLE TRANSFORMERS



● Input Voltage 230 v. continuously variable output from 0-260 v. ● GOOD REGULATION. Output voltage is substantially independent of load. ● SMOOTH CONTROL. Can be set closely to any output voltage within its range. ● HIGH EFFICIENCY. Very low losses under all load conditions. ● LONG LIFE. The same as that of any standard fixed-ratio power transformer when operated at rated loads. ● SMALL SIZE. Smaller than any other type of control of equal power rating. ● LINEAR OUTPUT VOLTAGE. Continuously adjustable from zero to 30% above-line voltage by a 320-degree rotation of the knob. The dial is calibrated to read directly in output voltage at rated line voltage. ● DIRECT-READING DIALS. All models are supplied with reversible direct-reading dials. Large white figures, easy to read at a distance. ● MODERATE TEMPERATURE RISE. Less than 50 degrees C. for continuous use. ● ADVANCED MECHANICAL DESIGN. Rugged construction—no delicate parts—protected with a strong iron cover. ALL FULLY GUARANTEED. DELIVERY EX-STOCK.

MODEL B.5
Current rating 5 amps.
£9.0.0
MODEL B.20
Current rating 20 amps.
£32.10.0

Mail Orders:

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Callers:

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Shop at RELDA for EVERYTHING IN ELECTRONICS

Each Model incorporates the highly successful HF/TR3 Amplifier (described opposite), thus ensuring truly "Hi-Fi" record and playback facilities.

All prices quoted provide for the COMPLETE RECORDER including CRYSTAL MICROPHONE and 1,200ft. Spool of Tape.

There are no "better value for money" Tape Recorders on the market—if you can't call and hear them send S.A.E. for fully descriptive leaflets.



Stern's "fidelity" TAPE RECORDERS

BEFORE YOU BUY—YOU SHOULD HEAR THESE RECORDERS—THEY ARE COMPARABLE TO THE MUCH HIGHER PRICED MODELS

- MODEL CR3/S. Incorporates the new Collaro "STUDIO" TWIN TRACK 3-speed Deck **£39.10.0**
H.P. Terms: Deposit £7/18/- and 12 months of £2/17/11.
- MODEL CR3/T. Incorporates the very popular 3-speed COLLARO Mk. IV "TRANSCRIPTOR" Deck, which has both upper and lower tape tracks **£47.10.0**
H.P. Terms: Deposit £9/10/- and 12 months of £3/9/8.
- MODEL TR3/Mk. VI. Incorporates the New TRUVOX Mk. VI TWIN TRACK 2-speed Tape Deck **£49.10.0**
H.P. Terms: Deposit £9/18/- and 12 months of £2/19/7.

TAPE AMPLIFIERS and PREAMPLIFIERS presented from MULLARD DESIGNS

MULLARD TYPE "C" TAPE-PREAMPLIFIER ERASE UNIT

The "Hi-Fi" link to add full tape recording facilities to High Fidelity home installations. Incorporates FERROXUBE POT CORE PULSE-PULL OSCILLATOR and 3-speed cable equalisation by FERROXUBE POT CORE INDUCTOR. FOR WEARITE—COLLARO—TRUVOX or BRENNELL TAPE DECKS. (STATE which when ordering.) Includes separate Power Supply Unit. **£14.0.0** or ASSEMBLED **£17.0.0**
H.P. £3/8/- Deposit and 12 months at £1 4 11.
(Excluding Power Unit £11/15/- and £14/10 - respectively.)



MODEL HF/TR3 TAPE AMPLIFIER

(Mullard Type "A" design)
A very high quality Amplifier incorporating 3-speed treble equalisation, using the latest FERROXUBE POT CORE INDUCTOR. FOR COLLARO-TRUVOX-BRENNELL or WEARITE Tape Decks, (STATE when ordering) has GILSEN Output Transformer. Includes separate Power Supply Unit. **£12.15.0** or ASSEMBLED **£16.10.0**
H.P. £3/6/- Deposit and 12 months at £1 4 2.



FOR THE HOME CONSTRUCTOR SPECIAL "COMBINED ORDER" PRICES

- (a) The COLLARO "STUDIO" TAPE DECK and our Mullard Type "C" PRE-AMPLIFIER and Power Unit assembled and tested **£29.10.0**
 - (b) As above but Type "C" PRE-AMPLIFIER supplied as complete Kit of Parts **£26.10.0**
 - (c) The COLLARO Mk. IV TAPE DECK and the MULLARD Type "C" PRE-AMPLIFIER and Power Unit assembled and tested **£35.0.0**
 - (d) As above but the Type "C" supplied as complete Kit of Parts **£32.0.0**
 - (e) The TRUVOX Mk. VI TAPE DECK and the assembled Type "C" PRE-AMPLIFIER and Power Unit **£40.0.0**
 - (f) As above but the Type "C" supplied as complete Kit of Parts **£36.10.0**
 - (g) The BRENNELL Mk. V Deck and the assembled Type "C" PRE-AMPLIFIER and Power Unit **£46.0.0**
 - (h) As above, but the Type "C" supplied as complete Kit of Parts **£43.0.0**
 - (i) The WEARITE 4A DECK with Type "C" assembled and tested **£56.0.0**
 - (j) As above, but the Type "C" supplied as complete Kit of Parts **£43.0.0**
 - (k) The COLLARO "STUDIO" TAPE DECK and our Mullard Type "A" TAPE AMPLIFIER and Power Unit assembled and tested **£25.10.0**
 - (l) As above but Type "A" TAPE AMPLIFIER supplied as complete Kit of Parts **£29.0.0**
 - (m) COMPLETE KIT to build the HF/TR3 together with the Mk. IV COLLARO "TRANSCRIPTOR" DECK (£1 extra if we are required to wire up Deck switches.) As above but HF/TR3 ASSEMBLED and TESTED H.P. Terms: Deposit £7, 12 months at £2/10/5. (£1 extra if we are to wire up Deck Switch Banks.) **£34.10.0**
 - (n) COMPLETE KIT to build the HF/TR3 together with the NEW TRUVOX Mk. VI TAPE DECK **£36.0.0**
 - (o) As above but HF/TR3 ASSEMBLED and TESTED H.P. Terms: Deposit £7/18/-, 12 months of £2/17/11. **£39.10.0**
 - (p) COMPLETE KIT to build the HF/TR3 AMPLIFIER with the BRENNELL Mk. V TAPE DECK **£41.10.0**
 - (q) As above but HF/TR3 ASSEMBLED and TESTED H.P. Terms: Deposit £9, 12 months of £3/6/-. **£45.0.0**
 - (r) THE ASSEMBLED and TESTED HF/TR3 AMPLIFIER with the WEARITE MODEL 4A DECK, incorporates Wearite Head Lift Transformer, etc. **£55.0.0**
H.P. TERMS: Deposit £11, 12 months of £4/0/8.
(Carriage and insurance on each above is 10/- extra.)
- Attractive PORTABLE CASE is available to accommodate the TRUVOX or COLLARO TAPE DECKS and we offer it together with ROLA/CELESTION 10 x 6in. LOUDSPEAKER—ACOS CRYSTAL MICROPHONE—and 1,200ft. SPOOL E.M.I. TAPE—ALL FOR **£9.10.0**
(Carriage and Insurance 5/- extra.)

A LARGE PURCHASE OF BRAND NEW and FULLY GUARANTEED TRUVOX and GARRARD TAPE EQUIPMENT ENABLES THESE OUTSTANDING PRICE REDUCTIONS



THE "MODEL HF/G2R" PORTABLE TAPE RECORDER (Original Price £33.0.0)

FOR ONLY **£22 GNS.** H.P. Dep. £4/14/-, 12 months £1/13/9. (Carriage and Ins. 10/- extra.)

INCORPORATES THE LATEST GARRARD "MAGAZINE" TAPE DECK and MATCHING AMPLIFIER. Based on the successful MULLARD TYPE "A" DESIGN and specifically developed to operate the GARRARD DECK. PRICE INCLUDES THE GARRARD TAPE MAGAZINE and 4in. SPOOL OF DOUBLE PLAY TAPE. A Twin Track Recorder operating at 3 1/2 in./sec. providing up to 1 hour 10 mins. playing time. The outstanding features being excellent performance and simplicity of operation. Incorporates EXT. SPEAKER SOCKET, also operates as independent amplifier for direct reproduction from P.U., mike or Radio tuner. Weights only 2 1/2 lbs.

WE ALSO OFFER DECK and AMPLIFIER CONNECTED, TESTED, FOR IMMEDIATE OPERATION, 19 cms. H.P. Dep. £4 and 12 months £1/0/4. Carriage and Ins. 10/- ex. INCLUDES SPEAKER, Tape Magazine and 4in. Spool of Double Play Tape. Comprises a complete tape recorder chassis ready for easy fitting into cabinet.

THE "MODEL TK/Mk. IV" PORTABLE TAPE RECORDER (Original Price £49/10/-)

FOR ONLY **£36.10.0** PRICE INCLUDES A 7in. SPOOL OF EMI TAPE. H.P. Dep. £7/8/- and 12 months £2/13/6. (Carriage and Insurance 10/- extra.)

INCORPORATES THE TRUVOX Mk. IV TAPE DECK ROLA/CELESTION 9 x 5in. LOUDSPEAKER and the Truvox Type 4 KW AMPLIFIER specifically developed by Truvox Ltd. to correctly operate their Mk. IV Tape Deck. This combination affords first-class tape recording facilities.

A Twin Track Two Speed model operating at 3 1/2 and 7 1/2 in./sec. Incorporates SAFETY BUTTON (prevents accidental erasure), Ext. Speaker, TONE and VOLUME CONTROLS, also operates as independent AMPLIFIER for direct reproduction from P.U., mike or Radio tuner.

WE ALSO OFFER THE DECK and AMPLIFIER AS FOLLOWS: Mk. IV TAPE DECK, £16/10/-, H.P. Deposit £3/8/-, 12 months £1/4/3. TYPE "K" AMPLIFIER, £15. H.P. Deposit £3, 12 months £1/2/9. COMBINED ORDER FOR BOTH DECK AND AMPLIFIER, £30. H.P. Deposit £6, 12 months £2/4/-. (Carriage and Insurance 5/- extra.)



STERN RADIO LTD. DEPT. W. 109 FLEET ST., LONDON, E.C.4
Telephone: FLEET STREET 5812/3/4

FULLY DESCRIPTIVE LEAFLETS ON ALL OF ABOVE ARE AVAILABLE—BUT PLEASE ENCLOSE S.A.E.

STERN'S MULLARD DESIGNS

COMPLETE KIT OF PARTS

Designed by MULLARD—presented by STERNS strictly to specification

MULLARD "5-10" MAIN AMPLIFIER

For use with the MULLARD 2-stage pre-amplifier with which an undistorted power output of up to 10 watts is obtained. We supply SPECIFIED COMPONENTS AND NEW MULLARD VALVES including PARMEKO MAINS TRANSFORMER and choice of the latest Ultra-linear PARMEKO or the PARTRIDGE Output Transformer.

Price: COMPLETE KIT (Parmeko Output Trans.) **£10.00**
Alternatively we supply ASSEMBLED AND TESTED **£11.10**

ABOVE INCORPORATING PARTRIDGE OUTPUT TRANSFORMER £1/6/- extra.

MULLARD'S 2-VALVE

PRE-AMPLIFIER TONE CONTROL UNIT

Employing two 6F8 tubes and designed to operate with the Mullard MAIN AMPLIFIER but also perfectly suitable for other makes. Supplied strictly to MULLARD SPECIFICATION and incorporating:

- Equalisation for the latest R.I.A.A. characteristics.
- Input for Crystal Pick-ups and variable reluctance magnetic types.
- Input (a) Direct from High Imp. Type Head, (b) From a Tube Amplifier or Pre-Amplifier.
- Sensitivity Microphone Channel.
- Wide range BASS and TREBLE Controls.

Price: COMPLETE KIT OF PARTS **£6.60** ASSEMBLED AND TESTED **£8.00**



COMPLETE MULLARD 5-10 AMPLIFIER

The popular and very successful complete "5-10" incorporating Control Unit providing up to 10 watts high quality reproduction.

Specified components and new MULLARD VALVES are supplied including PARMEKO MAINS TRANSFORMERS and choice of the latest PARMEKO or PARTRIDGE Ultra Linear Output Transformers.

Price: COMPLETE KIT, Parmeko Transformer **£11.10**

Alternatively we supply ASSEMBLED AND TESTED **£13.10**

Hire Purchase (Assembled Amp. only). Deposit £2/14/-, 12 months at 10/10

ABOVE incorporating PARTRIDGE OUTPUT TRANSFORMER £1/6/- extra.



COMPLETE MULLARD 3-3

A VERY HIGH QUALITY AMPLIFIER DEVELOPED FROM THE VERY POPULAR 3-VALVE 3-WATT AMPLIFIER DESIGNED IN THE MULLARD LABORATORIES.

Price for COMPLETE KIT OF PARTS **£7.10**
(Plus 6/6 carriage and insurance).
Alternatively supplied ASSEMBLED AND FULLY TESTED (Plus 4/6 carriage and insurance) **£8.19.6**

H.P. TERMS: Deposit £2 and 8 monthly payments of £1.

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.

STEREO "3-3" MAIN AMPLIFIER

Comprises two MULLARD 3-3 Main Amplifiers on one chassis. Operates with MULLARD STEREO PRE-AMPLIFIER. Output power 6 watts. Inputs for Crystal Pick-up and Radio Tuner.

Price: COMPLETE KIT OF PARTS **£10.00** or ASSEMBLED **£11.15.0**

An attractively presented Unit incorporating MULLARD PERMEABILITY TUNING HEART and corresponding Mullard valve line-up. Very suitable to operate with our Mullard Amplifiers.

FOR THE CONSTRUCTOR **£10.10.0** or ASSEMBLED **£14.5.0**

SPECIAL CASH ONLY OFFER !!

The 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 Resin—WE ALSO SUPPLY SEPARATELY:—

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- (b) The PORTABLE CARRYING CASE **£3 17 6** (Carriage and Insurance 1/- extra)
- (c) 6" In. P.M. SPEAKER **18 9**

"Hi-Fi" LOUDSPEAKERS WE HAVE IN STOCK A COMPLETE RANGE BY GOODMAN'S WHARFEDALE—W.B.

ILLUSTRATED AND PRICED LEAFLETS ON REQUEST

THE "ADD-A-DECK"

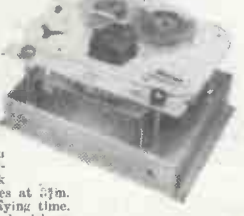
INCORPORATING GARRARD "MAGAZINE" TAPE DECK and the MATCHED MODEL HF 02P PREAMPLIFIER. Supplied on ONE CHASSIS (as illustrated) READY FOR USE.

PRICE: Including GARRARD MAGAZINE and a 4in. SPOOL DOUBLE PLAY **18 gns.**

H.P. Deposit: £3/16/- and 12 months at £1/7.8.

Provides complete tape recording facilities and designed to operate through the pick-up sockets of the standard type of RADIO RECEIVER or an AMPLIFIER, from which really first class reproduction is obtained. It consists of a Twin Track Deck connected to the Pre-amplifier and operates at 3 1/2 in./sec. speed, providing up to 1 hour 10 mins. playing time. Only needs connecting to the mains supply and pick-up sockets. Very simple to operate and easily installed in a cabinet, only four fixing screws being required.

H.P. TERMS ARE AVAILABLE ON ALL EQUIPMENT OVER £9. FULLY DESCRIPTIVE LEAFLETS ARE AVAILABLE FOR ALL EQUIPMENT, BUT PLEASE SEND S.A.E.



PRICE REDUCTIONS

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- (b) The "5-10" and the 2-Stage Pre-Amplifier both Assembled and Tested **£18.18.0**
H.P. TERMS: Deposit £3/16/- and 12 months of £1/7.8.
- (c) The COMPLETE KIT OF PARTS to build the Dual Channel "3-3" Amplifier and the Dual Channel Pre-Amplifier Control Unit **£21.10.0**
- (d) The Dual Channel "3-3" Amplifier and the Dual Channel Pre-Amplifier Control Unit both Assembled and Tested **£25.0.0**
H.P. TERMS: Deposit £5 and 12 months of £1/16/8.
- (e) The COMPLETE KIT OF PARTS to build one "5-10" Main Amplifier (Parmeko Transformer) and the Dual Channel Pre-Amplifier Control Unit **£21.10.0**
H.P. TERMS: Deposit £5 and 12 months of £1/16/8.
- (f) One "5-10" Amplifier (Parmeko Transformer) and the Dual Channel Pre-Amplifier both Assembled and Tested **£25.0.0**
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Prices quoted are subject to £1/6/- extra for Partridge Trans.

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Self powered with Cathode follower output. Incorporates Two Inputs for CRYSTAL MICROPHONES, one for CRYSTAL PICK-UPS and a Fourth for Radio or Tape. KIT OF PARTS ASSEMBLED AND TESTED **£10.0.0**
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Model I.L.C. one microphone input matched for moving coil or ribbon mike £1/7/- extra.



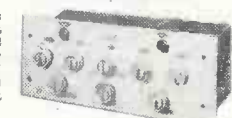
COMPLETE STEREO AMPLIFIER

Meets the many requests for a low priced but good quality Stereophonic Amplifier. Output power 4 watts. Inputs for Crystal Pick-ups and Radio Tuner.

KIT OF PARTS **£8.10.0** or ASSEMBLED **£10.10.0**

STEREO DUAL CHANNEL PRE-AMPLIFIER

This model incorporates two 2-valve Pre-Amplifiers (described above) combined into a Single Unit enabling it to be used for both STEREO PHONO and MONAURAL operation. It is designed primarily to cover our full range of MULLARD MAIN AMPLIFIERS but will also operate equally well with any make of Amplifiers requiring an input of 250 mv.



Price: COMPLETE KIT OF PARTS **£12.10.0** Alternatively ASSEMBLED AND TESTED **£15.0.0**
H.P. Terms on assembled unit: £3 Deposit and 12 months of £1/2/-.

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Many at REDUCED PRICES!!! Send S.A.E. for ILLUSTRATED LEAFLET



- THE EMI 4-speed single record player with separate crystal pick-up **4 gns.**
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- THE E.M.I. 4-speed Single Record Player, incorporating a high output crystal pick-up **£8. 9.6**
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- UA12 is also available incorporating the B.S.R. STEREO Pick-up, plays L.P. and 78 records **£10.10.0**
- GARRARD RC209 4-speed Autochanger fitted with latest Crystal Pick-up **£9.10.0**
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- The new GARRARD Model 4HF High Quality Single Record Player fitted with the latest T.P.A. 12 Pick-up arm and G.C.B. Crystal Cartridge **£18.7.6**
- GARRARD Model TA/Mk. II Single Record Player fitted with high output Crystal Pick-up, detachable head **£8.10.0**

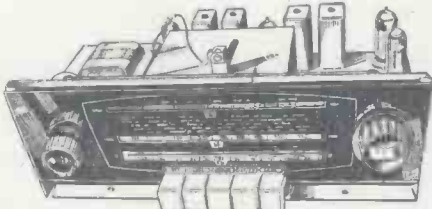
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A RANGE OF "EASY TO ASSEMBLE" PREFABRICATED CABINETS Designed by the W.B. "STENTORIAN" COMPANY for "Hi-Fi" Loudspeaker systems or to accommodate high quality equipment. The acoustically designed Bass Reflex Cabinets containing the very successful "Stentorian" speakers give really first-class reproduction and are well recommended. Models are also available to accommodate high-quality Amplifiers, Pre-amplifier, 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 RADIO LTD. DFT. W. 109 FLEET ST., LONDON, E.C.4
Telephone: FLEET STREET 5812/3/4

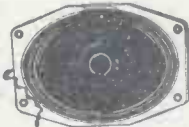
BRAND NEW AM/FM (V.H.F.) CHASSIS AT £13.6.8. (P. & P. 10/-)



Tapped input 200-225 v. and 226-250 v. A.C. ONLY.
Chassis size 16 x 6 1/2 x 5 1/2 in. high. New manufacture. Dial 1 1/2 x 4 in. in gold and black. Pick-up Extension speaker, Ac., E., and Dipole sockets. Five "plano" push buttons—OFF, L.W., M.W., P.M. and Gram. Aligned and tested.
With all valves & O.P. Transformer, Tone-control fitted.
Covers 1,000-1,900 M., 200-500 M.; 89-99 Mc/s.
Valves EZ80 rect., ECH81, EF89, EABC90, EL84, EOC85. Speaker and Cabinet to fit chassis, 47/6.
10 x 6 in. ELLIPTICAL SPEAKER, 20/- to purchasers of this chassis.
TERMS:—Chassis £5/7/6 down inc. cart.—and 6 monthly payments of 30/-, or with Cabinet and Speaker £5/10/- down and 7 monthly payments of 32/-.

3-VALVE AMPLIFIER (INCL. RECT.)

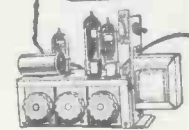
Capable of giving 4 watts. Mains and output transformer. Valves EOC85, EL84, EZ80, 3 Controls, volume, bass and treble. On/Off switch. Fully guaranteed. Chassis size 6 1/2 x 3 x 2 1/2 in.; with 7 x 4 in. elliptical speaker or 6 1/2 in. round (Goodmans); state which.
ONLY 75/- (3/- P. & P.).



13-CHANNEL TUNER

I.F. 34-38 Mc/s. requires valves PCF80 and PCC84. Removed from chassis but in working order.

7/6 (2/6 P. & P.) Knobs 2/6 extra.



50 SILVERED MICA AND CERAMIC CONDENSERS, 10/- 50 RESISTORS 5/-
144 yds. 1mm. P.V.C. flexible sleeving 10/- post paid.

NEW WAXED TUBULARS, 350 v. or above, 3 of each. .001, .002, .005, .01, .02, .05, .1mF, .25, .5mF, Total 21 for 4/6 (post 9d.). Not more than 3 of one type.

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all 4 speed; all with turnover cartridge, crystal—all 5/- extra cart.
Collam Conquest—£7/10/0; B.S.R. UA8—£6/10/0; UA8 Stereo—£8/17/6; B.S.R. latest UA14—£7/10/0.

GRAMOPHONE AMPLIFIER

with 5 in. SPEAKER On Fabric-covered Baffle 12 1/2 x 6 in. Mains and Output Transformers. EZ40 and EL41 Valves. Tone and Volume Controls. On/Off switch. Plenty of Volume. Fully Guaranteed.
ful for stereo. ONLY 63/-, post 3/-.

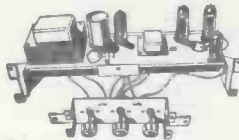


Two Knobs supplied. Ready to play. Use

PUSH-PULL AMPLIFIER £4/15/-

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Brand new 200-240 A.C. mains. Bass, treble and vol. controls flying panel. With valves EZ80, EOC83 and 2-EL84 giving full 8 w. Chassis 12 x 3 1/2 x 3 1/2 in. With o.p. trans. for 2-3 ohm speaker.

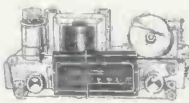


STEREO VERSION on same Chassis £5/15/- (P. & P. 3/-).

A Quality Tape Recorder. Valves EZ80, EOC83, ECL82, DM70 Record Level Indicator, Acos Crystal Mike. 850ft. Emitape. Extra spool. 3 1/2 in./sec. B.S.R. Monardeck (1) Vol. (2) On/Off Tone. (3) Ext. L.S. (4) Monitor. (5) Radio Input. (6) Mike Input. Fast forward and reverse controls. Cabinet size 14 x 11 1/2 x 7 in. Today's Best Value at 17 Gns. (10/- P. & P.). Low Interest Terms: £4 down and 5 monthly payments of £3. Write for descriptive leaflet.

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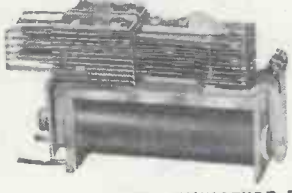
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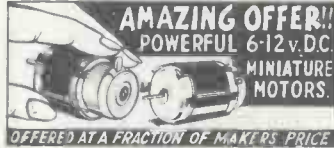
Siemens High Speed Sealed	2.202 + 2.202	H06A	15/6	2Ω	S.T.C. and G.E.C. Scaled	2 C.O.	4184GA	18/6
14332 + 14331	H06C	19/6	7000Ω	2 C.O.	4184GD	19/6		
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 Comprehensive range available from stock.



TELEPHONE SET TYPE "A." Ringing and speaking both ways on a four-core cable. Carries the voice loudly and clearly over any distance. Two handsets are supplied as illustrated and the set is complete with Pushes, Buzzers, Battery, Plugs and Sockets. We can supply 4-core PVC cable at 10d. per yard or 2-core at 3d. per yard extra. Price 75/- set, post 3/6.
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RESISTORS EX STOCK, IN QUANTITY WIRE WOUND, HIGH STABILITY CARBON ETC., BEST MAKES AT LOWEST PRICES.



MINIATURE PRECISION MOTOR, 12 v. D.C. Size 1 1/2 x 1 1/4 in. diam. Latest development. Extremely powerful with low consumption. Weighs as little as two ounces and totally enclosed in polythene protective case. Three position switch; forward, reverse and stop.

7,000 r.p.m., self lubricating and long life sintered bronze bearing, 15/6, post 9d. Ask for free length of polythene flexible drive.

ROTARY CONVERTERS. Input 12 v. D.C. Output 230 v. A.C. 50 cy. 135 watts. The ideal job for T.V. and tape recorders where A.C. mains are not available. £8/10/-, cge. 10/-. Also available with 24 v. D.C. input at same price.

ROTARY CONVERTER. Input 24 v. D.C. Output 220 v. A.C. 250 watts. Pedestal type with D.P. Ironclad switch, BRAND NEW, £17/10/-, carr. 15/-.

BATTERIES. Portable Lead Acid type, 6 volts 125 ampere hours. In metal case 1 1/2 in. x 8 in. x 1 1/2 in. (Two will make an ideal power supply for our 12 volt Rotary Converters.) Uncharged £6/10/- each, carriage 15/-. 24 volts 85 ampere. £14 each, carriage 15/-.

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H.P. CAPACITOR MOTORS
 230/240 volts, 50 cycles, 1420 r.p.m. 1/2 in. shaft, resilient mounting. Or with 1/4 in. shaft on Standard foot mounting. Either type, £5/10/-, carriage 10/.

VACUUM PUMP AND COMPRESSOR. Edwards type, IV, 1/4 in. shaft, complete with flywheel, couplings, oil filter and union. £6/10/-, post 3/6.

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 Single pole changeover, 3 amp. 250 volts, 1/6 ea., 12/- doz., £37/10/- per doz.

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MAINS TRANSFORMERS to suit above rectifiers.
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Counting to 9999.
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SATCHWELL THERMOSTATS adjustable between 70°-100° Fahrenheit. 0-440 v. A.C., 20 amps., 1 1/2 in. stem. Fitted cover: 25/-, post 2/6.
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SOLENOIDS suitable for remote control, mechanical indicators, etc. 12 v. D.C. 400 mA, 30Ω, 3/4 in. arm, 1/4 in. movement, 5/- each, post 1/6.
TERMINAL BLOCKS. 2-way 4/- doz., or box of 50 for 15/-, 3-way 6/- doz., 50 for 22/6, post 1/6.

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100 Microamp	3 1/2 in.	MC/FR	80/-
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250 Microamp	2 1/2 in.	MC/PR	40/-
500 Microamp	2 1/2 in.	MC/FR	37/6
1 Milliamp	2 1/2 in.	MC/FR	35/-
2 Milliamp	2 1/2 in.	MC/FR	25/-
30 Milliamp	2 1/2 in.	MC/FR	15/-
100 Milliamp	2 1/2 in.	MC/FR	15/-
200 Milliamp	2 1/2 in.	MC/FR	15/-
1 Ampere	2 1/2 in.	MC/FR	35/-
3 Ampere	2 1/2 in.	MC/FR	35/-
5 Ampere	2 1/2 in.	MC/FR	35/-
10 Ampere	2 1/2 in.	MC/FR	35/-
20 Volts	2 1/2 in.	MC/FR	35/-
30 Volts	2 1/2 in.	MC/FR	35/-
40 Volts	2 1/2 in.	MC/FR	35/-
500 Microamp	2 in.	MC/FR	25/-
1 Milliamp	2 in.	MC/FR	27/6
5 Milliamp	2 in.	MC/FR	27/6
10 Milliamp	2 in.	MC/FR	27/6
20 Volts	2 in.	MC/FR	27/6
30 Volts	2 in.	MC/FR	27/6
40 Volts	2 in.	MC/FR	27/6
15 Amps	2 in.	MC/FR	12/6
3 Amps	2 in.	MC/FS	27/6
5 Amps	2 in.	MC/FS	27/6
30-0-30 Amps	2 in.	MC/FR	15/6
50-0-50 Amps	2 in.	MC/FS	12/6
500 Milliamps A.C.	3 1/2 in.	MI/FR	30/-
25 Amps D.C.	2 1/2 in.	MI/FR	7/6
50 Amps A.C.	4 in.	MI/FR or PR	65/-
300 Volts A.C.	2 1/2 in.	MI/FR	25/-

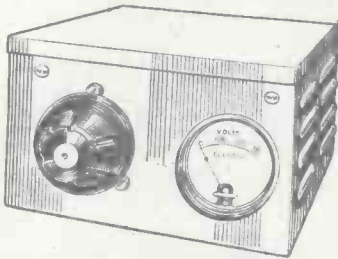


Postage on meters 1/6



New Taylor pocket-size Multimeter Model 127A. 20,000 ohms per volt, 20 megohms, 20 ranges, A.C. & D.C. £10. Post 2/6. Complete list of meters available.

FREQUENCY METERS. 45-55 cycles per second 230 volts, 6in. dia. Flush mount. Brand new in maker's box, £10/10/-, post 3/6.
METER RECTIFIERS 250µA 1 M.A., 5 M.A., F.W. bridge, 8/6, post 6d.
AMMETER. 0-3 amp D.C., by Turner, MC/FR, 6in. 90/-, post 2/6.
MICROAMMETER. 250 F.S.D. 3/4 in. F.R. Sangamo Mod. S37. Scaled for valve voltmeter. Circuit available free, 55/-, post 1/6.
UNI-PIVOT GALVANOMETER, by Cambridge Instruments, 50-0-50 microamps, 4in. dia. Knife pointer, mirror scale. Complete with leather carrying case. Ideal for laboratory use, £10, carriage 3/-.
PORTABLE VOLTMETER. 0-100 volts A.C./D.C. accuracy within 2%. 8in. mirror scale, knife pointer, in polished case. A precision moving iron instrument at a very low price, £4/19/6, post 3/6.
PORTABLE AMMETER. 0-3 amp. A.C./D.C. 3in. scale in case with handle, 35/-, post 2/6.
AVO TEST BRIDGES. 220/240 volt A.C. Measure capacities from 5pf. to 50 mfd. and resistances from 5 ohms to 50 megohms. Valve voltmeter range 0.1 to 15 volts and condensers leakage test, £9/19/6, post 3/-.
RACKS - POST OFFICE STANDARD. 6ft. high with U-channel sides drilled for 1 1/2 in. panels, heavy angle base.
SLYDLOK FUSES. 15 amp. with revivable cartridge fuse. Latest type G15 M.M. Complete with studs, nuts and washers, 3/6 each, post 6d. Also available 100 amp., type M.M. G 90, 14/6, post 1/-.
L. WILKINSON (CROYDON) LTD.
 19 LANSLOWNE RD. CROYDON SURREY
 Phone: CRO 0839 Grams: WILCO CROYDON



BRAND NEW VARIABLE VOLTAGE TRANSFORMER. 230 volt A.C. input. Fitted in steel hammer finish case complete with 0-300 volt M.C. A.C. Meter, fuse and neon indicator light. Output constantly variable from 0-270 volt A.C. Type 1. 2.2 amp. Price £8/10/-, carriage 10/-, Type 2. 5 amp. Price £12, carriage 10/-.

BRAND NEW VARIABLE VOLTAGE TRANSFORMER. For 230 volt A.C. input. In cases as above with meter, fuse and indicator light. Output constantly variable from 0-230 volt A.C. Type 15. 15 amp. Price £22/10/-, Carr. 15/-.

W. W. RHEOSTAT. New. 3.5K or 5K 25 watts. Price 7/6. P. & P. 1/6.

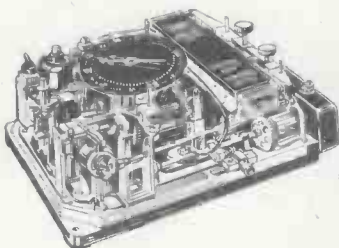
NEW WIRE WOUND RHEOSTAT ON CERAMIC. 58 ohm. 50 watt, complete with instrument knob. Price 8/6. P. & P. 1/6.

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.

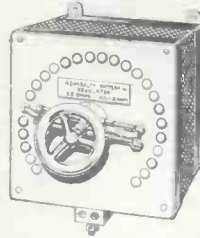
HEAVY DUTY L.T. TRANSFORMER. Very conservatively rated for continuous duty. New. In manufacturer's cases. Input 110-260 volt multi-tapped. 50 cycles, single phase. Output 28-29-30-31 volts at 21 ampere. Price £6/15/-, carriage 10/-.

ENGINE SPEED INDICATOR. On the basis of a special ex-R.A.F. meter which we are able to supply and a few small linking parts which can be purchased anywhere, an inexpensive engine speed indicator can be made up which works on simple pulse counting principles in conjunction with the contact breaker on the distributor. Will give direct reading in R.P.M. Full conversion instructions are supplied by us. Additional standard parts required easily obtainable for about 15/-, R.A.F. meter as offered by us 16/6, plus 2/6.

EX R.A.F. AIR POSITION INDICATOR. containing 3 ball and plate infinitely variable resolving gears, miniature spur bevel and worm gear drives, also toggle, push button and rotary switches, repeater motor, 4 mechanical counters, miniature lamp holders and lamps etc. As new. Illustration below. Price 22/6, P. & P. 3/6.



ROTARY SWITCH REGULATOR. 25 ohms, very conservatively rated at 4 amp., will handle 8 amp. Overall size 7 x 8 x 6in. Price 15/-, P. & P. 2/6.



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.

S.T.C. RECTIFIER. 36 plates by 120 mm. Bridge connected. Maximum A.C. input 60 volt. D.C. output 15 amp. New, perfect. Price 60/-, P. & P. 3/6.

BRIDGE RECTIFIERS. 12 x 110 mm Plates. Maximum A.C. input 60 volt. Maximum D.C. output 10 amp. 45/-, P. & P. 3/3.

BRAND NEW FREQUENCY METERS manufactured by **Nalder & Thompson Ltd.** Calibrated 45 cycles to 55 cycles per second. 6in. dial. Panel mounting type. In original manufacturer's boxes. **PRICE £10/15/- ea. Postage 3/6.**



20-WAY STRIP containing standard Post Office telephone Jack Sockets, overall size 11 x 3½ x ½in. New. Price 15/- each. P. & P. 1/6.

10-WAY STRIP standard Post Office telephone Jack Sockets, spacing allowing Igranic Jack Plugs. New. Price 10/-, P. & P. 1/6.

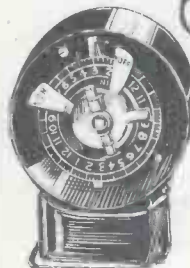
19-INCH RACK MOUNTING 20-WAY P.O. JACK STRIPS with 40 terminals at rear. Price 25/-, P. & P. 3/6.

19-INCH RACK MOUNTING 20-WAY P.O. LAMP STRIPS. Price 25/-, P. & P. 2/6.

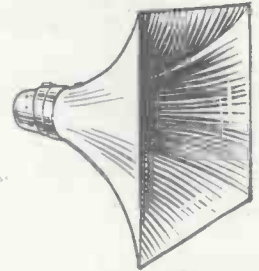
LATEST MOST MODERN TYPE OF EX W.D. MINIATURE HEADPHONES. As illustrated. Brand new, low impedance. Price: 10/6 plus P. & P. 1/6.



8-day clockwork TIME SWITCH. Contacts 2½ amp., 230 volt, 24 hour phase, ¼ hour divisions, allow 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. 2/-.



PYE LEVER OPERATING MICRO SWITCHES. Single pole changeover. Brand new. 4/- each or 42/- dozen, p. paid.



TANNOY P.A. LOUDSPEAKER. For outdoor use, metal exponential horn with 20in. square flare. Overall length 30in. Speech coil 15 ohms. Guaranteed in working order and good condition. Price £7/10/-. Carriage 10/-.

SOLAR OIL-FILLED CONDENSER. 240 mfd. for 230 V.A.C. or 600 volt D.C. Overall size 14in. x 9in. x 5½in. plus feet. Weight 46 lb. Brand new. Guaranteed perfect. Manufacturer's packing. Price £7/10/-, carriage 10/-.



100 YARD DRUMS GLASS BRAIDED FLEX, 10/010. New. 10/6 per coil. P. & P. 2/-.

18-WAY P.V.C. COVERED 14/36 WIRE, screened overall, covered with P.V.C. all colour coded, 3/6 per yd.; £15 reel of 100 yds. Carriage paid.

LEATHER FLYING HELMETS. Used but in good condition. Complete with Harness, Jack Plug and brand new. No. 13466 Earpieces. Price 22/6. P. & P. 2/-.

NEW UNCHARGED UNFILLED 12 VOLT ACCUMULATOR 9 ampere in unspillable plastic cases. Comprises 6 x 2 v. separate cells connected by terminal strips. 6 x 5½ x 4½in. over terminals. Price 19/-, plus P. & P. 2/9.

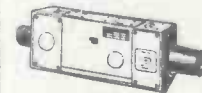


245 AMP. 2 VOLT ACCUMULATORS Admiralty type in wooden casing. Size 15 x 7½ x 7½in. Weight 60lb. Unfilled, uncharged. New. Price £4. Carriage 10/-.



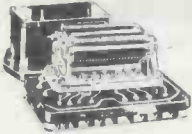
MINIATURE P.M. MOTOR. 12/24 volt, reversible. 1½in. dia. New. Price 10/6 each. P. & P. 1/-.

AIRCRAFT CINE CAMERA G458 Mk. III. Fully modified, fitted with f/3.5 triple anastigmat lens, takes 25ft. of 16mm. film, fitted with 24 v. motor. 16 exposures per sec. Brand new, original packing, £4/10/- each. P. & P. paid.



PACKARD BELL BRAND NEW RELAYS, 2 pole c.o. 6 volt 80 ohms. 7/6 each. P. & P. 6d.

MINIATURE RELAYS 250 ohms. Two makes. For operation on 4.5-9 volt. Ideal for transistor circuits. Weight just over 1 oz. Price 12/6 each.



SOLENOID OPERATED MAGNETIC RELAY.

Type 5CW/3945, 4 pole changeover, 10 A contacts 24 v. operation. Brand new 13/6. P. & P. 1/6.

CARPENTER'S TYPE POLARISED RELAYS. 2 x 9,500 turns at 1,685 ohms. Price 22/6 each. P. & P. 1/-.



HIGH SPEED RELAY. Siemens. Two bobbins 1,000 ohms each. New, 10/6 each. P. & P. 1/-.



SIEMENS H.S. RELAY. Very latest type, sealed. H96E. 1,700 ohms plus 1,700 ohms, single C.O. contacts. Brand new with fixing clip. In maker's cartons. Price 16/6 each, plus 1/- P. & P.

Siemens sealed similar relay to above, but 2.2 ohms plus 2.2 ohms. Minus clips, 12/6 each. Plus 1/- P. & P.

SUPERIOR BRAND NEW RELAY. 7,000 ohms coil. Will pull in at 750 microamps, and out at 450 microamp. Change-over, platinum contacts. Vacuum sealed, will therefore not be affected by oil, moisture or water and never needs adjusting. Weight 2½ oz. Price 18/6. P. & P. 1/-.

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 mA at 50 V A.C. or D.C. Size 1½ x ½ x ¾ in. Price 22/6 each.



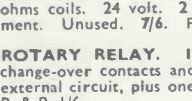
G.E.C. SEALED RELAY. Type M.1090. 180 ohms coil, 6/12 volt. 4 C/O. Brand new. 18/- P. & P. 1/-.

G.E.C. SEALED RELAY. Type M.1092. 670 ohms coil. 12/24 volt. 4 C/O. Ex new equipment. Unused. 10/- P. & P. 1/-.

G.P.O. 600 TYPE RELAY. 400 ohms coil. 24 volt. 2 C/O plus 2 M. New 7/6. P. & P. 1/-.

MINIATURE OPEN TYPE RELAY. 700 ohms coils. 24 volt. 2 C/O. Ex new equipment. Unused. 7/6. P. & P. 1/-.

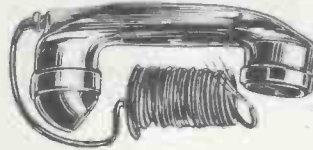
ROTARY RELAY. 12 volt. Heavy duty change-over contacts and one low current for external circuit, plus one break set. Price 7/6. P. & P. 1/6.



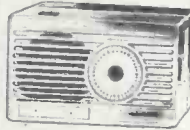
MINIATURE UNISELECTOR SWITCH. Two banks of ten plus home contacts one bank continuous of normal. 30 ohm coil for 24 volt operation. Brand new, manufacturer's packing. Price 22/6 each. P. & P. 2/6. As illustrated.



CLASS D WAVE METER. Latest release of these famous Hetrodyne wave meters with directly calibrated illuminated dial, most suitable for amateur transmitters, covers two ranges 1.9-8.0 Mc/s. and 4.0-8.0 Mc/s. Complete with reference crystals for zero settings, two valves, 2 x 6 volt vibrators, MAKER'S instruction book and matched set of headphones for monitoring. Designed for 6-volt D.C. operation, can easily be modified for mains and suitable transformer supplied for 7/6. In spot-on condition as tested by R.E.M.E. In transit case. Price 5 gns, each, plus 6/6 carriage.



SOUND POWER TELEPHONE HAND-SETS. Each couple connected by ordinary 2 core lighting flex will secure instant and reliable intercommunication. No batteries required. Price per set of 2 33/-, plus P.&P. 3/-.



MOULDED CABINET suitable for Transistor Set. Dual colour red/black. Size 5½ in. x 3½ in. x 1½ in. Gold metal dial. Price 7/6. P. & P. 1/6.

CONSTANT SPEED, PRECISION MADE, BATTERY DRIVEN D.C. GOVERNED MOTOR (Elliott Bros.). Commutator/brush incorporating loading ballast resistor 2,470 r.p.m. ± 2% at 12 volt. Loss on 8.5 volt only 4%. Size 1½ in. dia. x 2½ in. long. Spindle .77 in. long x .15575 in. dia. Weight 4 oz. New. Price 25/-, plus 1/- P. & P. Ideal for portable tape recording.

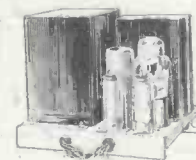


NEW IMPORTED EXTREMELY EFFICIENT MOTOR with tremendous power weight ratio. For 12 volt D.C. but very efficient on 6 volt. Three position switch. Weight 2.1 oz., size 1½ in. x 1½ in. dia. Speed 7,000 r.p.m. Self lubricating. 15/-, plus 1/- P. & P.

PRECISION MADE GEARED MOTOR BY DRAYTON REGULATOR CO., for 230 volt 50 cycles A.C.

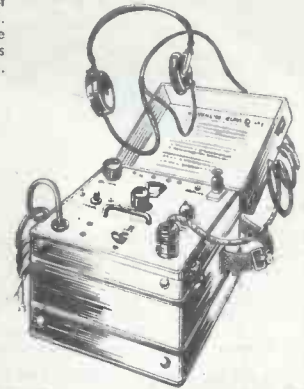


TYPE R.Q.R., reversible. 37 r.p.m., overall size 5 in. x 4 in. x 3½ in. Weight 4½ lb. Ex brand new equipment. Unused. Price £3/17/6. P. & P. 3/-.



MAINS POWER SUPPLY UNITS. Potted and sealed transformer and choke by famous maker. Mounted on metal chassis 6½ x 7½ in., complete with 5Z4 rectifier valve and full smoothing.

Input tapped 220-230-240 volts.
Output: 300 V. D.C. at 100 mA.
6.3 V. A.C. at 4.5 amp.
6.3 V. A.C. at 2 amp.
Rectifier supply 5 V. A.C. at 3 amp. Very conservatively rated. Price 47/6 plus P. & P. 6/6.



METERS GUARANTEED PERFECT

Charging Tapes
2½ amp. D.C. M.I. 2in. fl. rnd. 7/6
5 amp. D.C. M.I. 2½ in. fl. rnd. 11/6
7½ amp. D.C. M.I. 3½ in. proj. rnd. 12/6
9 amp. D.C. Hot Wire W.R. 2½ in. fl. rnd. 6/6
15 amp. D.C. M.C. 2in. rnd. 10/6
30 amp. D.C. M.C. 2in. fl. sq. 12/6
100 amp. A.C. M.I. 4½ in. fl. rnd. 32/6

Voltmeters
20 v. D.C. M.C. 2in. fl. sq. 10/6
30 v. M.I. 3in. proj. rnd. 10/6
300 v. A.C. M.C. 2½ in. fl. rnd. 27/6
300 v. A.C. M.I. 2½ in. fl. rnd. 22/-
400 v. A.C. M.I. 4½ in. rnd. 35/-
90-180 v. A.C. M.I. 4½ in. fl. iron 25/-

Milliammeters
1 mA. M.C. 2½ in. fl. rnd. 25/-
200 mA. M.C. 2½ in. fl. rnd. 12/6
500 mA. M.C. 2½ in. fl. rnd. 12/6

Microamp
50 microamp., scaled 0-100, M.C. 2½ in. fl. rnd. 42/6
500 microamp., M.C. 2in. rnd. F.L. scaled 15/600 volt. NEW 16/6

Postage on all meters 1/- each.

Miniature latest type moving coil 0-5 milliamp meter, 1½ in. diameter, flush fitting, complete with fixing clip. Price 17/6. P. & P. 1/-.



CRYSTAL CALIBRATOR No. 10. A



crystal controlled 4-valve high-grade instrument in the same category as the famous B.C. 221. Directly calibrated, does not require cross reference or charts — functions as follows:— (1) A crystal controlled oscillator which provides fixed frequency signals of 500 KC and all harmonics of 500 KC to beyond 10 Meg. and up to 30 Meg. (2) A variable oscillator from 250 KC to 500 KC, this enables all intermediate frequencies between 250 KC/s. and 30 Meg. to be produced and modulated. Supplied complete with 3 spare valves, all leads and maker's instruction book in carrying haversack. The complete outfit is brand new—repeat NEW. Price £4/19/6. Carr. 3/-.

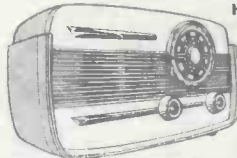
EX P.O. MAGNETIC COUNTER. 500 ohms type for 24 volt also 3 ohm types for 6 volt D.C. operation. Price 6/6 each. P. & P. 1/-.

Postages and carriage shown above are inland only. For overseas please ask for quotation. We do not issue a catalogue or list.

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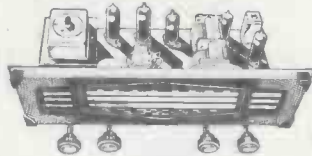
HARVERSON SURPLUS CO. LTD.



HARVERSON SUPERHET 4-KIT

A medium and long wave superhet. incorporating two I.F. stages modern B9 valves (UCH81, UBF89, UCL83, U785), built-in ferrite rod aerial. All you need supplied from theoretical wiring diagram to last nut and bolt (main components ready mounted), including an attractive contemporary styled cream plastic cabinet with gold trimmings. Size 11½ x 4½ x 6½in. **£6.12.6** Post 3/6

A.M. RADIOGRAM CHASSIS



A chassis of distinction, by a famous maker. Covering Long, Med. & Short Waves, plus gram position, this chassis (Size 15½ x 7 x 6½in. high) incorporates the latest circuitry, using fully delayed A.V.C., and negative feedback. Controls:—Tone, Vol.-On/Off, W/Change (L.M.S. & Gram.), Tuning, Tapped input 200-250 v. A.C. only. An attractive brown and gold illuminated dial with matching knobs, make this one of the most handsome, in addition to being one of the best performing chassis yet offered. Complete with valves (ECH81, EF89, EBC81, EL84, EZ81), knobs, output transformer, leads etc. **OUR PRICE ONLY £9.19.6** plus 4/6 post & packing.

MONAURAL AMPLIFIER



This amplifier as illustrated, made by a leading manufacturer. Mullard valves—ECC83, EL84 x EL84, EZ80. Bass Treble and Volume on remote panel. Elegant Knobs. **OUR PRICE** one month only **£4/16/6**, plus P. & P. 3/6.

CONDENSER/RESISTOR PARCEL
50 mixed P.F. Condensors and 50 mixed Resistors. An assortment of useful valves. All popular sizes—all new—a must for the serviceman and constructor **ONLY 10/- P. & P. 1/-**.

COSSOR C.R.T. SNIP

108K 10-inch. New and boxed, 15/-, plus 6/- P. & P.
75K 10-inch. New and boxed, 15/-, plus 6/- P. & P.

ION TRAP MAGNETS

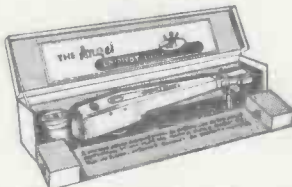
To suit the above, 2/9 each. P. & P. 3d.

TRANSISTOR RECORD PLAYER CASE

A few only—Transistor record player cases in light grey cloth—complete with motor board. Size: 12 x 8 x 6in. 18/6 each. P. & P. 1/9.

GRAM & TAPE EQUIPMENT BARGAINS

THE WORLD FAMOUS E.M.I. ANGEL TRANSCRIPTION P.U. (Model 17A)



A Pick-up for the connoisseur originally priced at £17.10.0. The last remaining few offered at **£4.10.0** Plus P. & P. 5/-.

PICK-UP CARTRIDGE BARGAINS

STUDIO P. 17/6
ACOS HIGH G. 17/6
E.U. POWER POINT ... 12/6
RONETTE 18/6
G.C.Z. 16/6
P. & P. 1/-

CYLDON 12 CHANNEL TURRET TUNERS

New purchase offered at still lower price. I.F. 33-38 Mc/s. Complete with PCC84 and PCF80 valves and 8 sets of Coils for 5 Band I channels and 8, 9, 10 Band III. New and unused. Value over **£7.** **OUR PRICE, Post paid..... 32/6**

MIDGET I.F. TRANS. & COILS

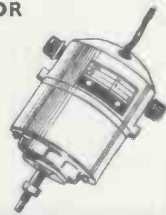
A pair of midget 465 kc/s I.F. transformers, plus L.V.V. and M.W. coils. **OUR PRICE 10/- per set. P. & P. 1/9.** Set of I.F. transformers for transistor superhet, 12/6. P. & P. 1/9.

SPEAKER FRET

Super quality heavily woven fret, 54 inches wide. Usual price, 50/- per yard. P. & P. 1/-.
OUR PRICE 12/6 per yard.

1/6 H.P. MOTOR

140 watt (approx. 1/6 H.P.). Series wound, 220/250 volt 50 cycle motor. Off load 14,000 rev/min. on load 8,500 rev/min. Ideal small saw, sewing machine, etc. **30/-** post free.

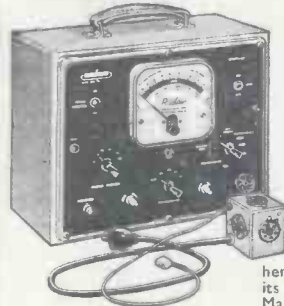


STEREOPHONIC AMPLIFIER

Complete with 2 Loudspeakers

This is a compact amplifier embodying the latest features and giving a high standard of reproduction, with ample volume. Supplied complete with valves (ECL82, ECL82, EZ80), panel, knobs, etc., and two specially selected 3Ω matched loudspeakers. We only have a few, and we will never be able to repeat this offer at such a low price! Don't risk disappointment! Order **£5.10.0** now!
Plus 4/6 P. & P.

TV TUBE TESTER/REACTIVATOR



- TESTS any tube without removal from set or carton.
- REPAIRS tubes discarded for low emission.
- MEASURES A.C. Volts, D.C. Volts, E.H.T.

The Radar Model 202 Tester-Reactivator is the most comprehensive instrument of its type on the British Market.

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- Visual Indication when reactivating is complete (a Radar exclusive)
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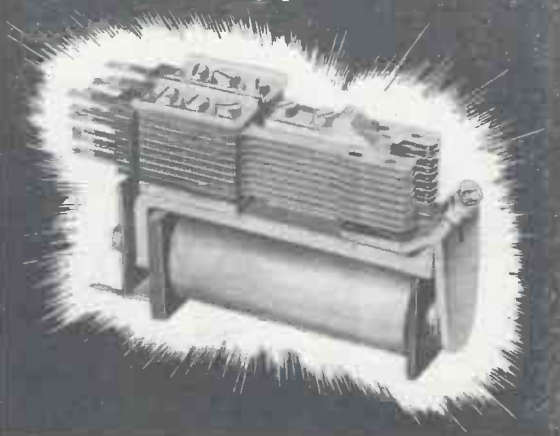
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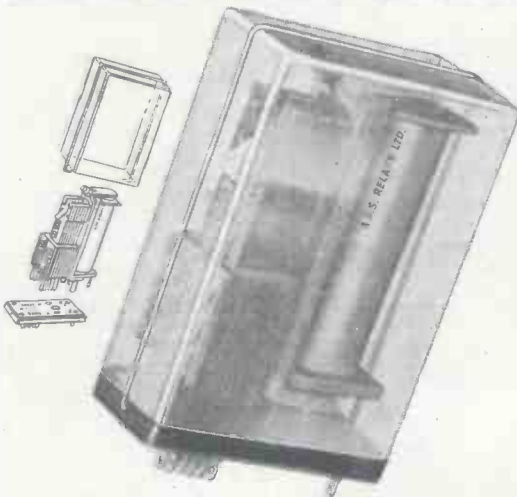
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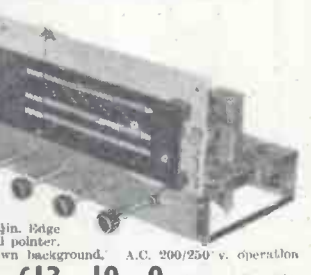
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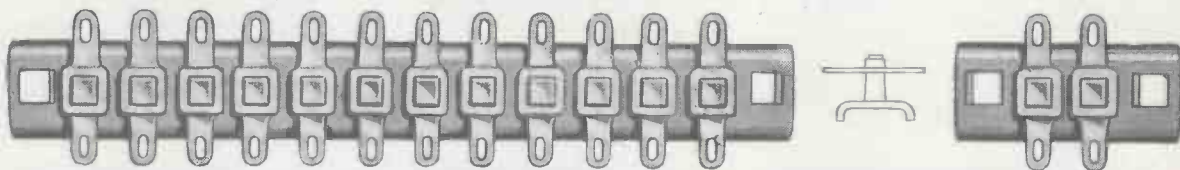
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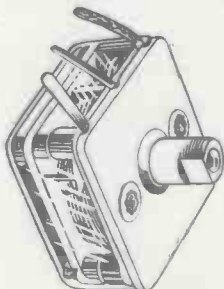
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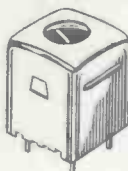
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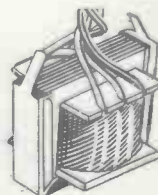
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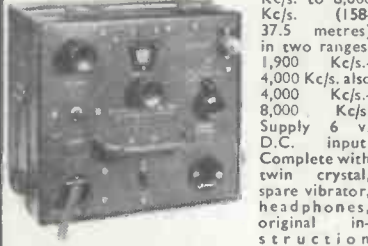
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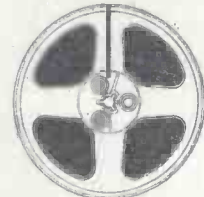
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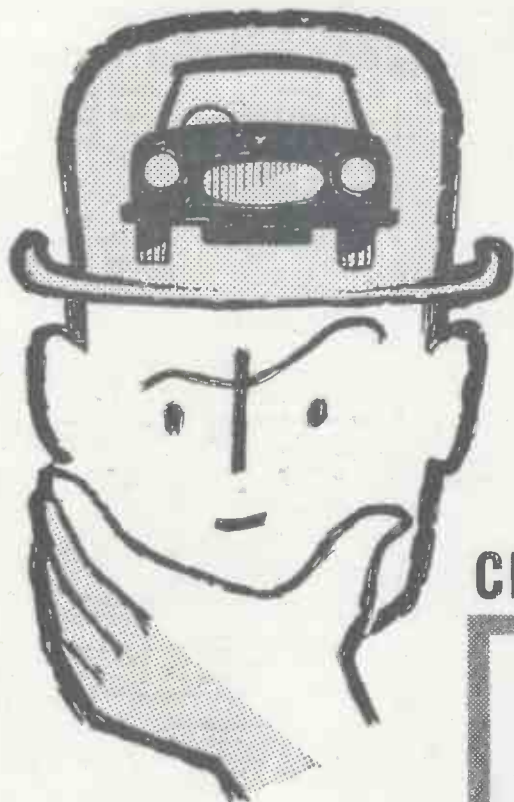
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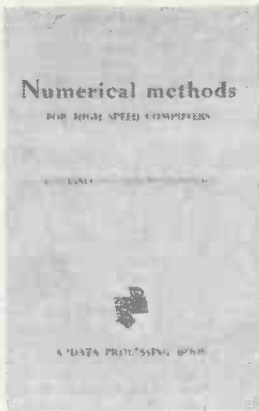
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Kits comprise—six 2½in. dia. Tubular Steel Sections of 8ft. length, top-section and base Pickets, Guys and Fittings. YOU can purchase this normally expensive MAST for a fraction of its cost. Please add £1 for (returnable) wooden carrying case. The MAST is particularly suitable to take aerials for T.V., Ex. F.M. and TV (especially COMMERCIAL) and has many other uses. Extra 6ft. sections can be supplied at 17/6 per section. Carr. 15/6.

£8.10.0 only

U.S.A. Type 45ft. TELECOM. AERIAL MAST. (7 sections, 6ft. 8in. x 2½in., guys, etc.). This entirely complete set in carrying case 12½ Gns. Carr. 17/6. Or 2 sets for £25. Carr. extra. British Manufacture only.

ARMY TYPE 32FT. MASTS similar to above but 10 lin. screw-sections, suitable for permanent lightweight installation. Kit in canvas bag, £5/15/-. Carr. 7/6.

Limited Quantity
36ft. TELESCOPE MASTS

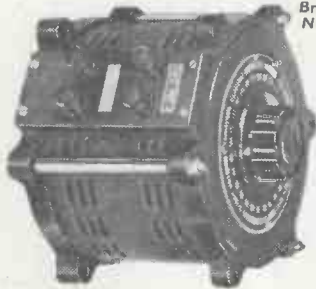
Finest quality brass. Non-rusting. Base diameter 2½in. Complete with hand-winding winch for easy, rapid extension; and cable-wire bracing stays. One of the best masts ever produced. **£35** each Carr. £1/10

750,000 YARDS !!
SCREENED WIRE FLEX
FOR ONLY 2d. per yd.



For immediate Delivery—far below cost. Specification: Close Braided 14/00108in. Covered .024 p.v.c. Tinned Copper. Screened. Assorted colours. Applications: Microphone leads, pick-up heads, etc. ON MAKER'S REELS. P. & P. TEN REELS £17. Carr. Paid. **36/8.**

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Brand New

OUTPUT (1.3kVA.) Completely Variable 0 to 260 volts. 5 amps. INPUT 230 volts, 50/60~ A SHROUDED FULLY VARIABLE TRANSFORMER FOR BENCH OR PANEL MOUNTING.

SIZE:—APPROXIMATELY 6" CUBE. WEIGHT:—APPROXIMATELY 13 LB.

PRICE:—RIDICULOUS, ONLY—**£9.0.0** SUPPLIED NEW AND BOXED

ALSO 10 amps. **£18.5.0** AND 20 amps. **£32.10.0**



World Famous

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"F" TYPE

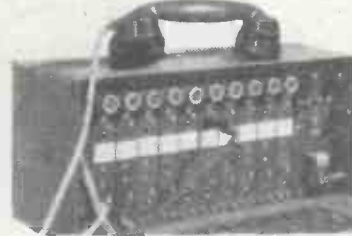
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£7-10-0 per pair 9/- carr.

The best portable telephone ever made. Original cost £40! Range up to 5 miles. Ideal for FACTORIES, BUILDING SITES, FARMS, OFFICES, 2 perfect case sets with batteries, 100ft. cable, etc.

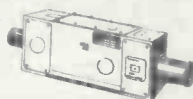
D3 STRANDED TELEPHONE CABLE. New Mile Drum 85/- Carr. 17/6.

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10 Lines U.C. Magneto Switchboard. Complete with Telephone handset, cord, plugs, lamps. Supplied complete and fully tested. £27/10.0. Complete Intercom. Telephone System for £65. Comprising (1) Switchboard; (10) Tele. "F" extensions (as above) and 1 mile drum of Don 3 telephone cable. Carriage extra. ENGLAND'S LARGEST STOCKS OF TELEPHONE EQUIPMENT QUANTITY & EXPORT ENQUIRIES ARE INVITED

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Fully modified, fitted with f/3.5 triple anastigmat lens, takes 25ft. of 16 mm. film, fitted with 24 v. motor. 16 exposures per sec. £3/19/6 each.

CONSTANT VOLTAGE TRANSFORMERS

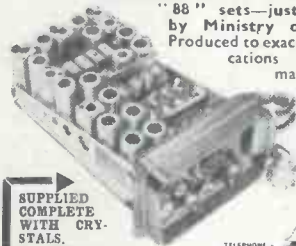
FERRANTI 71-KVA MOVING COIL Stabilized output voltage in the range 200-250 v. Plug-board tappings. The selected output voltage is constant with +1% at all loads 0 to 30/375 amps. when the supply voltage is varying over the range +8% to -12%.
★ Frequency compensated 45-65 and 54-66 c/s.
★ Excellent output wave-form.
★ Can be used as a variable transformer.
★ Unused. Complete with spares and instruction book at a fraction of the normal cost.
★ A.C. MAINS STABILIZER ONLY **£65**



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"88" sets—just released by Ministry of Supply. Produced to exacting specifications by leading manufacturers E.K. Cole & Co.



Only **£10** each

SUPPLIED COMPLETE WITH CRYSTALS. Accessories can be supplied to order at extra cost.



This Transmitter/receiver weighs only 5½lb. (approx.) and measures 3½in. x 5½in. x 9½in. It is a 4 frequency channel set, crystal controlled, 38-40/40-42Mc/s., and operates from a Standard Dry Battery—HT/LT. 94/1. 3 v. (i.e. Ruben Mallory Type 1). 14 of the current series of B7G valves are employed: 1-3A4, 6-IL4, 4-IT4, 1-1S5, 2-1A3. Each set is in first-class condition. Special quotations for quantities up to 3,000 sets. "22" SETS ALSO—300 available only. New condition £10 each



PUBLIC ADDRESS SYSTEM 15 GNS
FOR OFFICES, FACTORIES WAREHOUSES & CARS CARR 30/-

Manufactured by TRUVOX, etc. Comprises: Amplifier, four Loudspeakers, Heavy duty mic., Leads, etc. 6 or 12 v. D.C.

DOUBLE BEAM 'SCOPE' For D.C. & A.C. APPLICATIONS

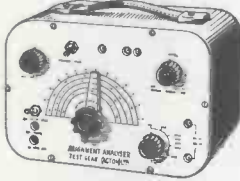


Engineered to precision standards, this high-grade instrument is made available at the lowest possible price, incorporating the essential features usually associated with luxury instruments. This "400PP" will appeal particularly to Servicing Engineers and Amateurs. A high gain, extremely stable differential Y-Amplifier (30 mV/C.M.). Provides ample sensitivity with A.C. or D.C. inputs. Especially suitable for measurement of transistor operating conditions where maintenance of D.C. levels is of paramount importance. Push-Pull X amplifier; Flyback suppression; Internal Time Base Scan Waveforms available for external use; pulse/output available for checking T.V. Line O/P Transformers, etc.; Provision for external X I/P and CRT. Brightness Modulation. A.C. mains 200/250 v. £19/19/- plus P. & P. 7/6 or 50/- deposit, plus P. & P. 7/6 and 12 monthly payments of 33/4.

FULL 12 MONTHS' GUARANTEE INCLUDING VALVES AND TUBE

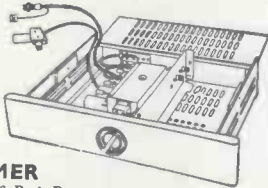
ALIGNMENT ANALYSER TYPE MC12

A.C. MAINS, 200/250 volts. Provides—"WOBBULATOR" (SWEEP FREQUENCY) OPERATION, for FM/TV alignment linear frequency sweep up to 12 Mc/s. From 400 Kc/s—80 Mc/s. CAPACITANCE MEASUREMENT. Two ranges provided 0-60 pf. and 0-120 pf. SPECIAL FACILITY enables true resonant frequency of any tuned circuit I.F. transformer, etc. to be rapidly determined. Cash price £6/19/6 and 5/- P. & P. H.P. terms 25/- deposit and 5/- P. & P. and 6 monthly payments of 21/6.



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Will tune to all Band I and Band III stations. BRAND NEW by famous manufacturer. Complete with P.C.C. 84 and P.C.F. 80 valves (in series) I.F. 16-19 or 33-38. Also can be modified as an aerial converter (instructions supplied). Complete with knobs.



32/6 Plus 3/6 P. & P.

HEATER TRANSFORMER

To suit the above, 200-250 v. 6/- Plus 1/6 P. & P.

B.S.R. MONARCH UA8 with FUL-FI HEAD



4-speed plays 10 records 12in., 10in. or 7in. at 16, 33, 45 or 78 r.p.m. Intermixes 7in., 10in. and 12in. records of the same speed. Has manual play position; colour brown. Dimensions: 12 1/2 in. x 10 1/2 in. Space required above baseboard 4 1/2 in., below baseboard 2 1/2 in. Fitted with Ful-Fi turnover crystal head. £6/10/6. Plus 5/- P. & P.

STEREO HEAD £7/19/6 Plus 5/- P. & P.

LINE E.H.T. TRANSFORMER

With built-in line and width control. 14 KV. Scan coil, 90° deflection, on ferrite yokes. Frame O.P. transformer 500 pf. 18 KV. smoothing condenser. Can be used for 14in., 17in. or 21in. tubes.

Complete with circuit diagram. 29/6 Plus 4/- P. & P.
As Above, £2.10 Plus 4/- P. & P.
but for 625 lines

FOCUS MAGNET suitable for the above (state tube), 10/- 2/6 P. & P.

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All with tapped primaries 200-250 volts.

0-160, 180, 200 v., 60 ma., 6.3 v. 2 amps., 10/6, 280-0-280, 80 ma., 6.3 v., 2 amp., 6.3 v., 1 amp., 10/6. 350-0-350, 70 ma., 6.3 v., 1 amp., 6.3 v., 2 amp., 10/6. 250-0-250, 70 ma., 6.3 v., 2 amp., 10/6. Postage and packing on the above 3/-.

SURFACE BARRIER TRANSISTORS

type SB 305, 15 Mc/s. 7/6 each.

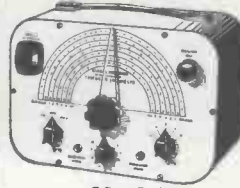
100% AUDIO TRANSISTORS

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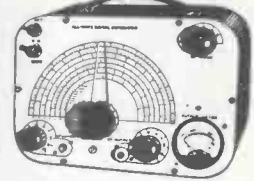
SIGNAL GENERATOR



£6/19/6

SIGNAL GENERATOR

Coverage 120 Kc/s.—230 Kc/s., 300 Kc/s.—900 Kc/s. 900 Kc/s.—2.75 Mc/s., 2.75 Mc/s.—8.5 Mc/s., 8 Mc/s.—28 Mc/s., 16 Mc/s.—66 Mc/s., 24 Mc/s., 34 Mc/s. Metal case 10in. x 6 1/2 in. x 4 1/2 in. Size of scale 6 1/2 in. x 3 1/2 in. Valves and rectifier A.C. mains 230-250 v. Internal modulation of 400 c.p.s. to a depth of 30 per cent. modulated or unmodulated R.F. Output continuously variable, 100 millivolts C.W. and mod. switch variable A.F. output and moving coil output meter. Grey hammer finish case and white panel. Accuracy plus or minus 2%. £4/19/6



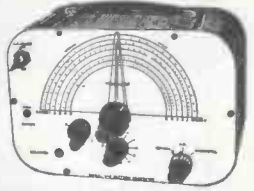
Or 25/- deposit and 4 monthly payments £1/6. P. & P. 5/- extra.

SIGNAL & PATTERN GENERATOR

£6/19/6

P. & P. 5/-

Or 25/- deposit, P. & P. 5/- and 6 monthly payments of 21/8. Coverage 7/6 Mc/s.—210 Mc/s., in five bands, all on fundamentals slow motion tuning audio output. 8 vertical and horizontal bars, logging scale. In grey hammer finished case with carrying handle. Accuracy ±1% A.C. mains 200-250 v.



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I F 34/38 Mcs. Brand new complete with biscuit for channels 2, 4, 8 & 9.

less valves 10/- plus 2/6 P. & P.
(Valves required P.C.C., 84 & P.C.F. 80.)
Pair of knobs to suit above, 3/6.

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Plus GERMANIUM DIODE and PRINTED CIRCUIT

Size 3 1/4 x 4 x 1 1/2 in.

Incorporating Ferrite Rod Aerial. Two Surface Barrier Transistors and one Audio. Tunable over medium and long waves.

To build yourself 39/6 Plus 1/6 P. & P.

ALL PARTS SOLD SEPARATELY
Circuit diagram 1/6, free with kit.



All transistors guaranteed 100%

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A.C. mains 200/250 v. Size 10 1/2 in. x 6 1/2 in. x 2 1/2 in. Incorporating 8 valves, H.F. pent. triodes, 2 output pent., and rectifier. For use with all makes and types of pick-up and mike. Negative feed-back. Two inputs, mike and gram., and controls for same. Separate controls for Bass and Treble lit. Response flat from 40 cycles to 15 Kc/s. ±2 db.; 4 db. down to 20 Kc/s. Output 8 watts at 5% total distortion. Noise level 40 db down, all hum. Output transformer tapped for 3 and 16 ohm speech coils. For use with 8td. or L.F. records, musical instruments such as Guitars, etc.

£4.19.6 Plus P. & P. 7/6.

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PORTABLE AMPLIFIER

On printed circuit for A.C. Mains 200/250 v. Size 4in. x 3in. with tone and volume control. Valves: ECL82 and EZ80, 39/6. P. & P. 2/6.

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Frequency	1,650 Cycles.
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Drive required at Resonance	Point 12 Volts 300 Microamps.
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Dimensions	3 1/2 x 2 1/2 x 2 1/2 ins.

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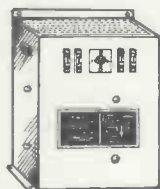
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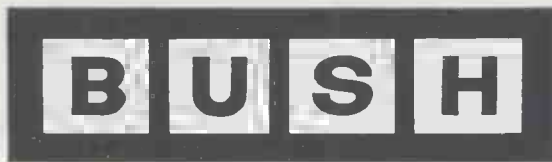
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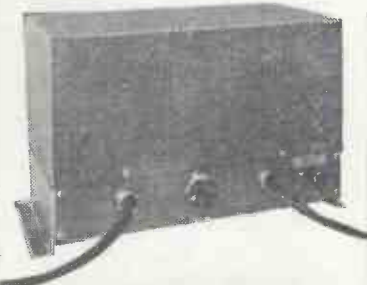
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Packing and Postage 7/-

WESTON MODEL 155 M.I. MIRROR SCALE, dimensions 7 1/2in. x 8 1/2in. x 3 1/4in. Range 150 Amps. P.P. 5/- £5

B.T.H. "X" BAND ECHO BOX

Directly calibrated frequency dial from 9,170 to 9,470 mc/s. Graduated attenuator. Microammeter resonance indicator. Complete with R.F. cable and coaxial-to-waveguide adaptor. PRICE, unused, and guaranteed. £32 0 0
 Packing and carriage 15/-.

OSCILLOSCOPES

COSSOR TYPE 1035 DOUBLE BEAM. Time Base 10μsec. to 150 millisecc. triggered or free running. Y1 Amplifier gain 3 to 3,000, with frequency response up to 7.0 Mc/s. for low gain and up to 60 kc/s. for high gain. Y2 Amplifier directly calibrated in Volts. £100 0 0

AIRMEC TYPE 723 SINGLE BEAM. Time Base 1μsec. to .5 millisecc. sweep, triggered or free-running. Amplifier Frequency Response D.C. to 5Mc/s. for sensitivity of 200 mV/cm. and 30 c/s. to 30 kc/s. for sensitivity of 20 mV/cm. Automatic brilliance control. Adjustable EHT Voltage. Mains operation. £75 0 0

EMI TYPE 379AT, A HIGH SPEED WAVEFORM VIEWING OSCILLOSCOPE. Time Base 1μsec. to 50 msec. triggered or free running. "Y" amplifier provides sensitivity of 2 to 120 mm/V. Time rise 0.7μsec. Frequency response D.C. to 5 Mc/s. for 2.5 db. down. Time measurements range 1μsec. with an accuracy of $\pm 2\%$. Voltage measurements range 0-500 V. D.C. or R.M.S. in six ranges, with accuracy of 3% F.S.D. Mounted on a trolley, with mains power supply unit. P.P. 50/- £130 0 0

TS-239/UP HIGH SPEED OSCILLOSCOPE. Single Beam. Sine-wave observable 10 c/s. to 5 Mc/s. Minimum rise time .08μsec. Sweep time .5μsec. to 50,000 μsec. triggered or free-running. Calibrating Voltage 1 to 1V peak. Brightness modulated timing marks of 2-1-100-500μsec. Sensitivity 1 to 100 v. for an image size of 6in. Illuminated graticule with adjustable brightness. 115 V. operation. Complete with accessory cables and probe. £180 0 0

PEN RECORDERS

STRIP CHART PATTERN SWITCHBOARD MOUNTING. PEN RECORDERS:

1 mA. D.C. F.S.D., Chart Speed 3in./min. 6in. Chart. Electrically driven	£55	0	0
5 mA. D.C. F.S.D., Chart Speed 3in./min. 6in. Chart. Electrically driven	£50	0	0
2.5-0-2.5 mA. D.C. F.S.D. Chart Speed 3in./min. 6in. Chart. Electrically driven	£50	0	0

RECORDING WATTMETER, three-phase, used to record from 0 to 1,000 kW. when used with potential transformer 6600/110V. and current transformer 60/5 amps. Chart speed 1in. per hour. £80 0 0

All Recorders are supplied complete with suitable strip chart paper.

Other speeds and ranges are also available. Please write for full details.

MARCONI TYPE TF-912A RF OUTPUT POWER METERS

Input Impedance 75Ω. Frequency range 80-160 mc/s. Power measurements range 0 to 25 watts in two ranges, with an accuracy of $\pm 5\%$ at 100 mc/s. in the middle of the range and $\pm 10\%$ at other power levels. Power supplies 4.5 V. internal dry cell. PRICE, fully overhauled and guaranteed. £25 0 0
 Packing and carriage 15/-.

MARCONI "STANDARD" SIGNAL GENERATORS TF-144G

Basic laboratory signal generator covering a range of 85 kc/s. to 25 mc/s. with continuously variable output from 1μV. to 1 V. Internal modulation 400 c/s. at up to 75% mod. depth. Mains operation. PRICE, fully overhauled to "as new" standard and guaranteed, complete with mains lead, battery lead and R.F. lead with dummy aerial. £85 0 0
 Packing and carriage £2.

"MEASUREMENTS CORPORATION" TYPE 84 "STANDARD" SIGNAL GENERATOR

Frequency range 300-1,000 mc/s. in one band, directly calibrated; calibration accuracy $\pm 5\%$; output level 1μV. to 100 m V. into 50Ω. Sine-wave modulation at 400-1,000-2,500 c/s. at 30% max. mod. depth. Pulse modulation with pulse width variable from 1 to 50μsec., pulse delay from 0 to 50μsec. at repetition rate from 60 to 100,000 per second. Power supplies 117 V. A.C. PRICE, fully overhauled and guaranteed. £220 0 0
 Packing and carriage £2.

TS-13/AP "X" BAND SIGNAL GENERATOR

This instrument includes self-contained wavemeter and power monitor. Frequency range 9,305 to 9,445 mc/s. It will provide either CW or pulsed output at a level of at least 50μW. Triggered operation with a pulse width variable from 1 to 2μsec., pulse delay from 6 to 200μsec. at repetition rate from 350 to 4,000 c/s. Self-synchronous operation at 1,000 c/s. Frequency modulated output when fed with sawtooth input. 115 V. A.C. operation. PRICE, fully overhauled and guaranteed. £80 0 0
 Packing and carriage £11/10/-.

TS-102/AP PULSE GENERATOR

The instrument provides triggered pulses, 8μsec. wide at 30 V. amplitude, positive or negative, into 72Ω load, at a rate of 400-500-1,000-2,000 c/s. and marker pulses 4μsec. wide spaced at 3μsec. continuously variable from 3 V. Marker pulses can be delayed with respect to trigger pulses from 0 to 360°. Marker pulses spacing accuracy $\pm 1\%$. 115 V. A.C. operation. £18 0 0
 Packing and carriage 15/-.

H.T. FLASH-OVER TESTERS

Test voltage continuously variable from 0 to 5 kV. A.C. or D.C. by means of a variable transformer. Power supplies 230 V. A.C. Complete with probes. PRICE, fully overhauled and guaranteed. £28 0 0
 Packing and carriage £11/10/-.

CINTEL R-C OSCILLATOR AND AUTOMATIC FREQUENCY MONITOR

Oscillator output from 10 c/s. to 100 kc/s. with an accuracy of $\pm 0.5\%$. Automatic Frequency Monitor will control actual oscillations within a pre-set period of time, viz.: 0.1, 1 or 10 sec. displaying the result on five digital meters. Basic accuracy of the counter is .005%. Mains operation. PRICE, fully overhauled and guaranteed. £220.
 Packing and carriage £5.

SPECIAL COMMUNICATION RECEIVERS

TYPE P-58. Frequency range 300 to 650 mc/s. Sensitivity at 300 mc/s.-100μV. for 6 db. S/N ratio. I.F. 45 mc/s. I.F. bandwidth 2 mc/s. for 6 db. down. Power supplies 230 V. A.C. PRICE, fully overhauled and guaranteed. £70 0 0

TYPE R-1294. Frequency range 500-3,000 mc/s. I.F. 13.5 mc/s. I.F. bandwidth 3.5 mc/s. Power supplies 150 and 300 V. H.T. and 6.3 V. A.C. L.T. External power supply unit available if required. PRICE, fully overhauled and guaranteed. £85 0 0

TYPE AN/APR-4. The Receiver Unit is essentially an I.F. amplifier with the associated audio and video stages and power supply unit. I.F. 30 mc/s. with bandwidth of 4 mc/s. and 6 mc/s. I.F. sensitivity from 35 to 56μV. R.F. ranges are obtained by means of interchangeable plug-in R.F. units which are available in the following ranges: 38-95 mc/s., 74-230 mc/s., 300-1,000 mc/s. Prices on application.

AVO ELECTRONIC TESTMETERS

Mains operated Electronic Universal Test Instrument offering the following facilities:-
Current: D.C. 25-100-250mA-1.25-10-25-100-250mA-1A.
Voltage: D.C. 250mV-1.25-10-25-100-250-1000V.
A.C. 1.25-10-25-100-250V.
Resistance: 1000MΩ, 10MΩ, 100KΩ, 1000Ω.
A.F. power: 500mW and 5W into an impedance of 2000, 500, 25, 10 and 5Ω.
Capacity: 5μF at 50V.
PRICE, fully overhauled and guaranteed. . . £25 0/0
Packing and carriage 10/-

AVO CR BRIDGES

Portable Mains Operated Serviceman's Component Bridge. Ranges of measurements; Capacity from 6mmF to 50 mF. Resistance from 5 ohms to 50 megohms. Valve Voltmeter from 10 to 15 V. RMS; Neon Leakage Indicator. Power Factor measurements in %.
PRICE pp.10/- £9

BROAD NEW BLOCK CAPACITORS

1μF 1,250V. Dubilier 8/-
1μF 2,500V. TCC Visconol 9/-
1μF 5,000V. Dubilier 17/6
1μF 7,500V. Dubilier 22/-
2μF 800V. TCC Visconol 3/6
4μF 200V. Dubilier 4/6
4μF 600V. TCC Visconol 5/6
8μF 200V. TCC or Dubilier 6/-
8μF 1,250V. Dubilier 10/-
N.B.—All voltages are D.C. working, at 75° C.
Packing and postage 9d. per capacitor.

D.C. SOLENOIDS

Type 700-28 Push-Pull Type, 24-28V, 1 Amp. holding force 12 lbs.; stroke 3/16in. Flange Mounting; Dimensions 2 1/2in. high x 2 1/2in. x 2in. 5/6, p.p. 2/-
Type 137 Push-Pull Type, 26V, 12 Amps; Holding Force approx. 40 lbs.; Stroke 1/2in.; Dimensions 3 1/2in. high x 2 1/2in. x 2 1/2in. 8/6, p.p. 2/-
Type 768-2, Pull Type, 28V, 17.5 Amps; Holding Force approx. 50 lbs.; Stroke 1/2in. Dimensions 3in. high x 2 1/2in. x 2 1/2in. 8/6, p.p. 2/-

HIGH SPEED RELAYS

SIGMA Type 4C1 or Advance Type G
1 B. 1amp. contact, 5,000Ω Coil. Current 4mA. ± 5mA. Will operate with change of current of 2 mA. Second hand 5/6
STEVEN'S ARNOLD Type 358 "MILLISECOND" Sealed, 24V, 1,400Ω Coil, 1 C.O. contact. Octal Base 17/-
Postage and packing 9d. per relay.

BALANCED ARMATURE MINIATURE RELAYS

Second hand, guaranteed.
1 M. contact at 5 amps. Coil 500Ω. Operating current 40mA., release 15mA. 6/8
2 C.O. bifurcated contacts at 500mA., 700Ω Coil. Operating current 16mA. Release 5mA. 7/-
Overall dimensions: 1 1/2in. x 1 1/2in. x 1/2in. Postage and packing 6d. per relay.

E.H.T. METAL RECTIFIER, Tubular

Type T36E 4T45, half-wave, maximum rms. voltage 1,220 V. at 2 mA., screw terminals 7/6
Ditto, solder tag terminals 5/-
Postage 6d. per rectifier.

TYPE 3 POWER UNITS

Mains operated rack mounted fully smoothed rectifier power unit providing adjustable H.T. voltage from 180 to 270 V. at 100 mA. and 3.3 V. A.C. at 4 amps. H.T. voltmeter and milliammeter are provided on the front panel.
PRICE, fully guaranteed £3 10 0
Packing and carriage 15 0

WESTINGHOUSE SELENUM RECTIFIER POWER UNITS

Input 115/230V., fully smoothed and fused. Output adjustable from 80 to 140V. D.C. by means of fine and coarse tap switches in the secondary winding. Maximum current 400mA. continuous. Dimensions: 17 1/2in. x 10 1/2in. deep x 3 1/2in. high p.p.7/6. 40/-

POST OFFICE RELAYS

Type 600, 600Ω Coil, 2 C.O. contacts 6/6
Type 8000, 500Ω Coil, 2 C.O. contacts 7/6
Packing and postage 9d. per relay.

200μA PORTABLE ADMIRALTY PATTERN METER

2 1/2in. Round Flush Mttd. Modern Movement Meter enclosed in a waterproof die-cast case fitted with rubber feet and carrying strap. Phone-jack connection. Unused. p.p. 2/6 £2 0 0

METERS

50μA DC MC 2 1/2in. Rd. Fl. Panel Mttd. 45/-
50μA DC Mc 4 1/2in. Sq. Fl. Mttd. SIFAM 65/-
200μA DC MC 2 1/2in. Rd. Fl. Mttd. 32/6
200μA DC MC 2 1/2in. Rd. Fl. Mttd. 35/-
500μA DC MC 2 1/2in. Sq. Fl. Mttd. 35/-
500μA DC MC 2 1/2in. Rd. Fl. Panel Mttd. 17/8
1-0-1mA DC MC 2 1/2in. Rd. Fl. Mttd., Sealed, Calibr. 0-100/200/400. Volts/mA. 22/6
10-0-10mA DC MC 2 1/2in. Rd. Fl. Mttd. 15/-
30mA DC MC 2 1/2in. Rd. Fl. Mttd. 15/-
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200mA DC MC 2 1/2in. Rd. Fl. Mttd. 12/8
500-0-500mA DC MC 2 1/2in. Rd. Fl. Mttd. 12/-
1 Amp. DC MC 2 1/2in. Rd. Fl. Mttd. 17/8
2 Amps DC MC 2 1/2in. Rd. Fl. Mttd. 17/8
5 Amps DC MC 2 1/2in. Rd. Fl. Mttd. 10/-
8 Amps R.F. Th.C. 2 1/2in. Sq. Fl. Mttd. 10/-
10 Amps DC MC 2 1/2in. Rd. Fl. Mttd. 17/8
20 Amps DC MC 2 1/2in. Rd. Proj. Mttd. 6/6
40 Amps DC MC 2 1/2in. Rd. Proj. Mttd. 6/6
30-0-30V DC MC 2 1/2in. Rd. Fl. Mttd., Suppressed Zero, reading range 18-36V. 15/-
150V AC MI 2 1/2in. Rd. Fl. Mttd. 20/-
150V AC MI 2 1/2in. Rd. Fl. Mttd. 20/-
150V DC MC 2 1/2in. Rd. Fl. Mttd. 20/-
300V AC MI 2 1/2in. Rd. Fl. Mttd. 20/-
Please add 2/6 in £ for packing and postage.

3-RANGE MICRO-MILLIAMMETER

Basic movements 50μA D.C. M.C. Ranges of 50μA, 250μA and 1mA switched by a trigger switch in the back, geared with sliding scale having separate graduations for each range. Instrument is fitted with leads for soldering to test prods or crocodile clips (not supplied) 50/-



Table listing various electronic components such as capacitors, solenoids, and relays with their specifications and prices.

TESTED AND GUARANTEED VALVES

Table listing vacuum tube valves including Cathode Ray Tubes, Klystrons, and Magnetrons with their technical specifications and prices.

Table listing vacuum tube valves including various diodes, triodes, and pentodes with their technical specifications and prices.

We have hundreds of other types in stock. Please send s.a.e. for current price list. Please add 2/6 in £ for packing and postage.

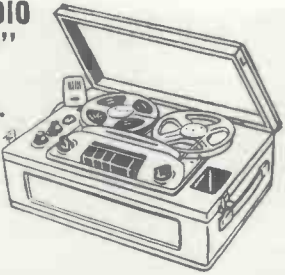
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40 gns.
NOW
29
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Quality Tape Recorder at this amazing reduced price. 7in. Standard reels. Latest Studio 3-speed Deck, 1½, 3½, 7½ I.P.S. 3 watts output. Attractive designed cabinet in beige. Size 19 x 13 x 8in. Terms available. Ins. & carr. 12/6.

EXTRAS: Microphone 27/6. Tape 25/-.

DELUXE TAPE RECORDER CABINET

ONLY 29/9

Beautifully made Cabinet. Size 13 x 10½ x 7in. Covered in two-tone coloured rexine cloth. Stylish design. Easily adapted to Record Player Cabinet. Exceptional value at this very low price. P. & P. 4/6.

RECORD PLAYER CABINET R.P.9 19/6

Exceptional offer. A lightweight portable player Cabinet in Rust or Cream. Famous manufacturer. Size: 14½ x 11½ x 6in. Complete with moulded deck board of attractive design. Takes B.S.R. TU3 single player; 2 control Amplifier; 5in. round Speaker. Post Packing & Ins. 4/6.

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- Stocks to Clear. Salvage Guaranteed**
- 9d. EACH
- 1D6, 3D6, 4D1, 6B7, 6B8, 6SA7, 8D2, 9D2, 12Y4, 15D2, 18, 75, 78, 21OVPT, 1203A, 2050, 2151, 7193, AR6, ARP18, D1, EA50, EB34, EF36, EF37, EF50, GT1C, KT24, NGT2, PM202, QP21, SP41, SP61, T41, TTI1, VR21, VW48.
- 2/8 EACH
- 6C4, 6F1, 6F12, 6F13, 6F14, 6F15, 6J5, 6K7, 7D5, 8D3, 10F1, B30, DF60, EF42, EF91, EF92, EL32, KT81, KTW61, P61, PEN45, PEN46, U22, U281, UF41, VP41, VP133, Z77.
- 5/9 EACH
- 6D2, 6P28, 6V6, 6X5, 10P14, 12AT7, 20P1, ECC81, ECC82, ECC83, ECL80, EF80, PCC84, PCF80, PL81, PL82, PL33, PY80, PY81, UL40.
- 7/9 EACH
- 5U4, 5Y3, 6CK5, 6SL7, 6SN7, 12K7, 10P13, 12Q7, 20D1, 35Z4, 451U, DH76, EBC38, ECH35, EL36, EL41, KT36, PZ30, TH233, PL38, U76, W76.

Post and Packing: On 1 valve 7d. On 6 valves 1/6. On 12 valves 2/6.

REPLACEMENT, REBUILT TV TUBES

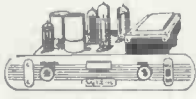


12 months' guarantee
Terms available over 20 weeks
Carr. & Ins. 15/6

21in.	£6.10.0	With
17in.	£5.10.0	Old
12,14,15in.	£4.10.0	Tube

TAPE RECORDER AMPLIFIER

£7/19/6



Compact, well designed 5 valve amplifier. Output 3.5 watts. Input for mike, radio and gram. Controls: record playback volume and on/off playback tone. Dia. 8½ x 3 x 4½in. Ins. and Carr. 4/6. 12 months guarantee. Terms available. Extras: Knobs 2/6 per set. Beautiful Perspex dial plate, complete with sockets for mike, radio and superimpose switch 3/6.

AMPLIFIERS, All portable 12 Months guarantee

- MK. D.5. 39/6.** New circuit employing ECL80 triode pentode output valve giving 3 watts output. A.C. only. Mains isolated. Single control for volume and on/off switch with knob. P. & P. 3/6.
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- MK. D.3A. 89/6.** As above de luxe model, with separate tone controls for treble and bass boost. P. & P. 3/6.

B.S.R. MONARDECK £9/9/6
3½ i.p.s. 5½ spools. Ins. & Carr. 4/6.

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- 6in. P.M. SPEAKER 8/9
Good quality and excellent value. P. & P. 2/9.
- BARGAIN SPEAKER 5/9**
8in. P.M. Repaired cone defect not affecting reproduction quality.
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As above but with output transformer.
- 8in. P.M. SPEAKER 9/9
Perfect quality. Fitted output transformer.
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8 x 3in. and 7 x 4in. Brand new. P. & P. on each 2/9.

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8in. P.M. Speakers fitted into polished cabinets. Standard matching to any receiver. (Complete.) Switch and flex included. P. & P. 3/9.

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31 gns.
Our price
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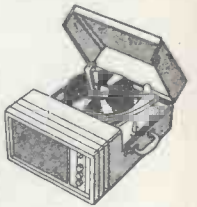
Beautifully styled rexine covered cabinet in Red or Beige. Size 14½ x 13 x 9½in. Storage comp. in lid for tapes and mike. Speed 3½in. per second. 2 controls. Contains 7 x 4in. elliptical speaker and incorporating B.S.R. tape deck. 3 months' guarantee. Ins. and carr. 12/6. Terms available.

17in. TV's 17½ gns.

Modern CHASSIS, modified Complete 17in. TUBE. VALVES — SPEAKER — KNOBS. Tuned ITV/BBC. Ready to use, fully guaranteed, TUBE 12 months, CHASSIS and VALVES 3 months. Cabinet to fit £1/11/6 if ordered with set. Salvage. Set—tube—cabinet despatched separately. Carr. and Ins. on set £1/5/-; on cabinet 8/6.

RECORD PLAYER CABINET (R.P.4)

79/6



Stylish cabinet by famous manufacturer. Cloth covered in contrasting colours. Grilled front control panel. Size 15 x 19 x 8½in. deep. Beautifully made — a cabinet of which you can be really proud. Takes 4-speed B.S.R. Auto-changer, 6½in. round or 7 x 4in. elliptical speaker. Room for any amplifier of your own choice. Carr. & Ins. 4/6.

BAKELITE CABINETS 2/9



Brand new. Colour brown. Attractive design. Size 12 x 7 x 5½in. Ideal for small receivers, converters, etc. P. & P. 3/9.

SLIDING DOOR CABINET 7/9

Radio cabinet covered in imitation lizard rexine. Suitable for small portable radio chassis. Post & packing 3/9.

PLESSEY TV CHASSIS

FOR SPARES 5/6

56 resistances. 54 condensers. 13 valve holders. 4 transformers. Chokes 250 m/a. Metal rectifiers 300 volts @ 250 m/a. Fuse panel. Focus magnets. Plugs. Carr. 7/6.

SOLO SOLDERING TOOL 12/6



110 v., 6 v. or 12 v. (special adaptor for 200/250 v., 10/- extra). Automatic solder feed including 20ft. reel of 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 3/6.

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Rate 9/- for 2 lines or less and 4/6 for every additional one or part thereof, average lines 6 words. Box Numbers 2 words plus 1/-. (Address replies: Box 0000 c/o "Wireless World" Dorset House, Stamford St., London, S.E.1.) Trade discount details available on application. Press Day April 1961 issue, Thursday, March End. No responsibility accepted for errors.

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Readers are warned that Government surplus components and valves which may be offered for sale through our displayed or classified columns carry no manufacturers' guarantee. Many of these items will have been designed for special purposes making them unsuitable for civilian use, or many have deteriorated as a result of the conditions under which they have been stored. We cannot undertake to deal with any complaints regarding any such items purchased.

NEW RECEIVERS & AMPLIFIERS

DUAL push-pull 10W AM/FM stereo quality chassis, inc. pre-amp tape and 2 High-flux speakers, leaflet.—Bell Sound Products, Marlborough Yard, Archway, London, N.19. [0186]

THE world-famous "Globe King" kit; new and improved version; complete with all parts, chassis, coils and valve, together with "Easy-Build" charts and instructions; a highly efficient one valve short wave radio with band spread tuning; hundreds of testimonials. 79/6 postage paid.

H.P. RADIO SERVICES, Ltd., 49-51, County Rd., Liverpool, 4, Estab. 1935. [0203]

RECEIVERS AND AMPLIFIERS—SURPLUS AND SECONDHAND

HRO Rx's, etc., AR88, CR100, BRT400, G209, S640, etc., etc., in stock.—R. T. & I. Service, Ashville Old Hall, Ashville Rd., London, E.11. Ley. 4986. [0053]

TELECOM 9 valve 90-215mc/s receiver, built-in L.S., A.C. power supply; £50. 20-WATT all transistor moodie amplifiers; 30gns. R.E.E. TELECOMMUNICATIONS, LTD., Telecom Works, Crewkerne, Somerset. Tel. 662. [9441]

RECEIVERS AND AMPLIFIERS WANTED

WANTED, Marconi receiver, 2-3 valve, period 1920-25, 6 volt valves and slab coils model, state price and condition.—Cole, Cadbeek, Wigton, Cumberland. [9428]

LOUDSPEAKERS—SURPLUS & SECONDHAND CONCRETE bass horn, as described W.W. Feb. '58; £10.—138, Mill Lane, N.W.6. Ham. 5264. [9448]

NEW DYNAMOS, MOTORS, ETC.

AT less than one-third cost.

LIMITED quantity brand new high quality reversible electric I.h.p. motors; AC 200/250V, 50 cycles synchronous; 1,500 r.p.m. with 2 mfd starting capacitor and circuit; specially made by leading manufacturer for professional quality tape recorder; ideal for enthusiasts requiring motor with one- or two-way operation. ONLY 47/6 plus post and packing 2/-. INDUSTRIAL ENGINEERING, LTD., Maylands Avenue, Hemel Hempstead, Herts. [9421]

DYNAMOS, MOTORS, ETC., WANTED

WANTED alternators, 9-10 KVA ex-W.D., G.E.C., B.T.H., E.E.C.—Box 3190. [9415]

DELCO 24 volt blower motors, Ref. 10KB/869, model 12970, or similar; quantity wanted.—Box 3505. [9446]

TRANSMITTING EQUIPMENT—SURPLUS AND SECONDHAND

UNUSED 230V TX rect. unit, outputs 880V D.C. 4A, 300V D.C. 1/5thA, 115V A.C. 1A, mains operated H.T. contactor, etc., 165lb; £10.—43, St. Marys Rd., Burnham-on-Sea, Somerset. [9452]

NEW TEST EQUIPMENT

HEATHKITS can now be seen in London and purchased on easy terms; free brochure.—Direct TV Replacements, Ltd., Dept. W.W. 27/3, 138, Lewisham Way, S.E.14. Tideway 6666. [9240]

TEST EQUIPMENT—SURPLUS AND SECONDHAND

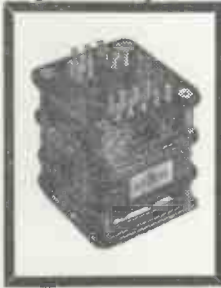
SIGNAL generators, oscilloscopes, output meters, wave voltmeters, frequency meters, multi-range meters, etc., etc. in stock.—R. T. & I. Service, Ashville Old Hall, Ashville Rd., London, E.11. Ley. 4986. [0056]

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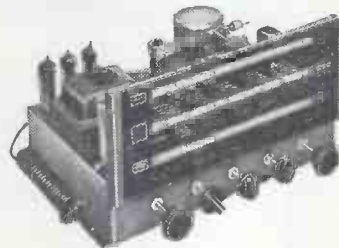
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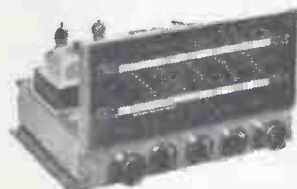
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TEST engineers.—Applications are invited from test engineers with previous industrial experience of testing radio communications, receivers and transmitter successful applicants will be offered positions on the company's permanent staff; starting salaries commensurate with qualifications and experience.—Apply in writing, giving full details to Personnel Officer, Redifon, Ltd., Broomhill Rd., S.W.18. [0252]

A VACANCY exists for an electronic engineer at the Radcliff laboratories of Zonal Film (Magnetic Coatings) Ltd., age 20-35 years. H.N.C. or Institute; applicants will be expected to be familiar with magnetic recording techniques and circuits; knowledge of computers and computer circuits would be considered an advantage.—Apply in first instance to Chief Electronic Engineer, The Tower, Hammersmith Broadway, W.6. [9424]

OVERSEAS. Electronic technicians are required by an oil exploration company with headquarters in the U.K. Men should be single on joining. Work will include the maintaining and operating of field equipment often under conditions of desert, jungle and swamp. The equivalent of an H.N.C. with practical experience in electronics, is essential. Tours overseas are of up to two years, followed by home leave.—Write with full particulars, covering any time spent in the Forces, to Box 2228. [0331]

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MINISTRY of Aviation require Electronic Engineers for development, planning production or inspection of Guided Missiles and other electronic equipment including communication and radar equipment at London Headquarters branches and other locations. Quas. recognised engineering apprenticeship or equivalent training and corporate membership of I.E.E. or exempting quals. Experience of modern electronic practice in communication or radar fields desirable and knowledge of guided weapon practice and servo mechanisms advantageous. Salary £830 (age 25)—£1,300 per annum (London, male). Maximum commencing salary £1,125 at age 34 or over (London). Slightly lower rates in provinces. With maximum commencing salary £1,095 at age 34 or over. Excellent career prospects and opportunities for established appointments. Forms from Ministry of Labour, Technical and Scientific Register (K), 26, King St., London, S.W.1, quoting D.790/OA. [9412]

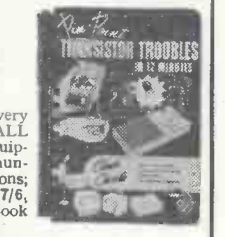
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ELECTRICAL and Electronic (Warminster, Tidworth, Ashchurch, Old Dabry, Ashford (Kent), Woolwich, Donnington (Shropshire), Deybrook, York, Adershot, Christchurch, Larkhill, Arborfield, Newark Catterick, Mill Hill, Northern Ireland and Malvern).
FOR appointment as Technical Assistant, applicants should possess O.N.C. in electrical or mechanical engineering as applicable or equivalently. Successful completion of an Artificers' Course in R.E.M.E. or Foreman of Signals Course may be accepted in lieu. Candidates should preferably have served a recognised engineering apprenticeship and a knowledge of Service equipment would be advantageous. Training can be provided to successful candidates lacking equipment knowledge and for work study appointments. Willingness to continue studies for H.N.C. at the department's expense would normally be expected and up to one day a week for attendance at a Technical College is likely to be granted. For certain appointments the ability to write clear and concise English is a decided advantage. CHIEF Technical Assistants are also required for work on electronic Army equipment. Vacancies exist at Woolwich and Malvern only. For appointment as a Chief Technical Assistant the candidate is expected to possess as a minimum the qualifications applicable to a Technical Assistant and, in addition, to have several years' experience in one or more of the branches of engineering applicable to Radar, Guided Weapons or Servo Mechanisms. A knowledge of R.E.M.E. repair procedure would be an advantage.

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NATIONAL salary scales—Chief Technical Assistant, £938 rising to £128 p.a., and Technical Assistant, £827 to £988 p.a. (minimum linked to age 26). These scales attract where applicable a London weighting addition of £25 to £30 p.a. Application forms from: Manager (P.E.553), Ministry of Labour, Professional and Executive Register, Atlantic House, Farringdon Street, London, E.C.4.
APPLICANTS should state on the application form the grade of appointment for which they wish to be considered and indicate any of the locations at which they are not prepared to accept an appointment. [9451]

ELECTRONIC Engineer, interesting, varied work on scientific instruments, small, rapidly expanding company provides friendly and informal conditions with good opportunities for advancement; essential qualifications: a thorough understanding of electronic valve circuitry at d.c. and low frequencies, both theoretical aspects and practical application; experience of transistors, printed circuits and/or magnetic amplifiers an advantage; state of fully career details and salary required. Technical Director, Shandon Scientific Co., Ltd., 6, Crownwell Place, S.W.7. [9419]

INTERNATIONAL AERADIO Ltd., has periodic vacancies overseas for Radio Technicians. City and Guilds Intermediate Telecoms. an advantage but not essential if applicant has considerable experience installation/maintenance H.F./V.H.F. low/medium power comms. Equipment; applications ex-service personnel of fully skilled categories welcomed; posts are permanent and pensionable; normally accommodation is provided with tax free emoluments equated to local conditions; additional marriage and child allowances; free air passages and insurance; kit allowance; generous U.K. leave; apply in writing.—Personnel Manager, 40, Park St., W.1. [0262]

MINISTRY of Aviation require Engineers in their Electrical Inspection Directorate at Bromley, Kent, to assist in technical direction, of Post A Electronic valves and transistors Post B Special purpose batteries. Duties include control of test-laboratories, close liaison with research and development establishments, manufacturers etc. and offer a unique opportunity to gain wide experience in these fields. Salary range £820—£1,500 (improved scales shortly available) according to age, with good prospects of promotion to higher grades, 5-day week, generous leave and opportunities to compete for established pensionable posts. The normal duties and responsibilities of the posts are at professional level and require candidates who possess the educational qual. and practical training required for Corporate Membership of the Institution of Electrical Engineers. Exp. in development, manufacture or inspection of electronic valves and/or transistors for Post A and of primary and/or secondary batteries for Post B, is desirable. Forms from Ministry of Labour, Technical and Scientific Register, (K) 26 King St., London, S.W.1, quoting D.830/OA closing date 9 March, 1961. [9413]

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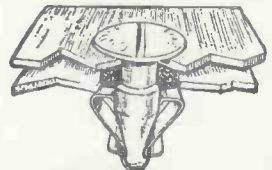
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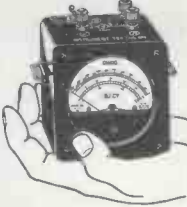
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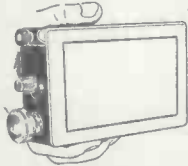
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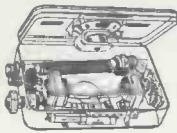
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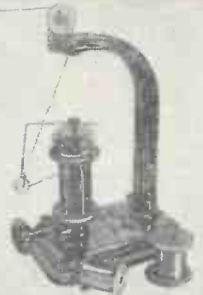
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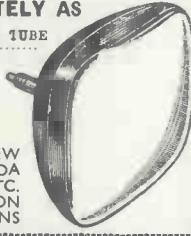
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