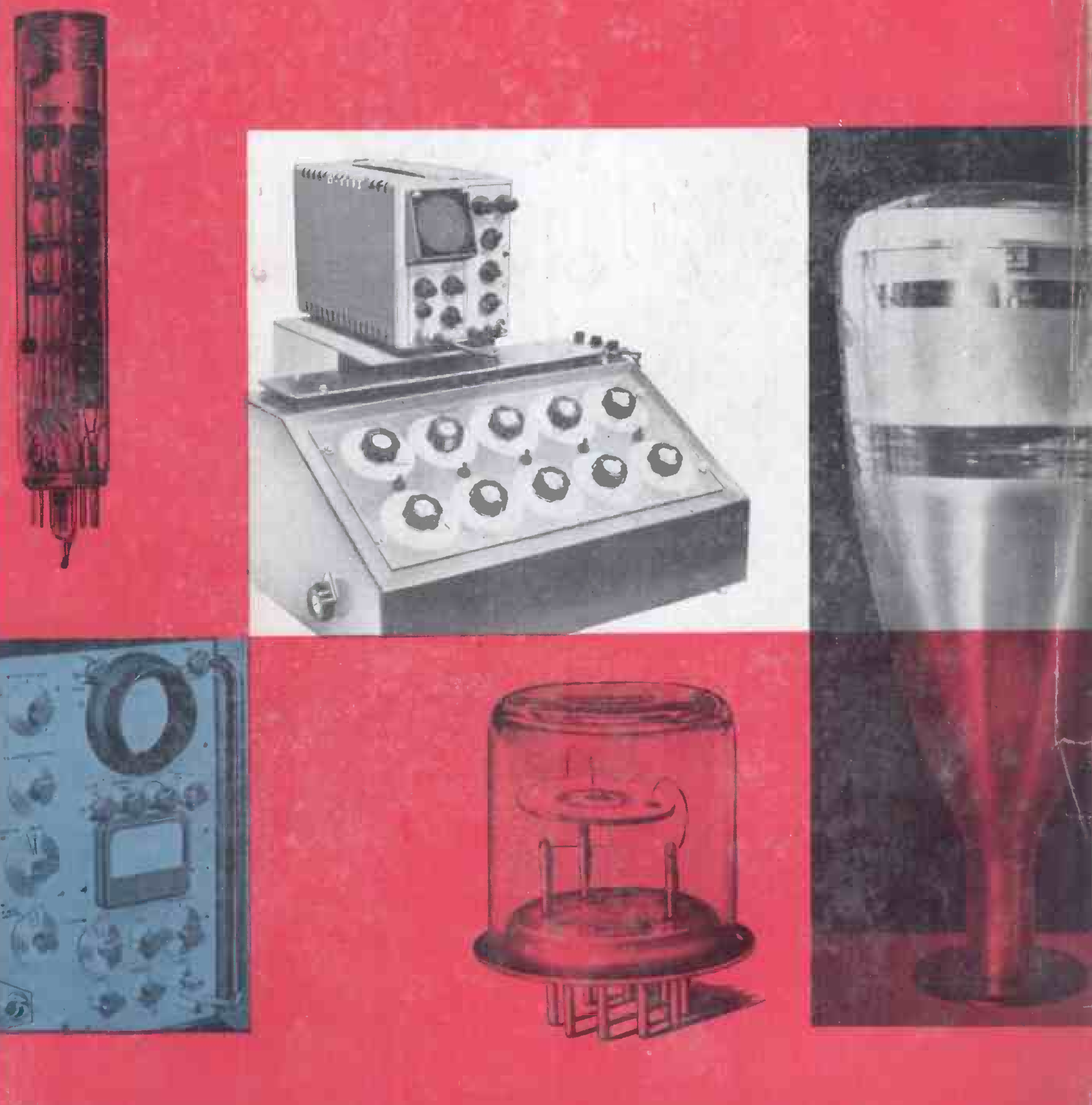
Wireless World

ELECTRONICS
RADIO
TELEVISION

MARCH 1961 TWO SHILLINGS



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MARCH 1961

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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) 10μV, the setting being indicated on a four-figure in-line read-out. The remainder, up to 10μV, 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.

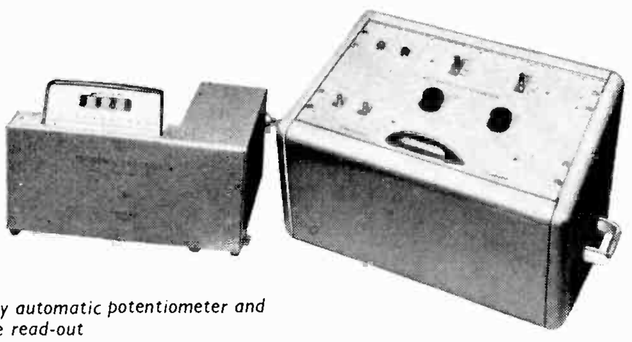
Frequency Measurement. A high proportion of frequency meters are digital in form and employ transistor counting decades with an upper speed limit of 10Mc/s, although the Airmec 298 will count at speeds up to 20Mc/s.

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.

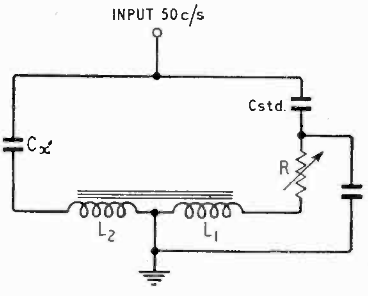
Frequency Standards are in greater demand as development work on stable sources proceeds. One such standard is the 16kc/s GBR transmitter at Rugby, which is controlled by the MSF standard. Two exhibits, one a joint example by the N.P.L. and Post Office Engineering Departments, the other a "private enterprise" 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.



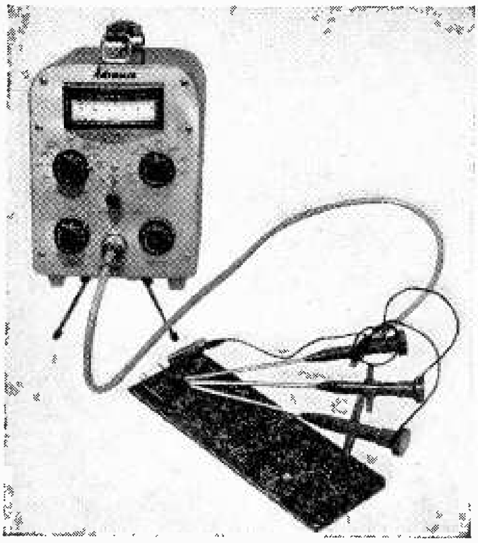
Tinsley automatic potentiometer and in-line read-out

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 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.

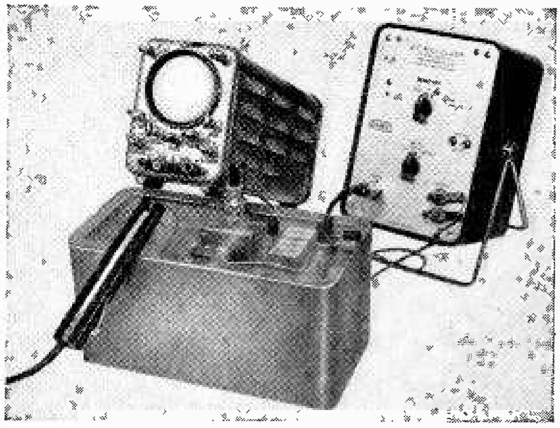


A.E.I. (Manchester) inductively coupled bridge for dielectric loss measurement.

An inductively-coupled dielectric-loss bridge is described by A.E.I. Research, for the measurement of tanδ in the range 0.0003 to 0.03. The bridge is balanced when the ampere-turns in L1 are equal to those in L2, i.e., when Cx is equal to Cstd, which is variable.



Advance in situ transistor tester.



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

If the dielectric loss of Cx exceeds that of Cstd, 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 tanδ.

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. Alternatively, a CR network connected in place of the coaxial cable will produce a pulse width of 2.6μsec. A button-operated switch provides a single pulse output.

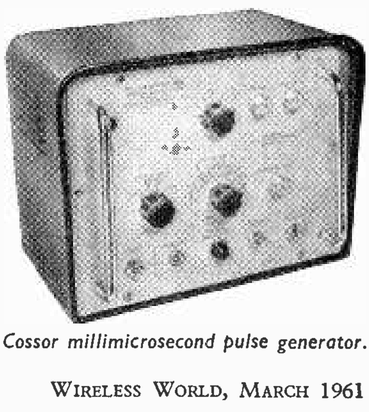
Accuracy of pulse repetition frequency is a feature of the Fleming crystal-controlled pulse generator 1478A. The p.r.f. generator is a 100kc/s crystal oscillator, the output of which is divided to provide five switched repetition rates. The highest-speed divider is a trochotron magnetic beam-switching tube, the remainder being EIT tubes. Bursts of pulses, 2μsec wide and with a rise time of 0.1μsec, 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. Milliclamp. 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.

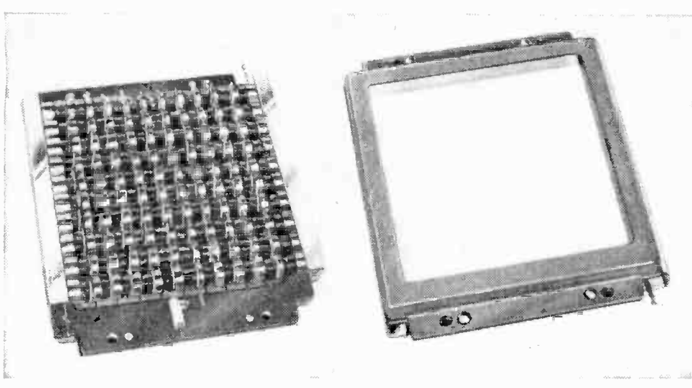
DISPLAY DEVICES

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.

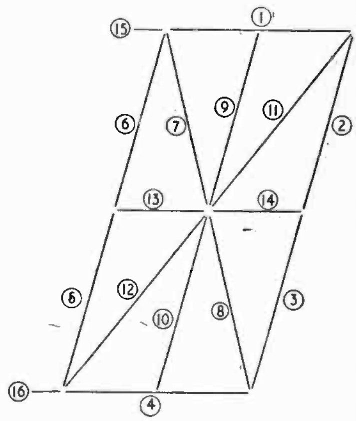
Electroluminescent Display for millimicrosecond pulses was shown by G. V. Planer. This consists in its simplest form of a row of electroluminescent areas connected in sequence to a delay line. When pulses are inserted from opposite ends of the line they travel towards each other producing, when and where 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 producing a television type of display with two delay lines on the x and y axes.

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



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 Phospotron 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.

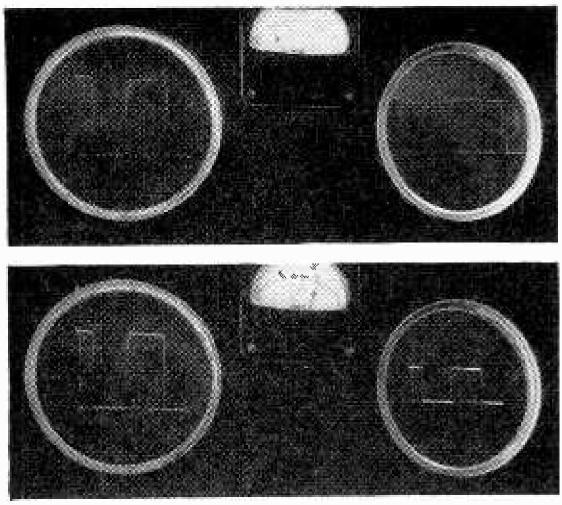
Post-deflection Acceleration of the electron beam in a cathode-ray tube is often used to increase trace brightness without incurring the loss of sensitivity that would result from an increase of final-anode potential. P.d.a. can lead to trace distortion,



Simplified diagram of layout of Ericsson "Phospotron" 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 timebase flyback is usually accomplished



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.

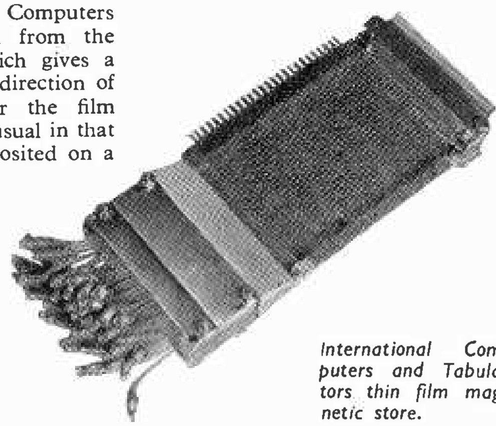
COMPUTERS

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.



International Computers and Tabulators thin film magnetic store.

Multi-Track Heads for recording as many as forty tracks on ¼-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

1μsec/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 1μA 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.

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 ± 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. 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. Photocells 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 "Teleremscope" 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 tin-plate 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.

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 100μV 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 Anæsthetics 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.

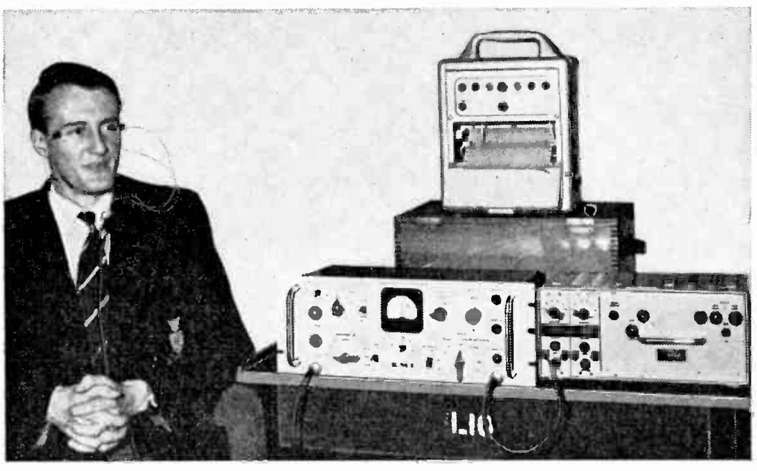
COMMUNICATIONS

IT is sometimes said that, for "steam" radio, development is complete. 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.

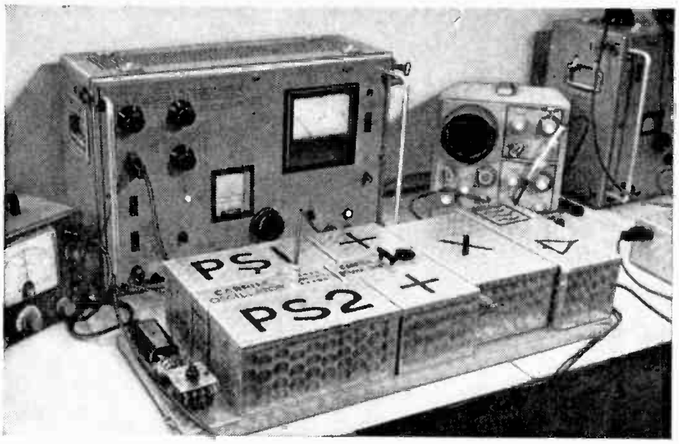
New S.S.B. Generation method developed by W. Saraga of A.E.I. uses only one multiplier-modulator stage compared with the more usual two. Summarizing previous methods briefly, it could be said that they depend either upon the use of filters to remove the unwanted sideband which is very near the wanted 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 150.5μsec intervals: these samples are then converted to a parallel six-bit code and fed into torsional wire delay lines 150μsec long, arranged so that the information circulates. The digits are thus spaced 0.5μsec 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; ×, 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 0.5μsec 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

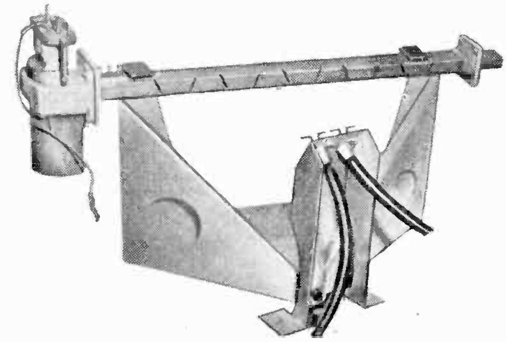
ONE of the main trends in this field, towards broader bandwidths, led this year more to new broadband components rather than, as in some previous years, to new wide band generators.

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.

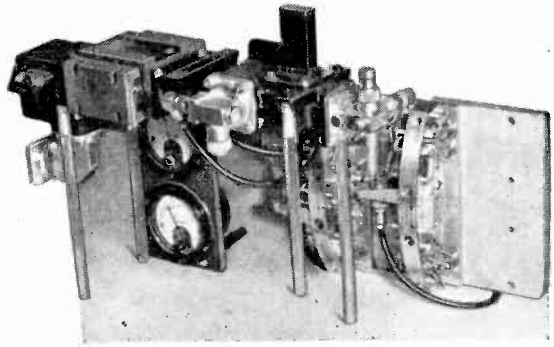
Radar Performance Monitor shown by Elliott enables the overall performance of the whole radar system to be observed. In this monitor the output from the radar aerial is received by a monitor aerial, attenuated by a total amount which can be varied to correspond to various path losses, and displayed on 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 5×10^5. 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 10^8 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. Hirst Research Centre. 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 Termilode) 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 2mμsec. Plessey demonstrated a Boff diode, switching power into a short-circuited line.

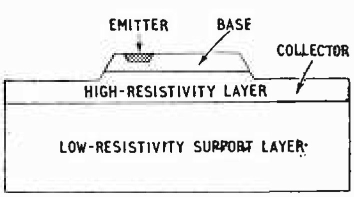
In an ordinary semiconductor junction, carrier storage results after the junction has been switched off by reversing the supply, in a gradual decay of the current output: this is usually made as short as possible by making the carrier lifetime short. In the Boff diode, however, a long carrier lifetime 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 thyratron, 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 0.2μsec 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, germanium 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.



Simplified diagram of section through expitaxial transistor.

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.ts. 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 developed 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 "guestimates" 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.

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	Rendar Instruments
Antone	Reosound Engineering
C.T.H. Electronics	Reslosound
Chapman Ultrasonics	S.T.C.
E.M.I. Electronics	Shure
Film Industries	Tellux
G.E.C.	Vortexion
Lustraphone	H. Warren
Magneta BVC	Westrex
Pamphonic Reproducers	Whiteley Electrical
Philips	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, Loebl & 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 countermeasures 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 Wirevision Ltd.

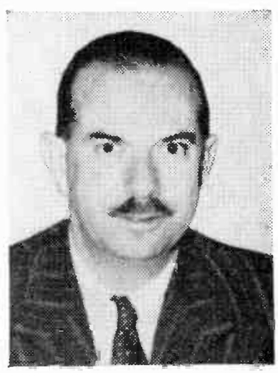
Air Vice-Marshal W. E. Oulton, C.B., C.B.E., D.S.O., D.F.C., has retired from the Royal Air Force after 32 years' service and joined the board of E.M.I. Electronics Ltd., as director responsible for Ministry work. He played a prominent part in setting-up the London Air Traffic Control Zone in 1946 and 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 Nucleonics 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 mircowave 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 ½-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), ½M 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 $\pm$1dB from 20c/s to 20kc/s.
(4) Total harmonic distortion $\leqslant$ 0.1% at 100mV r.m.s. output.
(5) Gain at 1kc/s to be within $\pm$ 0.5dB of unity voltage gain when feeding a load $\not<$ 50kΩ.

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 $\pm$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

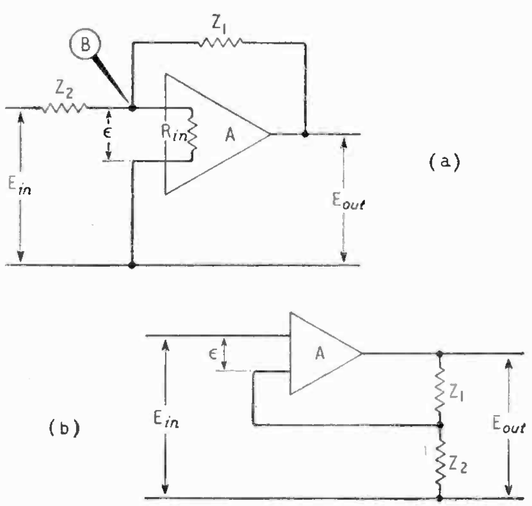
$$f(j\omega) = \frac{K(1 + j\omega T_2)}{(1 + j\omega T_1)(1 + j\omega T_3)} \quad \ldots \quad \ldots \quad (1)$$

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

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 50kΩ to magnetic cartridges.

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

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



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 50kΩ, which means that R_{in} must be of the order of 50kΩ. 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

* English Electric Aviation Ltd.

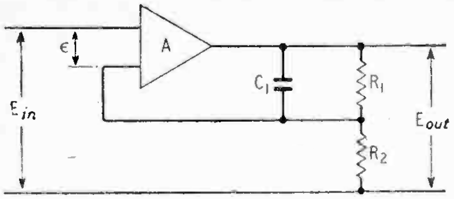


Fig. 2. Feedback amplifier providing bass equalization.

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 $T_1 = R_1C_1$

Therefore,

$$G(j\omega) = 1 + \frac{R_1}{R_2(j\omega T_1 + 1)}$$

$$= \frac{R_2(j\omega T_1 + 1) + R_1}{R_2(j\omega T_1 + 1)}$$

$$= \left(1 + \frac{R_1}{R_2}\right)\left[\frac{1 + j\omega T_1\left(\frac{R_2}{R_1 + R_2}\right)}{1 + j\omega T_1}\right]$$

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 $K = 1 + R_1/R_2$.

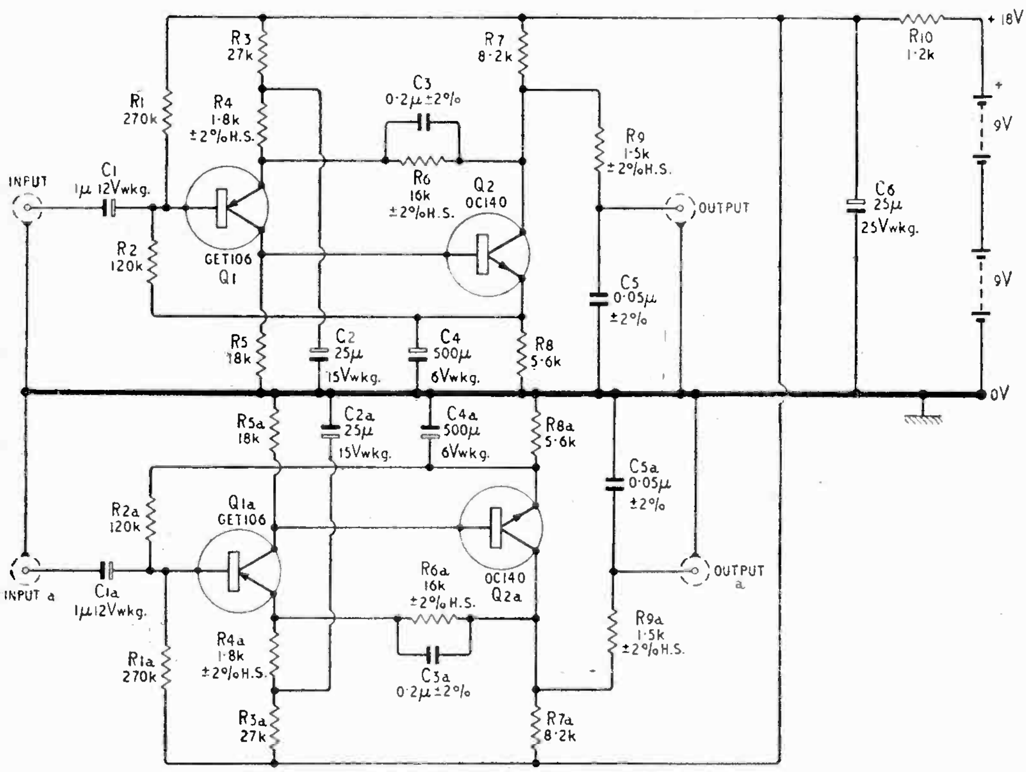
Thus if $T_1 = 3{,}180$ μsec, and $T_2 = 318$ μsec, then $G(j\omega) = f_b(j\omega)$. Thus bass equalization can be incorporated in the feedback loop.

In the circuit of Fig. 3, the components corresponding to R_1 C_1 and R_2 in Fig. 2, are R6, C3, and R4 respectively (and R6a, C3a, and R4a for the other channel).

Treble equalization is accomplished by a simple C-R network (formed by C5 and R9 in Fig. 3) with a time constant of 75μsec, 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 50kΩ 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 Q1, GET 106, a p-n-p low-noise transistor; and Q2, 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 ¼W, ±10% (H.S. means high stability) and all capacitors ±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 $\pm$ 0.2dB from 20c/s to 20kc/s. (This accuracy may be more conveniently expressed as $\pm$ 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 $\pm$ 0.6dB, and the total harmonic distortion, measured at 3.5kc/s and 100mV r.m.s. output, was $\leqslant$ 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 ± 0.5dB 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 ± 0.5dB 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
Camp Bird Finance
Camp Bird Industries
Camp Bird Investment Trust
Camp Bird Mining
Camp Bird Securities
Cold Forging
Coolers & Venders
Creston Electric
Electronic Reproducers
Electronic Reproducers (Components)
Grahams Trading Co.
Hanworth Engineering (Aircraft)
Inductoforce
Kelly Acoustics
Lambert & Son (Eastcheap)
Limit Engineering Group
Limit Manufacturing Co.
Limit Sales
Limit Tools & Gauges
A. Prince Industrial Products
Rubber Plastics
Tenaplas
Vending Supply & Service
West European Industries

Hartley Baird
- Baldwin, H. J., & Co.
- Baldwin Central Products
- Baldwin Durawire Cable Co.
- Baldwin Engineering Equipments
- Duratube & Wire
- Hartley Installations
- National Rejectors
- Salopian Industries (Metals)
- Thermat
- Waldogram Properties
- 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 frequencies) 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.

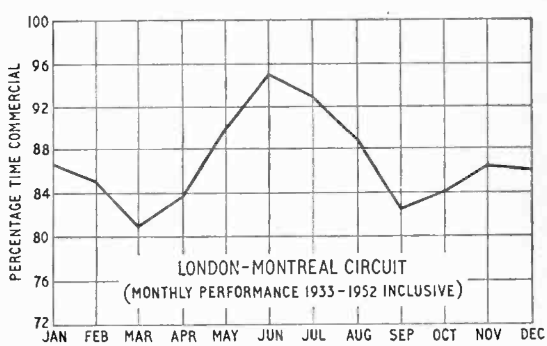


Fig. 1. Average monthly performance over the London-Montreal radio circuit for the years 1933 to 1952 inclusive.

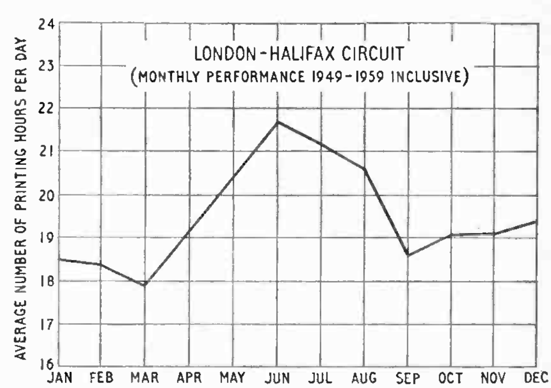


Fig. 2. Similar data to Fig. 1 over London-Halifax radio circuit for the years 1949 to 1959 inclusive.

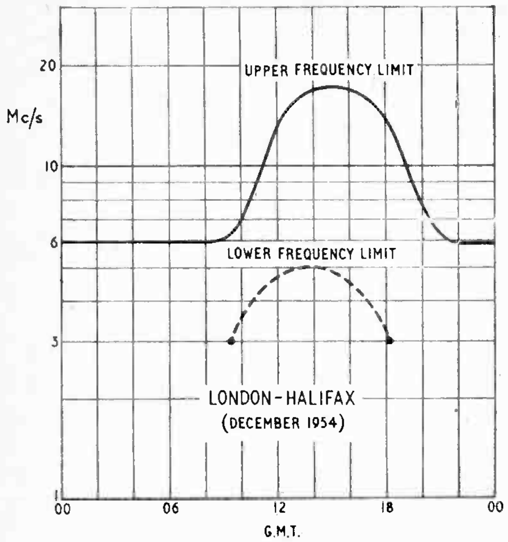


Fig. 3. Upper and lower usable frequency limits over the London-Halifax radio circuit for December 1954; year of minimum solar activity.

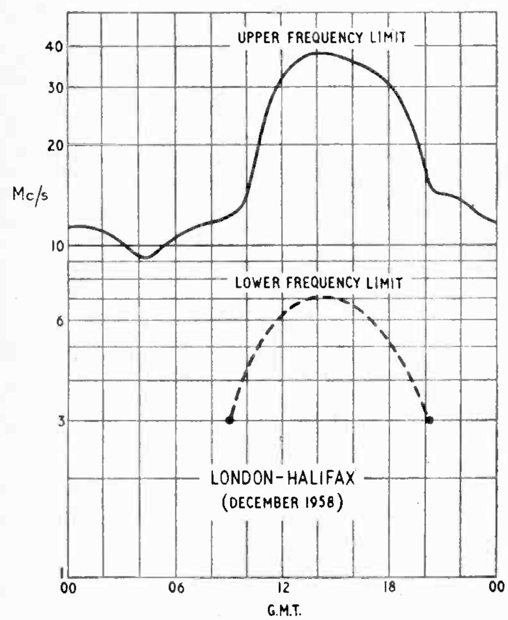


Fig. 4. Similar data to Fig. 3 but for December 1958; year of maximum solar activity.

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 1952[1] (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 16¼ 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 12¼. 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-

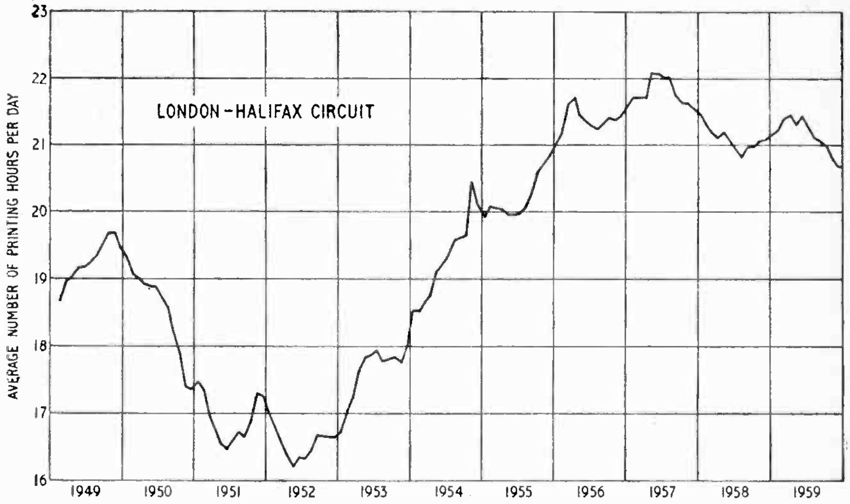


Fig. 5. Twelve-monthly running average performance over the London-Halifax radio circuit for the years 1949-1959 inclusive.

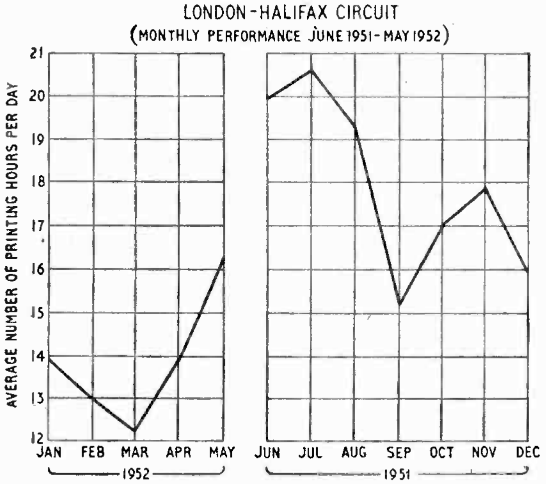


Fig. 6. Monthly average performance over the London-Halifax radio circuit from June 1951 to May 1952.

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 transmiter 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

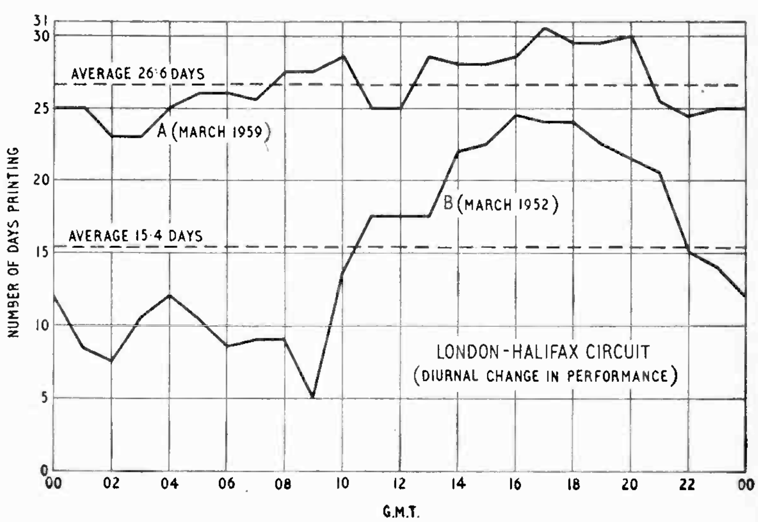


Fig. 7. Curves comparing diurnal changes in performance over the London-Halifax radio circuit for March 1952 and March 1959.

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 days[5]. As a result widespread interruptions to circuit operation occurred.

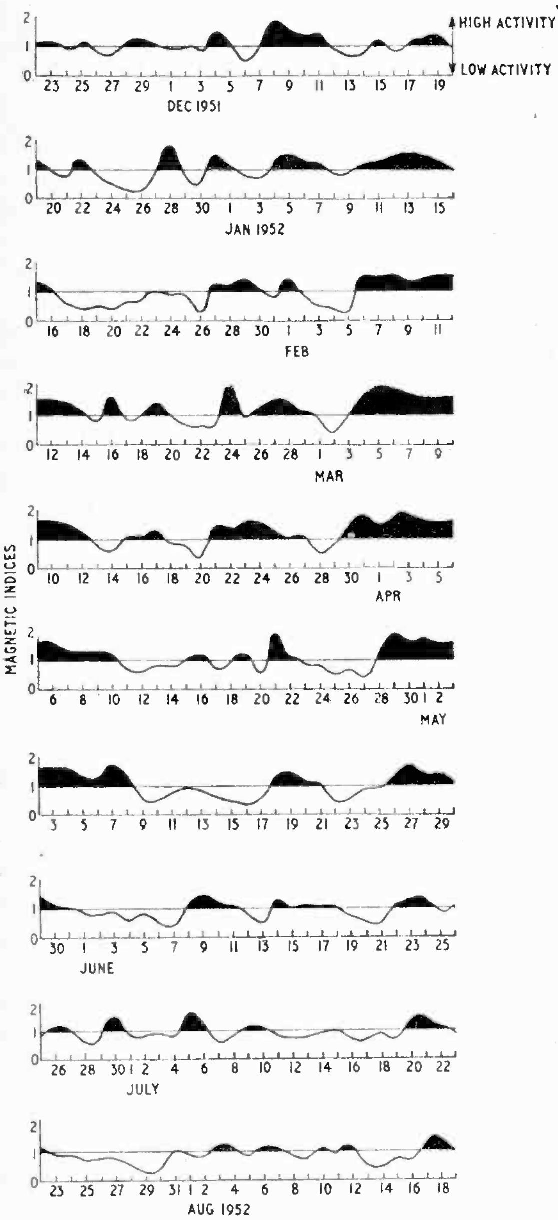


Fig. 8. Monthly magnetic activity during the solar low activity year 1952.

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.

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 ±0.1dB, 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 methods[2], 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 Amptitude/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 generator[3].

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,

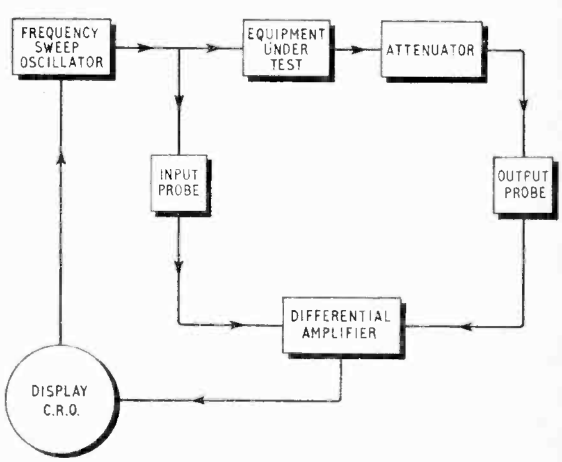


Fig. 8. Apparatus set up for differential measurements which overcome difficulties due to variations of oscillator output.

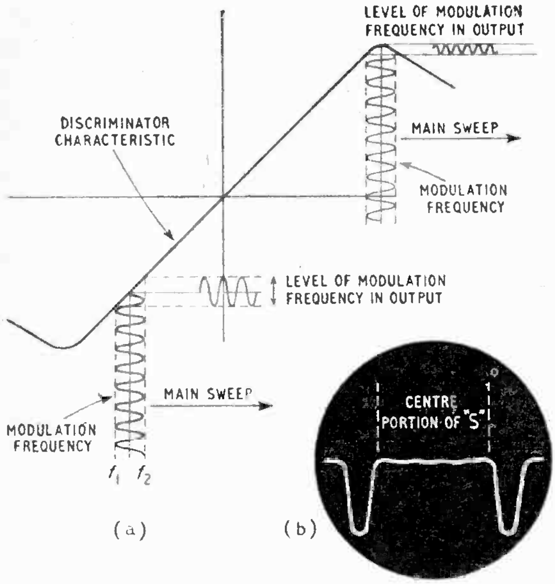


Fig. 9. (a) Production of first derivative of f.m. demodulator characteristic ("S"-curve) showing effect at two different points in the sweep and (b) display produced on c.r.o.

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 ±150kc/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

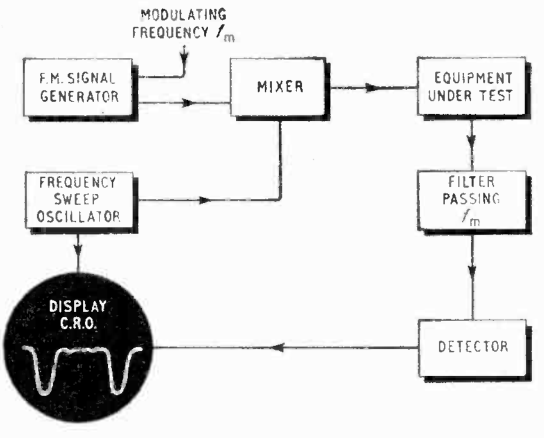


Fig. 10. Apparatus for display of first derivative of amplitude/frequency characteristic.

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 $p.d\phi/d\omega$. 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:—

$$\Delta\phi = p.d\phi/d\omega = p\tau \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

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 $1\mu s$ 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[4]. 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 l.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 applicatons of this method of measuring group delay the demodulator 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 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.

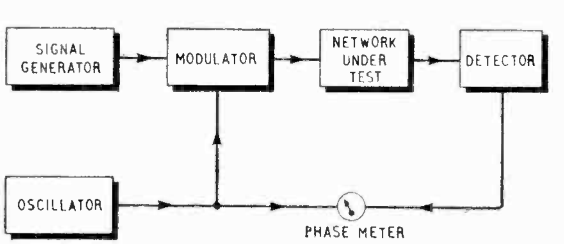


Fig. 11. Point-by-point measurements of group delay. The signal generator is, of course, an ordinary manually tuned type.

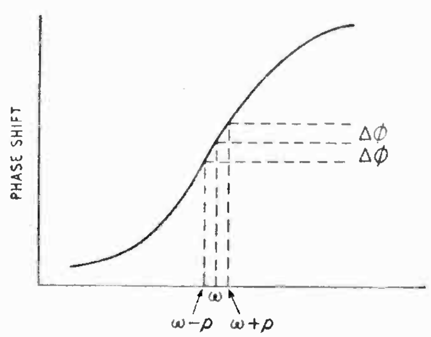


Fig. 12. Phase shift/frequency characteristic f r a network, showing principle of group-de measurements.

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_g 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

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

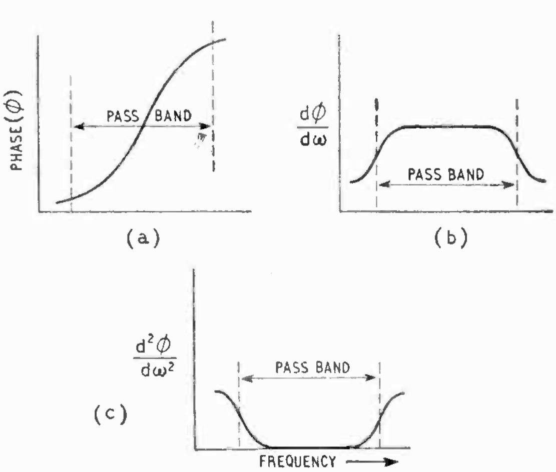


Fig. 13. (a) Example of a phase/frequency relationship compared with (b) its first derivative and (c) second derivative.

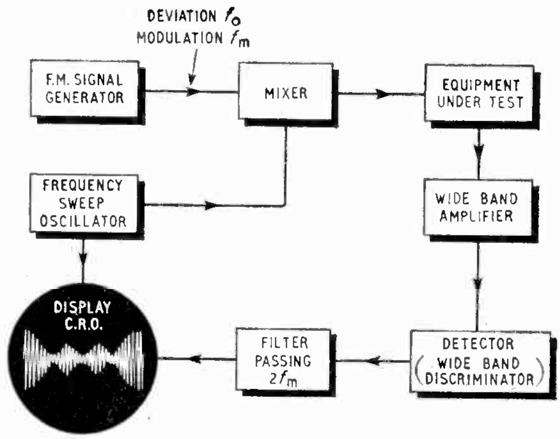


Fig. 14. Equipment arranged to display the second derivative of phase/frequency characteristic.

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 characteristic[5]. The relationship can be expressed in the following manner:—

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

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)

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

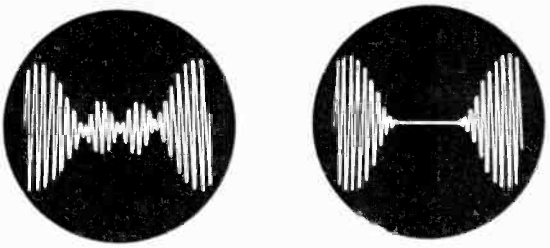
$\Delta\Omega = 2\pi f_o$ where f_o is the deviation frequency in c/s.

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



(a) (b)

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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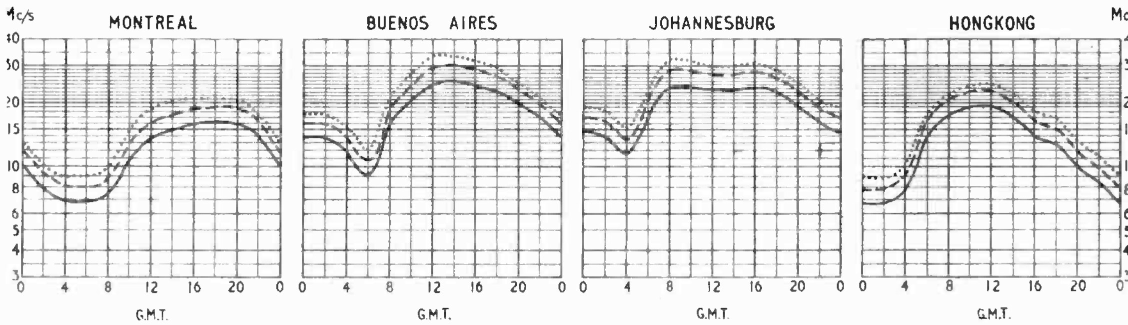
(To be concluded)

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.)

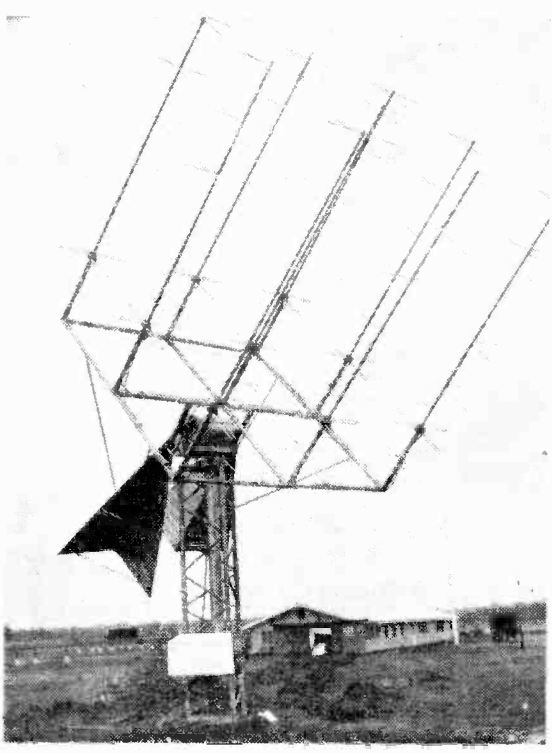
At Winkfield each interferometer consists of two pairs of aerial systems placed at diagonally opposite corners of a square. Each aerial system consists of eight colinear slot aerials, and all the slot aerials in one interferometer lie in the same direction. This gives both interferometers a response 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 FREQUENCIE

By T. W. BENNINGTON*

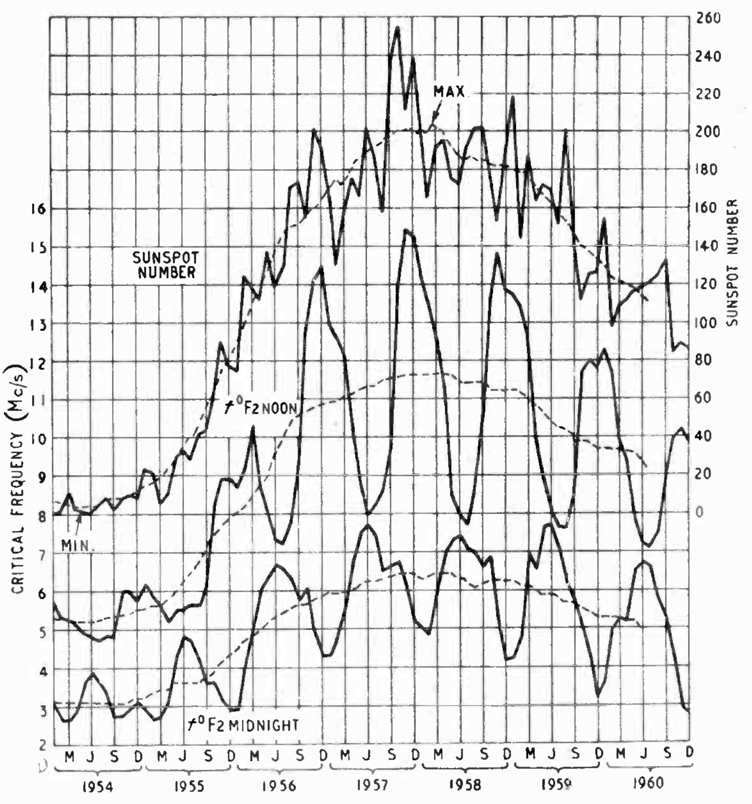
SINCE February/March 1958 the average solar activity has been decreasing, and throughout 1960 the decrease, as indicated by the 12-month running average of the sunspot number, continued at a relatively steady rate. At the end of the year, the value of this index of the solar activity was still, however, 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 prediction 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 declining 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 semiconductors. 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-6e. 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 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.

* 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.

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 ambivalance, 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:

$$g_m v_g + g_a v_a = i_a$$

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, $g_m v_g$, whereas it should designate the current flowing into Y_l. 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.

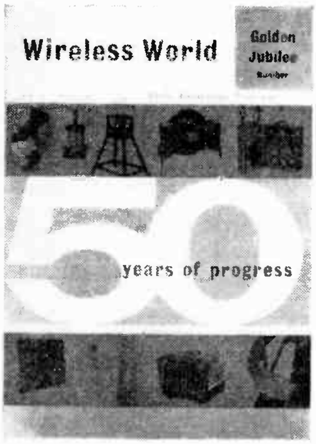
If the readers who fell at this fence now find they can clear it, they will find the rest of the course straightforward and rewarding.

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, $I_1, I_2, \ldots I_n$ 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.

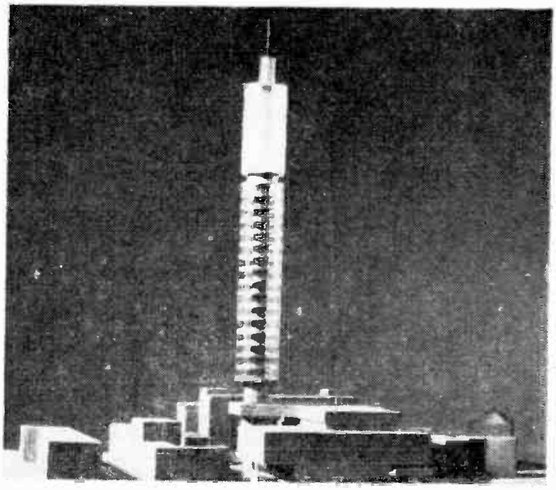
A request has been made to have the 4:3 aspect transmission standard reviewed by an appropriate committee.

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.

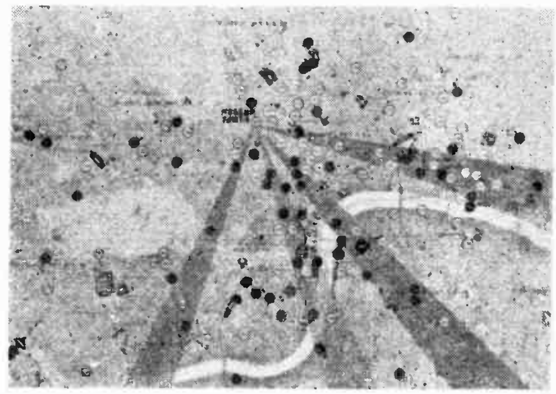
CHARLES E. TORSCH,
Chief Television Engineer, Rola Company.
Cleveland, Ohio, U.S.A.



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

500-FT RADIO TOWER

LONDON'S NEW LANDMARK



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

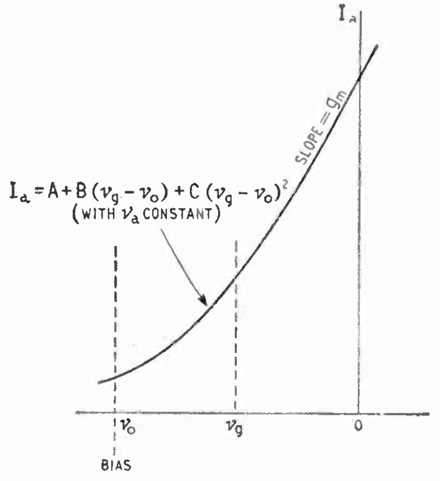


Fig. 1.

The series $I_a = A + B(v_g - v_o) + C(v_g - v_o)^2 + D(v_g - v_o)^3 \ldots$ etc. represents the true form of this curve where A, B, C, etc., are valve constants and v_o 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:—

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

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_a varies widely.

The anode characteristics (I_a/v_a with v_g held constant) of some triodes are of approximately parabolic form, i.e. $I_a = C(v_a - v_o)^2$ 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 $B(v_g - v_o)$ from the I_a/v_g series, thus permitting operation near the vertex of the parabola, i.e. $v_g = v_o$.

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 $B(v_g - v_o)$ in the valve

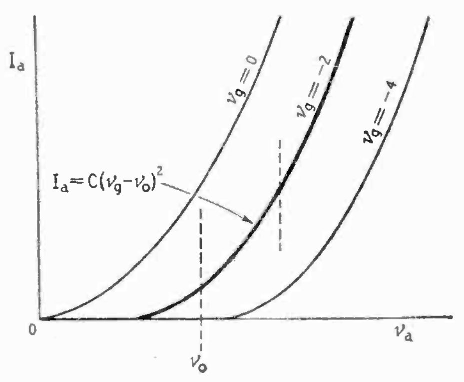


Fig. 2.

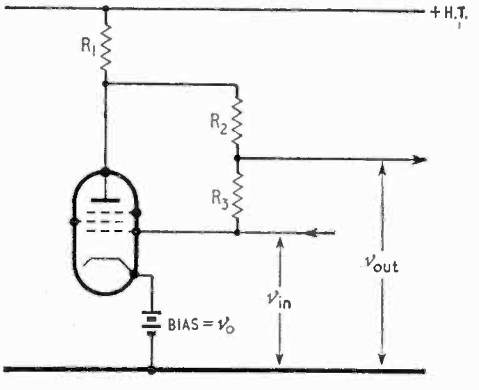


Fig. 3.

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 $v_{in} = v_g - v_o$ then $I_{a1} = A + Bv_{in} + Cv_{in}^2 + Dv_{in}^3 + Ev_{in}^4 \ldots$ etc. Now suppose we drive an identical valve V2 with the same input voltage but opposite in sign ($-v_{in}$) then $I_{a2} = A - Bv_{in} + Cv_{in}^2 - Dv_{in}^3 + Ev_{in}^4 \ldots$ etc. As I_{a1} and I_{a2} flow through a common resistor R the common anode voltage will be $v_{ht} - R(I_{a1} + I_{a2}) = v_{ht} - 2(A + Cv_{in}^2 + Ev_{in}^4 \ldots)$. 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:—

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

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. $I_a = A + Bv_g + Cv_g^2 \ldots$ 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

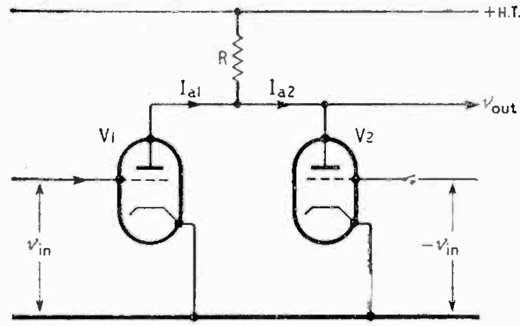


Fig. 4.

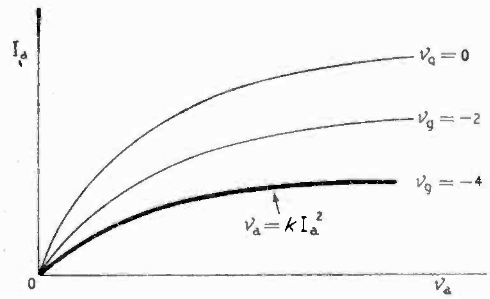


Fig. 5.

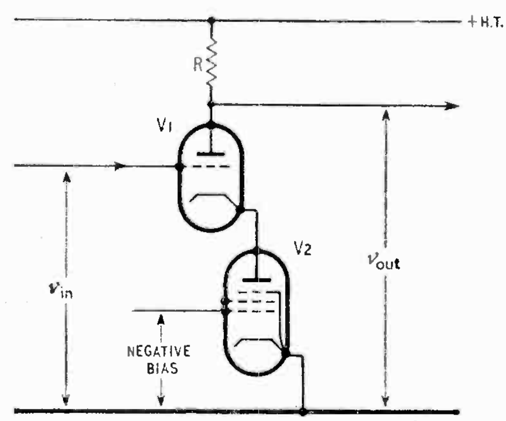


Fig. 6.

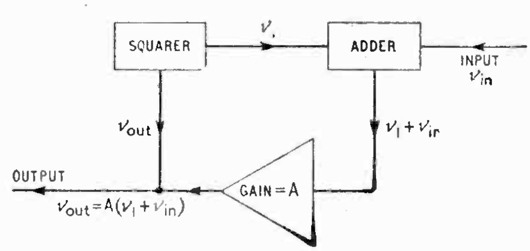


Fig. 7.

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:—

$$v_1 = -kv_{out}^2 \quad \text{(from the squarer)} \quad (1)$$

$$v_{out} = A(v_1 + v_{in}) \quad \text{(from the amplifier)} \quad (2)$$

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

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

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.

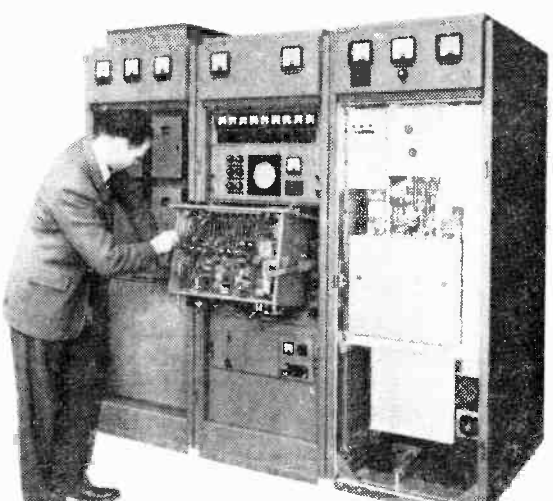
BORDER TELEVISION

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.

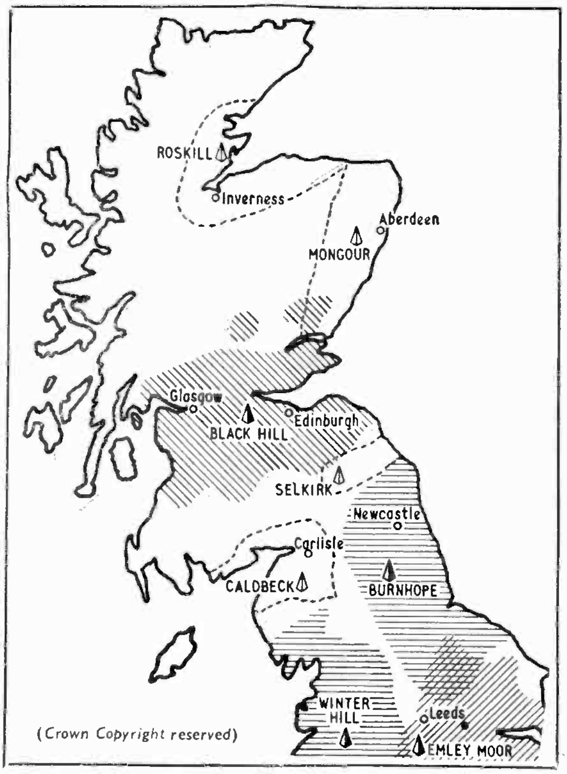
The associated station will be at Selkirk where the signals radiated from Caldbeck will be picked up and fed to vision and sound translators and re-radiated in another channel (yet to be decided). Selkirk will have a vision e.r.p. of 25kW.

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



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

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 co-operate 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 intial 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

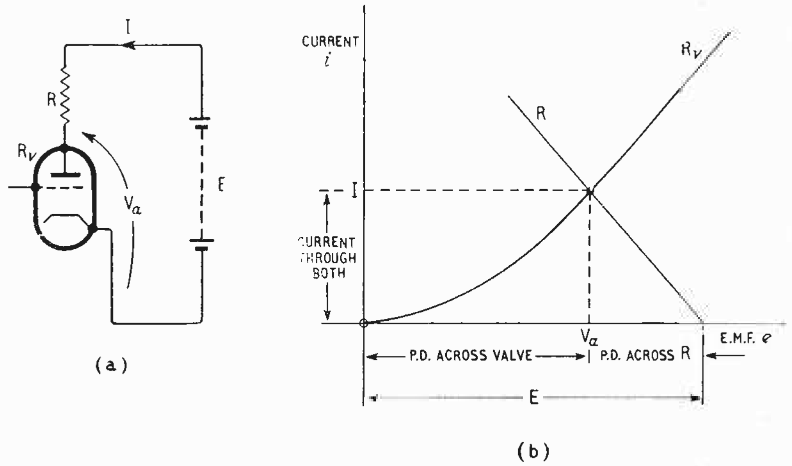


Fig. 1. (a) Simple valve circuit with load resistance R. (b) is the familiar load-line graphical method of finding the current I and anode voltage V_a.

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,

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

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

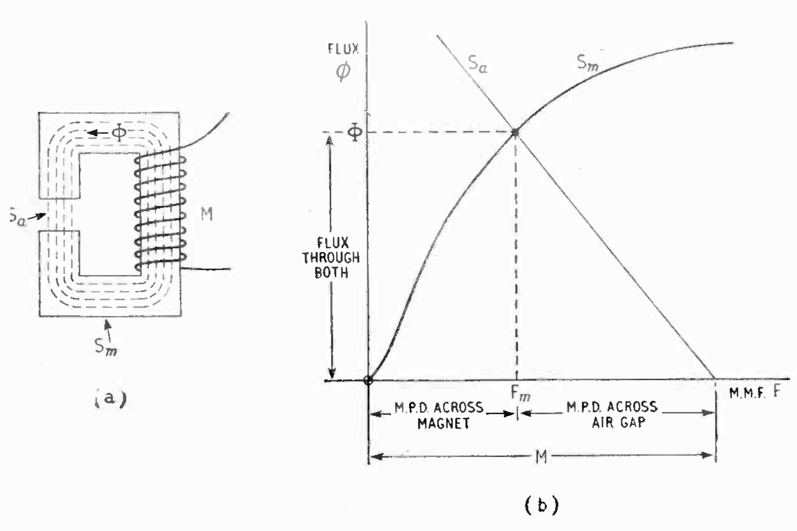


Fig. 2. Magnetic analogue of Fig. 1. The flux Φ corresponds to current I, m.m.f. to e.m.f., and reluctance (S) to resistance.

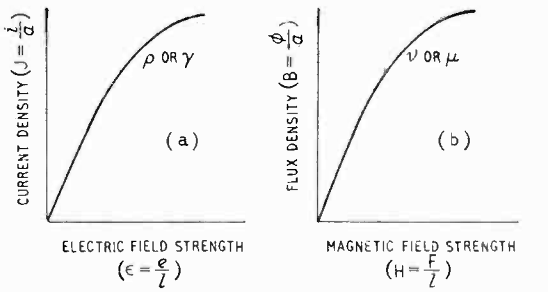


Fig. 3. (a) To transform the current/voltage graph of a resistor into a general one for its resistive material, the current is divided by the cross-sectional area of the resistor, and the applied voltage is divided by the length. (b) is the magnetic analogue, well known as a B/H curve.

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

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

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 electromagnetic 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 10^8? 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

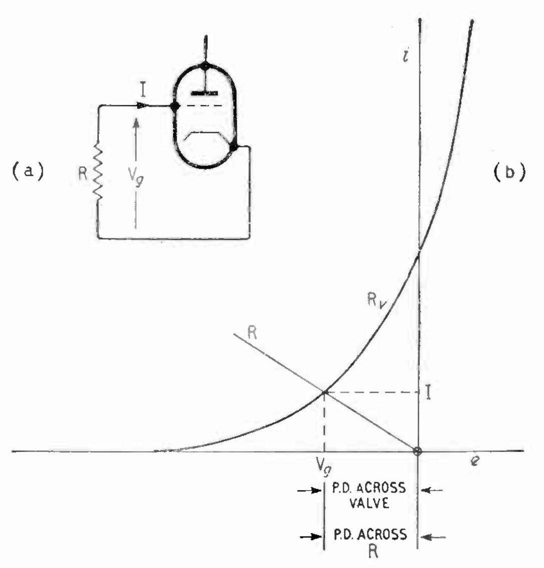


Fig. 4. (a) is the electrical analogue of a permanent magnet—a circuit in which some current flows even though there is no applied e.m.f. (b) is the same type of curve as in Fig. 1.

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.ds 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 "remanence" 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 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.

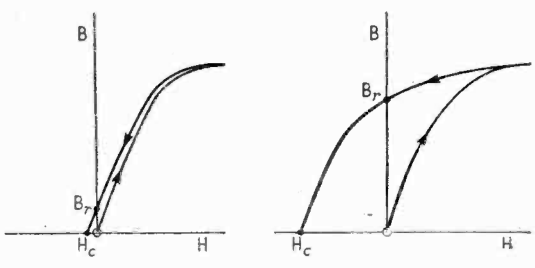


Fig. 5. Curves showing the results of increasing and decreasing the magnetizing force applied to (a) a "soft" (b) a "hard" ferromagnetic material.

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

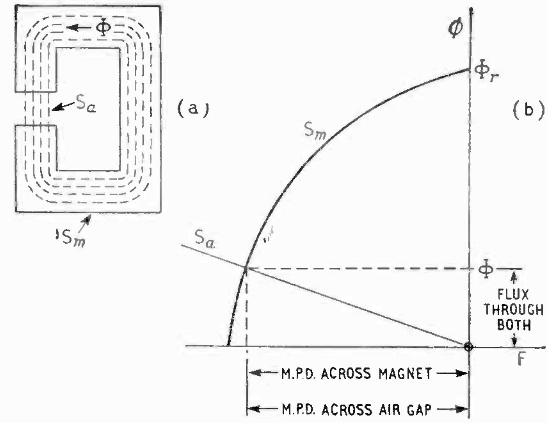


Fig. 6. This permanent magnet circuit and curve compares with the electromagnet circuit and curve in Fig. 2, and the electrical analogue in Fig. 4.

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 afaid 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.,

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

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

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

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

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

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

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 $-H_mB_m$ 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/m² (= 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_a—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 would be out of place to consider in what is intended to be a framework of theory serving as a first approximation in design.

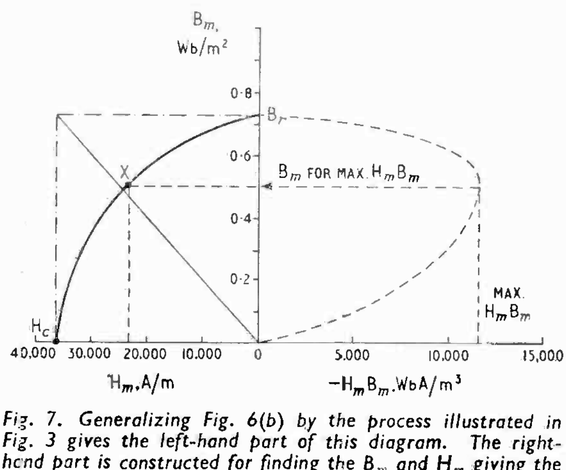
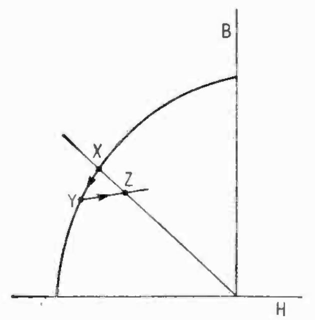


Fig. 7. Generalizing Fig. 6(b) by the process illustrated in Fig. 3 gives the left-hand part of this diagram. The right-hand part is constructed for finding the B_m and H_m giving the maximum value of $-H_mB_m$.

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.

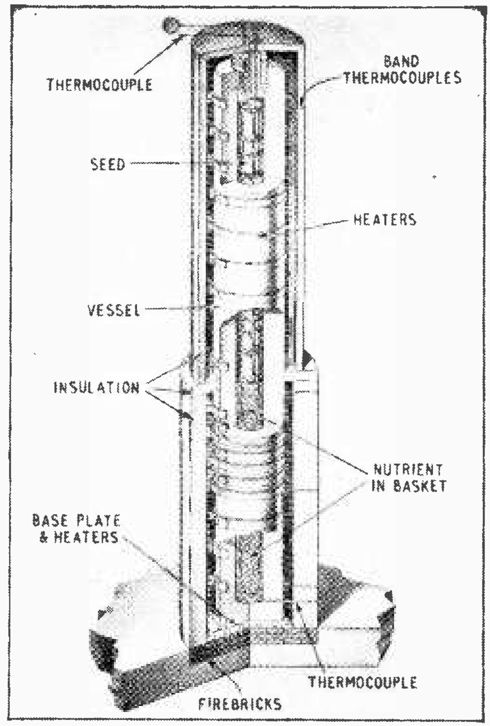
SYNTHETIC QUARTZ CRYSTALS

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.

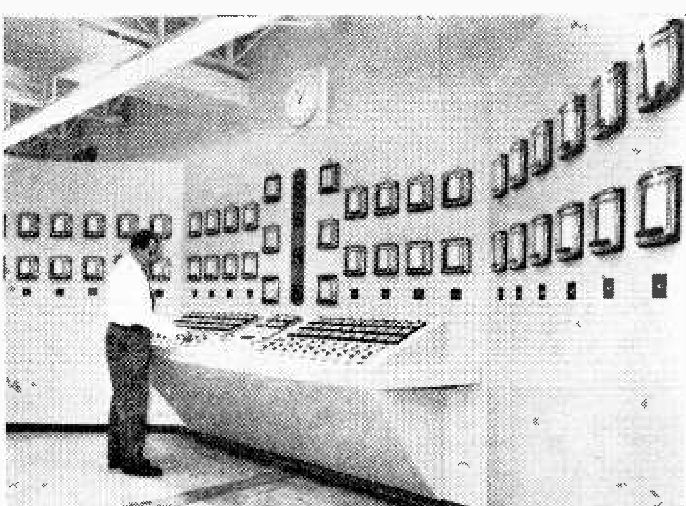
The hydrothermal process is used and depends on the maintenance of a critical temperature differential between the upper and lower regions of an autoclave-type growing vessel. This vessel has to withstand temperatures of the order of 700°F and pressures up to about 25,000 lb per square inch. In the upper 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 Government 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. Welldon 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.

BARNSLEY

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. Kemhadjian 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 'electrics' 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.)	Düsseldorf
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 foodstuffs 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 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.

No, cobber, this is not the flaming flying doctor.

UNBIASED

By "FREE GRID"

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.

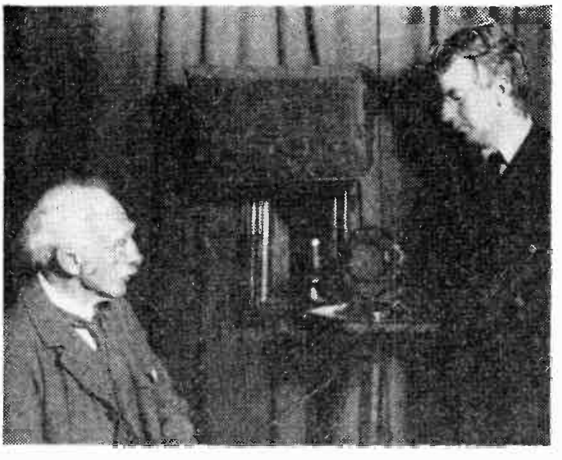
This technique of putting an error of the times into the mouth of a participant in the Scrapbook is a highly ingenious one which was used again in the "Scrapbook for 1931" broadcast on January 16th. But I was very greatly amused to hear a silly popular error put into the mouth of Freddie Grisewood, the 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.

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 televisors 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 broadcasting wavelengths, it had been garnering them from extra-mural sources, chiefly, of course, the Baird studios.



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

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 rangefinder 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 Manness 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?

INSTRUMENTS OF THE FUTURE *NOW* by AVO

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Noise Measurement:	1-20, 21-40 dB

Construction in general conforms with U.K. Inter-Service Spec. K114.

NEW AVO VALVE CHARACTERISTIC METER Mk. IV

This instrument has been designed to test any standard receiving or transmitting valve having up to a maximum anode dissipation of 25W. Inter-electrode insulation, anode current, mutual conductance and 'gas' current can be measured, and by making a series of tests, complete families of curves may be plotted. Rectifiers and signal diodes are tested under suitable load conditions. A comprehensive data manual is supplied with the instrument, which operates from 100-120 volts and 200-260 volts 50-60 c/s A.C. mains.

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Range of Anode-Voltage:	12.6–400 volts
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Heater Current:	3A max.
Anode Current:	100 mA max.
Mutual Conductance:	0.1–60 mA/V max.
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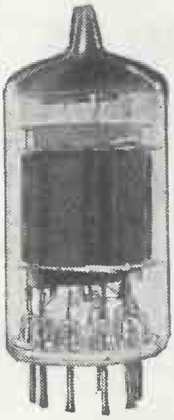
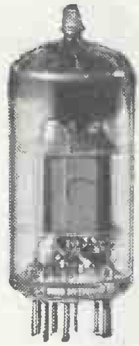
WIDEBAND



circuit designs simplified with new rf pentodes



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The introduction of the E810F and E55L wideband pentodes makes possible cascaded amplifiers with bandwidths hitherto only achievable by distributed amplifier techniques. They will be of particular interest to designers of wideband amplifiers for oscilloscopes, microwave radio links and telephone repeaters.

In the E810F the frame grid technique has been used for both the control grid and screen grid. This results in a particularly good ratio of anode to screen grid current. Moreover, special attention has been paid to the provision of an adequate grid base—making the valve ideally suitable for large signal applications.

The E55L has twice the anode dissipation of the E810F whilst still achieving a figure of merit of nearly 200Mc/s—a performance far in advance of conventional power pentodes. Like the E810F this large valve has the grid base required for large signal applications.

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	70kΩ	20kΩ
r_{g_1}	500Ω (f=100 Mc/s)	1000Ω (f=50 Mc/s)
Gain bandwidth product	238 Mc/s	194 Mc/s
Capacitances (unshielded)		
c_{a-g_1}	40mpF	110mpF
c_{in}	16pF	18pF
c_{in} (working)	25pF (I_k=40mA)	28pF (I_k=60mA)
c_{out}	3.5pF	4pF
Valve Base	B9A	B9D

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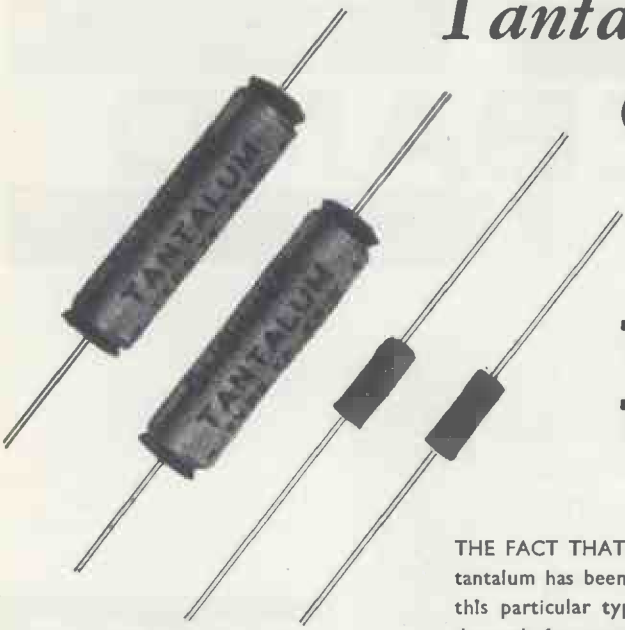

ACTUAL SIZE

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:—

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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.

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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.

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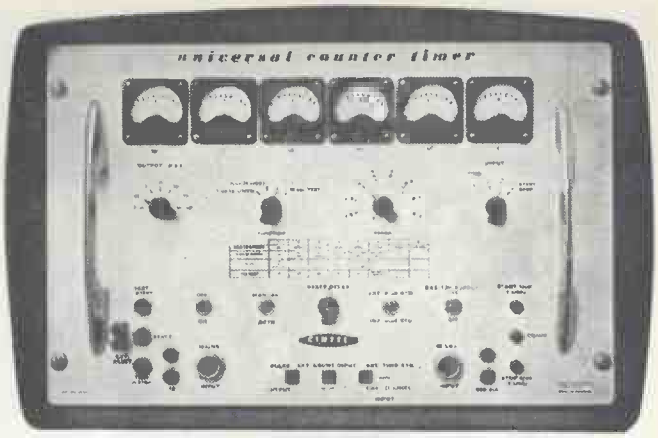
DN 262

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 3μsec to 1sec. The time for 1, 10 or 100 such events can be measured.

TIME/UNIT EVENT (2 LINE): For time measurement in range 1μsec to 2777hrs. of any interval defined by a positive or negative going pulse in any combination.

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Full technical specification available on request.

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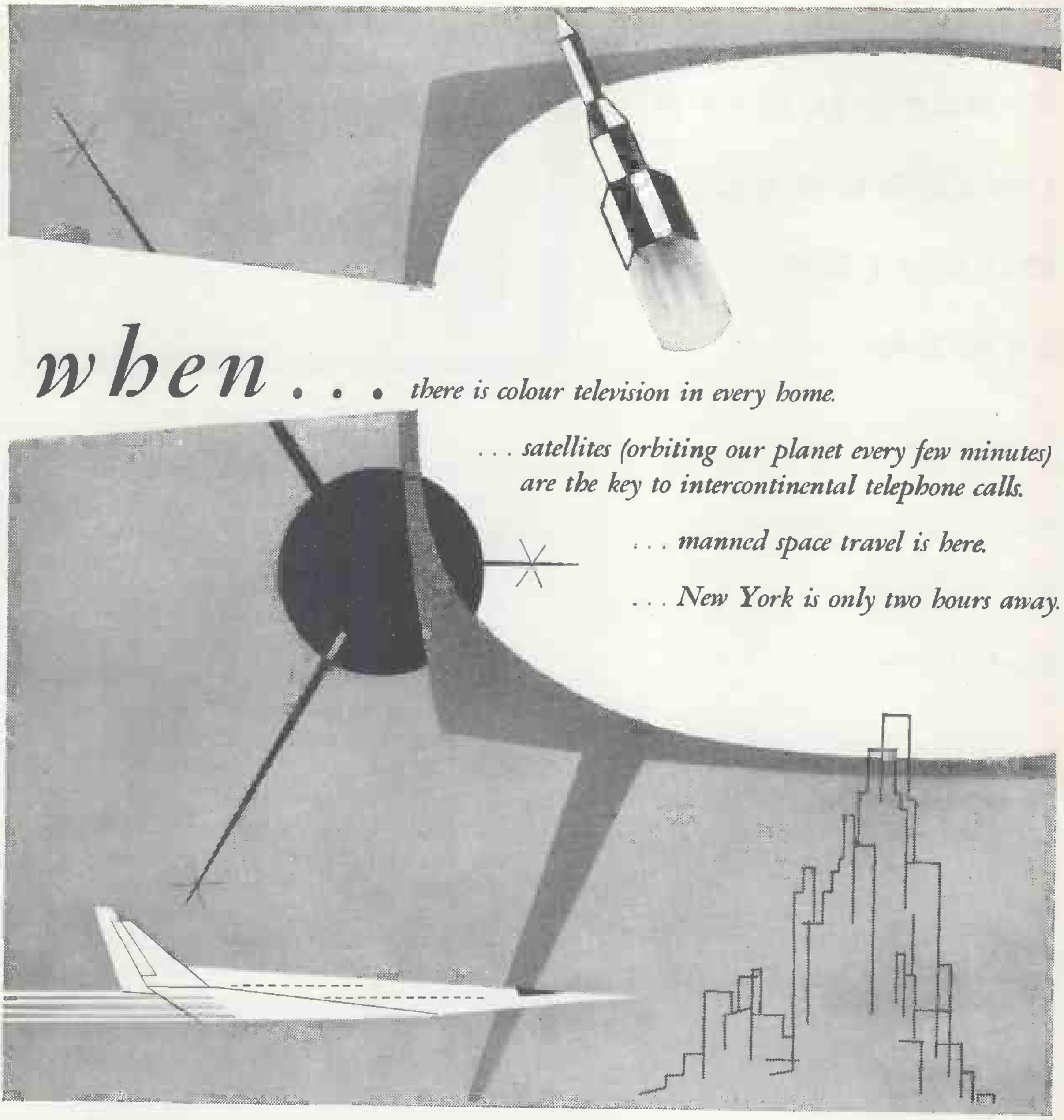
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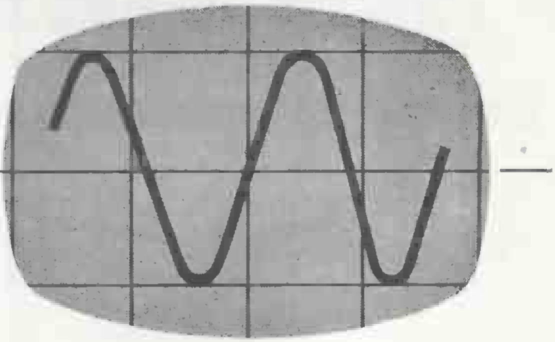

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Advance constant voltage transformers are available in the CVH range with low harmonic distortion in the output waveform, ideal for use with precision equipment sensitive to power frequency harmonics, and also with all equipment requiring a constant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

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

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- CONTINUOUS AND AUTOMATIC STABILIZATION
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- CURRENT LIMITING CHARACTERISTIC
- COMPACT DESIGN
- NO MOVING PARTS
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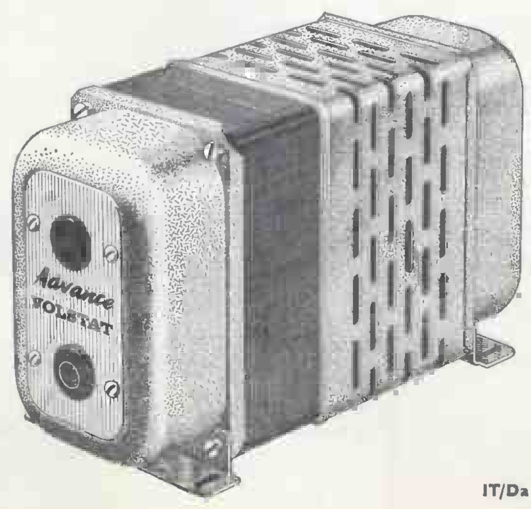

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IT/Da

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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.

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RESISTANCE-CAPACITANCE BRIDGE KIT Model C-3U

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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.; 150μA to 15A D.C.; 0.2Ω to 20MΩ. 4½in. 50 μA meter.

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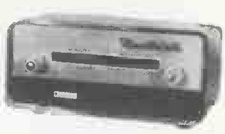

Tuning range 88-108 Mc/s. Flywheel tuning. Attractive Plastic Front Panel in two-tone grey with golden trim, surround and motif. Thermometer type visual tuning indicator. Pre-aligned I.F. transformers (eliminates adjustment). Three I.F. Stages. Wide-band low distortion. Ratio Detector. Complete R.F. 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).

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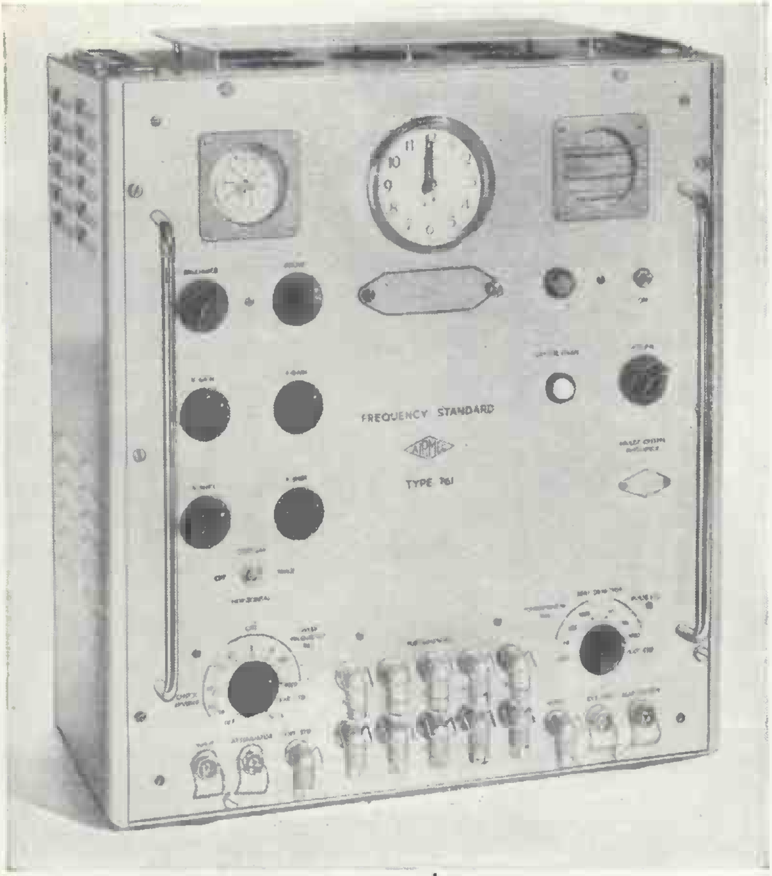

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TYPE 761

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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.

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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.

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- **100 kc/s crystal housed in an oven controlled at 70° C.**
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- **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.**

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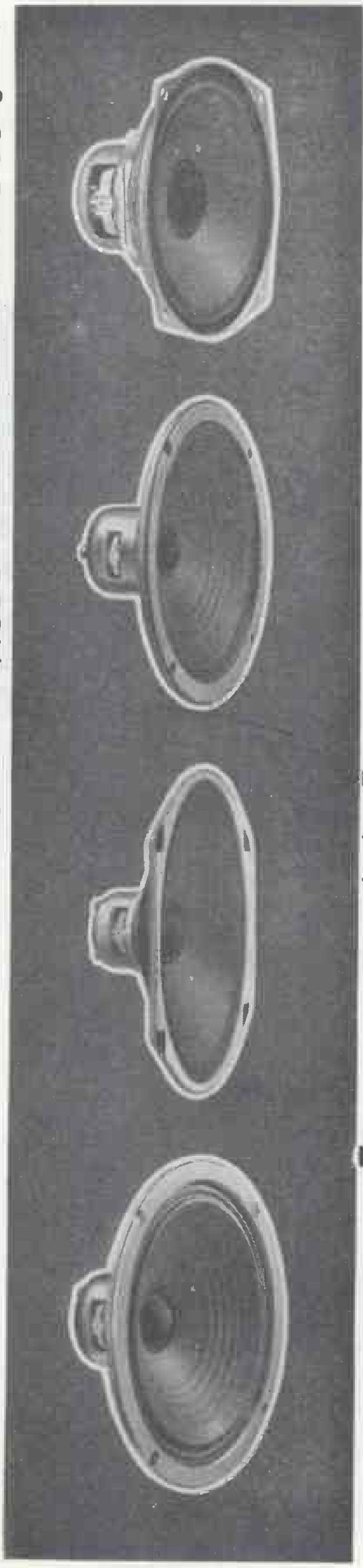

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We have made this selection from our wide range of speakers as they cover practically all the requirements of the replacement trade.

The new prices are now operative.

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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

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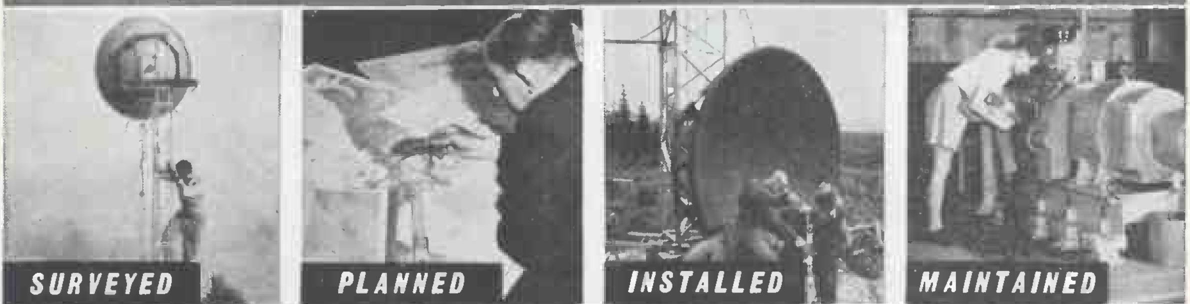
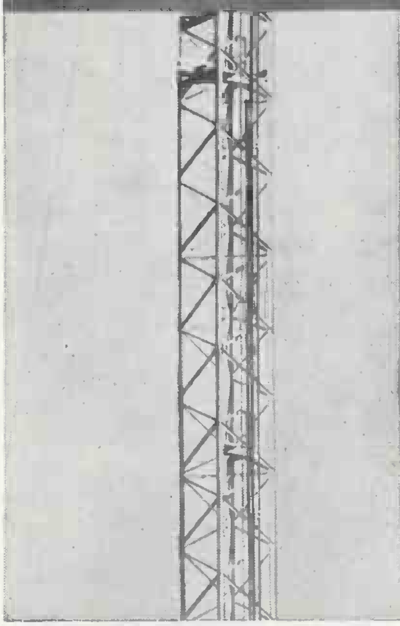
microwave communication systems





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EASY MAINTENANCE The design of the units ensures easy access to all parts of the equipment and the extensive use of printed circuitry allows speedy and accurate replacement of precision circuits by technician staff, without realignment of the equipment.

EXTREME SAFETY All high voltages are fully interlocked.

World leaders in all travelling wave tube microwave systems

The Post and Telegraph Authorities in more than 80 countries rely on

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COMMUNICATIONS SYSTEMS

MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED · CHELMSFORD · ESSEX · ENGLAND

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50 MICRO AMP MOVING COIL METERS

Brand New & Boxed—Large Stocks available.

3×2¾in. 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 μA. Makes 20,000 opv. multimeter. Multirange scales V-Ω-Ma/shunts and multipliers available.

0-50 μa

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

TWO METERS **35/-** (plus 1/- post)

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Useful for all kinds of testgear: a quality job with fully-formed pressed steel lids, welded construction, grey hammer finish enamel. Standard panel sizes 4 × 5½in. and 4⅝ × 7½in. available in depths 2-3-4-6in. as standard, from 9/6 to 27/-.

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

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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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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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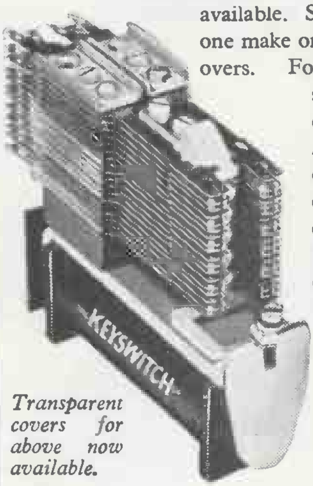

Transparent covers for above now available.

and now PLUG-IN 3000 Type Relays

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.
- ★ Contacts: up to 18 light duty or 12 heavy duty.
- ★ Complete transistorized units.
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- ★ Clip retains relay positively in any position.

SOCKETS AND FITTINGS ARE AVAILABLE FROM STOCK for immediate assembly of units.

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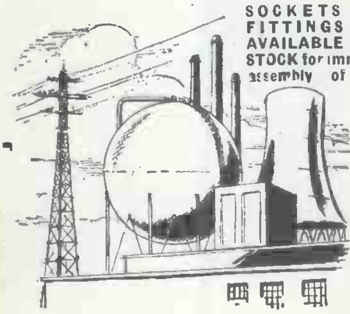
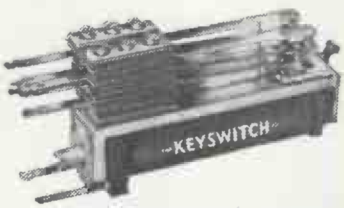
Operation AC or DC Switching or Signal Current AC or DC 5 to 500 micro-amps Transfer switching current 10 amps. or 500 v.

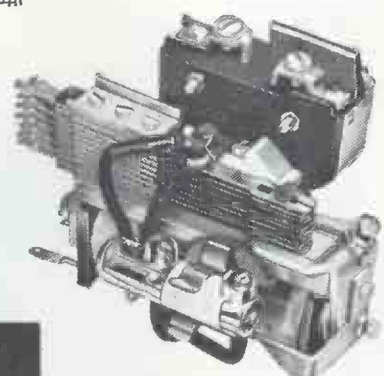




MINOR TYPE '600' (Fitted with double pole changeover for 250 volts, 2 amps.)

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.

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



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SPM 1

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★ BACKGROUND NOISE AND SPEECH LEVEL
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SPECIAL FEATURES INCLUDE

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★ 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 INSTRUMENTS

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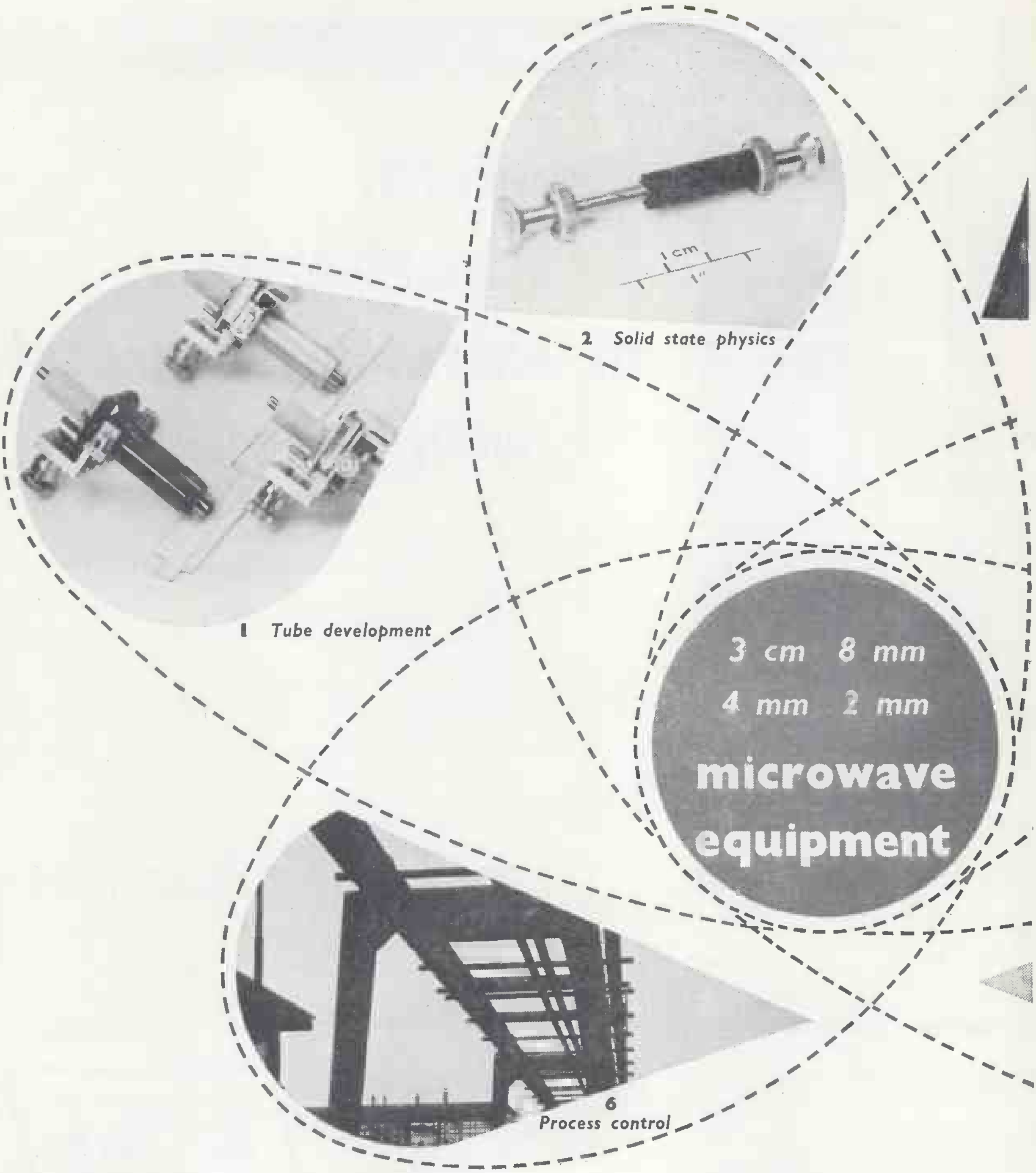
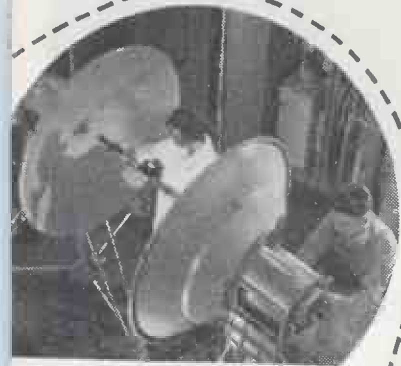
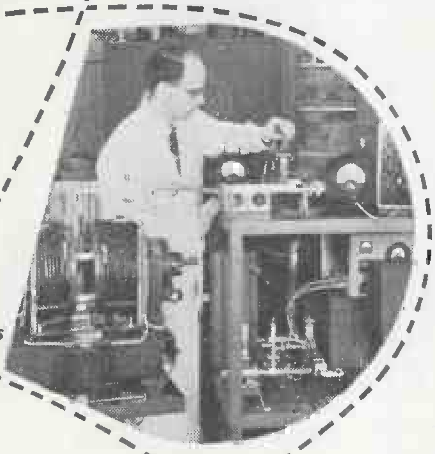


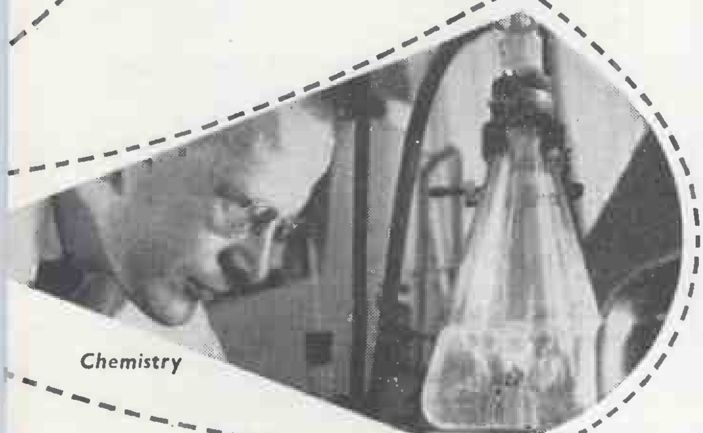
2 Solid state physics
1 cm
1"
1 Tube development
3 cm 8 mm
4 mm 2 mm
microwave
equipment
6
Process control



3 Telecommunication



4 Physics



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The world-wide Philips Industries are active in many branches of science and technology. Many of these are contributing to the development and application know-how of microwave equipment. The availability of information within the concern - as well as from outside sources - is logically leading to growing ranges of excellent components in the 3 cm, 8 mm, 4 mm and 2 mm bands.

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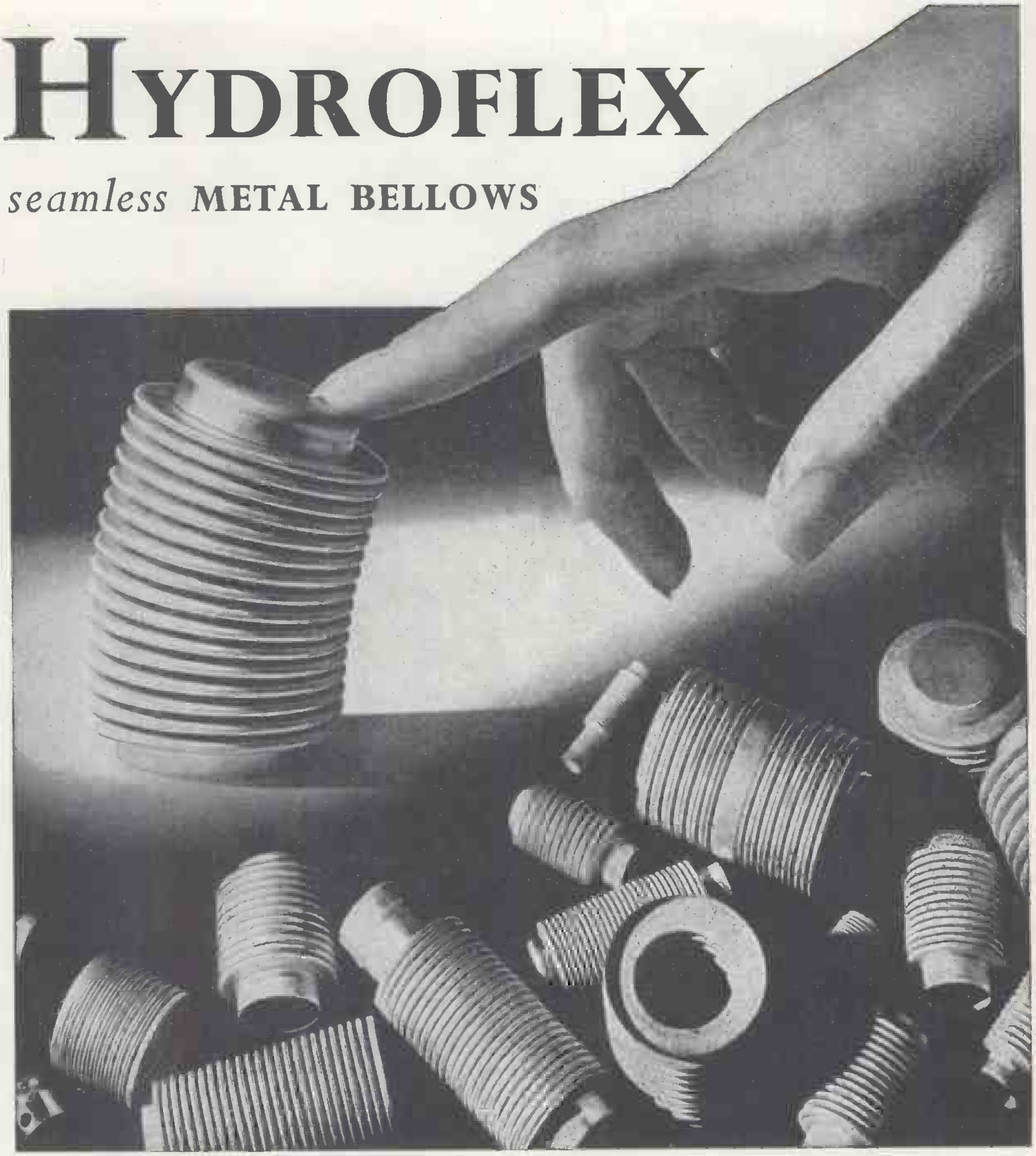

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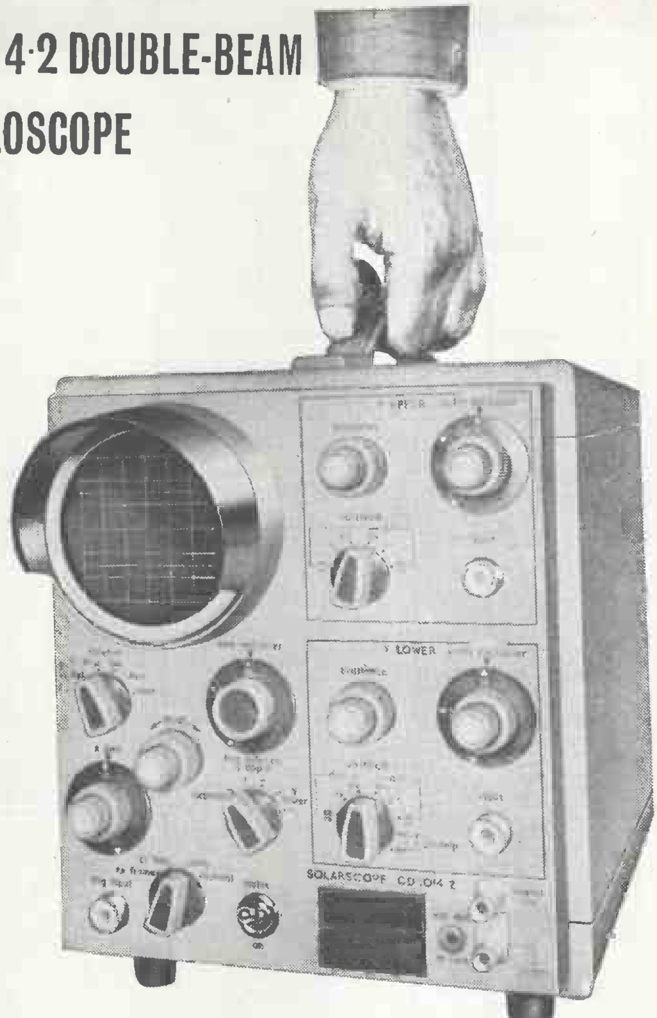

Carried around as your 'pet' instrument this versatile double-beam 'scope makes light work of any servicing or development problems.
The CD 1014·2 locks to video signals with the built-in TV sync. separators; gives bright, well defined traces at fast or slow speeds; has stabilised EHT ensuring accurate calibration independent of brightness levels; incorporates high gain pre-amplifier —in fact it has all the features that make it ideal for on-the-spot servicing and general research work anywhere in the world.

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'Y' SYSTEM includes two wideband amplifiers effectively covering DC–Servo–Audio–Video–and Transient applications.

Y_1 & Y_2 bandwidths DC–5 Mc/s (-3 dB) in the 100 mV/cm–100 V/cm range.
Rise time 70 mμsecs.
1 mV/cm maximum sensitivity on Y_2 a.c. input.
Inputs can be 'floated' with respect to earth.
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Measuring accuracy to 5%.

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Calibration squarewave 0.5 V pk-pk ± 1%, at mains frequency
Only 2 valve types used, silicon rectifiers, 'C' cored mains transformer
Mains input 110/220V ± 20V, 45-66 c/s
Consumption: 75VA
Weight 22lbs

'X' SYSTEM Basic time-base range 1 cm/μsec–1cm/sec, continuously variable; accurate to 5%.
Symmetrical expansion, continuously variable and calibrated at x 1, 2 and 5.
Adequate X shift centres any portion of the trace.
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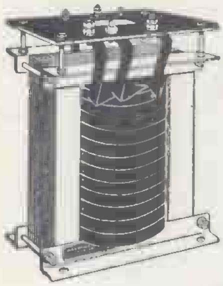

5 V	80 A	... £10
4 V	100 A	... £10
12 V	15 A	... £4
60 V	7 A	... £8
110 V	4 A	... £9
18 V	30 A	... £9
6 V	100 A	... £12
24 V	30 A	... £12
30 V	25 A	... £12
30 V	40 A	... £21
55 V	15 A	... £12
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110 V	10 A	... £15
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5 V	300 A	... £20
6–12 V	50 A	... £10
12 V	60 A	... £12
12 V	100 A	... £16
50 V	60 A	... £29
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2.5 V	5,000 A	.... £64
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2 V	10,000 A	.... £98
3.5 V	20,000 A	.... £127
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10 V	700 A	.... £59
10 V	2,000 A	.... £103
10 V	1,000 A	.... £66
10 V	900 A	.... £62
10 V	500 A	.... £38
10 V	300 A	.... £28
20 V	800 A	.... £80
20 V	3,000 A	.... £150
5 V	1,000 A	.... £39
22 V	1,000 A	.... £75
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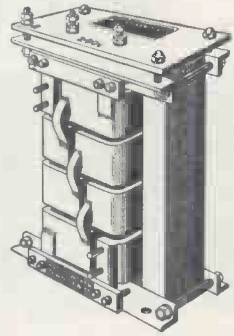
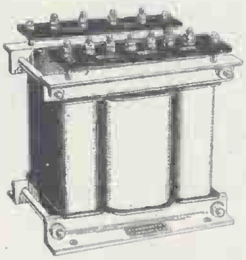


TRANSDUCTORS

SATURABLE REACTORS



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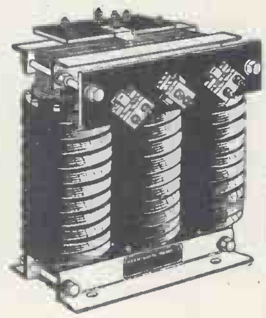
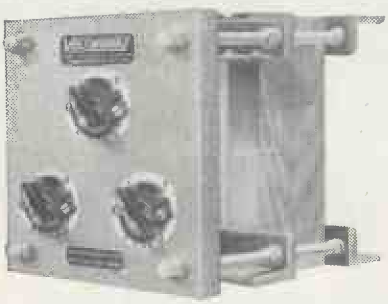
These and other Transformers can be supplied for 3-phase, 6-phase and 12- phase Rectifiers.





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30 A	£39	£50
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For 240 V. AC. The larger outputs are available for 3-phase supply.
Full load DC Volts and Amps are stated.
Prices are without Meters and Regulators.

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12 V	10 A	.... £15	36 V	60 A	.... £55
12 V	20 A	.... £22	110 V	5 A	.... £32
12 V	30 A	.... £28	110 V	10 A	.... £42
12 V	60 A	.... £45	110 V	15 A	.... £53
12 V	105 A	.... £62	110 V	20 A	.... £67
12 V	210 A	.... £83	110 V	25 A	.... £84
12 V	1,000 A	.... £185	220 V	130 mA	.... £15
24 V	12 A	.... £23	250 V	6 A	.... £49
24 V	20 A	.... £27	250 V	10 A	.... £70
24 V	30 A	.... £33	250 V	15 A	.... £89
24 V	60 A	.... £41	250 V	20 A	.... £110
24 V	105 A	.... £70	1,200 V	225 mA	.... £30
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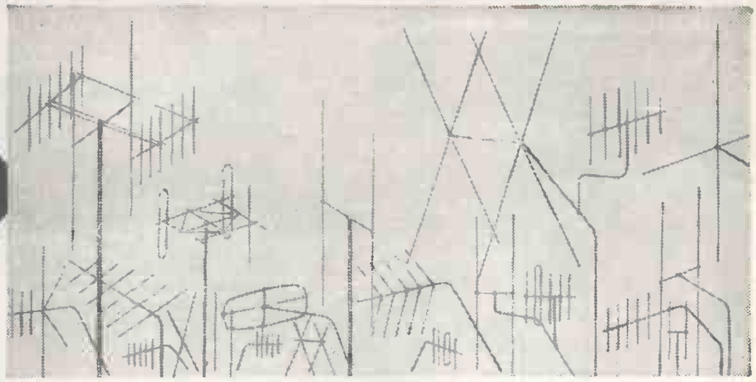

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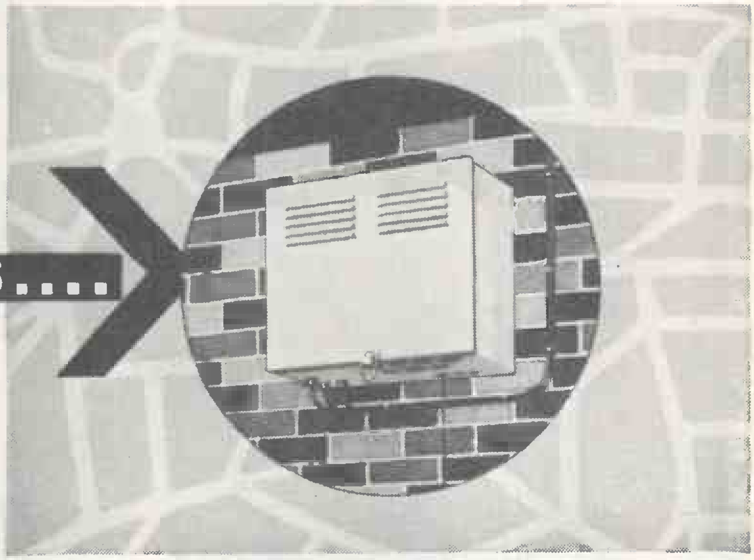

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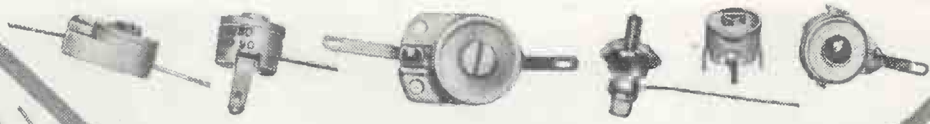

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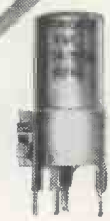

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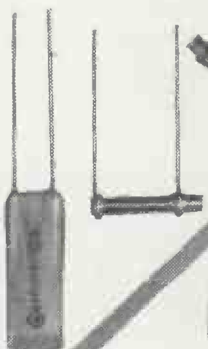

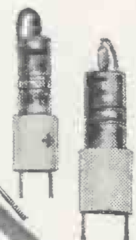

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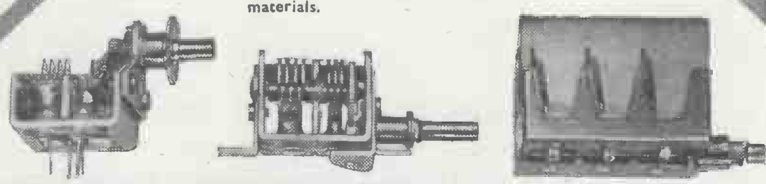

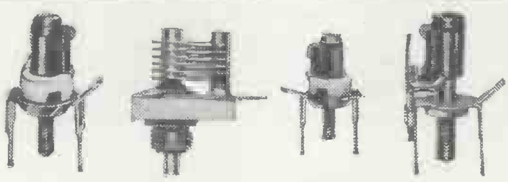

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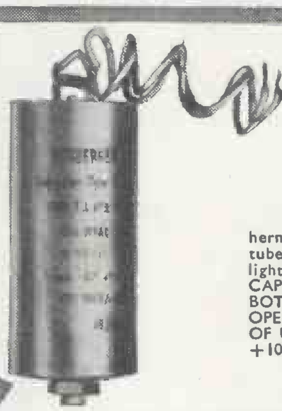

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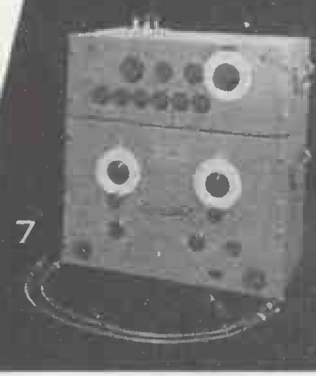

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U80/15	16—80	10.4	15	20*	6.5	3.30
U200/8	5.5—206	17	8	20†	9.5	2.49
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* Up to 30 Mc/s † Up to 20 Mc/s

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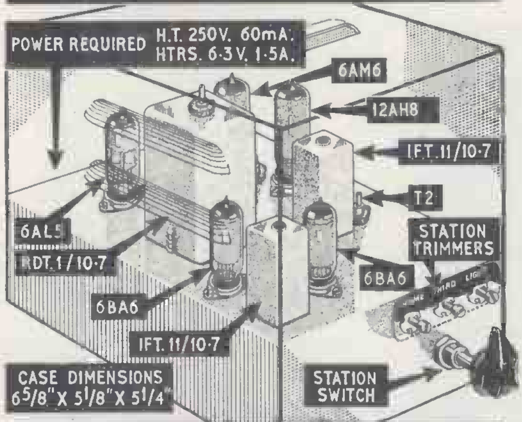

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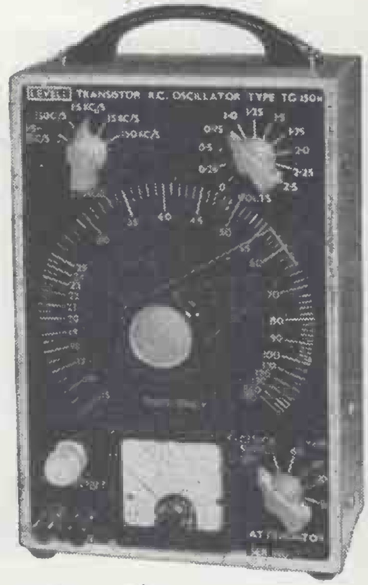

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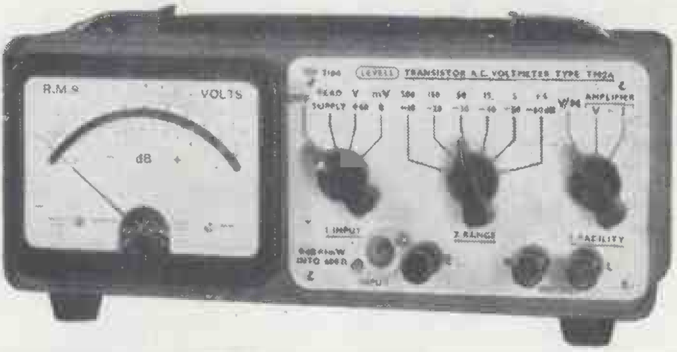

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4"	300	32 ..	10 0	450	48 ..	14 6	5¾"	1700	3 .. 0 ..	2 17 6
5"	600	1 hr 4 mins	1 0 0	850	1 hr 30 mins	1 8 0	7"	2400	4 .. 16 ..	4 0 0
5¾"	850	1 .. 30 ..	1 7 6	1200	2 .. 8 ..	1 15 0		SUPERGRADE		
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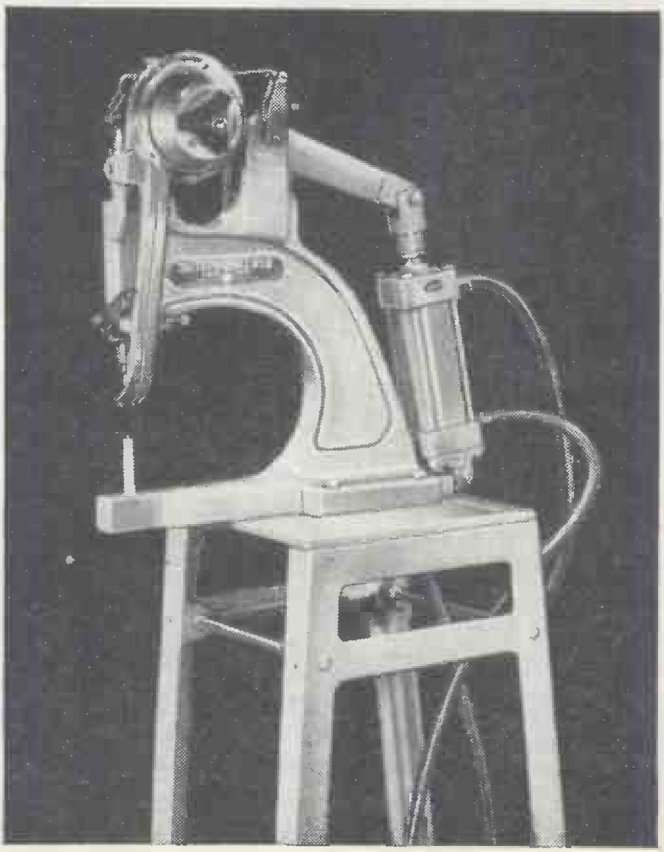

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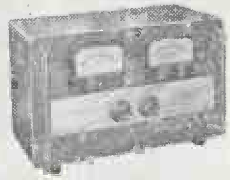

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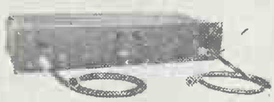

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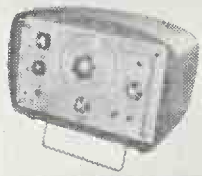

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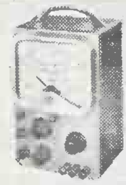

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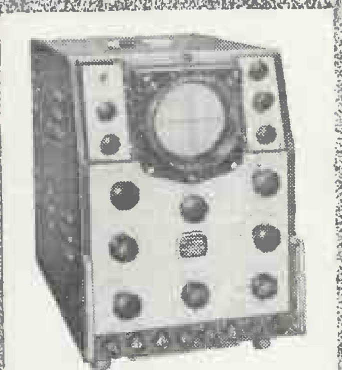

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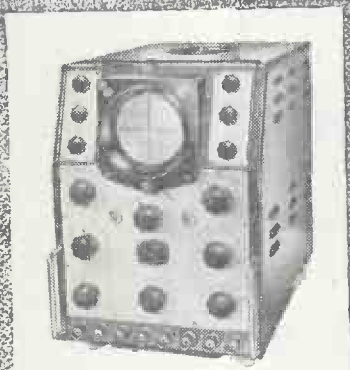

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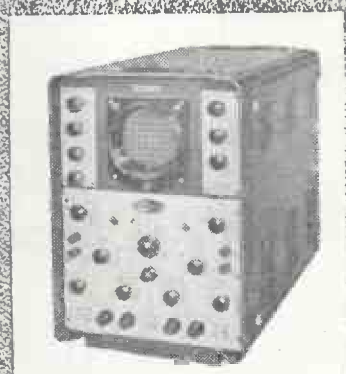

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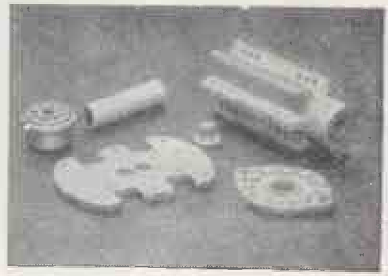

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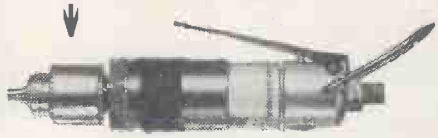

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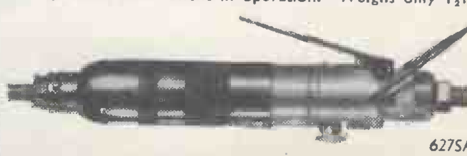

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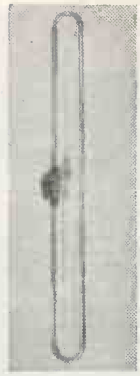

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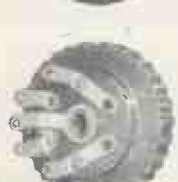
Type VC 1545

TYPICAL SPECIFICATION

Track maximum working voltage	200v DC
Switch maximum working voltage	50v AC or DC
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 200 KΩ control
Final resistance	5% } typical figure given for a 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
Turning torque over track	0.25 to 1.5 oz.ins., 18 to 108 g.cms.
Turning torque for switch operation ("on" or "off")	At least 0.5 oz.ins., 36 g.cms. greater than track torque, 0.75 to 5 oz.ins. 54 to 360 g.cms.
Total angle of rotation	283°
End stop torque	1.25 lb.ins., 1440 g.cms.
Weight	0.073 oz., 2.06 g.

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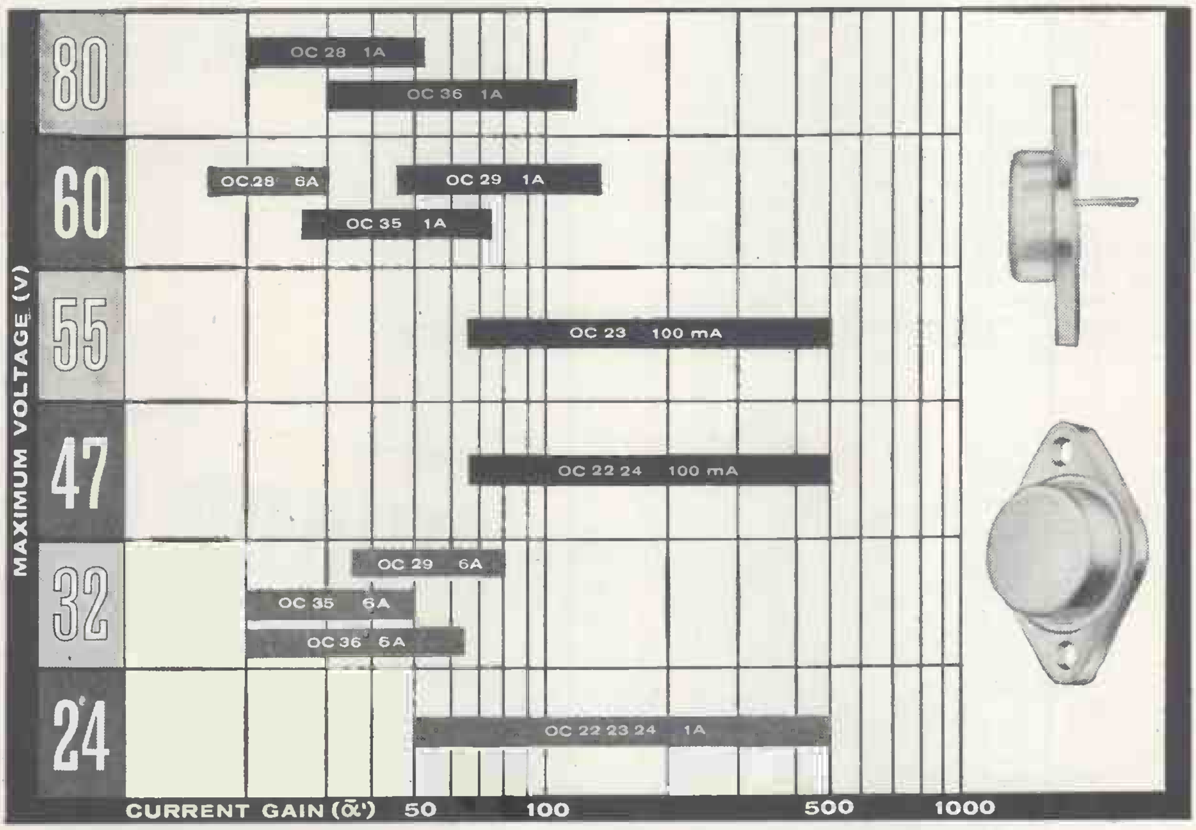

GREY is maximum allowable collector-emitter voltage at maximum continuous current.

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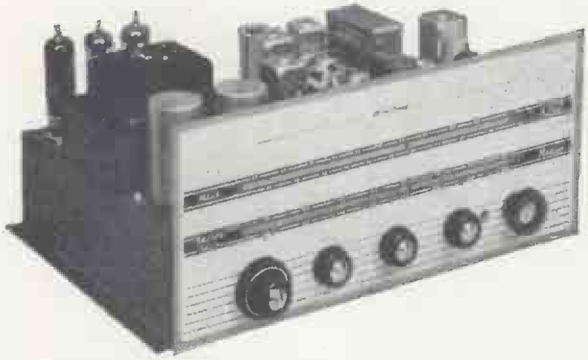

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STEREO 12 Mk. 2 42 GNS.

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.

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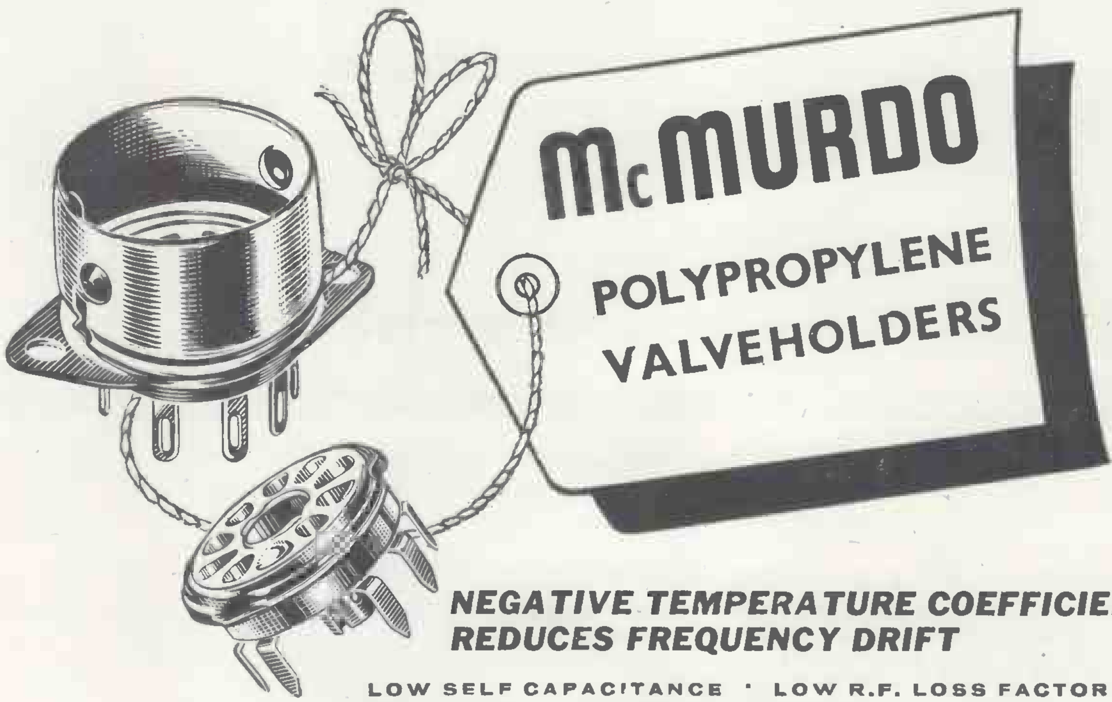

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Heater Voltage (volts)	V_h	6.3
Heater Current (amps)	I_h	0.3

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 ±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.

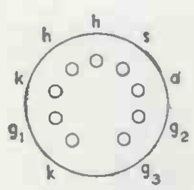
TYPICAL OPERATION

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

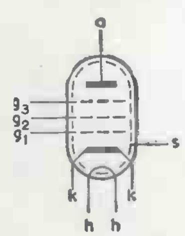
**Inter-electrode capacity with holder capacity balanced out.

††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



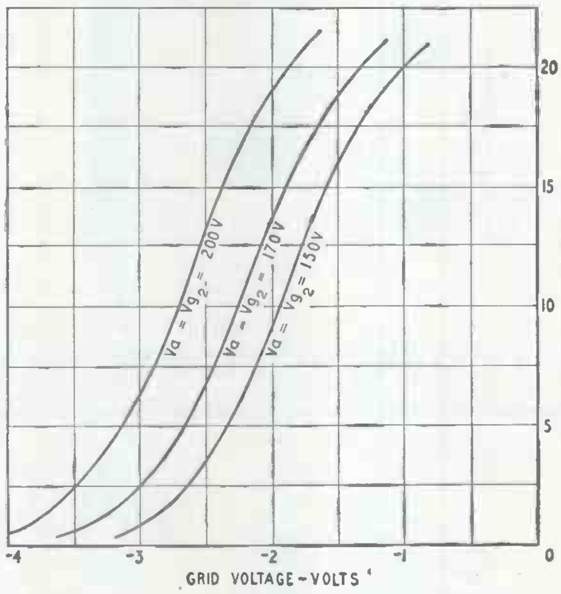
VIEW OF FREE END

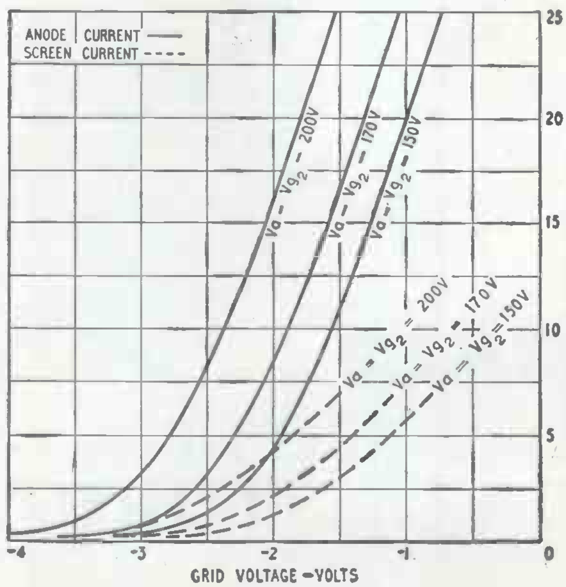


Maximum Dimensions (mm)

Overall Length	56
Seated Height	49
Diameter	22.2

Tentative Characteristic Curves of Ediswan Mazda Valve Type 6F24





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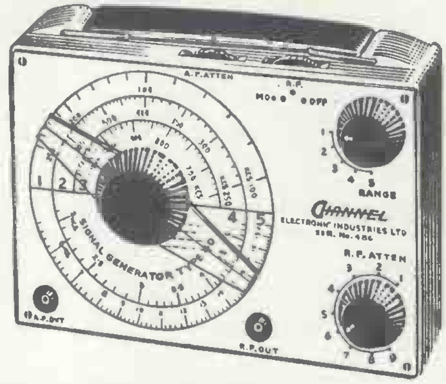

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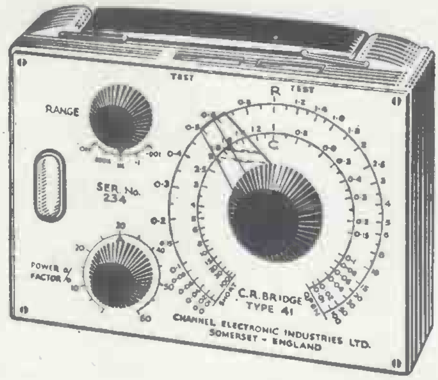

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- ★ Capacitance 5 μμF to 20μF.
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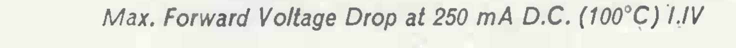

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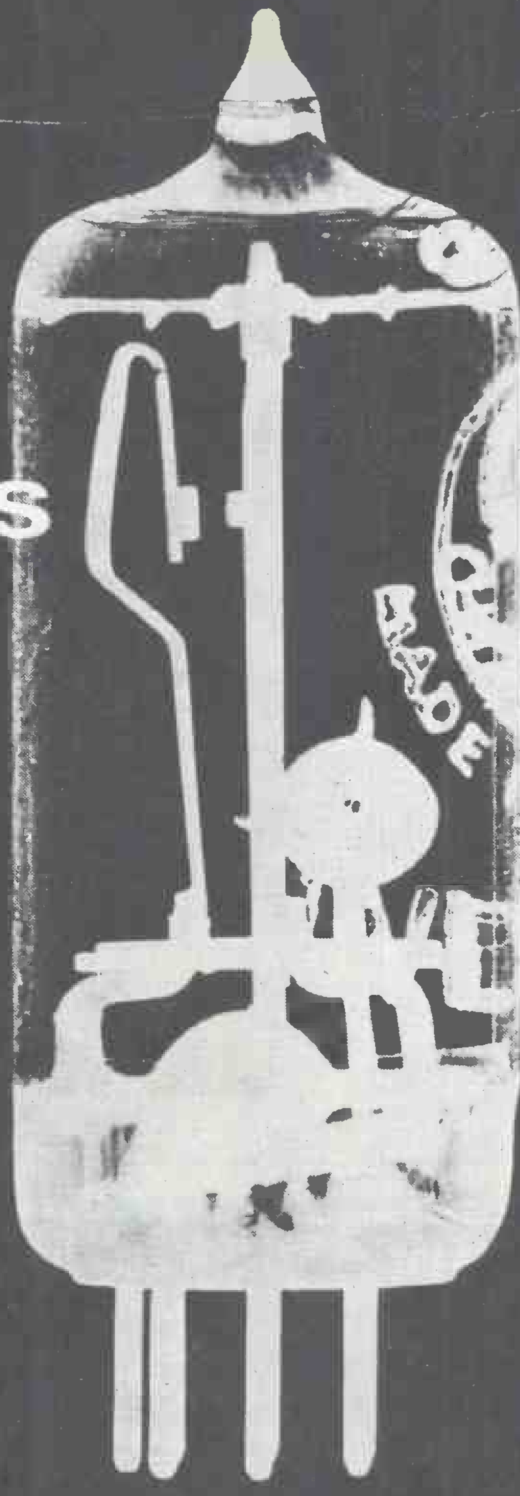

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S.102/1K	44	66	6·3
S.103/1K	36	54	27
S.104/1K	25	35	6·3
S.105/1K	20	30	27
S.106/1K	44	66	19

* Flying Lead Version

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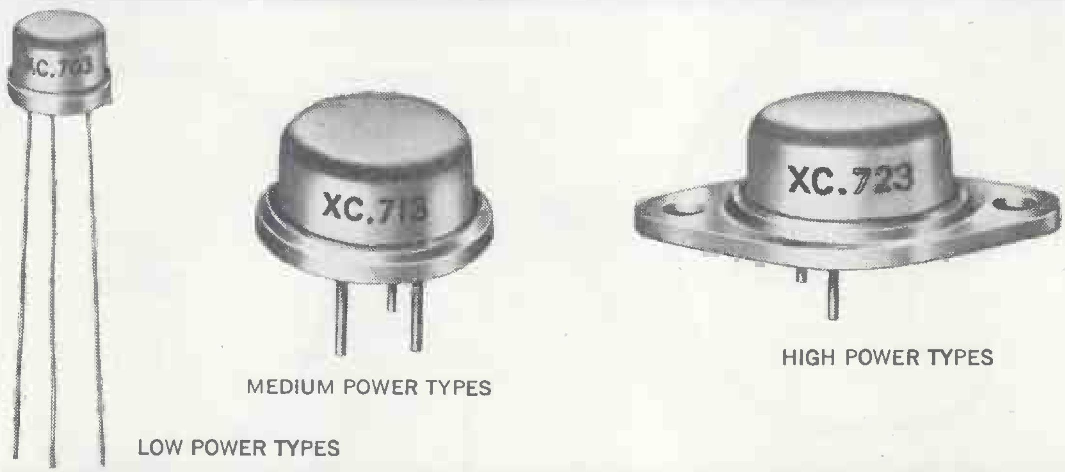

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	XC703	XC713	XC723
Maximum collector/base voltage (volts)	60	60	60
Maximum emitter/base voltage (volts)	12	12	10
Minimum h_{fe} (V_{ce} = 4V, I_c = 200 mA)	15	—	—
(V_{ce} = 4V, I_c = 750 mA)	—	15	—
(V_{ce} = 4V, I_c = 1.5 A)	—	—	10
Average f_{α} (V_{cb} = 28V, I_c = 5 mA) (Mc/s)	1.5	—	—
(V_{cb} = 28V, I_c = 5 mA) (Mc/s)	—	1.25	—
(V_{cb} = 12V, I_c = 100 mA) (Mc/s)	—	—	1

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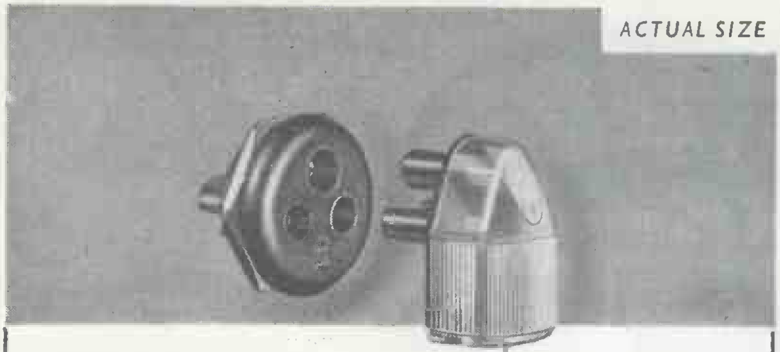

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With the increasing use of stainless steel in high-quality electronics' hardware, it is useful to have a basic appreciation of its nature. The name covers a whole family of alloys, each possessing distinctive properties, but all are derived from a minimum of three fundamental ingredients, iron, carbon and chromium. "Stainless" is a relative term, and these steels fall into two broad classes, the corrosion resisting varieties, and those which are merely rust resisting. Rust is formed by the action of oxygen (e.g. in air) on iron in the presence of moisture, and being the commonest type of iron corrosion, the rust resisting steels find many applications due to their other characteristic properties.

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.

Although stainless steels exhibit magnetic properties, these are not pronounced, and the magnetic transition point, i.e. the temperature at which these properties are lost, is in all cases much lower than for normal magnetic steels. With the corrosion resistant varieties the transition point lies far below ordinary ambient temperatures, so that these are usually termed non-magnetic, although in some cases work treatment leads to the appearance of magnetic properties at ordinary temperatures.

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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 $\overline{i^2} = 2eIB$, where e is the electron charge, I is the current, and B is the bandwidth.

Thus, for the cathode current: $\overline{i_k^2} = 2eI_kB$ .. (1)

and for the anode current: $\overline{i_a^2} = 2eI_aB$ .. .. (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 $[1 - (I_a/I_k)(1 - \Gamma^2)]$.

Thus, in the case of a tetrode where I_{g2} is the screen current:

$\overline{i_k^2} = 2eI_kB\Gamma^2$ .. .. (3)

$\overline{i_a^2} = 2eB\,[(I_a^2\Gamma^2/I_k) + (I_a\,I_{g2}/I_k)]$ .. .. (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:—

$\overline{v^2} = 4KTBR$ .. .. (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, is placed in series with a noise *voltage* generator of magnitude $\overline{v^2} = 4KTBR$ or, alternatively, in parallel with a noise *current* generator of magnitude $\overline{i^2} = 4KTB/R$. 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:—

$$R_{eq} = (2e/4KT)\,[(I_k\Gamma^2/g_k^2) + (I_aI_g/g_m^2I_k)] = R'_{eq} + R''_{eq} \quad (6)$$

where $g_m = \dfrac{\partial I_a}{\partial V_g}$, and $g_k = \dfrac{\partial I_k}{\partial V_g} \simeq g_m\dfrac{I_k}{I_a}$

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 $I_a\,I_{g2}/Ig_m^2I_k$, 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_f, 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.

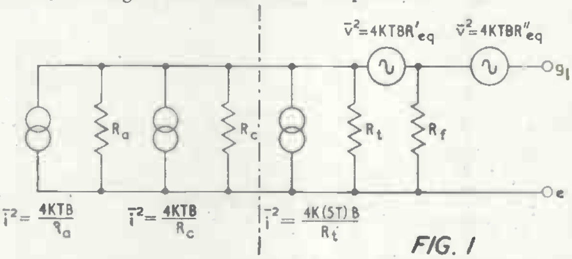

FIG. 1

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 g_1-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 g_1-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_{g2}/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-g_1 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-g_1 screening.

The next "Aspects of Design" article will deal with the use of the 30F27 in a tuner circuit.

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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)	$p_{g2(max)}$	0.5
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)

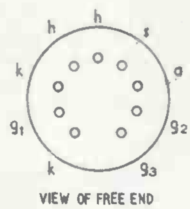
Input Capacitance	c_{in}	8.5
Output Capacitance	c_{out}	2.7
Grid 1 to Anode	c_{g1-a}	0.006
Grid 1 to Grid 3	c_{g1-g3}	0.1
Grid 1 to Grid 2	c_{g1-g2}	1.8
Grid 1 to Cathode	c_{g1-k}	6.0
Grid 2 to Anode	c_{g2-a}	0.19
Grid 3 to Anode	c_{g3-a}	0.45

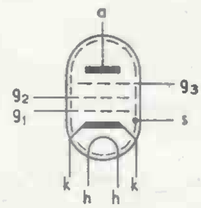
†Measured in fully shielded socket, without can.

Base: B9A (Noval) **Mounting Position:** Unrestricted

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

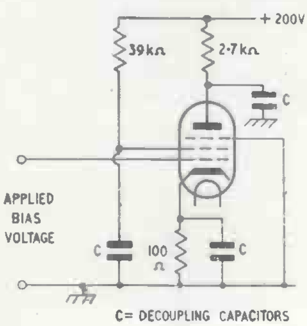


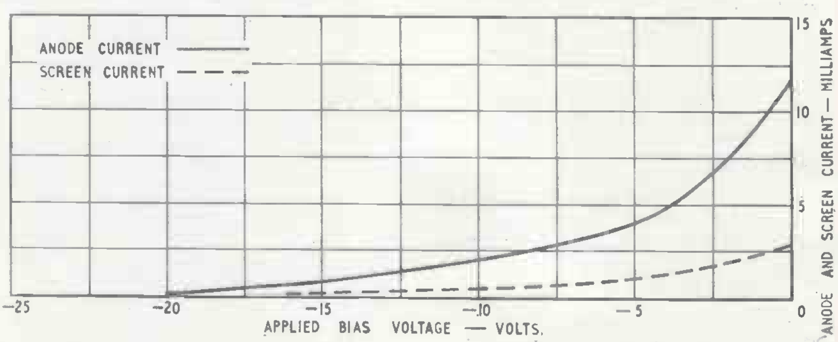


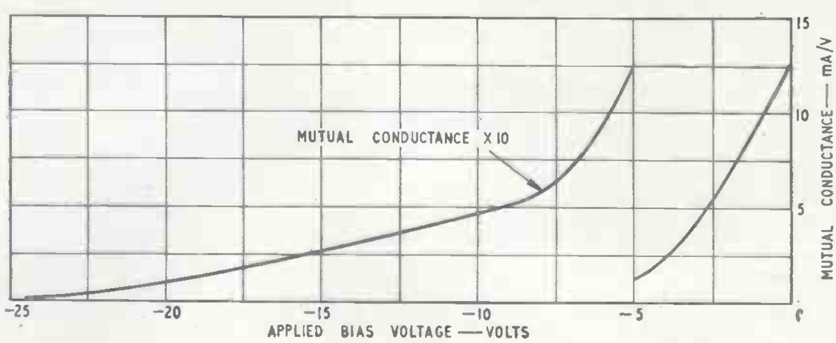
Tentative Characteristic Curves of Ediswan Mazda Valve Type 6F25

RISING SCREEN CHARACTERISTICS

TEST CIRCUIT







Maximum Dimensions (mm)

Overall Length	56
Seated Height	49
Diameter	22.2

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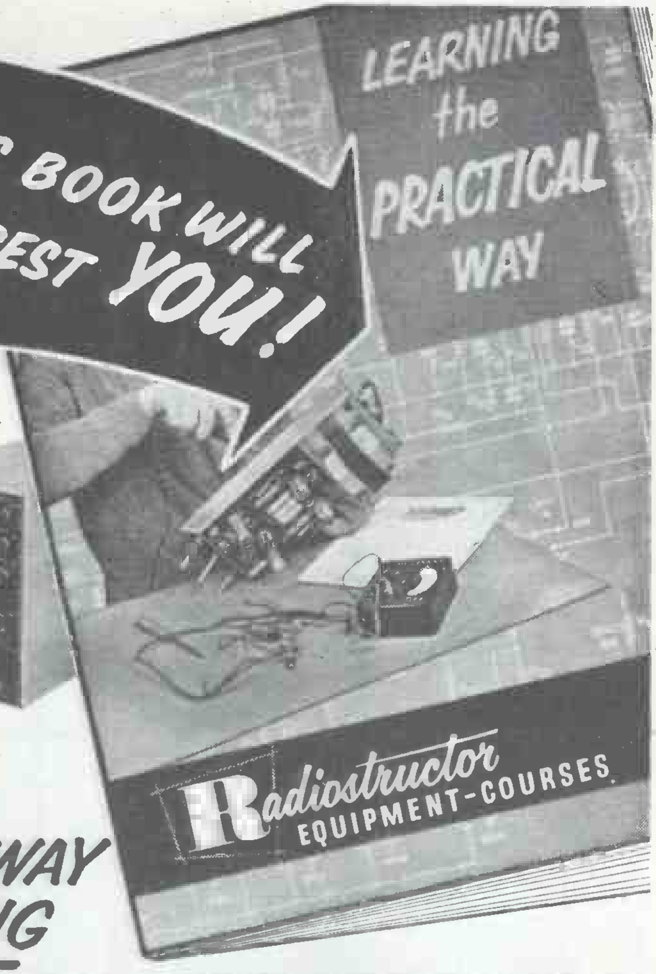

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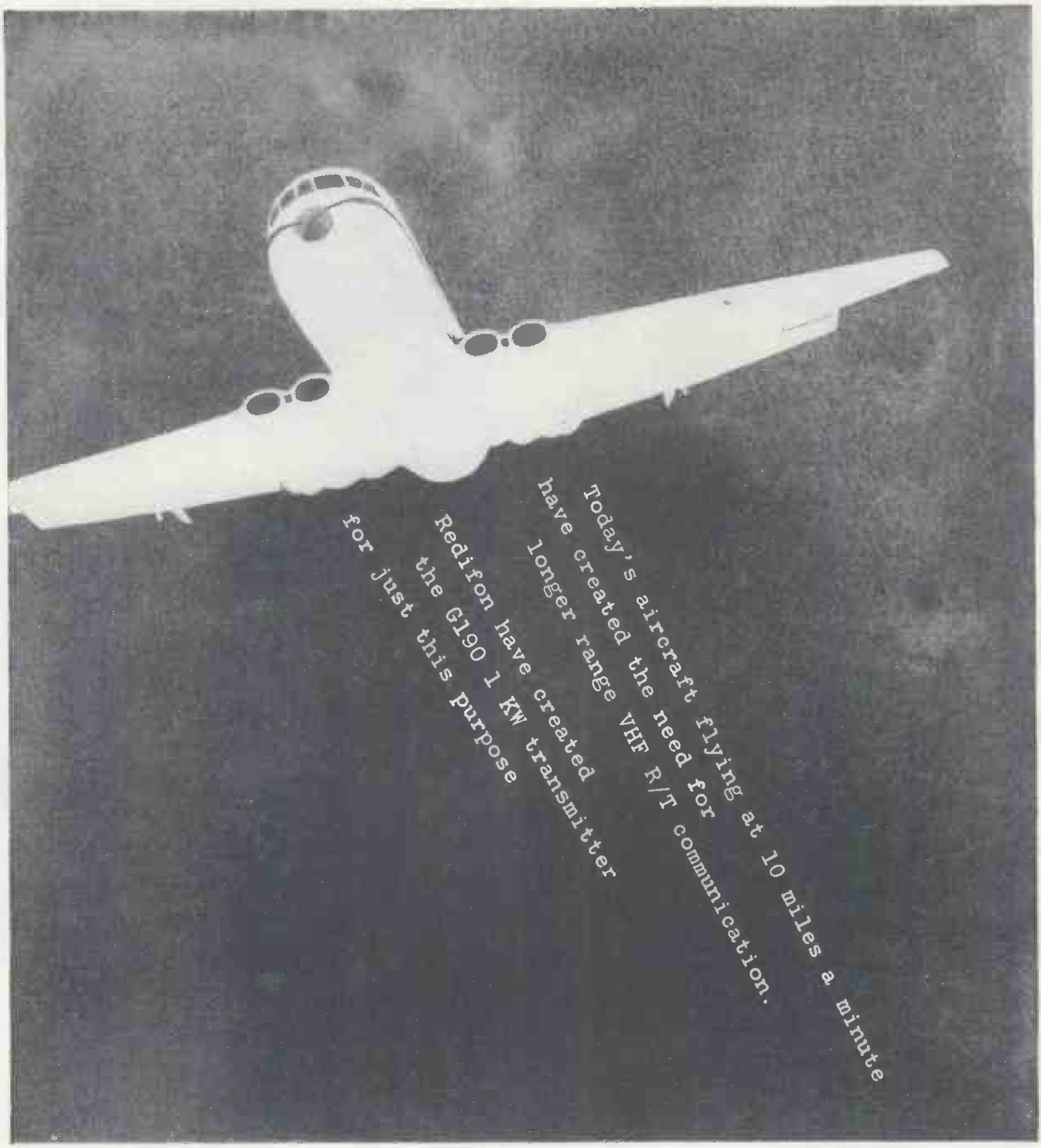

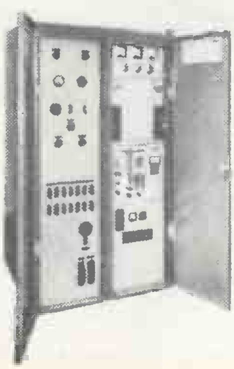

REDIFON G.190 1 kw TRANSMITTER
118—135 Mc/s without component change
High level AM modulation
Direct reading v.s.w.r. indication
Harmonic and spurious radiation
80dB below fundamental
Power supply 100—125 or 200—250 volts
50/60 c/s., single phase

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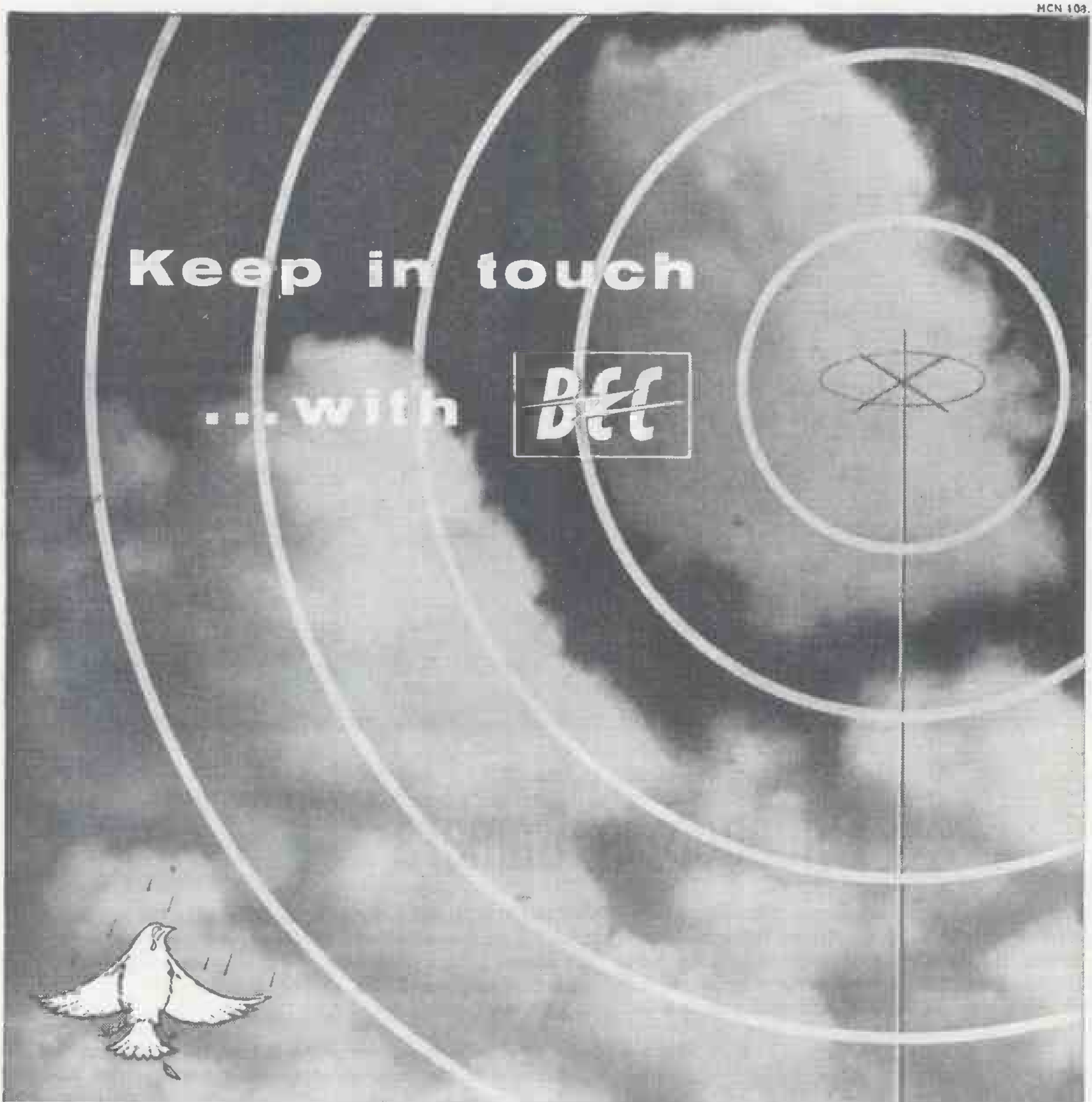
Redifon Limited Communications Sales Division,
Broomhill Road, London S.W.18. Telephone: VANdyke 7281.

A Manufacturing Company in the Rediffusion Group.

MCN 103.



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BCC's Type 400/100 VHF 15-watt Fixed Station makes other means of communication look a little old fashioned. It's designed for the control of mobile systems, point-to-point links, ground/air communications and similar uses. Two-way, single or dual frequency simplex, or duplex operation. Auxiliary units are available for extended or remote simplex or duplex operation. A fully-descriptive leaflet is available.

Consult our Systems Planning Service for full information
and guidance on communications systems planning

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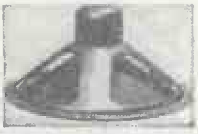
BCC

Crystal Mike by Acos

Model 39/1, this is ideal for tape or general amplifiers, complete with screened lead **39/6**, plus 1/- post.

Speaker Bargain



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.

TV Workshop Aids

E.H.T. SEALER. Apply with soldering iron. Stops corona discharge, etc. 2/6 per stick.

POLYTHENE TAPE. 2in. × 10 thou. for E.H.T. insulation up to 25 kV. 5/- per 12ft. roll.

SPONGE STRIP. ½in. × ½in. For sealing or cushioning, 9d. per foot.

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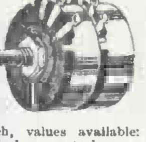
CELLULOSE CEMENT. Specially prepared for radio gluing of metal, glass, ceramic, wood, fabrics, 4/6 per tin.

Morganite Potentiometers

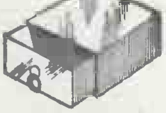


Single and 2-gang types available, standard size with good length spindle, all new and boxed. Single types, **1/-** each, values available: 5K, 10K, 25K, 50K, 100K, 250K, 1 meg., 2 meg. Gang type, 3/- each, values available: 5K±5K, 100K±100K, ½ meg. ± ½ meg., 2 meg. ± 2 meg.

Hi-Fi Snip Infinite Wall Baffle

Nicely veneered and polished. Corner fitting (attaches to picture rail). Takes up no floor space. Gives really fantastic results with only low-priced 8in. speaker. Fitting for tweeter. Only **45/-** each. carriage and insurance **3/6**.

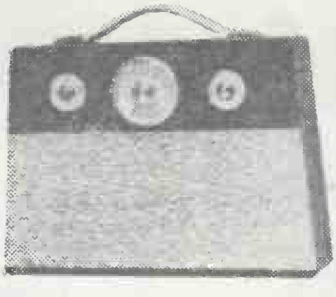
Component Storage Drawers



Stout board construction these drawers are ideal for small parts. Supplied complete with simple erection instructions. **1/6** each or 12 drawers each 6 × 2¼ × 6¼ in., **13/6**, post 2/-.

THE REAL COMPANION

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?

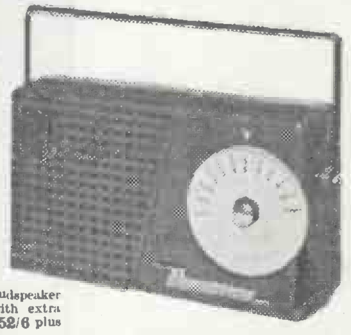
NOTE THESE FEATURES

- ★ 400/500 mw. Output Push-Pull.
- ★ 6 First Grade Transistors.
- ★ Latest Type Superhet Circuit.
- ★ Medium and Long Wave.
- ★ Internal Ferrite aerial litz wound.
- ★ High "Q" coils.
- ★ Latest type printed circuit with components plan.
- ★ Slow motion tuning.
- ★ Car aerial attachment.
- ★ Two-tone cabinet.
- ★ High flux elliptical speaker.
- ★ Size 11 × 8 × 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 ear type earphone **37/6** plus 2/- post and ins.

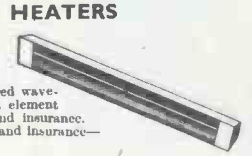
The Pocket Four. A loudspeaker model as above but with extra high gain audio stage **52/6** plus 2/6 post and ins.

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.

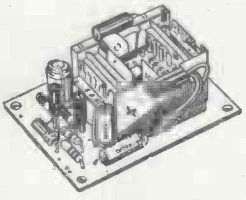
The Push-Pull 7. As pocket five but with 2 more transistors in a push pull moving coil speaker stage—really big output **£5/17/6** plus 3/- post and ins. **The Superhet 7.** As P.P.7 but a superhet with printed circuitry **£9/19/6** plus 3/6 post and ins.

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.

INFRA-RED HEATERS



These latest type heaters are ideal for bathroom, kitchen, bedroom, etc. They are simple to make from our easy to follow instructions—uses silica enclosed elements designed for the correct infra-red wavelength (3 microns). Price for 750-watt element and instructions, **15/6** plus 2/6 post and insurance. Or made up heater, 52/6, plus 3/6 post and insurance—fully tested and guaranteed.



1 WATT TRANSISTOR AMPLIFIER

2 × 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, 60-16,000 c/s ± 3 dB. Overall size 3 × 2.2 × 1.2in. **92/6**. Post and ins. 2/6.

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Extremely good test meter in bakelite case—1,000 o.p.v.—3½ movement AC/DC ranges: 10 v., 50 v., 250 v., 500 v., 1,000 v. A.C. and D.C.

1 mA.-100 mA.-500 mA. D.C. current resistance 0-2000 ohms 0-2 megs.

Size approx. 5in. × 3in. × 2½in.

Price **69/6** plus 2/6 post and ins.

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SB 078 15-20 M/cs	6/6
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AMERICAN 2N1727 100-150 M/cs	15/-
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AMERICAN T1832 400-600 M/cs	25/-
AMERICAN T1833 400-600 M/cs	25/-

Yaxley Switches

1 Pole 3 Way	1/6
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1 Pole 12 Way	3/-
2 Pole 2 Way	2/6
2 Pole 4 Way	2/-
2 Pole 6 Way	2/6
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2 Pole 12 Way	4/6
3 Pole 3 Way	1/6
3 Pole 6 Way	3/6
4 Pole 4 Way	3/-
6 Position Shorting	2/-
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6 Pole 3 Way	3/6
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FOR TRANSISTOR SETS

- Push-pull o.p.t. and driver **17/6** pair (500 milliwatt). **12/6** pair (300 milliwatt).
- 3 IF transformers and oscillator and circuit **23/6**.
- Ferrite aerial with coils for medium and long wave and circuit, **7/6**.
- Smallest possible electrolytics **1/9** each. 1 mfd. 2 mfd., 4 mfd., 8 mfd., 10mfd., 20 mfd., 30 mfd., 50 mfd., 100 mfd., 200 mfd.
- Smallest ½ watt resistors **5d.** each all popular values.
- Miniature 0.1 mfd., **1/-**. 0.05 .04 **9d.**, values up to 0.025 **6d.** each.
- Miniature slide switch **2/-**.
- Transistor holder **1/6** each.
- Set of 6 transistors for superhet in original packets guaranteed Mullard OC44, OC45, OC45, OC71 matched pair OC72, **£3/10/-** the set.
- Superhet 6 all first grade includes matched pair **45/-**.
- Ditto, second but tested, **30/-**.
- Oscillator and 2 I.F.—new American High Gain **35/-**.
- Red Spots **3/6**.
- White Spots **3/9**.
- Surface barriers 15 mc/s. **9/6**.
- Diodes **1/-**, sub-miniature **2/6**.
- 3in. Speakers 3 ohm **18/6**.
- 3in. Speakers 80 ohm **18/6**.
- 2½in. Speakers 3 ohm **19/6**.
- Elliptical Speaker, 7" × 4", 3 ohm or 35 ohm **19/6**.

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post orders are dealt with from Eastbourne, so for prompt attention please post your orders to 66 Grove Road, Eastbourne, marked Department 2. Callers may use any one of the Companies below.

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Phone: CRO 6558.	Phone: ARChway 1049	Phone: ILFord 1011	Phone: RUIslip 5780	Phone: ELGar 4444.
Half-day, Wednesday	Half-day, Thursday.	Half-day, Thursday.	Half-day, Wednesday	Half-day, Thursday.

A GREAT EGEN ADVANCE

...SINGLE COMPONENT AERIAL ISOLATOR

EGEN have made possible aerial isolation in one compact, robust component! Look at these features:

* Minimum space occupied inside chassis
* Easily installed
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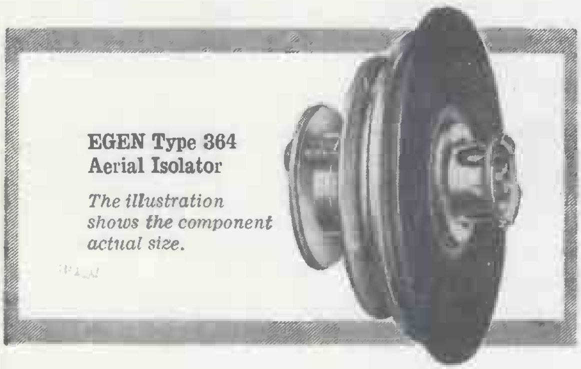
* Accepts standard 0.202 in. O.D. co-axial cable
* Component parts are not subjected to heat from soldering iron



EGEN Type 364 Aerial Isolator

The illustration shows the component actual size.

Write now for full details to:

EGEN ELECTRIC LTD

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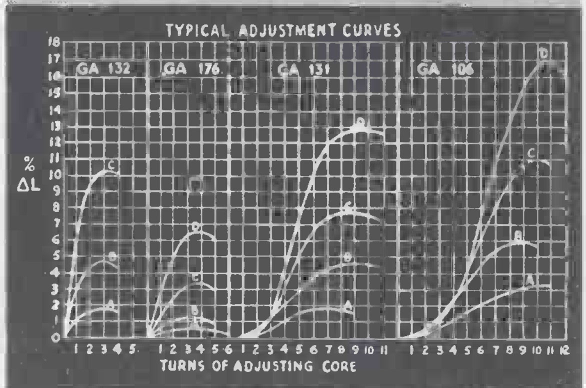
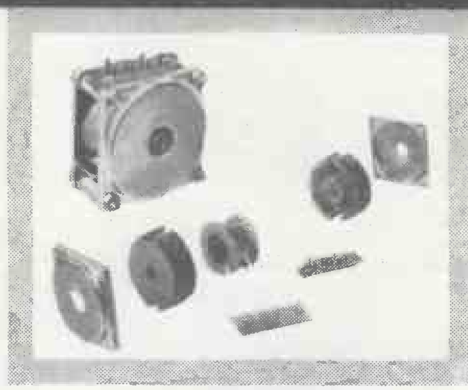
WPS 57

Gecolite

ASSEMBLIES

Adjustable Ferrite Cores



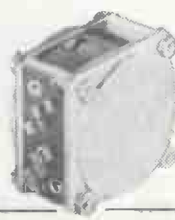


In Grade P. Gecolite, nominal initial permeability 1200/1880.

A series of adjustable ferrite core assemblies for use as high quality inductors at frequencies up to approximately 300 Kc/s is readily available.

Based on our range of Gecolite cores these assemblies are directly interchangeable with many non-adjustable assemblies already in use. In many cases therefore it is possible to dispense with the slower and more tedious methods of adjustment that have to be employed.

Write for Data Sheet 592.



A range of non-adjustable cores is also available.
Data Sheet 591.

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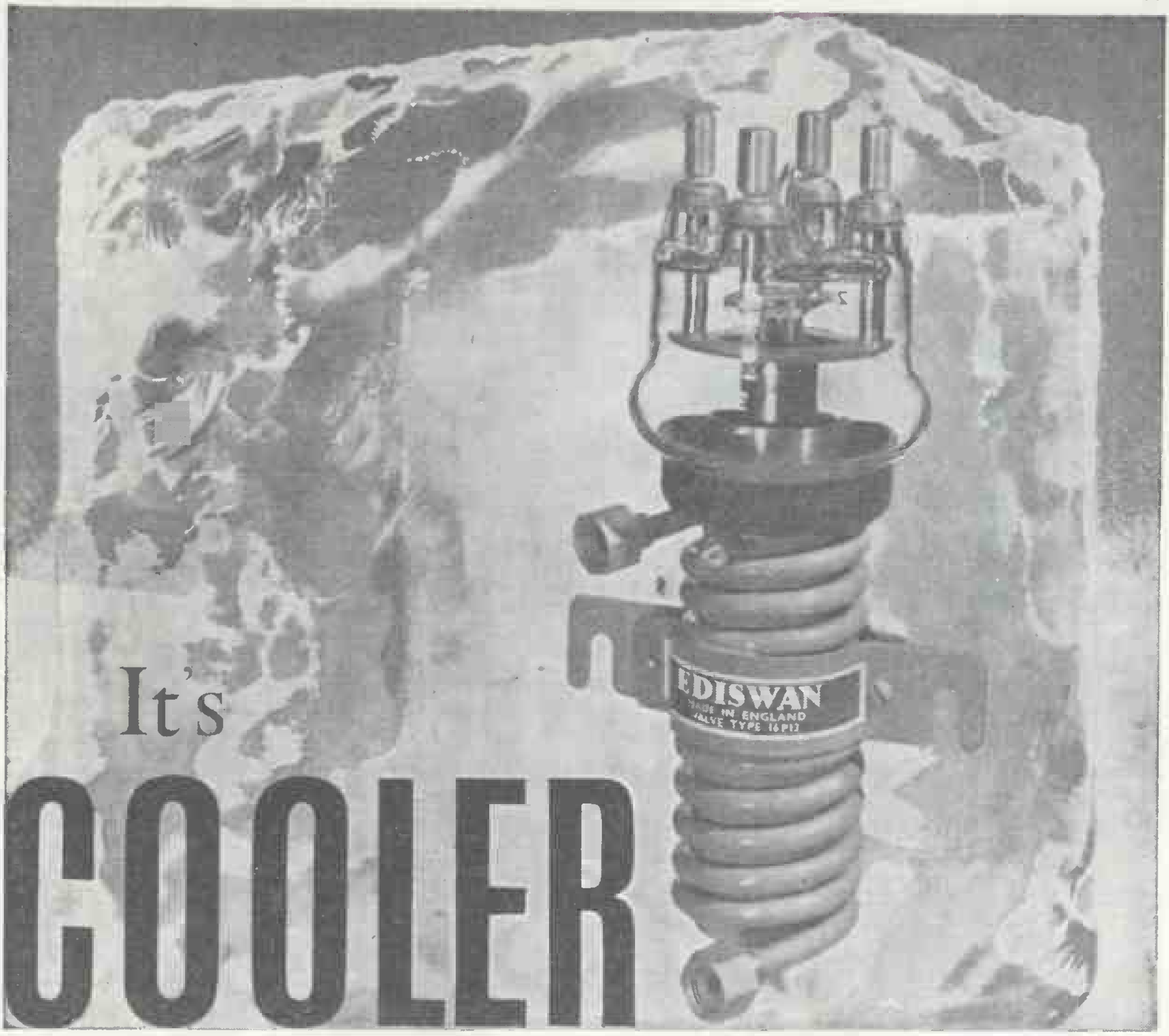
London Sales Office: Magnet House, Kingsway, W.C.2. *Tel:* Temple Bar 4668

A Subsidiary of THE GENERAL ELECTRIC CO. LTD. OF ENGLAND



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without a jacket!

The latest Ediswan water cooled valve has no jacket. Instead there is a spiral copper water tube attached directly to the anode. This method is much more efficient, keeps the valve cooler, and makes it cheaper to install and easier to maintain.

Tot up the extra advantages and then switch to these new valves for any application where you are at present using water jacketted valves.

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2. Seals eliminated reducing leakage risk.
3. Low water requirements—1 litre/3 kW anode dissipation.
4. More compact than conventional water cooled valves of similar rating
5. Includes the Ediswan patented over-dissipation protection device.

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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

Write for a copy of our latest catalogue
EDISWAN INDUSTRIAL VALVES AND CATHODE RAY TUBES.

** Other valves with anode dissipations up to 6 kW will be available shortly.*

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625 insulation tests, 25 leakage to screen, 25 continuity tests—all in 25 seconds.
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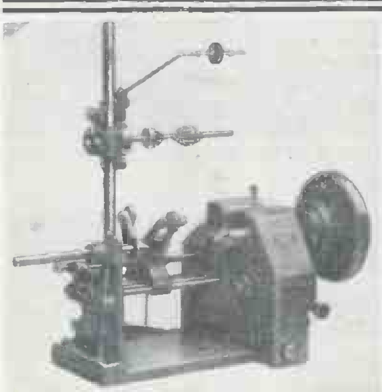

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AND HAND WINDING MACHINES

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Retail Price—DP4/L complete with connector and 18ft. screened lead £7 11 0
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A complete range of stands, swivel holders, etc., is available also.
A matching Unit (Type G7) can be supplied for adapting the microphone for a Recorder having a different input impedance, or when a long lead is required......... Retail Price £3 5 0

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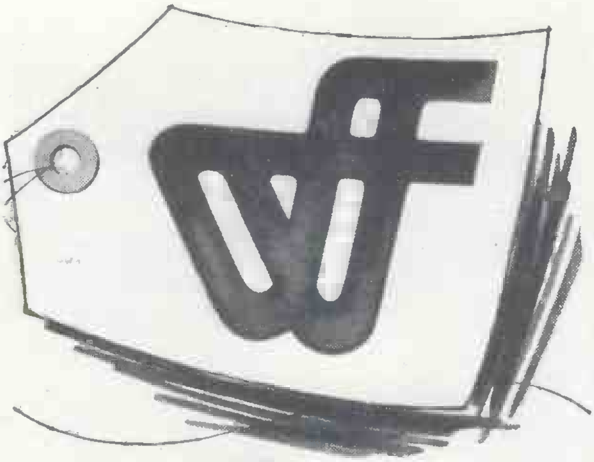

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2—OC45
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and
1—OA81
ONLY 60/- PER SET
or with 2—OA81, 62/6

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Capable of 1 watt Push-Pull
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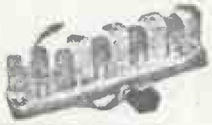

BRAND NEW WITH DIAGRAM

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125 kc/s to 20 Mc/s: Three Valve Crystal controlled Oscillator. Battery operated. Complete with Calibration Charts and Handbook. **£16** CARRIAGE FREE
NEW CONDITION WITH HANDBOOK.

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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/-

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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.

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£2-19-6 P. & P. 2/-.

TAPE DECKS
COLLARO STUDIO TAPE TRANSCRIPTOR
3 motors, 3 speeds 1⅞, 3¾, 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 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 TS1. Suitable for all audio applications. Post 6d. Each **3/6**
One dozen 35/- post free
Special prices quoted for large quantities.

AVANTIC STEREOPHONIC 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.
19 GNS. LIST PRICE £29/8/- 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, 8¾in. deep. LIST PRICE £29/8/-
19 GNS. CARR. & INS. 7/6.

STEP 11 STEREO PICK-UP PRE-AMPLIFIER UNIT
Size 7⅞ × 4⅜ × 2⅛in. 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. P. & P. 3/6.	£3-15-0
Garrard TA Mk. II. Wired for Stereo, plug in head, 4 speed single play. P. & P. 3/6.	£8-9-0

VERDIK TAPE RECORDERS
First class Tape Recorders using the famous Collaro transcription deck. 3 speed 1⅞—3¾—7½ I.P.S. Mic. and Radio inputs. 7in. × 3⅜in. internal speaker. Valve line up ECC83, ECL82, EM84. Wow and Flutter 0.15% total at 7½in/sec. Size width 15½in. depth 6½in., height 6¾in., weight 26lb. 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 knows manufacturer, ready for your Hi-Fi cabinet. Spec.: 2 EL84, 12AX7 and EZ81 push pull output Separate Bass and Trele 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 primarliy 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.

FOR RETURN POST SERVICE

12in. HEAVY DUTY 15 WATT SPEAKER 105/-.
ACOS DUST BUG FOR AUTOCHANGERS 23/4.
3 PIN CONTINENTAL PLUG AND SOCKET 4/9 pr.
PICK UP MATCHING TRANSFORMER BSR AF333 36/-.

P.W. TRANSISTOR SUPERHET PRINTED CIRCUIT VERSION

All components available from stock. Complete kit £9/15/-.

Full detailed shopping list, point to point wiring diagram, fully illustrated	1/6
Coil Set (Osc. and 3 I.F.T.s)	22/6
Driver Transformer	11/6
Output Transformer	10/6
Ferrite Rod Aerial	10/-
Printed Circuits	9/-
OO Gang Condensers	11/-
Volume Control V.C. 1545	10/6
Switch	3/6
Hardware Kit	4/6
Transistors (set of 6 plus crystal diode GD9)	70/-
Speaker	19/10
Case	7/6
Complete Kit of Condensers	15/-
Complete Set of Resistances	6/6
Trimmers (2)	2/8

All above components are brand new and are fully guaranteed.

AZ1	10/-	PEN45	8/-
AZ31	10/-	SP4	5/-
DAF96	8/-	TH30C	5/-
DF96	8/-	TP22	10/-
DK96	8/-	U10	9/6
DL96	8/-	U25	13/6
EABC80	9/-	U26	10/-
EAF42	9/6	U50	8/-
EB91	4/6	UABC80	9/-
EBC3	5/-	UAF42	9/6
EBC33	6/9	UBC41	8/6
EBC41	8/9	UBC81	11/4
EBF80	9/9	UBF80	9/-
EBF89	9/6	UCC84	10/11
ECC81	8/-	UCC85	9/6
ECC82	7/6	UCH42	9/6
ECC83	9/-	UCH81	9/6
ECC84	10/-	UCL82	11/6
ECC85	9/6	UCL83	13/6
ECF80	12/-	UF85	9/-
ECF82	10/6	UF89	9/-
ECH42	9/6	UL41	9/-
ECH81	9/-	UL84	9/-
ECL80	9/6	UU6	10/-
ECL82	10/6	UYIN	12/6
		UY41	7/6
		UY85	7/-
		VP23	6/6
		VR105/30	8/-
		VR150/30	7/6
		VU39(MU12/14)	8/9
		Y63	7/6
		1A7GT	13/6
		1C2	11/6
		1C5GT	12/6
		1H5GT	9/-
		1N5	10/6
		1R5	7/6
		1S5	6/6
		1T4	5/6
		3D6	5/-
		3Q4	7/6
		3Q5GT	9/6
		3S4	7/6
		3V4	8/-

VALVES

EF6	5/-
EF41	9/6
EF50	5/-
EF50SYL	7/-
EF80	7/-
EF85	7/-
EF86	12/6
EF89	8/9
EF91	5/9
EF91(BVA)	9/-
EF92	6/-
EK32	7/-
EL32	4/6
EL33	14/-
EL41	9/-
EL84	9/-
EL91	4/6
EM34	9/6
EM80	9/6
EM81	10/6
EY51	9/6
EY86	10/-
EZ40	7/6
EZ41	7/6
EZ80	7/-
EZ81	7/-
FC13	5/-
FW4/500	10/-
GZ32	11/6
HL23DD	8/6
HL42DD	10/-
KT2	5/-
KT33C	8/6
KT61	13/6
KTW61	6/6
MX40	12/6

VALVES

OZ4	5/6
PCC84	8/6
PCC85	11/6
PCF80	8/9
PCF82	11/6
PCL83	13/6
PL36	13/6
PL81	11/-
PL82	8/6
PL83	9/6
PX25	12/6
PY80	7/6
PY81	8/6
PY82	7/-
PY83	8/6
PEN4VA	10/-
PEN25	6/-

VALVES

4D1	3/-
5R4GY	9/6
5U4G	6/-
5V4	11/6
5Y3G	8/-
5Y3GT	7/6
5Z4G	9/-
6A7	10/-
6A8G	9/-
6AK5	5/-
6AL5	4/-
6AM5	7/6
6AM6	4/-
6AQ5	7/6
6AT6	8/6
6BA6	7/6
6BE6	7/6
6BH6	9/-
6BJ6	9/-
6BW6	9/-
6C4	4/6
6C5GT	6/6
6C6	5/-
6D6	5/-
6CH6	8/6
6F6G	7/-
6F6M	7/6
6J5GT	5/-
6J5M	6/6
6J6	5/6
6J7G	6/6
6K7G	4/-
6K7M	6/9
6K8G	6/6
6K7GT	5/9

6K8GT	10/-
6L6G	8/-
6L6M	9/6
6L18	11/6
6N7GT	7/6
6Q7G	7/6
6Q7GT	9/6
6SK7	6/-
6SL7GT	8/-
6SN7GT	7/6
6SQ7	9/3
6U4GT	12/-
6V6G	6/-
6V6GT	7/9
6X4	7/6
6X5G	7/-
6X5GT	7/-
6/30L2	12/6
7B6	10/6
7B7	8/6
7C5	8/-
7C6	8/-
7H7	8/-
7S7	9/6
7Y4	8/6
10F1	12/6
10P13	23/3
12A6	5/-
12AH8	12/-
12AT7	7/6
12AU7	8/-
12AX7	8/-
12BA6	9/-
12BE6	9/-
12C8	7/-
12J7GT	10/6
12K7GT	6/6
12K8GT	13/6
12K8M	13/-
12Q7GT	6/6
12SK7	6/-
12SL7	8/-
12SN7GT	10/-
15D2	7/9
25A6	9/-
25L6GT	10/-
25Z4	9/6
25Z5	8/-
25Z6	10/-
30FL1	10/6
30L15	23/3
30P4	15/-
30P12	12/6
30PL1	12/6
35L6GT	10/-
25Y5	9/9
35Z4GT	8/-
42	8/-
35Z5GT	9/-
50L6GT	8/6
75	10/6
80	8/6
142BT	3/6
210DDT	4/6
210VPT	3/6

MICROPHONES

★ Acos mic. **39/1**, crystal stick microphones for use as a hand, desk or floor stand unit, listed at 3 gns. **Our price 39/6.** Table stand 7/6 extra, floor stand adaptor 12/6 extra.

★ Acos Mic. 40, as supplied with modern tape recorders with a folding rest and 8ft. lead, listed at £1/15/-. **Our price 19/6.**

★ GBS Microphone, Pencil Stick type, fitted with muting switch 42/-.

★ T.S.L. Crystal "Stick" microphone, model MX3, for general purpose use, complete with table stand 45/-.

★ T.S.L. Moving Coil Microphone, for high or low impedance. Brown and cream plastic case with a fold, in table rest. 6ft. cable and a standard 3-way connecting continental plug. £4/4/-.

COLLARO STUDIO TAPE TRANSCRIPTOR

3 motors, 3 speeds, 1⅞, 3¾, 7½ i.p.s., take 7in. spool. Push button controls. **PRICE 12 gns.** Tape extra. Carriage and insurance 5/6.

COLLARO Mk. IV TAPE TRANSCRIPTOR

Four heads. Twin track operation. Pause control. Tape measuring and calibration device. Two motors. Fast re-wind. 7in. tape spool. 3 speeds. 3¾in., 7½in. and 15in. per second. Finish cream polystyrene cover plate with maroon control. Delivery from stock **£16/19/6.**

LATEST B.S.R. "MONARDECK" SINGLE SPEED

3¾in. i.p.s., takes 5¾in. spools. Simple controls. £8/8/0. Tapes extra. Carr. and insurance 5/6.

AUTOMATIC RECORD CHANGER UNITS

BSR "MONARCH" UA8. 4-speed unit with B.S.R. FULFI cartridge. **£6/15/0.**

BSR "MONARCH" UA8. As above but fitted with B.S.R. FULFI STEREO cartridge. **£6/19/6.**

GARRARD 210 Automatic Record Changer. 4-speed will take eight records 10in. and 12in. arm wired for stereo fitted MPM5 head moulding with GC8 mandral cartridge. **£10/19/6.**

BSR "MONARCH" UA14 4-speed unit in two-tone grey, **£7/19/6.**

COLLARO CONQUEST 4-speed fully mixing changer, complete with studio "O" cartridge. **£6/19/6.**

GARRARD RC120 Mk. 2 4-speed unit with manual control to enable records to be played singly. Fitted GC2 cartridge. **£6/19/6.**

LOUDSPEAKER UNITS
All Brand New

2½ square Rola C25	26/10
2½in. square EMI	18/6
4in. square Elac Tweeter	12/6
5in. round Plessey with O.P.T.	16/6
6½in. round Celestion	17/6
8in. round Richard Allen	18/6
10in. round Elac	25/-
12in. round Plessey	29/6
6in. x 4in. Plessey	19/6
7in. x 4in. Plessey	19/6
8in. x 5in. Celestion and Richard Allen	19/11
10in. x 6in. Celestion and Plessey	22/6

RECTIFIERS

RM1 5/3; RM2 6/9; RM3 7/6; RM4 13/6; RM5 19/6; 14A 86 19/6; 14A 97 19/6; 14A 100 19/6; LW7 17/6; 18RA 1-1-16-1 6/-; FC31 (14Ra 1-2-8-3) 22/6; FC101 (14RA 1-2-8-2) 16/6.

Rectifiers suitable for Battery Chargers 6 and 12 volt output:

2 amp....... 7/- 3 amp....... 10/-
4 amp....... 12/6 5 amp....... 14/6

HEAT TRANSFORMERS

All 240 v. input 4 v. 3 amp. 10/-. 6.3 v. 1½ amp. 6/9. 6.3 v. 3 amp. 10/-. 12.6 v. ¾ amp. 5/9. 5 v. 2 amp. 10/-. 2 v. 3 amp. 8/3.

SINGLE PLAYERS GARRARD

MODEL TA/MK. II 4-speed single player. Die-cast aluminium pick-up with GC2 cartridge. Automatic stop. 9½in. diameter turntable. **£8/10/4.**

COLLARO JUNIOR

4 speed turntable and pick-up. Complete with crystal cartridge and sapphire styli. Finish cream with maroon turntable mat and speed control. Price 75/- or turntable and motor only at 52/5. Pickup only 27/6.

WB STENTORIAN HF1012 10 WATTS 95/- EACH.
SCOTCH RECORDING TAPE 150/18, 7in. SPOOL 50/-.
TAYLOR MODEL 127A MULTIMETER £10.
REPANCO FS3 FERRITE SLAB AERIAL 7/6.
HENLEY SOLON INSTRUMENT IRON, MODEL 625, 24/-.
BELLING-LEE DIPLEXER L1338, 11/-.
BIB RECORDING TAPE SPLICER 18/6.
ELSTONE MULTI-RATIO OUTPUT TRANSFORMER 10 watts 23/-.
CAR RADIO AERIALS (TELESCOPIC) 39/6 each.
MINIATURE IF TRANSFORMERS 475 Kc/s 9/- pair.
PLASTIC SPEAKER CABINETS FOR 5in. UNIT, WHITE 15/-.

CATALOGUE

OUR 1961 CATALOGUE IS NOW AVAILABLE. PLEASE SEND 1/- IN STAMPS FOR YOUR COPY. TRADE CATALOGUE ALSO AVAILABLE. PLEASE ATTACH YOUR BUSINESS LETTER HEADING.

CO-AXIAL CABLE

Semi-air space 75 ohms 6d. yard.

"CABY" SUPREME MULTI-RANGE TEST METER

Solves your problems with speed and accuracy. Model A10. Measurement ranges: D.C. volts 10 v. to 1,000 v. A.C. volts 10 v., 50 v., 250 v., 500 v., 1,000 v. Resistance ohm; 10K ohms, 1 megohm. Size of meter 5¼in. x 3⅜in. x 1⅞in. Price £4/17/6 inclusive of test prods., instruction and batteries.

RECORDING TAPES

Plastic reel 7in. 1,200ft. tape. Top quality. 23/- each.
5in. reel 600ft. 12/9.

ALPHA RADIO SUPPLY CO.

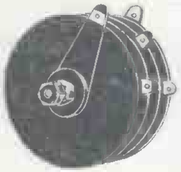
103 LEEDS TERRACE, WINTOUN STREET, LEEDS 7

TERMS: Cash with order or C.O.D. Postage and packing charges extra, as follows: Orders value 10/- add 1/-; 20/- add 1/6; 40/- add 2/-; £5/5/- add 3/-, unless otherwise stated. Minimum C.O.D. fee and postage 3/-. Full terms of business see inside cover of our catalogue. Personal shoppers 9 a.m. to 5 p.m. Monday to Friday. Saturday 10 a.m. to 1 p.m.

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



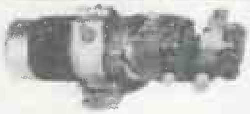
Full wave, bridge connected. All new and guaranteed.

12/18 v. 1 amp.	4/3	12/18 v. 10 amp.	22/6
12/18 v. 2½ 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. ¼ 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

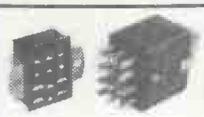
Brand new moving iron instruments by famous manufacturer. Housed in polished teak case, 8in. mirror scale. 2 ranges, A.C. or D.C. 0 to 160 v. and 0 to 320 v. Accuracy within 2%, £5/19/6 ea. P/P 3/6.

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 earpiece, 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/-.

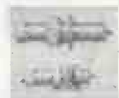
BRAND NEW Boxed 100 MICROAMP METERS.

Standard 2½in. flush panel mounting. Scale calibrated 0-100 microamps. 42/6 each. P/P. 1/3.
Also available 3½in. panel mounting 62/6 each.

COLLARO STUDIO TAPE TRANSCRIPTORS

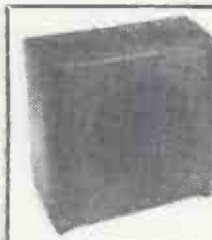
Latest 1961 model. 3 speeds 1⅞, 3¾ or 7½. Fitted with 3 separate motors, digital counter, press button switching, provision for fitting extra stereo head. Supplied brand new and guaranteed complete with spare 7in. spool. £12 each. P/P 3/6.

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



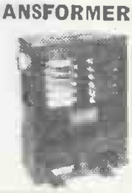
High quality 8in. 3 ohm. speaker housed in black crackle metal case to match AR-88 or H.R.O. receivers. Supplied brand new and boxed, 45/- each. P/P 3/6.

R.C.A. PLATE TRANSFORMERS. Primary 200/250 volts 50 cycles. Secondary 2,000/1,500/0/1,500/2,000 volts 500 milliamps. Supplied brand new and boxed, £6/10/- each.

PARMEKO TABLE TOP TRANSFORMERS

Input 230 volt 50 cycles. Output 620/550/375/0/375/550/620 volts 250 mA., 5 volt 3 amp., 5 volt 3 amp. Size 6¾in. x 6¼in. x 5½in. 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. £15 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.

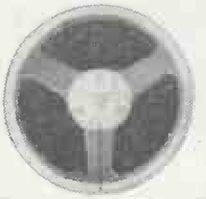
HOURS OF BUSINESS: 9 a.m.-6 p.m. Thursday 1 p.m. Open all day Saturday. Please print name and address clearly.

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/-
5¾in. 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., 5¾in. 2/3 ea., 7in. 2/9 ea.

BRAND NEW PLASTIC SPOOL CONTAINERS 5in. 1/6 ea., 5¾in. 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/-

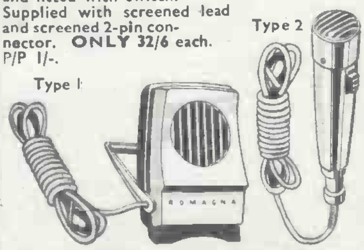
Postage extra.

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/-.



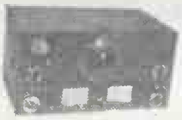
SANGAMO WESTON STANDARD VOLTMETER

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.

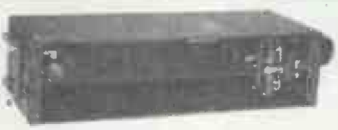


PHOTO VOLTAGE AMPLIFIERS

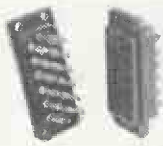
These special units contain a 1 microamp Tinsley galvonometer and a double selenium photo electric cell. Brand new £9/19/6 each. P/P 7/6.

FIELD TELEPHONE TYPE L.

Generator bell ringing, 2 line connection. Supplied fully tested, complete with batteries. 59/6 each. P/P. 3/-.

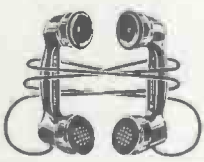
AMPHENAL CHASSIS UNITERS

All new and unused. Available with 15 or 18 pins. Both types 3/6 per pair.

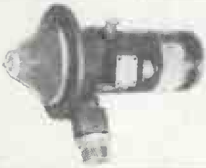


HALLICRAFTER 6 VOLT VIBRATOR POWER SUPPLIES. Housed in grey metal case and supplied with all necessary connectors etc. Made for SX28, S27, S36 receivers. Output 300 volts 170 ma., fully smoothed. Supplied new and boxed, 29/6 each. P/P 3/6.

SOUND POWERED TELEPHONE HANDSETS



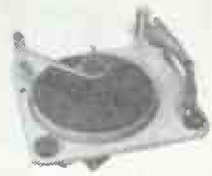
Make simple Intercom system. No batteries required. Just connect together with twin flex. Brand new only 15/- per handset. P/P 1/6. Suitable twin flex 2½d. per yd.



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.

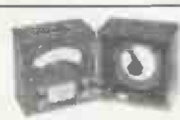
ALUMINIUM CHASSIS

18 swg, 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.

G.W. SMITH & CO (RADIO) LIMITED

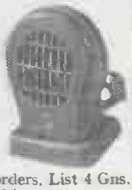
Phone: GERRARD 8204/9155
Cables: SMITHEX LESQUARE
3-34 LISLE STREET, LONDON, W.C.2

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 EZ80 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/-.

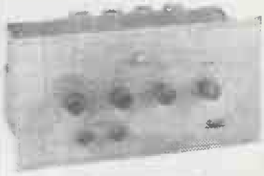
SPECIAL OFFER OF SPEAKERS WITH THIS KIT

Two 5in. for 20/-.
Two 6 x 4in., 25/-.

Suitable cabinets available to callers.

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: 13¾in. wide, 8¼in. deep, 3¾in. 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), 8 x 6in. 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. | 8 x 6 Middle Unit **15/6.** Post 1/6. | 4in. Tweeter **12/6.** Post **1/6.**

TAPE DECK & TAPE OFFERS

LIMITED NUMBER ONLY

The well-known MOTEK K10 Deck with push-button controls, 3 motors, 3-speed (1⅞, 3¾, 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.

COLLARO STUDIO TAPE TRANSCRIPTOR. 3 motors, 3 speed 1⅞, 3¾, 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 i.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

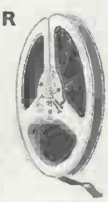
3in.	5in.	5¾in.	7in.	8¼in.
2/9	2/9	2/9	2/9	5/6

7in. Metal Spools, 1/9 each. Post extra.

COLLARO 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 Collaro Studio Transcriptor. Size 11¼ x 5 x 3in. Uses 3 valves, tuning indicator, contact cooled metal rectifier. Incorporates mike/gram/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 5¾in. spool.......... 21/-
850ft. on 5¾in. 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 5¾in. 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."

LASKY'S MIDGET T.R.F.

Handsome contemporary design case, overall size 8½in. wide, 4½in. deep, 5in. high. 2 latest double-purpose valves EBF89 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. (l., m., s.) from... **7 Gns.**
A.M./F.M. from .... **14 Gns.**
A.M./F.M. STEREO from **22 Gns.**

SEND FOR LASKY'S FABULOUS HI-FI CATALOGUE

100 large pages, 11¼ x 8¼in., copiously illustrated. A COMPARATOR-CATALOGUE to enable you to choose from all the latest hi-fi equipment. **Price 3/6,** post 6d. (Refunded on making your first hi-fi purchase.)

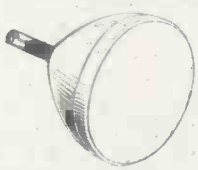
LASKY'S RADIO FOR COURTEOUS SERVICE & TECHNICAL ADVICE

LASKY'S RADIO

EVERYTHING FOR HOME CONSTRUCTOR & SERVICEMAN

C.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**
Carr. and Insur. 12/6.

16in. **METAL CONE,** famous make, type T901/A, 6.3 v., 0.3 amp. heater. **£6.9.6**
Carr. & Insur. 21/-.

17in. 90 degrees C.R. TUBES

Seconds but in perfect working order and guaranteed.
Carr. and insur. 12/6. **79/6**

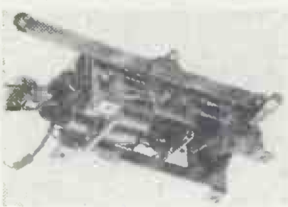
RE-GUNNED C.R. TUBES

GUARANTEED FOR 12 MONTHS

Type	From			Carr. & Ins.
12in. round	£5	10	0	12/6
14in. rect.	£5	10	0	12/6
15in. & 16 round	£5	19	6	12/6
17in. rect.	£5	19	6	12/6
21in. rect.	£7	19	6	21/-

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, 7¼ × 5 × 1½in. 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, ⅛th watt, most values available. Each 3½d. Per doz. 2/6.

CONDENSERS, RESISTANCES. High stability Resistances, Electrolytics. All values and sizes stocked.

SPEAKER COVERINGS. Large stocks of Tygan and "Someweave." Any size piece cut. Samples and prices post free.

MANY BARGAINS IN MULTI-TEST METERS

All new and guaranteed unused.

The KAPURA Mdl. 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 2¼in. **Weight:** 22 ozs.

Fully guaranteed. Complete with test leads. Post & Pkg. 3/6 LASKY'S PRICE **59/6**

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, 3¾ x 3¾ x 1⅞in. 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, 7¾ x 9¼ x 3¾in. 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: 4½ x 6¼ x 3⅛in.
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.
- ★ Medium and long waves.
- ★ Permeability tuning.
- ★ 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 × 5½in.
Price 2/-. Post 6d.
Latest 12-page BARGAIN BULLETIN included free.

★ 12-CHANNEL TURRET TUNERS ★

Large selection, many by famous makers such as Cyldon, 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, 14-25 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 TS1. Suitable for all audio applications.
Post 6d. **3/6**
One dozen 35/- post free.

Special prices quoted for large quantities. Enquiries invited.

OC44 15/-; OC45 15/-; OC70 8/6; OC71 8/6; OC78 15/- (Matched Pair 30/-): OC73 14/-; OC16 54/-.

EDISWAN MAZDA TRANSISTORS. The very latest types:
XB/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 GEX00, each 1/-. Per doz. 9/-.
All other types in stock.

"GOLTOP" 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. Suitable 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.

Mdl. CR.5. Crystal Earpiece, high imp. **12/6**
Mdl. 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.

TWO ADDRESSES FOR PERSONAL SHOPPERS

207 EDGWARE ROAD, W.2

PADdington 3271/2. Few yards from Praed Street.

42 TOTTENHAM COURT ROAD, W.1

Nearest Station: Goodge Street. MUSeum 2605

Please address Mail Orders and Enquiries to Lasky's Radio, Dept. W, 207 Edgware Road, London, W.2.

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 wavemeter 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 7½ x 4in. 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 multivibrator 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. at 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. 6¾ x 6 x 7½in. high. Weight 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 3¼ x 3¾ x 3¾in. high. 15/–.

TRIPLETT METER MOVEMENT
This article consists of a basic 400 microamp meter movement mounted on a Bakelite panel 5¾ x 2⅞. 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.

QQV06-40 37/6

PV1-35 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 RECEIVER

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. (16.2-4,000 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 10½ x 11½ x 6in. 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. £4/19/6, CARRIAGE 25/6.

T.C.C. VISCONOL CONDENSERS. 8 mfd. 800 v. D.C. wkg. at 71 deg. C. CP152V. Size 3 x 1¾ x 5in. 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, 5,000Ω 2 c/o., plat., M1052 17/6
Siemens High Speed, 1K+1K Ω, 1 c/over 10/6

GIANT COMPONENT PARCEL

Contains 100 ½ 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
LONDON, W.C.2 *TEMple Bar 0545*
Near Leicester Sq. Station. (Opposite Thorn 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%. 0-100H; 0-100μF; 0-1MΩ each in 5 ranges. Power Factor and "Q." Guaranteed £35.

HALLICRAFTER VIBRAPACK. Input 6 v. output 300 v. at 170 mA. Designed for SX28 or S27. Size 6½ x 7 x 7in. **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 stablised 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. 2½in. 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. 2½in. 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. 2½in. square flush panel mounting. BRAND NEW. Boxed. 42/6.

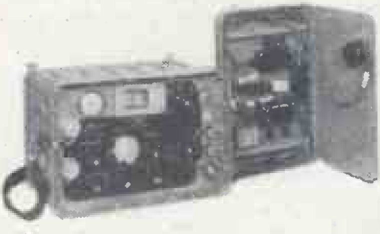
MULTIMETERS

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 5¼ x 3⅛ x 2¼in. Fully guaranteed with test leads, prods and internal battery.
59/6

PROOPS Walk-around Store
and MAIL ORDER SERVICE

52 Tottenham Court Road, London, W.1 • *Open 9-6, including Sats., Thurs. 9-1* • **LANgham 0141**

PRECISION AM/FM SIGNAL GENERATOR CT212

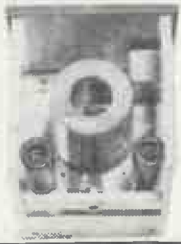


Highly stable, laboratory standard, Services Test Oscillator of modern ruggedised design in fully sealed cast case 12 × 11 × 8in.
Operating from 110-115 v., 220-250 v. mains, or 12 v. D.C., it covers 85 kc/s to 32 Mc/s in seven directly calibrated bands with high-ratio slow-motion tuning.

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 µv. 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, at the remarkable price of **£27.10.0** (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 6J6 arranged as an independent multivibrator with its inputs and outputs connected to a Breeze multisocket on front panel. Size: 4½ x 5¼ x 5¼in.

Brand New, complete with valves and circuit . . . SNIP **25/-** *post paid.*

MAINS TRANSFORMERS

200-250 volt 50 c/s. post paid

Type		
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

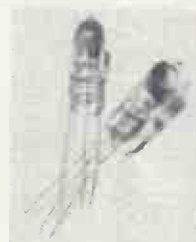
This is a later type than those previously available. A really serious job of sound design, crystal controlled, 10 mile range, transmitter and receiver covering any one frequency between 4125 and 7100 kcs in 25 kcs steps with standard crystal supplied—or any spot frequency between 3600 and 9000 kcs with special crystal supplied to order. Brand new, complete with headphones, throat mic., whip-antenna, plugs and leads. Size: 12 x 4 x 6¼in. 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*

ETCH-YOUR-OWN PRINTED CIRCUIT SETS **21/-** Post Free

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.

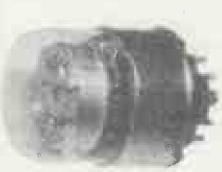
Cold Cathode Trigger Tubes



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.

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

CRYSTALS 2,800 to 9,800 kc/s

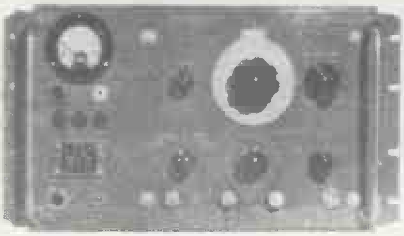
British 10X Type. ¾in. pin spacing.
Huge range of frequencies from 2,000 kc/s-9,800 kc/s.
All Ham Band frequencies 8/6 each. Other frequencies 6/6 each.
Orders under £2, P. & P. 1/6, over £2, post free.

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 6S7 and one 6SJ7), and RCA. 100 kcs Crystal.

Brand New, with W.W. Circuit for conversion **£6.10.0**

PRECISION SIGNAL GENERATOR CT53. A modern laboratory standard instrument still in current use



FEATURES

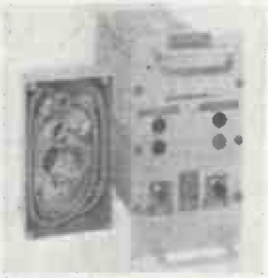
- Vernier tuned, Triple screened, 6-Band coil turret covering 8.9 to 300 Mc/s with 72 ohm output from 100 mV down to 1μV.
- Precision decade ladder and silver slide wire attenuator calibrated in voltage and 0–90db.
- Variable carrier level monitored by cathode follower and VTVM.
- CW or modulated 30% 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 $\frac{3}{4}\mu$ Sec.
- Seven B7G Valves, Potted "C" core transformers, Paper capacitors, Stabilised H.T.
- Selected spare oscillator, pre-aged spare monitor, 100μA 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. Plus 15/- for careful packing and carriage **£17.10.0**

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 11½in. high × 6in. wide × 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 μF 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.

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 1½ h.p. Both shafts ⅝in. 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.

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.

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 volt) from specially wound potentiometer in sealed die-cast housing with ¼in. 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

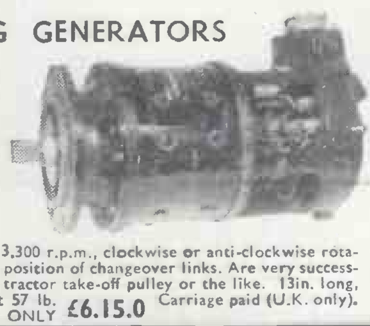
B.C. 221 FREQUENCY METER

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.). 2½in. 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. ONLY **£6.15.0** Carriage paid (U.K. only).

8 WATT HI-FI PUSH PULL AMPLIFIER

Separate control panel 6″ × 1½″. Volume/On-Off switch, Bass and Treble Boost controls and Pilot light. Amplifier Chassis 3¾in. × 8in. × 4in. 2 x ECL82 in Push Pull. Output transformer matched 3 and 15 ohms. 110-220-240V. A.C. with 6ft. mains lead.
All units guaranteed ready for installation.

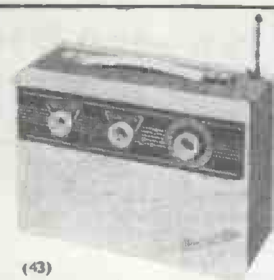
£5.10.0 plus 5/- Carriage

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

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 6¾in. 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

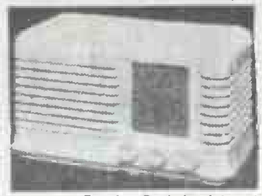
" PRACTICAL WIRELESS " POCKET SUPERHET
All required Components for the complete Osmor version as described in November issue of "Practical Wireless" now available at special inclusive price of £9/19/6 complete, including Printed Circuit and Osmor booklet. Overall size 5½in. x 3in. x 1¾in., 6 transistors, 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.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	£8 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 WII Wobbulator	£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/-	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	3/6	2/-
(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!!

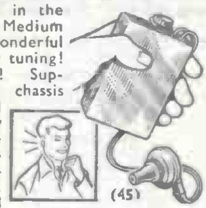
THE CLYNE RADIO "DE LUXE" PRINTED CIRCUIT SUPERHET (22)



A new two-wave band (L and M) Superhet using the latest miniature valves: ECH81, EF85 and ECL80, plus contact 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

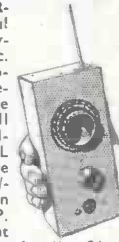
Completely portable—NO EXTERNAL AERIAL OR EARTH REQUIRED. This is an amazing little receiver with built-in aerial and small enough to be held in the palm of the hand. Medium wave reception at wonderful volume. No fiddley tuning!—condenser tuned! Supplied with drilled chassis and colour coded components. 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. (32) & (33)

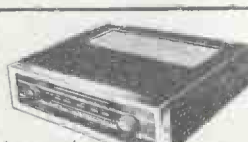
A wonderful little set you can take anywhere. Ideal for camping, etc. Detachable aerial rod supplied. Covers Medium waveband 200-500 metres. Can be built in approx. 1 hour. All necessary components available at the following SPECIAL INCLUSIVE PRICES: 1-valve version ONLY 35/- plus 2/- P. & P. Super 2-valve 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.



"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.

PRINTED CIRCUIT CAR RADIO



(39)

(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.

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.

★ MORE CLYNE RADIO BARGAINS ★

RECORD PLAYERS
Full range at usual competitive prices. Interesting H.P. facilities

E.M.I. 4-SPEED STEREO/MONAURAL SINGLE RECORD UNIT. Complete with Stereo Head and Sapphire Styli. 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 $10\frac{1}{2}$ 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/MONAURAL. 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 MPM2 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 prods, 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 $13\frac{1}{2}$in. x $9\frac{1}{4}$in. x $3\frac{1}{2}$in. 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. Ardente Standard magnetic type complete with lead and plug. Only **12/6.** P. & P. 1/-.

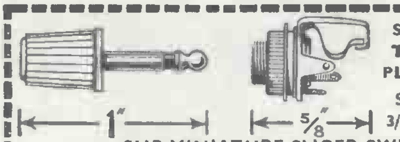
MINIATURE CRYSTAL DEAF-AID TYPE EARPIECE. Supplied with ear insert. 3ft. lead, sub-miniature jack plug and socket at **8/-** only, plus 1/- P. & P.

E.M.I. FULL FREQUENCY SPEAKER. Size $13\frac{1}{2}$in. x 8in. A further small quantity available. 3 ohm speech coil. **39/6** only, plus 2/- P. & P.

12in. BAKERS SELHURST LOUDSPEAKER. 15 ohms, 15 watt 30-14,000 cps. Brand new, **£4/10/-**. P. & P. 3/6.

12in. RICHARD ALLAN P.M. LOUDSPEAKER. 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 TRANSCRIPTOR. 3 motors, 3 speeds, $1\frac{7}{8}$, $3\frac{3}{4}$, $7\frac{1}{2}$ 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 $5\frac{3}{4}$in. spools—$3\frac{3}{4}$ 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 $7\frac{1}{2}$ 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 $11\frac{1}{2}$ x 3 x $4\frac{3}{4}$in. Supplied complete with attractive grey/blue escutcheon 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**, $5\frac{3}{4}$in. 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/–**, $5\frac{3}{4}$in. **2/3**, 7in. **2/6. PLASTIC SPOOL CONTAINERS** for spool sizes 5in. **1/6**, $5\frac{3}{4}$in. **2/–**, 7in. **2/3.** Any single item plus 6d. P. & P. Orders over £1, post free.

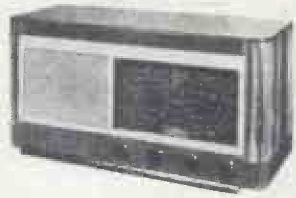
LANGUAGE COURSES ON TAPE!
Complete Elementary Course in French, Italian, German or Spanish. Phrase book supplied. 5" long play tape, 55 minutes at $3\frac{3}{4}$ i.p.s. Price ONLY 29/6 per course, Post Free!

EXTRA SPECIAL OFFER !!
A small three-valve **PORTABLE RECORD PLAYER AMPLIFIER** mounted on baffle 12 x 7in., with High Flux $6\frac{1}{2}$in. 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 fo 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 $13\frac{1}{2}$ x $8\frac{1}{2}$in. Fitted with carrying handle, **£3/9/6**, plus 5/- P. & P.

NOTE. If both items purchased together they will be supplied at a special inclusive price £8/7/6, plus 6/6 P. & P.

FRUSTRATED EXPORT. Not repeatable! 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 $21\frac{1}{4}$in. x $10\frac{1}{2}$in. x $10\frac{1}{4}$in. 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
R.F. up to 2.5 Mc/s. .... **5/-** ea.
OC169 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**; $6\frac{1}{2}$in. **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 transreceiver 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 $3\frac{1}{2}$in. 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.

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.

ALSO SEE PREVIOUS PAGES

C.R.T. BOOSTER TRANSFORMERS

For Cathode Ray Tubes having Heater/cathode short circuit and for C.R. Tubes with falling emission. Full installation instructions supplied.

Type A. Low Leakage windings. Optional Boost 25% and 50%. Tapped mains primaries:

2 volt	12/6 each
4 volt	12/6 each
6.3 volt	12/6 each
10.8 volt	12/6 each
13.3 volt	12/6 each

OUR LATEST SUPERIOR PRODUCT. Type A2. High Quality. Low capacity. 10/15 pf. Optional boost 25%, 50%, 75%. .... 16/6 each

Type B. Mains input. Low capacity. Multi-Output 2, 4, 6.3, 10 and 13 volts. Optional boost 25% and 50%. Suitable for all Cathode Ray Tubes 21/-.

RESISTORS. All preferred values. 20% 10 ohms to 10 meg., ¼ w., 4d.; ½ w., 4d.; 1 w. 6d.; 1½ w., 8d.; 2 w. 1/-. **HIGH STABILITY.** ½ w., 1% 2/-. Preferred values 10 ohms to 10 meg. Ditto 5% 9d., 100Ω to 5 meg.

WIRE-WOUND RESISTORS 25 ohms—10,000 ohms.

5 watt	1/3
10 watt	1/6
15 watt	2/-
12,500 ohms—50,000 ohms. 10 w.	3/3

WIRE WOUND POTS, 3 w. Pre-set Min. T.V. type Knurled Slotted knob. All values 10 ohms to 25K. 3/- ea., 30 K., 50 K., 4/-. Ditto ½ w. Carbon Track, 30 K. to 2 Meg., 3/-.

WIRE-WOUND POTS, 4 w. Standard size Pots. long Spindle High Grade. All values 50 ohms to 50 K. 6/6: 100 K., 7/6.

W/W EXT. SPEAKER CONTROL 10Ω, 3/-.

O/P TRANSFORMERS. Heavy duty 50 mA. 4/6. Multi-ratio push-pull 7/6. Miniature 3V4, etc. 4/6. Hygrade Push-Pull 10 watts, 15/6. Push-pull 20 w. 6 k. or 8 k. 30/-.

L.F. CHOKES. 15/10H 60/65 mA. 5/-. 10H 85 mA., 10/6. 10 H 120 mA., 12/6. 10H 150 mA., 14/-.

MAINS TRANSFORMERS 200/250 v. A.C.

STANDARD 250-0-250, 80 mA., 6.3 v. 3.5 a. tapped 4 v. 4 a. Rectifier 6.3 v. 1 a., tapped 5 v. or 4 v. 2 a. Ditto 350-0-350	22/6
MINIATURE 220 v. 20 mA., 6.3 v. 1 a.	10/6
MIDGET, 220 v. 45 mA. 6.3 v. 2 a.	15/6
SMALL, 200-0-200 50 mA., 6.3 v. 2 a.	17/6
STANDARD, 250-0-250, 65 mA., 6.3 v. 3.5 a.	17/6
HEATER TRANS., 6.3 v. 1½ a., 7/6: 3 amp.	10/6
GENERAL PURPOSE LOW VOLTAGE. Outputs 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 v. at 2 A.	22/6
AUTO. TRANS. 150w., 0, 10, 120, 200, 230, 250 v.	22/6

ALADDIN FORMERS and cores. ¼in. 8d.; ⅜in. 10d. 0.3in. **FORMERS** 5937 or 8 and Cans TV1 or TV2 2⅜in. sq. × 2¼in. or ⅝in. sq. × 1½in., 2/- with cores.

SLOW MOTION DRIVES. Epicyclic ratio 6 : 1, 2/3.

SOLON. Midget Soldering Iron, 220/40 v. 25 w., 24/-.

REMPLOY INSTRUMENT IRON. 220/40 v. 25 w., 17/6.

MAINS DROPPERS. 3 × 1½in. Adj. Sliders .3 amp. 1,000 ohms 4/3. .2 amps. 4/3. .1 amp. 2,000 ohms. 5/-.

LINE CORD. .3 amp. 60 ohms per foot .2 amp. 100 ohms per foot, 2-way, 6d. per foot; 3 way 7d. per foot.

CRYSTAL MIKE INSERT by Acos 6/6
Precision engineered. Size only ⅞ × 3/16in.
ACOS CRYSTAL STICK MIKE 39-1. Bargain 35/-.

MIKE TRANSF. 50 : 1, 3/9 ea., 100 : 1 Potted 10/6.

LOUDSPEAKERS PM. 3 OHM. 5in. Rola, 17/6. 6in. × 4in. Rola, 18/-. 7in. × 4in. R.A., 21/-. 10in. × 6in. Rola 27/6. 8in. Plessey, 19/6. 6½in. Rola 18/6. 8in. Rola, 21/-. 10in. R.A. 30/-.

HI-FI TWEETERS, 4in. 25/-. 12in. Plessey, 30/-. 12in. Baker 15 wt. 3 ohm. and 15 ohm models, 90/-. 12in. Baker foam suspension 15 w. 15 ohm. £6. 12in. Baker Ultra Twelve £17/10; 20 c.p.s. to 25 k.c.s.

I.F. TRANSFORMERS 7/6 pair
465 kc/s, slug tuning miniature can 1¾ × ⅞ × ⅞in. High Q and good bandwidth. By Pye Radio. Data sheet supplied
Weymouth I.F. Standard size 465 kc/s., 12/6 pair.

CRYSTAL DIODE G.E.C., 2/-. GEX34, 4/-. 40 Circuits 3/-

H.R. HEADPHONES. 4,000 ohms, brand new, 15/- pair.

SWITCH CLEANER Fluid, squirt spout, 4/3 tin.

TWIN GANG CONDENSERS. 365 pf. Miniature, 1⅞in. × 1¼in. × 1⅞in., 10/-. .0005 Standard with trimmers, 9/-; less trimmers 8/-. Midget 7/6: Single 50 pf. 2/6; 100 pf., 150 pf., 5/6. Solid dielectric 100, 300, 500 pf., 3/6.

VALVE HOLDERS. Pax. int. Oct. 4d. EF50, EA50, 6d. B12A, CRT, 1/3. Eng. and Amer. 4, 5, 6, 7 pin, 1/-.

MOULDED Mazda or Int. Oct. 6d. B7G, B8A, B8G, B9A, 9d. B7G with can, 1/6; B12A, 1/3; B9A with can, 1/9.

CERAMIC, EF50, B7G, B9A, Oct. 1/-. B7G, B9A Cans, 1/-.

SPEAKER FRET. Gold Cloth 17in. × 25in., 5/-; 25in. × 35in., 10/-. Tygan 54in. wide, 10/- ft., 27in. wide 5/- ft. Brown, Green or Red. Samples S.A.E.

WAVECHANGE SWITCHES

2 p. 2-way, or 3 p. 2-way; short spindle	2/6
5 p. 4-way, 2 wafer, or 3 p. 11-w. 3 wafer, 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

Wave change "MAKITS" 1 wafer, 8/6; 2 wafer, 12/6; 3 wafer 16/-; 4 wafer, 19/6; 5 wafer 23/-; 6 wafer 26/6.

TOGGLE SWITCHES. S.P., 2/-; D.P., 3/6; D.P.D.T., 4/-;

MORSE KEYS, good quality, 2/6.

SUB-MINIATURE ELECTROLYTICS (15 v.), 1, 2, 4, 5, 8, 25, 50 mfd., 100 mfd., 3/- each.

THE HI-GAIN BAND 3 PRE-AMP
Cascode circuit using Valve ECC84. 17db gain. Kit 29/6 less power; or 49/6 with power pack. Plans only 6d.
Also Band I version same prices.
(PCC84 Valve if preferred)

ARMSTRONG

AF/208 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 Feed-back.
- Separate wide range Bass and Treble Controls.
- 2 Compensated Pick-up Inputs.
- Frequency Response 30 - 22,000 c.p.s. ±2dB.
- Tape Record and Playback Facilities.
- Continental Reception of Good Programme Value.

For 3, 7½ 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. The hand-built construction, the superior finish and the high quality components are the same as those used for more expensive models. We confidently assert that there is no similar product on the market today which equals in value the Armstrong AF208.

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 Players, 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 (uncut boards)	49/6
Amplifier player cabinets with cut boards	63/-
2-valve amplifier and 6½in. speaker for above..	79/6

Ready mounted on baffle 12in. × 7in., 3in. deep.

MINIATURE 2-STAGE Hi-Fi AMPLIFIER. A.C. only. 200-250 v. Valves ECL82 and EZ80. 3 watt quality output. Mullard tone circuits, bass boost, treble and volume controls. Separate engraved Perspex front panel with de luxe finish. Heavy duty output transformer, 3 ohm. and shrouded mains transformer. Stove enamelled chassis size 6 × 5 × 3in. Bargain price £4/15/-. Circuit supplied.

CYLDON TURRET TELETUNER
I.F. 33/38 mc/s, 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.

VOLUME CONTROLS
Midget size: Long spindle. Guaranteed 1 year. All values. 5 K. ohms up to 2 Meg. No switch. 3/-. D.P. Sw. 4/6. Linear or Log Tracks.

80 Ohm Cable Coaxial
Semi air spaced. ¼in. dia. Ideal Band III 6d. yd. Losses cut 50%
FRINGE QUALITY AIRSPACED .... 1/- yd.

COAXIAL PLUGS .. 1/-   LEAD SOCKET .. 2/-
PANEL SOCKETS .. 1/-   OUTLET BOXES .. 4/6
BALANCED TWIN FEEDER per yd. 6d., 80Ω or 300Ω.
TWIN SCREENED BALANCED FEEDER 1/6 yd., 80 ohm.

ALUMINIUM CHASSIS. 18 s.w.g. Plain, undrilled, with 4 sides, riveted corners and lattice fixing holes with 2½in. sides 7×4in. 4/6; 9×7in., 5/9; 11×7in. 6/9; 13×9in., 8/6; 14×11in., 10/6; 15×14in., 12/6 and 18×16×3in., 16/6.

BLACK CRACKLE PAINT. Air drying, 3/- tin.
P.V.C. CONN. WIRE, coloured, single or stranded 2d. yd.
NEON MAINS TESTER SCREWDRIVERS, 5/-.
CORED SOLDER RADIOGRADE, 4d. yd., ½lb. 5/-.
PAXOLIN 1/16in. × 8in. × 10in., 1/6. **ION TRAPS** 5/-.

AMERICAN MAGNETIC RECORDING TAPE FERRODYNAMICS "BRAND FIVE"

5in. 600 feet	16/-	MYLAR DUPONT	
5in. 900 feet	18/6	Super High Fidelity	
5¾in. 1,200 feet	23/6	Double Play	
7in. 1,200 feet	25/-	5in. 1,200 feet	37/6
7in. 1,800 feet	35/-	7in. 2,400 feet	60/-

Illustrated leaflet S.A.E.
Spare Reels, plastic, all sizes 3/-
"Instant" Bulk Tape Eraser and Head Defluxer, 200/250 v. A.C. 27/6. Leaflet S.A.E.

RECTIFIERS, RM1, 5/-; RM2, 6/-; RM3, 8/-; RM4, 16/-; RM5, 20/-; FC31, 27/6; 14A86, 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 m.a., 9/6. 120 mA., 15/-.
COILS. Wearite "P" type 3/- each. Osmor Midget "Q" type adj. dust core from 4/- each. All ranges.
TELETRON. L. and M. T.R.F. with reaction, 3/6.
FERRITE ROD AERIALS. M.W., 8/9; M. & L. 12/6.
T.R.F. COILS. A/HF, 7/- pair. **H.F. CHOKES,** 2/6.

JASON F.M. TUNER COIL SET, 29/-. H.F. coil aerial coil. Oscillator coil two I.F. transformers. 10.7 Mc/s. Detector transformer and heater chokes. Circuit and component book, using four 6AM6 2/6. Complete kit FMT1 with Jason Calibrated dial and 4 valves, £6/5/-. New Jason Cabinet FMT2, £2 extra.

CONDENSERS. New Stock. .001 mfd. 7kV. T.C.C., 5/6; 20 kV., 9/6. .1 mfd. 7 kV. 9/6. 100pf, to 500 pf. Micas, 6d. Tubular 500 v. 0.001 to 0.05 mfd., 9d.; 0.1, 1/-; 0.25, 1/6; 0.5 1/9; 0.1/350 v., 9d.; 0.1/1,000 v., 1/9; 0.1 mfd., 2,000 v., 3/6; 0.001 mfd., 2,000 v., 1/9. 500 pf., 20 kV., 9/6.
CERAMIC CONDS. 500 v. 0.3 pf. to 0.01 mfd., 9d.
SILVER MICA CONDENSERS. 10% 5 pf. to 500 pf., 1/-; 600 pf. to 3,000 pf., 1/3.
CLOSE TOLERANCE (1± pf.) 2 pf. to 47 pf., 1/6. DITTO 1% 50 pf. to 815 pf., 1/9; 1,000 pf. to 2,000 pf., 2/-.
TRIMMERS. Ceramic 30, 50, 70 pf., 9d.; 100 pf., 150 pf., 1/3. 250 pf., 1/6. 600 pf., 750 pf., 1/9. Phillips, 1/- ea.

NEW ELECTROLYTICS. FAMOUS MAKES

TUBULAR		TUBULAR		CAN TYPES	
1/350 v.	2/-	50/350 v.	5/6	32/350 v.	4/-
2/350 v.	2/3	100/25 v.	2/-	100/270 v.	5/6
4/450 v.	2/3	250/25 v.	2/6	2,500/3 v.	4/-
8/450 v.	2/3	500/12 v.	3/-	5,000/6 v.	5/-
8/500 v.	2/9	8+8/450 v.	3/6	8+16/500 v.	7/-
16/450 v.	3/-	8+16/450 v.	3/9	32+32/350 v.	5/-
16/500 v.	4/-	8+16/500 v.	5/6	32+32/450 v.	6/-
32/450 v.	3/9	16+16/450 v.	4/3	50+50/350 v.	7/-
25/25 v.	1/9	16+16/500v.	6/-	64+120/350v.	11/6
50/50 v.	2/-	32+32/350v.	4/6	100+200/275v.	12/6

FULL WAVE BRIDGE SELENIUM RECTIFIERS. 2, 6 or 12 v. 1½ amp., 8/9; 2 a. 11/3; 4 a., 17/6; 6 a., 22/6.
CHARGER TRANSFORMERS. Tapped input 200/250 v. for charging at 2, 6 or 12 v., 1½ a., 15/6; 2 a., 17/6; 4 a., 22/6. Charger circuit free. **AMMETERS,** 4 a., and 5 a., 13/6.

NEW and boxed VALVES 90 day guarantee

1R5	7/6	6L6G	10/6	EA50	1/6	EY51	9/6
1S5	7/6	6N7M	6/6	EABC80	8/6	EY86	10/-
1T4	6/-	6Q7G	7/6	EB91	6/-	HABC80	12/6
2X2	3/6	6SA7M	6/-	EBC33	8/6	HVR2A	6/6
3S4	7/6	6SJ7M	6/6	EBC41	8/6	MU14	9/-
3V4	7/6	6SN7	6/6	EBF80	10/-	P61	3/6
5U4	7/6	6V6G	6/6	ECC84	9/6	PCC84	9/6
5Y3	7/6	6X4	7/6	ECF80	9/6	PCF80	9/6
5Z4	9/6	6X5	6/6	ECH42	10/6	PCL82	11/6
6AM6	5/-	12A6	7/6	ECL80	10/6	PEN25	6/6
6BE6	7/6	12AT7	8/-	ECL82	10/6	PL82	10/6
6BH6	9/6	12AU7	8/-	EF39	5/6	PY80	7/6
6BW6	9/6	12AX7	8/-	EF41	9/6	PY81	9/6
6D6	6/-	12BA6	8/6	EF50	5/6	PY82	7/6
6FG6	7/6	12BE6	8/6	EF80	8/-	SP61	3/6
6H6GT	3/6	12K7	6/6	EF86	14/6	UBC41	9/6
6J5	5/6	12Q7	6/6	EF92	5/6	UCH42	9/6
6J6	5/6	35L6	9/6	EL32	5/-	UF41	9/6
6J7G	6/6	35Z4	7/6	EL41	9/6	UL41	9/6
6K6GT	6/6	80	9/6	EL84	8/6	UY41	8/-
6K7G	5/-	807	5/3	EZ40	7/6	U22	8/-
6K8G	7/6	954	1/6	EZ80	7/6	U52	7/6

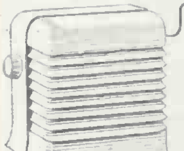
RADIO COMPONENT SPECIALISTS

48-HOUR MAIL ORDER
337 WHITEHORSE RD. WEST CROYDON

POSTAL SERVICE 1/-, OVER £2 FREE. C.O.D. 1/6. (EXPORT C.W.O. POST EXTRA.) Wed. 1 p.m. THO 1665 Buses 133 or 68

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.)*

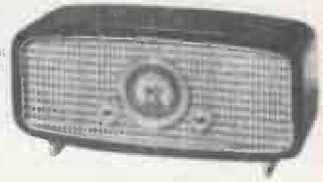
The answer to the modern Parents' problem for "Baby Sitting," this extremely efficient Unit is completely safe, being battery operated, its portability enables you to place the Master Unit in any part of the house. Extra Microphones may be used in different rooms without impairing the efficiency of the 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 1/6 P. & P.

Ever-Ready PP10 Battery Extra 11/-.



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 7¾in. x 5½in.

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 SPA11 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 14½ x 8¾ 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. LS. impedance, 4, 8 or 16 ohms. Dimensions 14in. x 8½in. x 7¾in. Original price 29 Gns. P. & P. 7/6. **OUR PRICE 19 Gns.**

AVANTIC STEP11. Stereophonic Magnetic Pick-up Amplifier Unit. Price £4/4/-.

SPECIAL BARGAIN OFFER

THE PERFECT STEREO SYSTEM

Two DL7/35 power amplifiers
One SP21 Stereo control unit
original cost £91 - 10 - 0
OUR PRICE **47 gns**

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 14½ x 9 x 8¼in. 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 14½ x 9 x 4in. Original price £28/10/-.

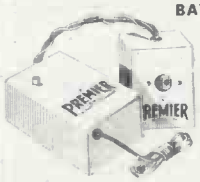
All this equipment is Brand New and in manufacturer's original sealed cartons. Full descriptive literature available.

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.

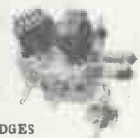
- High Q frame aerials.
- High sensitivity on both wavebands.
- Medium and long wave superhet circuit.
- Instruction book 1/6.
- Size only 8 × 8 × 4½in.
- Weight including batteries 5½lb.
- 4 valves of the economy type.



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 output of 3 watts. **£2.19.6** Plus 2/- 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 Turret 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.

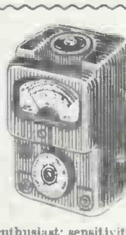
THE VICEROY QUALITY CRYSTAL MICROPHONE. A good-quality crystal Microphone for the discerning enthusiast, finished in polished steel with Muting Switch and detachable lead. Price 42/-, P.P. 1/6.

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 × 6½ × 5½in., in either walnut or ivory Bakelite or wood 1/- extra. Individual instruction books 1/- each, post free.

OUTSTANDING BARGAIN OFFER

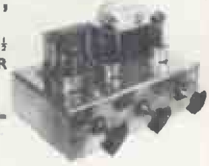


The Kapura Model UI Multimeter for only **59/6** (complete with Test Leads). P & P. 2/6.

A truly efficient Meter for the enthusiast: sensitivity 1,000 ohms per volt. A.C. and D.C. ranges (AC/DC) 0-10-50-250-500-1,000 v. D.C. current 0-100-500 m/a., 0-1 m/a. (at D.C. 0-10 v.). Resistance 1-2,000 ohms (centre 24 ohms). 100-200 K. (centre 2,400 ohms.). Size 5in. x 8in. x 2¼in. Brand new in manufacturers' original boxes.

THE 'MID-FI'

A NEW DESIGN 4½ WATT AMPLIFER 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 EF86, EL84, EZ80. Voltage adjustment for A.C. mains from 200/250 volt, 3 or 15 ohms impedance. Negative feedback. Size 7 × 5 × 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 1/6 P. & P. Batteries extra.

THE MODEL VT41 VALVE FILAMENT TESTER

Will instantly check the filaments of all Radio and T.V. Valves, Fuses and Dial Bulbs. Will also give an accurate circuit continuity test and also has built-in 7 and 9 valve straighteners. Size 5¾ × 3¾ × 1½in. with Battery, post paid.

PRICE **30/-**

CABY 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.

CABY 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**

R.S.C. A10 ULTRA LINEAR 30 WATT AMPLIFIER

HIGH FIDELITY PUSH-PULL UNIT EMPLOYING SIX VALVES. EF86, EF86, ECC38, 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, etc., can be simultaneously applied for mixing purposes. **AN OUTPUT SOCKET WITH PLUG IS INCLUDED FOR SUPPLY OF 300 v. 20 mA. and 6.3 v. 1.5 A. FOR A RADIO FEEDER UNIT.** Price in kit form with easy-to-follow wiring diagrams.

ONLY **11 gns.** Carr. 10/-. Or Factory built with 12 months' guarantee **£13/19/6. TERMS ON ASSEMBLED UNITS. DEPOSIT 31/9** and 9 monthly payments of **31/9.**

Cover as illustrated **18/9** extra. Type 807 output valves are used with High Quality Sectionally 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/cs. ± 12 D.B. to − 6 D.B. at 12,000 c/cs., hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish blue hammer. Overall size 12 × 9 × 9in. approx. Power consumption 150 watts. For A.C. mains 200-250 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 keen cash prices or on terms with amplifiers. **EXPORT ENQUIRIES INVITED.**

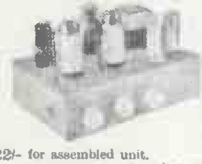
FULL RANGE OF LINEAR HIGH FIDELITY AMPLIFIERS ALWAYS IN STOCK.

GL3A MINIATURE 3 WATT GRAM AMPLIFIERS

For 200-250 v. 50 c.p.s. A.C. mains. Overall size only 11¾ × 2¾ × 2½in. Fitted Vol. and Tone Control with mains switch. Designed for use with any kind of single player or record changer unit. Output for 2-3 ohm speaker. Guaranteed 12 months. Only **59/6.**

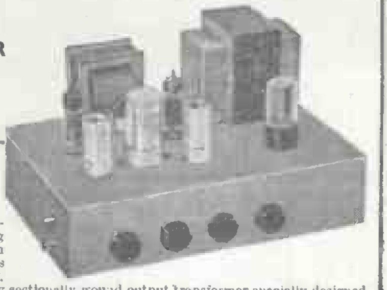
R.S.C. AS 4-5 WATT HIGH GAIN AMPLIFIER

A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high fidelity pick-up heads in addition to all other types of pick-ups and practically all 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. 26 mA. and L.T. of 6.3 v. 1.5 a. is available for the supply of a Radio Feeder Unit or Tape Deck pre-amplifier. For A.C. mains input of 200-250 v. 50 c/s. Output for 2-3 ohm speaker. Chassis is not alive. Kit is complete in every detail and includes fully punched chassis (with baseplate) with the blue hammer finish and point-to-point wiring diagrams and instructions. Exceptional value at only **£4/15/-** or assembled ready for use **25/-** extra, plus 3/6 carriage. Or Deposit **22/-** and five monthly payments of **22/-** for assembled unit.



HIGH FIDELITY 12-14 WATT AMPLIFIER TYPE A11

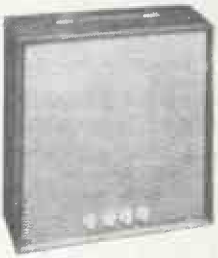
PUSH-PULL ULTRA LINEAR OUTPUT "BUILT-IN" TONE CONTROL PRE-AMP STAGES



Two input sockets with associated controls allow mixing of "mike" and gram. as in A.10 High sensitivity. Includes 5 valves: ECC83, ECC83, EL84, EL84, 5Y3. High Quality sectionally wound output transformer specially designed for Ultra Linear operation and reliable small condensers of current manufacture. **INDIVIDUAL CONTROLS FOR BASS AND TREBLE "Lift" and "Cut:"** Frequency response ± 3 D.B. 30-30,000 c/cs. Six negative feedback loops. Hum level 60 D.B. down. **ONLY 23 millivolts INPUT required for FULL OUTPUT.** Suitable for use with all makes and types of pick-ups and microphones. Comparable with the very best designs. For **STANDARD** or **LONG PLAYING RECORDS,** For **MUSICAL INSTRUMENTS** such as **STRING BASS, GUITARS,** etc. **OUTPUT SOCKET** with plug provides 300 v. 30 mA. and 6.3 v. 1.5 a. For supply of a **RADIO FEEDER UNIT.** Size approx.: 12.9-7in. For A.C. mains 200-250 v. 60 c/cs. Output for 3 and 15 ohm speakers. Kit is complete to last nut. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied. (Or factory built 45/- extra.) ONLY **8 Gns.** Carr. 10/-

If required louvred metal cover with 2 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 8in. l/speaker. Input sockets for Radio/Tape or Gram Pick-up and Mike /Instrument Pick-up. Handsome strongly made cabinet (size approx. 14 × 14 × 7in.). Finished in attractive and durable polychrome and fitted carrying handle.

£8.19.6 Carr.7/6. Or Deposit **£1** and nine monthly payments **£1.**

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 × 4in. elliptical for Treble. Cabinet is well made and finished as for Junior model. Size approx. 18 × 18 × 8in. **15 Gns.** Plus 10/- carr. **H.P. TERMS. DEPOSIT 34/9** and 9 monthly payments **34/9.** Both models for 200-250 v. A.C. mains.

COLLARO CONTINENTAL 4 SPEED DE LUXE 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 UA8. 4 speed T/O Pick-up with sapphire stylus **£6/19/6.** 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 l/speakers 15 ohms in Cabinet finished as above. Size 18 × 18 × 8in. **£7/19/6** or Deposit **17/9** and 9 monthly payments of **17/9.**

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. Primaries 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. 2½-3-3in.	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., c.t. 5 v. 3 a.	49/9
450-0-450 v. 250 mA., 6.3 v. 5 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
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350-0-350 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a.	18 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., c.t., 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	12 v. 1 a.	7/9
6.3 v. 2 a.	7/6	6.3 v. 3 a.	8/11
0-4-6.3 v. 2 a.	7/9	6.3 v. 6 a.	17/9
		12 v. 3 a. or 24 v. 1.5 a.	17/9

AUTO (Step Up/Step Down) TRANSFORMERS

50-80 watts 110-120 v./230-250 v.	11/9
150 watts 110-120 v./200-250 v.	27/9

OUTPUT TRANSFORMERS

Midget Battery Pentode 66:1 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., ot 3 or 15Ω fully shrouded	47 8

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

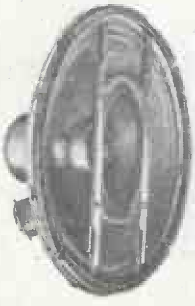
PARMEKO MAINS TRANSFORMERS. Fully shrouded.

500-0-500 v. 120 mA., 6.3 v. 4 a., 5 v. 3 a.	31/9

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 FIDELTY PICK-UPS. GP54 with HGP59/52 Cartridge. Turnover sapphire styli, 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 A11 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.**

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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.**

COSSOR OSCILLOSCOPE

A truly magnificent first-grade L.F. oscilloscope incorporating a hard valve time base, speeds 1–5–40 milliseconds, easily extended for a few shillings to 3 c.p.s. to 30 kc/s. speeds. Has high-class amplifier with fine and coarse gain controls. Brightness and focus controls, X & Y shifts. 115 v. and 230 v. mains power pack fully fuse protected. Employs 2¾in. tube ACR 10. Size 19in. x 7in. x 12in. FEW ONLY AT £10/10/-. Carr. 15/-.

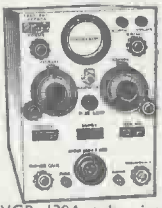
TELEPHONE PICK-UP COILS

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

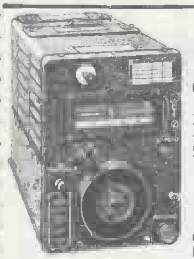


This basic scope represents one of the finest buys we have ever made. Contains Brilliance, Focus, Gain and 2-speed time base controls. Separate X plate terminals. Signal generator modulated at 2 freqs. over 150–255 Mc/s. Complete with 12 valves, VCR 139A tube, internal A.C. power pack and complete circuit 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. Specification:—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 10¼" x 9¾". 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 £6 post free.

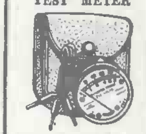
Batteries 20/- Per Set

Designed for reliable voice intercommunication 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. L.T. and 120 v. H.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 supersensitive microphone, 4ft. 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.

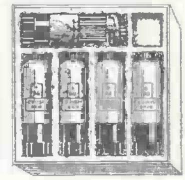
POCKET VOLT TEST METER



Two D.C. ranges: 0-250 v. and 0-25 v. Complete with test prods. and leather case. Very limited quantity. Only 12/6. P. & P. 1/6.

SPARE VALVE KIT

Here's a gift for all 38 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 tuneable ant. 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 bandspread 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 oscillates 470 kc/s above R.F. on first 3 bands, below on upper 6L7 mixer, 2-6K7 I.F.s, 6R7 det., A.V.C. 1st A.F. 6C5 pitch controllable oscillator, 6F6 and 5W4 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 MIKE 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 volts supply, etc. Brand new. Original cartons. Size 4in. x 7in. x 2in., 5/6 each. P. & P. 1/6, 3 for 15/-. P. & P. 3/6. 6 for 27/6. P. & P. 5/-.

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: 19¼ 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.

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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 £3 13/7.

TAPE AMPLIFIERS and PREAMPLIFIERS presented from MULLARD DESIGNS

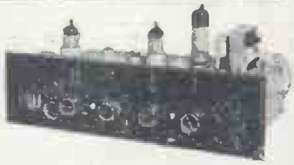
MULLARD TYPE "C" TAPE-PREAMPLIFIER ERASE UNIT

The "Hi-Fi" link to add full tape recording facilities to High Fidelity home installations. Incorporates FERROXCUBE POT CORE PUSH-PULL OSCILLATOR and 3-speed treble equalisation by FERROXCUBE POT CORE INDUCTOR. FOR WEARITE—COLLARO—TRUVOX or BRENELL TAPE DECKS. (STATE which when ordering.) Includes separate Power Supply Unit.

KIT OF PARTS.......... **£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 FERROXCUBE POT CORE INDUCTOR. FOR COLLARO-TRUVOX-BRENELL or WEARITE Tape Decks, (STATE which when ordering) has GILSEN Output Transformer. Includes separate Power Supply Unit.

KIT OF PARTS...... **£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**
H.P. Terms: Deposit £5/18/- and 12 months at £2/3/3.

(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**
H.P. Deposit £7 and 12 months £2/11/4.

(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**
H.P. Deposit £8 and 12 months £2/18/8.

(f) As above but the Type "C" supplied as complete Kit of Parts **£36.10.0**

(g) The BRENELL Mk. V Deck and the assembled Type "C" PRE-AMPLIFIER and Power Unit **£46.0.0**
H.P. Deposit £9/4/- and 12 months at £3/7/6.

(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**
H.P. Deposit £11/4/- and 12 monthly £4/2/1.

(Carriage and Insurance on above quotes 10/- extra.)

EACH OF ABOVE CAN BE SUPPLIED IN PORTABLE CASE FOR £5/10/- extra. THUS FORMING A COMPLETE PORTABLE PRE-AMPLIFIER. SEND FOR DETAILS.

(a) COMPLETE KIT to build the HF/TR3 Amplifier, together with the COLLARO "STUDIO" DECK **£25.10.0**

(b) As above but HF/TR3 ASSEMBLED and TESTED H.P. TERMS: Deposit £5/16/-, 12 months of £2/2/6. **£29.0.0**

(c) COMPLETE KIT to build the HF/TR3 together with the Mk. IV COLLARO "TRANSCRIPTOR" DECK **£30.15.0**
(£1 extra if we are required to wire up Deck switches.)

(d) As above but HF/TR3 ASSEMBLED and TESTED H.P. Terms: Deposit £7, 12 months at £2/10/5. **£34.10.0**
(£1 extra if we are to wire up Deck Switch Banks.)

(e) COMPLETE KIT to build the HF/TR3 together with the NEW TRUVOX Mk. VI TAPE DECK.......... **£36.0.0**

(f) As above but HF/TR3 ASSEMBLED and TESTED H.P. Terms: Deposit £7/18/-, 12 months of £2/17/11. **£39.10.0**

(g) COMPLETE KIT to build the HF/TR3 AMPLIFIER with the BRENELL Mk. V TAPE DECK **£41.10.0**

(h) As above but HF/TR3 ASSEMBLED and TESTED H.P. Terms: Deposit £9, 12 months of £3/6/-. **£45.0.0**

(i) 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 3¾in./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. Weighs only 22lb.

WE ALSO OFFER DECK and AMPLIFIER CONNECTED, TESTED, FOR IMMEDIATE OPERATION, 19 gns. H.P. Dep. £4 and 12 months £1/9/4. 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.
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INCORPORATES THE TRUVOX Mk. IV TAPE DECK ROLA/CELESTION 9 x 5in. LOUDSPEAKER and the Truvox Type "K" 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 3¾ and 7½in./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 £3/6/-. 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/-.

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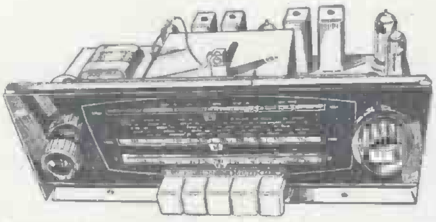
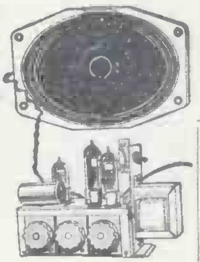
Telephone: FLEET STREET 5812/3/4

FULLY DESCRIPTIVE LEAFLETS ON ALL OF ABOVE ARE AVAILABLE—BUT PLEASE ENCLOSE S.A.E.

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 15 × 6¾ × 5½in. high. New manufacture. Dial 14½ × 4in. in gold and black. Pick-up Extension speaker, Ae., E., and Dipole sockets. Five "piano" push buttons —OFF, L.W., M.W., F.M. and Gram. Aligned and tested.
With all valves & O.P. Transformer, Tone-control fitted.
Covers 1,000-1,900 M., 200-500 M.; 88-99 Mc/s.
Valves EZ80 rect., ECH81, EF89, EABC80, EL84, ECC85. Speaker and Cabinet to fit chassis, 47/6.
10 × 6in. ELLIPTICAL SPEAKER, 20/- to purchasers of this chassis.
TERMS:—(Chassis £5/7/6 down inc. carr.—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 ECC83, EL84, EZ80, 3 Controls, volume, bass and treble. On/Off switch. Fully guaranteed. Chassis size 6½ × 3 × 2¼in.; with 7 × 4in. elliptical speaker or 6½in. round (Goodmans); state which.
ONLY 75/- (3/- P. & P.).

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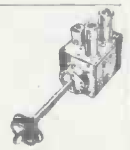
I.F. 34-38 Mc/s. requires valves PCF80 and PCC84. Removed from chassis but in working order.
7/6 (2/6 P. & P.) Knobs 2/6 extra.



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.

AUTOMATIC RECORD CHANGERS

all 4 speed; all with turnover cartridge, crystal—all 5/- extra carr.
Collaro Conquest—£7/10/0; B.S.R. UA8—£6/10/0; UA8 Stereo—£6/17/6; B.S.R. latest UA14—£7/10/0.

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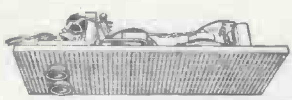

with 5in. SPEAKER On Fabric-covered Baffle 12½ × 6in. Mains and Output Transformers. EZ40 and EL41 Valves. Tone and Volume Controls. On/Off switch. Plenty of Volume. Fully Guaranteed. Two Knobs supplied. Ready to play. Useful for Stereo. ONLY 63/-, post 3/-.

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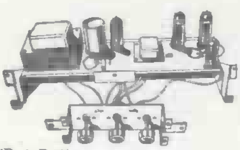
3/- P & P.



Brand new 200-240 A.C. mains. Bass, treble and vol. controls flying panel. With valves EZ80, ECC83 and 2-EL84 giving full 8 w. Chassis 12 × 3½ × 3½in. With o.p. trans. for 2-3 ohm speaker.

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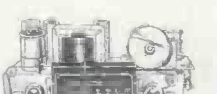
A Quality Tape Recorder. Valves EZ80, ECC83, ECL82, DM70 Record Level Indicator, Acos Crystal Mike. 850ft. Emitape. Extra spool. 3¾in./sec. B.S.R. Monardeck (1) Vol. (2) On/Off Tone. (3) Ext. L.S. (4) Monitor. (5) Radio Input. (6) Mike input. Fast forward and reverse controls. Cabinet size 14 × 11½ × 7in. 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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covering 88-95 Mc/s. Mullard permeability Tuner. Dims. 10½in. × 4½in. × 5in. high. ECC85; EF91; EF91 and 2 Diodes. Metal Rectifier. Mains trans. Fully wired and tested. Only £7/10/0 (4/- carr.). Room dipole 10/-. 300 ohm twin feeder 6d. yd.

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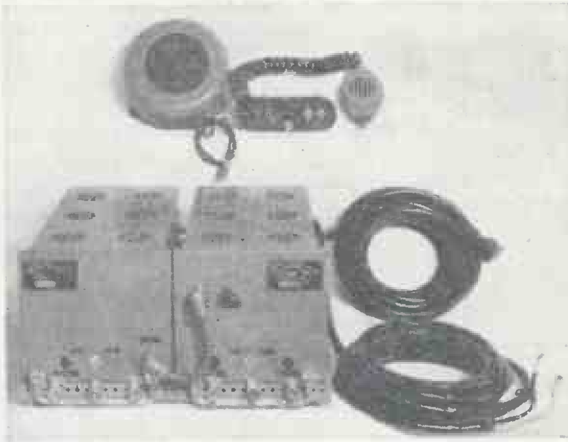

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Comprehensive range available from stock.

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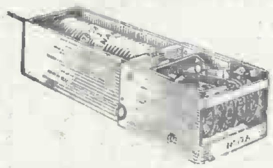

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2-6 v. D.C., **15/-** each, post 1/6.
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HIGH SPEED TYPE No. 100c., **35/-**, post 1/6.

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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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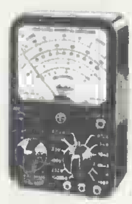
F.S.D.	Size	Type	Price
100 Microamp	3½in.	MC/FR	80/-
50 Microamp	2½in.	MC/FR	70/-
250 Microamp	2½in.	MC/PR	40/-
500 Microamp	2½in.	MC/FR	37/6
1 Milliamp	2½in.	MC/FR	35/-
2 Milliamp	2½in.	MC/FR	25/-
30 Milliamp	2½in.	MC/FR	15/-
100 Milliamp	2½in.	MC/FR	15/-
200 Milliamp	2½in.	MC/FR	15/-
1 Ampere	2½in.	MC/FR	35/-
3 Ampere	2½in.	MC/FR	35/-
5 Ampere	2½in.	MC/FR	35/-
10 Ampere	2½in.	MC/FR	35/-
20 Volts	2½in.	MC/FR	35/-
30 Volts	2½in.	MC/FR	35/-
40 Volts	2½in.	MC/FR	35/-
500 Microamp	2in.	MC/FR	25/-
1 Milliamp	2in.	MC/FR	27/6
5 Milliamp	2in.	MC/FR	27/6
10 Milliamp	2in.	MC/FR	27/6
20 Volts	2in.	MC/FR	27/6
30 Volts	2in.	MC/FR	27/6
40 Volts	2in.	MC/FR	27/6
15 Amps	2in.	MC/FR	12/6
3 Amps	2in.	MC/FS	27/6
5 Amps	2in.	MC/FS	27/6
30-0-30 Amps	2in.	MC/FR	15/6
50-0-50 Amps	2in.	MC/FS	12/6
500 Milliamps A.C.	3½in.	MI/FR	30/-
25 Amps D.C.	2½in.	MI/FR	7/6
50 Amps A.C.	4in.	MI/F or PR	65/-
300 Volts A.C.	2½in.	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 Round. Brand new in maker's box, **£10/10/-**, post 3/6.
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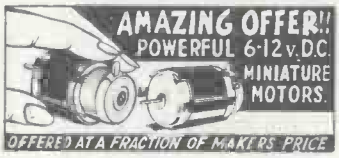
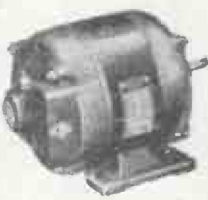
SLYDLOK FUSES. 15 amp. with rewirable cartridge fuse. Latest type G15 M.M. Complete with studs, nuts and washers, 3/6 each, post 6d. Also available 100 amp., type M.M. G 99, 14/6, post 1/-.

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.
TELEPHONE SET TYPE "K." The most compact telephone set available as the 4½in. flat battery and buzzer is built-in to the hand instrument. Ringing and speaking both ways on twin wire, instrument is complete with 5ft. flex. Easily hangs on the wall. Set of two instruments, **£5/10/-**, post 3/6.

RESISTORS EX STOCK, IN QUANTITY WIRE WOUND, HIGH STABILITY CARBON ETC., BEST MAKES AT LOWEST PRICES.



MINIATURE PRECISION MOTOR, 12 v. D.C. Size 1⅛ × 1¼in. 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/-**, cgc. 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 16in. × 8in. × 11in. (Two will make an ideal power supply for our 12 volt Rotary Converters.) Uncharged **£6/10/-** each, carriage 15/-. 24 volts 85 amperes. **£14** each, carriage 15/-.
NIFE BATTERIES. Nickel Cadmium. 6 volts 75 amps. Crated and connected. Brand new **£7/10/-**, cge. 15/-. Special inter-crate connector supplied free with two batteries.
15 AMP. BATTERY CHARGER (Westinghouse Type B.C.3) will charge three lead acid cells at 15 amps. Input 200/250 volts, 50 cycles A.C. Charging current is regulated by four-position switch and variable resistance for fine control. Fitted with 0/20 ammeter, rotary on/off switch and rewirable fuses. This first-class instrument at the bargain price of **£15**, carriage 15/-.



¼ H.P. CAPACITOR MOTORS

230/240 volts, 50 cycles, 1420 r.p.m. ⅝in. shaft, resilient mounting. Or with ½in. shaft on Standard foot mounting. Either type, **£5/10/-**, carriage 10/.
VACUUM PUMP AND COMPRESSOR. Edwards type., IV, ½in shaft, complete with flywheel, couplings, oil filter and union, **£6/10/-**, post 3/6.

SWITCHES ONE-HOLE FIXING

Single pole changeover, 3 amp. 250 volts, 1/6 ea., 12/- doz., **£37/10/-** per 1,000. Double pole on/off, 3 amps. 250 volts, with indicator plate, 3/- each. Double pole on/off, 10 amps. 250 volts, Painton with chrome pear dolly, 5/- each. Single pole on/off, rotary type by Lucas, suitable for car dashboard, with chrome front, 5/6 each. Postage on all switches 9d.

CERAMIC WAFER SWITCHES

1 Bank 1 pole	3-way	4/6 each	2 Bank 2 pole	4-way	10/6 each
1 Bank 1 pole	5-way	5/6 each	3 Bank 1 pole	11-way	18/- each
1 Bank 2 pole	2-way	5/6 each	3 Bank 6 pole	2-way	7/6 each
2 Bank 1 pole	11-way	12/6 each	3 Bank 4 pole	3-way	7/6 each
2 Bank 1 pole	12-way	7/6 each	4 Bank 2 pole	4-way	18/6 each

Others including Paxolin types: 1 Bank **3/6**, 2 Bank **5/-**, 3 Bank **6/6**, post 1/-. Full list available.

SELENIUM METAL RECTIFIERS

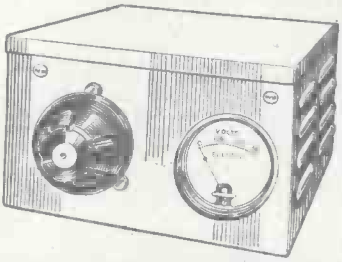
Charging Rectifiers. Full Wave Bridge.			
		12 Volts 6 Amps	22/6 each
12 Volts 1 Amp	8/6 each	24 Volts 1 Amp	13/- each
12 Volts 2 Amps	13/6 each	24 Volts 2 Amps	24/- each
12 Volts 3 Amps	16/6 each	24 Volts 3 Amps	28/- each
12 Volts 4 Amps	20/- each	24 Volts 4 Amps	36/- each

MAINS TRANSFORMERS to suit above rectifiers.

12 Volts 1 Amp	12/6 each	12 Volts 4 Amps CT107	29/6 each
12 Volts 2 Amps	24/- each CT109	12 Volts 4 Amps	25/- each
12 Volts 2 Amps	20/- each	24 Volts 6 Amps	50/- each

AUTO CABLE waterproof. Single. 14/36. **20/-** per 100 yds., post 1/6.
PUMP Electrically Driven by a 24 v. D.C. motor. Works efficiently on 12 v. Totally enclosed, self lubricating driven through 4 to 1 reduction gearbox delivering 60 g.p.h./30lb./sq. in. Inlet and outlet unions ⅜ BSP 37/6, post 2/6.
SIGNAL GENERATOR TYPE 52A. Input 230 volt 50 cycles, complete with leads, dummy antenna. Brand new in transit case. 6 to 52 Mc/s. inclusive in 4 bands with calibration charts. Coarse and fine attenuators. Int. and ext. mod. Output 0.5 volt to 100mv., impedance 70 and 100Ω, **£10**, carriage 10/-.
HEAVY DUTY SWITCHES, suitable for switchboards. Carries over 100 amps Consists of 2 S.P.C.O. coupled, **50/-** pr, post 3/-, or separately at **25/-**, post 3/-.
FANS INDUSTRIAL TYPE 230/240 volt A.C. Capacitor Motor, 16in. blades, adjustable louvres, filter. Ideal for paint shop. Brand new, **£20**, cge. 25/-.
AIR BLOWER powered by a 230 v. A.C. motor, 15in. fan. Volume of free air at max. r.p.m. is 1,250 cu. ft. per min. At maximum efficiency 900 cu. ft. per min. Brand new **£25**, carriage 30/-.
CATHODE-RAY TUBES. VCR 139A, 2½in. diam., **30/-**; 2AP1, 2in. diam., **25/-**. 5BP1, 5in. diam., **55/-**, all post 3/-.

L. WILKINSON (CROYDON) LTD.
19 LANSDOWNE 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.

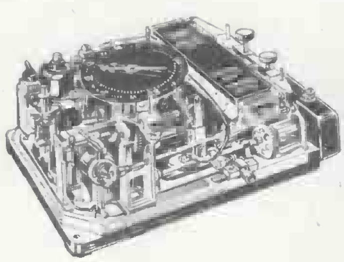
NEW WIRE WOUND RHEOSTAT ON CERAMIC. 58 ohm. 50 watt, complete with instrument knob. Price 8/6. P. & P. 1/6.

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.

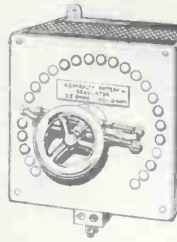
HEAVY DUTY L.T. TRANSFORMER. Very conservatively rated for continuous duty. New. In manufacturer's cases. Input 110–260 volt multi-tapped. 50 cycles, single phase. Output 28–29–30–31 volts at 21 ampere. Price £6/15/-, carriage 10/–.

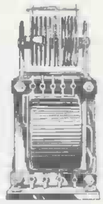
ENGINE SPEED INDICATOR. On the basis of a special ex-R.A.F. meter which we are able to supply and a few small linking parts which can be purchased anywhere, an inexpensive engine speed indicator can be made up which works on simple pulse counting principles in conjunction with the contact braker on the 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.



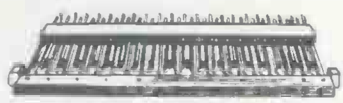


TWELVE PLATE F.W. BRIDGE CONNECTED RECTIFIER mounted on 200/250 volt A.C. input transformer. Output 36/40 volt D.C. at 1.2 amps. New, perfect. Price 16/6. P. & P. 3/6.

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.



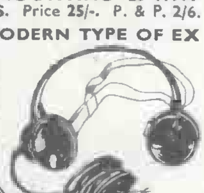
20-WAY STRIP containing standard Post Office telephone Jack Sockets, overall size 11 x 3½ x ¾in. New. Price 15/– each. P. & P. 1/6.

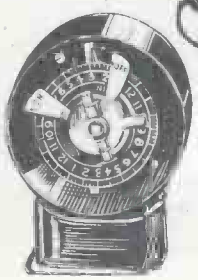
10-WAY STRIP standard Post Office telephone Jack Sockets, spacing allowing Igranic Jack Plugs. New. Price 10/-. P. & P. 1/6.

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.

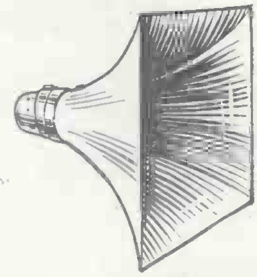
LATEST MOST MODERN TYPE OF EX W.D. MINIATURE HEADPHONES. As illustrated. Brand new, low impedance. Price: 10/6 plus P. & P. 1/6.





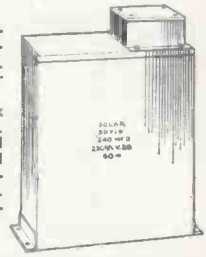
8-day clockwork TIME SWITCH. Contacts 2½ amp., 230 volt, 24 hour phase, ¼ hour divisions, allow setting for one make and one break to be made every 24 hours, complete with key. Used but guaranteed perfect. Price 27/6 each. P. & P. 2/–.

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/–.



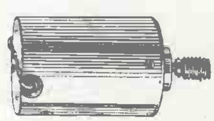
100 YARD DRUMS GLASS BRAIDED FLEX, 10/.010. New. 10/6 per coil. P. & P. 2/–.

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/–.

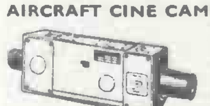
NEW UNCHARGED UNFILLED 12 VOLT ACCUMULATOR 9 ampere in unspillable plastic cases. Comprises 6 x 2 v. separate cells connected by terminal strips. 6 x 5½ x 4½in. over terminals. Price 19/-, plus P. & P. 2/9.

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. 1¾in. dia. New. Price 10/6 each. P. & P. 1/–.

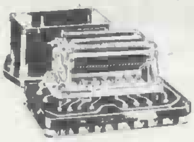
AIRCRAFT CINE CAMERA G45B Mk. III. Fully modified, fitted with f/3.5 triple anastigmat lens, takes 25ft. of 16mm. film, fitted with 24 v. motor. 16 exposures per sec. Brand new, original packing, £4/10/- each. P. & P. paid.



SERVICE TRADING COMPANY →

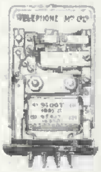
PACKARD BELL BRAND NEW RELAYS, 2 pole c.o. 6 volt 80 ohms. 7/6 each. P. & P. 6d.

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.

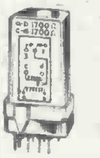


SOLENOID OPERATED MAGNETIC RELAY. Type 5CW/3945, 4 pole changeover, 10 A contacts 24 v. operation. Brand new 13/6. P. & P. 1/6.

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 way contact current 100 mA at 50 V A.C. or D.C. Size 1½ x ⅞ x ¾in. Price 22/6 each.

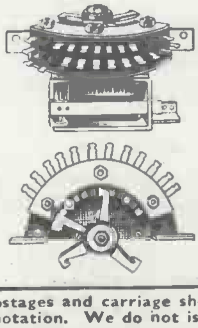
G.E.C. SEALED RELAY. Type M.1090. 180 ohms coil, 6/12 volt. 4 C/O. Brand new. 18/-. P. & P. 1/-.

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/-

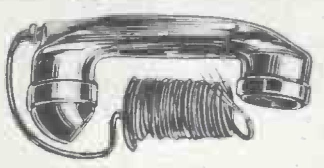
MINIATURE OPEN TYPE RELAY. 700 ohms coils. 24 volt. 2 C/O. Ex new equipment. Unused. 7/6. P. & P. 1/-.

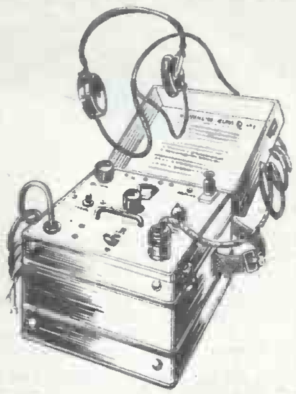
ROTARY RELAY. 12 volt. Heavy duty change-over contacts and one low current for external circuit, plus one break set. Price 7/6. P. & P. 1/6.



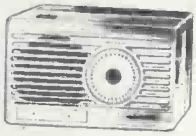
MINIATURE UNISELECTOR SWITCH. Two banks of ten plus home contacts one bank continuous of normal. 30 ohm coil for 24 volt operation. Brand new, manufacturer's packing. Price 22/6 each. P. & P. 2/6. As illustrated.

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.



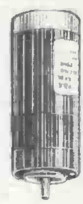


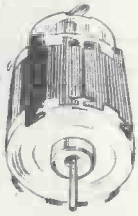
SOUND POWER TELEPHONE HANDSETS. Each couple connected by ordinary 2 core lighting flex will secure instant and reliable intercommunication. No batteries required. Price per set of 2 33/-, plus P.&P. 3/-.



MOULDED CABINET suitable for Transistor Set. Dual colour red/black. Size 5¼in. x 3½in. x 1¾in. 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 1⅛in. dia. x 2⅞in. long. Spindle .77in. long x .15575in. dia. Weight 4 oz. New. Price 25/-, plus 1/-. P. & P. Ideal for portable tape recording.

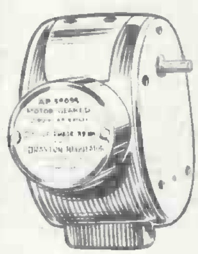


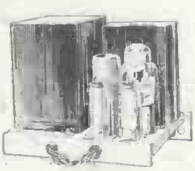


NEW IMPORTED EXTREMELY EFFICIENT MOTOR with tremendous power weight ratio. For 12 volt D.C. but very efficient on 6 volt. Three position switch. Weight 2.1 oz., size 1⅝in. x 1¼in. dia. Speed 7,000 r.p.m. Self lubricating. 15/-, plus 1/- P. & P.

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 5in. x 4in. x 5½in. Weight 4½ lb. Ex brand new equipment. Unused. Price £3/17/6. P. & P. 3/-.





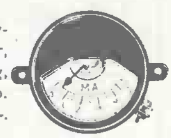
MAINS POWER SUPPLY UNITS. Potted and sealed transformer and choke by famous maker. Mounted on metal chassis 6¼ x 7½in., complete with 5Z4 rectifier valve and full smoothing. Input tapped 220–230–240 volts.
Output: 300 V. D.C. at 100 mA.
6.3 V. A.C. at 4.5 amp.
6.3 V. A.C. at 2 amp.
Rectifier supply 5 V. A.C. at 3 amp. Very conservatively rated. Price 47/6 plus P. & P. 6/6.

METERS GUARANTEED PERFECT

Charging Types	
2¼ amp. D.C. M.I. 2in. fl. rnd.	7/6
5 amp. D.C. M.I. 2½in. fl. rnd.	11/6
7½ amp. D.C. M.I. 3½in. proj. rnd.	12/6
9 amp. D.C. Hot Wire W.R. 2½in. 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. 4½in. 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. 2½in. fl. rnd.	22/-
400 v. A.C. M.I. 4½in. rnd.	35/-
90–180 v. A.C. M.I. 4½in. fl. iron	25/-
Milliammeters	
1 mA. M.C. 2½in. fl. rnd.	25/-
200 mA. M.C. 2½in. fl. rnd.	12/6
500 mA. M.C. 2½in. fl. rnd.	12/6
Microamp	
50 microamp., scaled 0-100, M.C. 2½in. 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, 1½in. 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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BARGAIN OFFERS *for the Constructor!*

TAPE RECORDER

Manufacturers' brand new, current production offer. Latest 5-valve circuit based on Mullard's famous design. Magic eye level indicator. Volume and tone controls. T.C.C. printed circuit already wired. Only power pack and controls to assemble and wire. Valves EF86, ECC83, EL84, EM84 & EZ80. A sensitive quality recorder at Special Unit Prices.

Wired printed circuit, power pack components, controls and knobs, etc. P. & P. 2/6 .... £5 15 0
Set of 5 valves, as above. P. & P. 1/- £2 5 0
B.S.R. Monardeck Tape Unit. P. & P. 4/6 .... £8 19 6
Bargain reduction for complete kit. Carr. 5/- £16 10 0
Attractive two-tone Cabinet and 9in. × 5in. speaker to house above at special discount price. P. & P. 4/6 .... £3 5 0
Illustrated Handbook with full details. Post free 2 6
Collaro Studio Tape Deck can be supplied with modified circuit as alternative for approx. (extra) £5 10 0

RECORD PLAYER BARGAINS Latest 4-speed models

NEW RELEASE by **E.M.I.**—4 speed Single Player Unit fitted with latest stereo and monaural xtal cartridge and dual sapphire styli. Auto stop and start. A fidelity unit and bargain buy at only **£6/19/6**, carr. & ins. 3/6.

SINGLE PLAYERS. B.S.R. (TU9) **90/-**; **COLLARO JUNIOR** studio P.U. **£4/10/-**. **AUTOCHANGERS.** B.S.R. (UA8). **£6/15/-**; **UA8 STEREO £7/10/-**. B.S.R. (UA14) latest model, **£7/19/6**. **COLLARO CONQUEST, £7/15/-**. **COLLARO CONTINENTAL £8/19/6**. Carr. 4/6.

BARGAINS GARRARD PLAYER UNITS

SINGLE PLAYERS
Model 4SP **£6/17/6**. Carr. 3/6.
Model TA Mk. 2, **£7/19/6**. Carr. 3/6.
Model 4HF, **£18**. Carr. 3/6.
AUTOCHANGERS. Model RC210, With plug-in GC8 Head. **10** gns. Carr. 4/6.
Transcription Auto Changer Model "A" just released **£18/19/6**. Carr. 5/-.

AUTO CHANGER RECORD PLAYER KIT

A.C. Supply 200v.-250v.
Attractive 2-tone cabinet—famous B.S.R. Monarch 4-speed, full mixer, 10-record gram unit. Full-fi xtal pick-up with dual styli for Std. L.P. recordings. 2-valve amplifier with quality neg. feedback circuit, volume and tone controls. Fully isolated from mains by double-wound transformer, NOT the live chassis type as often offered in cheap commercial models.

A recommended buy while stocks last!
Ready wired 2-valve Amplifier, complete with 6in. high flux speaker. **£3/19/6**, P. & P. 2/6
Two-tone Cabinet, 18in. × 13in. × 8in. **£3/3/-**, P. & P. 3/6
Collaro Conquest (160 v. model). **£5/19/6**, P. & P. 4/6
Complete 3 unit kit at special Autumn Bargain price. **£12/19/6**, Carr. 7/6
Simple assembly, a screwdriver only required.

TRANSISTORS BVA—1st Grade
New Reduced Prices

MAZDA		MULLARD		G.E.C.	
XA101	14/6	OC70	9/6	GET114	9/6
XA102	16/6	OC71	12/6	GET15	12/6
XA103	15/-	OCT72	15/-	Newmarket "Goldtop" V15/10P	15/-
XA104	18/-	OC44	23/6		
XB102	10/-	OC45	21/-		
XC101	10/6				

Germanium Diodes OA70 2/9; OA81 3/6; GEX34 4/-.

NEW BOXED VALVES ALL GUARANTEED

IT4	6/-	EABC80	8/6	EZ81	7/6
IR5, IS5	7/6	ECC84	9/6	MU14	9/-
3S4, 3V4	7/6	ECF80	9/6	PCC84	9/6
5Z4	9/-	ECL82	10/6	PCF80	9/6
6K7	5/-	ECL80	10/6	PCL83	12/6
6K8	7/6	EF80	8/-	PL81	12/6
6Q7	7/6	EF86	12/6	PL82	9/6
6V6	6/6	EF91	5/-	PL83	10/6
DAF96	9/-	EL41	9/6	PY80	7/6
DF96	9/-	EL84	8/6	PY81	9/6
DK96	9/-	EY51	9/6	PY82	7/6
DL96	9/-	EY86	10/-	U25	12/6

SPECIAL PRICE PER SET
1R5, 1T4, 1S5 or 3S4 or 3V4, **25/-**
DK96, DF96, DAF96, DL96, **35/-**
6K8, 6K7, 6Q7, 6V6, 5Z4 or 6X5, **32/6**.

JASON FM TUNER UNITS (87-105 Mcs)

Designer-approved kits of parts for these quality and highly popular tuners available as follows:—

STANDARD MODEL (FMT)—as previously extensively advertised. **COMPLETE KIT, 5** gns., P. & P. 2/6. Set of 4 spec. valves, **20/-**.

LATEST MODEL (FMT2)—attractively presented shelf mounting unit in enclosed Metal Cabinet with Built-in Power Supply. **COMPLETE KIT, £7**, P. & P. 3/6. Set of 5 spec. valves, **37/6**.

MODEL JTV2. Self-powered Switch Tuned B1-B2-B3 AM/FM Unit. 5 preset stations, AFC and AGC circuits. Complete Kit incl. ready-built and valved Turret Tuner, **£13/19/6**, P. & P. 3/6. 4 spec. valves, **32/6** extra.

MERCURY 2 similar to JTV2 less power pack. Complete Kit inc. ready-built turret unit **10** gns, P. & P. 2/6. 4 spec. valves **25/-**.

NEW JASON COMPREHENSIVE F.M. HANDBOOK, 2/6 post free. 48hr. Alignment Service, **7/6**, P. & P. 3/6.

MAINS TRANS. AND QUALITY OUTPUT TRANS. Mfd. in our own workshops to top grade spec. Fully interleaved and impregnated. Enquiries welcomed for small production runs, prototypes or individual jobs.

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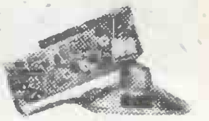

Famous manufacturer's 6 × 1 design based on Mullard and G.E.C. developments. Printed circuit, 6BVA 1st grade transistors, XA102, XA101 (2), OA70, XB103, XC101 (2) or equivalents. Quality components only supplied to ensure best results at attractive price.

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Printed Circuit, I.F.'s (3), Osc. coil, Driver Trans. and Ferrite rod aerial. P. & P. 1/6 **51/6**
Resistors, Condensers, Twin Gang and Volume control. P. & P. 1/6 .... **37/6**
7in. × 4in. Quality 35-ohm matching Speaker. P. & P. 1/6 .... **25/-**
Or
Complete Kit at special offer ONLY (post free) **£8/19.6**
Handbook and Circuit details, post free **2/-**

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1⅛in. dia. with **GOLD RING 1/-** ea. Ditto with **GOLD CENTRE 1/3** ea.
1in. dia. with **GOLD RINGS 9d.** ea. Ditto with **GOLD CENTRE 10d.** ea.
LARGE STOCKS—SEND YOUR ENQUIRIES.

CRT HTR ISOLATION TRANSFORMERS
New improved types, low capacity, small size and tag terminated, A.C. 200/250 v. Secondaries Nil, +25%, +50% **BOOST** for 2 v., 4 v., 6.3 v., 10.5 v., 12 v. or 13 v. tubes. **12/6** each. P. & P. 1/6.

COAX 80 ohm CABLE
Now only 6d. a yard.

High grade low loss Cellular Air Spaced Polythene—¼in. diam.—Famous mfr.

BARGAIN PRICES—SPECIAL LENGTHS
20 yds. .... **9/-** P. & P. 1/6
40 yds. .... **17/6** P. & P. 2/-
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RE-GUNNED TV TUBES
NEW REDUCED PRICES
PRICES REDUCED AGAIN—12 months' guarantee!

All tubes rebuilt with new heater, cathode and gun assembly—and now all tubes are completely rescreened and aluminised at no extra cost. Reconditioned virtually as new.

12in. **£5**, 14in. **£5/5/-**, 17in. **£5/10**, etc.

Exchange Allowance on old tube—12" 5/-, 14"/17" 7/6.

Carr. and ins. 10/-. Comprehensive stocks—quick delivery.

CONDENSERS—Silver Mica. All pref. values, 2 pf. to 1,000 pf., **6d.** each. Ditto ceramics **9d.** each. Tubulars 450 v. T.C.C. etc., .001 mfd.-.01 and .1/350v., 9d. each. .02-.1/500v., **1/-** each. .25 Hunts **1/6**. .5 T.C.C. **1/9**. .001 6kv. **5/6**. .001 20 kv. **9/6**.

RESISTORS—FULL RANGE 10 ohms—10 megohms 20%. ¼ w. and ½ w. 3d., ¾ w. 5d. (Midget type modern rating), 1 w. **6d.**, 2 w. **9d.**, 10% Hi-Stab, ¼ w., **5d.**, ½ w., **7d.**, 5% ½ w., **9d.**, 1% **HI-STAB**, ½ w., **1/6** (10-100 ohms **2/-**).

PRE-SET W/W POTS. T/V type, 25 ohms—50K ohms **3/-**. 50K—2 Meg. (Carbon **3/-**).

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TYGAN FRET (Contemporary pat.), 12 × 12in. **2/-**; 12 × 18in., **3/-**; 12 × 24in. **4/-**; etc.

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TUBULAR		CAN TYPES	
25/25 v. 50/12 v.	1/9	8 + 8/450 v.	4/6
50/50 v. 100/25v.	2/-	32 + 32/275 v.	4/6
8/450 v. 4/350 v.	2/3	50 + 50/350 v.	6/6
16 + 16/450 v.	5/6	60 + 250/275 v.	12/6
32 + 32/450 v.	6/6	100 + 200/275v.	12/6

Comprehensive range in stock.

VOLUME CONTROLS—5K—2 Megohms. **ALL LONG SPINDLES, MIDGET TYPE,** 1⅛in. diam. Guar. 1 yr. **LOG** or **LIN.** Ratios less Sw., **3/-**. D.P. Sw., **4/6**. Twin gang stereo controls less Sw., **6/6**. D.P. Sw. **8/-**.

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EMI 1st grade. Brand new sealed boxes.

Standard		Long Play	
3in., 175ft.	7/-	250ft.	9/-
5in., 600ft.	19/-	850ft.	25/-
5¾in., 850ft.	25/-	1,200ft.	31/6
7in., 1,200ft.	31/5	1,800ft.	45/-

SPARE REELS: Emitape, new, boxed. 3in. **3/-**, 5in. **3/8**, 5¾in. **4/-**, 7in. **4/6**.

SPECIAL PURCHASE. Famous manufacturers, 1st grade tape, in sealed white boxes.

Standard		Long Play	
5in., 600ft.	15/-	850ft.	19/6
5¾in., 850ft.	16/6	1,200ft.	22/6
7in., 1,200ft.	21/-	1,800ft.	32/6

Plastic Tape Reels, special offer. Manufacturers' surplus. 3in. **2/9**, 5in. **3/-**, 5¾in. **3/3**, 7in. **3/6**.

7 VALVE AM/FM RADIOGRAM CHASSIS

Valve Line-up: ECC85, ECH81, EF89, EABC80, EL84, EM81, EZ80.

Three Waveband and Switched Gram positions Med. 200-500 m., Long 1,000-2,000 m., VHF/FM 88-95 Mc/s. Philips Continental Tuning insert with permeability tuning on FM and combined AM/FM IF transformers, 460 Kc/s. and 10.7 Mc/s. Dust core tuning all coils. Latest circuitry including AVC and Neg. Feedback. Three watt output. Sensitivity and reproduction of a very high standard. Chassis size 13½ × 6¼in. Height 7½in. Edge Illuminated glass dial 11½ × 3¾in. Vertical pointer. Horizontal station names. Gold on brown background. A.C. 200/250 v. operation Magic-eye tuning

***Aligned and tested ready for use* £13 . 10 . 0** *Carr. & Ins. 5/-*

Complete with 4 Knobs—walnut or ivory to choice. Indoor FM aerial **3/6** extra.
10in. Rola (Heavy Duty) 30/-
8in. Goodmans special cone 21/6

Post & Pkg. 1/6.

As previously announced fresh supplies are now being received, but we regret some slight delay may be experienced in fulfilling orders for this popular item.

ONLY A FEW ITEMS ARE LISTED FROM OUR COMPREHENSIVE STOCK. WRITE NOW FOR FULL BARGAIN LISTS, 3d.

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Recommended Buy
12 v. operation Med. & Long Waves

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Complete Kit Bargain Price **£12.19.6** P&P 3/6.

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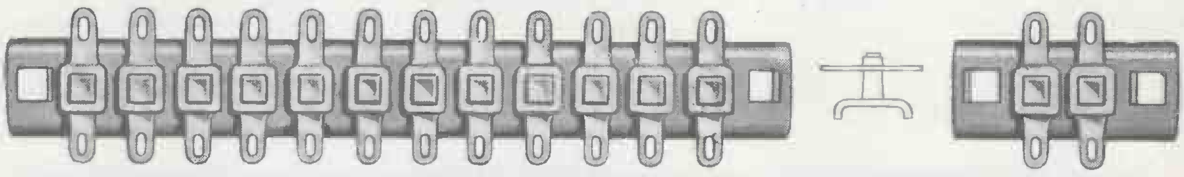

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- *ILLUSTRATIONS SHOW ACTUAL SIZE OF COMPONENTS*
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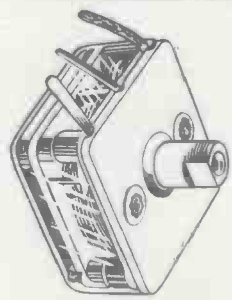
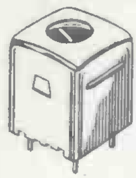


2 GANGED TUNING CONDENSER

With built-in trimmers. Enclosed in polystyrene casing. Size 1in. sq. x $\frac{7}{16}$in. dp. **17/6**

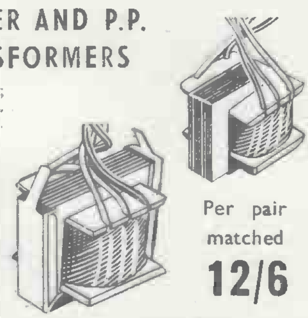


I.F. TRANSFORMERS AND OSCILLATOR COIL

Set of 3 I.F.s and coil. Can size $\frac{1}{2}$in. high x $\frac{3}{8}$in. sq. Individually checked before leaving factory. Very high Q, better than 125. Complete set...... **21/-**

MATCHED DRIVER AND P.P. OUTPUT TRANSFORMERS

Driver—size $\frac{7}{16}$ x $\frac{7}{16}$ x $\frac{3}{8}$in.; Output—size $\frac{11}{16}$ x $\frac{9}{16}$ x $\frac{5}{8}$in. 300in. mW. Coloured leads.



Per pair matched **12/6**

HIGH GAUSS MINIATURE LOUDSPEAKER

$1\frac{3}{8}$in. diam. x $\frac{3}{4}$in. deep M.C. speaker. 9,500 Gauss ensures remarkably good quality. **25/-**

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6 kV/A AUTO TRANSFORMER. 250/110 v. 50 cycles (fully tapped primary and secondary). Capable of 25% over actual rating. Brand new and unused, £15. Carr. 20/-.

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S.T.C. SELENIUM METAL RECTIFIERS. F/B, FOR BATTERY CHARGERS, ETC. NEW AND FULLY GUARANTEED

6 or 12 v. 1 amp.,	5/–;	24 v. 1 amp.	10/–;
12 v. 2 amp.	7/6;	24 v. 2 amp.	15/–;
12 v. 2½ amp.	12/6;	24 v. 3 amp.	25/–;
12 v. 4 amp.	15/–;	24 v. 4 amp.	30/–;
12 v. 6 amp.	20/–;	24 v. 6 amp.	32/6;
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Mint condition. Freq. coverage 540 Kc/s., 32 Mc/s. £50. Carr. 20/-. Also L.F.'s available. Freq. coverage 75-550 Kc/s., 1.5-30 Mc/s. £45. Carr. 20/-.

HEAVY DUTY REGULATING RESISTOR. 0.25 ohm. 200 amps. Wheel control, £4/15/-. Carr. 10/-.

CONDENSER, oil filled. 240 mfd. 230 v. A.C. or 600 v. D.C. Made in U.S.A. Size 21in. x 5¾in. x 9in. Brand new in original cases. £7/10/-. Carr. 5/-

DAKERS "SELHURST" SPEAKERS ALL BRAND NEW.

SPECIAL NEW ARRIVAL! "15in. VISCOUNT AUDITORIUM." 15 ohms at 400 c.p.s., 35 watts. Flux density 18,000. **OUR PRICE £15.**

"12in. P.M." 15 ohms, 15 watts, 30-14,000 c.p.s. Our price £4/10/-.

"AUDITORIUM" 12in., 15 ohms, 12 watts. 35-16,000 c.p.s. Flux density 14,500. OUR PRICE £7/10/-.

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Full descriptive specification available. S.A.E.

NEW AND UNUSED ACCUMULATORS.
12 v. 100 A.H. (75 actual) £4/10/-. Carr. 8/6.
12 v. 25 A.H. 45/-. Carr. 7/6.
2 v. 100 A.H. 75 actual (ex-Govt.) with carrying handle. Size 6½ x 6½ x 3½in., 15/- each. Carr. 3/6.
2 v. 16 A.H., as above. 7½ x 4 x 2in., 5/- each. P. & P. 2/-. 6 for 24/-. P. & P. 10/-.

QUALITY TEST EQUIPMENT

WAVEMETER CLASS D. Freq. band 1,900 Kc/s. to 8,000 Kc/s. (158-37.5 metres) in two ranges, 1,900 Kc/s.-4,000 Kc/s. also 4,000 Kc/s.-8,000 Kc/s. Supply 6 v. D.C. input. Complete with twin crystal, spare vibrator, headphones, original instruction manual and transit case. As new, £5/5/-.

VALVE TESTER TYPE 4. 200/230 v. A.C. input. Ex-Govt., in good condition, with descriptive book containing circuit diagram of instrument and how to test valves from 1.4 v. to 40 v. With valve holders for Brit. 4, 5, 7 pin and Octal, U.S., 5 and 7 pin, 1/Octal, side contact large Brit., 4 and 9 pin. Acorn and diode. Housed in wooden case with hinged lid. Few only, to clear at £5/19/6. Carr. 7/6.

BRIDGE MEGGERS. Evershed and Vignoles Series 2 in perfect condition. 250 v. £22. Carr. paid. Leather case available at 20/- extra.

MARCONI SIGNAL GENERATOR. TYPE TF511-F/1. Covering 10-18 Mc/s., 33-58 Mc/s., 150-300 Mc/s. In very good condition. Complete with full technical data and instructions. Unrepeatable at only £12/10/-. Carr. 20/-.

BRAND NEW CRYSTAL CALIBRATOR No. 10 (Battery powered 1.4 v. valves.) Complete with full working instructions, circuit diagram, carrying haversack, connecting lead and spare valves. Frequency range: 1.5 to 10 Mc/s. (nominal) but can actually be used up to 30 Mc/s. Weight 5lb. Size 7 x 7½ x 4in. As fully described in "Practical Wireless," Dec. issue, pages 691-693. ONLY £4/17/6. P. & P. 2/6.

MULLARD BRIDGE. Type GM. 4140/1. Mains operated from 100-250 v. A.C. Will test resistances from 0.1 ohm to 10 megohms and condensers from 10pf. to 10mfd. Good condition and complete with instruction booklet. £6/19/6. P. & P. 2/6.

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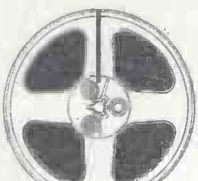
G.P.O. RACKS
19in. Heavy duty all steel Standard drilling.
5ft. 6in. angle uprights.
£3/10/-. Carr. 15/-.
6ft. channel uprights. **£5.** Carr. 15/-.

SUPER QUALITY RECORDING TAPES



600ft. 5in.	12/6
1,200ft. 5¾in.	19/6
1,200ft. 7in.	19/–
1,800ft. 7in.	29/–
2,400ft. 7in.	48/–

Many other types available including "Scotch," "EMI" etc. Send s.a.e. for our huge money saving literature on Tapes and Accessories.

COLLARO "STUDIO" TAPE TRANSCRIPTORS. Brand new in original cartons. 3 speeds. 1⅞, 3¾, 7½ i.p.s. 3 motors, digital counter, etc. Complete with 7in. spool, instructions and fixings. A.C. 200/250 v. operation. **SPECIAL PRICE £12.** Carr. 7/6.

MOVING COIL MICROPHONE. Complete with 12ft. screened lead. £2/10/-.

CRYSTAL MICROPHONE. Complete with 12ft. screened lead. £2/2/-. Both are recommended for professional use.

MICROPHONE STAND (Telescopic). With heavy 8in. dome black crackle base, chromium stand with screw top extends to 5ft. 4in. Will fit above mikes, etc., £2/10/-. Carr. 3/6.

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ROTARY CONVERTER. 24 v. D.C. input. 230 v. A.C. output at 250 watts. Complete with starting switch. New and unused. £15. Carr. 7/6.

ROTARY CONVERTER. 24 v. D.C. to 230 v. A.C. 50 cycles, 150 watts. Brand new and unused. £8/10/-. Carr. 7/6. Ditto, 100 watts £6/9/6. Carr. 7/6.

ROTARY CONVERTER. Ex-Govt. 12 v. D.C. input, 230 v. A.C. output 50 cycles at 135 watts. Complete in carrying case with lid. Voltage control; sliding resistance, mains switch and 0-300 v. A.C. flush meter. In good condition. £10. Carr. 10/-.

Motor only, without case, etc. Brand new and unused. £8/10/-. Carr. 5/-.

12 VOLT D.C. AMPLIFIER (Parmeko, Ardente). As new, 15 watt output with 2-EL35's in push-pull. Mike and gram. inputs, tapped output transformer, £9/19/6. Carr. 10/6.
(Suitable hand microphone for above 30/- extra.)

EXPONENTIAL HORNS by famous manufacturer of P.A. systems, 15 watt, 25in. long; 20in. square flare, 15 ohms speech coil. (Tannoy.) Good condition, £7/10/-. Carr. 10/-.

NEW P.M. HEAVY DUTY SPEAKERS

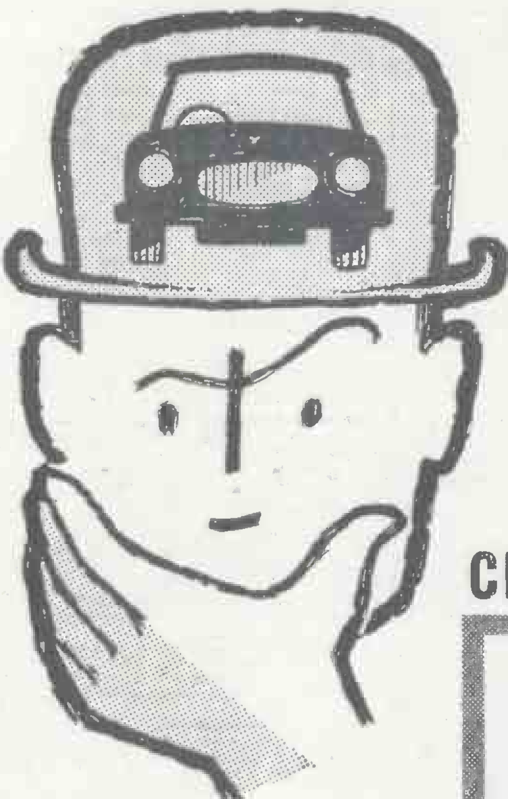
Complete with O.P. trans., in all steel blue-grey double grilled cabinet. 6in. 30/-. 8in. 32/6. Carr. 3/6 ea.

RE-ENTRANT LOUD HAILERS (Ex-Govt.). Heavy duty 20 watts all-metal 15 ohms. Diameter 15in., length 15in. (approx.). Good cond. £6/10/-. Carr. 10/-. Ditto. Brand new, £8. Carr. 10/-.

HEAVY DUTY ALL STEEL TRIPOD STANDS (as illus., Sept. issue). Adjustable every 6in. to approx. 9ft. 6in. when fully extended. (Folds up to only 4ft. 6in. for storage.) Suitable for outdoor speakers, public address systems, flood-lighting, etc. OUR PRICE £3/10/-. Carr. 5/-. (Ideal stand for the above loud hailer.)

TRUVOX/TANNOY LOUD-HAILERS. With 180 ohm line transformer and condenser. Impedance 7½ ohms, handling capacity 8 watts. Complete in slope-front wooden case. Brand new 25/-. Carr. 4/6.

AIRBORNE TRANSMITTER RECEIVER TYPE 1986. A mobile 10-channel crystal controlled V.H.F. Tx/Rx. covering 124.5/156 Mc/s. I.F. bandwidth 23 kc/s. Complete (less external attachments) in metal case, with all valves and 24 v. rotary power unit. Used but in first-class condition. ONLY £8/10/-. Carr. paid. Also, complete with control box and all necessary connecting leads, £12. Carr. paid.



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—then this is your issue!

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The Autocar

All good 'Labs' use Radiospares

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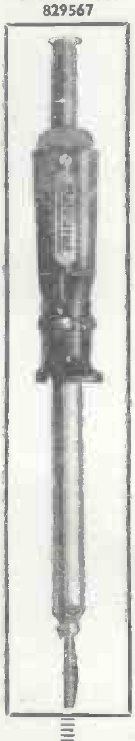

CECO

Vari-stat

THERMOSTATIC SOLDERING IRON

INSTRUMENT SIZE

The thermostatic soldering iron heats up very quickly (1¼ mins.) but never overheats or corrodes, and weighs only 4½ oz. The thermostat is easily adjusted to suit the grade of solder and keeps the temperature to within 15°C. It incorporates a micro-switch giving snap action on-off with minimum electrical interference. All parts of the instrument are interchangeable.

LIST PRICE 79/6

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AMPLIFIERS, STEREO AND MONAURAL, BY:
VERDIK, QUAD, ARMSTRONG, LEAK, ROGERS, W.B., DULCI, etc.

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GOODMAN, W.B., PLESSEY, T.S.L., WHARFEDALE, G.E.C., LORENZ, etc.

BUY NOW!!!

Definitely the last of the remaining stocks of the

AVANTIC BEAM-ECHO HI-FI EQUIPMENT

SP21 STEREO PRE-AMP CONTROL UNIT

A twin channel pre-amp control unit, has 6 inputs for each channel **INPUT SENSITIVITY** for 250 M/V or 1.5 V output **TUNER** 100 and 250 M/V. **Tape** 100 M/V flats 250 M/V. **PICK-UP** 5 and 50 M/V. Frequency response: 40 c/s. to 15 Kc/s. **TAPE OUTPUT 50** M/V., continuously variable bass and treble controls, loudness control and stereo balance control. Power required 6.3 V. at 1.3 amp. A.C. 350 v. at 5 M/A D.C. Will match any hi-fi amplifier. Manufacturer's price £28/10/-. **OUR PRICE** now £16/19/6. Carr. and packing 10/-.

AVANTIC PL6-21

High quality monaural power amplifier and pre-amp. compactly housed and suitable for shelf mounting or cabinet. Two EL84 three EF86, one ECC83, one EZ81. 30 watts peak; speaker impedance, 4, 8 or 16 ohms. Sensitivity: 4M/V on pickup, 3M/V on tape, 100M/V on tuner, Intermod. distortion 1% at 10W equivalent Sinewave output. Maker's price £28/10/-. **OUR PRICE** 19 gns. Post and packing 10/-.

AVANTIC SPA11 Stereo Amplifier

A twin channel amplifier and pre-amp., push-pull output, 10W peak each channel, rumble filter speaker impedance 4, 8 and 16 ohms. Tape output: 100M/V. Continuously variable treble and bass, stereo balance control. Input sensitivity: for 7W, 100M/V radio; 100M/V tape; 650M/V pickup. Manufacturer's price 28 gns. **OUR PRICE** 19 gns. Post and packing 10/-.

STEP 11 stereo pick up pre-amp. unit £4/14/6. P. & P. 2/6.

STEP 21 stereo tape pre-amp., £4/14/6. P. & P. 2/6.

ANOTHER SPECIAL HI-FI STEREO OFFER

The famous SP21 Stereo Pre-Amp. Control Unit specification as above with 2-10 watt ultra linear power amplifiers, push-pull output, **sensitivity** 40 M/V for 10 watts output. **Harmonic Distortion** for 10 watts at 1,000 CPS 1%. **Hum,** 75DB at 10W., output impedances 3, 8 and 16 ohms Spare power for tuner 250V at 35M/A and 6.3V at 2 amps. voltage 200/250 A.C. Valves EF86, ECC83, 2-EL84, EZ81, the 3 units making a high quality stereo combination. **OUR PRICE** £39/17/6. Carr. and packing 30/-.

A FEW ONLY STEREO REPRODUCERS

3 watts each channel. Using 2-ECL82, 1-EZ80, separate balance and tone controls, volume on/off switch, designed for crystal pickup, two tone cabinet 13 x 11 x 5in., blue and grey or beige and grey, 2 matching corner speaker cabinets 10in. wide, 20in. high, 7in. deep, with 8 x 5in. Hi-Flux speakers complete, price £13/19/6. Carr. and packing 7/6.

DECCA PORTABLE AMPLIFIER. As supplied in famous DECCAMATIC III. Complete with small cream knobs. Full range tone and volume controls. Employs ECL82 valve, Metal Rectifier. Size 3 x 3½ x 8¾in. Only 59/6 plus 2/6 P. & P.

SPECIAL CELESTION 8 x 6in. elliptical high flux loudspeaker to fit. 25/- plus 1/- P. & P.

THE NEW JASON *range for* CONSTRUCTORS

JTV2 Tuner completely assembled ready for use £25/7/-.

FMT1 FM Tuner. In kit form for cabinet mounting. One of the most popular tuners. Up to 60 miles normal range. Including valves £6/15/-. Power pack kit £2/14/9.

FMT2. In kit form with free standing case with power pack. Including valves £8/19/6.

FMT3. Variable tuner 88-108 mc/s. Variable AFC control dual limiters, approx. 80 mile range, including valves £10/19/6.

JTV2 Tuner self powered switched tuner for FM and TV sound. Both BBC and ITA as required, including valves £13/19/6.

MERCURY II switched FM/TV sound tuner in kit form for building into cabinet, including valves, £10/10/-. Power pack kit, £2/14/9.

EVEREST 6 s/het transistor portable, p/pull output, high quality speaker, matched transistors, neatly designed case, aerial input for use in car, complete kit £13/19/9.

EVEREST 7 transistor s/het portable, p/pull output, high quality speaker, extra RF stage, neatly designed cabinet, aerial input for use in car, all components complete £15/18/9.

2/6 post and pkg. on all the above, S.A.E. for details.

THE POPULAR "VERDIK QUALITY TEN"

10 watt push-pull ultra linear Hi-Fi amplifier with pre-amp. control unit. **Amplifier Valves** EF86, ECC83, 2-EL84, EZ81. Sensitivity 40M/V for 10 watts, output impedance, 4, 8 and 16 ohms, spare supply for tuner, 200/250V, A.C. **Pre-Amp.** valve EF86. **INPUTS** Radio 100M/V, tape 100M/V. **GRAM LP** 50M/V, 78 60M/V, **MIC** 10M/V, output socket for recording direct to tape recorder **Treble** between −10DB and +12DB at 10KCS. **BASS** between −10DB and +12DB at 20C/S. Finished in grey, green, stone enamel, control panel in gold lettering, fully guaranteed. Original price 20 gns. **OUR PRICE** £14/19/6. P. & P. 7/6.

ANOTHER MANUFACTURERS SURPLUS BARGAIN

The Cossor 4 valve s/het portable. L. and med. wave bands. 5in. speaker, using Ever Ready B126 90VHT, 7AD35 1½ VLT batt. Attractive 2-tone finish in red and grey. Dimensions 9 x 8½ x 4¼in. Original price 15 gns. Our price £7/19/6 plus P. & P. 3/-. Batts. 10/- extra.

Also suitable mains unit. Original price 63/-. **OUR PRICE** 45/- plus 2/- P. & P.

PORTABLE BATTERY ELIMINATOR MADE BY COSSOR

Housed in two containers which are to replace AD35 and B126 Batteries. 45/-, plus 2/- P. & P. only suitable for use with Dk96 Series valves. Also suitable for Above Portable Set.

"STOP PRESS"

A WOW OF A TRANSISTOR SET

Our New 6 Transistor S/Het Receiver using Guaranteed First Grade Transistors, Medium and Long Wave Bands, Printed Circuit, High Q Ferrite Rod Aerial, using "2¼in." Hi Flux Speaker, Provision for Car Aerial, will fit your pocket. Simple to follow Instructions. Only £8/19/6, Post 3/6.

Another version as above, using 7 x 4 Hi-Flux Speaker in a Wooden Cabinet as a Table Model. Only £9/19/6, Post 3/6.

TAPE DECK OFFERS

B.S.R. MONARDECK, uses 5¾ tape spools, twin track. Single speed, 3¾ I.P.S. at £8/19/6. Post & Pkg. 5/-.

Suitable tape amplifier for B.S.R. deck. Completely assembled, 3 watt o/put, valve line up ECC83, ECL82, EL84, metal rectifier, magic eye level indicator, frequency response 60 c/s—9,000 c/s. inputs for radio, gram, mic., superimpose, ideal for monitoring impedance, tone control, volume control. Dimensions 11½in. x 4in. deep x 6¼in. high. **OUR PRICE** £9/15/-. P. & P. 3/6.

FOR TAPE RECORDER CONSTRUCTORS

The new Collaro studio tape deck, using 3 motors, 3 speeds at 1⅞, 3¾ and 7½ I.P.S., will take 7in. spools, push button controls, £12/19/6, 5/- post and pkg. Well designed tape recorder amplifier (not a kit) for the studio deck, incorporating Mic/Gram/Radio inputs, ext. loudspeaker, superimposing switch, with matching knobs, separately mounted mains transformer. Frequency response 60-10K/c 3DB at 7.5 I.P.S., magic eye level indicator. Using ECC83, ECL82 and EM85 and metal rectifier. Assembly instructions. The 2 units, £25/10/- complete. Crating and insurance, 17/6. Suitable Acos mic. 40 for above, 25/-.

A repeat of our previous popular offer. The Collaro Mk. IV tape transcriptor tape deck, £17/10/-, crating and carr. 11/6.

The new **ARMSTRONG TAPE RE-AMPLIFIER PABO-3,** high quality unit, can be used with any Hi-Fi equipment will operate most tape decks, equalisation for tape speeds 3¾, 7½, 15 I.P.S., can play prerecorded tapes. Valve line up, EF86, ECC82, EM81 and OA81 diode, freq. response 30-17,000 C.P.S., at 15 I.P.S. 40-13,000 C.P.S. at 7½ I.P.S. Mic/radio/gram inputs. 20 watts maximum power required, attractive control panel. Complete 16 gns. 3/6 post & pkg. Power pack £2/19/6 extra.

BRAND NEW TV TUBES CHEAPER THAN REBUILDS

All brand new in famous maker's cartons. (1) 17in. rectangular aluminized 6.3 HRTS. .3 A. current; max. anode voltage 16 kV. Usual price £17/5/-. **OUR PRICE** £7/19/6. Crating and carr. 15/-.

(2) 14in. rectangular Tube, 6.3 heaters; .3 amp. current; max. anode 14 kV.; ion trap; external conducting coating; B12A base. £7/9/6. Crating and carriage 12/6.

(3) Ferranti 9in. Tube, round white fluorescence, 4 v. heater, max. anode voltage 7 kV. **OUR PRICE** 25/-. Crating and carr. 11/6.

A SNIP FOR CONSTRUCTORS

Build the Labgear Audio Output meter. Two ranges—25 milliwatts to 1 watt, 1 watt to 100 watts. Accuracy 5%. Input impedance 3, 15 and 600 ohms. Printed circuit. All components including 0-1MA moving coil meter and silver hammertone enamel case. Kit complete with instructions 59/6, post and pkg. 1/6.

FOR STEREO ENTHUSIASTS

The new Eagle Stereo balancer audio watt meter will balance your stereo speaker system, compensating for variation of acoustics and unmatched speakers. Ideal for monitoring audio outputs, suitable as a recording level indicator for your tape recorder, an improved advantage over "magic eyes." The AUDIO WATT METER assists in aligning AM and FM receiver, meter is calibrated for 0-30 watts for both 3 and 15 impedances. Cabinet in grey. 7 Gns. P.&P.2/6

DOUBLE BEAM 'SCOPE'

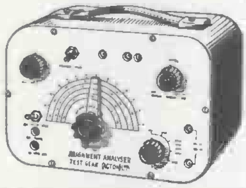
For D.C. & A.C. APPLICATIONS

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 "SCOPE" will appeal particularly to Service 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 Waveform available for external use; pulse/output available for checking T.V. Line O/P Transformers, etc.; Provision for external X 1/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

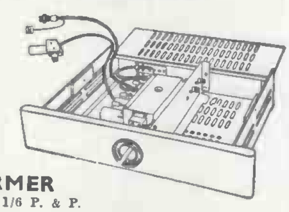
A.C. MAINS, 200/250 volts. Provides:— "WOBBULATOR" (SWEPT FREQUENCY) OPERATION, for FM/TV alignment linear frequency sweep up to 12 Mc/s. From 400 Kc/s—80 Mc/s. CAPACITANCE MEASUREMENT. Two ranges provided 0-60 pf. and 0-120 pf. SPECIAL FACILITY enables true resonant frequency of any tuned circuit I.F. 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.



CHANNEL TUNER

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: 12½in. x 10¾in. Space required above baseboard 4¾in., below baseboard 2½in. Fitted with Ful-Fi turnover crystal head. £6/19/6. 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 cuircuit diagram. **29/6** Plus 4/- P. & P.
As Above, but for 625 lines **£2.10** Plus 4/- P. & P.

FOCUS MAGNET suitable for the above (state tube), 10/-. 2/6 P. & P.

MAINS TRANSFORMERS

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.

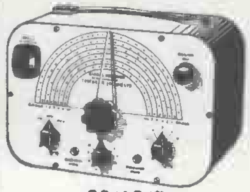
100% AUDIO TRANSISTORS

5/- each.

BATTERY RECORD PLAYER AND AMPLIFIER

Incorporating 45 r.p.m. "Starr" motor, "Acos" crystal pick-up, 3 transistor push-pull amplifier complete with transistors. Output 500 milliwatts, 49/6 plus 3/6 P. & P.

SIGNAL GENERATOR

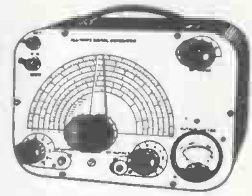


£6/19/6

Covering 100 Kc/s.-100 Mc/s. on fundamentals and 100 Mc/s. to 200 Mc/s. on harmonics. Metal case 10in. x 6½in. x 5¼in., grey hammer finish. Incorporating three miniature valves and Metal Rectifier. A.C. Mains 200/250 v. Internal Modulation of 400 c.p.s. to a depth of 30%. Modulated or unmodulated R.F., output continuously variable 100 millivolts C.W. and mod. switch, variable A.F. output. Incorporating magic-eye as output indicator. Accuracy plus or minus 2%.
Or 25/- deposit and 6 monthly payments of 21/6. Post & Packing 5/- extra.

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.—56 Mc/s., 24 Mc/s., 84 Mc/s. Metal case 10in. x 6½in. x 4½in. Size of scale 6½in. x 3½in. 2 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**

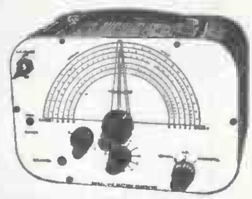


Or 25/- deposit and 4 monthly payments £1/6. P. & P. 5/- extra.

SIGNAL & PATTERN GENERATOR

£6/19/6 P. & P. 5/-.

Or 25/- deposit. P. & P. 5/- and 6 monthly payments of 21/6.
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.



CYLDON TURRET TELETUNER

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.

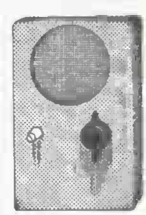
3-TRANSISTOR POCKET RADIO

INCORPORATING MINIATURE SPEAKER
Plus GERMANIUM DIODE and PRINTED CIRCUIT

Size 3¼ x 4 x ⅞in.

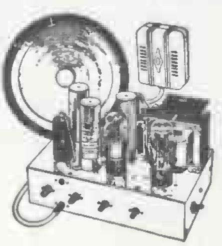
Incorporating Ferrite Rod Aerial. Two Surface Barrier Transistors and one Audio. Tunable over medium and long waves.

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%

8 WATT PUSH-PULL AMPLIFIER



COMPLETE WITH CRYSTAL MIKE AND 8in. LOUDSPEAKER

A.C. mains 200/250 v. Size 10½in. x 6½in. x 2½in. Incorporating 6 valves. H.F. pen, 2 triodes, 2 output pens., 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 lift. 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 15 ohm speech coils. For use with Std. or L.P. records, musical instruments such as Guitars, etc.

£4.19.6 Plus P. & P. 7/6.

Or £1 deposit, plus P. & P. 7/6 and 4 monthly payments of 23/-.

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.

RADIO AND T.V. COMPONENTS (ACTON) LTD.

23A, ACTON HIGH STREET, LONDON, W.3

GOODS NOT DESPATCHED OUTSIDE U.K. ALL ENQUIRIES S.A.E. TERMS OF BUSINESS C.W.O.

VALVES

Brand new, individually checked and guaranteed

Valve	Price
AC/DD	2/6
AC/HL	5/-
AC/P	4/6
AC/P1	2/6
AC5PENDD	4/-
AC6/PEN	5/-
AC/SP3	4/6
ACV4	7/-
AL60	6/-
AP4	4/-
AR8	5/-
ARDD5	2/-
ARP3	3/-
ARP4	3/6
ARP12	2/9
ARP21	5/6
ARP24	3/6
ARP34	4/6
ARTH2	7/-
ATP4	2/9
ATP7	5/6
AU1	5/-
AU4	5/-
AW3	4/-
AZ	8/-
BL63	6/-
BT45	40/-
BT9B	40/-
CY31	11/6
D1	3/-
D41	3/3
D42	4/-
D77	4/3
DA30	12/6
DAF86	8/-
DAF91	6/-
DD41	4/-
DET5	15/-
DET19	2/6
DET20	2/6
DF70	9/-
DF72	7/6
DF91	3/3
DF96	8/-
DH76	4/9
DK96	8/-
DL72	7/6
DL71	8/-
DL92	6/-
DL94	6/-
DL96	8/-
DX25	9/-
E1232	5/6
E1323	25/-
E1524	6/6
EA50	1/6
EAC91	4/6
EB34	1/6
EB91	3/9
EBC33	5/-
EBC91	3/9
EC52	3/-
ECC32	4/-
ECC81	5/6
ECC82	6/6
ECC83	7/-
ECC84	7/-
ECC85	8/-
ECC91	4/-
ECL80	8/-
EF22	7/3
EF32	5/-
EF36	3/6
EF37A	8/-
EF39	4/3
EF50	2/6
EF54	3/3
EF55	6/-
EF70	4/-
EF80	5/6
EF85	6/10
EF86	9/-
EF89	7/9
EF91	3/6
EF92	4/6
EF95	7/6
EL32	3/9
EL33	8/-
EL35	8/3
EL41	8/3
EL42	9/-
EL81	6/-
EL84	7/6
EL85	10/-
EL91	7/6
ESU208	8/-
EY51	8/-
EY86	8/-
EY91	3/6
EZ40	7/-
EZ80	6/6
FW4/500	6/6
GZ32	9/-
H30	5/-
H63	3/6
HL2K	3/-
HL23	6/-
HL23DD	8/-
HL41	4/-
HL41DD	8/-
KBC32	5/-
KF35	5/-
KT2	4/-
KT31	8/-
KT32	8/-
KT33c	4/9
KT44	6/3
KT63	6/-
KT66	11/-
KT241	9/-
KTW62	7/6
KTW63	6/6
L30	4/-
MH4	3/6
MHL4	3/9
ML4	4/-
ML6	6/-
MPT42	5/3
MS/PEN	6/-
N34	8/-
NR15A	3/-
NT37 (4033A)	10/-
OD3	5/-
P2	4/-
P41	4/-
P61	2/3
PCC84	7/-
PCC85	8/-
PCF80	7/-
PCF82	8/-
PCL82	8/6
PEN25	4/6
PEN46	5/-
PEN65	6/6
PEN220A	3/-
PENDD/1360	9/6
PG7/5	15/-
PL36	10/6
PL81	9/-
PL82	8/-
PL83	7/9
PM4DX	3/-
PM24A	4/-
PT25H	7/6
PX4	12/-
PY81	7/-
PY82	8/-
QP21	6/-
QP25	5/3
QP230	7/6
QQVO6-40	45/-
QS75/20	6/9
QS95/10	6/9
QS108/45	6/9
QS150/15	6/9
R3	8/-
R10	12/6
REL21	25/-
RK34	2/6
RL37	3/6
SP2	4/-
SP4B	7/6
SP13C	4/6
SP41	2/6
SP61	2/-
SP210	4/-
STV280/40	12/-
SU2150A	4/9
T41	7/-
TH41	9/-
VP22	11/-
TP25	15/-
TT11	3/-
U17	5/-
U18	6/6
U27	8/-
U52	5/-
UL41	7/-
UL84	7/6
UL85	7/-
UU9	5/6
V2D33B	8/-
V226	5/-
V248A	4/-
VP23	3/6
VP41	5/6
VR78	4/-
VR99	8/-
VR105/30	7/6
VR150/30	7/3
VS110	4/-
VT25	8/-
VU39	6/-
VU111	3/3
VU120	3/-
VU133A	3/-
W21 4 pin	7/-
W31	7/-
Y63	5/-
Y66	8/-
Z31	6/-
1A3	3/-
1A5GT	5/-
1C5GT	7/6
1D8GT	6/-
1E7GT	7/6
1L4	3/6
1LD5	3/6
1R5	6/-
1S5	5/9
1T4	4/-
2A3	8/-
2A5	8/-
2A6	7/-
2C34	2/6
2D4A	4/-
2X2	4/-
3A4	5/-
3B24	3/-
3E29 (829B)	60/-
3Q5GT	9/-
3V4	7/3
4A1	4/6
4D1	2/6
5U4G	5/-
5Y3GT	6/-
5Z3	8/6
5Z4G	8/-
6A6	5/-
6AB7	4/-
6AC7	3/-
6AG5	3/6
6AG7	6/-
6AJ7	4/3
6AK6	7/6
6AK7	8/-
6AM5	5/-
6AM6	6/3
6AT6	5/-
6B8	5/6
6B8G	2/6
6C4	3/6
6C5	6/-
6C6G	4/3
6C8G	5/-
6E5	5/-
6F5G	5/6
6F6G	4/-
6F8G	6/6
6F12	4/6
6F32	6/-
6G6G	3/-
6HA7	4/3
6H6M	2/-
6H6GT	1/9
6J5	3/6
6J7	7/6
6J5G	3/-
6J6	4/3
6K6GT	6/6
6K7G	2/3
6K7GT	4/9
6K8G	5/9
6K8GT	8/3
6K8M	8/6
6L5G	6/-
6L6	9/-
6L6G	6/6
6L34	4/6
6N7G	5/9
6N7GT	6/-
6Q7G	6/-
6R7G	6/-
6R7GT	8/-
6SA7	6/-
6SC7G	5/6
6SC7GT	6/-
6SG7	5/-
6SH7	4/6
6SJ7	6/9
6SF5	8/-
6SJ7G	5/9
6SK7	5/3
6SL7GT	6/6
6SN7GT	4/6
6SQ7	6/-
6SR7	6/6
6SS7	6/-
6SV6G	5/6
6V6GT	6/-
6X4	5/-
6X5GT	6/-
6Y6G	80/-
6Z4	5/6
7Q7	7/-
7Z4	6/-
8D2	2/6
9D2	3/-
10Y	8/6
12A6	5/-
12AH7	7/-
12AT7	5/6
12AU7	6/-
12AX7	7/-
12CB	3/-
12E1	22/6
12H6	2/-
12K8GT	9/-
12J5GT	3/6
12SA7	7/6
12SC7	4/6
12SG7	6/6
12SH7	3/-
12SJ7	6/-
12SK7	4/-
12SL7	7/-
12SN7	8/-
12SR7	6/-
15D2	6/-
15E	8/-
15R	7/6
21B6	9/-
30	5/-
35T	30/-
35Z4	5/-
35Z4GT	7/-
39/44	6/-
53A	3/-
58	6/-
59	6/-
71A	4/6
75	8/-
77	6/-
78	7/-
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83V	12/-
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85A1	12/-
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210LF	3/-
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801	6/-
803	22/6
805	30/-
807 AMER.	7/-
807BR	5/-
808	8/-
813	67/6
815	40/-
816	30/-
829A	30/-
832	15/-
843	7/4
901	15/-
866A	12/6
872A	35/-
930	8/-
954	2/-
956	2/-
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1629	4/6
6120	4/-
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8013A	25/-
8020	6/-
9001	4/6
9003	5/6
9004	4/-
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Tube	Price
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5CP1	42/6
5FP7	45/-
7BP7	40/-
12DP7	60/-
VCR97	15/-
VCRX258 (with scanning coil)	45/-
VCR138	30/-
VCJ39A	35/-

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Tube	Price
GST6	12/6
931A	50/-

Special Valves:

Valve	Price
2J31	45/-
3A/1481	45/-
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Complete V.F.O. Unit from TX53. Freq. range in 4 switched bands from 1.2-17.5 Mc/s. Two V.T. 501s as oscillator and buffer, 807 as driver, two S130s as voltage stabilizers. Output sufficient to drive two 813s in parallel. Slow motion drive directly calibrated in Mc/s. Provision for crystal control, metering of buffer and driver stage. Power requirements 400 v. and 6.3 v. D.C. Can also be used as low power transmitter. In excellent condition with valves and circuit diagram, **£6.** P. & P. 15/-.

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TCS RECEIVERS made by Collins of U.S.A., in fully guaranteed working condition. 1.5-12 Mc/s. Line-up: 12S7 (1), 12SQ7 (1), 12A6 (2), 12SK7 (3), power requirements 12 volts L.T., 225 volts H.T. **£11/10/-**, carriage 12/6.

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The Contessa is the professional looking set with the professional performance.

Study these brilliant features which cannot be found in any other kit—

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- Power of 410 milliwatts from the single-ended push-pull final stage.
- Specially designed aerial matching coil for use in a CAR.
- Only first grade fully-guaranteed Mazda matched transistors and diodes are used.
- Double tuned IF transformers for maximum gain and knife-edged selectivity.
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- Battery lasts 4 months with normal usage.
- Book supplied with detailed assembly instructions, diagrams and circuitry.
- Anyone can build this set—everything supplied—just a soldering iron required.

Inclusive price for all associated components, cabinet and battery, complete in every detail.
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Small, non-inductive, insulated, high-grade Capacitors, 150 v. Wkg., .15 Mfd. 5% 10d. .22 Mfd. 10% 9d. 2 Mfd. 10% 1/10. 250 v. Wkg., .068 Mfd. 9d. .1 Mfd. 1/1. .22 Mfd. 2% 1/4. 1 Mfd. 10% 1/7. 500 v. Wkg., 680 pF., 1,000 pF., 1,500 pF., 2,200 pF., 7d. each. 3,300 pF., 8d. 5,000 pF., 6,800 pF., .01 Mfd. 9d. each. 8,200 pF., 1/-. .022 Mfd., .03 Mfd. 10d. each. .047 Mfd. 2% .05 Mfd. 11d. each. .1 Mfd. 11d. .25 Mfd. 1/7. .5 Mfd. 1/3. 750 v. Wkg., 470 pF., 10% 820pF., 1,500 pF., 2,000 pF., 8d. each. 5,000 pF., 6,800 pF., 9d. each. .022 Mfd. 10d. 1,000 v. Wkg., 1,500 pF., 9d. 6,800 pF., 10d. .01 Mfd., 1,500 v. 1/-. .12 Mfd., .15 Mfd., 1/1 each.

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4 pin UX, 7d. 7 pin Brit. Pax. 3d. 7 pin Brit. Porc. 4d. Int. Octal Pax. 3d. Internat. Octal McMurdo 6d. Mazda Octal Pax. 3d. Loctals Amp. 6d. B7G Pax. 6d. B7G P.T.F.E. 8d. B7G Cer. with saddle and valve retaining spring 1/-. B8A Pax. 4d. B8A Amp. 6d. B8A Cer. 8d. B9A Pax. 6d. B9A Cer. 10d. B9A Cer. with saddle and valve retaining spring 1/-. B9A Cer. skirted 1/-. B9A Cans. 6d. B9A printed circuit 10d. B7G Valve cans 6d. EY86 High Voltage holders 1/3.

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Twin Gang .0005 Mfd. 2⅝in. × 2in. × 1⅞in. Spindle 5/16in. 4/-.
Min. Twin Gang .0005 Mfd. 2⅜in. × 1½in. × 1⅜in. Spindle ¼in. 5/6, with Trimmers 6/6, and Dust cover 7/6.
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DISC CERAMIC CONDENSERS 500 v. Wkg.

8.2 pF., 470 pF., 500 pF., .001 Mfd., .002 Mfd., .0025 Mfd., .003 Mfd., .005 Mfd. 6d. each. .01 Mfd. 9d.

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SUB MINIATURE ELECTROLYTIC CONDENSERS

Most with sleeves, all at 2/3 each.
.1 Mfd. 50 v., .25 Mfd. 15 v., .5 Mfd. 50 v., 1 Mfd. 25 v., 2 Mfd., 6 v., 15 v., 70 v., 4 Mfd., 12 v. 5 Mfd. 25 v., 6 Mfd. 3 v., 6 v., 8 Mfd. 3 v., 6 v., 15 v., 30 v., 10 Mfd. 6 v., 25 v., 16 Mfd. 3 v., 6 v., 30 v. 20 Mfd. 15 v., 25 Mfd. 12 v., 30 Mfd. 3 v., 6 v., 12 v., 50 Mfd. 6 v.

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Set of 3 I.F. Transformers 470 Kc/s plus Oscillator coil.
As specified for Mazda Circuits 23/6 complete.
As specified for Mullard Circuits 23/6 complete.
WTC oscillator Coils for Jackson or Plessey Gang 4/6 each. WTC 470 kc/s. I.F. Transformers 4/- each, 7/6 pair.

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5K., 50K., 220K., 330K., 1M, 2/-. 5M with switch, 4/6. 5K., 1/6, 500K preset 1/-. 1M Transistor Pots 2/-. 5K Transistor Pots 1/6.

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(Diameter ¾in. SHORT SPINDLES) 2/6 each.
100Ω, 250Ω, 400Ω, 470Ω, 500Ω. 1k., 2k., 2.5k., 5k., 10k., 15k, 25k., 50k., 100k., 250k., 500k., 1M.

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Knurled knob and 6BA fixing holes. Diam. 1in. 100Ω 5K. 10K., 25K., 50K., 100K., 200K., 250K., 500K., 1.5M., 2M., 1/3 each. 25K wirewound 1/6.

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1 pole 10 way. 1 pole 12 way. 2 pole 2 way. 2 pole 3 way. 2 pole 4 way. 2 pole 5 way. 2 pole 6 way. 3 pole 3 way. 3 pole 4 way. 4 pole 3 way.

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Moulded Tracks. Diam. 1⅛in., 2½in. spindles. 5K., 10K., 25K. Linear only. 50K., 100K., 250K., 500K., 1M., 2M. Log or Linear, less switch, 2/6 each. With switch 4/6.

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Crocodile clips 4d. Coax. Plugs and Sockets 2/2 per pair. Condenser clips 1in., 1⅛in., 1⅜in., and 1¾in. 6d. ea. Parmeko Smoothing Choke 8/9 Hy. 100 mA. 6/6. 500 pF. 15 Kv. moulded Condensers 2/6. WX2s Westector 6d. Transistor Twin gang condensers 387+166 pF. ex. equip. 4/6. Vibrator Hash Chokes 1/-. Ext. Loudspeaker panel with switch 1/-. OA81 3/-.

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Tapped to give the following specifications: Pri. 440–400 v. S.P. Sec. **220** v. or 110 v. 600 watts.
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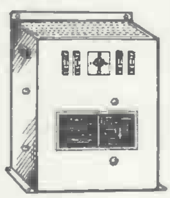

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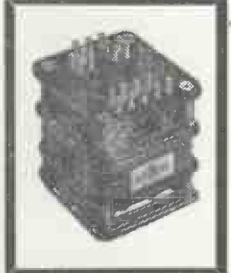

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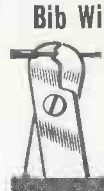

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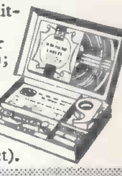

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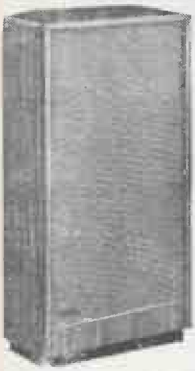

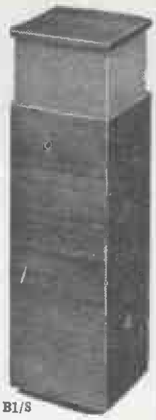

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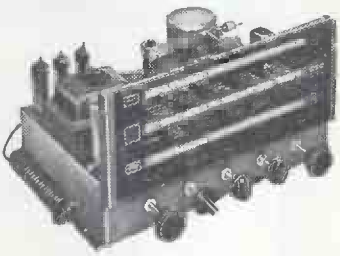

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APPLICANTS should state on the application form the grade of appointment for which they wish to be considered and indicate any of the locations at which they are not prepared to accept an appointment. [9451

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 fully career details and salary required to—Technical Director, Shandon Scientific Co., Ltd., 6, Cromwell 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—£1,300 (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 these 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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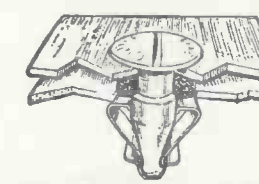

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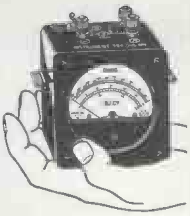

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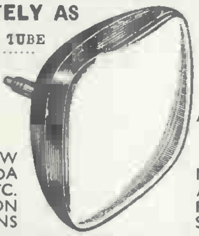

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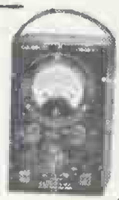

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