

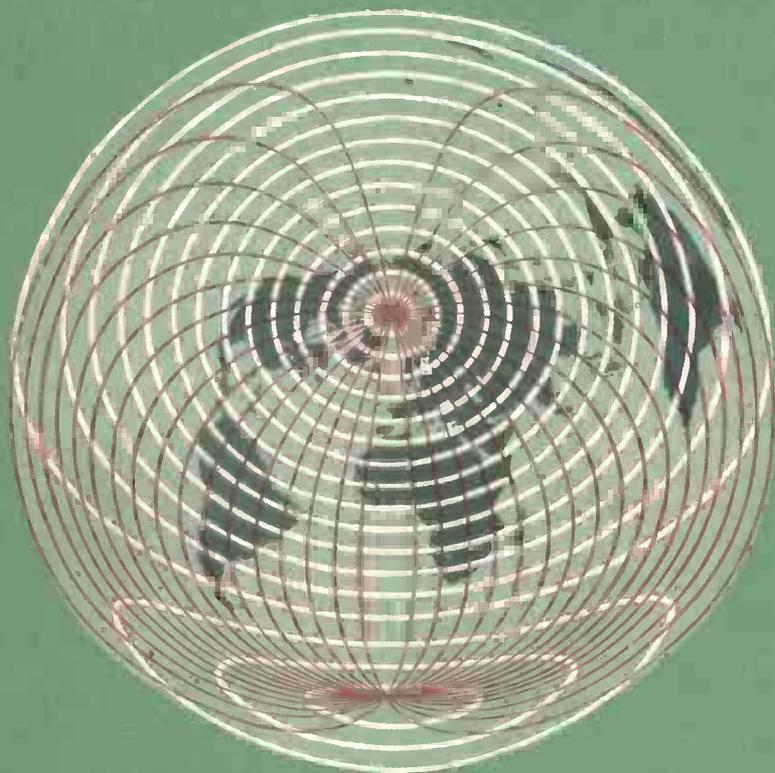
JULY 1960

TWO SHILLINGS

Wireless World

ELECTRONICS

Radio · Television



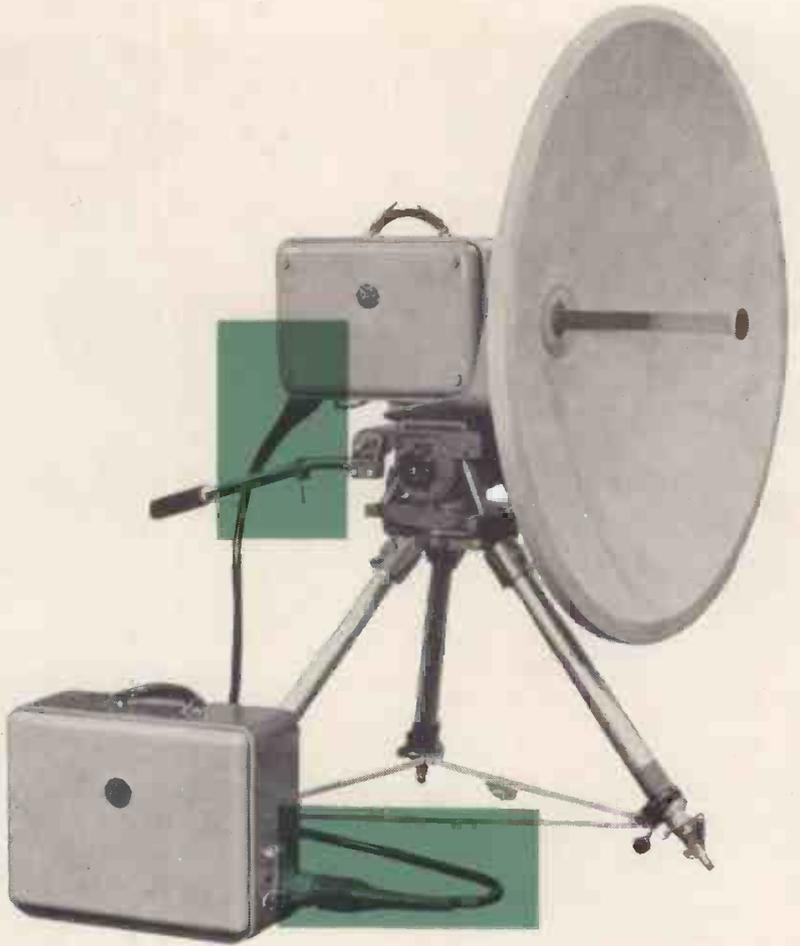
FIFTIETH YEAR OF PUBLICATION

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Wireless World

ELECTRONICS, RADIO, TELEVISION

JULY 1960

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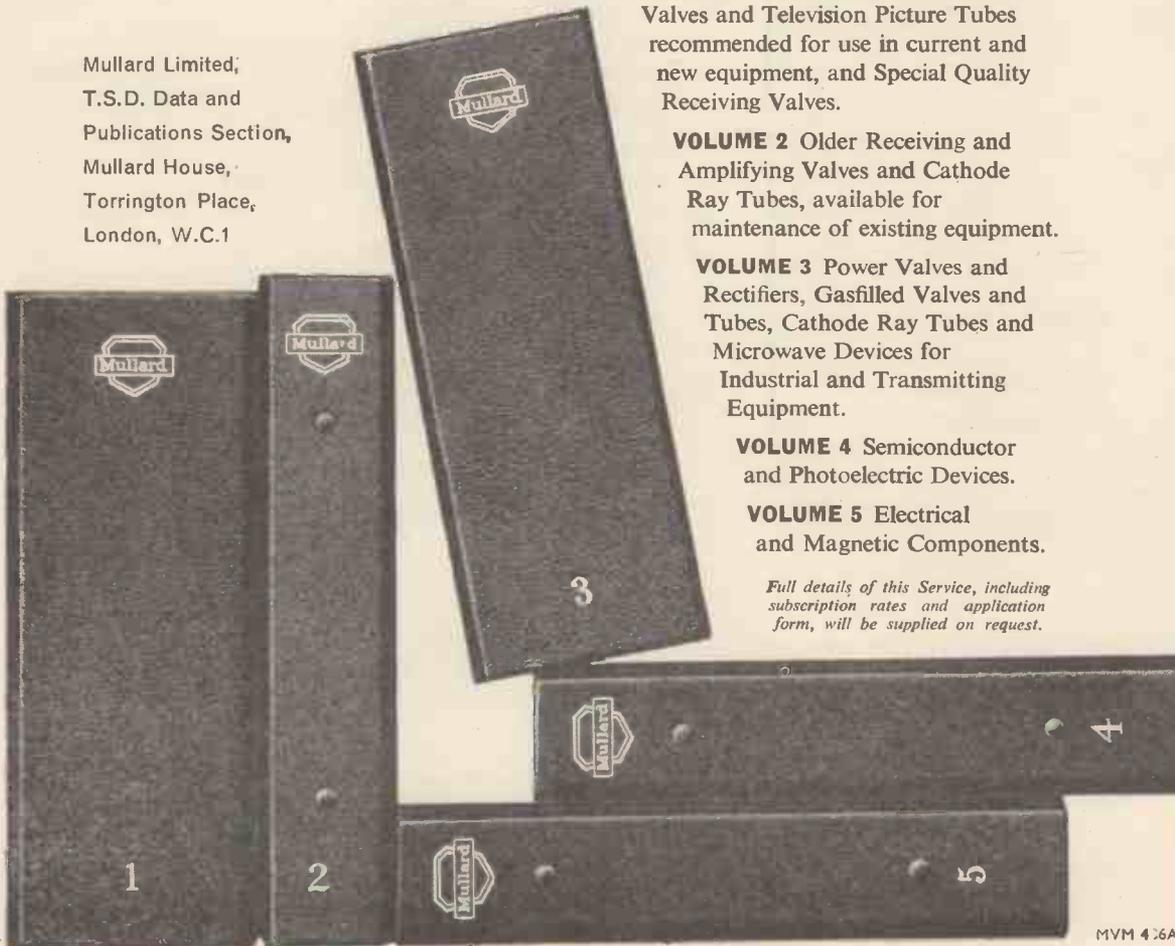
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Line Standards

IN 1956 the Postmaster General of the day asked the Television Advisory Committee amongst other things to say whether the existing 405-line standards were likely to remain adequate for all purposes for the next 25 years and if there was any reason why the United Kingdom should not adopt 625 lines for Bands IV and V if it were recommended by the C.C.I.R. as the European standard.

To the first question the Committee in its 1960 Report* has given an unequivocal no, on the grounds that a "definite" improvement in picture quality is possible with 625 lines (assuming also an equivalent increase in channel width) and that with the trend towards increasing picture size the line structure will be less visible with 625 than with 405 lines. A direct answer to the second question is avoided and the response takes the form of an inversion and a recommendation that 625 lines *should* be adopted, not only for Bands IV and V but ultimately for Bands I and III also.

Although the evidence for a case *against* 625 lines is included in the Report it is scattered and unco-ordinated, and before the growing compulsion towards a change of standard reaches the proportions of a general obsession, we think that the case for the retention of 405 lines should be made with at least equal emphasis. Briefly it is that the 405-line standard is already capable of giving better picture quality and higher definition than is at present realizable on the viewer's screen, and that any improvement which might be obtained from 625 is marginal and not worth the 15 years or more of disruption, the cost of duplicating services and the dual standards receivers which would be necessary to effect a change. When finally Band I and III stations were converted to 625 lines and the last 405-line-only receiver had become obsolete we should finish up with nation-wide dual standards receivers in which the 405 section would be redundant, and for our trouble we should have a slightly better picture but at least one national programme less than we could have enjoyed if we had stuck to 405 lines and 5Mc/s channel spacing.

How much better than 405 would the picture quality of 625 be in the home on the average commercial receiver? In our opinion, after seeing both British and Continental performance, not much. But if you do not accept our opinion read the report† of the Working Party of the Technical Sub-Committee of the T.A.C. which says (p.139) "... This is not very positive evidence for either the 405-line or 625-line pictures in Band V, but it indicates that the 625-line pictures are not worse than their 405-line counterparts and they are perhaps very slightly better." These tests were made with 7Mc/s channel

and 5Mc/s video bandwidth. With the proposed 8Mc/s and 6.75Mc/s respectively the difference in quality would undoubtedly be more "definite," but still, we think, marginal. Such differences as exist can be easily and much more economically accommodated by intelligent camera work and minor adjustments of viewing distance.

Visibility of lines on the larger screens is undoubtedly the strongest argument so far advanced against 405 lines, but the average assessment of observers in the field tests† is Grade 3 (definitely perceptible, but not disturbing) for 405 lines as against Grade 2 (just perceptible) for 625 lines. But there are less expensive ways of overcoming "lininess" than turning the whole broadcasting system into bedlam—at the receiver, for example, by the use of an elliptical scanning spot or "spot-wobble." Some people prefer to see the lines, taking them as an indication of a "sharp" picture, and have been known to switch off spot-wobble in sets in which it is provided. It is entirely a matter of personal opinion.

That a 405-line and 5Mc/s channel standard would put us in an invidious position in our international relations and upset European plans for the general adoption of 625 lines and 8Mc/s channels is not necessarily true. It may be a necessary expedient on the Continent where national boundaries are contiguous, but on this side of the Channel we have the advantage of geographical isolation, particularly on Bands IV and V where, as the field test report confirms, propagation is more difficult and (p.15) "the limits of a Band V service area are somewhat more precisely defined than those of a Band I service." Mutual interference with other European stations is much more likely on Bands I and III. Why then should we have prematurely committed ourselves to 8Mc/s spacing on the higher frequencies, while reserving the right to transmit for an indeterminate period with 5Mc/s spacing on the lower and more easily propagating bands? It would have been much better to forgo "tidymindedness" and to take advantage of our insular position to make the best use of the available bandwidth in providing more alternative programmes, at the same time safeguarding our neighbours' interests by careful attention to aerial directivity in stations near the south and east coasts.

Summarizing the case against a change to 625 we can say that (i) the value to the viewer in terms of picture quality would be negligible; (ii) there are cheaper and easier ways of overcoming "lininess" if it is thought to be objectionable; (iii) a third programme with national coverage would no longer be possible in Band III; (iv) if Bands IV and V were eventually brought into service, more programmes could be established earlier and at less cost with 405 than with 625 lines.

* Report of the Television Advisory Committee 1960, H.M. Stationery Office. Price 1s.

† "Television Field Trials of 405-line and 625-line Systems in the U.H.F. and V.H.F. Bands 1957-1958." Published by the B.B.C. Price 20s.

Instruments, Electronics and Automation

THE I.E.A. EXHIBITION AS SEEN BY THE TECHNICAL STAFF OF WIRELESS WORLD

AN ELECTRONICS exhibition is probably the only place where one would find accessories so remotely connected as television aerials and hydraulic valves. On this occasion the great diversity of the show at Olympia was partly due to the inclusion of many radio and electronic component manufacturers (there being no R.E.C.M.F. exhibition this year). Such variety inevitably meant a much larger exhibition than the one held in 1958, and both the Grand and National Halls were occupied. Technical interest, too, was greater—particularly in the field of automatic control, where there were more complete systems to be seen in addition to the isolated bits of apparatus used in these systems.

INDUSTRIAL ELECTRONICS

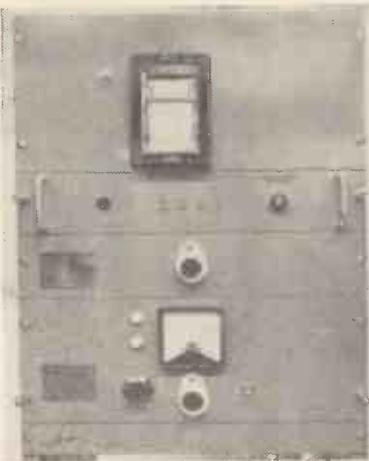
Process Control Systems.—Most of the automatic control equipments on view were intended for continuous-process operations, as, for example, the continuous adjustment of properties of liquids flowing in pipes. This type of application allows the general principle of the servomechanism to be used. A monitoring transducer measures the required property of the material concerned and the measured value is compared with the required value to produce an error signal, which is used to actuate a control device to correct any deviation. An example of this straightforward technique was a temperature controller for electric furnaces, shown, rather appropriately, by the Phoenix Telephone and Electric Works. The input signal is derived from a thermocouple and from a reference signal given by a potential divider connected across a Zener diode voltage source. The difference output from the thermocouple and reference source is amplified by magnetic amplifiers and used

to control a saturable reactor which in turn controls the supply of electrical power to the furnace. The feature of this system is that it avoids the use of mechanical contacts which have to be periodically serviced.

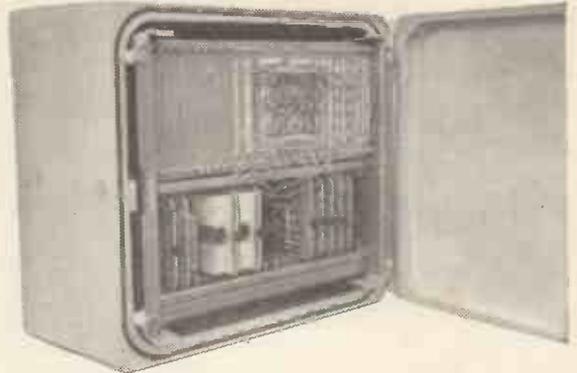
In such systems the control signal is usually directly proportional to the amplitude of the error signal. There are certain processes, however, which require the control signal to be a more complex function of the error signal. For example, in some plants a measured deviation in the form of a sudden step might, if fed back as a correcting signal, cause "hunting" in the process control system. It might be necessary, therefore, to integrate the sudden step into the form of a slowly rising control voltage. In many of the controllers on view there were, in fact, facilities for providing these special functions—usually integration and differentiation (to give a control signal depending on the rate-of-change of the error signal). These, in addition to the normal proportional control, give

what are commonly known as "three-term" controllers. As an example, Evershed demonstrated a three-term controller being used to control automatically the concentration of mixtures of liquids on the basis of conductivity measurements. The measuring transducer produces an electrical signal proportional to conductivity, and a resistance network gives the difference between this value and the desired value (set manually by a potentiometer from a voltage source). The difference signal then passes through an amplifier system in which its amplitude can be manually set and its waveform modified by adjustable integrating and differentiating circuits—to emerge as a signal which controls the rate of operation of one of the pumps contributing to the mixture of liquids.

An integrating circuit was used for giving a delay effect on the control signal in an interesting equipment shown by Haynes & Haynes on the Lancashire Dynamo stand. This was for controlling the wall thickness of plastic tube during extrusion. Variations of wall thickness are used to regulate the speed of the motor which drives the "haul off" conveyor system for the plastic tube. The measuring transducer is a capacitor with its two plates not parallel but inclined to each other so that a section of the plastic tube can pass between them. The tube wall, therefore, provides part of the capacitor's dielectric and any variations in wall thickness alter the capacitance. This transducer is connected in series with another capacitor of equal value to a 3-Mc/s oscillator, and an output signal is taken from between the two



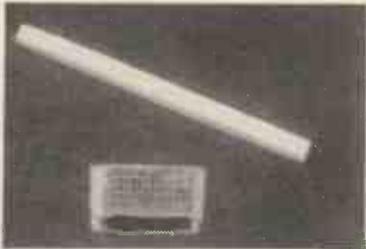
Phoenix Telephone temperature control equipment.



De Havilland "Anatrol" analogue computer for process control.

capacitors. The result is a bridge arrangement in which any unbalance between the two capacitors (due to wall thickness variation) is indicated by the amplitude of the output signal, while the direction of unbalance (increase or decrease of thickness) is indicated by the phase of the output signal relative to a reference signal from the oscillator. These changes are detected and passed to the integrating circuit, the output of which is used to control the variable-speed drive of the plastic tube conveyer.

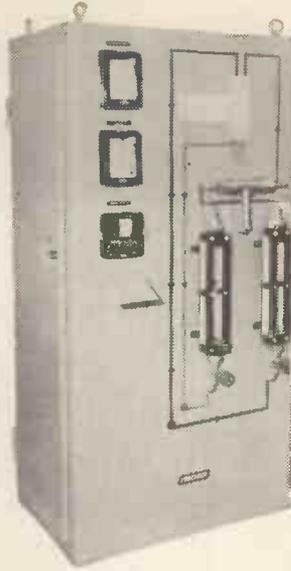
Data Processing.—One could not go very far in the exhibition without seeing some equipment or other for the transmission or conversion of information—for telemetering, communications, computation, or the "logging" of data from transducers in industrial plants. A particularly impressive example was a large equipment shown by Bristol Aircraft for converting tape recordings, obtained from the receiving end of a 24-channel time-multiplex telemetering system, into the form of data on punched cards. By this means the weeks of work normally required for analysing the telemetered information could be reduced to a single day. An electronic analogue-to-digital converter, also shown by Bristol, had the unusual feature of giving a digital output which was corrected for any non-linearity, drift or gain variations in the analogue transducer



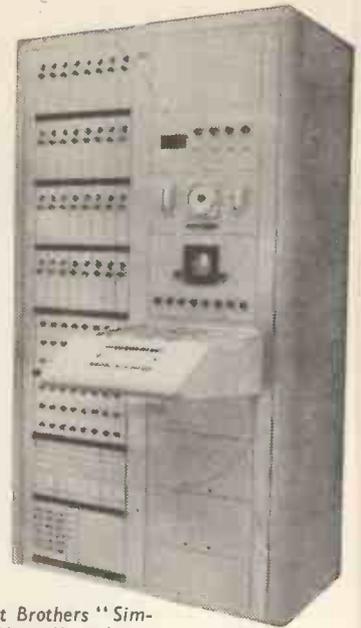
Texas Instruments solid-circuit binary adder, compared in size with a safety match.

system providing the input. This correction is achieved by supplying to the converter, along with the analogue input, reference voltages which are a calibration of the analogue signal and are subject to the same unknown variations. The converter works on the well-established principle of comparing the analogue input with a succession of fixed voltages; when equality is reached the action stops and a binary counter registers the number of comparison steps which have been taken. In the Bristol Aircraft system these fixed voltages are provided by the reference voltages mentioned above, so that the unwanted variations in the transducer system are automatically compensated.

Another type of error correction was a feature of many of the telegraph and digital data transmission



Evershed equipment with three-term controller for controlling mixture of liquids.



Short Brothers "Simlac Minor" analogue computer.

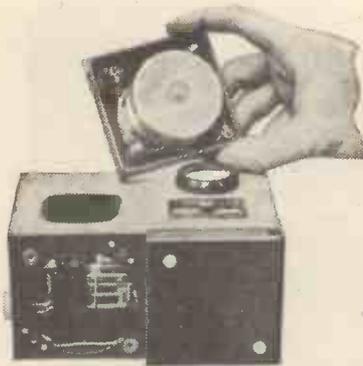
systems on view. In general, the method consists of transmitting extra digits along with the normal information. These give a special pattern to each of the characters or numbers transmitted so that any mutilations of the signal in transit can be automatically recognized at the receiving end. Great interest was attracted by a G.P.O. demonstration of this principle in which the number of errors detected and the number of characters transmitted were "clocked-up" on counters. In general such correction techniques can reduce the normal error rate of about 1 in 40,000 characters to about 1 in 10^8 characters.

Turning to the computation side of data processing, one of the most interesting exhibits relating to the design of computers was a working binary adder constructed from semiconductor solid-circuits. Demonstrated by Texas Instruments, it consisted of a group of tiny flat plates of silicon, measuring $\frac{1}{8}$ in by $\frac{1}{8}$ in, each of which was an integrated circuit element formed by diffusion, etching and deposition techniques. Four types of solid circuit elements were used: (1) voltage inverters, each consisting of a transistor, a diode and resistors, (2) diode gates for AND and OR operations, (3) a bi-stable circuit, containing transistors, diodes, resistors and capacitors, for delay purposes, and (4) a diode gate to provide the correct drive for the bi-stable circuit. Interconnections were made with the aid of printed conductors and the whole adder was well spread out for display purposes. In practice, however, the individual circuit elements are packed together face to face into a tiny cube—the incredibly small size of which can be

seen from the illustration on this page. The saving in volume over an equivalent adder using conventional semiconductor devices is of the order of 100:1, according to Texas.

Semiconductor circuit elements are now the standard thing for all new digital computing systems, and one particularly interesting example was a digital machine shown by Elliott-Automation, designed for incorporation in process control loops in industrial plant. The machine is called the "Optimat," because it is not a straightforward computer but a device for seeking the optimum performance point within a specified regime of operation of the plant. It does this by making trial-and-error incremental variations in the control signals to the plant until the plant conditions meet the specification (which is laid down in the programme to the machine). In this way optimum performance can be obtained even against the influence of uncontrolled parameters in the operation of the plant. The logical elements, established already under the name "Minilog," are transistor and diode circuits mounted on printed circuit cards which in turn are wired in groups on to larger boards carrying plugs for insertion into a chassis.

For simpler process control applications the analogue computer is particularly suitable, since the control and monitoring signals to and from the plant are necessarily analogue signals. An example at the exhibition was the "Anatrol" analogue computer, developed by de Havilland, which was shown as a means of solving equations necessary to keep the composition of a blended product at some specified value. As



Electromethods Series 5100 miniature chart recorder, showing 2in diameter chart.

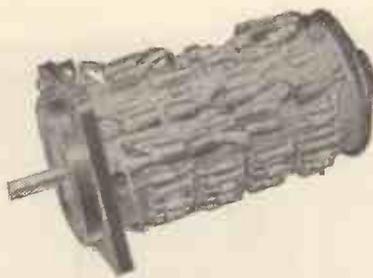
in the "Optimat," the circuitry was based on semiconductor devices.

An analogue computer with some unusual facilities was the "Simlac Minor" shown by Short Brothers & Harland. It has a push-button selection system which enables the d.c. amplifiers and passive circuit elements to be selected and connected to various measuring instruments and also allows the coefficient potentiometers to be automatically set up, by servo control, to an accuracy of 0.1%. A novel "patch-cord" system gives flexibility of interconnection between the units while using the minimum number of cords and avoiding the need for the cords to cross. The computer is actually a small general-purpose machine and uses 32 d.c. amplifiers.

Information Recovery from difficult-to-get-at places is common in these days of "sputniks"; however, many examples are far nearer at hand than an orbiting artificial satellite—the inside of a continuous paint-stoving oven, for instance, or the face of a piston in a running internal-combustion engine.

Shown on the D.S.I.R. stand was a small telemetry transmitter designed to fit inside the piston of an engine. Developed by the British Internal Combustion Engine Research Association, recourse to telemetry was made because the number of slip rings and wiping contacts required could have resulted in false signals and would have been difficult to maintain. The single-transistor transmitter operates at about 2Mc/s, feeding an aerial which projects into the crankcase. A thermistor sensing element on the face of the piston modulates directly the frequency of the transmitter. To withstand the high temperatures built up, and the oil present, the unit is encapsulated. A silicon transistor is used.

Another approach was illustrated by Electromethods, with their series 5100 recorder. This a miniature ($6\frac{1}{2} \times 4\frac{1}{2} \times 3\frac{1}{2}$ in) instrument using a clockwork-driven chart of pressure sensitive paper only two inches in diameter. A self-balancing bridge



Ericsson "Rotapulse" transducer for automatic weighing.

system is used, balance being achieved between the input and a slide wire whose moving contact is coupled to the stylus marking the chart. Periodically the input signal is removed automatically and a second servo system re-balances the zero of the bridge.

For applications such as monitoring the temperature throughout a stoving oven, the whole recorder, complete with its battery pack, can be put inside a vacuum flask with leads connected to an external resistance thermometer. When used for potential recording the sensitivity is such that signals of 10mV or so may be registered. For use with a resistance sensing element, accuracy figures quoted were $\pm 2\%$ of f.s.d. and variation of zero and sensitivity $\pm 0.25\%$.

Weighing Automatically materials into bins or sacks is a typical example of how automation can reduce the physical labour of a task, and at the same time cut down clerical work with its opportunities for error. The adaptation of an ordinary weighing machine, too, brings in a common problem—the sensing of rotation without the imposition of a significant load on the apparatus. The general principle is that the rotation of the scale pointer is sensed and converted to pulses, which are counted and registered on a reversible decimal stepping display. Pre-set circuits allow the rate of delivery of the material to be reduced as the correct weight is approached and cut off when the weight is correct. A converter may be fitted, for instance, to operate a teleprinter which would record the weight.

Microcell, in their Type 171 machine, use a radially striped disc coupled to the pointer spindle and another stationary grating. Light shining through the gratings is thus modulated by the passage of the rotating grating, and picked up by photocells. To allow for other than critical damping of the weighing machine, the sense of rotation must be discovered so that the counter can be "instructed" whether to add on or take off pulses. This is done by using two photocells with 90° angular separation.

The Rotapulse transducer, shown by Ericsson, is also primarily an

optical system: it is offered as an entirely separate unit with low-friction bearings (less than 0.05oz/in torque is required). Four quadrantly positioned phototransistors are used, and with the 250 and 249 segments on the gratings 1,000 pulses are given for each revolution of the spindle. The pulse-forming circuits are transistorized and are built on a flexible printed-wiring board which is wrapped round the rotating mechanism.

A selsyn transmitter is coupled to the weighing-machine pointer in the E.M.I. "Emiway" equipment. This transmits the rotary motion to the remote equipment where analogue to digital conversion is achieved by a coded disc driven by the synchronous receiver motor. The control unit provides for the checking of the machine zero, two reduced rates of feed and the starting of the print-out operation. The accuracy achieved is better than one part in 2000 in 360° , or 0.1% of f.s.d.

Industrial Television.—When direct viewing through windows or by means of large mirrors is impracticable, stereoscopic television may well provide a solution, for instance, when handling radioactive substances behind screening. To give a true solid image two pictures must be presented, one to each eye, from the positions and angles of view that would be occupied by the eyes if they were observing the scene to be transmitted.

E.M.I. were showing a stereo TV system using two small cameras with automatic adjustment of the angle subtended to the subject by the eyes, achieved by coupling to the optical focus control. Display was on two c.r.t.s, the images being combined by a half-silvered mirror and the tubes were covered with orthogonally-set sheets of optical polarizing medium. The wearing of similarly polarized spectacles separated the pictures at the eyes.

Pye, however, were showing stereo TV with only one camera, amplifying chain and c.r.t. This was achieved by the use of mirrors to produce the left and right views on halves of the



Stereoscopic television camera showing optical system for producing left- and right-eye views (Pye).

sensitive area on the camera tube. The monitor thus displays side by side the two images, which are directed into the appropriate eyes by an optical system similar to that used on the camera. Of course, the solid picture produced is of only half the area of a "flat" picture, but this is of no importance for industrial purposes.

E.M.I. were demonstrating their new colour camera which uses three vidicon tubes and a novel optical system. The optical system utilizes supplementary lenses in the lens turret to give varying fields of view. Inside the camera the light is split into its red, green and blue components by mirrors and filters, and then individually focused on to the tubes by separate lenses. The smearing of moving objects so often seen with vidicon pick-up tubes has been reduced considerably by the use of new short-lag tubes.

The camera is designed to operate on 625, 525 and 405 line systems. This was a general trend noted throughout the exhibition; for instance, Thorn were showing a picture monitor and waveform generator capable of being switched between these standards and Epsilon, in their range of industrial television equipment also cater for quick changing from one standard to another. The Epsilon equipment incorporates a picture monitoring circuit which adjusts automatically the potential fed to the camera tube for a 50:1 variation in light intensity.

Unit Construction seems to be the main trend in industrial control and automation equipment. The aim of this, of course, is to have available a number of standard blocks, such as amplifiers, counters, timers and power units, which can be fitted together to suit practically any requirement. This must reduce the "electronic" interest of the system, but it must be remembered that the prime requirement for industrial equipment is that it should, in the event of a fault, remain unserviceable for the minimum possible time. The best method of fulfilling this requirement is the use of standard plug-in "blocks," so that only a small number of spares need be kept. This approach was exemplified by, for instance, Mullard, with their Combilements and Norbits, Fox Yarborough and Lancashire Dynamo, who were also exhibiting a unit rack assembly developed for naval use. This uses a novel cooling method. Instead of the usual extractor fan and inlet filter drawing air through the actual apparatus, cooling is achieved by mounting heat-producing components on a spring-loaded metal plate. When the unit is forced fully home this plate is pressed into intimate contact with the machined walls of the closed "cell" in which the unit is held. The cell walls are of extruded light alloy, carrying internal finned ducts through which

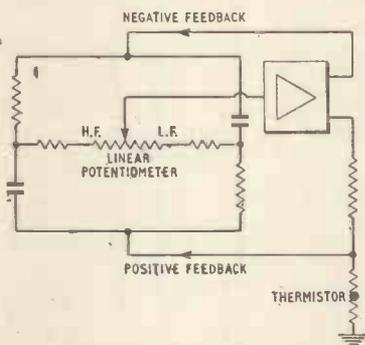
air is drawn. In this way efficient air-cooling is achieved without the fire danger caused by forced-draught cooling of racks of open equipment.

Power-supply units have become more or less standard in their design, but one novelty seen on the stand of International Electronics was a transistor-stabilized 300-V 500-mA unit. Normally transistors are not used for h.t. stabilization because of the danger of damage should the supply

be short circuited. However, by designing the error-amplifier so that, in the event of a short circuit, the output transistors are switched hard on, and by including a current-limiting resistor in the unstabilized side of the supply, the dissipation in the transistors can be kept low enough to ensure safety while the output fuse blows. Naturally, the use of transistors achieves a considerable saving in weight and bulk.

MEASURING INSTRUMENTS

Sine Wave Oscillators.—In a transistorized oscillator shown by R.R.E., constant output (within ± 0.1 dB), low distortion (<0.1%) and a wide frequency range (10 to 1) are obtained by means of a basically simple circuit (see diagram) in which a single linear potentiometer controls the oscillation frequency. This potentiometer is connected between two simple CR leading and lagging phase-shift networks



Basic circuit of new R.R.E. oscillator.

so that the phase of the amplifier input can be varied. Oscillations are produced at the frequency at which the input phase is the same as the positive feedback output phase. (In the circuit diagram the "upper" resistor and capacitor should have a higher impedance than the corresponding "lower.") Three transistors are used in the amplifier circuit. If a linear potentiometer is used, the oscillation frequency varies nearly logarithmically with the spindle angle except near the beginning and end of the potentiometer element. A linear potentiometer also gives a more uniform scale graduation spacing than is usually obtained with a logarithmic potentiometer. This is because a logarithmic potentiometer normally approximates to the ideal logarithmic curve in three straight line segments, so that at the two joints of these segments a sudden change in the scale graduation spacing is produced.

An unusual method of sine wave generation is used in the Marconi

TF1382 low-frequency (down to 0.003c/s) sine, square and ramp waveform generator. The latter (ramp) waveform is that basically produced in this generator. This waveform is then shaped in a Zener diode circuit to produce sine waves with a distortion of less than 5%. Square waves are also produced from the triangular waveform via a bi-stable circuit.

A tone-burst generator was shown by Ferguson. When fed with a sine-wave input this produces sine waves in bursts whose individual duration and repetition rate can be varied, each burst containing an integral number of sine waves. Such a generator is useful for testing audio amplifiers, since its output provides a simple approximation to the high peak-to-mean power ratio conditions of music and speech. When an amplifier is fed with such bursts its output-stage operating point corresponds more closely with that obtained in practical use than does the operating point obtained with a high-power continuous sine-wave input. Marginal instability is also easier to detect when the high-power signal is cut off at the end of each burst. To obtain such bursts the sine-wave input is gated on and off, the gating being controlled from the sine-wave input so that only an integral number of sine waves is produced in each burst.

Oscilloscopes.—Transistorized instruments were shown by Microcell and Tektronix(L). An unusual feature of the latter instrument is that the flyback trace is suppressed by feeding a suitable signal to a separate deflection plate system in the c.r.t. so that these plates intercept the beam. Intensity modulation of the beam is also possible.

A cathode-ray tube containing a set of deflection plates forming the capacitive elements in a lumped L-C line (travelling-wave deflection) is

Agents in U.K. for foreign instruments: (C.L.) Claude Lyons Ltd., Valley Works, Hoddesdon, Herts; (G & G) Griffin & George (Sales), Ltd., Ealing Road, Alperton, Wembley, Middx.; (L) Livingston Laboratories, Ltd., Retcar Street, London, N.19; (N & T) Nash & Thompson Ltd., Hook Rise, Tolworth, Surbiton, Surrey; (R.H.C.) R. H. Cole (Overseas), Ltd., 2 Caxton Street, London, S.W.1.

used to obtain a response up to as high as 100Mc/s in the Tektronix^(L) Type 585.

A very small (5in×3½in×6½in) oscilloscope was shown by Sciaky Electric Welding Machines. A single EF91 is used for the time base and a second EF91 as the d.c. Y-amplifier. The response extends to 300kc/s at a sensitivity of 700mV/cm.

An unusual feature of the oscilloscopes shown by the East-German VEB Funkwerk Kopenick^(G & G) is that no internal Y-amplifiers are provided, separate units being available for this purpose.

Switching between as many as five inputs is an unusual facility possible with the Czech Krizik^(N & T) K552 oscilloscope. The inputs are switched on and off in turn either by a 100kc/s multivibrator, or alternatively, for viewing high-frequency waveforms, in synchronism with the timebase.

The frequency range of an oscilloscope for recurrent waveforms can effectively be greatly extended by using very fast rise-time pulses to sample various portions of a recurrent waveform, the sampled pulses being stored and amplified in the relatively much larger time between the taking of successive samples. This method was described more fully in our review of the 1959 Physical Society Exhibition (March 1959 issue, p. 131), with reference to an oscilloscope shown by the U.K. Atomic Energy Authority. It was also used in oscilloscopes or attachments for existing oscilloscopes shown this year by Lion Electronic Developments, Hewlett-Packard^(L), Tektronix^(L), and Lumatron^(L). Usually the high-speed sampling pulse is obtained from avalanche-operated transistors and a rise time of about 0.6mμsec is obtained. In the Lumatron^(L) Model 12 oscilloscope, however, a dynode secondary-emission valve is used to provide the fast-rise time sampling pulses. The pulses from the dynode are clipped and differentiated to provide a final pulse rise time of only 0.4mμsec.

Transistor Testers.—An unusual measuring meter for such instruments—the quadrant electrometer—is used in the French A.O.I.P. Tran-

sistometer. Input and output resistances, leakage currents and gains can be measured by this instrument. All measurements are referred to measurements of collector current changes. These are carried out by first charging both pairs of quadrants to a voltage proportional to the collector current. One pair of quadrants is then kept at this potential by a high-insulation capacitor, while the other pair is brought to a new potential proportional to the changed collector current. The electrometer deflection is then proportional to the change in collector current. One advantage of this system of measurement is that the initial conditions are stored so that any change can be accurately measured after an interval of time.

Features of the new Microcell Type 156 are the use of a wide-range (1kc/s-10Mc/s) oscillator as signal source, and a differential valve-voltmeter as indicator. This type of indicator eliminates errors due to spurious voltages developed across the resistive networks. Cut-off frequencies, amplification factors, leakage currents and turnover voltages can be measured with this instrument.

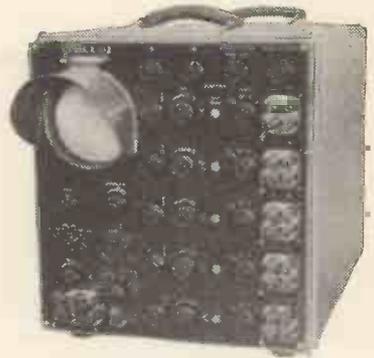
An instrument for service departments—the Type 105C—was shown by Labgear. This can measure current gains and collector leakage currents and turnover voltages.

Collector voltage/collector current characteristics at up to five different base or emitter input currents can be simultaneously presented visually on the Dobbie McInnes Transigraph TG104 oscilloscope. Current gains, output impedances and optimum operating conditions can then be readily determined.

Grid-dip Meters were shown by Grundig Instruments and the Czech firm Kovo^(N & T) (Tesla BM342). These consist simply of a calibrated oscillator whose grid current can be measured. They can then be used as an absorption resonance-frequency indicator (minimum grid current) or as a signal source. Alternatively, the oscillator valve can be connected as a diode and the instrument used as an absorption wavemeter (maximum current).

Frequency Response curve tracers usually display simply the output variation so that inaccuracies and complications are produced if the input source varies. However, in the Siemens^(RHG) ratio tracing receiver Type Rel 3K217c the input is used to alter the gain of the output amplifier so that input variations of up to 10dB are compensated for to within 0.3dB. The amplified output traced on the c.r.t. screen is then proportional (within 0.3dB) to the response.

Voltage Measurement.—A precision (0.05% accuracy) r.m.s. decade voltmeter—the D-930-A—was shown by Muirhead. In this instrument the

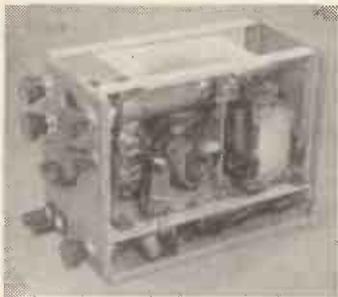


Kovo Krizik (N & T) five-channel oscilloscope.

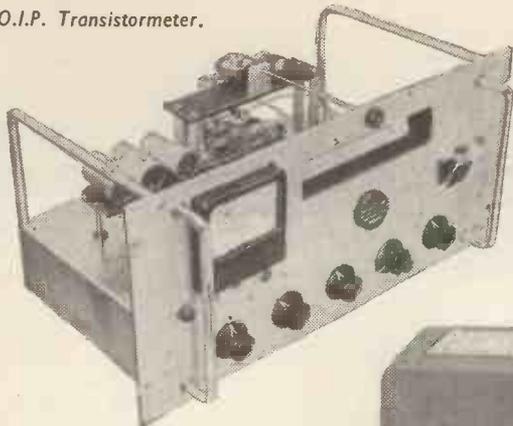
unknown voltage is fed via the range switch to an a.c. amplifier followed by a decade attenuator and second a.c. amplifier. The output of this second a.c. amplifier is fed to a Wheatstone resistor bridge in which a lamp forms one arm. Since the resistance of this lamp depends on the electrical heating power developed in it, the bridge balance is determined by the r.m.s. value of the input. The point at which the bridge balances is first standardized against the direct voltage from three Weston reference cells. This voltage is then reduced by about 80%, and the bridge rebalanced by adding an internally supplied a.c. voltage. This standardizes the a.c. voltage. This voltage is then attenuated and fed to the input of the voltmeter to standardize the a.c. amplifier gains. In the Marconi TF1377 suppressed-zero voltmeter potentials are measured by balancing them off against the output of a potentiometer fed from a standard voltage—the potentiometer setting being shown on a three-digit indicator. Residual unbalance voltages and thus voltage changes can be measured by means of a differential valve voltmeter.

Both the amplitude and phase of a voltage can be measured by a simple device shown by F. C. Robinson and Partners. In this instrument current is fed from the mains, or from any 15W, 15-Ω output impedance amplifier, through a standard potentiometer P₁ in series with the primary of a mutual inductance. Across the secondary of this inductance is connected a second potentiometer P₂. The voltages developed across the two potentiometers P₁ and P₂ are then 90 degrees out of phase. The phase and amplitude of an unknown voltage can then be measured by balancing this voltage off against the outputs of the potentiometers P₁ and P₂.

Wires carrying alternating current can be detected without having to make any contact with them by picking up the electrostatic field produced by the current in the Everett Edgcombe "Metrac" live



Sciaky miniature oscilloscope.



line indicators. These instruments have been developed for use with high-voltage cables and are amply sensitive enough to detect live wires at the standard safe working distance which, for example, is 8½ ft for 11kV.

An interesting circuit is used in the Southern Instruments E.R.I.C. Universal Electronic Multimeter which can measure both direct voltages and currents. This circuit is direct-coupled throughout and consists of three cascaded pairs of balanced cathode-coupled amplifiers (the first pair using electrometer valves) followed by a pair of cathode-follower outputs. In use, one of the two inputs is cross-connected to one of the outputs, a different input being connected according to whether voltage or current is being measured. If, in addition, a standard resistor is connected between the other input and output, the impedance between the two inputs is then very low (voltage drop <5mV) so that direct currents are conveniently measured between the two inputs. On the other hand, with the standard resistor disconnected, the impedance between the unconnected input and output is extremely high so that direct voltages are conveniently measured between this input and output. Input voltages can also be stored on a 0.15μF polystyrene capacitor (producing an input impedance of 10¹³Ω) so that a reading can be taken after the probe has been removed from the test point. Resistances can also be measured with this instrument.

Current Measurement.—An unusual photo-electronic chopper technique is used in the prototype Nanoammeter shown by the French firm A.O.I.P. Here the unknown d.c. input is passed through a photo-resistor on which a light is shone. This light is periodically interrupted by a mechanical movement so that the photo-resistance is periodically altered. The d.c. input is thus partially converted into a.c. which is then amplified and measured.

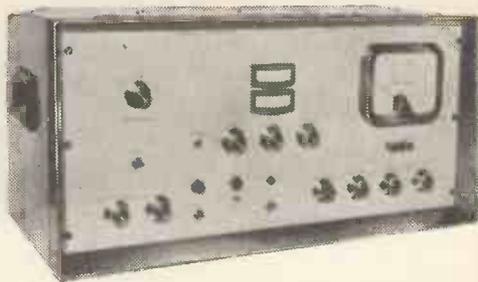
Direct currents can be measured down to 3mA full scale without interrupting the circuit under test in the Hewlett-Packard Model 428A



Everett Edgcombe
"Metrac" live line
indicator.

clip-on d.c. milliammeter. In this instrument the magnetic field produced by the current in a probe of magnetic material which is clipped round the current-carrying conductor is measured by a fluxgate technique. In this technique an a.c. signal passed through a coil wound on the probe drives this probe into magnetic saturation on alternate half cycles. The additional field due to the current makes the magnetization curve of the probe slightly asymmetrical with respect to zero field and induction. This results in a second harmonic output being produced in a second coil wound on the probe. This second harmonic output is detected and measured. Interfering effects produced by uniform direct fields (such as the earth's field) can be arranged to cancel out by using the fact that the fields on opposite sides of a current-carrying conductor are in opposite directions. The probe is also magnetically shielded against external a.c. or d.c. fields. An advantage of this method of measuring current is that no resistance and very little inductance (<0.5μH) are introduced into the circuit being measured.

Power Measurement.—In the Burndeft BE281 powers can be measured at frequencies up to 1,000Mc/s by feeding them to a 50-Ω coaxial resistor (made up of a carbon film on a cylindrical ceramic core) which is mounted along the axis of exponential cavity to provide broad-band matching. The r.f. voltage developed across a portion of the resistor is rectified and measured. This purely



Microcell transistor test set.



Tektronix (L) tran-
sistor oscilloscope.

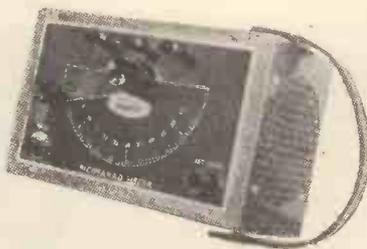
electrical method of measurement gives a much faster response than is obtained when r.f. is measured by using it to produce a heating effect (as in a bolometer).

L, C, R Measurement.—When high-loss reactive components are measured using bridges, the measurements of the reactive and resistive parts of the component usually influence each other so much that many adjustments are needed to obtain a balance point. Two general methods of considerably reducing the number of such adjustments required were seen. In capacitor bridges shown by Rank Cintel and Winston Electronics phase-sensitive detectors are employed so that the resistive and relative out-of-balance voltages (which differ in phase by 90°) can be separately detected and zeroed. In the General Radio (G¹) Type 1650-A L, C, R bridge, the resistive and reactive adjustments are mechanically connected by friction clutches such that, when the resistive adjustment is altered, the reactive adjustment is also altered so as to keep the ratio of the resistive and reactive parts constant; but, when the reactive adjustment is altered, the resistive adjustment is not affected.

In capacitance meters shown by E. C. Robinson & Partners and the Czech firm kovo^(N & T) (Tesla Model BM271) measurements are made by placing the unknown capacity in a resonant circuit which also contains a calibrated variable capacity. By keeping the resonant frequency fixed by adjusting the calibrated variable capacity, the effect of the unknown

capacity can be measured. In the Tesla BM271 the resonant circuit is placed across the output of a fixed-frequency oscillator and adjusted to resonate at the oscillator frequency by maximizing the voltage developed across the circuit. By also adjusting this voltage to a fixed value by means of a variable resistor placed across the unknown capacitor, the loss of the capacitor can be similarly measured. This variable resistor consists of a thermionic diode with a by-passed variable resistor in series with it; this arrangement providing a resistance which is sufficiently non-inductive for use up to 30Mc/s. In the F. C. Robinson and Partners Picofarad Meter the resonant circuit forms part of an oscillator and the resonance is adjusted to a fixed frequency by listening to the audio beats produced with another fixed-frequency oscillator in a loudspeaker. Since the oscillator frequencies are at 1.5Mc/s, such beats produce a very exact indication of correct frequency adjustment.

A very simple method of measur-



Robinson & Partners Picofarad Meter.

ing inductors and capacitors used in radio or television receivers is used in the East-German V.E.B. Werk für Fernmeldewesen (G & G) LCM1. An oscillator with a cathode-follower output stage provides an alternating current which is passed through the component. The voltage developed across the component is then a sufficiently accurate indication of the component reactance, since the resistive loss in components used in radio or television receivers is generally small.

PARTS AND MATERIALS

Strip Wiring is formed from flat copper strips a few thousandths of an inch thick, supported and insulated from each other and external contact by plastics films.

Technograph has been making flexible "printed" wiring for several years, including, for instance, resistive elements on a rubber compound (for the de-icing of aircraft control surfaces), and strain gauges on various films such as Terylene. Their latest strip-wiring cable consists of copper conductors sandwiched between two layers of 0.001-in Melinex film. The Melinex softens sufficiently to be stripped from the copper at about 160°C, so leaving free the ends of the conductors, for connection. T.C.C. introduced a flat-strip cable, called Flexistrip, at the exhibition: in their cable the copper strips are moulded into polythene, and an overall jacket of Melinex is then applied. Possibly the most startling thing about strip cables is their flexibility—Flexistrip, for instance, passes the DEF5000 test, which involves no fewer than 20,000 flexings, and is normally applied to tinsel-braid cables.

Connectors for strip-wiring could take practically any form; for instance, it could be soldered directly to a printed-wiring board, or be fitted with eyelets. However, any method requiring individual handling of each wire to achieve a disconnection is not likely to be acceptable where many connections are required. Thus several connectors have made their appearance, each quite different in principle.

Belling and Lee were showing an experimental moulded housing to fit on to either circuit-board connectors

or a small piece of board, so forming a socket and plug which can be attached to the cable. The housing itself has three slots through which the cable is passed, to form a cable grip. The ends of the strip are pierced and soldered onto lugs projecting from the socket or plug board and the housing, which has a snap-on cover, can incorporate a finger-release locking clip.

N.S.F. have a modified form of their Varicon interconnection tags, which, when mounted on a printed-wiring board, form both "plug" and "socket" contacts. The modified tag carries on its rear a toothed portion under which the end of the unstripped cable is trapped. On mounting the tags, the teeth cut through the insulation and enter the conductor, so making contact. Slots punched in the board could provide a cable grip. For quick assembly Varicon can be supplied in strips of thermoplastic material, which, after fixing the tags to the board, is warmed and removed.

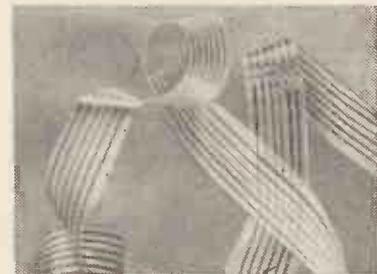
Continental Connectors, a division of Ultra, were showing a fitting like an ordinary circuit-board socket. However, it accepts only a very thin section—the end of a flexible strip cable, in fact, with the conductors cleaned of insulation and folded back over the cable. For very flexible cables which would not be rigid enough for direct plugging in, a thin piece of board could be used as a supporting member, with the stripped strip conductors folded over the edge of the board. Again, slots in the board could provide for a cable grip and retaining mechanism.

Connection to Printed-wiring boards

is made without the use of solder by a new technique shown by Belling and Lee. Known as Prestincert, it depends upon the discovery that a disc or peg can, with the aid of a die and press, be punched into sheets of insulating material or metal without first making a hole for it. Knurling the edges of the insert prevents rotation, and the die can pen over the penetrating end, so forming a strong fixing. For component connection the peg is formed into a lug with a soldering terminal at the top and an oversize collar that seats firmly on the board. A slot, cut diagonally into the peg across a diameter, takes the component lead: on punching, the lead is squeezed into intimate contact with the board and the insert, the excess wire being sheared off. Also insulation on the wire is stripped automatically.

Printed Power resistors, shown by Technograph, consist of a meandered resistive track on an insulating coating on a metal panel. This may then be fixed to another metal plate, possibly the chassis of a piece of apparatus, for dissipation of heat at ratings up to 10W/in². The resistance values and ratings on one of the panels displayed suggested that it was intended for use as the mains-dropping resistors in a television receiver, so we arrive at the paradox of having to put back the chassis to act as a cooling fin for the contact-cooled h.t. rectifier and mains dropper, after eliminating it by the use of printed-wiring panels!

Capacitor Construction has for several years remained largely unchanged, except for the entry to the field of plastics-film dielectrics. However, a development shown by Dubilier may well challenge the ubiquitous wax and paper capacitors. The Dubilier "Blue-cap" employs a paper dielectric, but instead of wax, a synthetic-resin impregnant is used. The absence of wax or oil in the manufacturing process makes possible hermetic sealing in a plastics



Flat-strip cable, by Technograph.

sleeve without danger of moisture penetration at the lead-in wires. The sleeve material has a high melting point and is designed to withstand any normal soldering operations.

Another novel construction was shown by Hunts, in their WF49 "Duolectric" capacitors. These are

housed in aluminium cans and occupy roughly a third of the volume of the equivalent rating of waxed-paper types. To achieve this reduction polyester film has been used as the dielectric; but to avoid the relatively high cost of metallized film a sandwich construction of plain film with metallized paper electrodes has been employed. The largest Duolectric capacitor ($2\mu\text{F}$, 1kV) is only $3 \times 1\frac{1}{4}$ in.

Work on tantalum electrolytic capacitors has resulted in the elimination of liquid sulphuric acid as the electrolyte; the effects of a burst or leaking capacitor containing this can only too easily be imagined. Hunts have developed a chemically inert-electrolyte for use in slug-type capacitors, which are, for extra safety, contained in two cans, one inside the other. Dubilier have a range using a solid layer of semiconductor material as the "electrolyte" and a sprayed-zinc coating is used for the second electrode. Other types (Dubilier and Hunts) utilize a construction similar to that of the common "dry" aluminium electrolytic capacitor.

Push-button TV Tuners have many advantages in simplicity of operation; for instance, it is not necessary, as it is with some rotary types, to clank through several unused channels, possibly moving inadvertently the fine tuner as well. A.B. Metal Products had on show a new four-channel push-button unit using a frame-grid cascode triode and triode pentode in the common circuit arrangement. In place of the rotary turret, however, was a push-button mechanism for selecting two Band-I and two Band-III channels. When a button is depressed it allows the appropriate coil strip to rise under spring pressure and engage with several double-leaf contacts projecting from "busbars" joined to the rest of the circuit. A feature of the new tuner is that separate preset fine-tuning controls for each channel

are put into circuit by an extra contact on the coil strip.

Wire-less Transformers or, more correctly, piezoelectric transformers, were shown by Brush. These depend for their operation on the mechanical excitation of ceramics such as lead titanate zirconate either by another section of the same ceramic or by the magneto-strictive effect in a ferrite carrying a winding. Demonstrated was one of bar form, used to light a small neon sign needing about 1mA at 2kV. The low-potential part of the bar was excited by 10V applied from an oscillator connected across its "thickness." Here the impedance is relatively low, but by polarizing the other half of the $\lambda/2$ -long bar along its length it can be made to oscillate in the lengthways mode, which corresponds to a high impedance between the ends of the $\lambda/4$ section. Thus, by attaching wires to the ends of this bar a high potential at low current may be extracted.

The efficiency of the ceramic-to-ceramic transformer shown was of the order of 50%; but, by driving the lengthways-mode "crystal" from a magneto-strictive transducer cemented to it, greater power can be fed in to the bar, with a consequent increase in both efficiency and output, which may be made as high as 40kV.

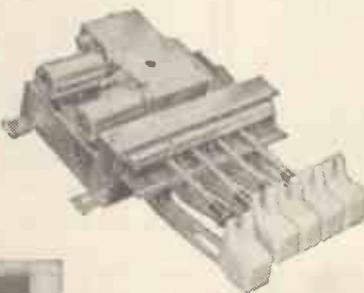
Semiconductor Devices.—High-frequency transistors at economical prices is the aim of the alloy diffusion method of manufacture developed by Mullard, and a whole range of new p-n-p types based on this principle was on view. Briefly, the technique uses a wafer of p-type germanium to form the collector, and on one face of this two metal pellets are placed side by side to form the emitter and base. During heat treatment n-type impurities diffuse into

the germanium wafer from both pellets to produce an extremely thin base layer between the emitter and base electrodes. At the same time, p-type impurities diffuse relatively slowly out of the emitter pellet only and produce a small p-type layer around this pellet, confined within the n-type base layer. The high-frequency properties are obtained mainly as a result of the extremely thin base layer (about 5 microns) and partly because the graded distribution of impurities gives an accelerating field which reduces the transit time of the current carriers through the base even further.

In addition to the established OC170 and OC171 made by this technique, Mullard showed two low-noise transistors for v.h.f. communications which give power gains of 10dB at frequencies of 100Mc/s and 200Mc/s respectively. There was also a switching transistor for use in computers operating with p.r.f.s up to 10Mc/s, and a type for driving ferrite core stores which was capable of producing 0.5A output pulses with rise times of less than 40 nanoseconds. A p-n-p-n four-layer switching device made by the same technique had an impedance ratio for its "on" and "off" states of higher than 3 million to one, while an avalanche switching transistor was capable of producing 50mA pulses with a rise time of 1 nanosecond (10^{-9}).

Other manufacturers are using the "mesa" construction and the drift-field technique for their high-frequency transistors. A.E.I., for example, had two new mesa transistors, XA161 and XA162, with minimum cut-off frequencies of 25Mc/s and 35Mc/s respectively, and three drift types, XA141, XA142 and XA143, with minimum cut-off frequencies of 20Mc/s, 40Mc/s and 60Mc/s respectively. This firm has also introduced four power transistors for industrial applications. Two of them, XC155 and XC156, have peak current ratings of 10A and collector-base voltage ratings of 80 and 100 volts respectively. The other two, XC141 and XC142, have peak current ratings of 3A and collector-base voltage ratings of 40V and 60V.

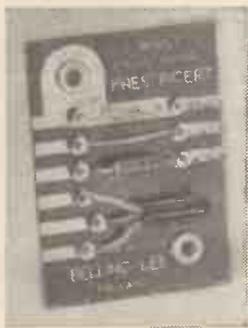
In the field of power control, as distinct from power amplification, the silicon-controlled rectifier is rapidly invading the domain of the industrial thyatron and other large devices. It enables several kilowatts of power to be controlled by a few milliwatts. Examples were shown by Westinghouse and International Rectifier. On the Westinghouse stand an impressive demonstration was given of a 10kW tungsten-lamp sign being turned on and off by two silicon controlled rectifiers connected, in inverse parallel, between the a.c. supply and the load. The r.m.s. output voltage was varied by controlling the proportion of each half cycle for which the rectifiers were conducting.



Above: Four-channel push-button TV tuner (A.B. Metal Products). Fifth button actuates on/off switch and six-button version can switch in separate f.m. tuner.



Left: Brush 2-kV piezoelectric transformer.



Left: Demonstration circuit board with components connected by the Belling-Lee "Prestincert" principle.

T.A.C. REPORT

TECHNICAL FEASIBILITY OF ALTERNATIVE PLANS FOR TV DEVELOPMENT

SINCE the Television Advisory Committee was reconstructed in 1952, under the chairmanship of Admiral Sir Charles Daniel,* it has issued several reports but the most eagerly awaited was that published on June 1st.† Although the broad terms of reference of the committee are "To advise the Postmaster General on the development of television and sound broadcasting at frequencies above 30 megacycles per second and related matters, including competitive television services and television for public showing in cinemas and elsewhere," the committee was asked in March 1956 specifically "for advice on fundamental technical problems of television development." In particular the members were asked whether they would

(a) recommend whether the existing 405-line standards were likely to remain adequate for all purposes for the next 25 years;

(b) say whether there was any reason why the United Kingdom should not adopt 625 lines for Bands IV and V in this country, if it were recommended by the International Radio Consultative Committee (C.C.I.R.) as the European standard;

(c) make recommendations regarding the general principles of a compatible colour system for operation, initially at least only in Bands IV and V;

(d) recommend the best technical means of transmitting the colour signals associated with (c) above, bearing in mind that these need not necessarily be in the same frequency band as the monochrome signals;

(e) take note of, and report on, any proposals by the B.B.C. or I.T.A. for adding colour to transmissions within Bands I and III; and

(f) give their views as to the technical advantages to be gained from the use of higher standards in Bands I and III, if the possibility of extension of television into Bands IV and V were to be disregarded, and taking into account the improvement in receiver and other apparatus that may be expected in the next 25 years.

It is in answer to these specific questions that the present report was presented to the P.M.G.

Because of the widespread interest in the report Mr. Bevin promised Members of Parliament that it would be published. It is, however, stated in the foreword, and the P.M.G. has personally stressed the fact, that the Government has reached no decision as to which of the possible alternatives should be adopted. Furthermore, if any changes in line

standards were to be decided upon, they would require to be made in accordance with a long-term phased programme which should take account of the interests of the viewers, the broadcasting organizations, and the radio industry. The committee has emphasized that 405-line services would need to be continued for many years so that there would be no question of 405-line receivers becoming prematurely obsolescent.

It will be appreciated that although the questions posed are technical, there are political and economic factors which enter very largely into the picture. For example:

(a) the number, nature and coverage of the television programmes to be provided;

(b) the method and time-table by which the new standards should be introduced;

(c) the costs of introducing the new standards and the way in which they could be met.

These are, however, mostly outside the committee's terms of reference and the purpose of the report is solely to give the Government the technical information it needs to formulate policy.

Over the past two or three years various technical studies, including propagation tests in Bands IV and V, 625-line test transmissions from a Band V transmitter at Crystal Palace and colour transmissions on 405 lines, have been undertaken by the T.A.C.'s Technical Sub-Committee‡ in collaboration with the D.S.I.R., the radio industry, Post Office and broadcasting organizations.

How Many Programmes?

As is shown in Table I, Bands I and III, if fully exploited on the present 405-line standard, could provide three programmes—two with at least 98% coverage and one with a coverage of over 95%.

Tests have shown that an acceptable television service could be provided in Bands IV and V. Nevertheless, the service area of a transmitter operating in these bands would be more restricted than for the lower bands and more irregular, particularly in mountainous or hilly terrain, and to give a nation-wide service a greater number of transmitters would therefore be needed. The report states that whereas some 20 stations are required in each of the lower bands to provide upwards of

* See Appendix I for list of present members.
† Report of the Television Advisory Committee, 1960, Stationery Office. 1s.

‡ See Appendix II for list of present members.

TABLE I

Band	Range (Mc/s)	No. of channels for operation on		No. of channels per national programme		No. of programmes which could be provided using	
		405 lines 5 Mc/s channels	625 lines 8 Mc/s channels	No.	for estimated population coverage	405 lines and 5 Mc/s channels	625 lines and 8 Mc/s channels
I	41—68	5	3	5	98%	2 (98%) & 1 (95—98%)	2 (95—98%)
III	174—216	8	5				
IV	470—582*	22	14	12/13	95%	3 (98%)	2 (98%)
V	606—800*	38	24	17/18	98%	4 (95%) & 1 (70%)	2 (95%) & 1 (90%)

*As amended at the Geneva Conference, 1959.

98% population coverage, possibly four or five times as many stations would be needed in Bands IV and V to give 95% coverage.

Because of the undoubted advantages of the v.h.f. bands over the u.h.f. bands for television, the Committee sought advice whether any broadening of Band III was practicable within the foreseeable future. The Radio Industry Council, too, feel strongly that any extension of television up to four national or near-national programmes should, if at all possible, be accommodated within Band I and an extended Band III. Both the Committee and the R.I.C. were, however, informed "that the pressure in the v.h.f. portion of the spectrum is immense, and that the Government must hold a balance between desirable broadcasting development and the requirements on these frequencies for other services." That being so, at this stage no hope can be held out that additional frequencies could be made available in the v.h.f. bands for television purposes. Any extension of television must, therefore, be made in the u.h.f. bands.

It is stated in the report, although this may not have been previously generally known, that the T.A.C. advised the P.M.G. early last year that the U.K. delegation attending the C.C.I.R. meeting at Los Angeles (April, 1959) should be empowered to say that "in the interests of frequency planning the United Kingdom would adopt an 8Mc/s channel in Bands IV and V, if Europe generally adopts this, and further that if the United Kingdom should decide to adopt 625-line standards in those Bands a 6Mc/s video bandwidth would be used."

405-line Standard Inadequate

The Committee states that good as the 405-line picture may be for the size of screens now in general use they do not think the 405-line system will be adequate for the next 25 years.

As will be seen from Table II the majority of European countries as well as some in the western hemisphere and Australasia have adopted 625 lines. In field trials in Band V a comparison was made of 405-line and 625-line pictures. The results showed that the overall assessment of the 625-line pictures was not significantly different from that of 405-line although in areas of comparatively high field strength the 625-line pictures generally received a slightly higher assessment. The Technical Sub-Committee felt that the fact that there was not a significant difference in the overall assessment of picture quality was due partly to the nature of the trials and partly to the restriction of the video bandwidth of the 625-line system to 5Mc/s. They considered, however, with one dissentient, that with further development of this system using a 6Mc/s video bandwidth and receivers with improved noise factors 625-line pictures, particularly on larger screens, would show a definite superiority. Following further international discussion the Sub-Committee considered that there would be technical advantages and no loss in picture quality in restricting the video bandwidth to 5.5Mc/s and increasing the width of the vestigial side-band from 0.75Mc/s to 1.25Mc/s.

Assuming it to be the Government's policy to develop television beyond the capacity of the present two bands, the committee points out that the introduction of Bands IV and V will provide the last opportunity of improving the standards of definition. They recommend the use of 625-line with an

TABLE II

	Adopted in	Channel width
405-line	United Kingdom Ireland	5 Mc/s
525-line	Bermuda Brazil Canada Colombia Cuba Dominican Rep. El Salvador Guatemala Iran Korea Japan Mexico Nicaragua Panama Peru Philippines Puerto Rico Saudi Arabia Thailand Uruguay U.S.A.	6 Mc/s
625-line	Argentina† Australia Austria Belgium Bulgaria* Cyprus Czechoslovakia* Denmark Egypt Finland E. Germany W. Germany Hungary* Iraq Italy Lebanon Netherlands New Zealand Nigeria Norway Poland* Portugal Rumania* Spain Sweden Switzerland Turkey U.S.S.R.* Venezuela† Yugoslavia	7 Mc/s (*8-Mc/s; † 6-Mc/s channel)
819-line	Algeria France Belgium Monaco Morocco Luxembourg	} 13 Mc/s 7 Mc/s

8Mc/s channel in these bands and ultimately in Bands I and III. It is pointed out that the maintenance of 405-line operation here would show the United Kingdom to a disadvantage in Eurovision as standard convertors degrade picture quality, particularly for conversion to a higher standard, and this would have its effect in selling United Kingdom programme material to the rest of Europe.

On the question of colour the members of the committee state "we are of the opinion that present technical and economic limitations make it undesirable to introduce a colour television system in the near future. We will report further on the technical details of colour television standards as soon as we are in a position to do so."

APPENDIX I

Present members of T.A.C.
Admiral Sir Charles Daniel, chairman.
B. St. J. Trend (Treasury).
D. W. G. L. Haviland (Ministry of Aviation).
W. A. Wolferson (Post Office).
H. Carleton Greene (B.B.C.).
Sir Robert Fraser (I.T.A.).
G. Darnley Smith } (Radio Industry).
C. O. Stanley }
Sir Edward Herbert.
Lord Aberconway.
Sir Walter Puckey.
J. L. Judd (Post Office), secretary.

APPENDIX II

Present members of Technical Sub-Committee
A. H. Mumford (Post Office), chairman.
Sir Harold Bishop (B.B.C.), deputy chairman.
Capt. C. F. Booth (Post Office).
A. B. Howe (B.B.C.).
P. A. T. Bevan (I.T.A.).
T. C. Macnamara (Associated Television).
Dr. L. F. Broadway (E.M.I.).
K. I. Jones (Ferguson).
E. P. Wethey (K.B.).
V. J. Cooper (Marconi's).
Dr. R. L. Smith-Rose (D.S.I.R.).
T. M. C. Lance (Rank-Cintel).
C. W. Sowton (Post Office), secretary.

WORLD OF WIRELESS

I.T.A. Plans

FUTURE plans for the extension of the coverage provided by the I.T.A. stations include five new transmitters to be opened next year and further stations the following year. As has already been announced, the Authority is also increasing the height of the masts at Croydon (which with its new aerial will then have an e.r.p. of 200kW) and at Black Hill and Lichfield.

The first three stations, to be brought into service next spring, are the dual transmitters in the south-west—Stockland Hill, Devon (channel 9) and Caradon Hill, Cornwall (12)—and Caldbeck, near Carlisle (11). Towards the end of 1961 a high-powered transmitter will be opened in Kincardineshire, Scotland, on channel 9 and a low-power transmitter at Selkirk, the channel for which has not yet been announced.

Stations planned for 1962 are for Inverness-shire, West Wales, Londonderry and the Channel Islands if the provisions of the Television Act are extended to cover the Islands.

Receiver Production

THE sale of 17-inch television receivers continues to dominate the home market and in 1959 represented 91% of the 2.75M receivers sold. The previous year's figure was 83% of the 2M sets sold. The sale of 21-inch sets rose from about 100,000 in 1958 to 165,000 last year—the percentage of the total sales being 5 and 6 respectively. The demand for 14-inch sets continues to decline.

Receiver exports for 1959, valued at £3,247,000, declined by 8% compared with the previous year. Sweden, for the second successive year, heads the list of receiver importers with a total of £298,796 of which all but £5,000 was for television receivers. Nigeria is second in the list with a value of £248,531, but little of this was for television—the country's first TV stations opened last October. The second highest importer of television receivers was Eire with £101,934 worth.

These figures are given in the annual report of the British Radio Equipment Manufacturers' Association.

Inst.P. and Phys. Soc. Amalgamate

PROPOSALS for the amalgamation of the Institute of Physics and the Physical Society have been a frequent topic of discussion and now a new body under the name "The Institute of Physics and The Physical Society" has been incorporated.

The Physical Society was founded in 1874 and on the initiative of that Society the Institute of Physics was founded 45 years later. The original scheme for the Institute envisaged a kind of federation of societies interested in physics.

Broadly speaking, the scientific meetings and publications of the Institute were confined to applied physics, while those of the Society were concerned more with pure physics. As, however, over the past 20 years or so, the boundary between these two aspects became less defined, there has been increasing

overlap in the activities of the two bodies and in their membership.

The three Institute of Physics grades of membership—fellow, associate and graduate—will continue under the new organization but there will also be fellows of the Physical Society.

The first president of the amalgamated body is Sir John Cockcroft.

Birthday Honours

AMONG the recipients of awards in the Queen's Birthday Honours list are the following:—

Knighthood

Dr. Gordon B. B. M. Sutherland, F.R.S., Director, National Physical Laboratory.

Dr. Basil F. J. Schonland, C.B.E., F.R.S., Director, Research Group, U.K. Atomic Energy Authority.

K.B.E.

Dr. Robert Cockburn, C.B., O.B.E., Chief Scientist, Ministry of Aviation.

C.B.

Major-General E. S. Cole, C.B.E., Director of Telecommunications, War Office.

Dr. J. S. McPetrie, Director-General of Electronics Research and Development, Ministry of Aviation.

C.B.E.

Dr. T. E. Allibone, F.R.S., Director, A.E.I. Research Laboratory, Aldermaston.

Dr. R. A. Smith, Chief Scientific Officer, Royal Radar Establishment.

O.B.E.

F. W. Bates, Works Director, Kelvin and Hughes.

Dr. L. F. Broadway, Head of E.M.I. Research Laboratories.

R. J. Clayton, Manager, G.E.C. Applied Electronics Laboratories.

Dr. A. L. Cullen, Professor of Electrical Engineering, University of Sheffield.

F. J. D. Taylor, M.B.E., Staff Engineer, Post Office Research Station.

M.B.E.

F. H. Austen, General Manager, Rediffusion (South East), Ltd.

W. F. Coleman, Deputy Director of Broadcasting (Engineering), Ghana.

W. G. Dickson, Wireless Communications Superintendent, Ministry of Home Affairs for Northern Ireland.

C. A. Green, lately Communications Officer, Office of the U.K. Commissioner for Singapore and Commissioner-General for South-East Asia.

C. H. Pope, Radio Supervisor, War Office.

B.E.M.

Miss S. Holloway, Communications Officer, Birdlip Radio Station, Ministry of Aviation.

Jubilee Lectures.—To mark the 25th anniversary of the formation of the company, Ultra Electric (Holdings), Ltd., is organizing a series of lectures, the first of which will be in the Recital Room of the Royal Festival Hall, London, on September 14th. The speaker will be Professor Arthur Porter, Dean of Electrical Engineering at the University of Saskatchewan, whose subject will be "The evolution of instrumentation." On October 19th, also at the Royal Festival Hall, G. W. A. Dummer, Superintendent of Components Research, Development and Testing at R.R.E., will review the latest developments in components.

D.S.I.R. Grants for Radio Astronomy.—In addition to continued support for the Manchester University's Jodrell Bank experimental station with three grants totalling £187,000, it is stated in the D.S.I.R.'s 1959 Report that it has awarded nearly £40,000 to Professor M. Ryle for the development of new techniques and equipment at Cambridge University. Professor Ryle's work will be aimed at new methods of constructing and improving radio-telescopes and new automatic systems of data-recording for automatic computation.

Disc Production.—Figures issued by the Board of Trade show that in the first four months of this year the production of 45 r.p.m. records increased by 41% compared with last year (17.3M against 12.3M) and 33½ r.p.m. discs by 22% (5.5M against 4.5M). During the same period 63% fewer 78 r.p.m. discs were produced (1.5M compared with 4.1M a year ago).

Licences.—During April the number of combined television-sound licences in the U.K. increased by 98,932 bringing the total to 10,568,685. Sound-only licences totalled 4,484,063, including 432,790 for car radio. In West Germany (including West Berlin) the number of sound radio licences showed a decrease for the first time during the first four months of the year—15,617,338 compared with 15,899,447 on January 1st. During the same period combined television-sound licences increased from 3,385,003 to 3,883,145.

St. Dunstan's has re-established a scientific committee to study the whole field of sensory reading and guiding devices. This is announced in the charity's latest report. Members of the committee are: Air Commodore G. Bentley Dacre (chairman); Dr. A. M. Uttley, superintendent, control mechanisms and electronics division, N.P.L.; Dr. H. B. Barlow, King's College, Cambridge; Dr. R. L. Beurle, English Electric Valve Co.; Dr. D. E. Broadbent, director of applied psychology research unit of the Medical Research Council, Cambridge, and Lord Fraser of Lonsdale.

Anglesey Radio, the new Post Office coast radio station at Amlwch opened by the P.M.G. on May 23rd, has taken over all the coast station services previously provided by Seaforth Radio, which it replaces.

"Broadcast Entertainment by Wire."—We regret that, due to a printer's error, the name Teleng, Ltd., was misspelt in the acknowledgments on page 214 of the May issue.

Potential-indicating Lamps.—Acru's fluorescent-green indicator lamps require a minimum striking potential of 160V, not 7 160V as stated on p. 301 of our June issue.

Biological Engineering Society is the name of a new group which was formed in June. The society has a distinct bias towards electronics and is intended to bring together doctors, physiologists, electronic engineers, mechanical engineers and physicists to further the applications of engineering to biological and medical problems. The president is Dr. R. Woolmer of the Royal College of Surgeons, and the acting secretary is Dr. A. Nightingale, Physics Laboratory, St. Thomas' Hospital, London, S.E.1.

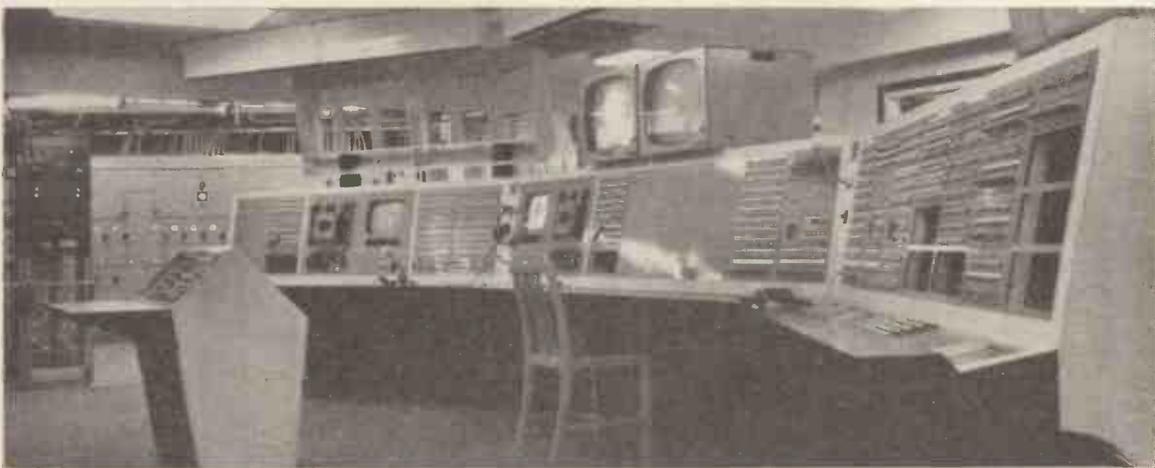
Control Engineering.—A short course providing an introduction to control engineering theory and practice is being conducted by the Loughborough College of Technology from July 18th to 29th. A leaflet, obtainable from the college, gives details of the course. The fee for the course and full residence is 35 gn.

Non-Destructive Testing.—A conference on the "Theory and practice of ultrasonic inspection" is to be held at the Queens Hotel, Cheltenham, from September 22nd to 24th. The arrangements are being made jointly by the Institute of Physics' Non-Destructive Testing Group, the Society of Non-Destructive Examination and the Non-Destructive Testing Society of Great Britain. Details can be obtained from the conference secretary, I. M. Barnes, Materials Laboratory, de Havilland Propellers Ltd., Hatfield, Herts.

Air Traffic Control.—The Guild of Air Traffic Control Officers is to hold its third A.T.C. Convention at Bournemouth on October 18th and 19th. Details are obtainable from the Guild at 118, Mount Street, London, W.1.

Electronic telephone exchanges is the subject of a conference being organized by the I.E.E. for November 22nd to 24th. It is hoped it will provide an opportunity for the interchange of information and experiences of the construction and operation of fully electronic exchanges both in this country and overseas. Further details and a form of registration may be obtained on application to the I.E.E., Savoy Place, London, W.C.2.

"Television Explained."—First published in 1947 under the authorship of W. E. Miller, managing editor of the *Wireless and Electrical Trader*, this book is now in its 7th edition. It includes a new chapter on combined television and f.m. sound receivers. Both this edition and the preceding one were revised by E. A. W. Spreadbury, associate editor of the *Trader*. It is obtainable from our Publishers, price 12s 6d.



FOCAL POINT of the B.B.C. Television Centre, Wood Lane, London, W.12. All sound and vision signals from the nine studios and the telecine and videotape machines are fed to this Central Apparatus Room for distribution. The first transmission from the centre is on June 29th.

Audio Manufacturers' Group of the British Radio Equipment Manufacturers' Association has elected the following member firms (whose representatives names are in parentheses) to form the management committee: A.E.I. Sound Equipment (L. R. Metcalfe); Beam-Echo (H. M. Rahmer); E. K. Cole (J. A. Catchpole); Clarke & Smith (Major J. F. E. Clarke); Electric Audio Reproducers (L. Stone); Gramophone Co. (H. S. Futter); Gramipian Reproducers (J. E. Morley); Jason (G. G. Blundell); Lowther (D. M. Chave) and Trix (D. A. Lyons). The Committee has re-elected Major J. F. E. Clarke as chairman and elected D. M. Chave vice-chairman in succession to D. A. Lyons.

Autumn Audio Fair.—The venue for this year's Autumn Audio Fair is to be the Palace Hotel, Southport, Lancs. It is being organized by Audio Fairs Ltd., 22 Orchard Street, London, W.1, and will be held on October 7th, 8th and 9th.

R.I. Club.—The report presented at the annual general meeting of the Radio Industries Club on May 31st recorded a membership of the "parent" club of 996. The membership of the seven affiliated clubs in the provinces is 1,330. F. W. Perks, chairman of Radio Industry Exhibitions Ltd. and immediate past chairman of B.R.E.M.A., is the new president of the club.

Radio Ball.—This annual function organized by the Radio Industries Club during the National Radio Show will be held at Grosvenor House, Park Lane, London, W.1, on August 26th.

I.E.E.—More meetings were held by the Electronics and Communications Section of the I.E.E. than all three other sections of the Institution. The Electronics and Communications Section also has the largest membership (6,171) of any specialized section. During the year ended in March, the Institution membership increased by 1,678 to 46,222. Student members increased by 592 to 4,689 and graduates by 530 to 14,545.

Personalities

Lord Halsbury has been appointed a Governor of the B.B.C. until 1962 in succession to Sir Edward C. Benthall, who has resigned. Lord Halsbury was managing director of the National Research Development Corporation for ten years until his retirement in March, 1959. He is now chairman of International Rectifier Co. (G.B.) Ltd., which was formed by the International Rectifier Corporation of the U.S. and the Lancashire Dynamo Company, and also of L.C.E. Ltd. recently formed jointly by G. & E. Bradley (a subsidiary of Joseph Lucas) and Collins Radio Co. of America.

Alan Wolstencroft is the new Director of Radio Services in the Post Office in succession to W. A. Wolverston, who, as announced in our last issue, has become a Deputy Director General. Mr. Wolstencroft, who is 46, joined the Post Office in 1936. He was closely associated with the preparations for the setting-up of the Independent Television Authority in 1954 and was in fact its first secretary for a year.

M. L. Jofeh, O.B.E., A.M.I.E.E., manager of the industrial division of Sperry Gyroscope Co., which he joined in 1947, has been appointed an additional director. For several years he headed the engineering unit at the company's Stonchouse, Glos., factory, but in 1954 returned to Brentford as deputy chief engineer. He was appointed chief engineer in 1957 and, with the reorganization of the company in January last year, became manager of the industrial division in which is concentrated the company's interests in industrial control engineering. For eleven years before joining Sperry Mr. Jofeh was in the research laboratories of Cossor.

John D. Clare, M.Sc., A.M.I.E.E., has succeeded Air Commodore H. B. Wrigley, C.B.E., as Director of Guided Weapons Research and Development (Air) in the Ministry of Aviation. Born in 1920 and educated at Birmingham University, Mr. Clare was employed throughout the war in the development laboratory of the G.E.C., Coventry. From 1945 to 1950 he was a senior engineer with Sobell Industries. He then entered the Civil Service at what is now the Royal Radar Establishment, and was for five years section leader responsible for the centimetric receiver system on new fin control "radar" and low-altitude guided weapons. Since 1955 he has been superintendent of the surface-to-air guided weapons department.



J. D. Clare



R. I. Kinross

R. I. Kinross, M.I.E.E., managing director of Rediffusion Research, Ltd., is the new president of the Society of Relay Engineers. He was for nine years with E.M.I. and for a year with Philco before the war. During the war he served in the Royal Corps of Signals and was seconded to Military Intelligence. He joined Rediffusion after the war as chief engineer of a region, and subsequently took charge of the company's Development Department. He has been managing director of Rediffusion Research and a director of Television Research since 1958. R. P. Gabriel, B.Sc., M.I.E.E., A.M.Brit.I.R.E., the new vice-president of the Society of Relay Engineers, is chief engineer of Rediffusion.

P. W. Faulkner, O.B.E., has joined Rank-Xerox Ltd. as deputy managing director. He joined Plessey in 1952 and for some time was general manager of the company's commercial and metallurgical division at Towcester, Northants. He has been a director of the Plessey International Co. and also an executive director of the Plessey Co. for several years.

J. W. Soulsby, chief radio officer in the British India Steam Navigation Company's vessel *Uganda*, has been re-elected chairman of the Radio Officers' Union for the sixth consecutive year. He joined the Marconi Marine Co. at the age of 18 in 1918. W. S. Armstrong is again vice-chairman. It is his fourth term of office. Mr. Armstrong, who is 47, was with the Marconi Company's marine staff until 1947, when he was appointed to the staff of the Inspectors and Technical Employees' Section of the Union.

J. Sykes, M.I.E.E., M.Brit.I.R.E., M.I.N., has left the Ministry of Aviation, in which he was superintendent of the civil aviation communications centre at Croydon Airport, and is setting up as a consultant specializing in technical training and recruitment schemes. He has been with the Ministry and its predecessors for 25 years. Mr. Sykes, whose address is Red Lion Court, Stalbridge, Dorset, serves on the City and Guilds Advisory Committee on Telecommunication Engineering, and the membership committee of the Brit.I.R.E.

P. T. H. Dannahy, A.M.Brit.I.R.E., has joined Radio and Allied Industries Ltd., manufacturers of Sobell and McMichael receivers, as chief radio engineer. He was chief engineer and production manager with Peto-Scott Electrical Instruments until 1945, when he joined the Ferguson Radio Corporation as chief radio engineer.

P. T. H. Dannahy



E. David Parchment, who joined Leever-Rich Equipment last August as technical sales manager, has been appointed a director in place of **G. W. Parkes**, who has resigned from the directorate of the company. Mr. Parchment was for many years with the Decca Record Co. and subsequently was sales director of Epsilon Sales and Services Ltd.

W. E. C. Varley, Assoc.I.E.E., A.M.Brit.I.R.E., has been appointed by the B.B.C. Superintendent Engineer, Transmitters, in succession to **E. F. Wheeler**, O.B.E., D.L.C., M.I.E.E., who has retired after 17 years in the post and 36 years' service with the Corporation. Mr. Varley joined the Corporation in 1933. During 1943 and 1944 he was chief broadcasting engineer at the Allied Forces Headquarters in North Africa.

M. H. Hall, M.B.E., has become Assistant Superintendent Engineer, B.B.C. London Television Studios, in succession to **H. Walker**, O.B.E., A.M.I.E.E., who is retiring. Mr. Walker joined the B.B.C. in 1931. He was appointed engineer-in-charge of the Alexandra Palace television station in 1950 and since 1953 has been Assistant Superintendent Engineer, London Television Studios. Mr. Hall joined the Corporation in 1927. In 1950 he was appointed engineer-in-charge of the B.B.C. Television Studios at Lime Grove.

W. D. Hatcher, B.Sc.(Eng.), A.M.Brit.I.R.E., who succeeds Mr. Hall as Engineer-in-Charge, London Television Studios, joined the B.B.C. in 1931. During the war he was concerned with the design and equipment of the B.B.C.'s high-power short-wave transmitting stations.

C. Powell, contributor of the article "Radio Aids to Hydrography" in this issue, has been with the Decca Navigator Co. since 1946. He is now in charge of the company's technical information department, but was initially concerned with applications of the Navigator for surveying and originated the two-range Decca technique. Mr. Powell's industrial career began in 1934 when he was personal assistant to **P. K. Turner**, of Hartley-Turner Radio. For part of the war he was attached to the Army Operational Research Group.

J. H. Mitchell, B.Sc., Ph.D., M.I.E.E., has been appointed to succeed **G. D. Christie** as chairman of the board of directors of Associated Transistors Ltd., which is operated jointly by Automatic Telephone & Electric Co., English Electric, and Ericsson Telephones. Dr. Mitchell, who is director of research of Ericsson Telephones, which he joined in 1947, was at the Bawdsey Research Station in 1936 and for his radar contributions he received an award from the Royal Commission on Awards to Inventors. Mr. Christie, who is a director of A.T. & E., remains a member of the board of Associated Transistors Ltd.

D. M. MacKay, B.Sc., Ph.D., who is in the Wheatstone Physics Laboratory, King's College, London University, has been appointed to the Research Chair in Communication founded by Granada Television in the University College of North Staffordshire.

Wing Commander A. R. Gilding, newly appointed assistant technical secretary of the Electronic Engineering Association, was until recently in charge of the branch of the Air Ministry responsible for airborne radio servicing policy and some aspects of new airborne equipments. Throughout his career in the R.A.F., which he began in 1927 as an aircraft apprentice, Wing Commander Gilding specialized in communications and radar. For two years before being posted to the Air Ministry in 1954, he was at N.A.T.O. headquarters, Oslo.

OBITUARY

Rupert Browne, O.B.E., B.Sc., who, owing to ill-health, resigned from the secretaryship of the Radio Industry Council in 1957, died on May 21st. Born in 1897 and trained as a chemist, Rupert Browne graduated at London University. In 1924 he joined the staff of the National Association of Radio Manufacturers and then, when the Radio Manufacturers' Association was formed, he joined that organization. When in 1945 the Radio Industry Council was born out of the R.M.A. he became its secretary. He was appointed an O.B.E. for his work on a war-time committee, under the chairmanship of Lord Hankey, devising and working a scheme, in collaboration with others in the radio industry, for the training of radio engineers for the Services.

F. G. Robb, A.M.I.E.E., chief of Marconi's Test Division from 1948 until his retirement five years ago, died on May 14th. He was with the company for 36 years except for a period during the last war, when he was seconded to the Admiralty, where he became chief of radar test. He was for some years in the company's design and development section, where at one time he worked on the development of transmitters for the Marconi-Franklin short-wave beam system.

John A. J. Cooper, sales director of Leever-Rich Equipment since 1954, died on May 16th at the age of 67. After service with the War Department, Mr. Cooper joined the B.B.C. in 1928 and became senior recording engineer in the engineering division.

Philatelists among our readers will be interested in this series of six stamps recently issued by the Czechoslovak Postal Authorities commemorating International pioneers of wireless. They are **Tesla** (Yugoslavian); **Popov** (Russian); **Branly** (French); **Marconi** (Italian); **Hertz** (German); and **Armstrong** (American). Each stamp includes a portrait of the pioneer and an illustration depicting an aspect of his work.



News from the Industry

Relay Exchanges Ltd., record a group trading profit during 1959 of £3,583,311, compared with £2,515,988 the previous year. After deducting over £2M for depreciation and provision for renewal of equipment and £128,182 for taxation, the year's net profit was just over £1M. Subsidiaries of Relay Exchanges include 16 radio and television relay companies, six Rentaset renting companies, four retail concerns and three manufacturing companies including Goodmans Industries.

Simms Motor and Electronics Corporation have announced a group trading profit for the past year of £1,037,690 before taxation, compared with the previous year's £632,072. Taxation absorbed £548,200 in 1959 and £366,000 the year before. Reference is made in the directors' report to the activities of N.S.F., which in terms of output and profit ranks second in the group, and to the recent acquisition of Cawkell Research and Electronics.

Pye closed-circuit television has been installed in a new plant of the Dunlop Rubber Co. at Fort Dunlop, Birmingham, to facilitate the examination of tyres being tested at speeds of up to 500 m.p.h. Each of the two cameras has two lenses. A calibration grid is electronically superimposed on the television display in the control room from which the cameras are remotely operated.

The Chloride Electrical Storage Co. has opened new central research and development laboratories at Fletcher Avenue, Clifton, Swinton, Manchester, for fundamental research into the physics of electrochemical couples, including fuel cells, and into the problems of extending life and reducing weight and cost in conventional types of cell. The laboratories have a floor space of 41,500 square feet and there is a staff of 180, including 40 qualified specialists.

Du Mont Agents.—Aveley Electric Ltd., of Ayrton Road, Aveley Industrial Estate, South Ockendon, Essex, have been appointed U.K. agents for all products of the Allen B. Du Mont Laboratories Inc., of the U.S.A. The Du Mont range of equipment includes the new 425 digital-readout high-frequency oscilloscope, oscilloscope recording cameras and photo-multipliers.

Ferranti announce that they are engaged in the development of another radar fire control system, Airpass II. The original Airpass was shown publicly for the first time at the S.B.A.C. show at Farnborough last September. Airpass II will provide the following facilities:—air-to-air radar search and automatic tracking, computer-controlled approach for blind or visual attacks, and radar-assisted attacks against surface targets.

Britec Ltd., of 17 Charing Cross Road, London, W.C.2 (Tel.: Whitehall 3070), have been appointed distributing agents for Elesta cold-cathode tubes and electronic controls manufactured in Switzerland.

Marconi's are supplying a 50-kW 50-cm airfield control radar, Type S264, with two moving-coil display units and ancillaries, for the Royal Radar Establishment airfield at Pershore, Worcestershire.

R.C.A.—Dr. H. R. L. Lamont, director of R.C.A. European technical relations, has moved his office from Pall Mall to 36 Berkeley Square, London, W.1 (Tel.: Grosvenor 1217).

A new factory for the production of selenium rectifiers and silicon diodes was opened at Oxted, Surrey, on May 25th by the International Rectifier Company (Great Britain) Ltd., which is jointly owned by Metal Industries Ltd. (through its acquisition of Lancashire Dynamo Construction) and the International Rectifier Corporation, of Los Angeles.

Grundig in N. Ireland.—A new company, Grundig Works Ltd., is being formed in Belfast to operate a factory in Dunmurry on the outskirts of the city. The factory, which is planned to begin operation in September, will initially produce one model tape recorder, but eventually other equipment will be made. All products made at the factory will be distributed throughout the U.K. by Grundig (Great Britain) Ltd. The directors of Grundig Works include Max Grundig (founder of the organization), three others from the parent company and G. S. Taylor, chairman and managing director of Grundig (G.B.) and of Wolsey Electronics.

Nash & Thompson Ltd., Hook Rise, Tolworth, Surbiton, Surrey, have been given approval as a Part III Test House (including testing under environmental conditions) by the Director General of Inspection for Functional and Performance Testing of Electronic Components. The company's environmental and electronic testing laboratories have been in existence for over six years and have been approved as a Test House by the Air Registration Board for some time. Any firm or organization may submit components for testing to a specification and a Certificate of Test will then be issued stating that the tests have been carried out in accordance with the requirements of the Air Registration Board or Director General of Inspection.

E.M.I. Electronics Ltd. have supplied the vision equipment and have carried out the "technical" wiring and installation at Associated Rediffusion's new Studio 5, opened recently at Wembley, Middx. They are also supplying 15 cameras for the television studios being constructed at Teddington, Middx. for A.B.C. Television.

Marconi's have been awarded the contract for the supply and installation of the vision and sound transmitters for the new I.T.A. station at Caldbeck to serve the Carlisle area. In addition to the duplicated transmitters and ancillary equipment, Marconi's are supplying the mast and horizontally polarized sixteen-stack quadrant aerial which will give a vision e.r.p. in the direction of maximum propagation of over 100kW.

EXPORT NEWS

Midas range of magnetic tape data recording equipment developed by Royston Instruments Ltd., of Byfleet, Surrey, is to be marketed in the Western Hemisphere and Australasia by Lockheed Aircraft Services Ltd., of Ontario, California.

The Italian hydrofoil, *Freccia dell'Adriatico*, which operates a passenger service between Trieste and Venice (a distance of 80 miles) at an average speed of 40-45 knots, carries Kelvin Hughes marine radar type 14/9. Kelvin Hughes have also received orders for radar for Italian-built hydrofoils for operation in Norway and Finland.

Poland.—Three Marconi Mark IV television cameras and ancillary equipment have been ordered for the Warsaw studios of the Katowice station which was equipped by Marconi's. Polish television operates on the 625-line, 8Mc/s standard.

Brazil.—The complete studio and transmission equipment for a new television station at Recife, Brazil, costing in the region of £250,000, has been supplied by Marconi's.

India.—G. S. Dhingra, director of Union Radio & Appliances Private Ltd., of 72 Janpath, New Delhi, will be visiting the U.K. in July to negotiate with firms interested in collaborating in the manufacture in India of components such as fixed and variable resistors and capacitors, loudspeakers and switches.

Wire Broadcasting in Holland

PLANS FOR DISTRIBUTING TELEVISION OVER THE EXISTING SOUND NETWORK

ALTHOUGH Holland is a relatively small country it has always held a high reputation for its contributions to art, science and the social services. In broadcasting its radio stations led the way in Europe in the early days, and today it enjoys one of the most efficient and widely disseminated wire distribution systems in the world.

This is run by the postal telegraph and telephone authorities, the Netherlands PTT, which was made responsible during the war for control of several independent networks and has since continued to develop and extend an integrated system.

The accompanying map gives some indication of the coverage (1959) of the main trunk cables and branches.

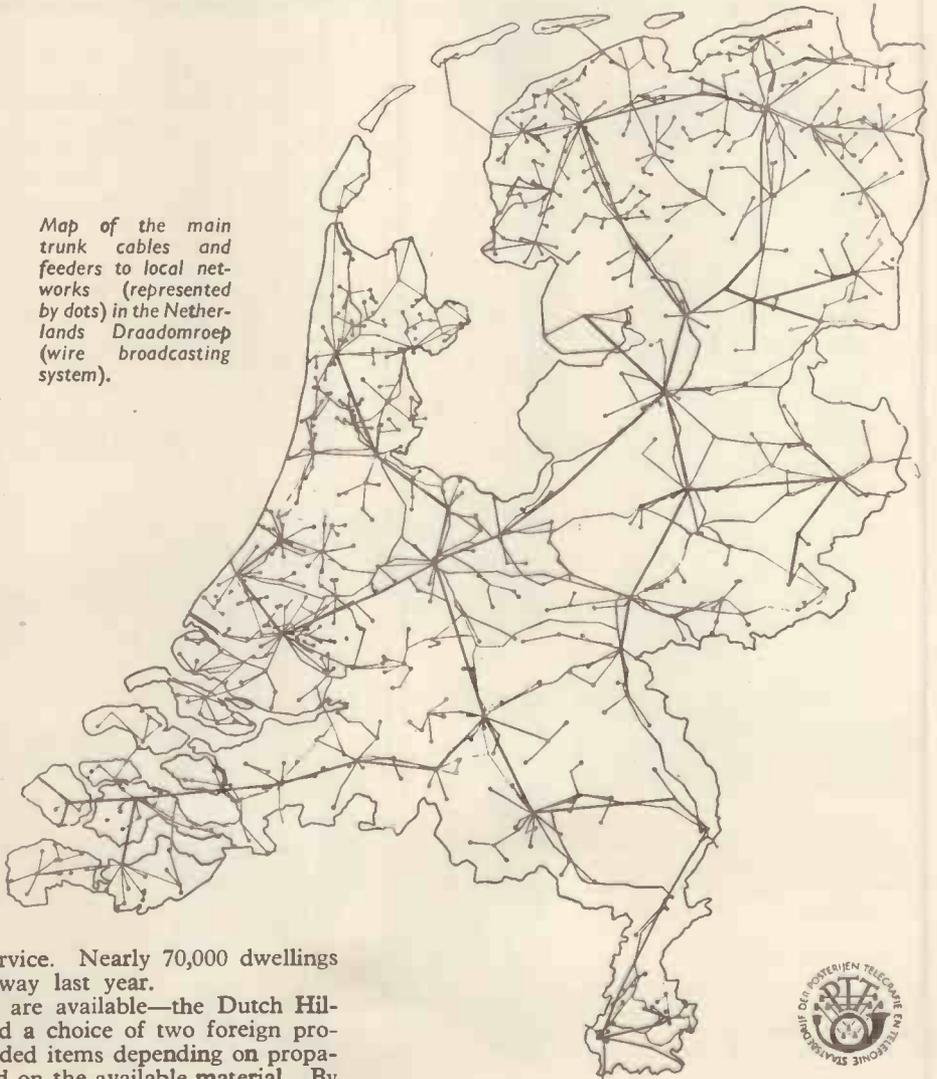
Points on the map represent one or more power amplifiers feeding local "networks" of anything up to 1,800 houses. The total number of subscribers in Holland is about 500,000 in a population of 11 millions (1 in 22) whereas in Great Britain the ratio is 1 in 50 (1M in a population of 50M). All new housing estates in Holland are now wired in advance for telephone and broadcast relay services, without any obligation on the tenants to become subscribers. Terminal outlets are embedded in the wall plaster and covered by a flush-fitting cover, which is easily replaced by a control panel with stepped volume control and selector switch if the occupants of the house or flat elect to take the relay service. Nearly 70,000 dwellings were fitted in this way last year.

Four programmes are available—the Dutch Hilversum I and II and a choice of two foreign programmes or of recorded items depending on propagating conditions and on the available material. By

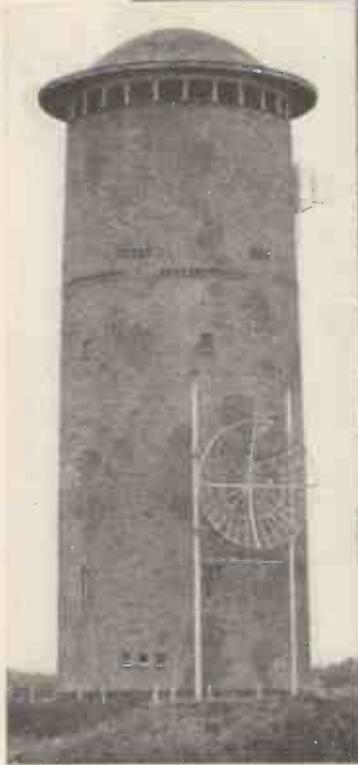
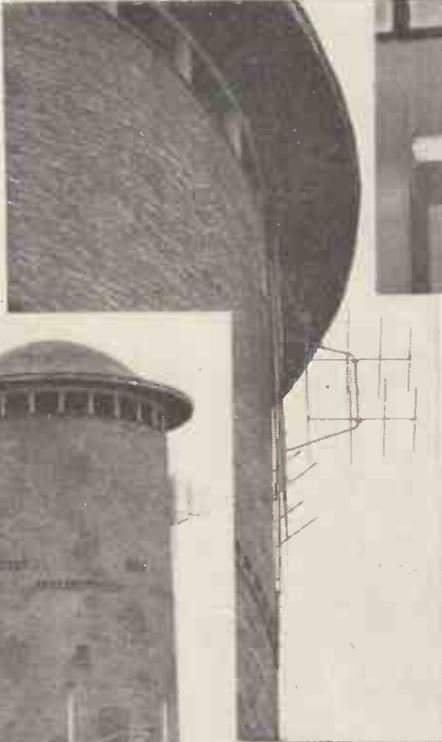
mutual arrangement with the Belgian authorities, any of their programmes may be selected by remote control and passed direct from Brussels to Rotterdam by land line. Programmes from other countries are picked up by special receivers placed at favourable sites on the borders of Holland. The receivers for the three B.B.C. services are installed in a water tower at Domburg on the island of Walcheren and normally give an acceptable signal/noise ratio from Wrotham (130 miles) or Norwich.

Special care is taken to provide high quality of reproduction and a frequency response of 40c/s to 10kc/s \pm 2dB is guaranteed in all parts of the system. Local distribution amplifiers are housed

Map of the main trunk cables and feeders to local networks (represented by dots) in the Netherlands Draadomroep (wire broadcasting system).



in kiosks which are visited regularly each month by technical staff in a van specially fitted with the instruments necessary for a thorough check of performance. The audio power available at the subscribers' outputs is of the order of $\frac{1}{2}$ watt which provides an acoustic level sufficient for most people's needs if a loudspeaker of reasonable efficiency is used. Although the authorities do not supply more complicated reproducing equipment, guidance is given for those who may wish to use existing receivers or add high-quality power amplifiers.



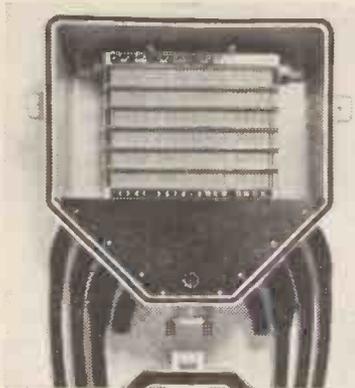
Above: The receiving station for English programmes is situated at the top of the water tower at Domburg in the island of Walcheren.

At present there is no regular wire distribution of television in Holland, but a thorough investigation has been made* of the feasibility of using the existing sound broadcasting cables at high frequencies. It has been found that the polythene-insulated, un-screened cables with four pairs, each twisted with different pitches have a good performance at frequencies up to 10Mc/s and that the older paper insulated cables can also be used satisfactorily. The polythene cables used in Holland appear to suffer less from increased attenuation—about 10 to 15% under adverse conditions compared with over 30% for similar types used elsewhere. The average loss per kilometre is between 23 and 57dB at the chosen vision carrier frequency of 7Mc/s depending on the

* See for example "Some Problems Concerning the Experimental Wire Television Service as Realised in the Netherlands," by A. P. Bolle, *Het PTT Bedrijf*, Vol. IX, No. 3, November 1959.



Right: Control centre at Rotterdam, where programmes are selected and monitored. Level indicators for each of the four programmes are at the back of the control desk.



Above: Distribution box for subscribers' lines. Television and/or sound signals can be applied to any subscriber by the insertion of the appropriate resistive or inductive elements which are encapsulated in foamed polystyrene resin.

Right: A mobile laboratory visits each network amplifier once a month for a thorough check of performance.



type of cable under consideration. The cross-view between pairs at a distance of 2km is better than 40dB. With a sending level of 3 volts peak-to-peak the maximum radiated field at a distance of 3 metres is $200\mu\text{V/m}$. Interference picked up on the un-screened cable would be of longitudinal character and experience has shown that its magnitude is unlikely to cause trouble unless the signal level falls below 20mV.

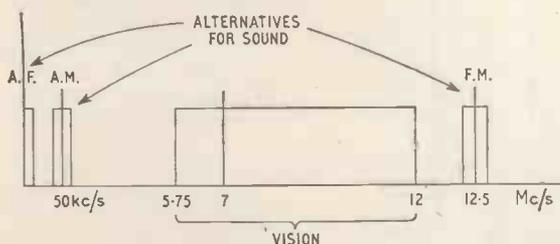
The characteristic impedance of the cables at r.f. is of the order of 100 ohms and careful matching at all junctions is necessary to avoid reflections and "ghosts." The ratio of the special transformers used at these points varies according to the number of subscribers which may be up to as many as 16. The impedance "seen" at the secondary is about 1.5 ohm and as each subscriber's loading is of the order 5,000 to 10,000 ohms decoupling is very effective. Separation of sound and vision takes place after the subscriber's selector switch by simple series inductors and capacitors.

By using a vision carrier of 7Mc/s with a complete upper sideband and vestigial lower sideband it is possible to legislate for the use of existing receivers by changing the oscillator frequency and to keep the f.m. sound signal at the normal spacing of 5.5Mc/s, i.e., at 12.5Mc/s. Alternatively, if special simplified television receivers become available for use with the wire system it is proposed to

provide the sound accompaniment as a double sideband a.m. signal on a 50kc/s carrier. This is preferable to sending the sound at audio frequency as it enables the original four sound-only programmes still to be distributed. Although the initiation of a regular wire television service in Holland still awaits official sanction and possibly the backing of private enterprise to provide the recommended special receiving equipment, the technical problems of transmission have been solved.

Through the courtesy of the Netherlands PTT *Wireless World* was able recently to witness test transmissions of alternative television programmes over standard four-pair cables carrying the regular sound programmes. The two television signals were using synchronized carriers on adjacent pairs of an experimental circuit installed at the Leidschendam research laboratories. Excellent picture quality was obtained and there was no trace of interference from either sound or the alternative vision programme, even when the modulation of one vision carrier was switched off and the raster examined at full gain.

Similar tests carried out over a period of a year with the collaboration of subscribers in a district of the Hague have proved the reliability of the system in the field. Only one live television programme is at present available in Holland, but satisfactory tests of cross-view were made with the alternative programme supplied by a pattern generator. It was also confirmed that the effect of any external interference picked up by the un-screened feeders is negligible.



Spectrum of the proposed television transmissions with possible alternatives for the sound accompaniment.

European Television Stations

Europe's 680 or more television stations in Bands I, III and IV are tabulated geographically and in order of frequency in the 5th edition of the list of TV stations produced by the Technical Centre of the European Broadcasting Union. A chart showing the stations in each of the channels is included in the publication, which is obtainable from the E.B.U., 32 avenue Albert Lancaster, Brussels 18, Belgium. The list and its supplements costs 50 Belgian francs.

High-gain Video Amplifier*

FURTHER NOTES ON VERSIONS FOR GRID OR CATHODE MODULATION

By R. G. YOUNG

IT is very gratifying to learn from the Editor that there has been a widespread interest in, and requests for, further practical details of a circuit which I should have thought would have been of merely limited interest. Evidently many folk still prefer to make their own television receivers, even in these mass-produced days and in spite of the trouble in getting parts. You almost need a licence to get 110° scanning coils!

The circuit was evolved after many efforts to overcome i.f. instability, bearing in mind that "fringe-area" operation was required. The instability manifested itself partly by bad streaking after bright objects—this was particularly so in scenes containing venetian blinds or staircases. The other effect was a black edge on bright objects, due to overshoot; this was not quite so bad, but looked terrible on Test Card C.

It seemed to me that the trouble arose from excessive signal levels appearing at the detector diode. The only answer could be to get more video-frequency amplification, and this circuit was the result after much trial-and-error experimentation with various arrangements.

It seems a little complicated, but it goes into a

space $5\text{in} \times 2\frac{1}{2}\text{in}$ quite comfortably (see Fig. 1). I put both cathode-bypass capacitors on top of the chassis where they were easy to get at, as a change of 20% in value produces an appreciable difference in the picture, and can make or mar results. It appears that if the first cathode-bypass capacitor is too high in value, a "ring" at about 2Mc/s is caused and too high a capacitance in the second amplifier cathode circuit causes a less-severe ring at about 1Mc/s.

In the original version definition was quite satisfactory with a wideband i.f. amplifier; but it is possible that the circuit might be used with an i.f. amplifier having a narrower pass-band, in extreme fringe conditions. In this case a choke in the second v.f. stage anode circuit can improve the picture.

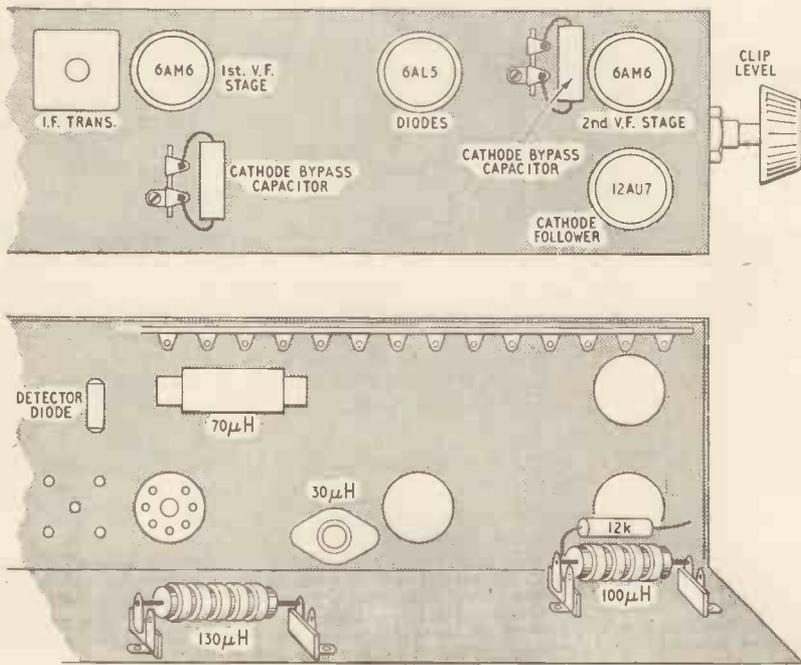
Fig. 2 is the final result. Shown here is the use of a thermionic diode for the detector—some readers may prefer it—and it does make the polarity quite clear.

If space is very limited a triode-pentode of the ECF82 type can be used for the second amplifier and cathode follower with, however, a loss both of gain and peak-to-peak output (about 30%). Some may wish to eliminate the cathode follower altogether. To do this would mean using a lower-value anode

resistor in the second v.f. stage, as the stray capacitance of the c.r.t. and synchronizing separator would then become important. The effect would then be to reduce the available output (peak-to-peak). It could be done, but I do not recommend such a radical change, just to save a single triode; better to use a triode-pentode. Further information about the use of cathode followers in v.f. amplifiers was given in a Mullard technical advertisement (*Wireless World* for August, 1955, p. 90†).

It may be desired to use the amplifier in a receiver designed for grid modulation of the c.r.t. Several changes are needed in addition to the

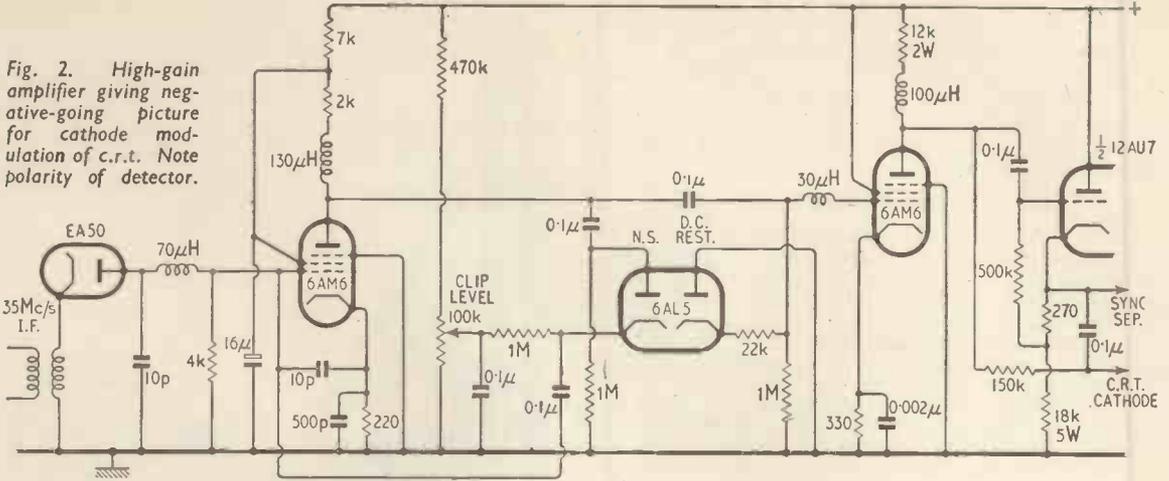
Fig. 1. Top and under-side views of $5 \times 2\frac{1}{2}$ -in chassis layout used for cathode-modulating version of amplifier. Leads must be kept short and stray coupling avoided.



* See "Letters to the Editor," p. 294, *Wireless World*, June 1960.

† This is an abridged version of a paper published in *Mullard Technical Communications* No. 12 (May 1955), p. 42.

Fig. 2. High-gain amplifier giving negative-going picture for cathode modulation of c.r.t. Note polarity of detector.



changes in polarity. The d.c. restorer becomes superfluous as the second v.f. stage grid will do the same job, by reducing the cathode bias. The purpose of the "safety circuit" round the cathode follower in Fig. 2 is to ensure that, in the event of a valve failure, the c.r.t. beam is cut off. For grid modulation of the tube this is achieved when the feed is taken directly from the cathode follower, so this safety circuit is not necessary. The modified circuit is shown in Fig. 3.

There now remains to be supplied data on choke winding. The coils of 70μH and 30μH are close-wound solenoids, and the 130μH and 100μH inductors employ pile-wound sections. Details are shown in Fig. 4. All the coils were checked on an inductance (audio-frequency) bridge: it would be wise to adopt this procedure because surprising variations in inductance can occur with hand-wound coils.

It must be remembered, too, that when one of these circuits is used to replace the existing video amplifier in a receiver, some adjustment to the brilliance-control network may be necessary to achieve proper range of control.

In conclusion, one unexpected bonus from the use of this circuit is the apparent reduction of "snow"

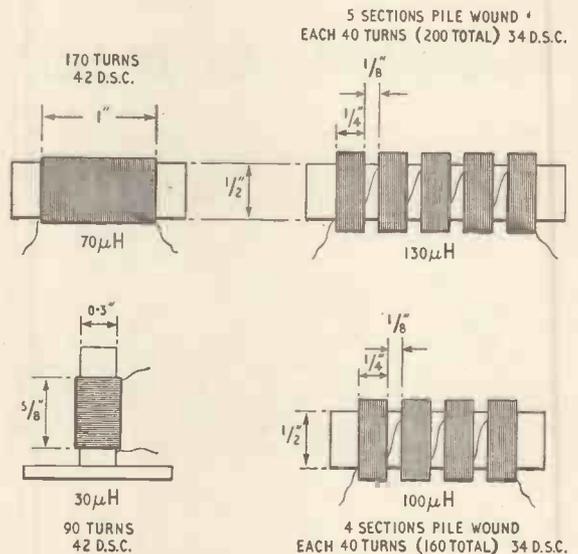
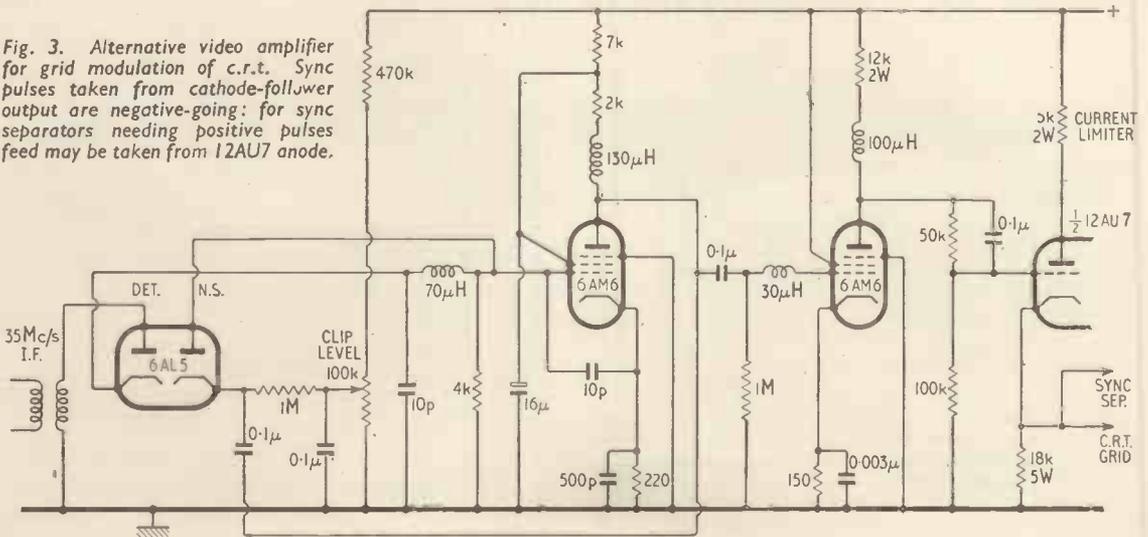


Fig. 4. Coil-winding details (wire gauges given are s.w.g.).

Fig. 3. Alternative video amplifier for grid modulation of c.r.t. Sync pulses taken from cathode-follower output are negative-going: for sync separators needing positive pulses feed may be taken from 12AU7 anode.



on the picture; just why that is, I do not attempt to explain, but just mention it in passing.

Several readers have asked for recommendations of diode type. This is quite unimportant; I have tried Mullard OA10, G.E.C. GEX34 and "unknown" (surplus) types and could perceive no difference in the image obtained.

APPENDIX

For use at i.f. below 35-38Mc/s the filtering is not really satisfactory. As the circuit stands, a small amount of an i.f. below say, 20Mc/s, could appear in the output. This might not cause trouble in all cases, but it would be advisable to connect a 70- μ H choke in series with the cathode follower output when using a low i.f.

Where $\frac{1}{2}$ -in diameter formers are not available 0.3-in diameter can be used. For the 130- μ H and 100- μ H coils use wire gauge and spacing as shown in Fig. 4 but increase each section to 65 turns. The 70- μ H coil would be sectionally wound with similar dimensions to the 100- μ H choke, but each section would contain 50 turns.

Birmingham-London TV Link

SO that programmes, rehearsals and advertisements originating at A.T.V Alpha Studios, Aston Road, Birmingham, can be seen at Associated Television's headquarters in London, Pye Telecommunications Ltd. have installed for A.T.V a 7Gc/s, 135-mile-long link for both sound and vision. Three automatic repeater stations are used at Meriden, Cold Ashby and Barkway and the terminals are on the C.M.L. building in Birmingham and at Highgate, London.

A feature of the Barkway repeater, which has a tower over 200ft high, is the use of passive reflectors on the tower with the microwave transmitter and receiver aerial "dishes" mounted horizontally only a few feet above the ground. Normally both the transmitter and receiver would have to be placed at the top of the tower, or long waveguides would be necessary to feed the aerials, so a considerable saving in both initial and



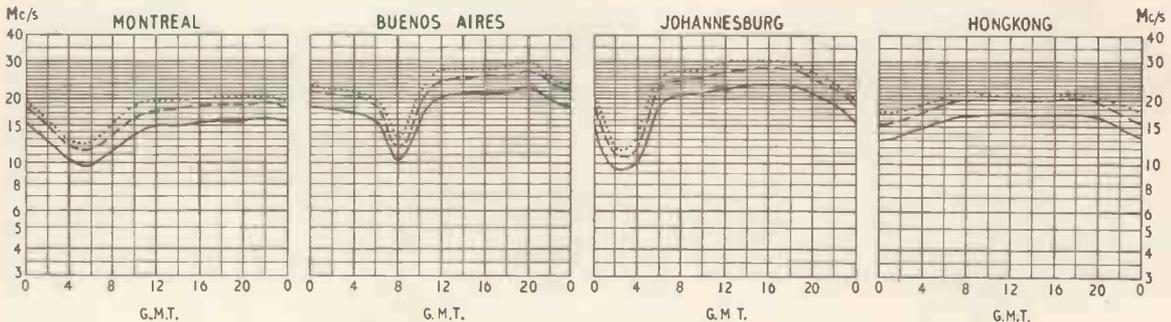
Plane passive reflector on mast reflects to next repeater beam from aerial at ground level.

maintenance costs has been made possible by the use of this technique of "mirroring" at the top of the tower the aerials at ground level.

Faults occurring at any station are automatically indicated on the London control board by telemetry circuits operating over a 450-Mc/s control link. Authority to install and operate the system was granted by the General Post Office, who have recently made available a band of microwave frequencies for such operations.

SHORT-WAVE CONDITIONS

Prediction for July



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 July.

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



General view of the four huge reflectors at Thule, Greenland

BMEWS

American Long-range Radar Warning System

ALTHOUGH primarily a defence project for N. America the ballistic missile early warning system (BMEWS for short) is of more than passing interest to us in the U.K. first for its technical features and secondly because one of the three "forward bases" is to be in this country. Under an agreement between the U.S.A. and the U.K. we are co-operating in setting up and operating a radar tracking station on Fylingdales Moor, Yorkshire. The technical equipment for the station is being provided by the U.S. but the station will be commanded and operated by the R.A.F. The other two bases are at Thule, Greenland, and Clear, Alaska, and all three will be linked by duplicated communication channels, using cables, tropospheric scatter and microwave radio links, to the control centre of the North American Air Defence Command (NORAD) at Colorado Springs, Colorado.

The first base to be completed is at Thule which is planned to come into operation later this year. At this site there are four large rectangular reflectors each measuring 400 feet long and 165 feet high. These are for the pulsed-Doppler detection radar and together they will give a total azimuth coverage of 150 degrees.

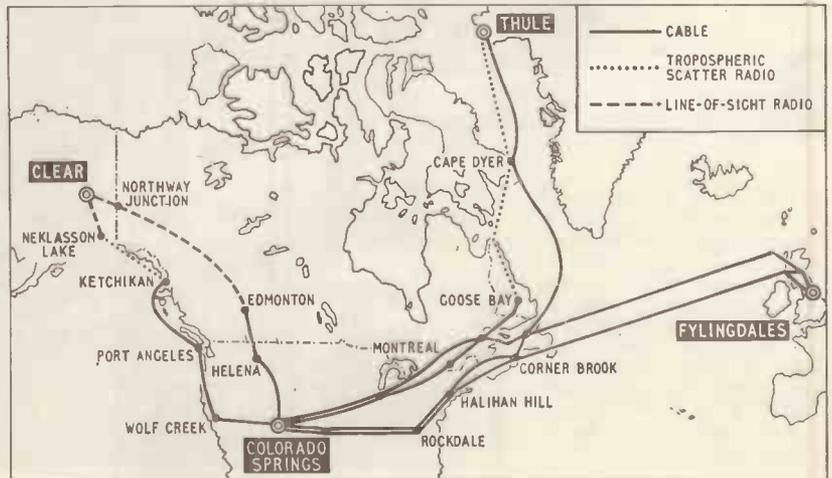
Pulsed transmissions, fed into each reflector from horns on its nearby transmitter building, form two stationary horizontal fans at different elevations. Prediction of the probable land fall of a missile will be obtained by extrapolating its path from the range, azimuth, bearing and time sequence

data recorded as it passes through the fans. Three similar reflectors, giving a coverage of over 100 degrees are being installed at Clear, Alaska, which is scheduled to come into operation some time next year.

At Thule there will also be a dual purpose tracking radar the paraboloid of which will be housed in a specially treated plastic sphere 140 feet in diameter. It is this type of radar which will be installed in this country. At Fylingdales there will be three of these radomes capable of both detecting and tracking missiles and they will provide azimuth coverage of over 100 degrees.

The paraboloid and its pedestal weigh over 150 tons. The radome of the prototype tracking radar at the R.C.A. establishment at Moorestown, New Jersey, was assembled from 1,646 hexagonal sections

Communication routes linking the three radar bases with the BMEWS control centre in Colorado. It will be seen that all links are duplicated.



each section consisting of a 6in thick "biscuit" of resin-impregnated paper between fibre glass walls.

At Thule station staff are protected against possible radiation hazards by the provision of screened passages linking all buildings on the one mile-square site.

The three stations when completed will have an overall range of some 3,000 nautical miles, which is ten times that of the DEW (Distant Early Warning) line which was established across the North American continent some time ago.

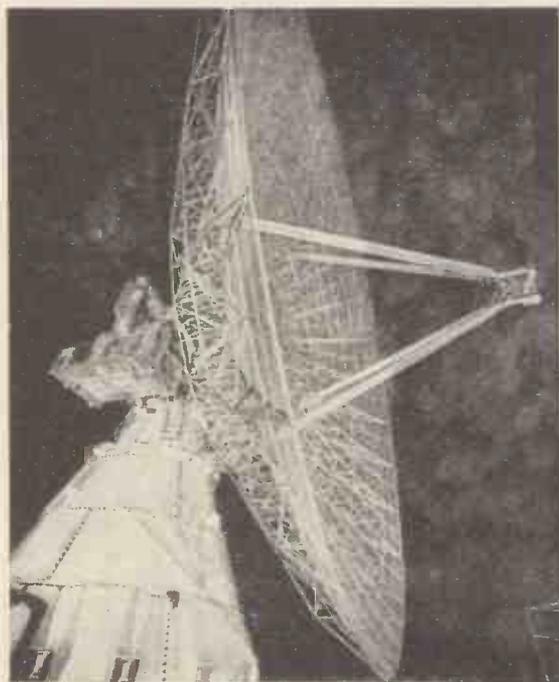
Reliability of the whole system is of paramount importance. To ensure continuous operation all equipment is duplicated and there is an elaborate system of checking and monitoring installed.

Some idea of the magnitude of the whole BMEWS project can be gained from the following statistics given by the American Department of Defense. Although R.C.A. is the "prime contractor" for the project with Western Electric responsible for the communications network, there are 2,900 sub-contractors. The permanent staff at Thule when it becomes operational will be about 1,000 and at Clear about 600.

The estimated cost of the whole project is over \$950M; about half this sum being for the Thule site.



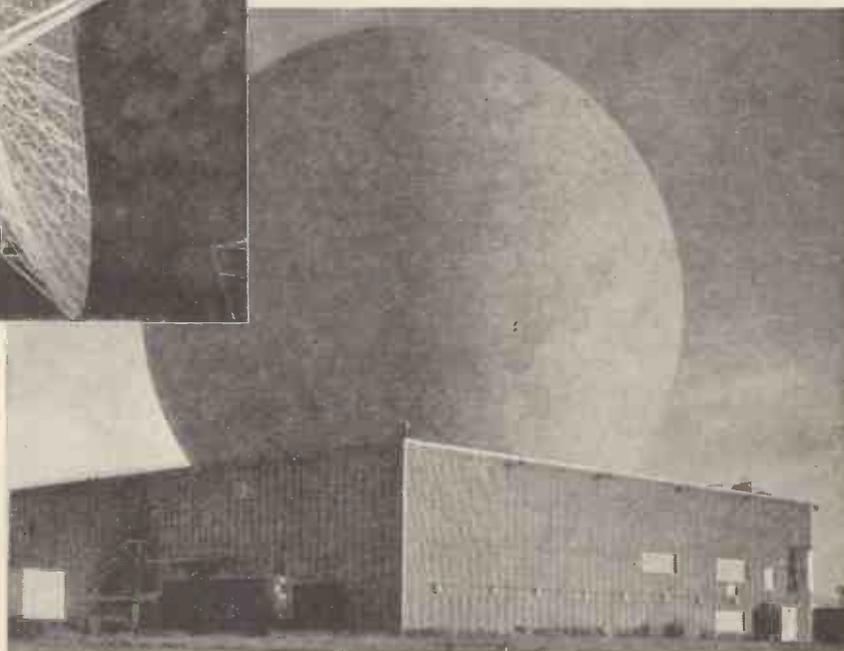
High-power klystrons for the BMEWS project.



Scanner of the tracking radar inside its 140-foot radome. Note the sectional construction of the sphere. On the right is the prototype radome housing the tracking radar atop its transmitter-computer building at the R.C.A. experimental establishment at Moorestown, New Jersey. The buildings and radome to be built at Fylingdales, Yorkshire, will be of similar construction.

The cost to the U.S. Air Force of the Fylingdales site is \$114M.

At the Thule site power during the construction of the station and subsequently for the operation of the system is supplied by a U.S. Navy generator ship—incidentally, the heat dissipated by the generating equipment keeps ice from forming in the basin in which the vessel is anchored.



BETTER CIRCUIT DIAGRAMS

By PATRICK HALLIDAY

SHOULD WE ADOPT CONTINENTAL CONVENTIONS ?

ASK any service or maintenance engineer which part of a service manual is the most important: infallibly the answer will be "the circuit diagram." Without it the engineer is like a sailor without a chart; with it—no matter how little other information may be available—the skilled man will be prepared to tackle the most complex unit. But do British equipment manufacturers always make their main circuit diagrams as clear and as informative as possible? Here the answer will be no less certain—in many, too many, cases an unequivocal "no."

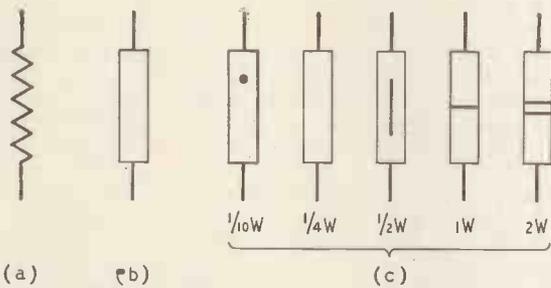


Fig. 1. The "common or garden" fixed resistor, (a) as cultivated in Britain, (b) the less elegant but equally distinctive Continental variety, (c) a Continental bunch, complete with wattage coding.

For more than a decade, drawing offices have had as their guide British Standard 530:1948, "Graphical Symbols for Telecommunications," together with a series of supplements, now six in number. Even the most casual inspection of the circuit diagrams actually used in maintenance manuals by British electronic firms will show, by the great diversity of styles, that so far this Standard is accepted fully by only a small percentage of draughtsmen—or at least of those who determine the house styles. But are the circuit diagrams, even when drawn in accordance with B.S. 530, as informative as they might be? And do they not represent far too much wasted time and effort in the drawing offices? It is illuminating to compare traditional British circuit conventions and symbols with those now coming generally into favour on the Continent, more especially in Austria and Germany. The best European circuit diagrams (and it must be admitted immediately that there are many very bad ones) may look strange and unattractive at first to British eyes, but they offer substantial advantages both to those who must pay for their production and to the ultimate user, once he has familiarized himself with their codes and circuit symbols.

In British practice, the resistor—possibly the most common of all components—requires upwards of nine separate lines (see Fig. 1 (a))—and over-enthusiastic draughtsmen, proud of their ability to produce a mathematically correct zig-zag, not infrequently extend them to as many as seventeen or eighteen bends. If the wattage reading of the

resistor is to be indicated, it must be written out alongside the symbol, adding time and clutter to the diagram. The unadorned rectangular box of the Continental diagram, Fig. 1 (b), is not only simpler to produce (particularly with a stencil), but opens the way to providing wattage information with a minimum of effort. Fig. 1 (c) shows a commonly used code which can quickly be added to the box, reproduces well and requires no extra space.

Fixed capacitors or condensers (for, despite all the efforts of the powers that be, the old term still marches gaily on) are drawn basically similar the world over (Fig. 2 (a)); but the overseas draughtsman seems much more inclined to throw in additional information for good measure. In the United States, it is common practice to indicate the correct connection for the "earthy" side (outer foil) by using a curved line on one side: Fig. 2 (b). On the Continent, the correct voltage rating is often indicated by means of simple codes; a representative code is shown in Fig. 2 (c). The objection may be made that, when reproduced by printing processes, small dots may appear or disappear accidentally; in practice this would seem to be no more bothersome than the many other potential sources of error.

The widespread Continental adoption of the nano-farad unit of capacitance ($1\text{nF}=1000\text{ pF}$ or 10^{-9} farad) is yet another valuable aid in cutting down

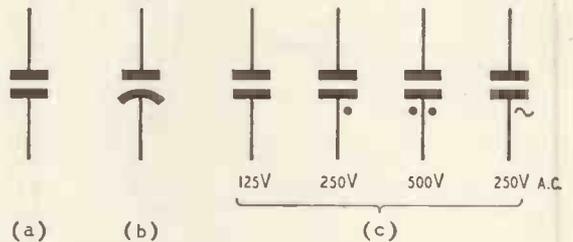


Fig. 2. How the familiar two-line capacitor symbol can be adapted to provide additional information: (a) standard; (b) indication of outer foil connection; (c) a representative voltage rating code as used on the Continent.

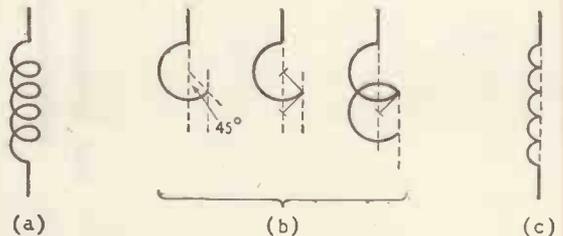


Fig. 3. Coils may look like (a), but to draw this symbol accurately is not simple—one way is shown in (b) which is not so quickly accomplished as the straightforward half-circles (c) now widely used on the Continent and in the United States

drawing time and circuit clutter when showing component values on circuit diagrams rather than relegating them to a separate component list—a practice which, though leading sometimes to overcrowding of the diagram, is generally popular with service and maintenance engineers, especially where the complete wattage or voltage specification can be given. More and more drawings for service manuals, British and foreign, now include on the main diagram the valve pin numbers and typical check voltages, as well as component values. With the nanofarad, such values as 0.003 μF , 0.02 μF need be shown only as 3n, 20n, retaining μ for values of 0.1 μF and above. Incidentally, why do so many firms persist—despite paragraph 36 of B.S.530—in adding μ , F or H after every value? It is a long time now since even the Royal Navy abandoned its beloved jars of capacitance.

Then there is the question of inductive components. Here Continental and American practice scores on production time, if for no other reason. Fig. 3 (a) shows the traditional British symbol for all forms of inductors. To produce this accurately on the drawing board requires a procedure along the lines indicated in Fig. 3(b). Compare this with the symbol now finding increasing favour on the Continent and in the United States—Fig. 3(c)—which is just a series of half circles but which is every bit as distinctive as the traditional symbol (often, in fact, clearer when reproduced on a small printing block which may cause the small loops of the British symbol to fill in).

Audio-frequency and mains transformers take a considerable time to draw accurately with the loop system of Fig. 4(a), particularly by draughtsmen whose ambition it appears to be to include almost as many symbolic turns as there are real ones. The Continental style, Fig. 4(b) may look a little uglier at first—but how much easier to produce! And immediately distinguishable from other types of transformers.

To come down to earth (or chassis) on the Continent requires only one small line—Fig. 5(a)—compared with our four (Fig. 5 (b)). Indeed the main chassis line is frequently omitted altogether, again simplifying production, though—to some British eyes—often resulting in a rather untidy and difficult to follow circuit diagram.

The sum total of the time spent in British drawing

Fig. 4. Will export orders wait while your drawing office painstakingly produces the mains transformer (a)? Your European rival may beat you to it with the simply produced (b).

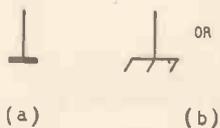
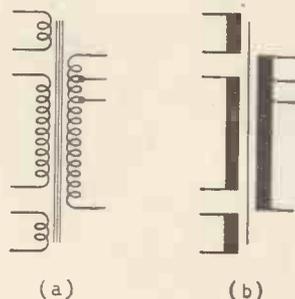


Fig. 5 The single line of (a) takes less time to draw than the four lines of (b).

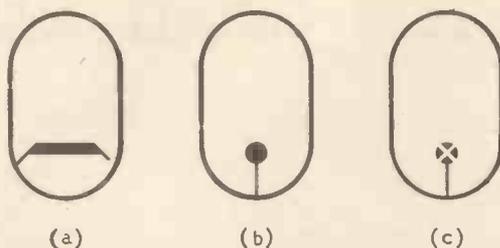


Fig. 6. Sketch (a) may seem a distinctive cathode, but (b) is quicker to draw, and in the form (c) provides additional information.

offices in producing carefully shaped valve cathodes (Fig. 6(a)) in accordance with British Standards—sensibly not done, one notices, by *Wireless World*—would surely make any organization and methods man come down heavily in favour of the Continental short-cut (Fig. 6(b)). A useful additional feature of this symbol is that it can easily be adapted to indicate that a particular cathode is common to other parts of a multiple valve (Fig. 6(c)).

One should perhaps not be too hard on British traditional conventions: in the best examples the circuit diagrams look good, are easy to follow, and keep many draughtsmen contentedly exercising their skill—even if so many of the lines they draw are unnecessary and add nothing to the information conveyed to the user. But keep those Time and Motion Study people out of the drawing offices, or many firms may finish up—despite B.S. 530—adopting some at least of the Continental practices.

CLUB NEWS

A mobile rally is being organized jointly by a number of clubs in the southern counties for July 17th. It will be held at Beaulieu Motor Museum, near Southampton. Control stations G31VP/A (1980kc/s) and G2HIF/A/(144.13Mc/s) will be operating from 10.30 a.m. Programmes of the Southern Counties Mobile Rally, costing 6d, are available from R. Bassett, 42 Northam Avenue, Shirley, Southampton.

Prestatyn.—Meetings of the Flintshire Radio Society are now held at the Ffrith Hotel, Ffrith, Prestatyn, at 7.30. At the meeting on July 4th, T. A. P. Colledge, of the G.P.O., will talk on subscriber trunk dialling. On the 25th the club is holding a 160-metre d.f. hunt.

Tunbridge Wells.—The second of a series of talks on 2-metre operation will be given to members of the West Kent Amateur Radio Society by the president, W. H. Allen (G2UJ), on July 22nd. The club meets on alternate Fridays at 7.30 at Culverden House, St. John's, Tunbridge Wells.

"The Eyes of the Few"

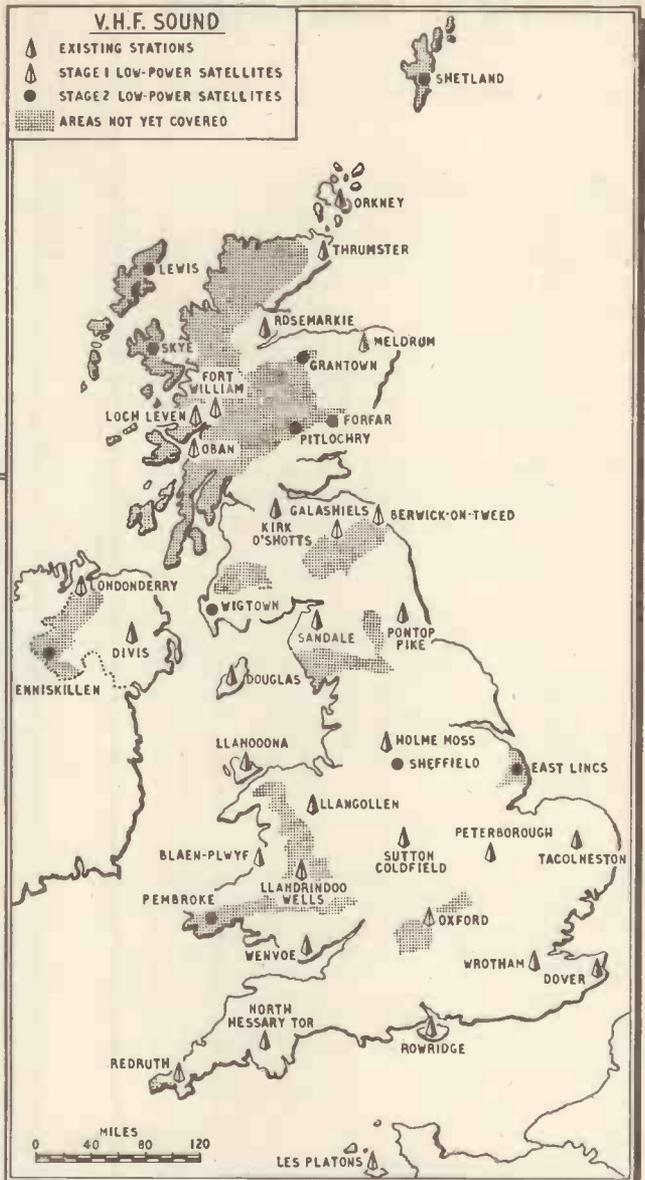
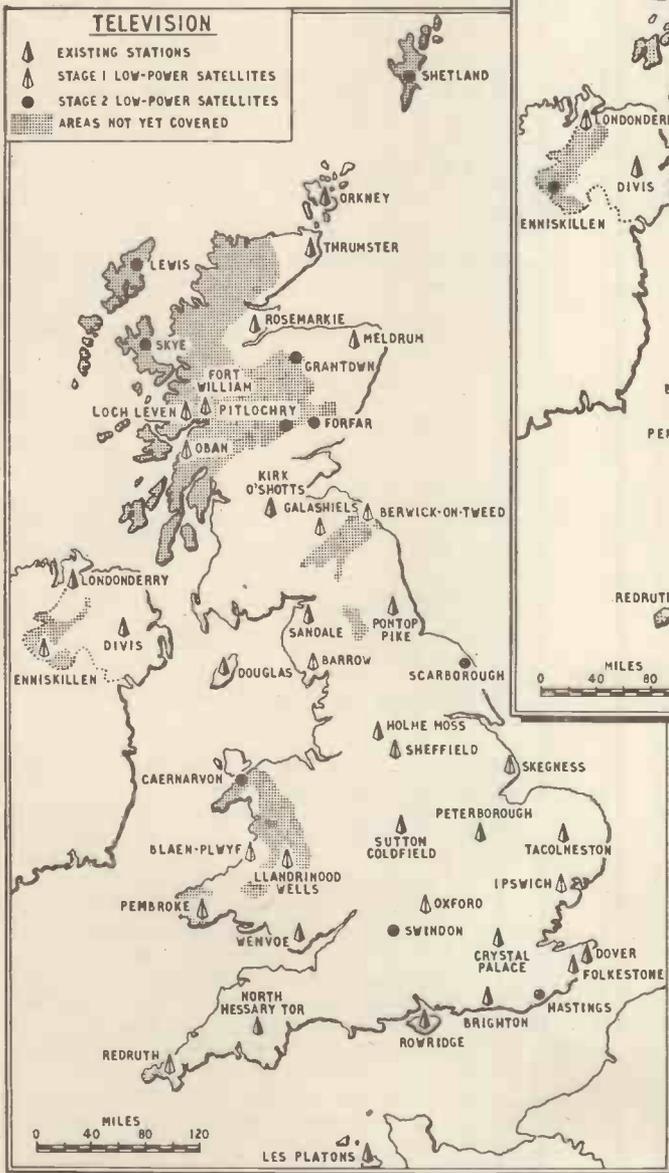
THE many *Wireless World* readers who served in the wartime R.D.F. system (radar to newcomers) would be well advised to take this book* on holiday with them. If, like the author—Daphne Carne, née Griffiths—they spent 1940 in the active Kent and Sussex sector, they may find it almost unbearably nostalgic. Unpretentiously told, this account of the experiences of a W.A.A.F. R.D.F. Operator is vivid and exciting. Those who were not there to see for themselves should find it not only entertaining and at times moving but also informative concerning an essential and none-too-well publicized part in the saving of the world from Nazi domination.

M. G. S.

*P. R. Macmillan Ltd. 15/-. pp. 238. 14 illustrations.

B.B.C. SATELLITE STATIONS

THE coverage of the present 23 B.B.C. television stations is about 98.8% of the population, though this figure includes people in some areas where reception is, at times, subject to severe interference. When the 14 stations (marked stage 1 on the map below) announced last year, come into service by March, 1962, a further 200,000 people will come within the service area and about a million will have an improved service. The P.M.G. has now given "approval in principle" to the second stage of the B.B.C.'s plans for extending and improving



television coverage. This provides for a further 10 satellite stations, which, when completed early in 1964, will bring television to about another 100,000 people and improve the service for a further 400,000.

Plans have also been announced for extending the v.h.f. sound service. The coverage of the existing 20 stations, most of them providing a three-programme service, is a little over 97% of the population. Stage 1 of the v.h.f. satellite scheme (see above map) which is also scheduled to be completed by 1962, adds a further 10 stations bringing the service to a further 640,000 people. The 11 satellites to be erected by 1964 under Stage 2 will bring the service to another 350,000 people.

Pickup Design

By J. WALTON*

RELATIVE IMPORTANCE OF VARIOUS FACTORS

VARIOUS excellent articles have appeared from time to time on one or more of the factors mentioned here, so that it is not proposed to enter deeply into these factors in themselves, but rather to try to indicate their relative importance.

This is attempted as a result of observing how such articles sometimes cause those who do not have the facilities or time to make quantitative comparisons to attend to a particular feature in a manner that is disproportionate to its overall effect on the performance of the gramophone.

Pickup Arm Length and Stylus Tip Radius

I am starting with "tracking error" since this seems to be a common source of care and of a desire for longer pickup arms in systems with a far greater source of distortion, namely the size of stylus tip employed.

Now if we accept the maxim that a chain is as strong as its weakest link, and we also wish to play the last ten minutes or so of our precious l.p. records, then we must consider the fact that the size of the stylus tip is the factor causing the greatest distortion in any type of gramophone pickup.

The distortion due to tracking error is given by H. G. Baerwald¹ as

$$\eta_2 = \frac{V\alpha}{u} \times 100$$

where η_2 is the percentage second harmonic distortion, V the peak recorded velocity, α the tracking error in radians and u the groove speed.

Let us then consider a moderately large signal at the inside of the record where tracking error will do its worst: say 5 cm/sec r.m.s. lateral velocity when the diameter is 4½ in on a record rotating at 33½ r.p.m., and a tracking error of 4 degrees. Then the groove velocity

$$u = \frac{4.75 \times 3.14 \times 2.54 \times 100}{3 \times 60} = 21 \text{ cm/sec}$$

$$\text{so that } \eta_2 = \frac{5 \times 1.41}{21} \times \frac{4}{57} \times 100 = 2.3\%$$

which, after correcting for the recording characteristic,

$$\approx 1.3\% \text{ (second harmonic)}$$

Now, according to H. E. Roys², the main component of the lateral tracing distortion is given by

$$V_{D_3} = \frac{3(\pi r f)^2 V^3}{4u^4}$$

where V_{D_3} is the third harmonic distortion velocity, r the stylus tip radius and f the frequency.

And, if V_{D_3} is small, this is approximately equivalent to

$$\eta_3 = \frac{3(\pi r f V)^2 \times 100}{4u^4}$$

where η_3 is the percentage third harmonic distortion.

Take the same signal of 5 cm/sec and the smallest available stylus radius of 0.0005 in (which according to usual manufacturing tolerances is likely to be nearer 0.0006 in). Since the distortion here depends on frequency, we will take a moderate 3kc/s.

$$\begin{aligned} \text{Then } \eta_3 &= 75\pi^2 \times \\ &= \frac{(0.0006 \times 2.54 \times 3000 \times 5 \times 1.41)^2}{21^4} \\ &= 4\% \end{aligned}$$

which, after correcting for the recording characteristic,

$$= 1.6\% \text{ (third harmonic)}$$

i.e. with 5 cm/sec r.m.s. velocity at 3kc/s, the distortions from a 4-degree tracking error and from a nominally ½-thou stylus are about the same.

Moreover, we may say that below such figures where tracking and tracing distortions are equal they are both of little importance for practical hi-fi purposes.

Distortion figures above this point, however, are attained at an enormously greater rate in the case of tracing distortion than in the case of tracking error distortion.

For instance by the time one "reaches" even

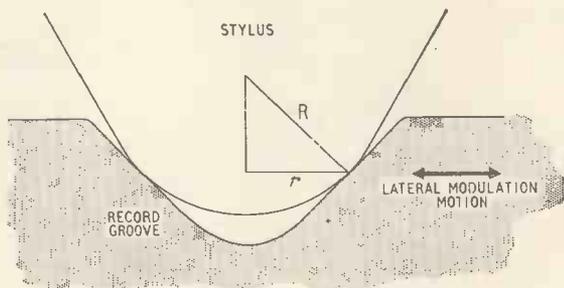


Fig. 1. "Effective stylus tip radius" (r) for lateral modulation.

10cm/sec at 4kc/s, we get 12% tracing distortion and 2.6% tracking-error distortion, even for a nominally ½-thou tip, and a nominally 0.0007-in tip gives 20% tracing distortion. However, I must say that where the values calculated are extremely large, they are not so large by measurement.

Since an 8-in arm can give a 2½-degree tracking accuracy, and certainly better than 4 degrees even with manufacturing tolerances, there would appear to be no advantage in exceeding 8in unless the stylus tip radius can also be reduced to well below 0.0005 in.

Whilst considering tracing distortion, I would like clarification upon whether or not the change in the effective stylus tip radius with modulation adds another variable to the equations. Lateral modulation motion would appear to me to give

* Decca Record Co. Ltd.

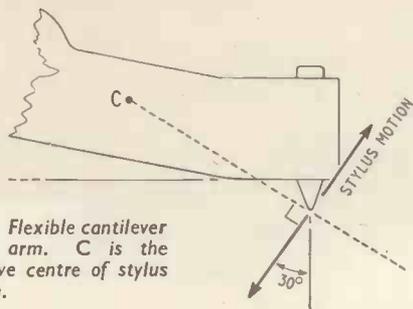


Fig. 2. Flexible cantilever stylus arm. C is the effective centre of stylus motion.

significance to the dimension r (see Fig. 1) which I call the "effective stylus tip radius." This is $1/\sqrt{2}$ times the actual radius R for a 90 degree unmodulated groove, but is modified to a higher value by the pinch effect.

Thus the effective stylus tip radius would appear to me to be an extra variable in the lateral case, but not in the stereo case of a 45 degree movement. However, the effective tip radius is the larger (equalling the actual radius) for stereo, and this must be a factor giving greater distortion in stereo reproduction, unless, of course, the correspondingly smaller actual tip radius is used.

I would conclude this section by saying that since only lighter tracking-weight pickups allow of smaller stylus radii on account of their effect on wear, a gramophone pickup must primarily be assessed on its genuine tracking weight and tip radius.

Needle Trail, Vertical Tracking and Stereo

Again, if the effect of tracking error was serious, we should be in greater trouble with vertical tracking errors in stereo pickups than has actually appeared to happen, since a difference of 23 degrees of "vertical" tracking angle occurs between the cutterheads of one manufacturer and another, to say nothing of differences between different pickups, and a further 15 degrees change between the top and bottom records in a changer.

It is not my intention to belittle these discrepancies. On the contrary, I am at present trying to correct the vertical motion of a flexible transmission arm similar to that described in the April 1959 issue of *Wireless World* (p. 182). Since the whole stylus arm flexes here, an effective centre of rotation can be found which determines the instantaneous direction of motion of the stylus tip.

For the arrangement shown in Fig. 2; as used in a typical mono head, the "vertical" motion is at 30 degrees to the vertical. This is unimportant in the mono case since the actual forward movement due to the lift produced by pinch effect is too minute to add any significant further tracing errors, but the departure from vertical motion must be very much reduced in a stereo pickup.

Let me take this opportunity of discussing the effective centre of rotation in relation to cantilever stylus arms in general, and needle trail in particular.

Any normal cantilever arm will have an effective centre for the stylus motion, and not only will this govern the direction of "vertical" motion of the stylus, but it will also give the effective trail of that stylus.

Now it has long been considered advantageous to have a small amount of needle trail, and some cantilever styli have been criticised on this basis when

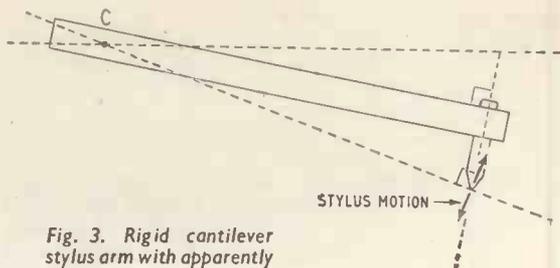


Fig. 3. Rigid cantilever stylus arm with apparently negative rake.

the rondel has been mounted with an apparently "negative rake" (as in Fig. 3). But surely the original purpose of "positive rake" as it was applied to the older type of needle (as in Fig. 4(a)) was to ensure that any forward drag at the stylus tip did not cause the stylus to dig further into the groove (as in Fig. 4(b)) with a cumulative effect upon this drag and its resultant digging.

The cantilever shown in Fig. 3 is, however, completely exonerated if its flexing centre is at C as shown, for it then has in fact an effective positive rake of about 70 degrees. This does not, however, exonerate the cantilever from having a 20 degrees to vertical "vertical" motion if it is to be used for stereo.

Vertical Compliance and Tracking

It could be imagined that the "hill and dale" aspect of stereo where there is no restriction in the vertical downward direction could lead to a condition where the groove receded from the stylus at a more rapid rate than that at which the compliance could cause the stylus mass to follow. It might be thought also that mechanical resistance to motion of the stylus arm could give an even more stringent tracking condition, and that all these problems were something not encountered in lateral recording in which two groove walls "direct" the stylus.

It can be shown, however, that there is no essential difference between the lateral and vertical cases, since not only are the groove walls at 45 degrees to both the vertical and horizontal, but also the friction, particularly at low tracking weights, is too low to make any appreciable difference between the lateral force required to make the stylus ride up out of the groove and the vertical force required to make the stylus leave the groove in a frictionless manner as in the "hill and dale" case.

Consider Fig. 5. For static equilibrium the upward reaction force F on the stylus tip of mass m must equal the tracking weight, and m must also be subject to an equal downward force F . If the groove is suddenly lowered then the acceleration a of the

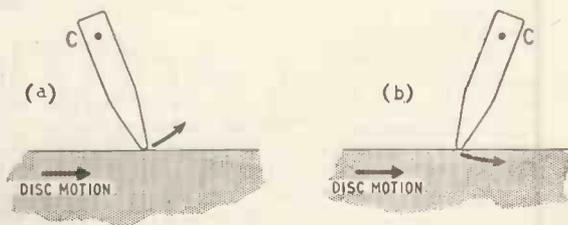


Fig. 4. Older-type styli with positive (a) and negative (b) rakes.

stylus tip mass m is given by $\alpha = F/m$. Thus the acceleration is not dependent upon the compliance but on the tracking weight and stylus mass, provided that the displacement of the stylus is too small to appreciably alter F .

In fact the groove displacement at .8 kc/s and a peak recorded velocity of 22 cm/sec is $22 \div (2\pi \times 8000) = 0.00044$ cm. Now consider a 1-gm pickup with an effective stylus tip mass of $\frac{1}{2}$ mgm and a compliance of 25×10^{-6} cm/dyne. The static displacement of the stylus as the pickup is placed on the record is 0.025 cm. Thus the above condition that the groove displacement be too small to appreciably alter the 1 gm force on the stylus is fulfilled. The stylus acceleration is thus 2000g, which is nearly twice that of the groove ($2\pi \times 8000 \times 22$ cm/sec² \approx 1100 g), and the tracking possibilities thus remains as for lateral modulation.

Mr. R. W. Bayliff in as yet unpublished work relating to the Decca stereo pickup has pointed out that a stiffer vertical movement can give a greater tracking capability, for a given effective stylus tip mass and tracking weight, in that portion of the upper middle register where the vertical compliance

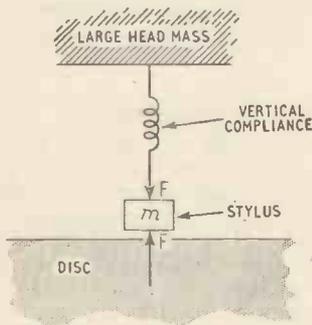


Fig. 5. Stylus tip mass (m) in static equilibrium. F is equal to the tracking weight.

resonates with the effective tip mass. But this does not alter the main argument, nor that a greater compliance gives a greater tracking possibility at all frequencies below this resonance and that a lower tip mass gives better tracking above this resonance.

If resistance is now introduced into the stylus arm, this will have its greatest effect at maximum velocity (zero acceleration with a sine wave) and have no effect at zero velocity (maximum acceleration). Thus the vertical tracking condition is as before, and provided that the maximum force due to resistance is not greater than that due to stylus inertia or cantilever stiffness then no additional tracking weight is required.

It might be said, however, that to cope with a peculiar case where the effects of maximum velocity, acceleration and displacement all occurred together, then a tracking force corresponding to the sum total would be required.

There would also appear to be the possibility of an integration of upward signal impulses by the momentum of the head so as to require extra tracking weight thereabouts. This of course applies also in lateral recording in the form of integration of impulses not only of vertical pinch effect movements but also of extra forward drag due to modulation, this integration being converted into side thrust that tends to push the stylus out of the groove so as also to require extra tracking weight. However, due to

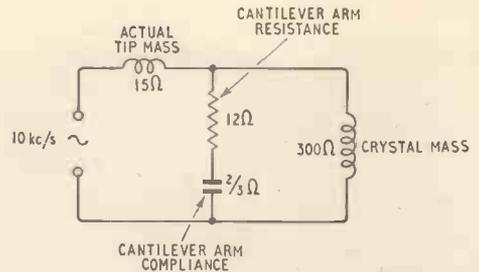


Fig. 6. Simplified mechanical impedance analogue of a flexible cantilever arm pickup. Typical impedance values at 10 kc/s are shown.

the pickup arm geometry, the side thrust here will only be about one-fifth of the forward drag. Thus although the stylus arm resistance may be limited in magnitude to, and entirely out of phase with, the other factors of mechanical impedance for sine wave motion, then even in that motion, the resistance and impedance could conceivably have a combined effect in their integrated sum.

And we could probably continue "in ever decreasing circles" discussing this and that smaller and smaller points, but the problems of producing a high-fidelity stereo pickup do not, I think, yet warrant this.

Groove Speed and Record Wear

Since most record deformation normally takes place at points of maximum acceleration or displacement, it would appear therefore that the inclusion of a substantial amount of resistance in the stylus arm will not decrease the life of a record.

I might mention that the increase with age of the resistance of p.v.c. must be taken into account in most of the pickups in use. This increasing resistance may also alter the effective stylus impedance at high frequencies as shown by Fig. 6.

When considering record wear in a theoretical way we have usually started from Hertz's equations for a static indenter in the elastic range, and a conception of record wear is then evolved around the "mean pressure" under the indenter (thus the pressure is assumed to be inversely proportional to the square of the stylus radius). Now not only does this assume a direct relation between mean pressure and wear, and so does not take into account any wear due to the greater impact of a larger stylus radius in a smaller groove curvature (i.e. under conditions of high tracing distortion) but it does not even take into account the linear speed of travel of the stylus in an unmodulated groove.

I hope to be able to present some experimental results in the near future on these last aspects and their general relation to the gramophone record. Results so far obtained indicate that recourse to lower turntable speeds would be severely detrimental not only to quality (distortion varying inversely as the fourth power of the groove speed) but also to record life, and that other means of gaining playing time are both possible and preferable.

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- 1 *Jour. Soc. Motion Picture and Television Engineers*, Vol. 37, Nov. 1941, p. 591.
- 2 *R.C.A. Review*, Vol. 10, June 1949, p. 254.

Ohm's Law and Negative Resistance

—AND THE LAW THAT KIRCHHOFF FORGOT TO INVENT

By "CATHODE RAY"

SPECTATORS of the recent duel between D. L. Clay and myself in the correspondence columns no doubt noted with interest Mr. Clay's shrewd thrust with my own weapon dated August 1953. To alter the metaphor, he used my own voice to pronounce me dimmer than a beginner. Must I accept this unflattering assessment, or alternatively eat my 1953 words? The dilemma is unattractive. Being a generous opponent, however, Mr. Clay invited further explanation. This course (assuming the Editor is equally generous with space) I elect to adopt. Quite apart from the obvious possibilities of a verbal smokescreen for evasive action, further explanation appears to be justified for the following reasons. With youth now at the helm, what Cathode Ray said in 1953 must seem almost as far-off as what Gladstone said in 1888. Next, in a misguided attempt to be brief, what I said (or didn't say) in last February's issue evidently left room for Mr. Clay—and maybe others—to find obscurities and contradictions. And the whole thing has convinced me that Ohm's law is even more treacherous than I thought, and that is saying a lot.

First of all (summarizing the 1953 contribution) we must say what we mean by "Ohm's law." My guess is that what most people mean is

$$I = \frac{E}{R}$$

(or its equivalent, $E=IR$ or $R=E/I$) in which E is the e.m.f. in volts required to drive a current I amperes through a resistance R ohms. Though undoubtedly a useful piece of information, this would have looked very strange indeed to Dr. Ohm, who would have been at a loss to account for his name being attached to it, since volts and amperes

had not been invented in his lifetime and the ohm was a unit of wine, equal to about 40 gallons and therefore presumably beyond the means of a struggling teacher. Even the concepts of e.m.f. and resistance would have been novel to him. So much so that it is not easy for us, saturated in "Ohm's law," to follow just what it was that Ohm discovered. Put into modern terms, it seems to have been that the ratio of e.m.f. across a conductor to current through it (i.e., its resistance) does not vary with the amount of current, provided the temperature is constant.

Note that our "Ohm's law"— $R=E/I$ —says nothing of the kind. For all it knows, R may be variable. In these days of semiconductors it often is. But Ohm's experiments were carried out on metal wires, and the constancy of their resistance has been confirmed within very much closer limits than were possible with his crude apparatus.

It is probably too late to make "Ohm's law" mean what Ohm meant, which is true for metals but not for semiconductors or insulators. We call metallic resistances "ohmic" or "linear" (because their current/voltage graphs are straight lines passing through the origin). But "Ohm's law" in present-day usage is simply a convenient formula, relying on a system of units Ohm never knew, and true for any kind of conductor, linear or otherwise. It can also be regarded as a definition of resistance.

However, the thing is not quite as simple as that, because *sometimes* "Ohm's law" must be understood to imply the "law of Ohm" (as we may call what Ohm meant). For instance, an elementary exam paper might say "The current through a 500- Ω resistor is 0.3A; use Ohm's law to find the voltage across it." This obviously means the well-known formula, and it would make no difference to the answer if the resistor disobeyed the "law of Ohm." But if the question were "When 150V is applied to a resistor the current is 0.3A, what is with 40V?" one would have to assume the resistor obeyed the "law of Ohm" to be able to answer it at all. A knowledge of the system of units used is unnecessary, whereas the answer to the first question would depend on the units (e.g., it could be 150V, 0.15kV, 15,000,000,000 e.m.c.g.s. units, or 0.5004 e.s.c.g.s. unit).

There are some other circumstances to be understood. Ohm's experiments were carried out with d.c., and that is generally taken for granted in connection with "Ohm's law" too. Fig 1 shows current/voltage graphs for two resistances, which can both be recognized as ohmic by their straightness. It doesn't matter how much e.m.f. is applied (so long as the temperature is not altered appreciably); its ratio to the current gives the same resistance every time. Reversing E (i.e., multiplying it by -1) reverses I too, so we have the continuations towards the bottom left.

Fig. 2, which is the sort of result we might get with

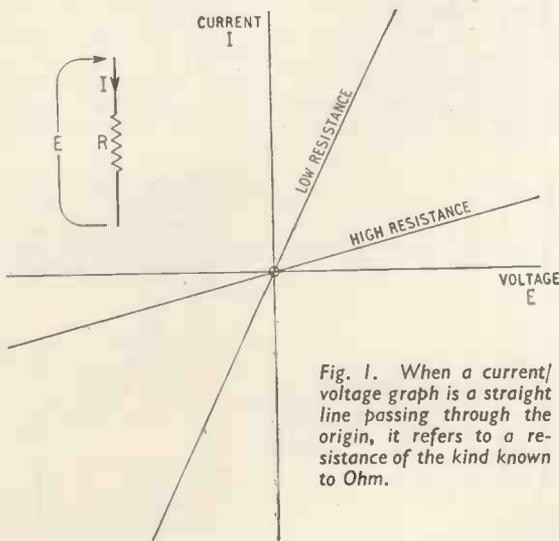


Fig. 1. When a current/voltage graph is a straight line passing through the origin, it refers to a resistance of the kind known to Ohm.

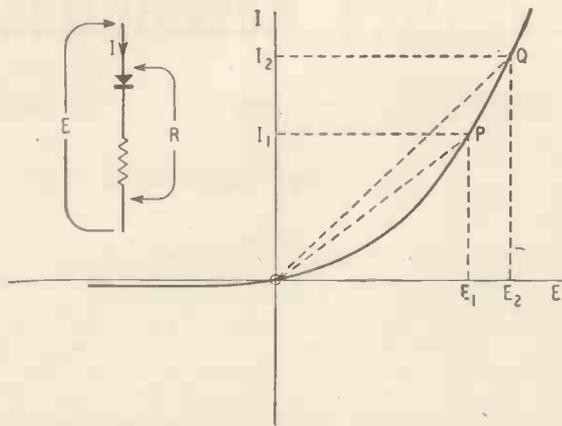


Fig. 2. Many circuit elements now in common use have resistances that do not follow the pattern of Fig. 1. Though non-linear to d.c., they may be at least approximately linear to a.c. within limits, as for example P to Q here.

an ohmic resistor in series with a germanium rectifier, is quite different. E_1/I_1 gives one value of resistance, which anyone ignorant of non-ohmic resistances would assume to be representable by the dotted line OP. Increasing the voltage to E_2 causes a disproportionate current increase to I_2 , so the calculated resistance E_2/I_2 , represented by OQ, is less. Neither of them is the resistance most likely to interest us in this more sophisticated era, when E might consist of a steady voltage half-way between E_1 and E_2 , plus an alternating voltage with peak value $(E_2 - E_1)/2$. The latter would alternate between E_1 and E_2 , and the corresponding part of the current would alternate between I_1 and I_2 . So far as this current is concerned, the resistance (being represented by the nearly straight line PQ passing through the a.c. origin) is almost ohmic, and less than either of the d.c. values. It is known as the a.c. or incremental resistance. The poor beginner is usually left to guess from the context whether "resistance" means the d.c. or the a.c. kind.

The next complication is that the circuit may contain reactance. In point of fact, it is bound to; but what I mean is that the reactance may be enough to have an appreciable effect on the amount of a.c. flowing. Now there are various ways of handling this. A common one in elementary textbooks is to produce the following (or something equivalent) as "Ohm's law for A.C.":

$$I = \frac{E}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}}$$

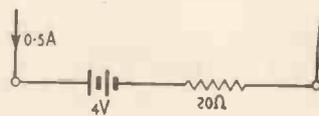
Having now gone on record as accepting, however reluctantly, "Ohm's law" as meaning " $I = E/R$ ", I will no doubt be exposing myself to attack from Mr. Clay if I object to the above on the ground of its being outside the experience of Dr. Ohm. In self-defence I might claim that it is wildly remote from his experience. But my main objection is that it brings in a new principle. To teach beginners that reactance is just a special kind of resistance that applies only to a.c. (as some books do) may make it look easier at first but is likely to make things more difficult later on. I would be inclined to emphasize that reactance is something quite different

from resistance, even though it is reckoned in ohms and mixed up with it in impedance. The reason is that resistance is essentially something that takes any electrical energy it can lay its hand on as an outright gift, whereas reactance accepts it only as a short-term loan, scrupulously paying it back in full within a single a.c. cycle. (Idea for a chapter title in Cathode Ray's Monster Nursery Book of Electrical Theory—"The Story of the Bad Mr. R and the Good Mr. X." Including, of course, "Pat-a-cake, pat-a-cake, Vector's Man; Turn it through half pi and mark it with 'j'"). Anyway, just now resistance is enough to be thinking about, without complicating the issue with reactance.

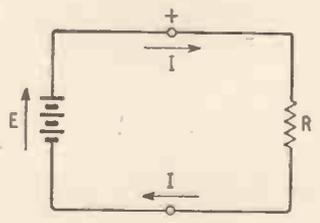
For we are coming to the bit that was turned against me. I said (in 1953) "that it is no good trying to apply Ohm's law to a circuit containing an e.m.f.—at least, not without allowing for the e.m.f. If $E = IR$ were applied to find the voltage between the terminals [in Fig. 3 here] the answer would be $0.5 \times 20 = 10$. But the measured voltage would be 14. The reason for this discrepancy is obvious, and even a beginner would have to be rather dim to fall into the trap." So I suppose it really was asking for trouble to offer (in 1960) the diagram reproduced here as Fig. 4, and, having requested the audience to look between the terminals eastwards to see a positive resistance R, proceed to turn them around facing the battery and suggest that it appears to be a negative resistance—even with the proviso "not an ohmic one in this case!". Being more modest than you might think, I had not imagined the possibility of anyone following my utterances with such attention as to be able instantly to quote any of them made within at least the last seven years. I hope it will be a lesson to me.

Mr. Clay—for none other than he is the prodigy alluded to—skilfully turned aside my defensive stroke (which was to ask what gave him the idea that I was applying "Ohm's law" to Fig. 4) by a thrust cunningly disguised as an apology. He said he was sorry he had incorrectly assumed I had used "Ohm's law" to show that a generator is equivalent to a negative resistance, but it was the only way he knew of obtaining a value of resistance from a voltage and current. And to increase my discomfiture he added that he also assumed "non-ohmic" meant "non-linear," but, as the current did not affect the voltage in any way, perhaps "non-resistive" would have been better.

"Touché," I believe, is the appropriate expression. Not that I concede having said anything actually wrong, but an explanation which left room for such



Left: Fig. 3. In measuring the real d.c. resistance between the terminals, one would have to exclude the 4-V battery



Right: Fig. 4. This is the controversial diagram. Is it legitimate to regard the battery as a negative resistance?

comments can't have been a very good (i.e., fool-proof) explanation of negative resistance. The fault was not in what I said but in what in my haste I didn't say to guard readers against the treacheries of "Ohm's law."

So let us begin with Fig. 4 again. Looking at what we have between the terminals on the right-hand side, we recognize exactly the situation we met in Fig. 1. We measure the voltage between the terminals, and find it to be equal to E . We also find a current I flowing from the positive to the negative terminal, which is conventionally the same direction. So the current has the same sign (+ or -, depending on which terminal we choose as our reference) as the voltage. We therefore have the data for plotting the two points P and P' in Fig. 5. If we had the opportunity to vary E we would be able to plot more points, which (assuming R to be "ohmic," in the sense already defined) would all fall on the sloping straight line marked " R ."

Now let us about-turn and consider the same pair of terminals from the opposite direction. Performing the same two measurements, we would find the

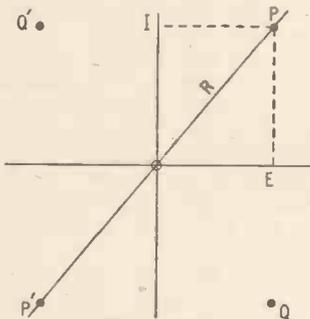


Fig. 5. P and P' are points on a current/voltage graph of R in Fig. 4. Q and Q' are points measured in the same way on E .

direction of the current reversed relative to the voltage, so the results would have to be represented in Fig. 5 by Q and Q' . Since P and P' represented R , Q and Q' must represent $-R$. That is what I meant by saying that the battery was equivalent to a negative resistance. The logic of the conclusion seems inescapable. Moreover, the positive resistance R is a dissipator of power; its opposite or negative should therefore be a source of an equal amount of power, and that is precisely what the battery is. And, just as according to Kirchhoff's Second Law the total voltage around a circuit (reckoning a current-carrying resistance as a negative voltage source) must be zero, in an alternative view

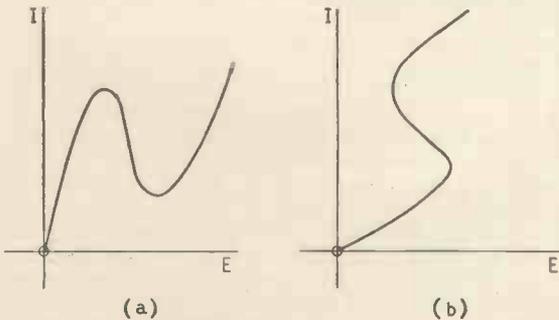


Fig. 6. Two types of current/voltage curve showing negative resistance.

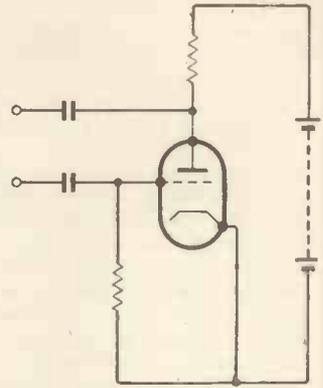


Fig. 7. A practical "negative resistor."

the total resistance around a circuit (reckoning a voltage source as a negative resistance) must be zero. And, just as the negative voltage source in Kirchhoff's law is a rather peculiar one, depending entirely on the current, so my negative resistance is (as Mr. Clay pointed out) an analogously peculiar one. If we had the opportunity to vary R , the additional points would not lie on the straight line joining Q' to Q . They would, of course, be on vertical lines through Q' and Q . That was why I warned readers not to expect an ohmic resistance. And since this is only an extreme case of the sort of thing we found in Fig. 2, I am sticking to that, rather than Mr. Clay's "non-resistive." For the equivalent negative resistance of the battery is found by "Ohm's law," in just the way he is used to. But I ought to have warned him (and less knowledgeable readers) that an equivalent resistance is one calculated by applying "Ohm's law" without regard for the rule (needed for finding real resistances) about excluding sources of e.m.f. For example, the equivalent or apparent resistance between the terminals in Fig. 3 is $14/0.5=28\Omega$. The 4-V battery absorbs the same power and has the same voltage across its terminals as an 8- Ω resistor at that current. In fact, unless one was allowed to vary the current one could not distinguish between the battery and a resistor by any electrical test.

Just as the source of current-opposing e.m.f. in Fig. 3 is thus equivalent to a positive resistance, the source of current-assisting e.m.f. in Fig. 4 is equivalent to a negative resistance, as I hope all can now see. The point I was trying to make in this way is that a negative resistance is in effect a power source. I did not intend to convey that all negative resistances vary with current in the same way as the battery in Fig. 4 does. Practical negative resistances are negative over only a limited range of current and voltage, and fall into the two classes shown in Fig. 6, distinguished for obvious reasons as "N" and "S" types. Because of this limited range they are of interest chiefly as regards a.c. (Compare Fig. 2.) Certain valves and semiconductor devices* have characteristic curves of one or other of these types. Similar effects can be produced artificially by positive feedback in an amplifier. For instance, an a.c. negative resistance is found between the terminals in Fig. 7, and a tuned circuit connected to them is set into oscillation thereby, provided that its positive resistance isn't enough to make the total resistance positive.

* A new example is coming up for attention next month.

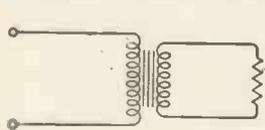
Mr. Clay and perhaps spectators around the ring may be thinking—even openly saying—that in order to get myself out of an awkward position I have been making up the rules as I go along. In 1953 I said any fool can see that one mustn't include e.m.f.s when applying "Ohm's law," and in 1960 I said of course that is only for "real" resistances; for "equivalent" resistances one can. Where is there a rule about there being different sorts of resistance?

The British Standard definition of resistance (B.S.205:1943, No. 1276) says "That property of a body by virtue of which it resists the flow of electricity through it, causing a dissipation of electrical energy as heat. It is equal to the constant difference of potential applied to the ends of the body divided by the current which it produces when the body has no e.m.f. acting therein."

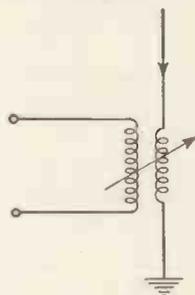
That is not only resistance in the strictly real sense, but is confined to d.c.—note the *constant* d. of p. That obviously doesn't get us very far in these days, but lower down (No. 1283) there is a definition of "effective resistance":

"Of a circuit element with alternating current. The component of the terminal voltage in phase with the current divided by the current. The power dissipated in heat divided by the square of the current."

This is really two definitions, defining quite different things. The second one agrees with No. 1276, and in fact could be substituted for it as an a.c./d.c. definition. For the power P in a d.c. resistance is given by EI , and dividing that by I^2 leaves E/I , which is "Ohm's law" again. I am assuming that the definers meant strictly the power dissipated as



Above: Fig. 8. What is the a.c. resistance between the terminals?



Right: Fig. 9. And what is the resistance between these terminals?

heat in the circuit element referred to. That is rather an important point, as we see if we consider Fig. 8. What is the "circuit element" to which the terminals are connected? The primary winding? The whole transformer? Or the transformer and its load regarded as one element?

With any reasonably efficient transformer, the heat dissipated in the primary, or even the whole transformer, should be small. Most of the power fed in at the terminals would be dissipated in the load resistance. But if that is reckoned as a separate circuit element, its heat mustn't be counted. Its effect on the circuit between the terminals is *solely as an e.m.f.*—the e.m.f. induced in the primary by current flowing in the secondary circuit, which depends mainly on the load resistance. However, if the whole of Fig. 8 is deemed to be "a circuit element," then this e.m.f. is a purely internal arrangement for distributing the dissipation, and the definition is of the strict kind.

Note that heat is also dissipated in the iron core,

because currents are induced therein, and in the insulation because of charging currents between wires, and extra "skin-effect" heat in the wires because of e.m.f.s induced in them. It would be hopeless to try to find the a.c. resistance of the whole thing accurately by counting up the ohms due to all these different effects; hence the idea of doing it in one by measuring the power and dividing it by the current squared. This gives the single resistance that would run away with the same power when the same current was flowing.

How do we measure this power? Since the definition refers to power dissipated as heat, we are committed to a calorimeter measurement, which is a messy, time-consuming and (except perhaps in the N.P.L.) inaccurate business. So we are strongly attracted to the first No. 1283 definition, which allows us to measure the electrical power fed in. In this circuit it would give the right answer. But not everywhere. Consider Fig. 9. Here, if the thing is doing its stuff, most of the power is radiated. To make the two definitions agree it would then be necessary to stretch the "circuit element" to include the entire universe, which seems rather far-fetched. Or, in case the heavy old electrical engineers who composed this definition begin to murmur that of course they didn't mean this new-fangled wireless telegraphy, we can quickly silence them by passing on to the example of an a.c. circuit feeding an electric motor. The second No. 1283 definition would include only the power dissipated as heat in the motor, which should be quite small; the second would include also all the mechanical power developed by the said motor, which could be many times greater.

These are only a few of the recognized varieties of resistance, more of which are defined in B.S.204.

To sum up: It seems that in its strictest sense the resistance of any circuit or part of a circuit concerns the power dissipated as heat therein. Measuring amounts of heat is something we definitely don't want to do. With d.c. we can avoid it by using "Ohm's law," provided we carry out a preliminary frisking to make sure the thing being measured has no concealed e.m.f.s. With a.c. we measure the current in phase with the applied e.m.f., but if we exclude all e.m.f.s we will find ourselves excluding almost everything but standard resistors. Most often, we want to include at least all the losses, whether they come into our circuit as e.m.f.s or not. We may want to include all permanent departures of power, such as radio waves, light, sound, etc.

No doubt it was naughty of me—even with the praiseworthy object of reducing the thing to ultimate simplicity—to begin with a d.c. circuit, Fig. 4, without explaining unmistakably that this was just as a step towards the a.c. circuits of commerce, in which "equivalent" and "effective" resistances are established conventions. Another point is that even with a.c. resistance, counting effects brought in by e.m.f.s, these e.m.f.s usually bear some relationship to the input current, whereas E in Fig. 4 is completely independent, like the battery in Fig. 3 (apart from its internal resistance). As I have shown, the principle involved here is not fundamental, but it would have been better to have pointed out that the battery didn't behave like a practical negative resistor if the current was varied. I hope, however, that it has been justified by the bringing to light of Kirchhoff's hitherto unknown Third Law.

LETTERS TO THE EDITOR

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

Demonstrating Electron-spin Resonance

FOLLOWING the description¹ by G. B. Clayton of a demonstration apparatus for electron-spin magnetic resonance absorption, readers may like to know of a simple modification to the circuit which enables a satisfactory estimate of the magnetogyric ratio, γ , to be made. The time required for the observation is such that it may easily be carried out in the course of a lecture, thus adding greatly to the value of the demonstration.

γ is given by the relation $2\pi f = \omega = \gamma B$ and it is the ratio of the magnetic moment to the angular momentum of the electron, not the reciprocal of this ratio as given in the article. f is the frequency of the radio-frequency oscillator, B the magnetic flux density at the sample. If f is expressed in Mc/s and B in weber/m² we have

$$\gamma = (2\pi f/B) \times 10^6 \text{ coulombs/kgm}$$

The frequency, f , may be measured in a convincing manner by means of a short-wave wireless receiver. A characteristic purring tone will be heard, representing a pair of absorption pulses repeated at 100 c/s.

For the measurement of the resonance value, B , of the magnetic flux density an ammeter (reading r.m.s. current) is inserted in series with the Helmholtz coils and some provision is made for varying the current continuously. This can most conveniently be done by use of a "Variac," but failing that a rheostat will do. As the current is reduced the trace on the oscilloscope screen shrinks until, for a certain value, i , of the r.m.s. current, the extremes of the trace coincide with the peaks of the absorption line. Then the field, B , is given by

$$B = 4\pi \times 10^{-7} \times (8N/5\sqrt{5R}) \times \sqrt{2} i \text{ weber/m}^2$$

where N is the number of turns on each coil and R is the radius of the coils in metres.

The resulting value of γ may be compared with the known value of the charge-to-mass ratio, e/m , for the free electron, namely 1.76×10^{11} coulomb/kgm, since for the unpaired electrons in diphenyl picryl hydrazyl at frequencies above 5 Mc/s,

$$\gamma = e/m$$

to a very good approximation².

In an actual demonstration, with an oscillator frequency of about 24 Mc/s, I obtained

$$\gamma = 1.7 \times 10^{11} \text{ coulomb/kgm.}$$

The oscillator² was found to work very well at this frequency without the capacitors C_1 and C_2 , adjustment of the amplitude being made by varying C_0 .

The University, Edinburgh. A. G. A. RAE

¹ *Wireless World*, Feb., 1960, p. 68.

² *Wireless World*, Feb., 1960, p. 70, Fig. 8.

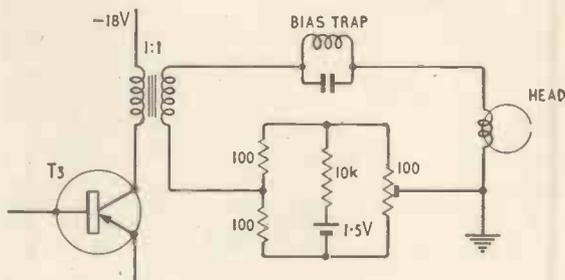
³ Garstens, Singer and Ryan, *Phys. Rev.* Vol. 96 (1954), p. 53.

Transistor Tape Recorder Amplifier

I HAVE just read Mr. Blick's article in your April issue and I congratulate him on an elegant solution to the problem of the recording amplifier.

Although the leakage of modern electrolytic capacitors is reasonably low, the small residual magnetization of the head would be enough to introduce noise in the recording process and harmonic distortion in the playback process. A solution which avoids this is to use a double-wound transformer in place of the reactor L , in Mr. Blick's Fig. 1. The recording head directly connected across the secondary eliminates the leakage current although not, of course, switching transients.

It is probably worth while for high-quality work including a variable direct e.m.f. in the secondary circuit



(see accompanying diagram) and to adjust this for minimum noise when playing a virgin tape. This is also the condition for minimum distortion.

Salisbury Polytechnic, PHILIP F. RIDLER
S. Rhodesia.

Deeper Amplitude Modulation

MR. BLANCHARD (June issue) is no doubt correct in his facts and I have myself noticed all the effects, including the distortion. Increased percentage modulation and clipping also reduce the dynamic range, which is also observable. Furthermore, the operation of the a.g.c. system in normal sets will be affected by the increased modulation and is likely to reduce even further the dynamic range.

The practical result, in my view, would be unfortunate as it would be the fashioning of another nail ready for the coffin for medium- and long-wave amplitude modulation.

No medium- or long-wave service hinders international contacts and aids the spread of extremist nationalism but on a purely personal level I, and presumably Mr. Blanchard, find the Continental broadcasts more entertaining than those of the B.B.C. or else why roam the ether? If we really want entertainment why surrender to the evidently ever-selfish motorists?

London, N.W.11. L. STREATFIELD

V.H.F./F.M. Car Radio

R. V. TAYLOR'S article in the June issue on v.h.f./f.m. reception in a car was interesting, but having experimented extensively with this myself, and decided that it was not the answer unless operating only in small areas relatively near to a transmitter, perhaps my remarks would be of interest.

I first started some eighteen months ago, exactly as Mr. Taylor suggests, by using a standard commercial tuner feeding into the a.f. and power pack unit of an ordinary car radio. The alterations necessary to do this were very simple, consisting merely of re-wiring the valve heater. The adjustable car-radio whip aerial was set at 2½ feet, and was in what was then the normal position for such an aerial—on the offside front wing.

One of the first things I discovered was the need for far better interference suppression on the car than was ever necessary for good medium- and long-wave reception, the main trouble coming from the voltage regulation. After quite a lot of trouble, this was cured, as

were other sundry crackles coming from unbonded parts of the car, although generator whine was never quite eliminated. Surprisingly enough, the ignition gave no trouble at all! When all this had been done, I found that the level of interference from other traffic was too high for comfort, but, of course, nothing could be done about it. However, the receiver worked fairly well, and was used for some time to find out whether the service area of the v.h.f. transmissions was large enough to warrant making up a receiver with better amplitude limiting. It was found with this tuner that the area within which the v.h.f. programme was of use (i.e., little fading or interference) was only a circle of about 20 miles radius. Outside this radius, in towns, flutter and distortion were much in evidence, although in the country reception was naturally better, but outside 30 miles reception was pretty poor anywhere, except, of course, on the tops of hills. Modifications were made to the tuner to improve limiting, but this only gave an increase of the good usable range to 25 miles, and the maximum usable range to 40 miles. If circles of these radii are drawn round the major transmitters on a map, the large gaps in coverage will be noted. Of course, these radii take no account of the topography, so that ranges in some directions may be better than others, but this will not materially affect the overall result.

The sensitivity of the tuner was not in question, it being possible to hear Sutton Coldfield on the South Coast, although the signal was quite useless for entertainment.

Another difficulty was that of tuning accurately, which had to be done if maximum a.m. rejection was to be achieved. Since it was obviously impossible to use visual indicators of any sort, tuning had to be done by ear, and with the slight fading experienced even in the best areas of coverage, this was quite difficult. In fact, I usually found it best to stop the car and then tune accurately.

Several Continental journeys were made with the v.h.f. tuner installed, and the situation there was even worse, due to the widespread use of low-power repeater stations. These had an effective range of about only 10 miles and when travelling on a motor-road this meant that it was necessary to re-tune (if a new station were available, that is!) every 15-20 minutes.

All these factors contrast very unfavourably with medium- and long-wave reception, about the only advantage v.h.f. having over these for car use being that when a good signal is obtainable, it is free from interference from other transmitters. The fact that better quality is to be obtained from v.h.f. is not significant for mobile reception, unless listening is confined to periods when the car is stationary—hardly mobile reception! Fading on medium waves is not a problem until ranges of 100-150 miles are reached, and then only at night, and so there are no gaps in the B.B.C. coverage of the U.K. If one can tolerate a little noise, it is possible to listen to Home or Light programmes while holidaying on the Continent, which certainly cannot be done with v.h.f. And tuning is far easier with a.m. than with f.m. if it has to be done aurally.

For these reasons I took the v.h.f. tuner out of the car some months ago, and reverted to the usual frequencies, with a certain amount of relief. Experiment with v.h.f./f.m. in a car by all means, but I don't think it's nearly as much use there as it is at home!

Tangmere, Sussex.

W. BLANCHARD

WHILST many of the considerations involved have been dealt with adequately in Mr. R. V. Taylor's article, this cannot be said of the treatment of interference generated by the vehicle itself. However effective the a.m. interference rejection of the sets may be, the remainder of the set must be very prone to interference conveyed by the power supply lead and probably interference radiated from the ignition system and other electrical components of the vehicle. Mr. Taylor makes no men-

tion of this and from long experience of this I can say that it is a very difficult problem.

Mr. Taylor is also, probably unintentionally, misleading regarding the B.B.C. v.h.f./f.m. coverage. At chimney-pot height what he says regarding the field strength laid down by the B.B.C. transmitters is no doubt true, but it is certainly not true of the field strength at car radio aerial height. It is, for instance, quite impossible to get an adequate signal on the road between London and Birmingham, and the same applies in many other places, and a thorough survey of this has shown that for a satisfactory car radio set, it is necessary, however effective may be the v.h.f./f.m. car radio, for medium- and long-wave a.m. reception facilities to be provided as well.

Pinner, Middlesex.

W. CROSSLAND

Power Transformer Design

IN his article on small power transformer design (June issue) Mr. Saull seems to have made an error in his example of a practical design. In step (c) he uses a figure of 216 T/in² for the LT1 winding whereas Table II shows that 17 s.w.g. enamelled copper wire winds 289 T/in². Consequently the remainder of his calculations for the example are wrong.

Using the figure shown in Table II the LT1 winding will occupy 0.125 sq in, making the total for the two l.t. windings 0.24 sq in. The remaining space for the h.t. winding is then 0.39 sq in, from which it is found in step (e) that the T/in² is 9,168. The nearest wire gauge from Table II is therefore 34 s.w.g., having a current carrying capacity of 66.5 mA. In consequence this winding will have a slightly lower copper loss, resulting in a small improvement in regulation and efficiency.

St. Leonards-on-Sea, Sussex. W. E. THOMPSON

MAY I comment upon a statement by Mr. D. Saull in his article (June issue) "Power Transformer Design"?

Whilst not disputing that for mechanical reasons it may be preferable to wind the heavier gauge windings of a transformer first, an improved voltage regulation is not necessarily obtained for this winding arrangement.

The voltage regulation is a function of the sum of the primary resistance, R_p , referred to the secondary terminals, and the secondary resistance, R_s , that is, the effective secondary voltage drop = $I_s (R_p/n^2 + R_s)$ where $n = I_p/I_s = \text{turns ratio}$.

The shorter mean length of turn of the secondary winding will reduce R_s , however the resultant longer mean length of turn of the primary winding will increase R_p , and, for equal primary and secondary winding areas, the effective secondary voltage drop will be unchanged.

Weymouth.

A. D. WAITE

The author replies:

Mr. W. E. Thompson is perfectly correct; I apologise for the error quoted by him which came about through misreading the comprehensive wire tables that I normally use when transformer designing. These tables include single and double silk and cotton covered wire, in addition to enamelled wire. The turns/in² I quoted for 17 s.w.g. wire was 216 which is, of course, for double-cotton-covered wires. As Mr. Thompson points out, I should have used 289 turns/in² in my example.

It is refreshing to see that Mr. Thompson has read my article with a discriminating mind and eye and is not prepared to accept all he sees in print without first agreeing. I like to see this quality in a reader—it keeps up the standard of technical literature. Once again, sorry for my error Mr. Thompson!

The point brought up by Mr. A. D. Waite is, I believe, a controversial one amongst transformer designers. Some say the winding sequence should be h.t. winding, primary winding, and l.t. windings on the outside; others say a winding sequence of primary winding first, followed by

the h.t. windings, and finally the l.t. windings on the outside; a third group, which I support, believe that the best results are obtained by winding the l.t. windings on first, the h.t. windings last, and positioning the primary in the centre of the transformer.

In support of the windings sequence I have chosen I will make these points—it is up to the reader to make his final choice.

(1) The purpose of my article was to produce a quick method of design; one that contained a minimum of variables; one that the design engineer could "get into" without too much preliminary digesting—otherwise he might just as well read a standard text book on transformer design.

(2) Positioning the primary between the l.t. and the h.t. windings, and consequently more to the centre of the lamination window, gives a smaller flux gradient across the window area. This results in a lower leakage inductance—consistent with the growing requirements of power supplies for transistorized, or partly transistorized, equipment.

(3) For design simplicity, the l.t. windings are required to carry current densities up to 2,000 A/sq in. A winding on the extreme inside is approximately half the length of one of the extreme outside, hence approximately half the resistance. However, if the primary is in the centre its resistance will not alter a great deal if moved slightly inwards or outwards. Primary current is a function of secondary wattage and, with small power transformers, the l.t. windings are responsible for the lion's share.

H.t. windings are operated at lower current densities, and in the smaller variety of power transformers, their resultant primary wattage is the lamb's share.

Heating effects are also a consideration: I^2R , if R is small, is half the answer that would have resulted if R became $2R$. L.t. windings placed near to the core will lose heat, through the large surface area of the laminations, quicker than directly from a smaller surface area in contact with air, had the l.t. windings been placed on the extreme outside.

Now reflected resistance, $n = \sqrt{R_1/R_2}$, only holds good at 100% efficiency. With 86% efficiency, which is an average for small power transformers, not all of the secondary resistance is reflected into the primary winding!

We haven't discussed leakage currents between windings when the transformer is connected in circuit. These currents produce a chemical effect resulting in the enamel coating on the wire and other insulation deteriorating, an important factor in long-term installations such as instrumentation equipment used in atomic power stations.

My article was based on simplicity and therefore generalized. It contained a little error—perhaps inexcusable, but I have, I hope, tried to lead the engineer to the meat, cutting away the fat; and I say, "Brother, put these turns on and you will produce a transformer that is reasonable. You might be able to improve on it—but if time is money to you—I think that you will find it acceptable."

D. SAULL

Wire Broadcasting

IN your article in the May issue describing the TV relay equipment you mentioned Capt. P. P. Eckersley's experimental sound relay where the electric light supply mains were used for programme transmission. Some years before Capt. Eckersley's experiments I applied to the Post Office, in association with Charles Melhuish, at that time proprietor of the Crapstone and Yelverton Electricity Supply Co., for permission to install on the company's supply a Multi-Programme Broadcast Relay using an h.f. carrier modulated by a number of lower frequency sub-carriers each accommodating a separate radio programme. Our plans were well advanced including the special mains spacing and h.f.c. arrangements required, and one of the receivers even included a form of a.g.c. which varied the gain by altering the h.t. voltage. It was not very effective!

Although we had the support of the late Sir Arthur de Breece then living at Dunster, our plans were turned down by the Post Office as they were held to infringe the B.B.C. monopoly. I bring this to your notice as, although there may have been previous proposals along these lines, of which I am not aware, ours did precede Capt. Eckersley's.

Haverfordwest,

K. F. PONTING-BAKER

Radio Telescope

"UNBIASED" by "Free Grid," in your May 1960 issue, finds the name radio telescope inadequate and confusing and suggests that an entirely new word should be given to this instrument. I quite agree with him and since he has asked your readers to help in this matter, I would suggest "electronic cosmoscope" or "radio cosmoscope."

Mombasa, Kenya.

K. C. FOLEY

Medical Electronics

THE third International Conference on Medical Electronics opens at Olympia on July 21st for a week. Some 100 papers will be presented at this conference which is being organized by the Electronics and Communications Section of the I.E.E. in association with the International Federation for Medical Electronics.

About 80 exhibitors are participating in the exhibition which is being held at Olympia throughout the conference. In the following list of exhibitors we have indicated the country of origin of those from overseas. The exhibition will be open daily from 9.30 to 6.0; admission is 3s 6d.

A.E.I.
Air-Shields (U.S.A.)
Allen & Hanburys
Alvar-Electronic (France)
Amplivox
Antares (France)
Ateliers de Construction
Beaudouin (France)
Atlas-Werke (W. Germany)
Atomic Weapons Res. Estab.
Bailey, I. G., & Co.
Barr & Stroud
Becker, J. (Holland)
Belling & Lee
Bird Oxygen Co. (U.S.A.)
Chiba Electric Works (Japan)
Coulter Electronics
Cox, Stanley
Dawe Instruments
Disa Elektronic (Denmark)
Ekco Electronics
Electronic & X-Ray Applications
Electronic Industries Assoc. (Japan)
Electronic Machine Co.
Elektronlaboratoriet (Denmark)
Elema-Schonander (Sweden)
Elga Products
Endometrics
English Electric Valve Co.
Etudes et Constructions
Electro-Medicales (France)
Faraday Electronic Insts.
Frieseke & Hoepfner (W. Germany)
Fukuda Electro Co. (Japan)
Fukuda Medical Electric Co. (Japan)
G.H.S. Electronics
Godart & Miinhardt
Godart-Miinhardt (Holland)
Heiwa Electronic Institute (Japan)
Hellige & Co. (W. Germany)
Heywood & Co.
Hilger & Watts
Hitachi (Japan)

Infra Red Development Co.
Japan Radio Co. (Japan)
Leitz, E. (Instruments)
Leitz, E. (W. Germany)
Leland Instruments
Marconi Instruments
Medische Apparaten (Holland)
Mullard Equipment
Multitone Electric Co.
Nagard
New Electronic Products
Nikkoh Electronic Instrument Co. (Japan)
Nippon Electric Co. (Japan)
Nuclear Enterprises (G.B.)
Officine Toscane Elettromeccaniche (Italy)
Offner Electronics (U.S.A.)
Ossa (Switzerland)
Picker International Corp. (U.S.A.)
Purtschert, M. J., & Co. (Switzerland)
R.C.A. Great Britain
S.S. Electronics
Sanborn Co. (U.S.A.)
San'ei Instrument Co. (Japan)
Sanyei Manfg. Co. (Japan)
Saunders-Roe & Nuclear Enterprises
Schwarzer, F. (W. Germany)
Selig Electromagnetics
Shimazu Seisakusho (Japan)
Siemens-Reiniger-Werke (W. Germany)
Sierex
South London Electrical Equipment Co.
Telco (France)
Telefunken (W. Germany)
Tinsley & Co.
Tokyo Shibaura Electric Co. (Japan)
Dr. Ing. J. F. Tonnies (W. Germany)
Townsend & Mercer
Winston Electronics



Electronics in Israel

STEADY GROWTH EXEMPLIFIED AT THE RECENT EXHIBITION IN TEL AVIV

By R. DANZIGER, M.Brit.I.R.E.

THE first Electronics Exhibition was held recently in Tel Aviv and was organized by the IEMA (Israel Electronics Manufacturers Association) and the trade schools. Since its modest start in 1950 the electronics industry has increased the value of its annual output from 350,000 to 8,000,000 IL (Israel Pounds).

The 1960 exhibition was the first of what is intended to be a series of annual events. The main part of the show was devoted to domestic radio receivers which ranged from tiny transistorized sets through car radios to elaborate "hi-fi" equipment for rooms with special acoustic arrangements. Wood was still the favourite material for the Continental styled cabinets of most makers with plastic materials being the exception. Some firms showed prototypes of their future production programme including TV sets, stereo amplifiers, tape recorders and d.c. record players.

An important part of the exhibition was the components show. Except for valves, transistors and certain types of condensers and resistors all parts are manufactured in Israel. A wide range of components was shown including piano-type waveband switches, polystyrene condensers, several types of variable condensers, many types of loudspeakers and tweeters and a wide range of all types of transformers and coils.

Perhaps the most interesting part of the show was that devoted to the professional exhibits. Whilst the manufacture of professional electronics equipment is still at its beginning, it is backed by considerable know-how. Outstanding in this section were electronic fire alarms and counters made by ELCO (Ramat Gan), printed circuits, epoxy castings and pulse equipment by Israel Electronics Co. (Rishon Lezion) and quartz crystals by Tadir

(Holon). All being up to a high standard both in respect of specification and finish. Other items in the professional section included timers, miniature pulse transformers, measuring gear, electro-medical equipment, loud hailers and of course a large variety of office and industrial intercommunication systems.

In addition to the commercial exhibits one wing of the show was devoted to training aids and the work of the students of the trade schools. There are seven major trade schools in Israel with 4-year courses in electronics. They have a combined capacity for 500 students and turn out about 200 qualified technicians per year. The demand for places at those schools is considerable and stiff entrance examinations are held, resulting eventually in a high standard of training. The exhibits in this section included many student-built equipments such as oscillators, amplifiers, transmitters, etc., but also more advanced equipment such as u.h.f. waveguides, pulse-shaping circuits nicely demonstrated by means of several oscilloscopes, and even a radio-controlled model aeroplane.

The most sophisticated equipments were shown by the two leading academic teaching institutions, The Hebrew University, Jerusalem, and the Technion, Haifa. They exhibited an analogue computer, pulse generators, coincidence plug-in units and even a 24-channel pulse height analyser.

One leaves the exhibition with the definite impression that the local electronics industry has left the "music box" stage for good and is embarking on a serious domestic and professional production programme in the electronics field.

The exhibition, with a floor space of 500m², comprised 27 stands and was open for four days (4 hours per day) during which time the number of visitors was of the order of 2,000.

Radio Aids to Hydrography

DECCA TWO-RANGE AND LAMBDA POSITION-FIXING SYSTEMS

By C. POWELL*

This article describes the latest version of one of the radio aids to survey at sea. The aid is used extensively throughout the British Commonwealth and in ships of the Royal Navy

THE science of Hydrography", says the Admiralty textbook on that subject, "originated in the need for the production of maps specially designed for the use of the mariner. . . . During the nineteenth century nearly every specialised maritime country founded a department for the sole purposes of dealing with the issue and publication of charts and for the co-ordination and execution of marine surveys, and immense progress has been achieved in the production of charts". An important contribution to that progress, since the Second World War, has been made by radio position-fixing systems, and these are now accepted as standard surveying equipment in hydrographic work.

A radio position-fixing system can be used to fix the position of the survey ship, so that observations can be assigned to their correct geographical positions; to hold the ship on the survey tracks, and to navigate the ship to the survey area with the minimum delay and wasted steaming. It can be used when haze or mist prevent shore marks from being used for fixing and running lines by the classical methods; also at distances such that shore marks are beyond the limit of visibility. This has brought radio aids into the field of oceanographic surveying, involving ship-to-shore distances of several hundred miles. A widely-used radio aid to surveying at sea is Two-range Decca; as this is derived from the Decca Navigator^{2, 3} some aspects of the latter should be noted.

Decca Navigator.—Decca employs unmodulated c.w. transmissions occupying spot frequencies in the 70-130 kc/s band. At these frequencies, the attenuation of the surface wave is sufficiently small to permit use of the system by ships at distances greatly exceeding that of the "radio horizon" and the stability of propagation condition during the hours of daylight, coupled with the potentialities of the phase-comparison method of obtaining a position line, make possible a degree of accuracy appropriate to most hydrographic-survey requirements. A chain of Decca stations normally comprises a central master with two or three outlying slave stations disposed about it. The slave transmissions are phase-locked to the master and the basic function of the receiver carried by each user of the system is to compare the phase of the master transmission with that of each slave. The phase differences are displayed on three pointer-type phasemeters, known as Decometers (one for each master/slave combination) and each reading locates the user on one

of a family of hyperbolic constant phase-difference lines focussed on the master station and the appropriate slave. A position fix is given by the intersection of two such position-lines: on board ship the readings are usually plotted manually on a chart overprinted with correspondingly-numbered Decca-grid lines. In aircraft, and in certain special-duty ships, the fix is continuously displayed on an automatic plotter (Flight Log⁴ or Track Plotter) which provides a pictorial presentation of position by a pen, representing the user vehicle, moving across a map.

Two-range Decca.—Soon after its commercial introduction in 1946, the Decca Navigator became established as an aid to hydrographic surveying by use of the permanent European coverage as it then existed, supplemented by mobile chains in Greenland, Sweden and the Persian Gulf. In 1950, however, there arose an operational requirement which the conventional Decca station layout could not meet; a survey organization operating in the Antarctic required a radio position-fixing system having the characteristics of Decca; but using only two shore stations instead of three because three suitably-disposed and habitable sites could not be found in the area of the proposed survey. As a solution the survey department of the Decca Navigator Company proposed a layout in which the two slave stations would remain on the shore, the master being installed on the survey ship together with the receiver. While confining the use of the chain to a single ship at a time, this arrangement overcame the siting difficulty and also introduced other advantages, notably the fact that the Decometers now indicated the direct distances to the shore stations rather than the distance-differences of the conventional system.

The ensuing development of the Two-range system into an operational hydrographic-survey tool was undertaken in close co-operation between the Hydrographic Department of the Royal Navy, the Admiralty Signal and Radar Establishment (now the Admiralty Surface Weapons Establishment) and the manufacturers.

Principles of Two-range System

The layout of a Two-range chain is shown diagrammatically in Fig. 1. The master transmitter on the ship radiates a c.w. signal of frequency $12f$ where f is approximately 14 kc/s. As all the radiated and phase-comparison frequencies are harmonically related, as in conventional Decca, it is more convenient to refer to them in a harmonic notation rather than in numerical terms. The "red" slave station ashore receives the master transmission and radiates a signal of frequency $8f$, in a manner such that the slave and master signals have a constant phase relationship at the common multiplied-up frequency value of $24f$; a stable pattern of constant-phase-difference lines is therefore generated about

*Decca Navigator Co. Ltd.

the two stations (broken lines in Fig. 1) this pattern being identical with that which would be produced if signals frequency $24f$ (about 340 kc/s) were actually radiated from master and slave. In the shipborne receiver the signals are received and multiplied for phase comparison at $24f$, and the phase-difference meter (Decometer) makes one rotation if the ship-to-slave distance alters by one phase-difference cycle or "lane". Along the line between master and slave, the lanes recur at uniform intervals each equal to half a wavelength at the comparison frequency, and the lane pattern that the ship uses therefore takes the form of a family of concentric circles centred on the slave station. At $24f$, the lanewidth is roughly 420 metres and the Decometer, which can be read to less than half-a-hundredth of a revolution, will therefore respond to a change of a metre or two in the ship's distance from the slave. A similar process takes place in the "green" co-ordinate ($9f$ slave frequency) at a common comparison frequency of $36f$, giving in this

case a lanewidth rather less than 300 metres as shown in the accompanying table.

Each Decometer embodies a lane-counting pointer geared down from the phasemeter rotor, together with a subsidiary indicator driven through a further stage of gearing and recording groups of lanes ("zones") passed through. Assuming a value for the speed of propagation of electromagnetic radiation, these readings can be converted into distance units: this is generally done by plotting them on a chart overprinted with the two patterns of circular position lines, numbered to correspond with the Decometer readings and drawn at constant radial intervals of one or more lanewidths. A "two-range" fix of the ship's position with respect to the shore stations is given by the intersection point of the two circles (interpolating between the lines on the chart as required) indicated by the meter readings.

If a second receiver were placed close to, say, the red-slave station, the red Decometer reading of this receiver would show no change even if the ship

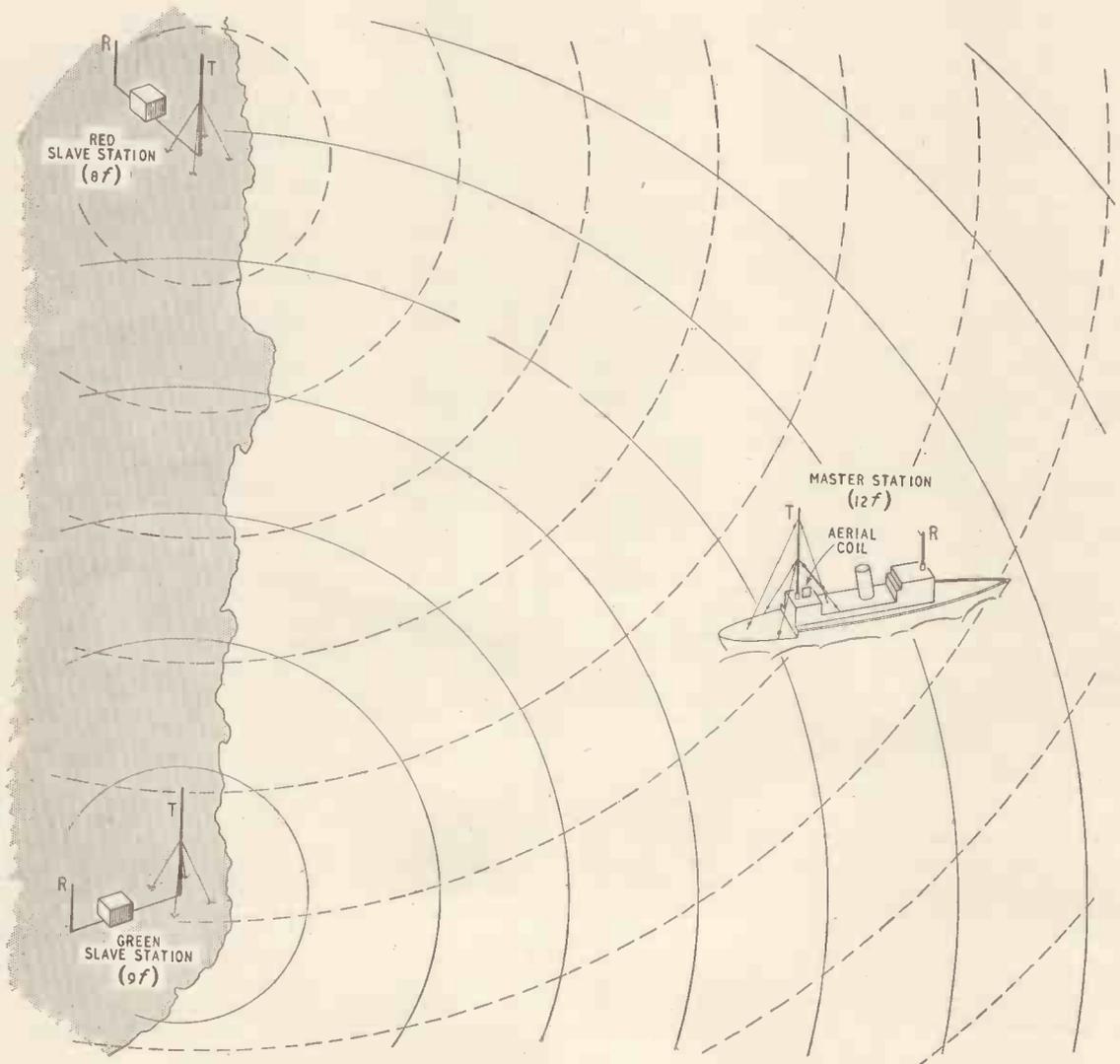


Fig. 1. Diagram of layout of Two-range Decca Hydrographic-survey system.

TABLE
Typical values for frequency and lane width

Function	Carrier Frequencies		Phase Comparison Frequencies		Lane Width
	kc/s	harmonic	kc/s	harmonic	($v=299,650$ km/sec) metres
Master	177.6	12f	—	—	—
Master Identification (Lambda system only)	162.8	11f	—	—	—
Green	133.2	9f	532.8	36f	281.2
Red	118.4	8f	355.2	24f	421.8

Note: All frequencies are harmonically related to a non-transmitted fundamental value f .

altered her position by several hundred miles; this is because the slave station's function is to radiate a signal having a constant phase relationship with the incoming master transmission. The shipborne Decometer indicating the master/slave phase difference is, however, sensitive to any change in the ship-to-shore distance, as this alters the length of the transmission paths from the master to the slave and back without a corresponding change in the direct path from the master to the ship receiver.

If maximum accuracy is to be secured from the system, corrections have to be applied for the non-uniform speed of propagation of radio waves in the groundwave mode and for fixed phase shifts. The full expression for measurement of the distance between the ship and a slave station therefore becomes:

$$d = (\lambda cf/2) (\phi - \alpha - \psi)$$

where d is the distance from the "electrical centre" of the ship to the mid-point between the receiving and transmitting aerials at the slave station, $\lambda cf/2$ is the lanewidth in metres for the appropriate pattern, assuming free-space velocity, ϕ is the observed Decometer reading (whole lane number plus fraction), α is the "locking constant," and ψ is a correction to the free-space value of the speed of propagation.

The exact location of the electrical centre of the ship in the above formula is found by calibration at a known distance and on a number of different headings. The locking constant is the name given to the overall phase shift due to the close proximity of the receiver to the master transmitter (placing the former in the "induction field") and, at the slave station, a possible fixed displacement from the nominal zero phase-difference condition that is assumed to exist between the received master signal and the outgoing slave transmission. The value of the locking constant for each pattern is found at the start of a survey by observations at exactly known distances from the slaves, and is thereafter subtracted from all observed Decometer readings.

The quantity ψ refers to the dependence of the effective speed of propagation upon the nature of the medium over which the signals are transmitted—an aspect of the groundwave mode of propagation which is of fundamental importance when the transit time of low-frequency signals forms the basis of position or distance determination. This phase lag with distance results from absorption of energy by an imperfectly conducting earth* and Fig. 2 shows a practical set of phase-lag correction curves for the red and green patterns. The increase in the cor-

rection value at short ranges is the result of the complex field existing around the transmitter, and the increase beyond 100 km or thereabouts is the effect of the phase lag. The mean speed of propagation resulting from the phase lag varies widely with the electrical characteristics of the medium over which the signals are transmitted; e.g., the sum of experience so far with Two-range Decca points to a mean velocity of 299,650 km/sec over seawater transmission paths, while a corresponding figure for land paths of the lowest soil conductivity yet encountered (of the order of $\sigma=5 \times 10^{-15}$ e.m.u.) amounts to about 298,400 km/sec. If no steps were taken to correct for this variation, an uncertainty of 1 part in 240 could exist in the range determination (assuming the possibility of a Two-range chain being operated over land as well as over sea) which would render the system completely unacceptable as a survey instrument. Fortunately it is possible to apply corrections for different path conductivities; also for paths of mixed conductivity such as the case where a large island or promontory intervenes between the ship and the shore.

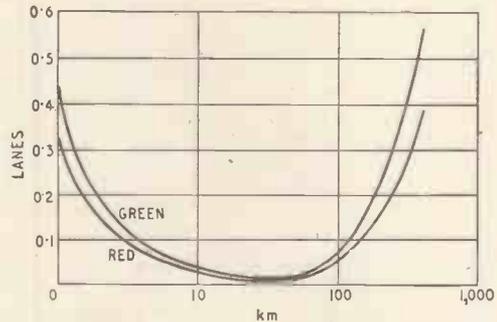


Fig. 2. Phase correction (expressed in lanes) for seawater transmission path.

Application of the corrections shown in Fig. 2 for transmissions over seawater leaves, with present knowledge, a residual uncertainty amounting only to one or two parts in ten thousand. The curves were constructed on a theoretical basis, but have been confirmed by observations with the conventional Decca system as well as with the Two-range version at distances up to about 200 km: beyond this distance it is hoped to obtain practical

* This has been the subject of theoretical work, notably by Sommerfeld, Bremmer and Norton, which is described in detail in a paper by A. B. Schneider. Extensive work has also been carried out by Dr. B. G. Pressey and his associates at the Radio Research Station (D.S.I.R.).

confirmation from trials specially designed for this purpose. Here we encounter a familiar problem in the practical deployment of modern radio aids to surveying and navigation: to check the radio aid satisfactorily it is necessary to know distances and positions with an accuracy several times greater than that of which the aid itself is capable, and this is liable to tax present survey resources to the utmost. For example, if the correct value of ψ over seawater could be determined experimentally without error, the Two-range technique should then be capable of measuring, say, the distance from a point on the north coast of East Anglia to a point near Aberdeen with an accuracy of one or two parts in 50,000, yet this is not far short of the accuracy with which the actual distance between the two points in question can be stated from present survey knowledge.

Random Errors.—The phase errors so far described can be partly or wholly corrected. Rather more important are errors of a random character, which may be due to instability associated with wave propagation or with instrumental variations, or both. From sunset until sunrise at all seasons, and also during daylight in winter, random variations due to skywave interference start to become detectable at ship-to-shore distances of about 40 miles, and thereafter increase in magnitude with range. The actual survey operations requiring accurate fixing are, therefore, generally confined to daytime, but this does not apply to incidental manoeuvres such as journeys between different survey areas, which call for a lower degree of accuracy than the survey itself. Typical random-error contours for the use of the system by day are indicated in Fig. 3. In practice, the overall accuracy of Two-range Decca has been such as to permit plotting of the results at a chart scale of 1:70,000 (about one inch per nautical mile) without the errors or variations due to the system itself being detectable at this map scale.

A geometrical characteristic of the Two-range layout is the relatively large proportion of the coverage, compared with a hyperbolic system having the same distance between the slave stations, within which a high fix accuracy can be obtained. The angle of cut between the two circular position-line patterns is good (i.e., near 90°) over a wide area, and the layout is favourable in that there is no lane expansion such as occurs when similar equipment is operated as a hyperbolic chain.

Referencing.—A potential source of error in the receiver itself arises from the differential phase shifts between the master and slave channels. To check and correct these, the receiver incorporates a reference source, whose output is a $0.5\mu\text{sec}$ pulse having a recurrence frequency equal to the fundamental value f , to which all the transmitted and phase-comparison frequencies in the system are harmonically related. Applying this pulse to the input of the receiver, each channel extracts its harmonic frequency. As the harmonics are related to a common fundamental, the two Decometers would read zero if there were no differential phase shifts in the channels. If a reading other than zero is observed, a compensating phase shift is applied so that a zero reading is restored.

Frequencies.—The transmissions are of the pure continuous-wave type with no modulation. This characteristic enables receiver bandwidths of a few

c/s to be employed, which in turn secures the required performance from transmissions of low radiated power. The shipborne master transmitter installation radiates approximately two watts and the slave stations (in the standard version of the system) approximately four watts. The use of low-power transmissions having no modulation sidebands minimises the problems of frequency allocation and of mutual interference with other services.

Those familiar with conventional Decca will have noticed from the table that a different harmonic relationship for the transmitted frequencies is used

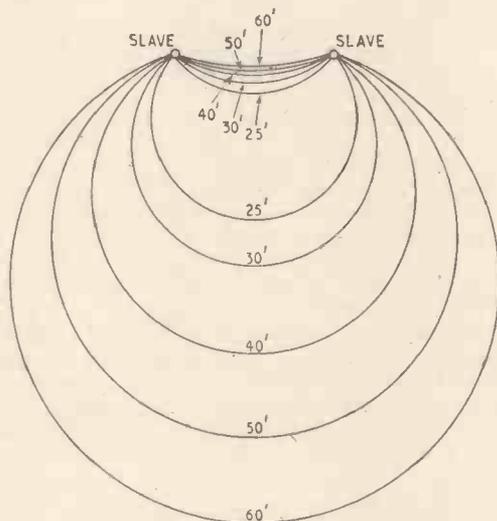


Fig. 3. Fixing-accuracy contours in feet for summer daylight operation. Contours are drawn for a 0.01 lane deviation.

in the Two-range version of the system, the master frequency having twice the normal harmonic value. This is in order to secure maximum strength of radiated signal from a shipborne aerial mast which is necessarily of restricted size. On the frigate-type survey ships of the R.N. Hydrographic Service, for example, the height of the mast is limited by the available staying radius to about 45 feet. Early Two-range chains used a master frequency $6f$, i.e., a spot value between 85 and 90 kc/s, which resulted in a radiated power of approximately one-third of a watt for an input to the aerial of 350 watts. By doubling the frequency an approximately eight-fold gain in radiated power for the same input is achieved, and this has permitted operation in tropical regions, where the noise level is high, at distances well in excess of 150 miles.

Equipment.—Briefly reviewing the items of equipment comprising a Two-range Decca chain, the shipborne master installation consists of a duplicated unit containing a stable crystal oscillator which provides the source of the master signal, feeding a 350-watt c.w. transmitter. The 45-foot tubular transmitting aerial mast (Fig. 4) is base-insulated and is supported at three heights by stays insulated at their lower ends.

The shipborne receiver is generally installed in or near the chart room and uses a standard Decca receiving aerial which is a vertical fibreglass tube containing a length of insulated wire. The receiver

(Continued on page 355)

is of the Decca "survey" type which is capable of use with either the hyperbolic or the Two-range layout, the latter necessitating two small adjustments: a reduction in the gain of the master channel because of the proximity of the master transmitter, and a reversal of the sense of Decometer rotation so that the readings increase instead of decrease with distance from the slave station. The Decometers are supplemented, when necessary, by the Track Plotter which is the marine counterpart of the Flight Log. Ashore, each slave station comprises, in duplicate, a "control unit" which contains the oscillator forming the signal source, together with the equipment for phase-locking the outgoing slave transmission to the received master signal. The second "standby" control unit, as it compares the phase of the master and slave transmissions and displays their phase difference, acts as an independent monitor of the phase pattern. The transmitter is similar to that used at the master, and a similar transmitting aerial system is employed except that, in general, its height is approximately twice that of the shipborne mast.

Lane Ambiguity.—From a practical point of view, Two-range Decca as so far described has a serious limitation in the form of a high degree of pattern ambiguity. From the above table it will be seen that typical lanewidths for the two co-ordinates are about 420 and 280 metres respectively, which means that before starting work, or after an interruption, the user must know his distance from the red shore station to better than ± 210 metres and from the green to better than ± 140 metres. At moderate ranges this has not given rise to any serious difficulty; the ship usually starts from a known point in any case, appropriate plotting procedures can reveal the development of a whole-lane error should this occur and, if the journey to a check point where the lane values are known should have to be made this may not be a major undertaking when surveying within a small area. At distances greater than about 100 miles from the stations, however, the lane ambiguity becomes an increasingly serious problem, and some form of lane identification, such as is provided on all the permanent Decca navigational chains, would greatly improve the system. The conventional Decca lane-identification method does not lend itself to use with mobile transmitting equipment where light weight and compactness are paramount, but a modified technique known as the "Lambda" method (Low-AMBIGUITY Decca) which overcomes this difficulty has recently been evolved and is incorporated in a new Decca survey system based on the Two-range principle.

Lane Identification in the Lambda System

In essence, any lane-identification system consists in superimposing upon the ambiguous lanes a coarse pattern in which one "lane" or phase-difference cycle embraces a number of the fine lanes. Thus, if a pattern resulting from phase comparison at a frequency $1f$, using the previous notation, is superimposed upon the $24f$ red pattern, a phasemeter responding to the coarse pattern would make one revolution for 24 red lanes passed through, and would indicate the correct red lane number for the ship's position in a group of 24. Similarly, a $1f$ pattern will identify the correct green ($36f$) lane out of a group of 36. As there will be many more than 24



Fig. 4. British Naval Survey Ship equipped with Two-range Decca showing tubular aerial mast for transmission of the master signal.

or 36 lanes in the total fine patterns, some ambiguity will still remain; but, remembering that the " $1f$ " lanes are about 10km wide measured along the master-to-slave line, this requires only that the user should know his distance from the slave station initially to ± 5 km in order to be able to make use of the coarse patterns for setting correctly the Decometers. In practice, this remaining degree of ambiguity causes no difficulty since the ship's position can be found accurately enough by an astronomical fix or other standard practice.

Since it is out of the question actually to transmit $1f$ (14kc/s) from the stations, this frequency must be extracted from them by other means. In the Lambda system, the shipborne receiver obtains a $1f$ master signal direct from the appropriate circuit in the master-transmitter control unit. For the receiver to obtain a $1f$ signal from the slave stations, which normally transmit $8f$ and $9f$ for red and green respectively, the slave frequencies are momentarily counter-changed so that, given a means of "memorising" the original phases of the signals, a $1f$ beat note can be derived from each station. Comparing the $1f$ transmission thus obtained from the slave with the $1f$ signal from the master results in the generation of the $1f$ phase pattern necessary for lane identification.

Lane identification is initiated in the Lambda system by stopping the $12f$ transmission from the ship and replacing it, for about 1.3 sec, by an $11f$ signal. This triggers the changeover of frequencies at the slave stations and provides the slave with a "notching" datum, to be described later.

A locked-oscillator technique is used at the shipborne receiver to extract the required $1f$ beat note from each slave station. (Fig. 6(b)). At the receiver on board, the $8f$ and $9f$ locked oscillators preserve the phase of the signals that normally control them, and $1f$ beat notes are extracted for each slave by mixing the oscillator outputs with the signals received during lane identification. The phase difference between the master and each slave at the frequency $1f$ is displayed by a sector-shaped pointer on the coarse Decometers (lower dials in Fig. 5). If the lane-identification pointer moves so as to enclose the lane-counting pointer, the latter is reading correctly. If this does not occur, the lane-counting pointer is reset manually to the position indicated. After the one-second lane identification transmissions the normal transmissions are resumed until the user again decides to check or identify the lanes. The actual indications are "frozen" for several seconds, for ease of reading.

Lambda Lane Patterns.—In a system designed for oceanographic surveying several hundred miles from land, every possible precaution must be taken to ensure continuity of operation. The ambiguity which the lane-identification system is designed to resolve should be made less severe, if this is feasible, and the possibility of a whole lane error occurring should be reduced to the absolute minimum. Accordingly, in the Lambda system the basic patterns are produced by comparing phase at the frequency of the slave transmission without multiplication. This results in a greater discrimination against noise interference than when frequency multiplication takes place, leading to a greater range for a given probability of lane loss. At the same time the lanes thus generated by phase comparison at the relatively low slave frequency are correspondingly wider and less ambiguous.

The basic Decometers (the two lower dials on the display unit shown in Fig. 5) respond to these slave-frequency patterns and the movements are so geared to the lane-counting pointers that the latter make one revolution per zone, i.e., one revolution for 8 red slave-frequency lanes and 9 green slave-frequency lanes. On turning manually the red meter with the reset button, therefore, it will be found that the lane pointer can take up any one of eight equally spaced positions around the dial. The lane-identification pointer is coaxial with the lane-counting pointer, so that the basic function of the former is to indicate which of these eight positions is the correct one, i.e., to identify the correct slave-frequency lane within a zone of 8 or 9 such lanes for red and green respectively. As already mentioned, a rough fix serves to tell the user which zone of each pattern he is in. The individual zones are counted, as in normal Decca practice, by additional dials appropriately geared to the lane-counting pointers.

Unhappily, technological achievements do not include the extraction of something from nothing, and owing to its wide lanes the system as described

so far would be three times less sensitive to a change in the distance from the ship to the red slave station than the earlier version of Two-range Decca, and four times less sensitive in the green co-ordinate. To remedy this, narrower lanes are interpolated between the slave-frequency lanes simply by carrying out a further phase-comparison at a higher frequency. This requires further frequency-multiplication in the receiver, together with additional discriminators and a pair of fine Decometers, as shown in the block diagram of Fig. 6 (a). The fine meters, which are the upper pair on the display unit, make one revolution per $24f$ (red) and $36f$ (green) lanes, and thus restore the pattern sensitivity to the same level as that of the previous system. Except in the strictly arithmetical sense, no extra ambiguity is introduced by this measure; the lower Decometers have scales marked in fine-lane units and can be read to a fraction of a fine lane, and a glance at the upper meters which are calibrated in hundredths furnishes the second digit. In effect, therefore, the upper meters operate simply as expanded scales for the coarse meters, and present no individual setting-up problem apart from the necessity that they should periodically be "referenced" to zero together with all the other meter movements in the system.

"Notching."—Reverting to the generation of slave-frequency lanes, it will be realized that these contain an additional ambiguity of their own, which is true of any Decca pattern in which phase is compared at a frequency lower than one or both of the radio transmissions involved; this is the result of frequency-division which, even if it does not take place literally in a dividing circuit, is nonetheless carried out in effect when slave-frequency lanes are produced. Here we need consider only the phase relationship between a slave station such as the red (frequency $8f$) and the $12f$ master transmission to which it is phase-locked. Granted that the phase-control circuit at the red slave holds the outgoing $8f$ signal at zero phase difference with an $8f$ signal derived from the master, it can do this for three different relationships between the $8f$ and $12f$ master signals. In other words, the $4f$ frequency corre-



Fig. 5. Display unit of Lambda-type installation. Upper meters indicate fine pattern readings (comparison frequencies $24f$ and $36f$). Whole lanes and lane identification are given by lower dials.

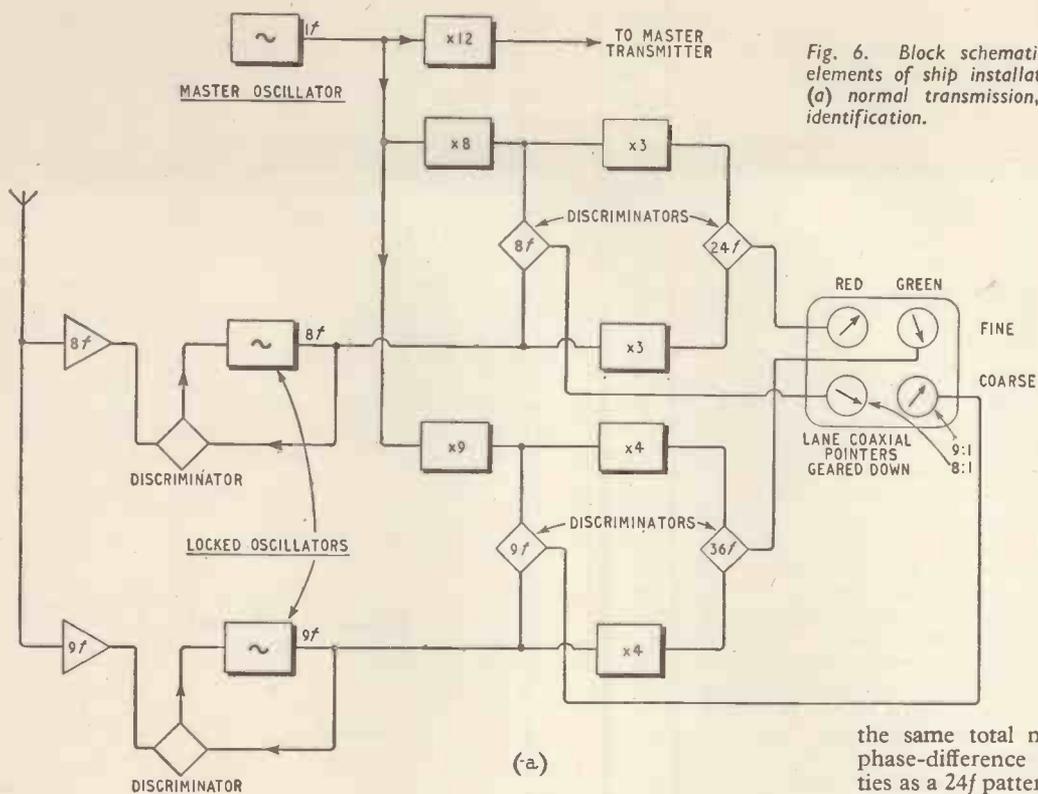
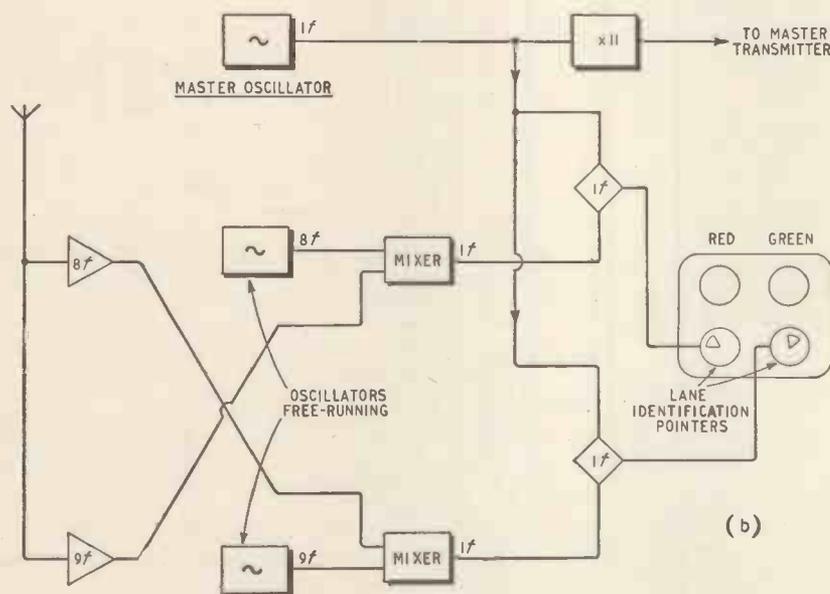


Fig. 6. Block schematic of main elements of ship installation during (a) normal transmission, (b) lane identification.



sponding to division of the $12f$ by 3 can start on any $12f$ cycle it likes without affecting the phase comparison at $8f$, but for every one such cycle giving the correct pattern phasing, there are two which produce pattern errors of either one- or two-thirds of an $8f$ lane. These "notch" errors, as they are called, are equivalent to shifts of one or two fine ($24f$) red lanes respectively, so that if nothing were done about them the $8f$ pattern that we have gone to so much trouble to generate would have exactly

the same total number of phase-difference ambiguities as a $24f$ pattern, despite the relatively wide slave-frequency lanes. Further, if there is a potential notch error in counting down $12f$ to $8f$, there must also be a greater uncertainty in extracting $1f$ signals from the various stations for lane-identification purposes in the manner already described. In practice, all such ambiguities are dealt with by the single notch-correcting facility embodied in the equipment.

Ship Installation.—Fig. 6(a) is a rudimentary block diagram of the receiver in its normal state (i.e., in the absence of lane-identification transmissions). The master transmitter circuits, other than the output stages, are incorporated in the same box as the receiver, and the $1f$ oscillator which forms the basis of

the master transmission also provides the receiver with its master phase datum. For the latter reason, there is no notch ambiguity problem at the receiver, since the slave-frequency master signals required by the receiver are derived direct by selecting the eighth and ninth harmonic from the pulse output of the $1f$ oscillator, and no uncertainty therefore exists as to the relationship of these signals with the $12f$ transmitted signal which is also derived directly from the same oscillator.

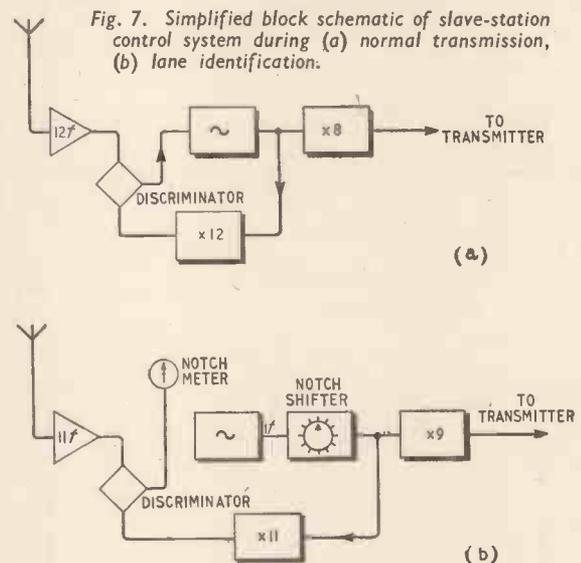
The functioning of the two receiving channels by which the shipborne equipment obtains the red and green slave signals depends upon the use of locked oscillators; that is to say, stable crystal oscillators in temperature-controlled "ovens" whose outputs are compared in frequency and phase with the received slave signals and locked to them by servo loops involving phase discriminators and reactance circuits. The oscillator outputs therefore provide noise-free replicas of the incoming signals, an arrangement which decreases the effective bandwidth of the receiver, as well as furnishing the phase memory required by the method of lane identification shown in Fig. 6(b).

Slave Stations.—Figure 7 shows the essentials of a slave station. The signal source is an oscillator of frequency $1f$ which is locked at its twelfth harmonic to the incoming $12f$ master signal. The equipment is identical at the two slave stations; if we assume that it is switched to operate as a "red" slave, the eighth harmonic of the basic $1f$ oscillator is amplified and transmitted continuously, except during lane identification. The locking of the slave to the master, upon which the generation of a stable pattern of position line circles depends, is carried out in two stages. The incoming master signal, having been passed through a two-stage crystal filter also in the "oven," is amplified and phase-compared with the twelfth harmonic of the slave's oscillator. The discriminator output controls the phase of the oscillator to keep the $12f$ signals phase-locked. The second stage of phase-locking (not shown in the diagram) is between the radiated output from the aerial and the input to the transmitter. The $8f$ output of the oscillator passes to the transmitter through a reactance stage. This is controlled, in turn, from an $8f$ phase discriminator, in which the drive and radiated $8f$ signals are phase-compared, to keep the radiated signal locked to the drive signal, irrespective of capacity changes in the transmitting aerial. This whole arrangement is duplicated at $9f$ so that the slave transmission at that frequency during lane identification shall be similarly phase-stable with respect to the master.

Elimination of the notch ambiguities is simply a matter of ensuring that the slave $1f$ oscillator has the correct phase relationship with the master $1f$ oscillator and this relationship is displayed to the slave-station operator every time the ship initiates a lane-identification transmission. The "notch meter" indicates the phase-difference between the $11f$ signal from the master (i.e., the eleventh harmonic of the master oscillator) and the eleventh harmonic of the slave oscillator. The latter is sufficiently stable for it still to be considered as locked to the interrupted $12f$ master signal, so that the twelfth harmonics of the two oscillators are already in phase; if the eleventh harmonics are seen by the notch meter to be also in phase the master and slave oscillator outputs will have the correct (i.e., zero) phase relationship at their fundamental frequency. If one of the eleven other possible readings is observed, a 12-position notch control, which operates a phase-shifting network, is turned a sufficient number of clicks in the appropriate direction to bring the eleventh harmonic of the oscillator into the right phase. The use of a click device on the phase control simplifies the setting up process as correction can then be made after the lane-identification period (≈ 1 sec) has finished.

When the meter reads zero, the whole system is correctly notched, i.e., the slave transmissions have the correct phase relationship with the master at the fundamental frequency $1f$ and hence also at the transmitted harmonic frequencies. The probability of a notch error developing during a day's work has been shown to be extremely remote. However, to enable the slave operator to check the notch in the event of an interruption in transmission, provision is made for him to request the ship to initiate a lane-identification transmission. The signal takes the form of a momentary phase shift in the slave transmission which is too rapid to introduce a Decometer error, but which serves to trigger a "slave-call" lamp on the receiver display unit.

On the survey ship, the receiver and the input sections of the master transmitter are now housed in a bulkhead-mounted container similar in size to that of the familiar Decca Navigator Mark 5 shipborne



set; the transmitter itself and the aerial system are disposed in the same way as before (Figs. 1 and 4). The slave stations are stowed on board the ship in transit, and are then taken ashore in small boats or helicopters and set up for the duration of the survey. To assist stowage and transport, the units are housed in standardised boxes of the type used for Army signals equipment: hydrographic surveys are in the nature of military operations, and every possible effort has to be made to ensure mobility as well as reliability in the equipment that the modern surveying employs.

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- 5 Schneider, A. B. Phase Variations with Range of the Ground Wave Signal from C. W. Transmitters in the 70-140 Kc/s Band. *Journal of the Brit. I.R.E.*, Vol. 12, No. 3, March 1952, p. 181.

Elements of Electronic Circuits

15.—THE "BOOTSTRAP" TIMEBASE

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

A TIMEBASE circuit which uses both positive and negative feedback is shown in Fig. 1. Known commonly as a "bootstrap" timebase, it comprises:—(i) A switch, consisting of a triode V1 operated by a negative-going square pulse, shunting the timebase capacitor C. (ii) A charging resistor, R, across which a constant potential is maintained. (iii) A triode, V2, connected as a cathode-follower amplifier, i.e., with current negative feedback, and developing unity gain. (iv) A capacitor, C₁, providing positive feedback to V2, the feedback voltage being developed across the timebase charging resistor R.

The operation of the circuit is as follows. An initial quiescent state is assumed with V1 conducting and V1 anode at a low potential. A negative-going square wave cuts off V1, and the timebase capacitor C starts to charge via R. If point X in Fig. 1 had been connected to a fixed h.t. potential C would have charged in an exponential fashion. To provide linear charging we endeavour to keep the potential across R constant so that the current through it is constant also. In other words, the waveform generated at Y must also appear at X. (Hence the description "bootstrap" timebase—derived from the notion of pulling oneself up by one's bootstraps.)

This type of action is achieved in the following way. The V2 stage is arranged to have approximately unity gain by operating it as a cathode follower. The timebase waveform developed at Y, if applied to V2 grid, therefore appears in phase at V2 cathode. We now connect the cathode of V2 via C₁ to point X, which (by cathode follower action) will follow the potential of Y. Thus, by positive feedback via C₁, a constant potential can be maintained across R, through which the timebase capacitor C is being charged. As a result C charges linearly.

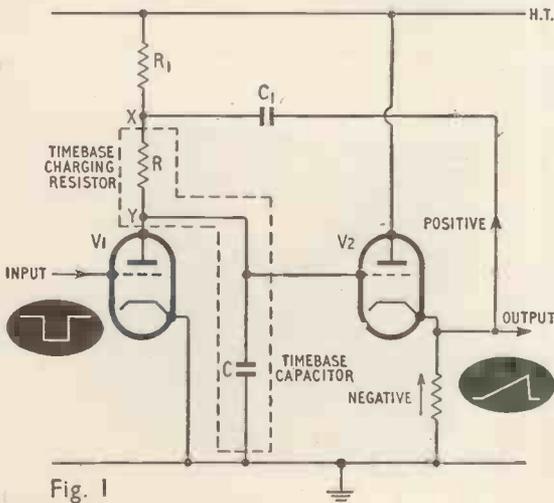


Fig. 1

The potential levels during the quiescent period are maintained by C₁ and R₁. Capacitor C₁ does not discharge appreciably during the period of the sweep provided that:

(a) the value of C₁ is very much greater than C;
(b) the time constant C₁R₁ is large compared with the duration of the sweep. Voltage changes across C₁ during the sweep must be small, otherwise the voltage across R will not be constant, thus causing non-linearity;

(c) the time constant C₁R is also large compared with the duration of the sweep.

Ideally the voltage across R should be exactly constant, but this cannot be attained in practice on account of the gain of V2 departing from unity. With a gain of less than 1 the voltage at X lags slightly on that at Y, the current through R falls slightly and the timebase sweep voltage becomes non-linear.

During the quiescent period (i.e., absence of input voltage at V1 grid) current flows through R₁, R and V1 to earth. During the period of the sweep, the current through R remains constant but the decrease in current through R₁ is made up by that flowing through C₁.

B.S.R.A. Constructors' Competition

THIS year's competition, held in conjunction with the annual dinner of the British Sound Recording Association, was notable for the exceptionally high standard reached by all the competitors, not only in design but in the workmanship and finish of the sound recording and reproducing equipment shown.

The President's Trophy was awarded to L. Widger, A.M.I.E.E., for a fully automatic system of sound accompaniment for a cine film in which commentary from tape and background music from discs are blended through mechanically-operated faders by notch cues on the film and conducting strips on the magnetic tape. The system includes means of precise speed control of the film and facilities for recording the combined sound effects on a single tape if required.

A neat v.h.f./f.m. receiver with pulse-counter-type discriminator won the *Wireless World* prize. This was designed by R. N. Baldock, B.Sc., in cylindrical form (2in diameter × 8in long) for mounting behind existing panels where space may be limited. Another tuner, with a similar discriminator, also of very compact design was entered by A. Robinson and was runner-up in the section for non-members of the Association.

A. J. Harper was awarded the Guy Fountain Prize with a neat turntable and pickup mounting incorporating an unusually smooth pickup lowering mechanism, most of which is below the motor board.

A prize for non-members of B.S.R.A. has been donated by *Hi Fi News* and was won this year by J. T. Gilbert for a stereo tape recorder using a modified commercial mono deck and with an unusually wide range of facilities, including dual level indicators and a built-in oscillator for balance adjustments.

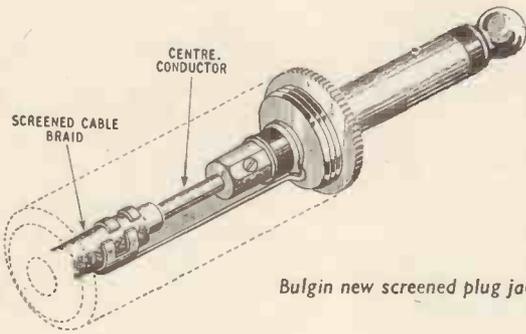
Manufacturers' Products

NEW ELECTRONIC EQUIPMENT AND ACCESSORIES

Screened Jack Plug

A FULLY screened telephone or microphone plug with standard $\frac{1}{4}$ -in-diameter shank, has been introduced by A. F. Bulgin and Co. Ltd., Bye-Pass Road, Barking, Essex, primarily for use with tape recorders, but it has also applications wherever screened concentric or coaxial cables are terminated in a plug of this kind. It takes cables up to $\frac{3}{8}$ -in outside diameter and the screw-on metal cover, which is electrically connected to the shank electrode of the plug, is available with either polished chrome (P538) or 22ct gold plate (P539) finish. The price is 4s 6d in either finish.

No soldering is required, the centre conductor of the cable is secured by a grub screw to a terminal block and



Bulgin new screened plug jack.

the screened sheath is gripped in a claw-like clamp, which serves also to take any strain on the cable.

A companion 6-mm model, for use with "Continental" equipment, is available also.

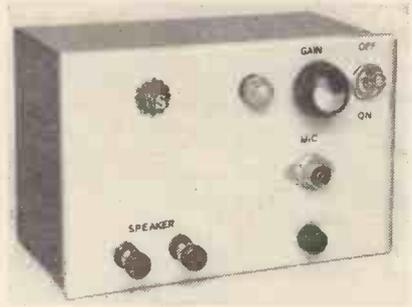
Flexible Wood-veneer Strips

THE processed forms of wood—from plywood to veneered chipboard—have very definite advantages for the construction of equipment and loudspeaker cabinets; but, if it is desired to "finish" as polished wood, inferior or complicated construction of the edge joints often has to be adopted to cover the multi-layer or chip nature of the material. To avoid the need for difficult construction Flexible Veneers Ltd. offer the $\frac{3}{4}$ -in-wide Agastrip and Agatape paper-backed, flexible-veneer edging strips in light oak, mahogany and walnut. Agastrips are supplied in four- and ten-yard-long coils with the grain across the strip and with along-the-strip grain in 3-ft lengths. These have to be glued on; but the self-adhesive Agatape (19 $\frac{1}{2}$ -in lengthwise-grain strips) has only to be pressed on to the clean, dust-free surface.

The address of Flexible Veneers Ltd is: Cobbs Court Buildings, Carter Lane, London, E.C.4.

Transistorized Public-address Amplifier

WITH the new WS Electronics "Lilliput" amplifier a maximum output power of 12W r.m.s. into an impedance of 3 or 15 Ω may be obtained from an input of 2mV r.m.s. at 30 Ω impedance. The average current consumption when amplifying speech to maximum power output is about 1.5A (at 12V d.c.). The amplifier may be operated from 12, 24 or 28V d.c. supplies. Fuses in the amplifier protect the battery supply against being shorted out and also prevent the transistors being



WS Electronics "Lilliput" transistor public-address amplifier.

damaged by the application of a reversed voltage. The weight of the "Lilliput" amplifier is 5lb and its size 6 $\frac{1}{2}$ in by 4in by 4in. It costs £19 10s and is manufactured by W.S. Electronics Ltd., of Brunel Road, East Acton, London, W.3.

High-resistance Kilovoltmeter

THE E.I.R. Instruments kilovoltmeter has a sensitivity of 250k Ω /V and indicates over the ranges 0 to 100V, 0 to 20kV (direct only) and 0 to 300M Ω on a 4-in scale. Using a 100- μ A basic movement, the 4- μ A f.s.d. sensitivity is achieved by the use of a cathode-follower current amplifier. This has a high-value cathode resistor, thus stabilizing the meter against mains-supply variations and the effective grid-to-earth resistance is 25M Ω , corresponding to the 100-V range. To change to the 20kV range a 5-G Ω (5,000M Ω) series resistor mounted in an insulated tube is used: this resistor is a single unit of a special type rated at 30kV. To measure resistance the unknown resistor forms a potential divider from h.t. with the input resistance of the meter.

Capable of operating from 110 or 200 to 250-V a.c. supplies the meter is available in several forms (skeleton for incorporation in equipment, wooden or metal case, with or without megohm range) and it costs between £20 and £23.

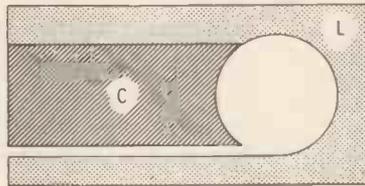
Manufacturers: E.I.R. Instruments Ltd., 329 Kilburn Lane, London, W.9.

100-V and 25-kV meter has sensitivity of 250k Ω /V.



Technical Notebook

Industrial R.F. Generators usually employ large tank circuits in which the losses have to be kept to a minimum. This implies the use of a high-Q circuit with a small value of tuning capacitance; but then the variable reactance imposed by the work may "pull" their frequency outside the set limits. A large tank-circuit capacitance can overcome this effect by swamping the imposed variations, but the losses in a circuit of normal construction are then increased. In *Mullard Technical Communications*, Vol. 5, No. 41, F. Dittrich describes the design of "laminated circuits," the aim of which is to combine the inductive and capacitive components of the tuned circuit, at the same time avoiding joints and sharp corners in the path of current flow. The tuned circuit is made up from a set of plates of the form shown in the sketch, stacked and spaced, alternate plates being reversed to make the cross-hatched portions overlap from alternate edges and form the capacitance. This forms a parallel-plate capacitor with an integral single-turn inductor



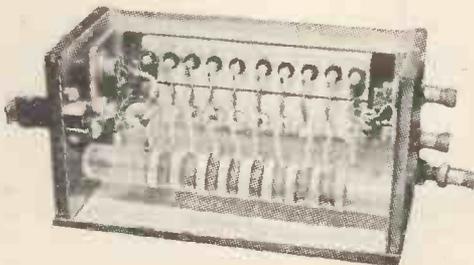
—the inductor being split into many sections so that each section carries only the circulating current associated with its own capacitor plate. Another advantage is that, outside the cross-hatched area on the sketch, adjacent plates are at the same r.f. potential so that metallic spacers and bolts may be used for assembly.

Adjacent-Channel Interference due to multiplex signals may not be so great in practice as simple theoretical considerations would indicate, according to a letter from L. B. Arguimbau published in *Proc. I.R.E.* for August 1959. Measurements on two commercial v.h.f./f.m. receivers were made—one nominally broad-band and the other nominally narrow-band. In both cases there was little change in adjacent-channel interference when an ordinary f.m. signal was replaced by an f.m. signal which included a sub-carrier such that the maximum total deviation was increased (although at the same time the main-carrier de-

viation was reduced and the amplitude of the added sub-carrier was made less than that of the main carrier). The reason for this small change in adjacent-channel interference with increasing deviation is probably due to the fact that in any practical receiver the response outside the passband does not fall off immediately to zero. In this latter simple theoretical case where the response outside the passband does immediately fall off to zero, if the deviation of a signal normally just outside the passband is increased, the interference, of course, increases from zero to some finite value, so that the proportionate increase in adjacent-channel interference is theoretically infinite.

Drop-outs and Noise due to imperfections in the tape are problems besetting any type of magnetic-tape recording, but for digital work either can result in false information. Many precautions are thus taken to reduce the effect of these distortions. The Telegraph Construction & Maintenance Company have attacked the root of the problem by, surprisingly enough, returning to the *Blattner-phone* idea, replacing the oxide-coated tape by 0.001-in thick Vicalloy. This material is a malleable and ductile permanent-magnet alloy with a saturation flux density of about 12,000 gauss. It is claimed that, due to the lower incidence of drop-outs and noise, much more information can be packed on the tape, so saving space in compact instrumentation.

Pulse Shortener developed by the Admiralty Surface Weapons Establishment uses variable-capacitance diodes as the capacitors in a lumped-constant transmission line. To shorten a pulse the bias on the diodes is altered so as to decrease their capacitance as the pulse is travelling down the line. This decrease in the diode capacitance produces an increase in the velocity of propagation down the line. Since the pulse continues to occupy the same physical length of line, this increase in the pulse velocity decreases the pulse period. Decreasing the diode capacitances also increases the pulse energy stored.



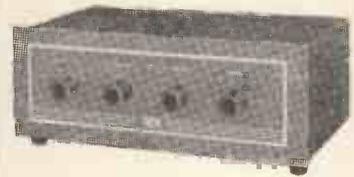
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RANDOM RADIATIONS

By "DIALLIST"

It's Worked in New Zealand

A READER in New Zealand tells me that the term radiotrician, which I mentioned in the April issue, is in fairly common use in his country, but the official word is serviceman. Official? Yes, in New Zealand it is illegal for anyone who has not served a specified term as a trainee and subsequently passed an official examination to undertake the servicing of any mains-operated electronic equipment. Having served his time and passed the exam, he is registered as a serviceman and receives his certificate of competence. To become a trainee, a man must obtain a "permit to assist" a certificated tradesman for so many years, after which he can present himself as a candidate for the exam. We have, of course, in this country the R.T.R.A. exams and certificates in both sound radio and television servicing; but it isn't agin the law to undertake such work if you haven't got these certificates. Whether or not it should be is a moot point. I wonder what readers think about it?

Wire or Wireless?

WHICH, I wonder, will win the race to provide better television and v.h.f. sound reception in places where they're not now too good? Stage 2 of the B.B.C.'s expansion programme

is scheduled for completion by March 1964 and the additional 21 satellites will bring in an important number of new viewers and listeners, as well as improving reception for many thousands more. But the piped services people are getting on fast with the job of providing strong "clean" signals in places where they're now weak, or interference-ridden, or both. Myself, I'm rather inclined to believe that piping is the only certain way of providing good services in built-up areas in which interference, ghosting and so on are bad. But it probably would be uneconomic to extend it to remote country districts and it's the villages and isolated houses that satellite transmitters and translators can do most to help.

V.H.F. DX

FROM Aylesbury comes further news of successful long-distance reception on the very high frequencies. The reader who sends it tells me that in the four years in which he's been at it he has logged all bar one of the B.B.C.'s v.h.f. stations. He has also logged nearly 60 European stations, including thirty-six in Italy. He points out how heavily the v.h.f. DX-er scores over his medium-wave opposite number. On the very high frequencies good, clear reception of

Continental stations can be obtained; but that's too often far from being the case on the crowded medium- and long-wave bands.

The Dry Cell Problem

IN the May issue of *Wireless World* I mentioned the possibility of serious damage through the puncturing of one or more cells of a partly run down dry battery left in a transistor receiver, a hearing aid, or an ohmmeter. Several suggestions for making things safe have come along; wrap the battery with Sellotape or with insulating tape, or place it in a polythene bag in the set and should it spring a leak, throw it away bag and all. So long as there's room for a wrapped battery and provided you can contrive watertight exits for the connecting leads, any of these should answer. But the real answer is surely that dry batteries meant for use in such apparatus should be made up of leakproof cells. They cost a bit more, but in my view it's jolly well worth it, for I have never known a leakproof cell of good make to belie its name, even though badly treated. Just to see what would happen, I once kept a trio of run-down leakproof cells on the shelf for a whole year. They weren't leaking when I threw them away.

V.H.F. and Polarization

AS you know, the B.B.C.'s v.h.f. sound transmissions are horizontally polarized and I have been surprised to find that with an horizontal dipole I have often picked up vertically polarized signals sent out by non-broadcasting stations. This so intrigued me that one day I tried the experiment of changing my aerial from the horizontal to the vertical position. Reception from the local broadcasting station wasn't so good; but I *did* get a signal of some kind with the dipole in any position between the horizontal and the vertical. A friend who often listens to European v.h.f. stations tells me that with his horizontal Band III dipole he is frequently able to receive vertically polarized transmissions—or at any rate, transmissions emanating from vertical aerials—from other countries. It must be, I suppose,



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that as they journey these very short waves tend to twist a little.

Electron Beam Welding

SINCE writing the note in the June issue on electron beam welding and cutting I have learned that the originator of the technique in Europe was J. A. Stohr, of the French Atomic Energy Authority. I am interested to learn also that Edwards High Vacuum Ltd. have obtained a licence to manufacture in this country vacuum welding equipment using an electron bombardment heat source. Edwards also kindly sent me a reprint of a paper on the subject presented by two members of their research staff, M. E. Harper and E. G. Nunn, at a recent meeting of the Institute of Welding.

Getting Down to It

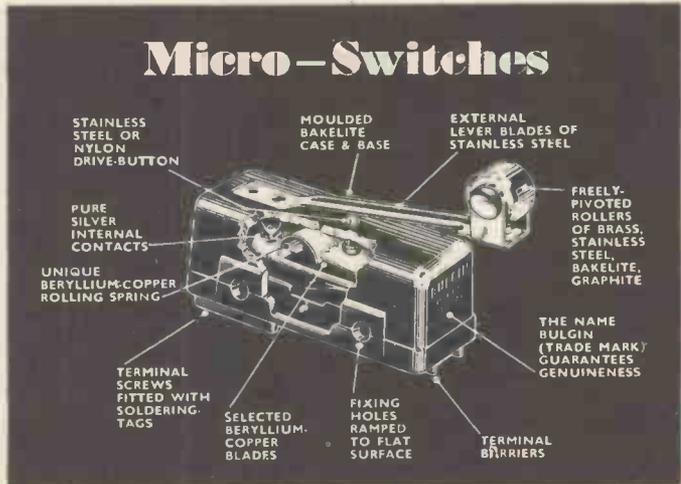
THE striking and animated picture entitled "TV," which attracted so much attention at this year's Royal Academy Exhibition, might well have had a sub-title "How not to watch it," for nearly every method of obtaining a poor picture and straining the eyes is being practised by the viewers. To begin with, the receiver is on the floor, which means that except for the children and the dog, who are themselves on the carpet, everyone must look right down at the screen—a most uncomfortable business and hard on the eyesight. The children, poor mites, have their eyes within inches of the screen. Despite the fact that they're already so close to the set all the grown-up viewers are leaning forward. It's a question of artistic licence, I suppose.

Without the Book

AMAZING—isn't it?—what a mess a ham-handed fellow who tries to adjust a television receiver can make of things. I don't mean by taking the back off and poking about inside but just by messing with the external controls. A friend of mine recently acquired a first-rate set, capable of showing an excellent picture, which was put in and adjusted by his dealer. When I dropped in a few days later to see how it was doing I found that it was showing just about as bad a picture as you can imagine. Surely the dealer hadn't left it like that, I suggested. No, I was told, it wasn't quite like that: but the owner thought that he could make it just a tiny bit better, so he tried his hand. No, he hadn't bothered about the instruction book; just tried altering one knob's setting after another. Afraid he hadn't made much of a job of it; could I be so kind . . . ?



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Radars in 1896?

IF I were to state that radar was invented before radio communication, it would probably result in strong letters of protest being sent to the Editor. Yet this is stated almost daily in the popular Press and even, I'm sorry to say, in some so-called technical journals.

The writers do not make this statement directly but they certainly do in effect when they tell us, for instance, that radar was used at Jodrell Bank to switch on and off the transmitter of one of the American space probes. We also often hear that "radar waves" are used to control guided missiles, and to destroy American rockets in mid-flight when it has been found necessary owing to something having failed to work out according to plan.

This grievous perversion of the word radar is obviously due to the fact that these offending writers imagine it to mean control at a distance or, in other words, telearchics. To some extent this is the fault of people in responsible positions who coined the expression "secondary radar" to describe what was really a special application of telearchics. No doubt the expression secondary radar is highly convenient for those who know what they are talking about but it was bound to cause confusion and trouble among the less well-informed who at once proceeded to apply the term radar to any other application of telearchics.

Now if we are going to allow the word radar to be used as a synonym for telearchics we must, to be logical, be prepared to admit that radar was invented before radio communication. A moment's thought will make this clear.

Everybody will admit that before it was possible to establish radio communication, Marconi and others had to find some means of causing incoming radio waves to waggle the diaphragms of a pair of headphones or trigger off a local source of power to operate the armature of a morse inker. In other words, telearchics, which is loosely and falsely called radar-control by certain writers, had to precede radio communication, as is made abundantly clear in Marconi's patent specification of June, 1896.

However, telearchics—and therefore wrongly so-called radar—was established long before 1896. I have been reading a book published in 1917 and written by B. F. Meissner, of the U.S. Navy. It is mainly about the control of torpedoes by telearchics—which the author calls teledynamics or radiodynamics.

In this book Meissner stresses that

the first instance of the electrical control of mechanisms from a distance was when Le Sage, of Geneva, established his electrostatic telegraph nearly two centuries ago in 1774. Its wireless counterpart—using the word wireless in its literal sense—was in 1838, when Steinheil obtained deflections of a galvanometer needle over a distance of fifty feet by means of earth currents.

I will cap this by pointing out that in 600 B.C., Thales of Miletus demonstrated wireless control at a distance when he caused amber to attract pieces of paper. Obviously, even in pre-electrical days, telearchics always preceded communication, for no matter whether we receive a message aurally or visually, it is first necessary for the incoming signals to waggle our eardrums or agitate our retinae.

Music Hath Charms . . .

EVERBODY has heard of Congreve's famous words:—

"Music hath charms to soothe a savage breast,

To soften rocks, or bend a knotted oak,"

and it is for this reason that in days of old, young men used to serenade their lady loves, and try to soften their hard hearts by fiddling beneath their bedroom windows. This technique is, of course, exactly the same as that employed by a snake charmer who can, by a suitable tune, bend the most savage serpent to his will.

In the jargon of present-day psychological science, this musical mesmerizing of a maiden would be called conditioning her to accept a proposal.

I hear that this old technique has been adopted by some go-ahead dentists to soothe their patients and "condition" them to accept pain. So far I have only heard of it being employed in the case of a young lady of my acquaintance, but it may be used on some men also, for certain of our sex are undoubtedly as susceptible to the strains of Orpheus' lute as were any of the other beasts of the field.

The lady who supplied me with the information, told me her dentist used the very latest technique in

supplying the mesmerizing music. He had installed a modern stereophonic system which ground out a scherzo as his drill ground into her carious cavity.

I am wondering if the choice of music is always left to the dentist's professional judgment or whether the patient can have a say in the matter. A scherzo is, of course, a light, quick and animated movement; in fact, just the sort of movement the patient herself would make when the drill lighted on a nerve.

The whole thing is thus reminiscent of the technique of the ancient Chinese dentist who, so Marco Polo would have us believe, used to employ thumbscrews on the patient when extracting a tooth. The idea was, of course, that the pain of the thumbscrews acted as a counter-irritant to the oral pain inflicted by the dentist. The thumbscrew agony was so excruciating that the dental pain paled into insignificance.

That being so, I think that if I had my choice, I would pick as my counter irritant something by Bartok or Hindemith as I cannot think of anything more painful than being forced to listen to their efforts. Modernists will naturally not agree with me and would probably choose Bach or Beethoven as their counter irritants. But for a tooth extraction,



Counter-irritant to oral pain

of course, nothing would be so effective as the Eton boating song which accompanies the words "we all pull together."

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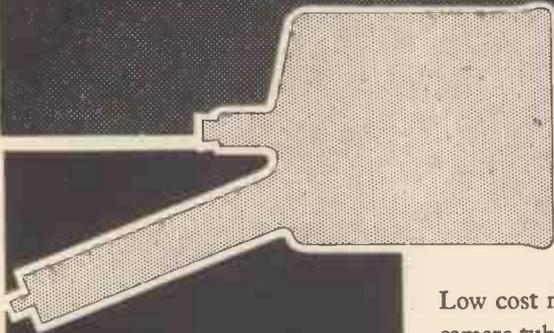
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* Display storage tubes

Advanced development is now in progress on both bi-stable and half-tone storage tubes. The bi-stable tubes are electrostatically deflected and are intended for use in infinite persistence oscillograph applications. The half-tone tubes are magnetically deflected and provide a bright flicker-free display with controllable persistence characteristics. Uses for these half-tone tubes include radar displays where ambient light levels are high and equipment for the display of information received on slow-scan narrow bandwidth systems.

* Information storage tubes

Tubes are being developed which provide electronic writing and reading facilities for use in information processing systems. Of particular interest is a single-gun tube capable of storing a high resolution television picture for purposes of standards conversion, or processing for band-width compression. In the radar field it has applications in systems employing true-motion display or moving target indication.

* Solid State display devices

Among the solid state devices under active investigation is a light amplifier which utilises a combination of electroluminescent and photoconductive principles. Other devices in this sphere of activity include solid state image converters and multi-element devices.

* Transparent Phosphors

In applications where the ambient light is extremely strong it is possible, in some instances, to maintain contrast by using display tubes with transparent phosphors. Experimental tubes show that although the brilliance of the trace is naturally less than that of a normal tube, only negligible ambient light is reflected from the transparent tube screen, and an effective display is obtained.

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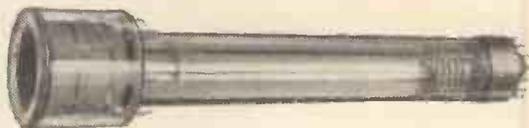
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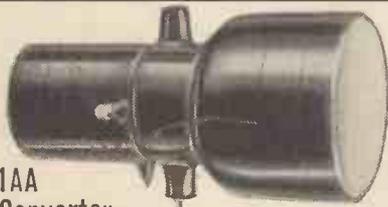
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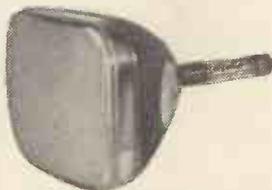
5820 Television Camera Tube

The 5820 is a 3-inch image orthicon tube with an exceptionally high sensitivity and a spectral response approaching that of the human eye. It is a direct equivalent of the American tube of the same type number.



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DH10-78 Helical P.D.A. Tube

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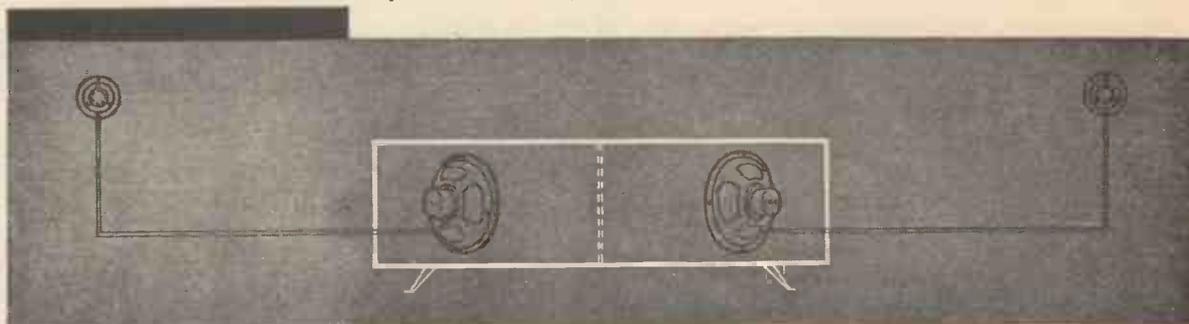
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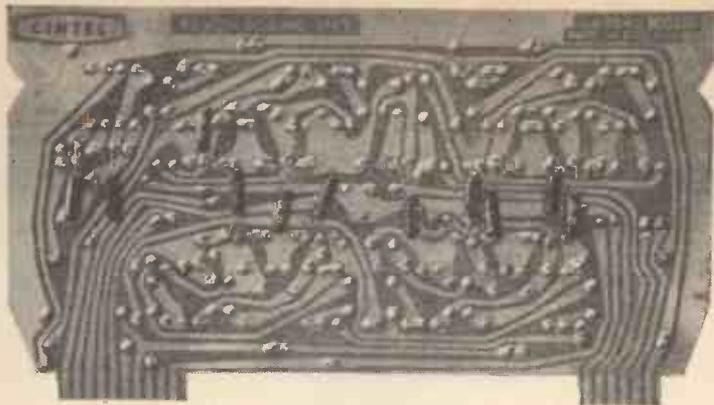
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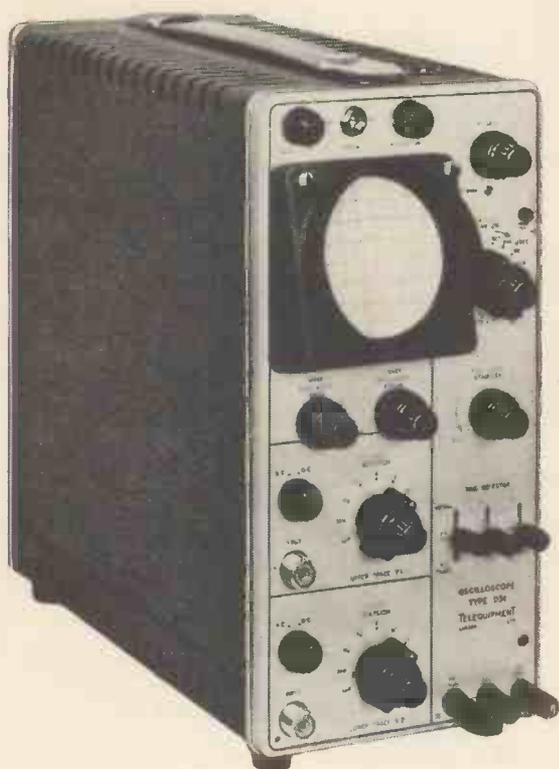
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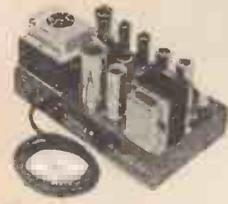


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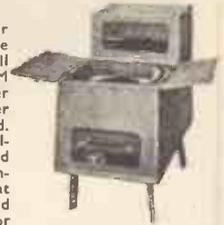
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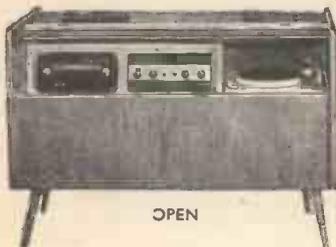
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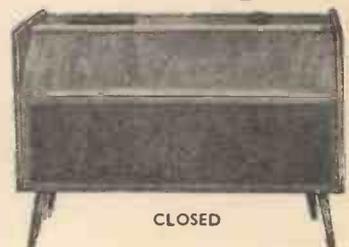
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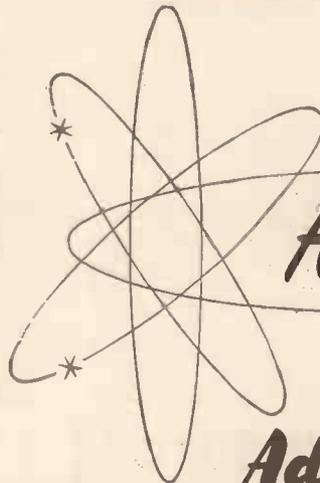
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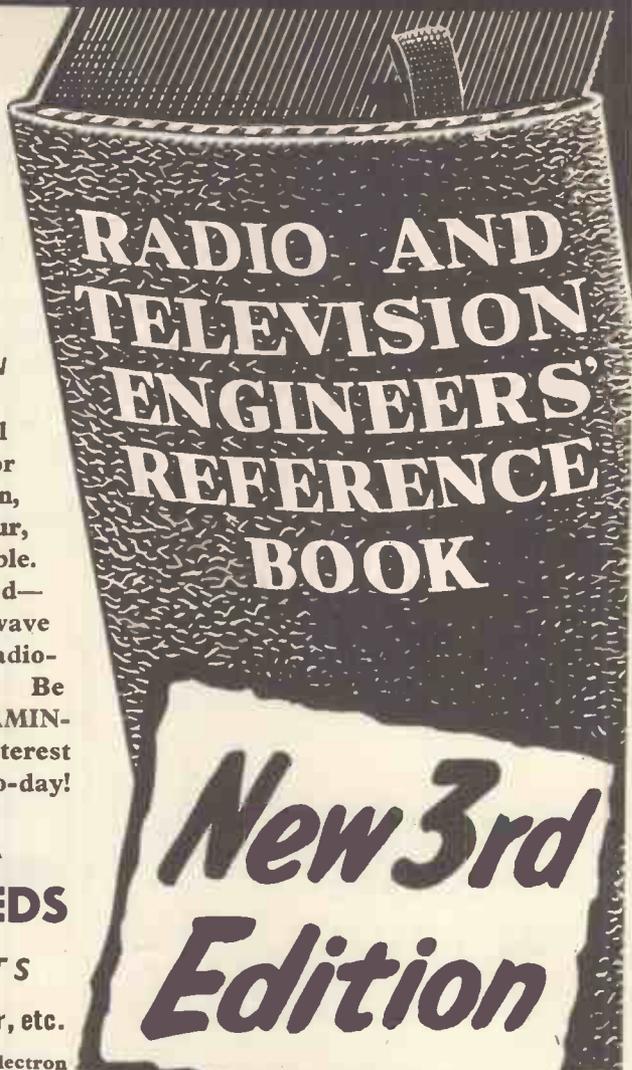
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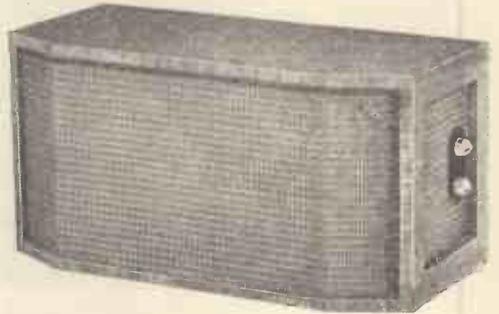
An inexpensive column speaker constructed from a concrete pipe and fitted with an 8/145 unit attracted much interest and admiration at the London Audio Fair because of its clean open sound.

The absence of cabinet resonance produces bass of unusual crispness normally associated with larger and more expensive speakers.

A complete kit of wooden fixtures including absorbent wadding and diffusing cone are available at a price of £3 15s. 0d. Full details free on request. Suitable concrete pipes can be purchased from builders' merchants at about 12/6. Recommended unit type 8/145 £6 19s. 11d. inc. P.T.

W3 THREE SPEAKER SYSTEM

Where a ready-to-use complete speaker system is required the W.3 in its handsome cabinet is always a popular choice.



BASS L.F. output is produced by a special 12in. unit type WLS/12 fitted with a heavy cone and a new type of suspension which permits large linear excursions and gives a low fundamental resonance of 25-30 c/s.

TREBLE The upper registers are handled by 5in. and 3in. units connected in parallel via a quarter section 1 kc/s. dividing network, with an extra series capacitor to protect the small speaker. The volume controls permit adjustment of midrange and treble to give tone control and facilitate balancing speakers on stereo.

Cabinet size 28in. x 14in. x 12in.
Weight 48 lb. complete. Impedance 15 ohms.
Maximum input 15 watts.
Effective frequency range 30-20,000 c/s.

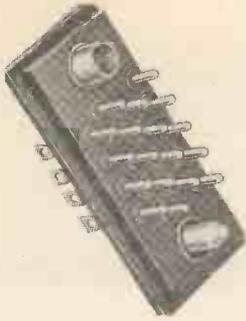
The elegant cabinet is available in a choice of walnut, oak or mahogany veneers. Also available in white-wood, price £36/10/-. Tropical model made with resin-bonded plywood can be supplied at £2 extra.

Descriptive leaflet free on request.

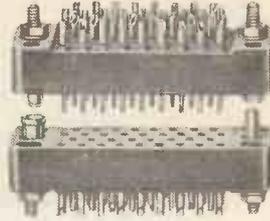
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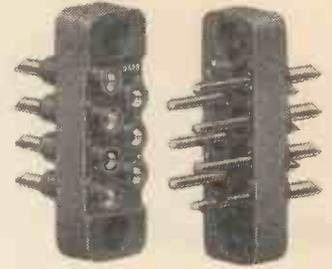
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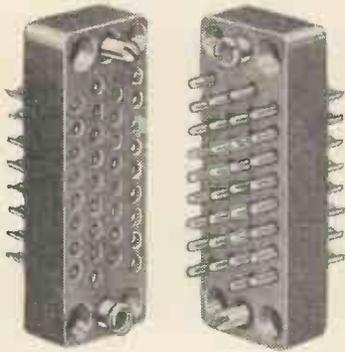
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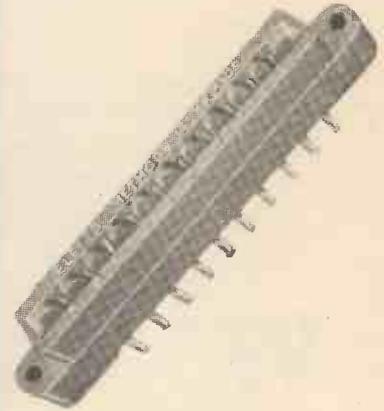


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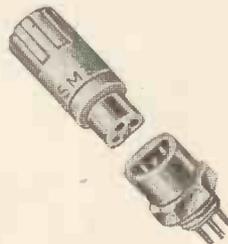
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R-C Oscillator Type TF 1101

A compact general-purpose oscillator giving a low-distortion output of $\frac{1}{2}$ watt max. into 600 ohms. Frequency range 20 c/s to 200 kc/s. Output level indicated by panel-meter and calibrated attenuator. A band-pass filter provides for a 1-ke/s output of very low distortion.



Audio Tester Type TF 894A

The TF 894A covers from 50 c/s to 27 kc/s. It comprises a heterodyne oscillator and 0- to 50-dB, 600-ohm attenuator combined with a three-range a.c. voltmeter which is available for external use. Output: 2 watts maximum at 600, 15, and 3 ohms. Voltmeter ranges: 80, 8, and 4 volts full-scale.



A.F. Power Meter Type TF 893A

A wide-range absorption-type power meter for use in the frequency range 20 c/s to 35 kc/s. The power measurement range is 20 μ W to 10 watts and the input impedance can be set to any of 48 different values between 2.5 ohms and 20 k Ω .



Distortion Factor Meter Type TF 142F

Measures total spurious content, up to 30 kc/s, of inputs within the fundamental frequency range 100 c/s to 8 kc/s. Distortion measurement range: 0.05 to 50%. The input can be at any level between 500 mV and 500 volts.



A.F. Power Meter Type TF 1347

A sensitive, accurate, direct-reading instrument. Its ten power ranges, covering 10 μ W to 6 W, and 5 $\frac{1}{2}$ -inch meter provide excellent discrimination. Impedance range: 2.5 Ω to 20k Ω in 11 steps. Frequency characteristic substantially flat from 50 c/s to 20 kc/s.



Wave Analyser Type TF 455E

Gives amplitude and frequency of individual components of either audio signals or the modulation envelopes of r.f. signals up to 500 Mc/s. Its a.f. range is 20 c/s to 16 kc/s and its amplitude measurement range is 30 μ V to 300 volts.

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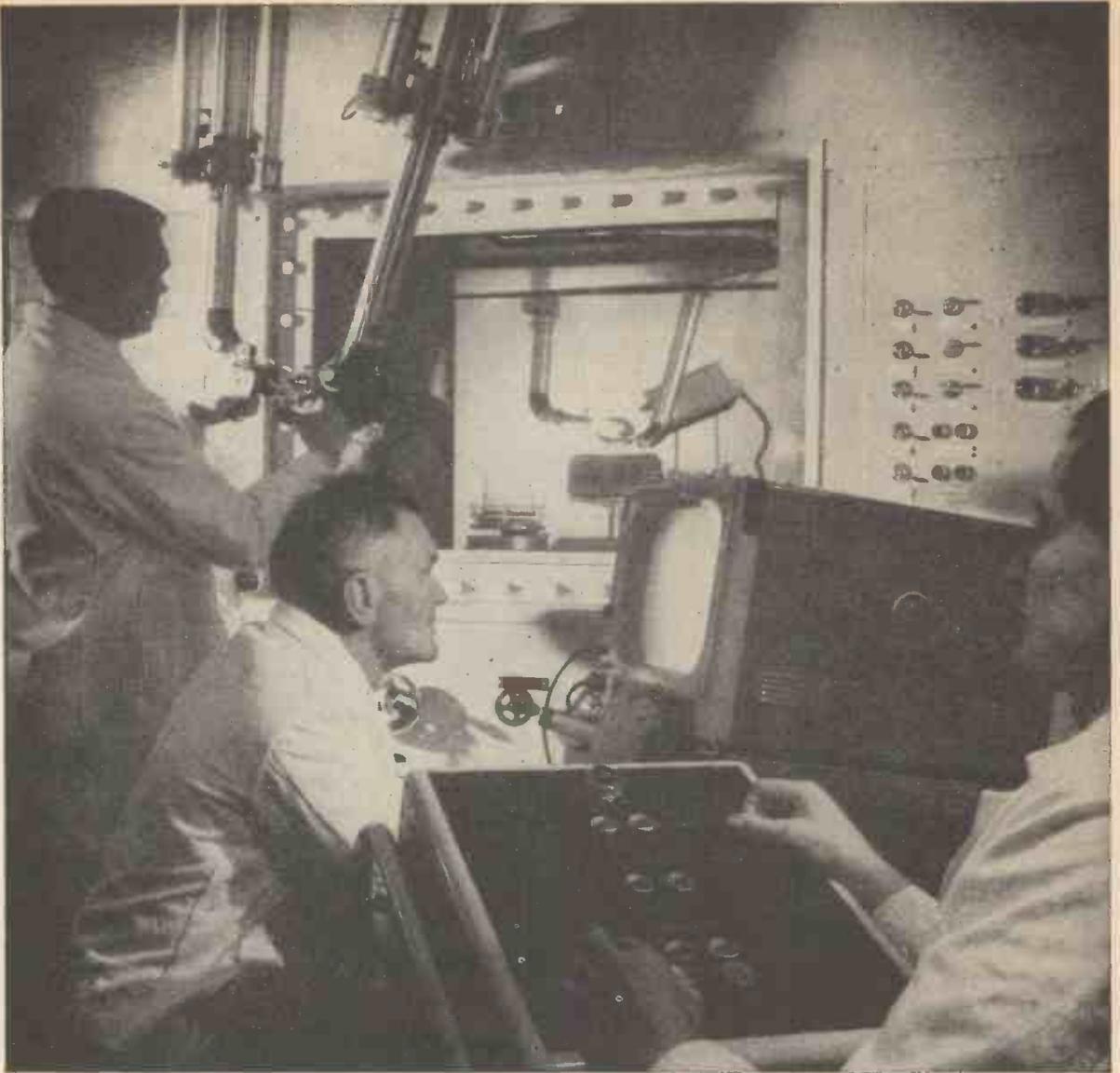
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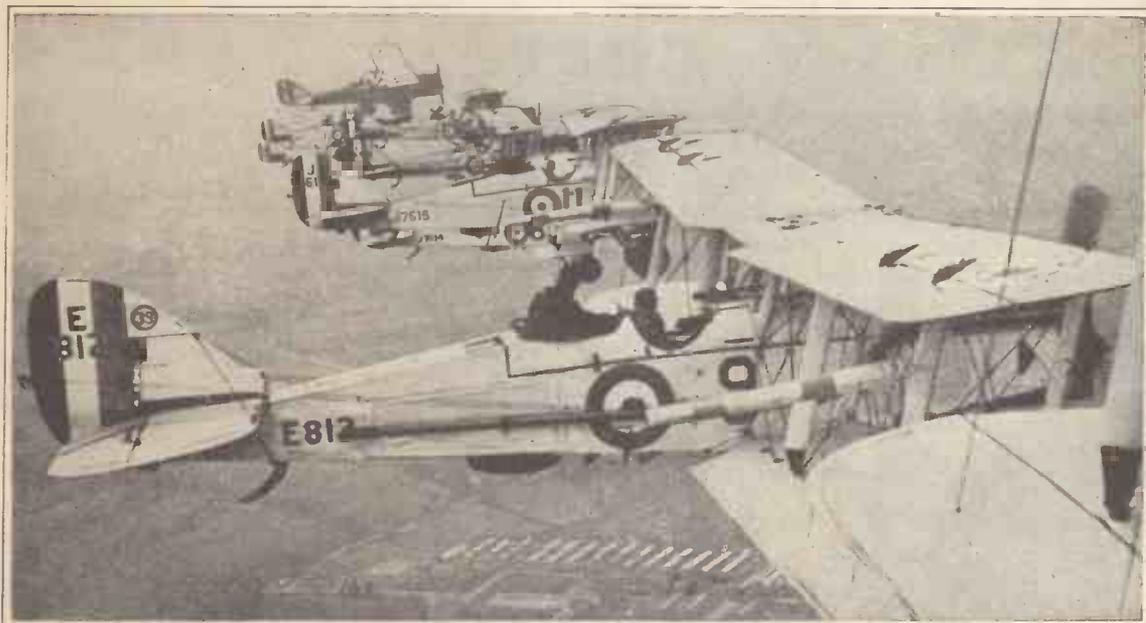
Pye at Dounreay



The Pye Instrument Group has supplied all the equipment to the U.K. Atomic Energy Authority for the irradiated fuel element laboratory at Dounreay. In addition to supplying equipment, Pye Ltd. acted as consultants and designers on all matters in that laboratory relating to instrumentation and remote handling. The illustration above shows manipulators working in conjunction with a television camera to handle and measure a sample from the fast reactor.

27th June, 1925

“Hello Cuckoos”



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It seems a far cry from those first few spoken words between the ground and the Cuckoo Squadron to the latest automatic navigational systems. But today an aircraft's safety rests on the efficient working of its instruments. Likewise in radar, pulse and other electronic equipment, reliability is the most important consideration.

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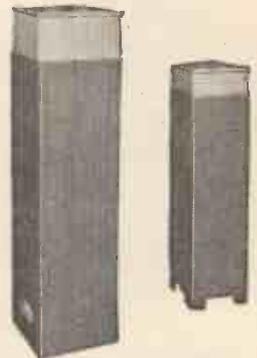
W.B.8S Stereo Amplifier £23.15.0



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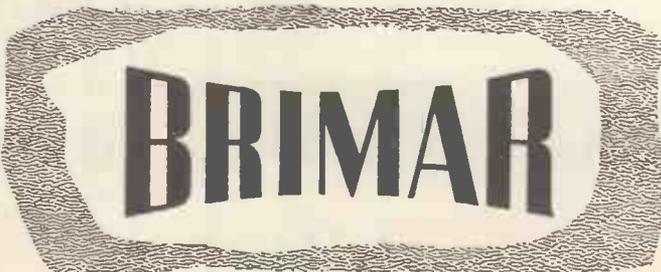
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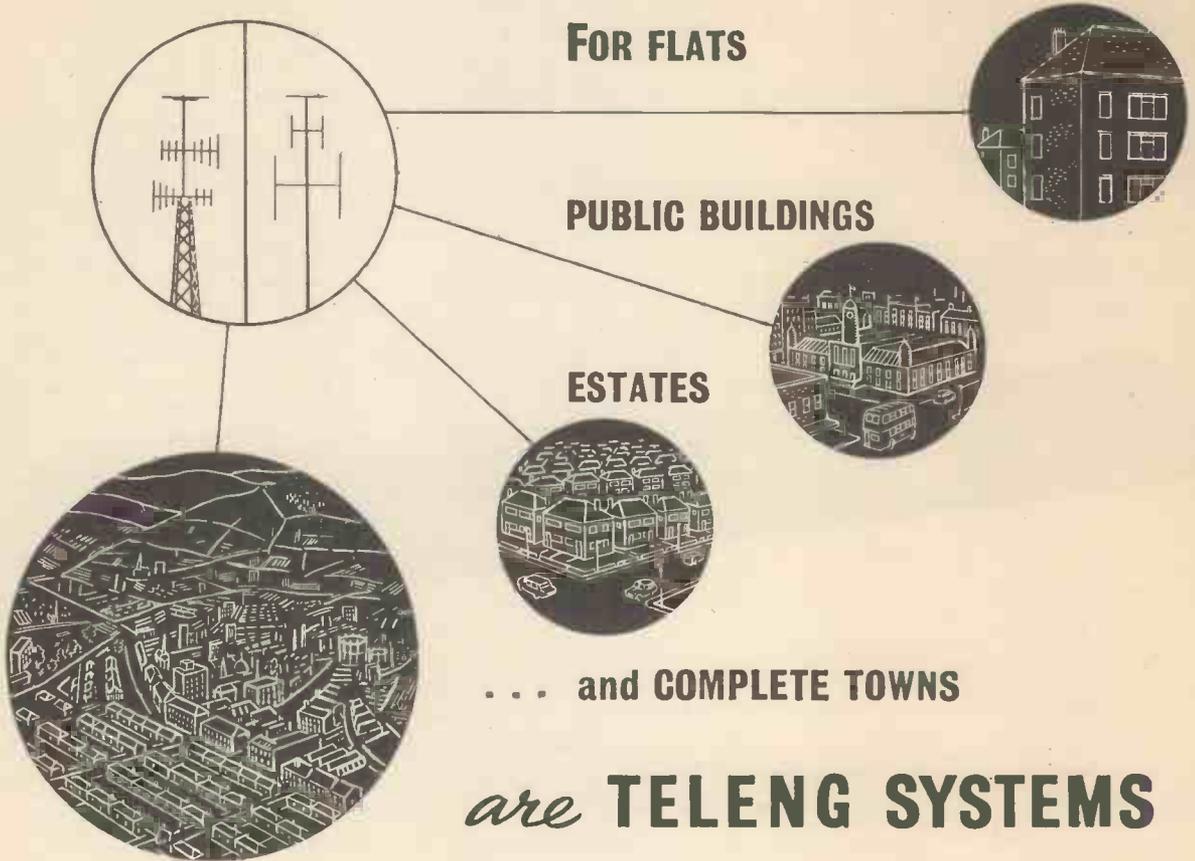
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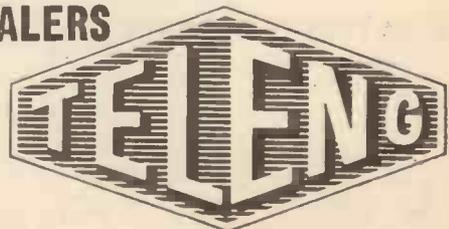
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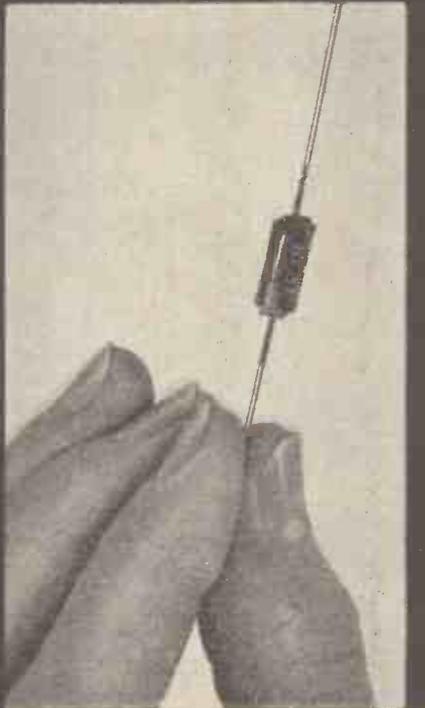
SILICON h.t. power rectifier type FST1/4 for television receivers

The FST1/4 Silicon Power Diode has been specially designed for domestic television receiver H.T. power supplies and is of particular interest to circuit designers planning receivers with 110° scanning, 625 line receivers and colour television receivers. Two diodes may be used in series to provide capacitor smoothed H.T., direct from 250 volts A.C. mains.

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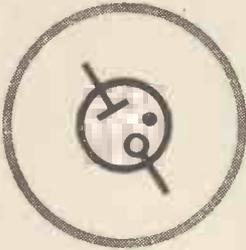
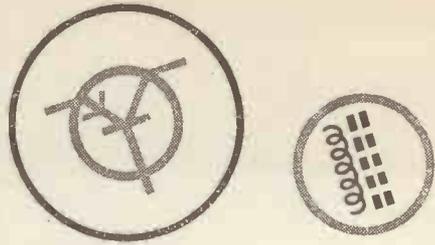


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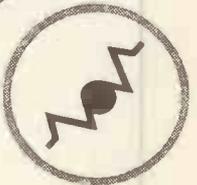
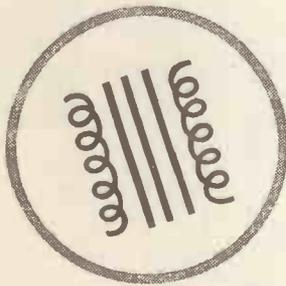
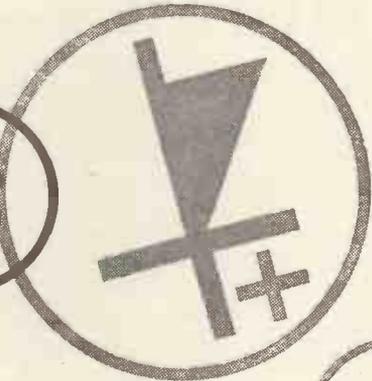
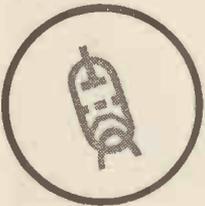
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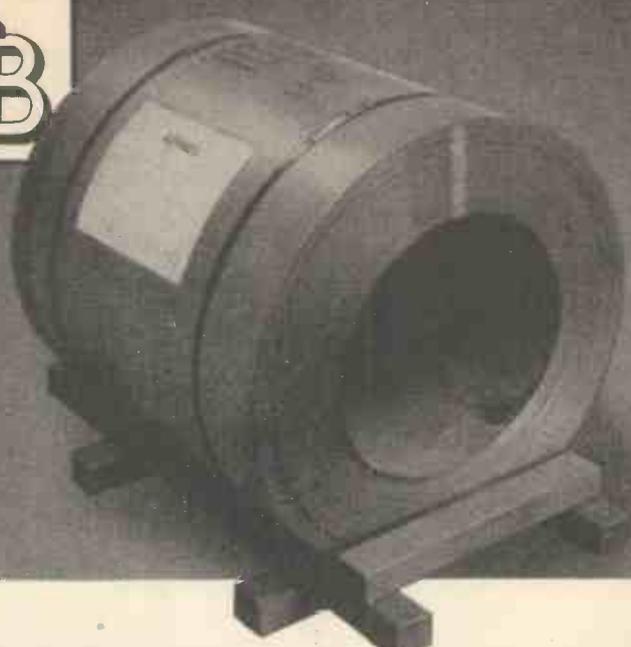
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ALPHASIL 37	50	.51 watts/lb.
ALPHASIL 33	50	.46 watts/lb.

ABOVE—A 4,000-lb. coil of 30" wide x .013" thick, ready for despatch.
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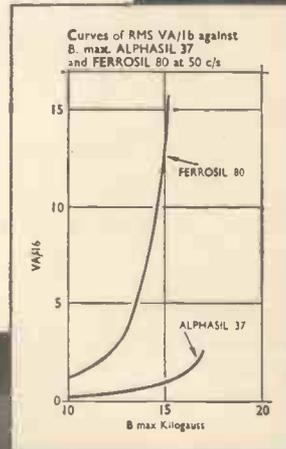
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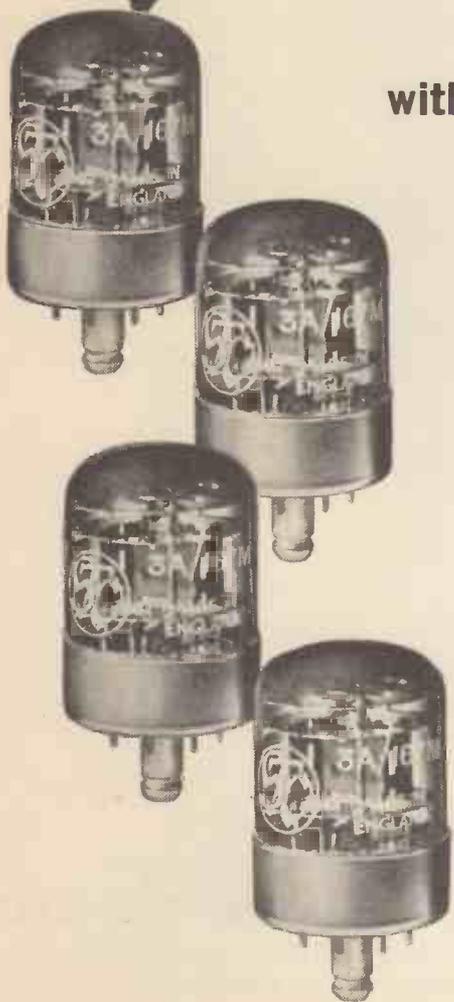
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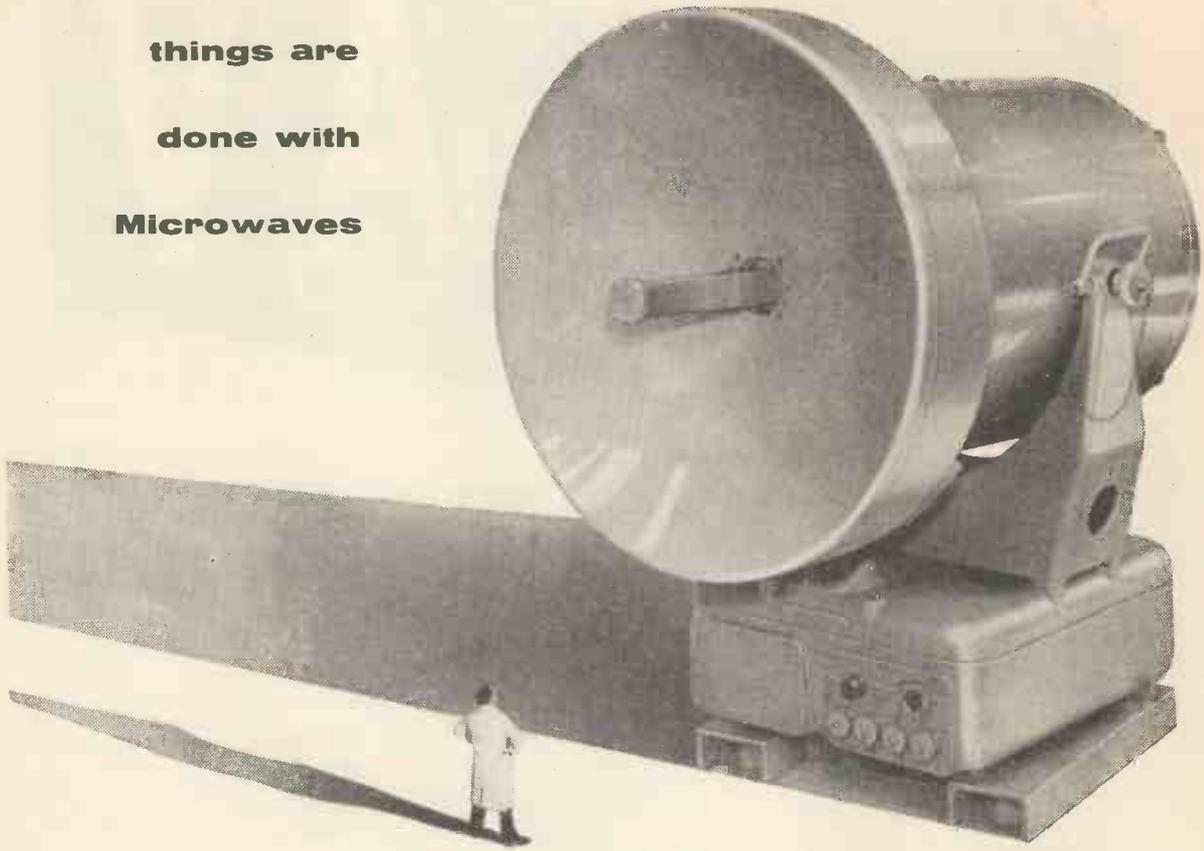
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for highest initial permeability, useful for wide-band frequency transformers, current transformers, chokes, relays and magnetic shielding.

PERMALLOY 'B'

has lower initial permeability than Permalloy 'C' but has a higher value of flux density. It is suitable for use where high permeability to an alternating field superimposed upon a steady polarising field is required.

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for very high resistivity without undue lowering of the maximum flux density. Variation of permeability with frequency is small. Ideal for H.F. applications.

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V-PERMENDUR

for high permeability with a very high value of maximum flux density. Finds special application for use as high quality receiver diaphragms, also motor generators and servo-mechanisms in aircraft where weight and volume are important factors.

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Specific Gravity	8.3	8.8	8.15	8.4	8.2
Electrical resistivity—microhms per cm cube	55	60	90	26	26
Initial permeability μ_0	2 000 to 4 000	15 000 to 40 000	1 800 to 3 000	400 to 1 000	700 to 1 000
Maximum permeability μ_{max}	15 000 to 40 000	50 000 to 150 000	12 000 to 20 000	200 000 to 400 000	3 000 to 6 000
Magnetising force for H_{max} oersteds	0.20 to 0.40	0.025 to 0.04	0.2 to 0.5	0.03 to 0.10	2.0 to 6.0
Maximum flux density, gauss	16 000	8 000	13 000	14 000	24 000
Coercive force in oersteds for $B_{max} = 5 000$ gauss	0.16	0.03	0.15	0.05*	2.3†
Remanence in gauss for $B_{max} = 5 000$ gauss	4 000	3 500	3 500	13 000*	16 000†
Hysteresis loss in ergs/cc/cycle for $B_{max} = 5 000$ gauss	160	40	200	220*	12 500†
Total loss in watts/lb for $B_{max} = 5 000$ gauss 50 c/s 0.015 in. sheet	0.11	0.04	0.2	0.3*	4†

* for $B_{max} = 14 000$ gauss † for $B_{max} = 20 000$ gauss

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Simplicity of Control

The Quad 22 Control Unit . . . with every practical refinement for the full appreciation and enjoyment of music for the discriminating listener . . . yet so simple and easy to operate. For instance, the Push Buttons . . .



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approach to
the original
sound**

THE PUSH BUTTONS

19 different services are provided by these six buttons. Programmes from radio, gramophone, tape or microphone can be reproduced stereophonically, or monaurally using one or two channels simultaneously. In addition to this, any one of four playback characteristics is available for record equalization.

THE ACOUSTICAL MANUFACTURING CO. LTD.

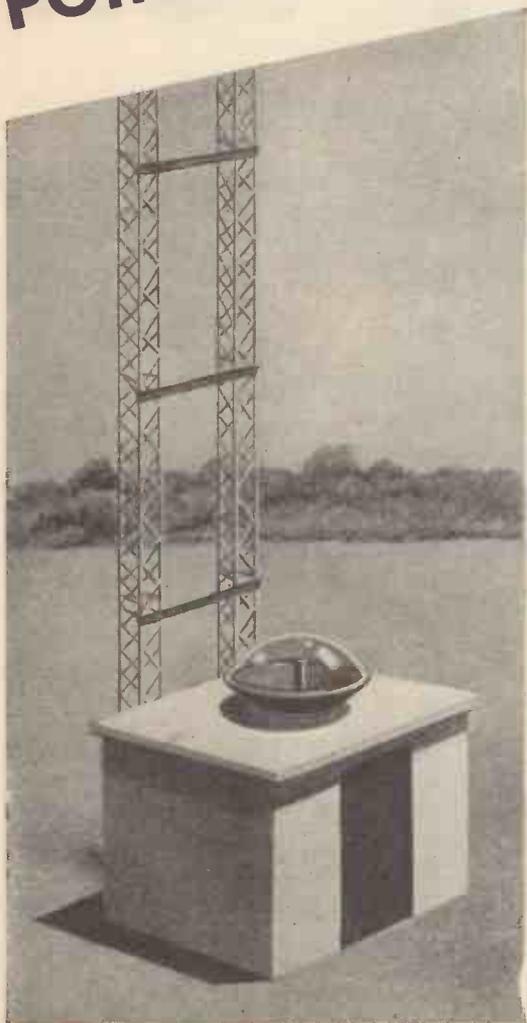
Huntingdon, Hunts. Telephone: Huntingdon 361



*Send a postcard
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POINT TO POINT

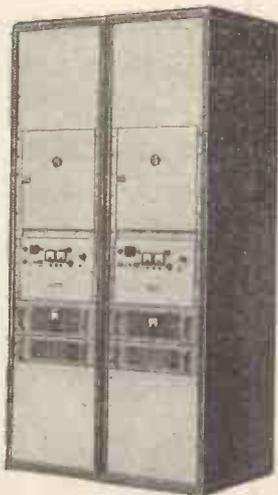


AS SUPPLIED TO:

Associated Television Ltd.
 Scottish Television Ltd.
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MICROWAVE LINKS

This Pye microwave television link Type PTC M1000 is suitable for use with the N.T.S.C., C.C.I.R. or the British 405-line systems. A sub-carrier f.m. music link circuit is incorporated. The normal frequency range is 6575 to 7425 Mc/s but models can be supplied to cover the range of 5925 to 6425 Mc/s. The r.f. power output is 1 watt. Wave guide or passive reflector installations available. Transportable link equipment is also available.

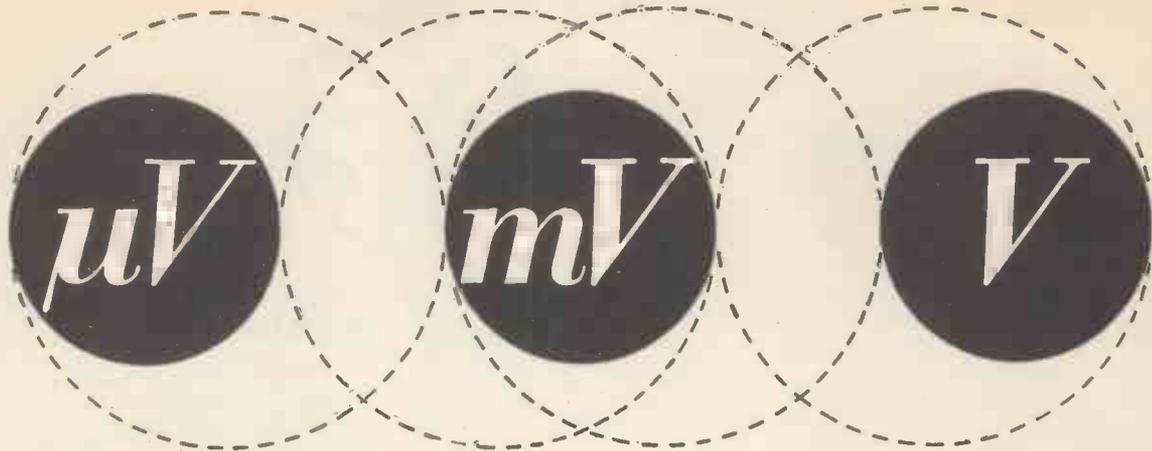


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Amplifier volt

sensitive | *accurate* | *reliable*

- *Provided with internal calibration voltages.*
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- *For all normal mains supplies (110-245 V, 40 c/s-100 c/s).*
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GM 6012

Broadband Millivoltmeter, type GM 6012

- Frequency range:** 2 c/s - 1 Mc/s
- Measuring range:** 1 mV (f.s.d.) - 300 V in 12 steps
- dB scale:** -80 dB up to +52 dB (0 dB = 1 mW into 600 Ω).
- Input impedance:** 4 MΩ in parallel with 20 μμF (up to 3 V)
10 MΩ in parallel with 10 μμF (in the other ranges).
- Overall accuracy with respect to full scale:**
 - within ± 2.5%, 5 c/s - 100 kc/s
 - within ± 5%; 2 c/s - 1 Mc/s
- Pre-deflection:** < 100 μV

High Frequency Millivoltmeter, type GM 6014

- | | Without
pre-attenuator | With
pre-attenuator |
|---------------------------|--------------------------------------|--------------------------------------|
| Frequency range: | 1 kc/s - 30 Mc/s | 10 kc/s - 30 Mc/s |
| Measuring range: | 1 mV (f.s.d.) -
300 mV in 6 steps | 100 mV (f.s.d.) -
30 V in 6 steps |
| dB scale: | -80 dB up to -8 dB | -40 dB up to +32 dB |
| Damping at 1 kc/s: | 1 MΩ | 50 MΩ |
| 1 Mc/s: | 700 kΩ | 10 MΩ |
| 30 Mc/s: | 50 kΩ | 2 MΩ |
| Input capacitance: | 7 μμF | 2 μμF |
- Pre-deflection:** Compensated by electrical zero setting
- Variations of the frequency characteristics:**
< 5% over the whole range, with respect to the response at the frequency of the calibration voltages.
- Overall accuracy:** < 3% with respect to full scale and with reference to the frequency characteristic.

meters

DC Microvoltmeter, type GM 6020

- | | Input I. | Input II |
|-------------------------|---|---|
| Measuring range: | 100 μV (f.s.d.)
10 V in 11 steps | 10 mV (f.s.d.)
1000 V in 11 steps |
| Input impedance: | 1 MΩ (± 1.5%)
in parallel with
20 μμF | 100 MΩ (± 1.5%)
in parallel with
10 μμF |
- Overall accuracy with respect to full scale:** 3%
- Pre-deflection:** < 5 μV
- Drift:** < 1 μV per hour after 1 hour of warming-up
- Automatic polarity indication doubles the effective scale length with respect to centre-zero instruments.
- DC currents may be measured directly with this instrument due to the high accuracy of the input resistance.
- Measuring range:** 100 μμA (f.s.d.) - 10 μA
- Accuracy:** < 3.5%



GM 6014

Instruments: quality tools for industry and research





fit Garrard for Good....



MAGAZINE TAPE DECK

Unique design plus magazine loading makes tape recording and play back easy and good. No threading, anchoring or spilling of tape. Tape can be stopped at any point, magazines removed and replaced later.



MODEL 4 HF

A high quality single Record Player elegantly styled and carefully designed to provide maximum reliability with fidelity of reproduction. Fitted with TPA 12 Pick-Up Arm

And now the latest unit to bear the Garrard name—Model 210 Record Player and Automatic Record Changer. Elegantly styled to match in with modern equipment design. Produced with the same engineering skill that characterises everything in the Garrard range.

★ MODEL 210

Plays any number of records up to eight, either 7in., 10in. or 12in. at 16 $\frac{1}{2}$, 33 $\frac{1}{3}$, 45 and 78 r.p.m. 10in. and 12in. of the same speed can be mixed in any order. May also be played manually.



MODEL TPA 12

Transcription Pick-Up Arm designed for monaural and stereophonic record reproduction. It is an instrument of the highest quality with its modern styling finished in Ivory, Chrome and Red. Fitted with M.P.M.4 Plug-in moulding which accepts most cartridges, it is the companion to the Model 301 Transcription Motor.



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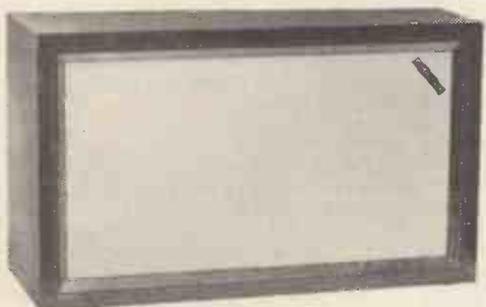
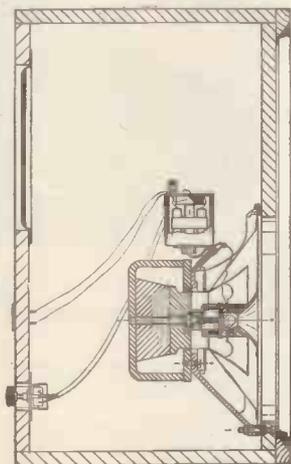
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TELEX 44-271



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PIONEERS OF COMPACT LOUDSPEAKER SYSTEMS



There was once a time when Full Range High Fidelity reproduction from a Loudspeaker housed in a *small* enclosure was considered impracticable—the text books said so and this appeared to be confirmed by experimental work.

The first real break-through came before the war—from GOODMANS—with the introduction of a high compliance twin-cone unit mounted in a totally enclosed 18" cube. After the war, development was taken up again and complete multiple Loudspeaker Systems were developed for use specifically in very small enclosure volumes. Again GOODMANS led the market. Then the research and development effort was directed to overcome the remaining disadvantages; complexity, low efficiency, high cost. The result was Model A.L/120—incorporating all the valuable experience gained over many years as well as the latest developments in enclosure loading, diaphragm design, high frequency radiation, magnet design, to say nothing of advanced methods of precision manufacture.

This achievement is best judged and appreciated by ear; the actual description of the A.L/120 is as follows:—
Frequency range 35 c/s to 20,000 c/s with a maximum power handling capacity of 15 Watts. Overall enclosure size—24" x 11½" x 14½". Enclosure loading—Acoustical Resistance (GOODMANS Patent No. 790997 [British]). Drive unit: 12" Triaxial unit comprising *three concentrically mounted radiating elements*, each designed to specialise in low distortion reproduction of one part of the overall scale; bass, middle, treble; and integrated on to a common axis to approach the ideal of the "point source" radiator with its freedom from phase interference between the separate units. Bass radiation is from a large diaphragm with plastic treated high compliance suspension, with mechanical crossover to a moulded high stability mid-range radiator; and finally electrical crossover (twin ½-section L.C. network 12 db/octave) to a high precision horn loaded high frequency pressure unit, with separate L-pad balance control.

Model A.L/100 also follows these lines in most respects, except that it employs a two element drive unit and provides smooth coverage from 35 c/s to 15,000 c/s, with a power handling capacity of 12 Watts.

THESE LOUDSPEAKER SYSTEMS ARE DESIGNED AND BUILT WITH GREAT CARE TO BRING *TRUE* HIGH FIDELITY INTO YOUR HOME—COMPACTLY, ELEGANTLY, EXCITINGLY.

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A.L/120... Price £29. 10. 0

as illustrated

A.L/100... Price £23. 10. 0

Both models available in walnut or mahogany finish.

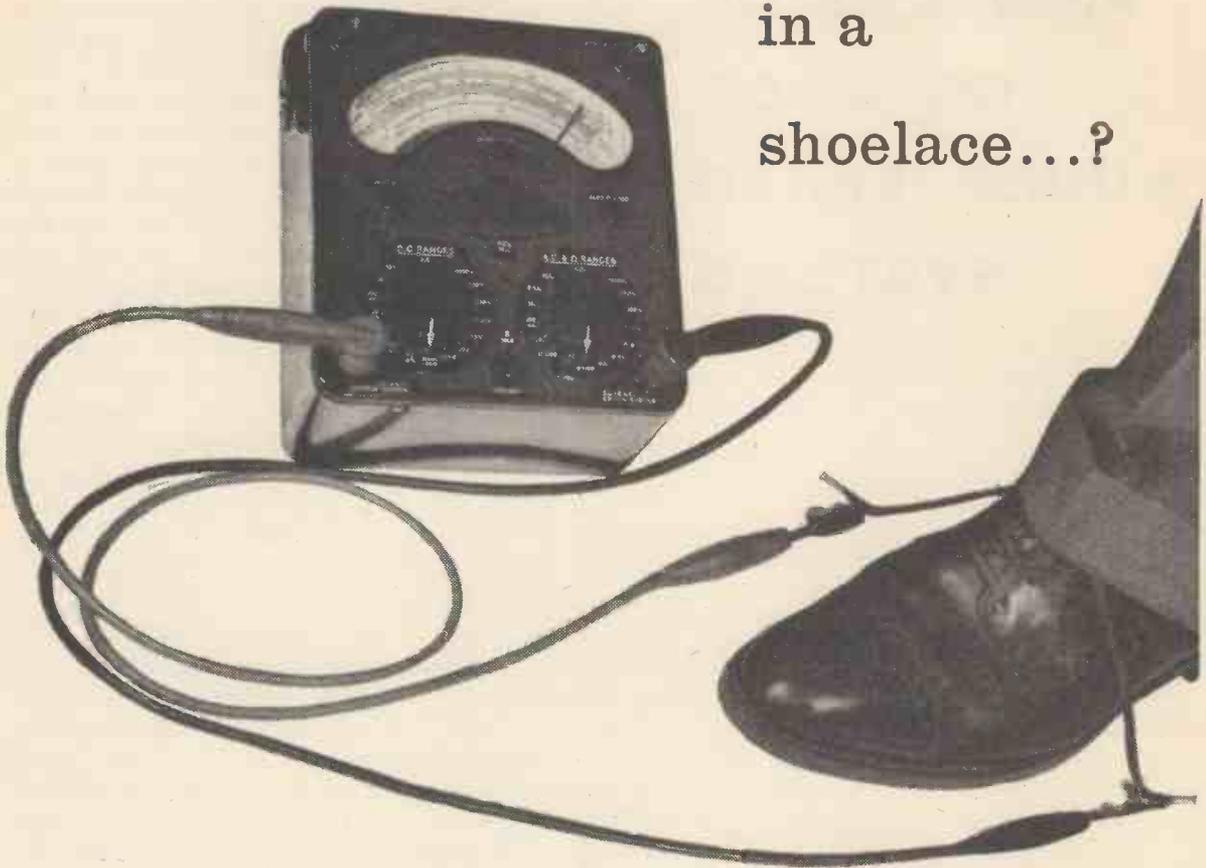
GOODMANS INDUSTRIES LIMITED, Axiom Works, Wembley, Middx.

Tel. : WEMbley 1200 (8 lines) Grams : Goodaxiom, Wembley, England.

In every sense the greatest range—in every country the greatest name.

how many ohms

in a shoelace...?



Fanciful? No, because as our photograph proves, a shoelace can be made electrically conducting by impregnating it with "dag"* colloidal graphite.

Unrealistic? As a practical proposition the shoelace test is just that; as a simple illustration of a fundamental idea we think it is effective enough.

Over-simplified? Perhaps, yet thousands of cars are fitted with a non-metallic conducting braid which has much in common with a shoelace impregnated with colloidal graphite.

A non-conducting material can be made conductive by treating it with "dag" colloidal graphite, either by impregnation (surface coating or dipping after manufacture) or incorporation (addition during manufacture).

Furthermore, you can impart any or all of the many other characteristics of colloidal graphite: low friction and "parting" properties, resistance to heat and wear, chemical inertness.

* Registered trade mark of Acheson Industries (Europe) Ltd: licensed user—Acheson Colloids Ltd.

Acheson

Colloids

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(a subsidiary of Acheson Industries (Europe) Limited)

Manufacturers of dispersions of colloidal graphite, molybdenum disulphide, silver, glass vermiculite in suitable carrier liquids including oil, water, white spirit, alcohol and toluene.

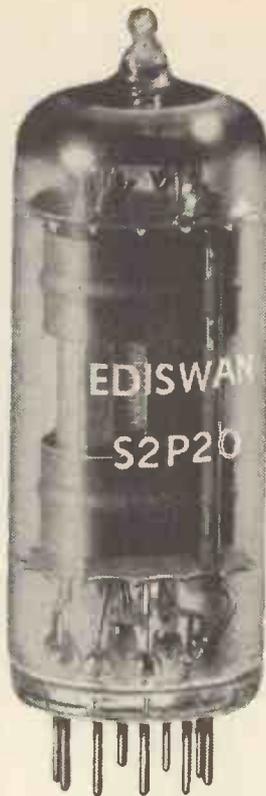
If your problem is basically how to make plastics, natural or synthetic fibres, leather, cloth, paper or wood electrically conducting, then you should get in touch with us.



Also Acheson Colloids Company, Port Huron, Michigan, U.S.A. and Acheson Colloids N.V. Scheemda (Gr.) Netherlands

Another outstanding new Ediswan valve

with a CV4000 specification



The EDISWAN S2P20 (CV4097) Filamentary Beam Tetrode

Here is a new special quality Filamentary Beam Tetrode with a really low anode voltage, for use as an RF Power Amplifier at frequencies up to 100 Mc/s.

Instantaneous filament heating enables the valve to be switched off during non-duty periods, which makes it particularly suitable for use in battery operated portable equipment. Its specially rugged construction enables the valve to withstand continuous vibration at 2.5 g and a short duration shock of 500 g.

MAIN PARAMETERS ARE AS FOLLOWS:—

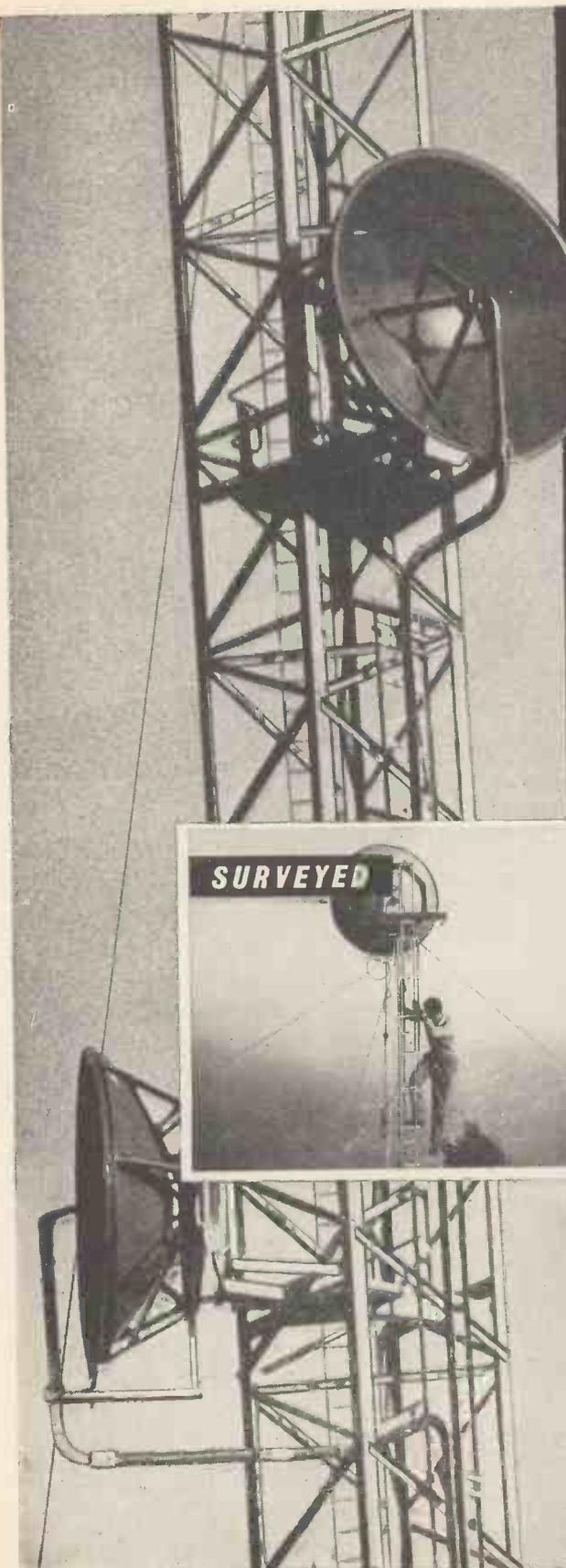
V_f	Filament Voltage (volts)	2.5 or 5.0
P_f	Filament Power (watts)	1.15
$V_a(max)$	Anode Voltage, maximum (volts)	150
$V_{g2(max)}$	Screen Voltage, maximum (volts)	150
g_m	Mutual Conductance (mA/V)	4.3
$P_a(max)$	Anode Dissipation, maximum (watts)	5.0



Associated Electrical Industries Limited

Radio and Electronic Components Division
Industrial Valves and Cathode Ray Tubes Department
155 Charing Cross Road, London, W.C.2.

Telephone: GERRARD 8660 Telegrams: Sleswan Westcent London
CRC 1671



MARCONI microwave communication systems

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GREAT RELIABILITY

The use of travelling wave tubes in the repeaters has allowed considerable reduction in the number of valves and components used. Thus the likelihood of unexpected failure has been considerably reduced.

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.



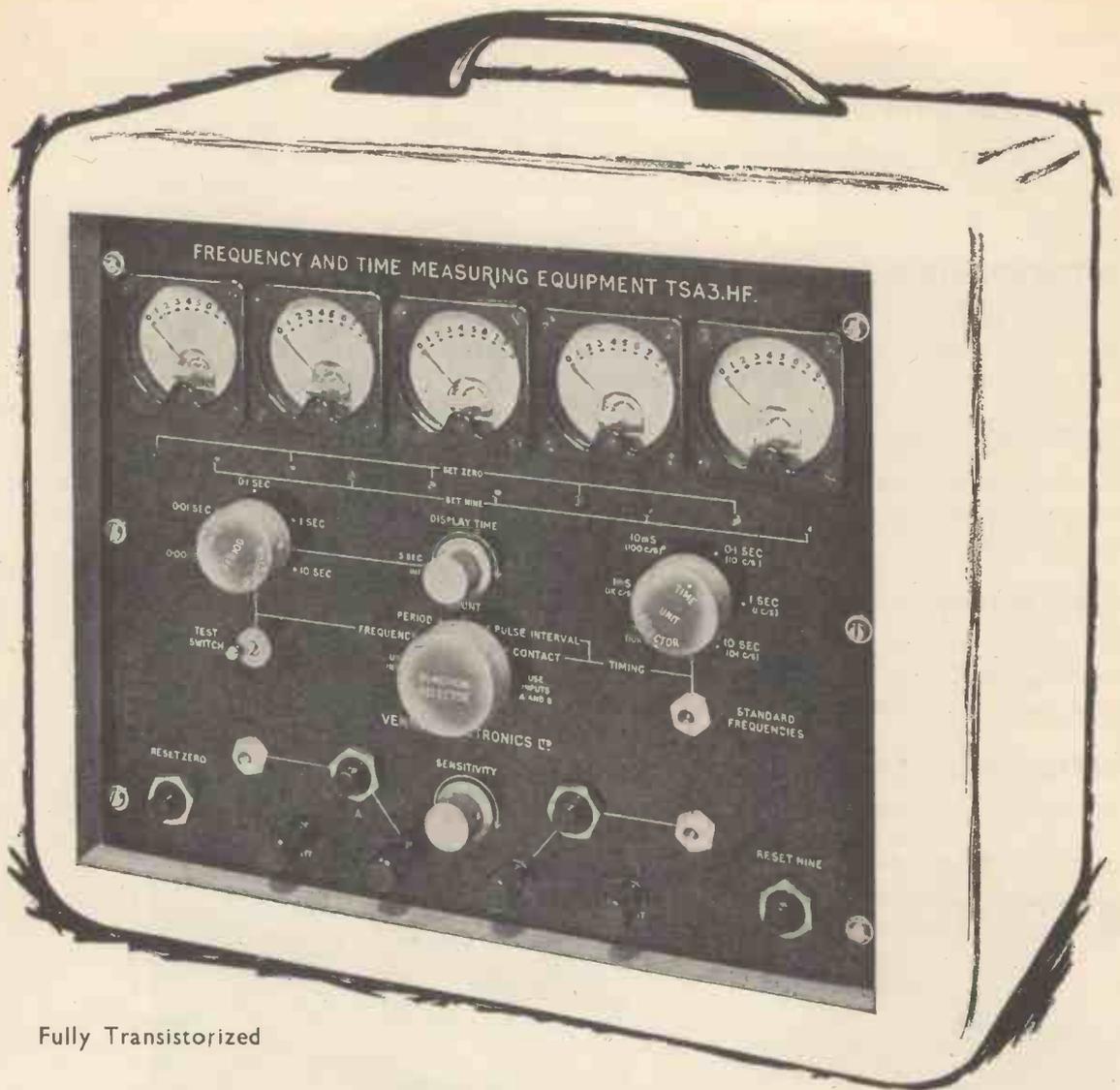
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... call it what you will, E.E.V. Co's Power Tetrode C1134 is the CV2799, the equivalent of the QQV03/20A and a recent addition to the large range of valves manufactured by the Company. Please write for complete technical data on this, or any other of our products.

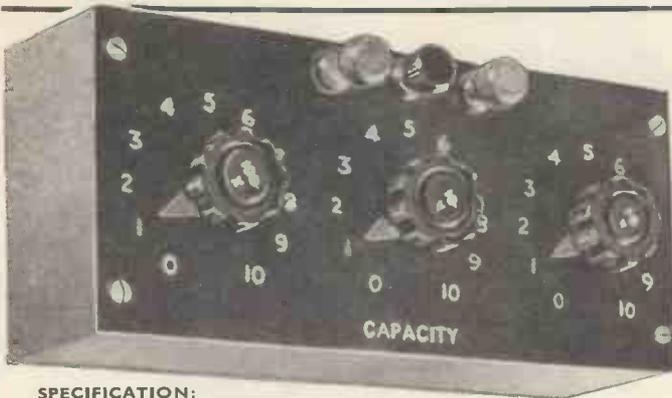
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Chelmsford, England
Telephone: Chelmsford 3491

WINSTON DECADE BOXES



SPECIFICATION:

Range	.001 mfd. to 1.11 mfd.
Zero capacitance	50 pf.
Accuracy	± 5%.
Maximum voltage	750V D.C.
Terminals	Screw type
Mounting	Metal case and panel.
Finish	Blue hammertone case. Black and silver photoetched panel.
Dimensions (overall)	Height 3 ins. (7.5 cms.) Width 8 ins. (20 cms.) Depth 3½ ins. (9.5 cms.) Weight 5 lbs. (2.3 Kgs.)



SPECIFICATION:

Range	100 ohms to 111,000 ohms.
Zero resistance	0.006 ohms.
Accuracy	± 1%.
Maximum current	10's decade 100 mA 100's decade 35 mA 1000's decade 10 mA
Terminals	Screw type.
Mounting	Metal case and panel.
Finish	Blue hammertone case. Black and silver photoetched panel.
Dimensions (overall)	Height 3 ins. (7.5 cms.) Width 8 ins. (20 cms.) Depth 3½ ins. (9.5 cms.) Weight 5 lbs. (2.3 Kgs.)

These resistance and capacitance decades were developed by one of our engineers some years ago. The reason for the development was that when engineers wish to ascertain the required value of a condenser or resistance in a part of a circuit, or when they are using decades for normal test functions, there is no point in purchasing expensive decades of the 1% variety. Our engineer considered that resistance and capacitance boxes giving normal commercial tolerances at about one-quarter of the normal price would be most attractive to laboratories, universities and factories throughout the world.

Decade Capacitor Box

Accurate decade capacitors are valuable for use in work where a widely variable capacitor of accurately known value is required for audio frequency use. Mechanical and electrical shielding is provided by the metal case and panel. The capacitor elements have no electrical connection to the case and panel for which a separate shield terminal is provided. Positive detent mechanisms and pointer knobs permit the operator to sense the switch position without looking.

Price **£11-11-0**

Decade Resistor Box

Accurate decade resistors are valuable for use in work when a widely variable resistance of accurately known value is required for D.C. and audio frequency use. Mechanical and electrical shielding is provided by the metal case and panel. The resistance elements have no electrical connection to the case and panel for which a separate shield terminal is provided. Positive detent mechanisms and pointer knobs permit the operator to sense the switch position without looking.

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from AIRPORTS

to ZYMURGISTS

Multitone leads in pocket staff location



By far the largest number of hospital and industrial installations of the pocket receiver type in this country, and overseas, are Multitone. Our selective induction system "Personal Call" is saving time, money and worry in well over 100 different types of industrial concerns from airports to zymurgists. (We are looking for a Quill Manufacturer to complete the alphabet.)

The New MULTI-CHANNEL equipment provides over 400 individual channels using the new flat receiver (as illustrated)

THE MULTITONE

personal call
system of staff location

Additional Facilities

ELECTRONIC TRUNCHEON

The Electronic Truncheon is no bigger than standard equipment carried by guards and serves the same purpose, but inside there is a transmitter which, when the button is pressed, sends out a signal. This is picked up by the loop of wire around the area to be protected. The pulse is used to operate a small receiver, which automatically switches on any form of electrical alarm. It can be operated from any point in the area.

INTERNAL TRANSPORT COMMUNICATION

The Multitone "Personal Call" loudspeaker-receiver has been designed to solve the problem of conveying verbal instructions to transport vehicles used for handling loads inside a given area. Messages can be conveyed to all or selected vehicles from the central transmitter.

MULTITONE INDUCTION SYSTEMS CAN SOLVE YOUR STAFF LOCATION PROBLEMS:

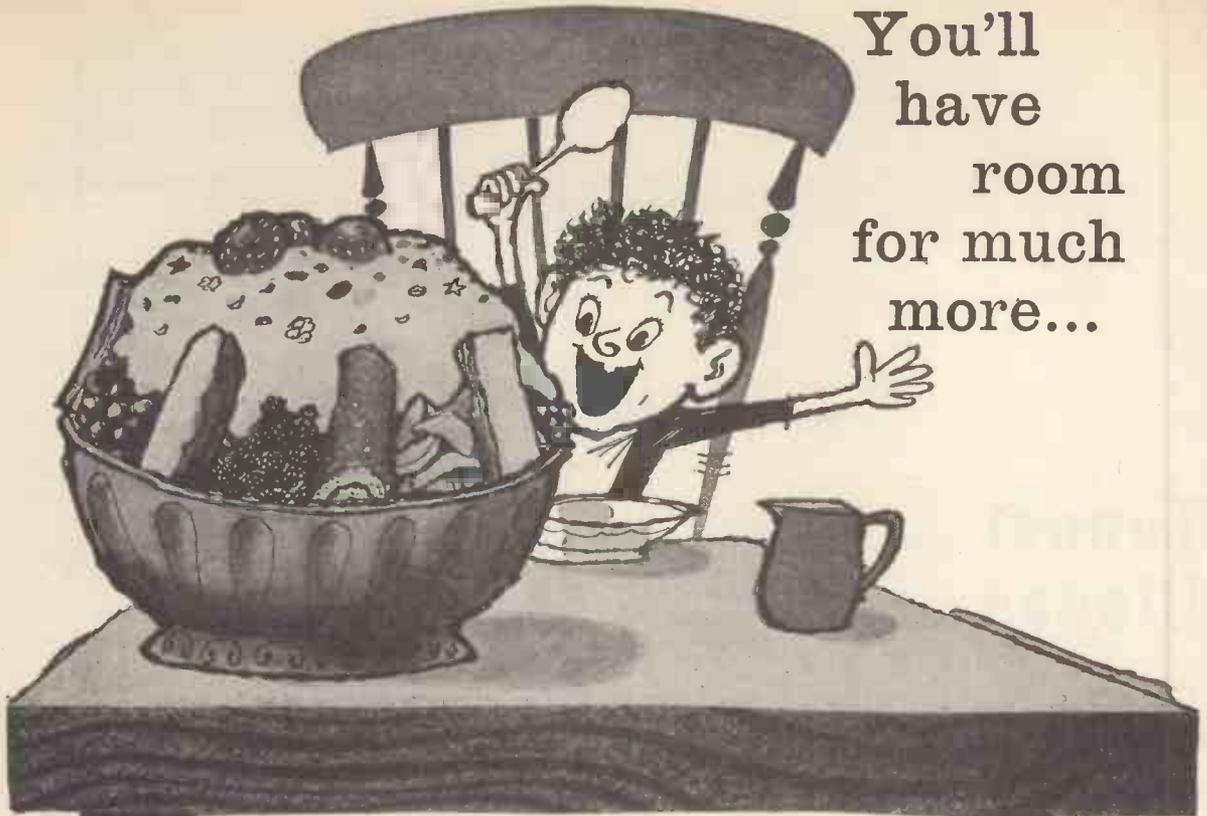
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(the 'peep-peep' in the pocket), the only staff location system worth installing

Write or 'phone for further particulars. We can be found in 10 seconds.

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have
room
for much
more...



... with the A.T.E. Series TAA
Telegraph Terminal Equipment

This unit is specially built to be as compact as possible, giving you room for much more equipment without overcrowding. The unit, comprising an electronic distributor and an operating head, is equipped with two tape readers arranged to operate alternately for continuous transmission of messages. The space taken is kept to a minimum because the operating head measures only 6½" in width.

Equipments are available to operate with conventional point to point, synchronous and semi or fully automatic switching systems.

Special features are:—

a. Automatic transmission of:—

1. Station call sign and serial number before any message.
2. Start of message and end of message preambles when operating in conjunction with automatic switching system.
3. Error signal and end of message preamble in the event of a mistake in the tape message being discovered by an operator.
4. A 100 character test message.
5. A routine message of up to 48 characters.
6. Station call sign and serial number at pre-determined intervals while no traffic is being handled.

b. Speeds 45.5, 50, 75 bauds selected by means of a switch, together with a

spare position for an optional speed. c. 7, 7½ or 8 unit code.

d. Stopping a transmission and re-starting at the point when a transmission was interrupted, or at any point without starting a new preamble. In the case of a tape, this facility may be used to repeat, or omit a particular portion of the message.

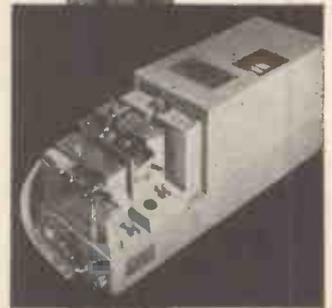
e. Transmitting the test message direct from the distributor.

Operating Head

Dimensions 6½" x 22" x 9" (16.5 cm x 56 cm x 23 cm). Weight 31 lbs. (19.1 Kg).

Electronic Distributor

Dimensions 19" x 8½" x 3½" (48 cm x 21 cm x 9 cm). Weight 23 lbs. (10.7 Kg).



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STROWGER HOUSE, ARUNDEL STREET, LONDON, W.C.2.
Telephone: TEMPLE Bar 9262. Strowger Works, Liverpool 7.

Tunnel Diodes

The current June issue of **ELECTRONIC TECHNOLOGY** includes an article on one of the latest and most promising solid-state devices—the tunnel diode.

In this, the author gives complete details of the principles of operation and electrical characteristics and discusses the desirable and undesirable features of the diode. Applications of the device are considered and are illustrated with a number of practical circuits including an oscillator, a free-running multivibrator and a divide-by-two circuit.

ELECTRONIC TECHNOLOGY covers all technical interests in electronics, using this word in its widest possible sense. All the familiar features of ELECTRONIC & RADIO ENGINEER are retained, including, of course, the well-known Abstracts and References section. Regular readership will keep you in constant touch with progress in the entire field.

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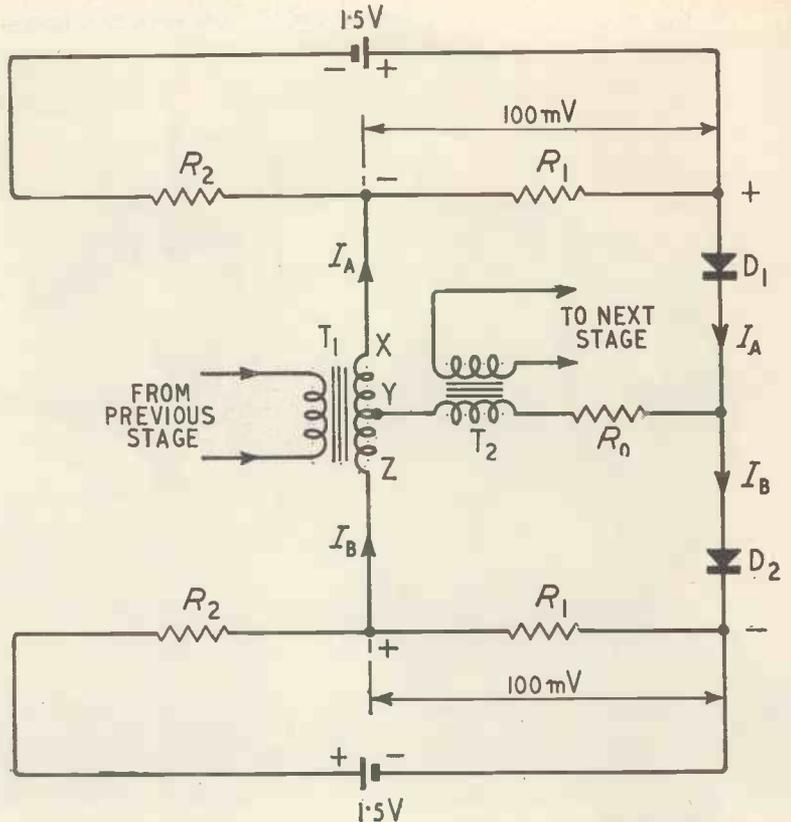
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ARTICLES IN THE JULY ISSUE INCLUDE:

THYRATRON PULSE GENERATOR

A pulse generator which uses a thyatron as an electronic switch in a novel circuit is described in this article. The generator produces pulses of exponential shape at reasonable output stability within repetition rates from 1 c/s to 12 kc/s. The principles of operation are discussed and complete circuit details are given.

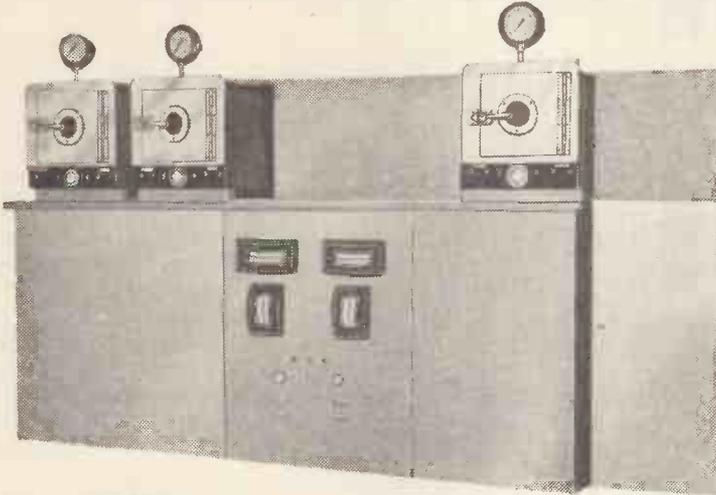
PULSE MEASURING EQUIPMENT

This article describes a system which was developed to investigate the phase difference between the signals from a single very low frequency transmitter received at two sites simultaneously. In addition to general design considerations, the authors discuss equipment details and performance.



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3-position Oven complete with glove box, all vacuum equipment, temperature controllers, safety device, etc.



Single position Vacuum Oven. Temp. 0-300°C
Vacuum range 10^{-4}
double ended for fitting in glove box.



Single position C.R.T. Pumping Unit complete with vacuum reading, automatic controls, electric seal-off, etc.

We design and manufacture Ovens to customers' special requirements. Should you have any problems in this field, our Technical Department is always willing to help you solve them.

Vacuum Ovens with temperatures of up to 600°C are also manufactured by us on similar lines but with Sectional Heating and Water Cooled Ends. Glove Boxes supplied with ovens as required.



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SUPERSPEED CORED SOLDER
for normal electrical assembly work

SUPERSPEED 'XX' CORED SOLDER
specially developed to solder tarnished, plated, and/or oxidised surfaces easily

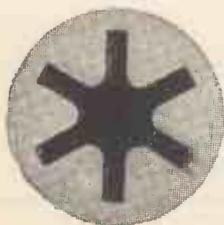
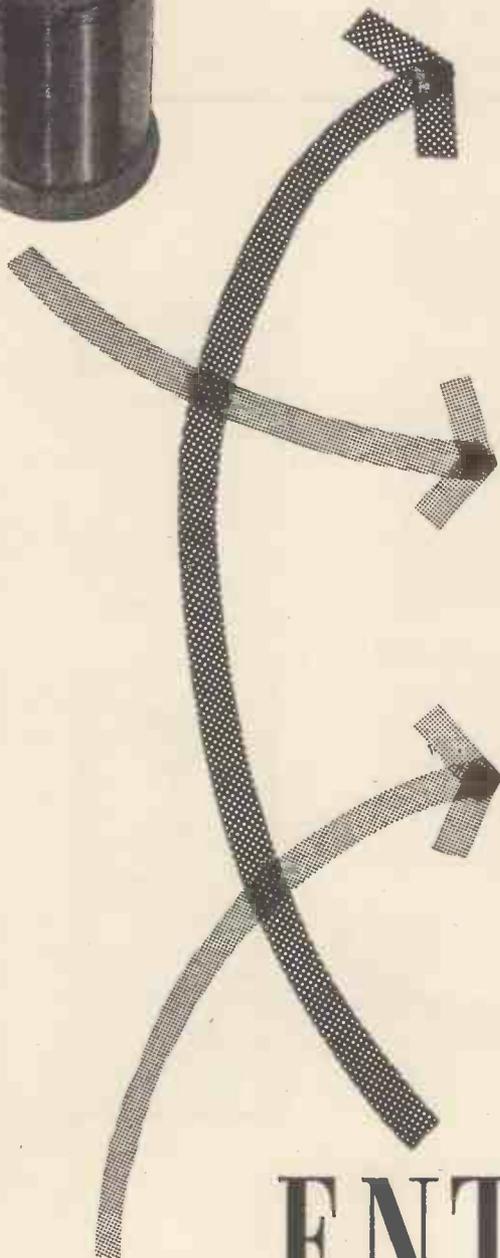
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This **NEW** **MILLIVOLTMETER**

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- 300 μ V to 100V in 8 ranges
- Frequency Range
20c/s—10Mc/s
- Accuracy \pm 3% of actual
reading

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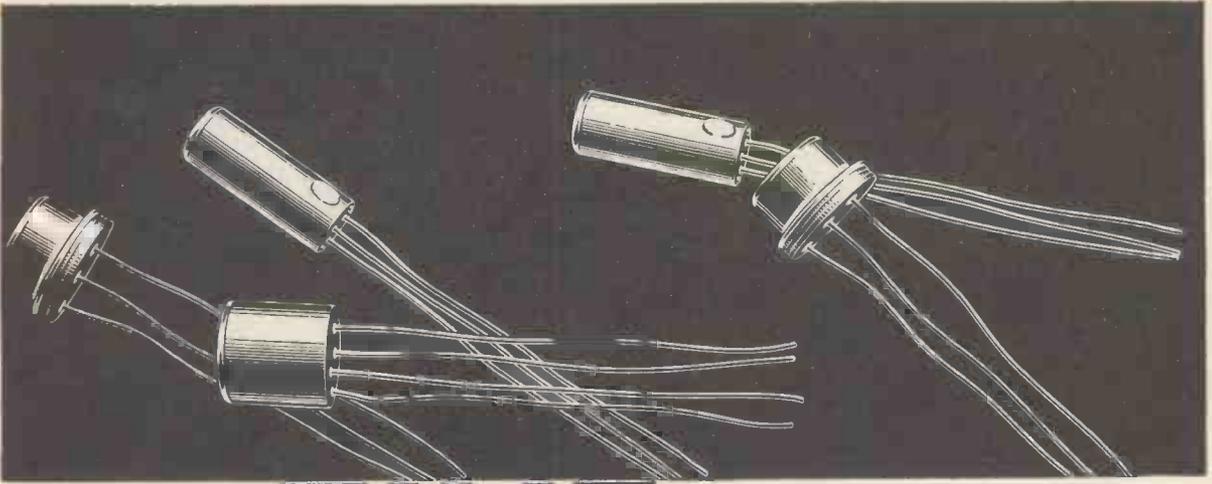
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MILLIVOLTMETER TYPE 264 is intended to measure alternating voltages from 300 microvolts to 100 volts in the frequency range 20 c/s to 10 Mc/s. It consists essentially of a negative feed-back wide-band amplifier terminated in a rectifier circuit and indicating meter. The input is taken either to a high-impedance low-capacity probe or to a 75 ohm input socket on the front panel which allows a direct connection to be made to the amplifier when required. As a low-impedance output from the amplifier is also available on the front panel, the instrument may be used as a wide-band amplifier; the gain then being adjusted by means of the meter multiplier switch.

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ALLOY DIFFUSED
TRANSISTORS**

*** V.H.F. Communications Transistors**

Here is the most direct development of the highly successful OC170 and OC171—a new Mullard low noise transistor for 100 Mc/s r.f. amplifier stages in professional communications equipments. Power gain is greater than 10 dB and noise less than 6 dB at 100 Mc/s. This is being followed by another transistor with the same performance at twice the frequency which is also intended for use in V.H.F. communications receivers.

*** Extremely High Speed Logic Transistors**

The alloy diffusion technique can be used to provide logic transistors for operation at a p.r.f. of 10 Mc/s which will fully 'bottom'. An especially sophisticated transistor is being made available to meet all the requirements of the logic circuits for the next generation of high speed computers. This transistor will have a f_1 greater than 300 Mc/s at 10mA, a low bottoming voltage and a very rapid turn-off time. Already available is a favourably priced logic computing transistor with a frequency cut-off greater than 40 Mc/s, a maximum collector current of 25 mA and a maximum voltage of 40 V.

*** Fast, High Current Core Driver Transistor**

A new core driver transistor is to be introduced shortly for high speed storage in conjunction with the new high performance logic transistors. This has a collector current of 750 mA and a very fast rise time— f_1 is greater than 60 Mc/s.

The high frequency and power characteristics of this transistor also suit it for carrier telephony and transmitting equipment where an output of three watts at 8 Mc/s can be obtained, or up to one watt at higher frequencies.

*** PNP Switching Transistor**

A wider view of the potentialities of the alloy diffusion technique has led to the development of a four layer pnpn device. This is a three terminal germanium transistor with a negative resistance characteristic which can be operated as a high speed electronic switch. After being switched "on", the transistor automatically remains bottomed until it is switched off. This characteristic makes the device particularly suited for use as a speech path cross-point in automatic telephone exchanges.

Extremely simple arrangements can be devised for astable, monostable and bistable circuits. Maximum ratings are in the region of 35 volts and 25 mA. The on/off (or series : parallel) impedance ratio is three million to one.

*** Special Avalanche Transistor**

A more specialised alloy diffusion development, but one which is invaluable for some applications such as high speed sampling oscilloscopes, is a device which does not function by normal transistor action but which utilises the "avalanche" phenomenon.

This transistor works over a limited current region, but has a high gain and an exceptionally fast rise time of the order of a millimicrosecond. Its pulse current is as high as 50 mA which represents a remarkable current rate of rise of 50 amps per microsecond.

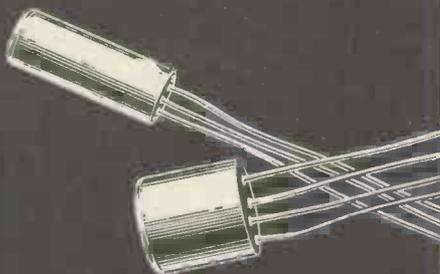
The germanium alloy diffusion technique—proved by Mullard in the quantity production of OC170 and OC171 r.f. transistors—has been intensively developed to provide transistors for a much broader range of applications. In many new industrial fields equipment designers will be able to specify Mullard "alloy diffused" when they need high performance transistors and when economies must be borne in mind.

Specific types of industrial transistors outlined here are successively being put into production. Sample quantities are becoming available — watch Mullard announcements in the coming months for full details.

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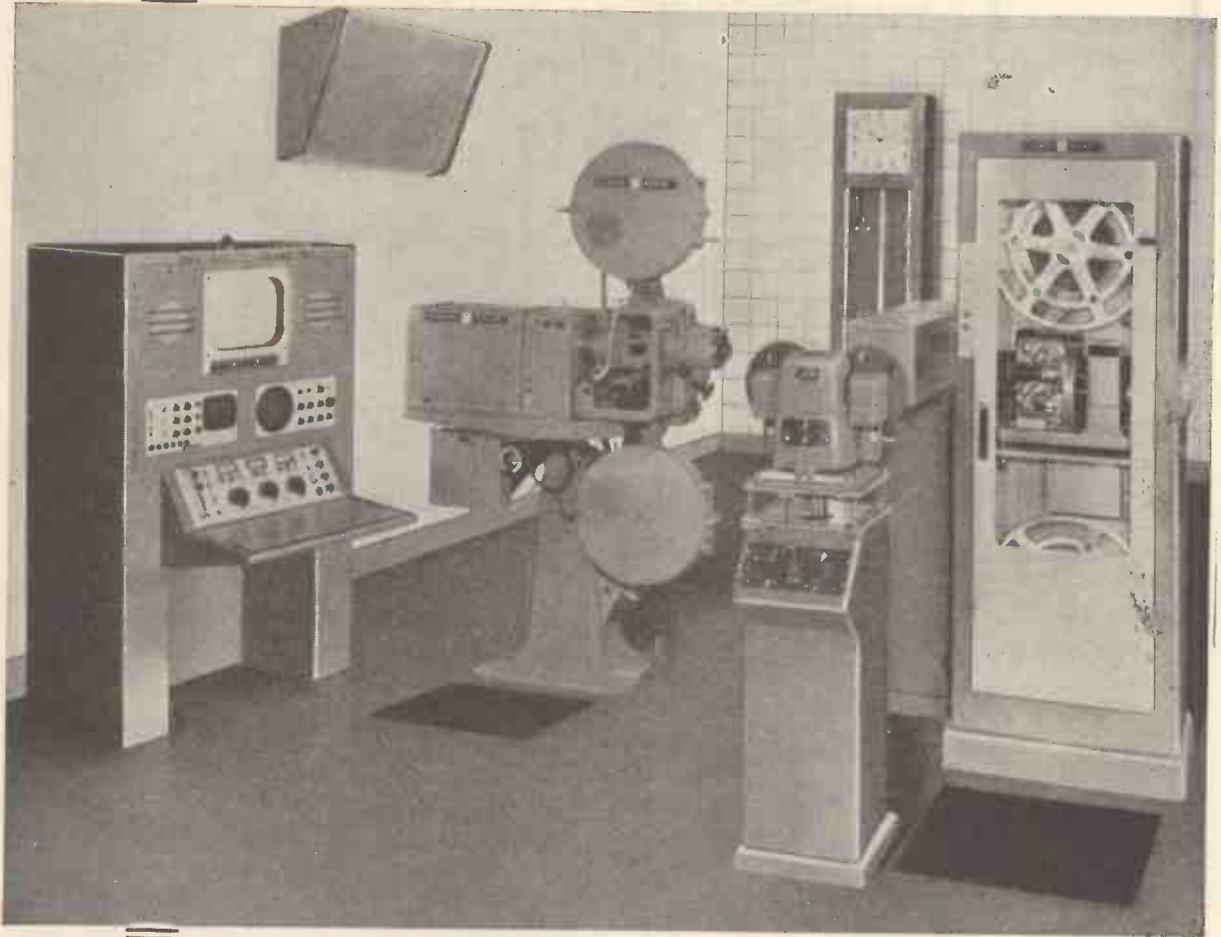
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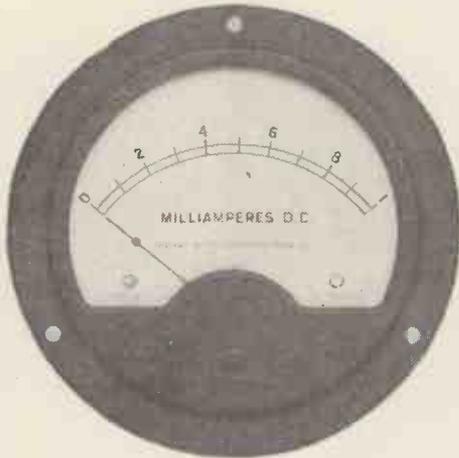


The Pye Teleciné Equipment is designed to give studio-quality transmissions of 16 mm and 35 mm sound film and standard transparencies. It will handle a wide variation of film density and gives excellent monochrome rendition of colour films. Push-button starting and stopping is provided on projectors and at control position, with optional facilities for interlocking projector mechanisms. A special pick-up tube, the Stacion 935, has been developed for use with this equipment, but the camera has been so constructed that alternative tubes may also be used. Scanning equipment and suitable projectors are available for the various television systems.

- * Complete teleciné installation comprises camera unit, control desk, 35 mm and 16 mm sound film projectors and slide projector.
- * Multiplexed operation with facilities for up to 3 image sources.
- * Single switch for positive or negative film reproduction, automatic change of gamma correction being applied in each case.
- * Infra-red filter in lamphouse permits still frame operation.
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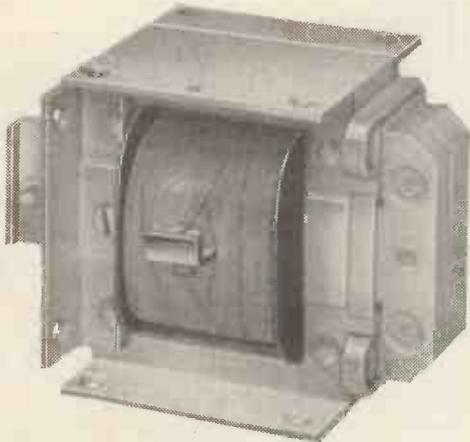
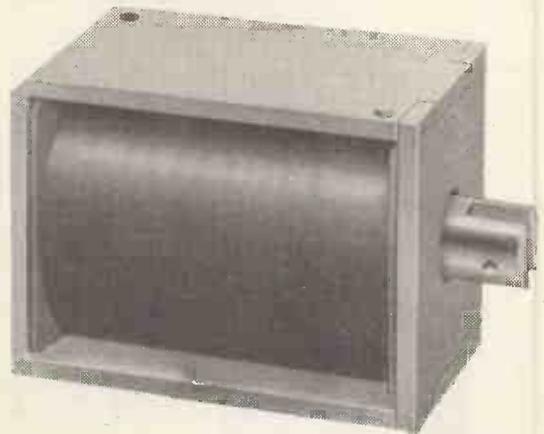
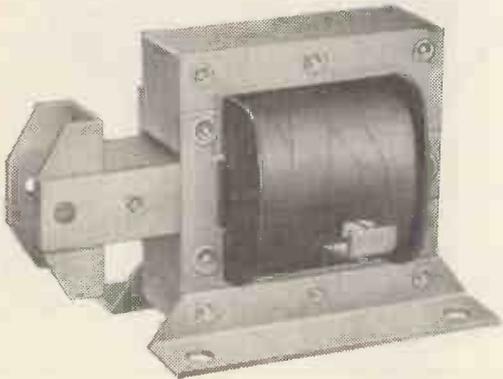
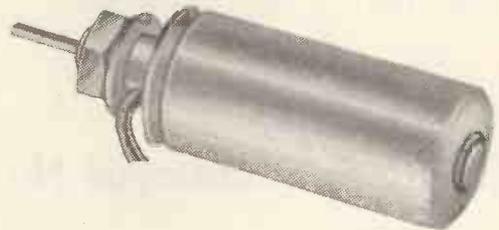
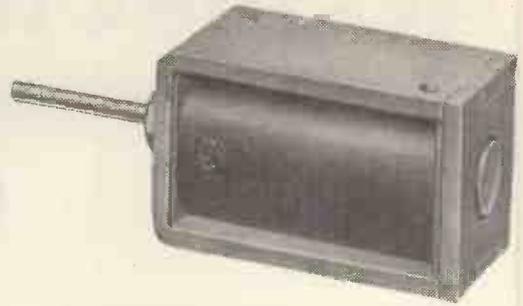
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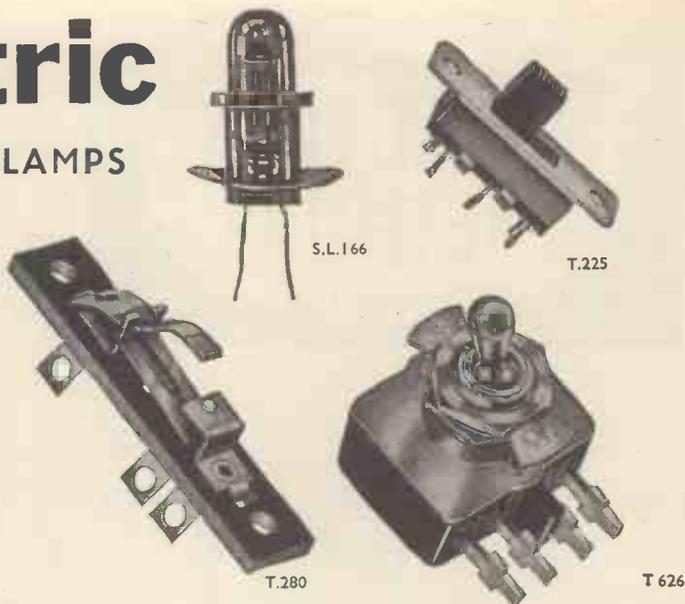
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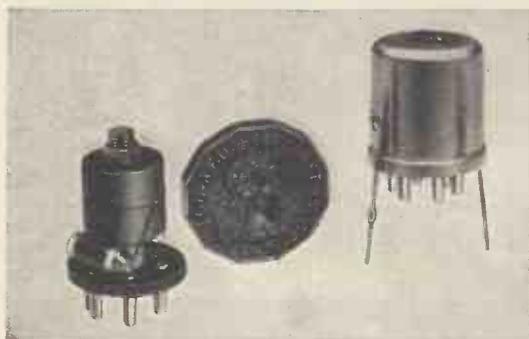
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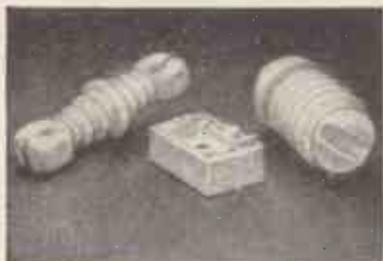
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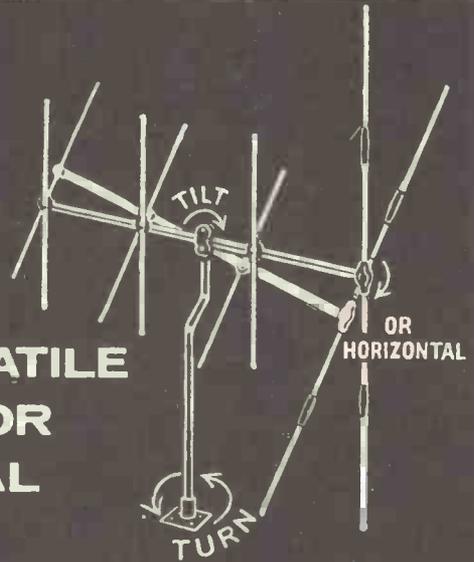


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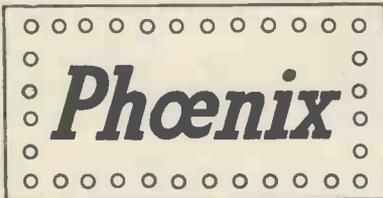
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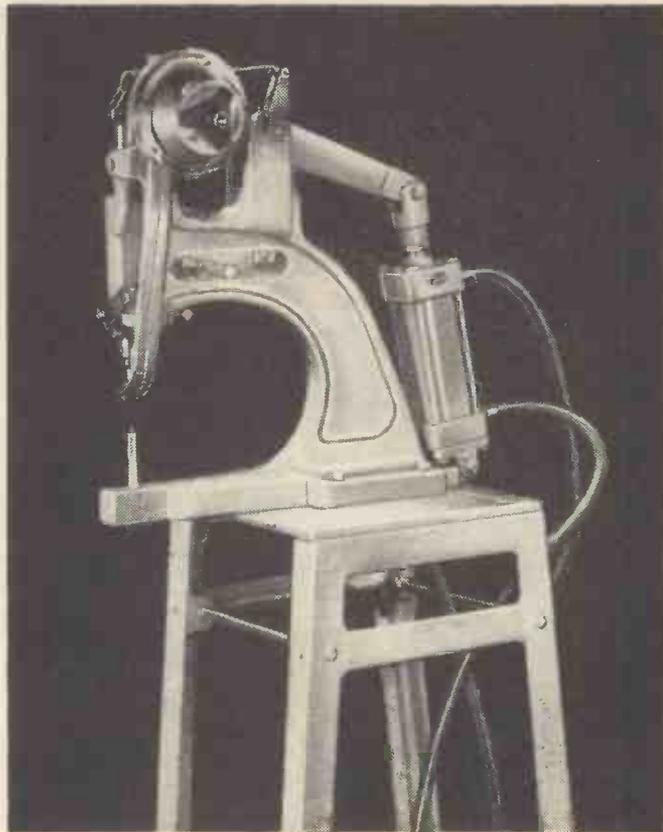
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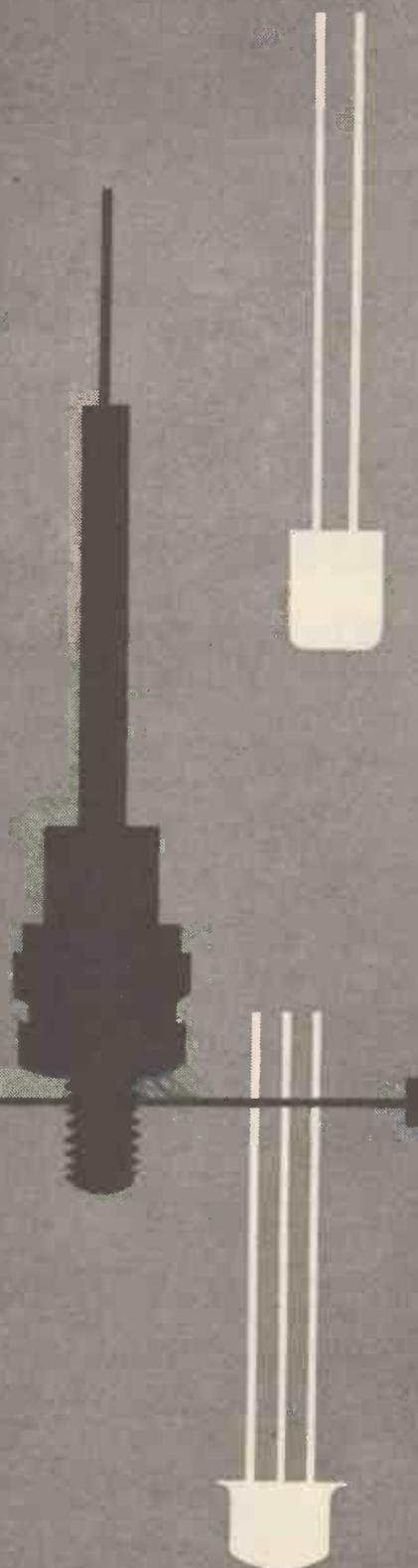
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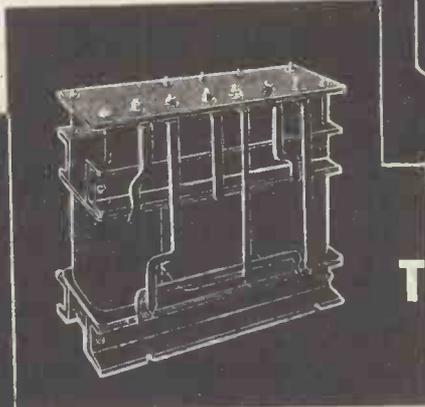
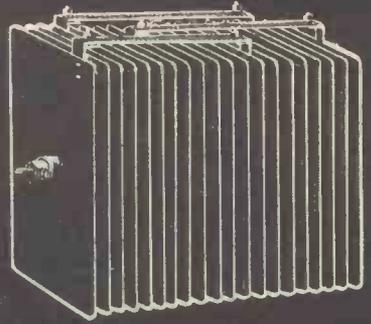
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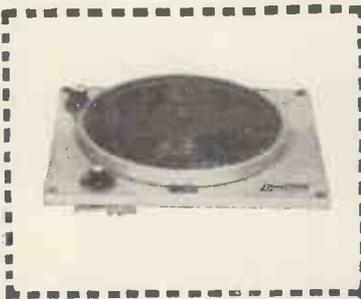
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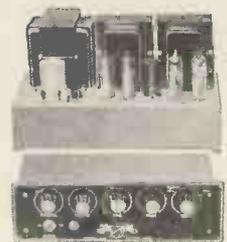
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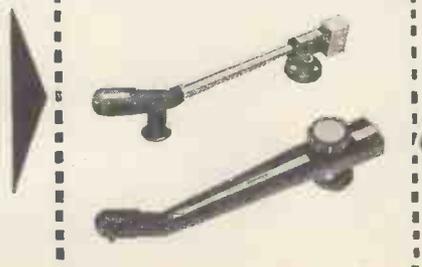
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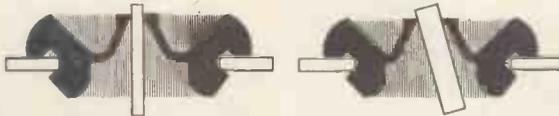
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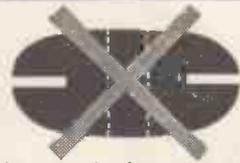
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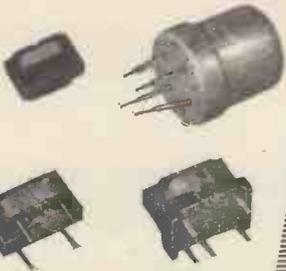
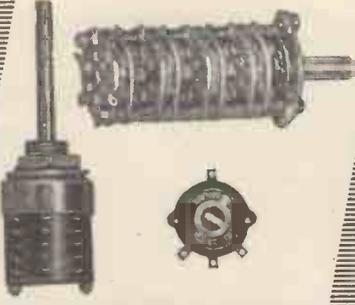
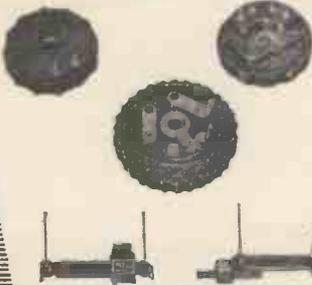


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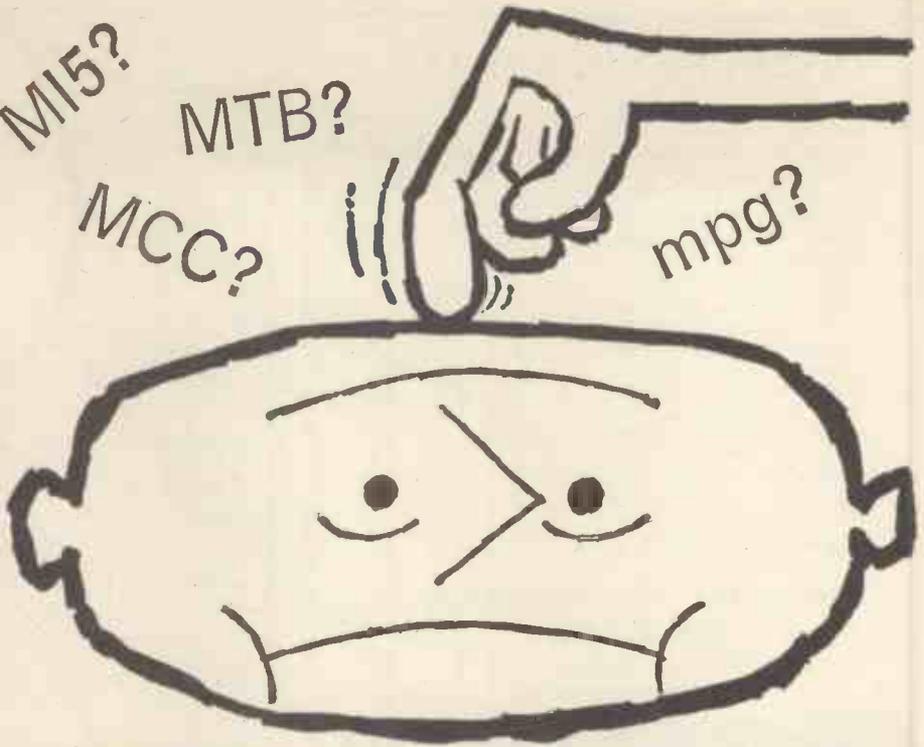
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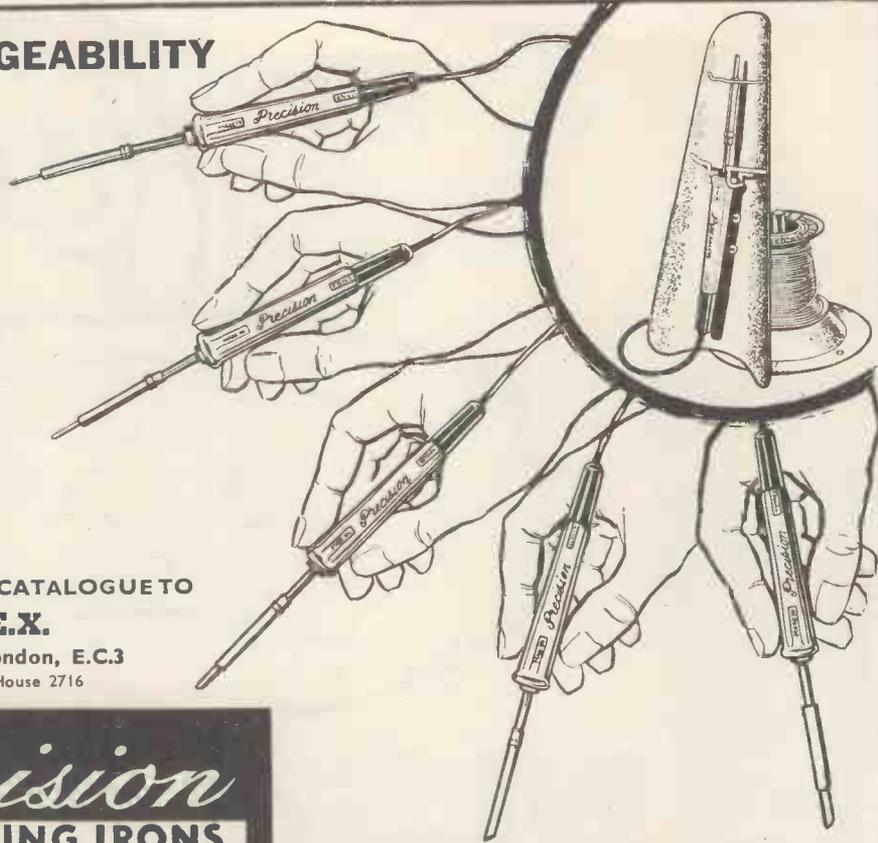
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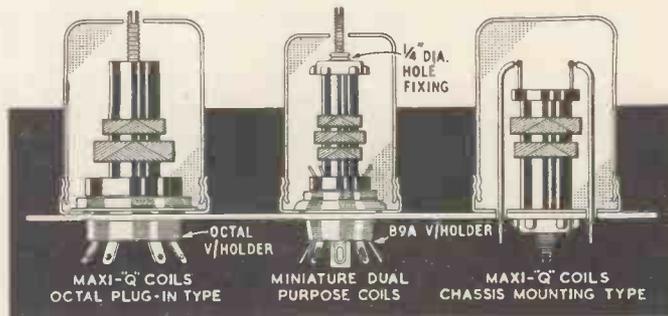
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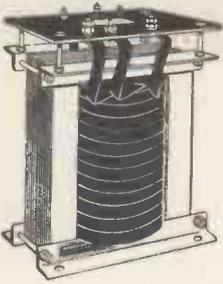


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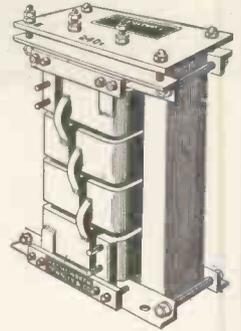
TRANSFORMERS



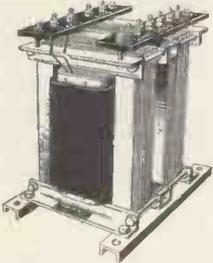
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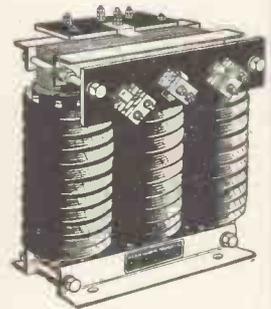
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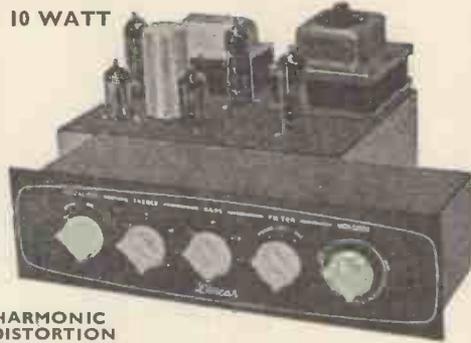
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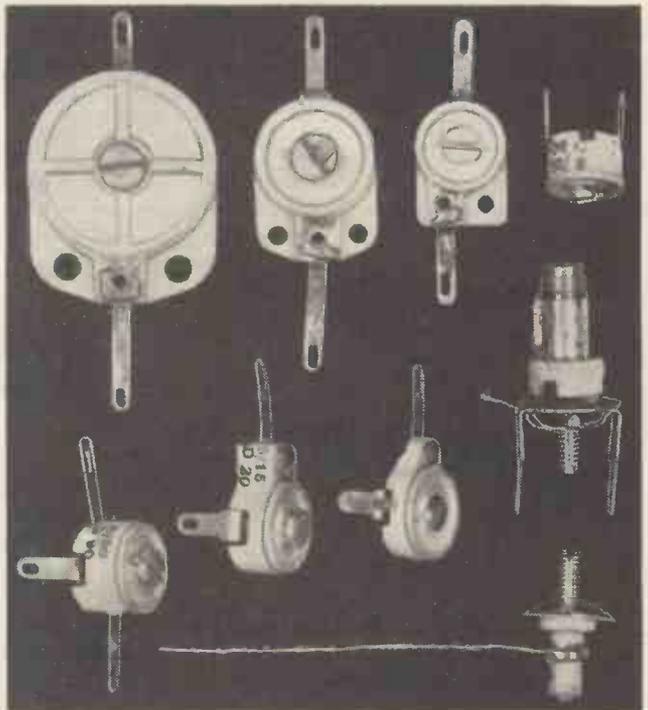
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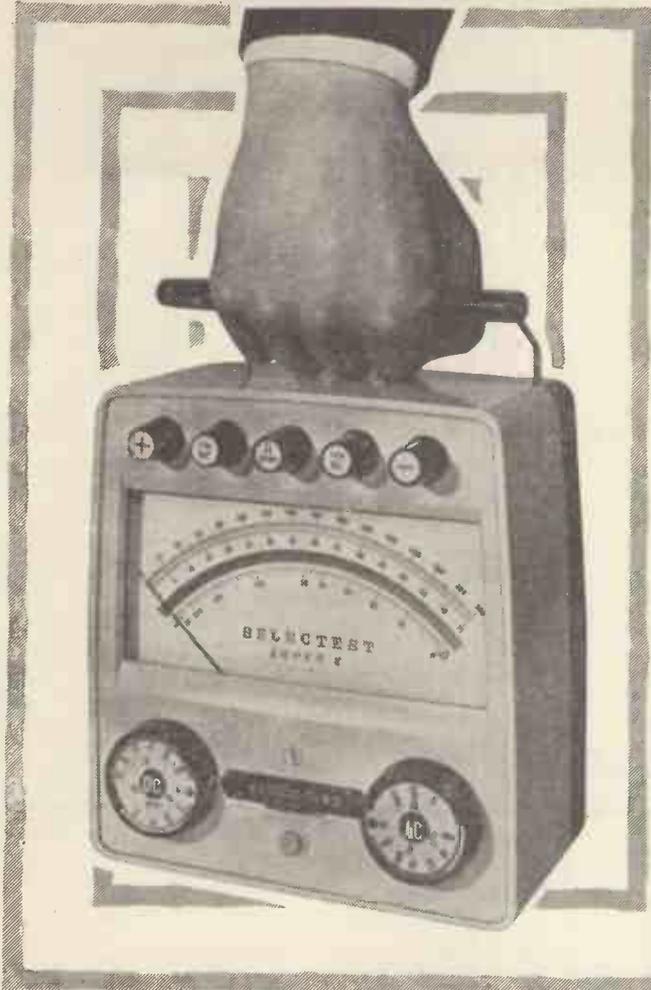
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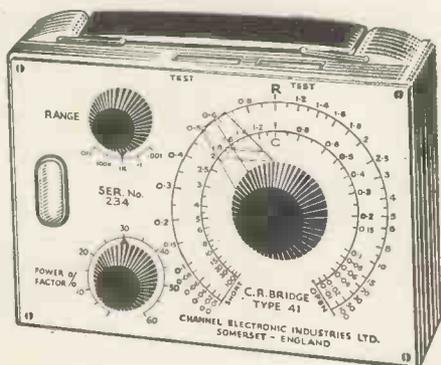
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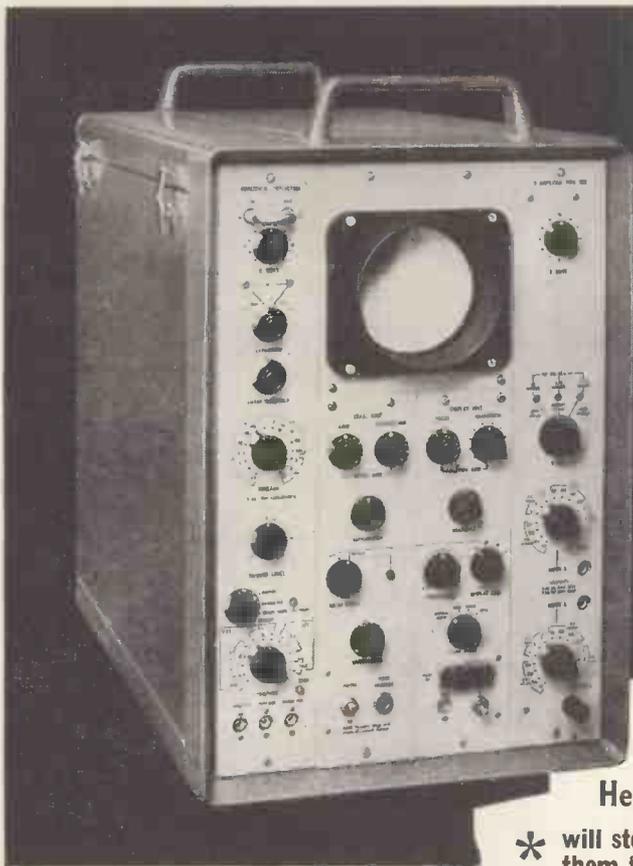
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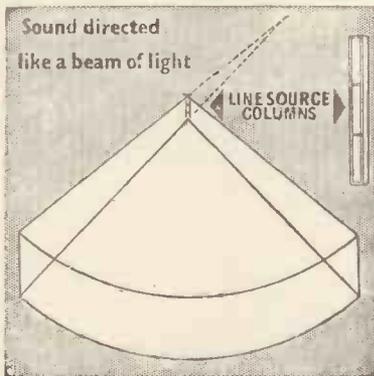
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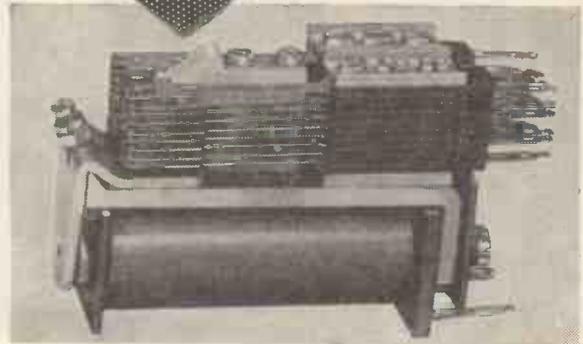
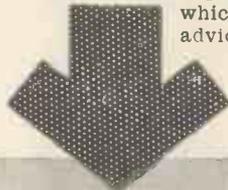
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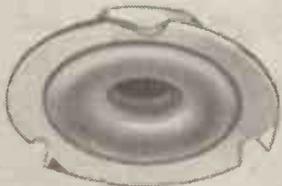
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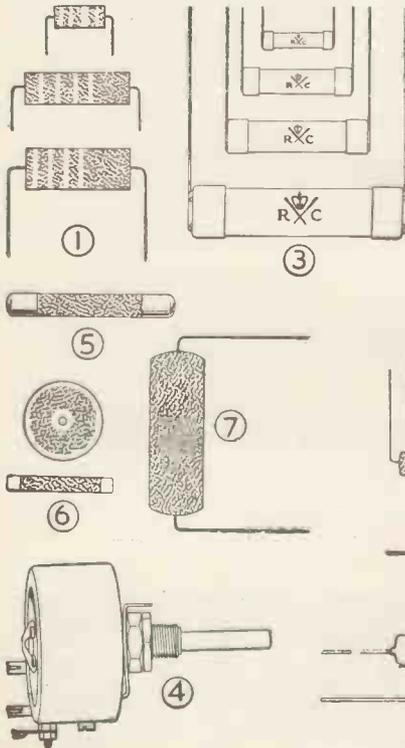
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WIREWOUND			
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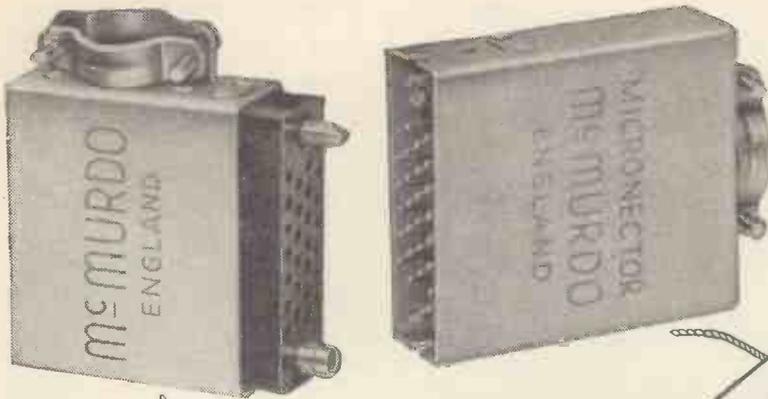
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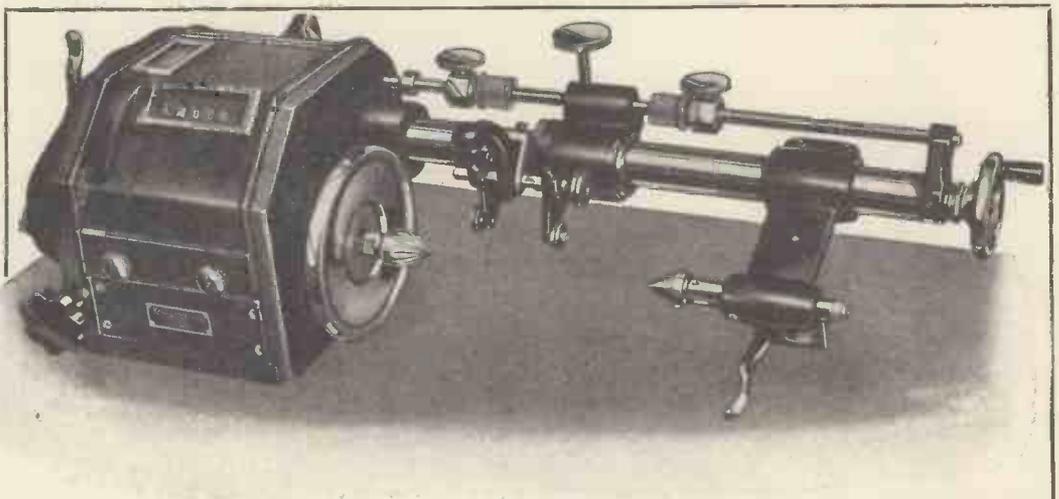
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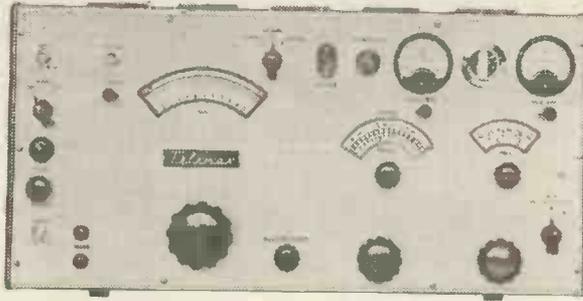
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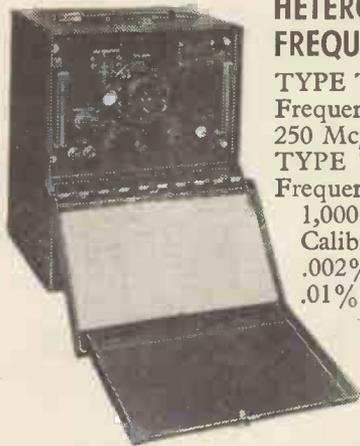


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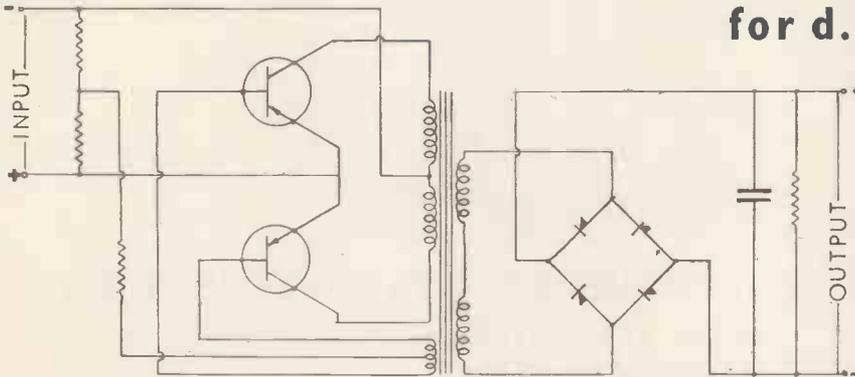
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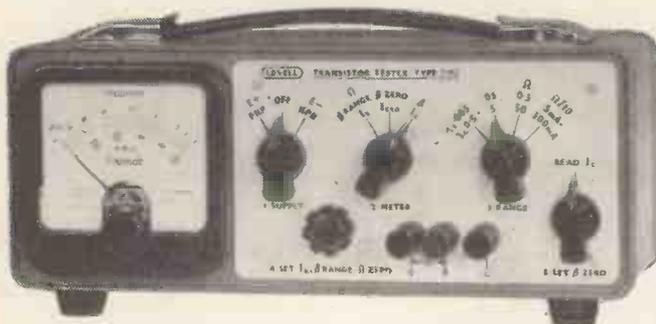
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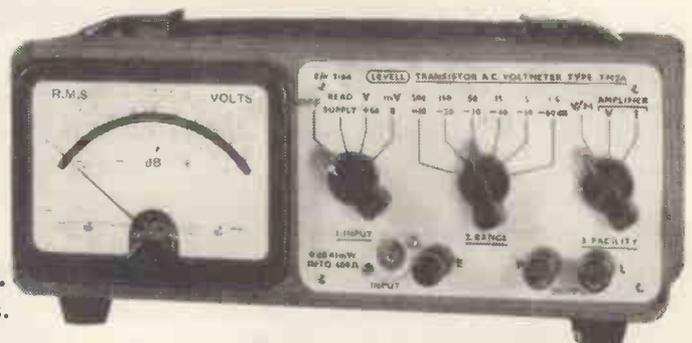
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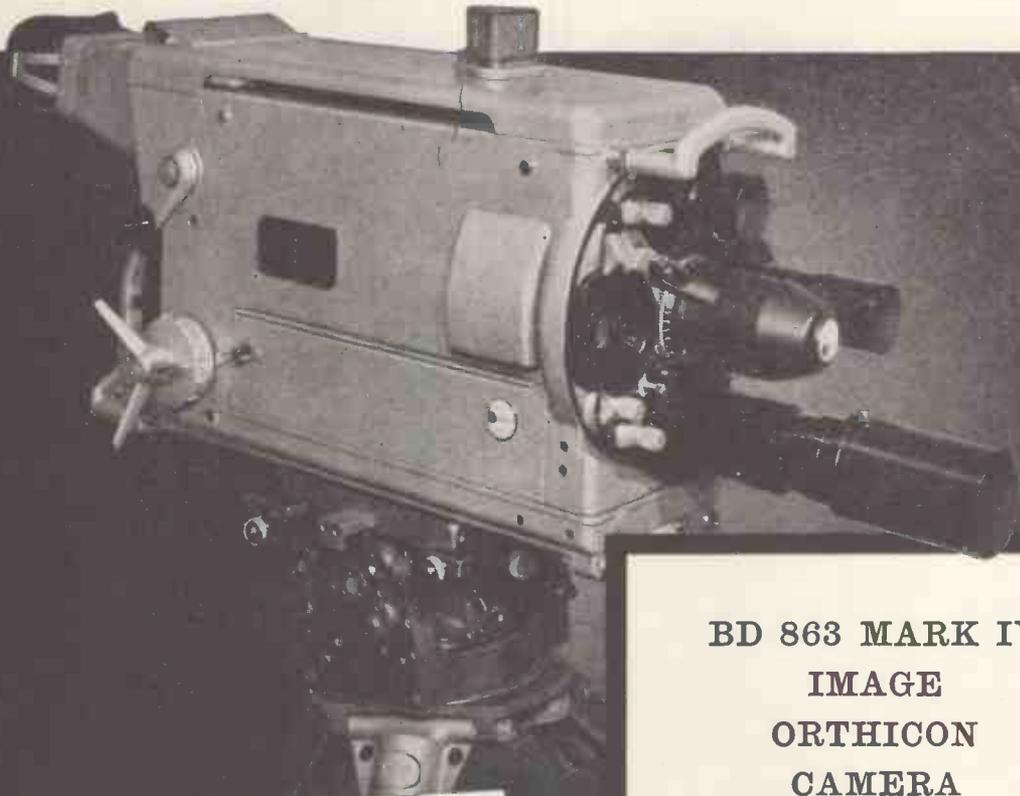
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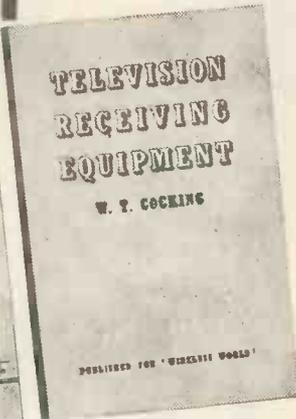
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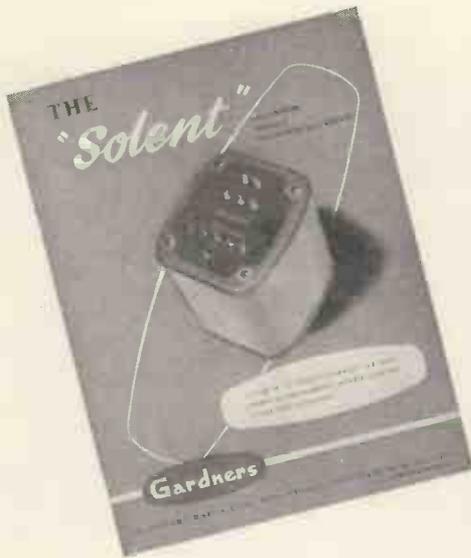


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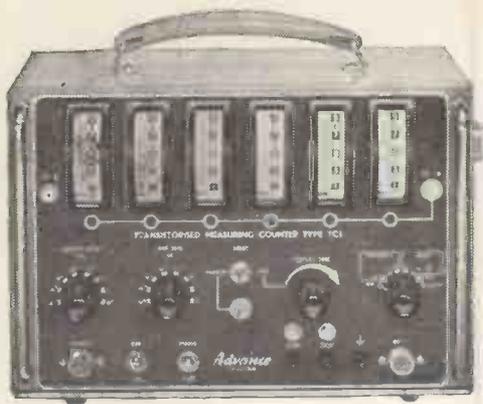
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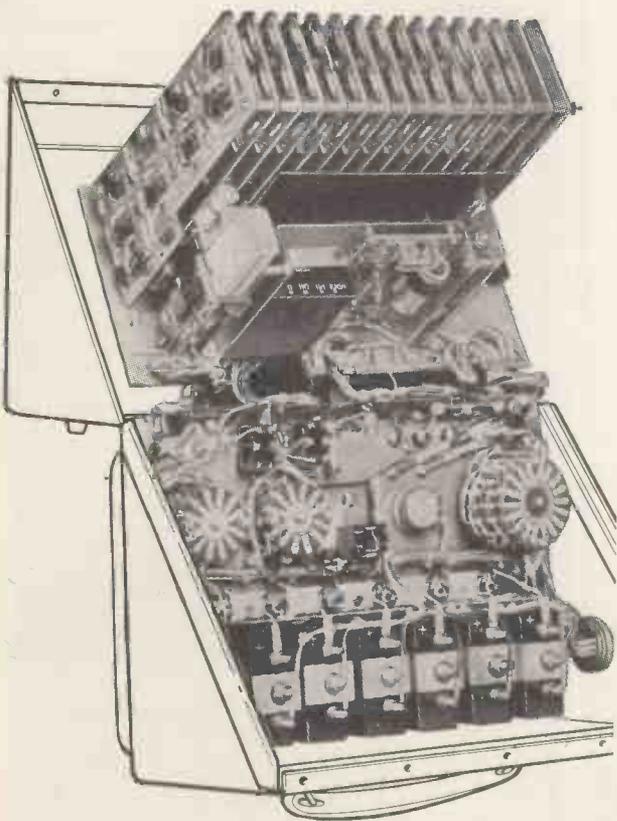
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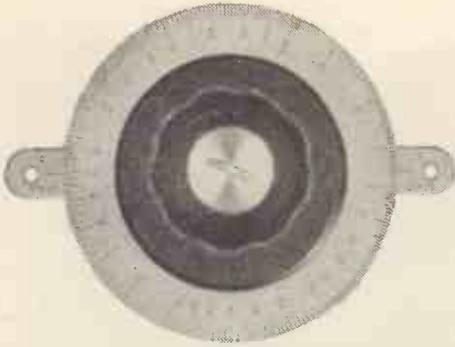
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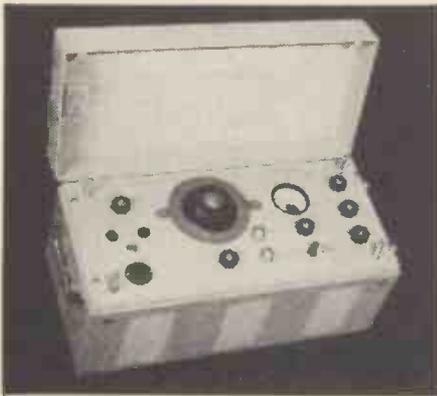
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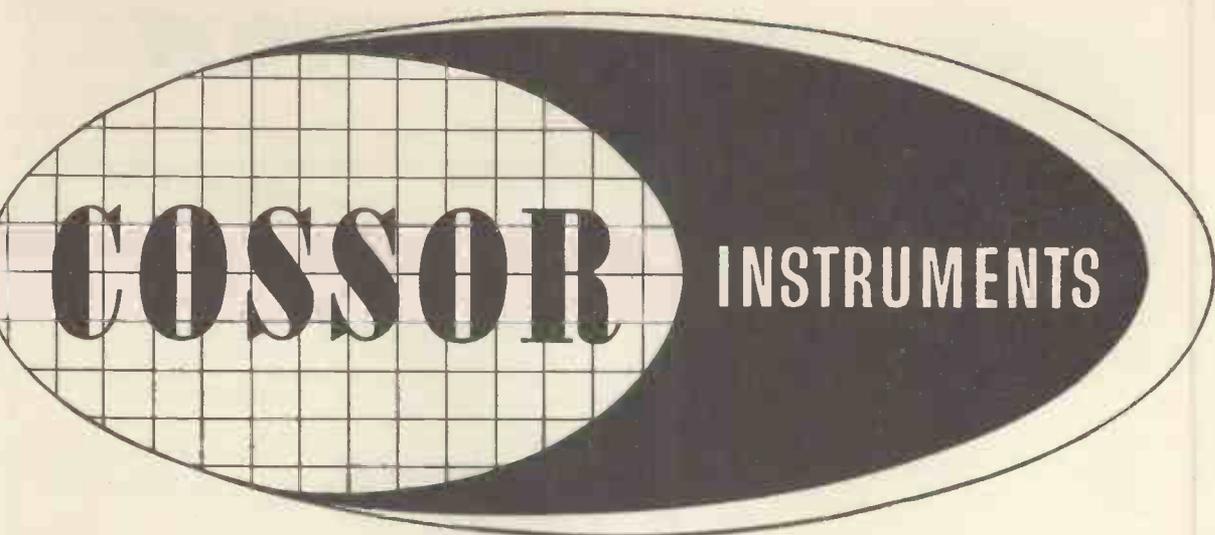
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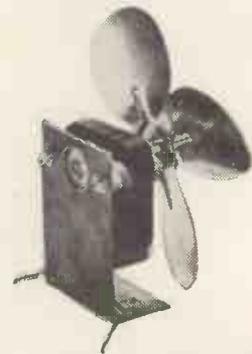
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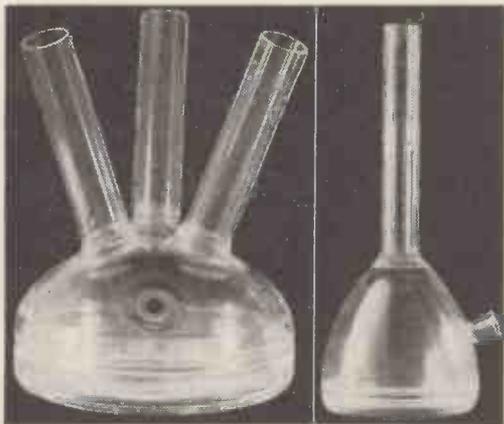
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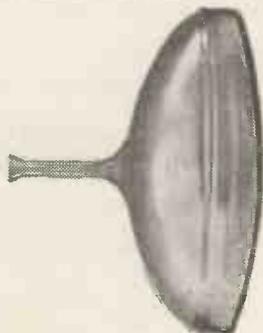
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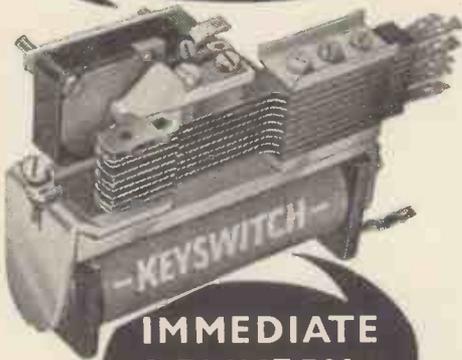
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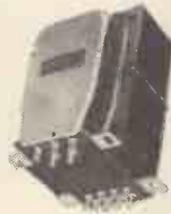
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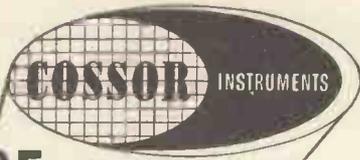
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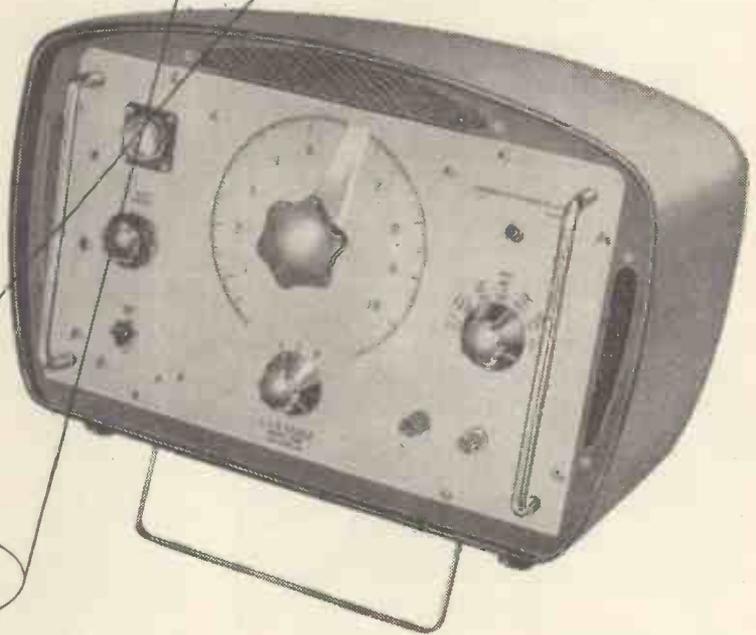
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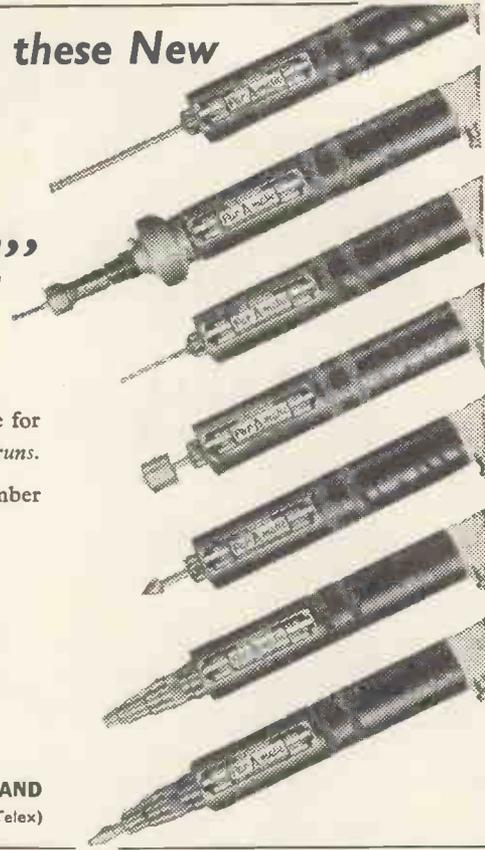
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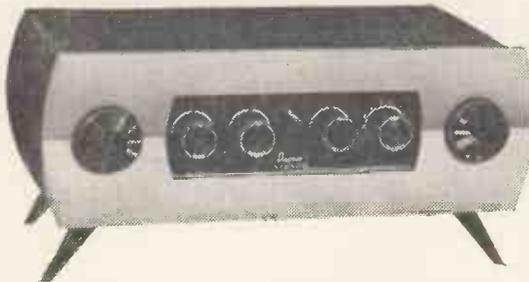
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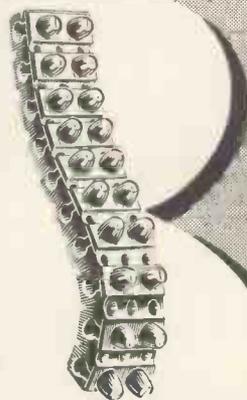
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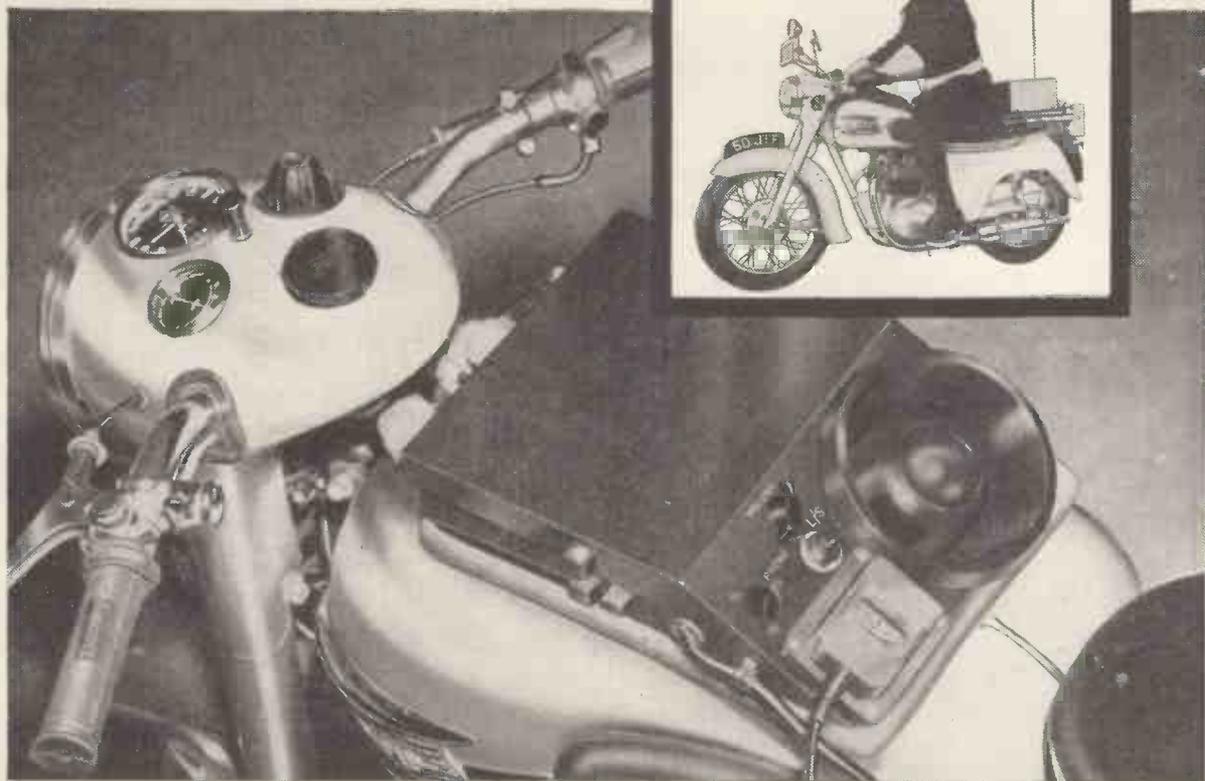
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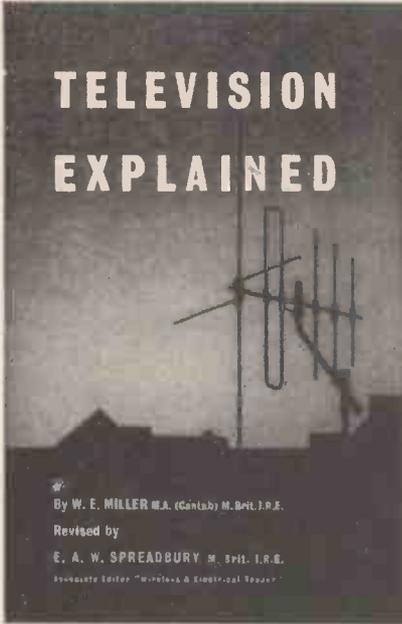
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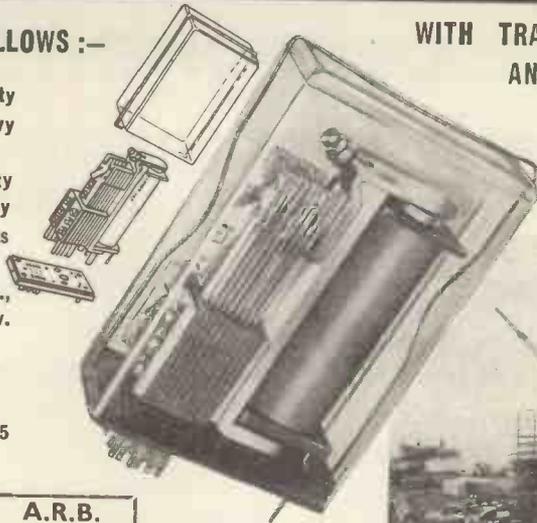
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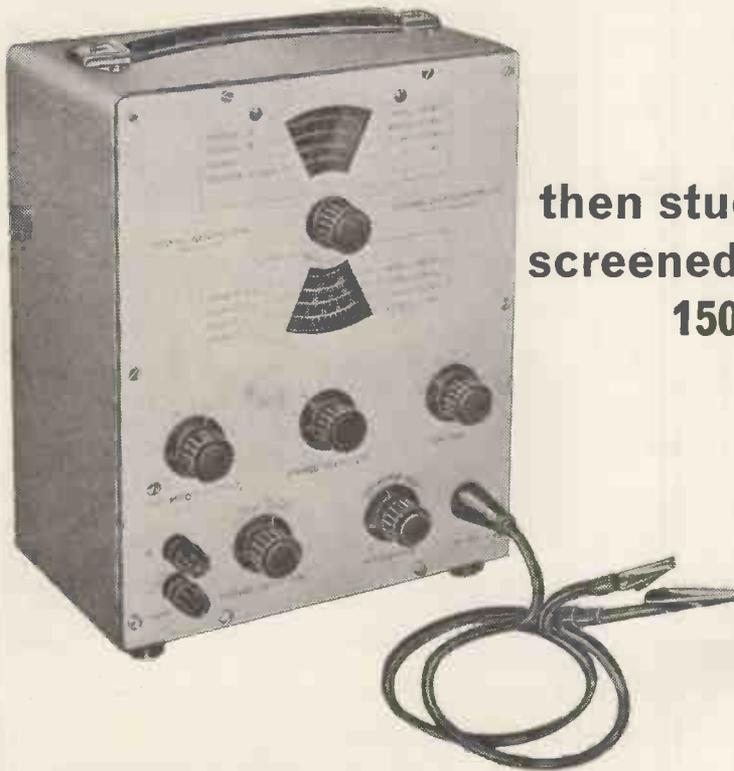
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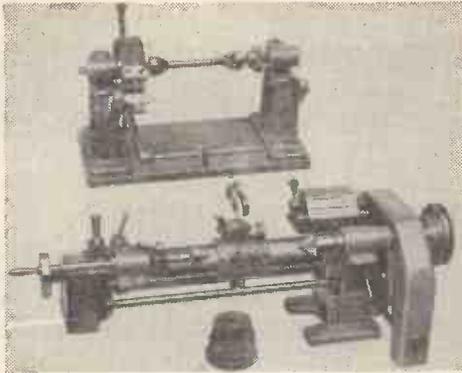
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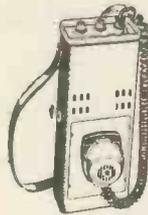
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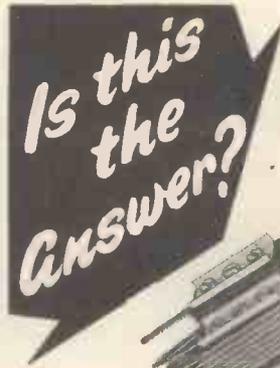
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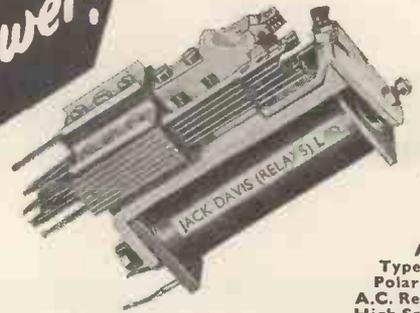


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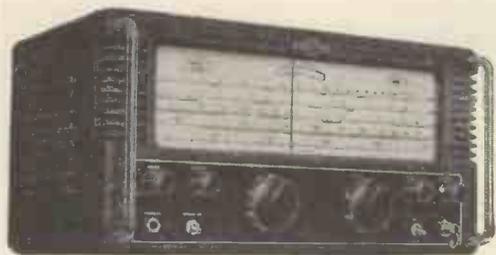
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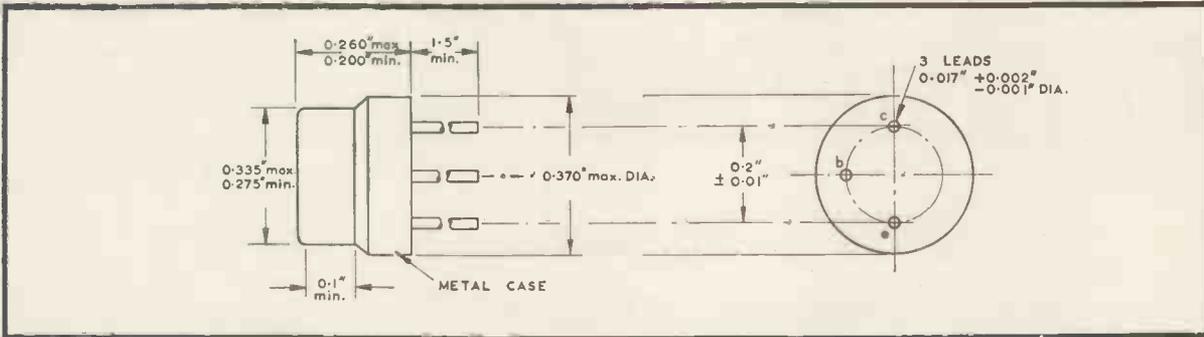


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Collector dissipation $T_{amb}=25^{\circ}C$ (mW).....	120
Collector dissipation $T_{amb}=71^{\circ}C$ (mW).....	10

PARAMETER CHARACTERISTICS* ($T_{amb}=25^{\circ}C$)

		XA141	XA142	XA143
Static current amplification				
at $V_{ce} = -7V, I_c = -5mA$ (h_{FE}).....	Minimum	20	20	20
	Average	45	45	45
Collector to base capacity (pF).....	Average	2	2	2
	Maximum	5	5	5
Gain/bandwidth product (frequency for current gain=1) at $V_{ce} = -7V, I_c = -5mA$ (Mc/s).....	Minimum	20	40	60
	Average	30	50	75

*Typical production spreads

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Wireless World

ELECTRONICS, RADIO, TELEVISION

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OF PUBLICATION

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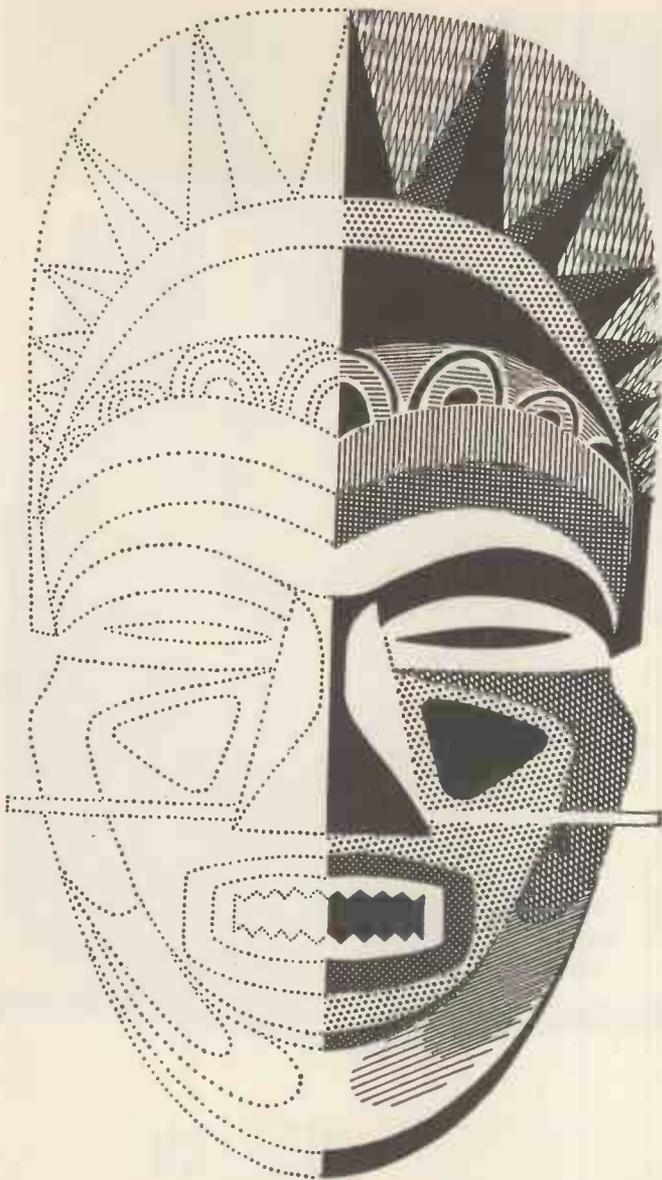
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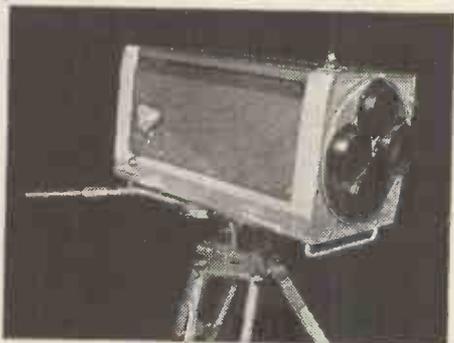
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Fusing, part 2

A Fuse is a device for opening a circuit by means of a conductor which is designed to melt when an excessive current flows. Properly speaking, the term covers the complete device including any housing. The active part of the fuse, which breaks the circuit, is the Fuse-element. This may be an open wire bridging two terminals, or it may be supported on a carrier or enclosed in a cartridge, the element and its immediate container being called a Fuse-link.

One must never lose sight of the fact that a fuse is a thermal device; melting of the element occurs when its temperature is raised to the characteristic level of the material of which it is made. The melting point is a precise physical property of a metal or alloy and the amount of heat energy required to raise a given mass of it to the melting point is therefore a precise quantity under any specific set of conditions. However, any variation of these conditions such as alteration of the temperature differential, or of the heat losses, will alter the quantity of heat required to produce melting, and in relation to a fuse-element this means that its performance will be affected. Thus, a fuse-element made of a material which melts at 250° C. will require appreciably less applied heat to blow it in the tropics than at the north pole or, put another way, if a fuse-element is chosen to give adequate protection to an equipment at the equator, it may not satisfactorily protect the equipment in mid-winter in northern Alaska where it might take appreciably longer to operate under the same degree of fault current. Equally, a fuse-element running in a zone of unusually high temperature, e.g., inside an enclosure where considerable heat is developed, may interrupt the circuit without any electrical fault having occurred.

There are other practical considerations associated with thermal effects. The element in an unfilled cartridge fuse-link is usually designed to be supported at the ends only, clear of the walls of the tube. However, if such a fuse-link is badly made so that the element rests on the inside of the bore, some heat will be conducted away by the tube wall, which means that additional energy will be needed to replace

this; i.e., protection will be less satisfactory than the designer intended. A similar effect can occur if the element is slack, even if it is not actually touching the inside of the tube under normal running conditions. As soon as excess current commences to flow, the expansion of the element as the temperature rises may cause it to sag against the cartridge wall, and this will slow down the rate of temperature climb, and delay fusion and opening of the circuit. This is one of the reasons why "Belling-Lee" do not enclose identity labels inside glass cartridge fuse-links, since there is a risk of them touching the elements and altering the blowing characteristic. (Another practical reason is that the very action of blowing usually so disfigures the label as to render it unidentifiable! We think it preferable to stamp the rating indelibly on the end caps, since even marking the glass is rendered ineffectual if the tube becomes broken.)

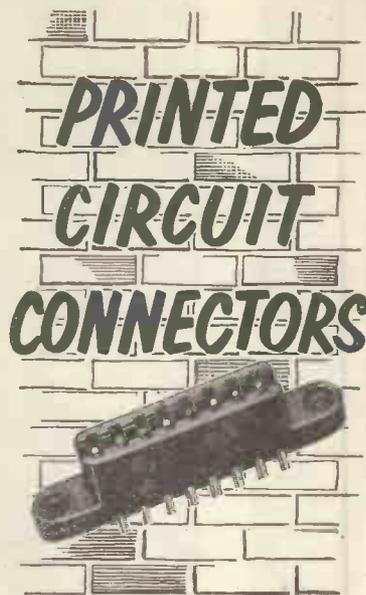
The position of mounting, and the connections to a fuse also introduce thermal effects which can affect performance. When mounted vertically, heat generated at the bottom of the element helps to raise the temperature at the upper end, and accelerates blowing. Poor contact resistance at the ends of a fuse-link can lead to the development of considerable heat, and it is not uncommon for a high rating fuse-link mounted in a faulty carrier to blow prematurely, or for the soldered connection between element and caps to melt. The use of a fuse-link of higher rating than its carrier can produce a similar failure due to overheating of the carrier, and the fact that a carrier accepts a fuse-link does not necessarily mean that they are intended to work together. The connecting links between a fuse and the circuit can also have a bearing on the performance, for together with the terminals they form a heat sink, and excessive cooling due to the use of too generous conductors can retard the rate of action of the element and impair the protection.

For all these reasons the design and testing of fuse-links are related to closely specified operational conditions which are well known to circuit designers, and fuse-link types and ratings in an installation should not be altered indiscriminately.

(To be continued)

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- L.1381. Polarising Block

These connectors employ unique spring contacts, curved in two planes, which ensure constant, low contact resistance with minimum wear on board and connector.

They can be used with conventional or printed wiring at the solder spills. When used with printed wiring the base printed circuit should be drilled or punched with holes on a 0.05 in. grid. The plug-in board (single- or double-sided) should have a thickness of 0.0625 in. ± 0.005 in.

The mouldings have open ends to obviate machining of wide boards, and permit end-on grouping of connectors to accommodate broad rows of contacts.

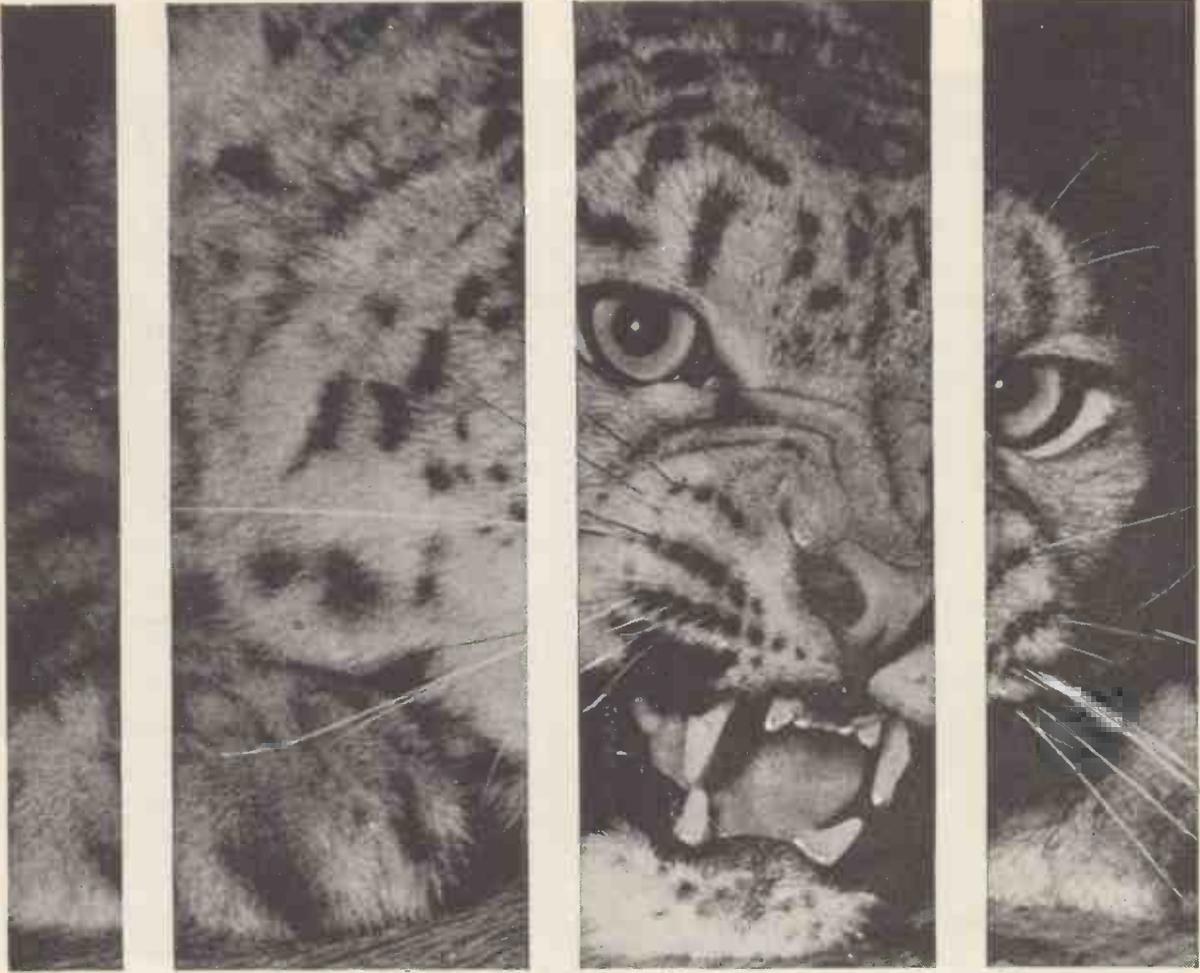
The insertion of a board can be controlled by guides, mounted on the connector or separately. Correct polarity can be achieved by replacing one of the contacts by a Polarising Block, and slotting the board to engage this.

Other printed circuit components are available to cater for screened (coaxial) and unscreened connections, and the fitting of fuse-links. Please write for details, indicating your particular interest.

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SCR961	25	35	10	120	0.5	20	2	15
SCR962	50	75						
SCR963	100	150						
SCR964	150	225						
SCR965	200	300						

* For zero or negative gate voltages

† Depends on cooling system and conduction angle.

‡ Value depends on circuit.



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Aspects of design

24 FM RATIO DETECTOR (PART I)

This is the twenty-fourth of a series of special features dealing with advanced problems in television and radio circuit design to be published by The Ediswan Mazda Applications Laboratory. We will be pleased to deal with any questions arising from this or other articles, the twenty-fifth of which will appear in the August 1960 issue.

The ratio detector is a circuit used for the detection of frequency modulated signals, and, by suitable design, it can be made insensitive to unwanted amplitude modulation of the signal. The frequency modulation is detected by making use of the phase differences between the voltages across the primary and across each half of the centre tapped secondary circuit of a double tuned transformer as in the normal phase discriminator. Typical detector circuits are shown in Figs. 1 and 2.

The rectified currents in the diodes D1 and D2 are varied by the deviation of the signal frequency from its central value and the difference between these currents, flowing through the output audio load R_L , produces the required audio output signal. The diodes conduct at the peaks of the input signal, allowing the stabilising capacitor C_1 to be charged to a voltage dependent on the signal strength. The stabilising capacitor and its associated parallel resistance R_1 have a sufficiently long time constant to resist any rapid change of potential. Hence, if the input signal increases, the current flowing into the capacitor rapidly increases, and this adds very considerably to the load on the tuned circuits, consequently reducing their gain. Similarly, a reduction of signal causes a reduction of loading and an increase in gain. By this means, rapid variations in the signal strength (i.e. amplitude modulation) are considerably reduced.

There is a limit to the amount of downward modulation (i.e. temporary reduction of signal) which can be handled by a ratio detector. At some value of modulation, depending on the particular circuit used, both diodes are biased beyond cut-off and the circuit fails to function as an FM detector. From tests carried out on FM receivers, under widely varied conditions of reception, it is generally considered that an acceptable design has an AM-FM rejection ratio not less than 35 dB (see below for method of measurement), and that the FM detector should handle a downward amplitude modulation of 40%.

The stabilising capacitor in itself cannot entirely eliminate the effects of amplitude modulation, and various methods are used to reduce the unwanted output by producing an antiphase component. Some methods principally affect the balanced component, i.e. the AM component which is dependent on the frequency deviation, and others the unbalanced component, i.e. the AM component which is independent of frequency deviation. To obtain good AM rejection a combination of methods may be necessary.

A well designed ratio detector should meet the following requirements:—

1. The load resistance across the diodes must be low enough to reduce the average working Q to a value at which the circuit can handle the maximum likely amount of downward modulation. In general the working Q should be about a quarter of the unloaded Q.
2. The coupling between primary and secondary should be less than critical coupling at the working Q.
3. The ratio of tertiary voltage V_3 to the half secondary voltage V_2 should be nearly unity.
4. The FM detector characteristic must be linear over a frequency band which will handle a deviation of ± 75 kc/s plus any drift in the receiver oscillator.
5. The stabilising capacitor value must be large enough to maintain limiting action at the lowest audio frequency. This is particularly important in an unbalanced circuit where one side of the load resistance is "earthy" and the voltage across the stabilising capacitor appears in the audio output.
6. The AM rejection ratio should not be unduly dependent on the level of the signal input, and any method of improving the performance figure must cater for the spread in production tolerances of all the circuit components, including valves or crystal diodes.

MEASUREMENT OF AM REJECTION RATIO

The unwanted AM audio signal depends in general on the amount by which the carrier frequency differs from the centre frequency of the discriminator curve. Thus, if the amplitude and frequency modulated signals are applied individually, the measured ratio will be very dependent on the alignment of the discriminator circuit. For this reason a better assess-

ment of the ability to discriminate against AM is made by using a signal which is simultaneously amplitude and frequency modulated, but using different modulation frequencies to enable the signals to be separated after detection. As the output from the AM may contain appreciable harmonics, it is advisable to use a lower frequency for the frequency modulation, and to separate the audio modulation output by means of a high pass audio filter.

Suitable conditions are achieved by using 30% frequency modulation (i.e. ± 22.5 kc/s deviation) at 50 c.p.s. and 30% amplitude modulation at 400 c.p.s.

The rejection ratio is then given by
$$\frac{\text{rms audio output produced by FM}}{\text{rms audio output produced by AM}}$$
 expressed in dB where suitable correction is made for the insertion loss of the audio filter network used in the measurement.

If the unwanted AM output is known to be mainly due to an unbalanced component, the rejection ratio can be satisfactorily obtained by measuring the audio output using amplitude and frequency modulation separately applied.

TYPES OF RATIO DETECTORS

Two basic types of ratio detector circuits are shown in the illustrations, and obviously there are a number of ways in which their individual features may be combined. Fig. 1 uses a separate tertiary winding tightly coupled to the primary circuit, and a bifilar secondary winding to obtain a good electrical centre tap on the secondary circuit. The diode load is balanced to earth. AM rejection is improved by a suitable choice of values for resistors R_2 and R_3 . Fig. 2 uses a tap on the primary winding instead of a separate tertiary winding, and a capacitor tap on the secondary winding. The use of a capacity tap avoids the necessity of using a bifilar winding in the secondary circuit. The circuit, in addition, uses an unbalanced diode load, and AM rejection can be improved by a suitable choice for R_4 and C_2 . The unbalanced circuit is essential if the diodes in a triple diode triode valve are used in an FM detector.

In the next issue, details will be given of a ratio detector circuit based on Fig. 2 which is designed to give a consistently good AM rejection performance.

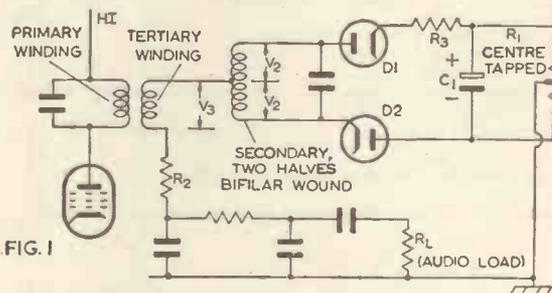


FIG. 1

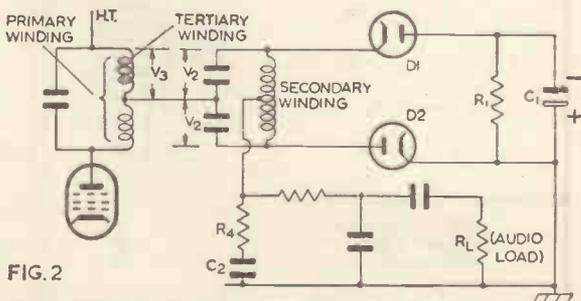


FIG. 2

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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) $\Gamma_{g1-k}(w)$ 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

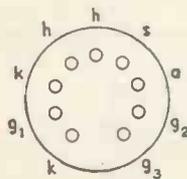
Effective Figure of Merit (Valve and Circuit) (Mc/s) 220

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

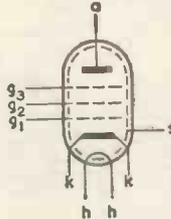
††Given by $\frac{g_m \times 10^3}{2\pi \sqrt{C_{in(w)} C_{out}}}$ see "Aspects of Design" No. 1 for

further details. (Wireless World July 1958.)

Base: BA9 (Noval) Mounting Position: Unrestricted



VIEW OF FREE END

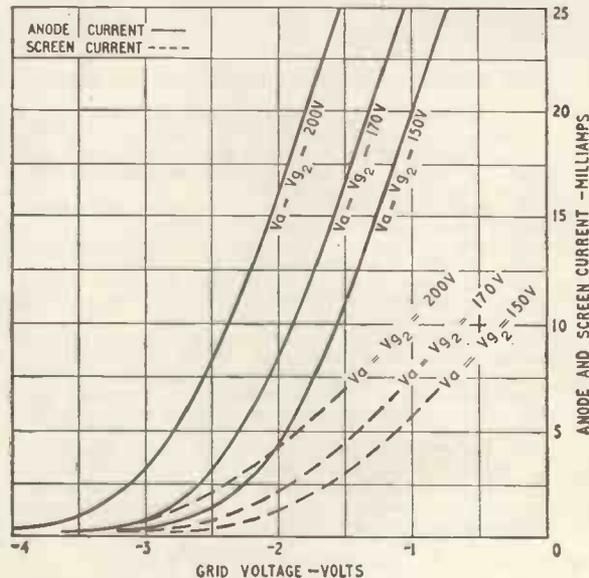
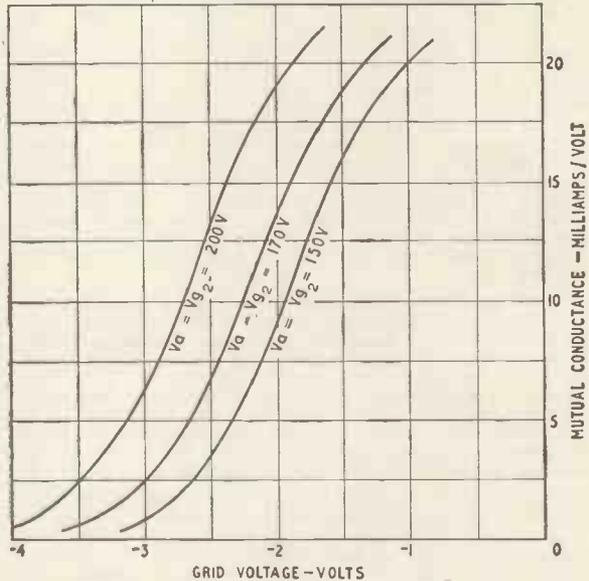


Maximum Dimensions (mm)

Overall Length	56
Seated Height	49
Diameter	22.2



Tentative Characteristic Curves of Ediswan Mazda Valve Type 6F24



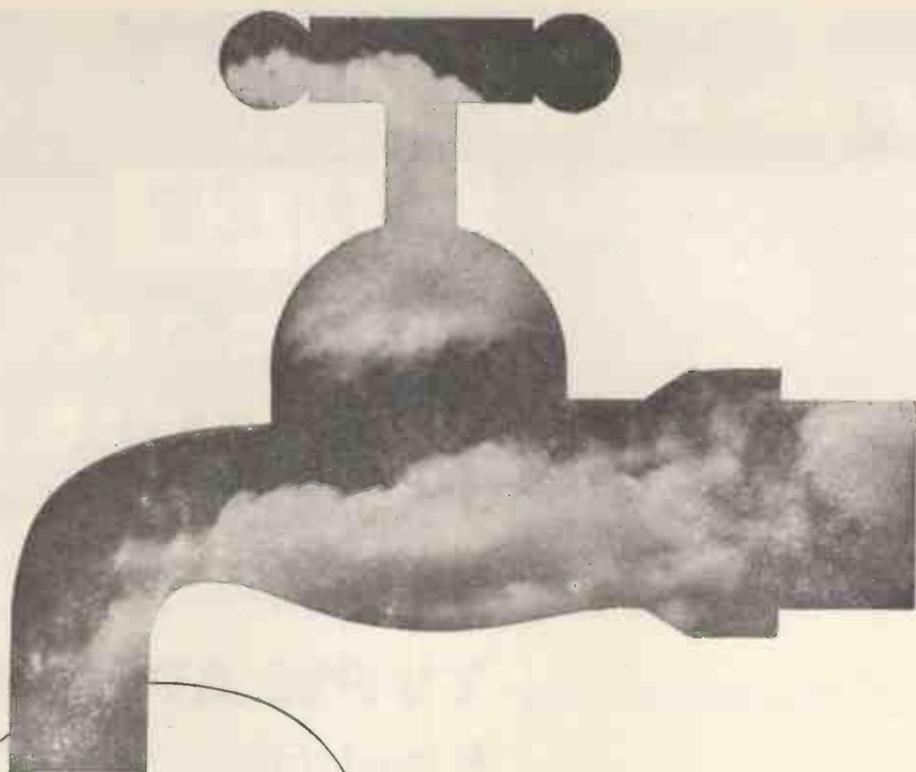
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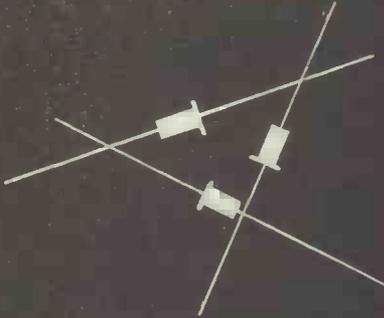


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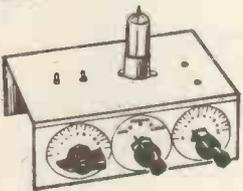
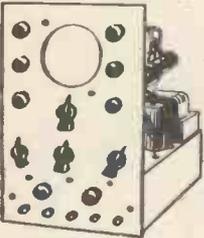
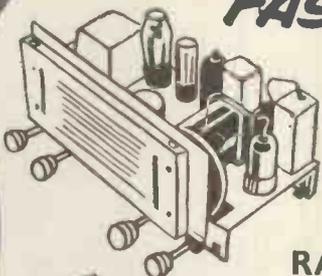
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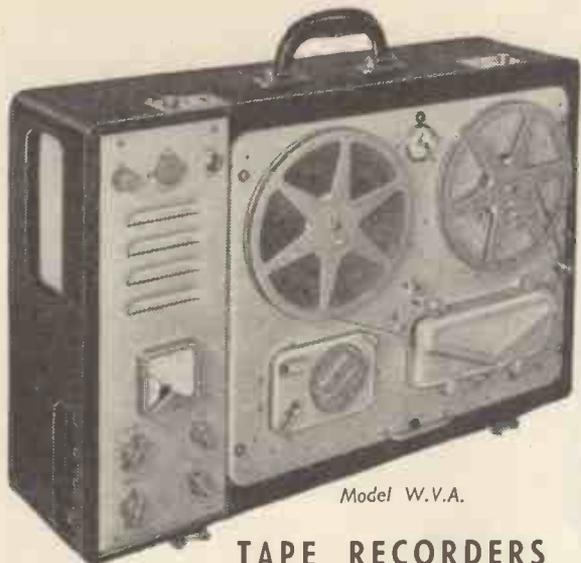
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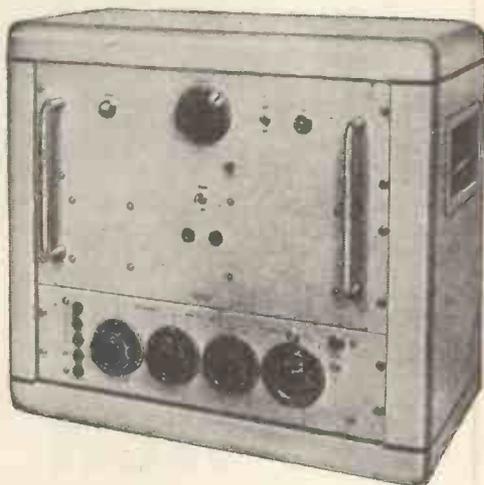
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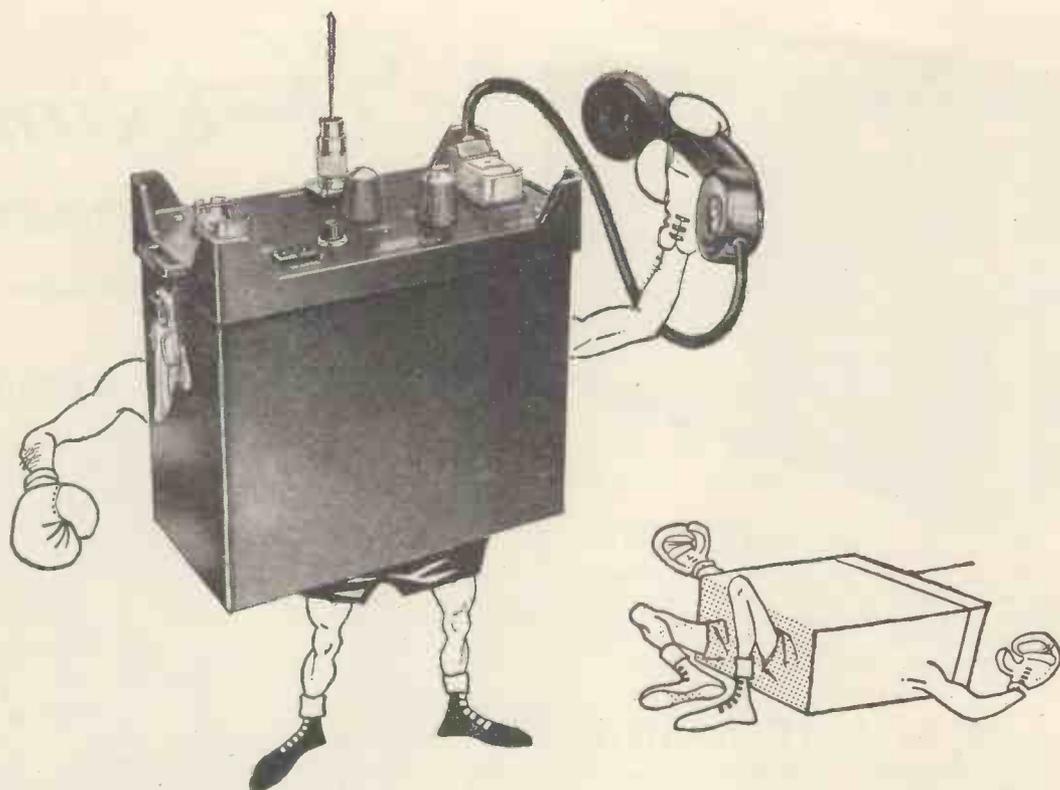
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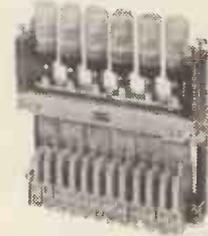
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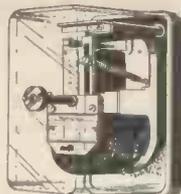
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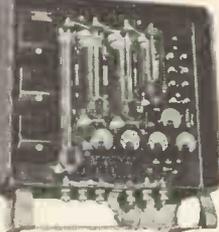
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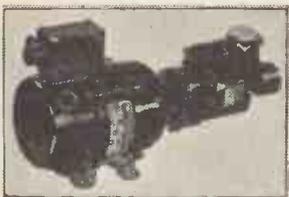


Type A. 500 w. 18 v.—contains three reverse current relays, one voltmeter rated 25 v. f.s.d., one main ammeter rated 40 amps. f.s.d., one secondary ammeter rated 15 amps. f.s.d. and two secondary meters rated 20 amps. f.s.d., one 2 ohm variable resistor, one 11 ohm variable resistor and two 1.2 ohm variable resistors. Complete in metal case 2ft. 6in. x 2ft. 8in. approx. Price £2/15/-, carriage and ins. 15/-.
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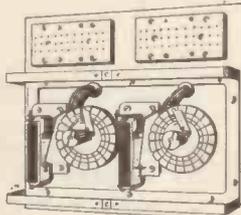
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R-1124A	76
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R-1082	A.S.B.-3
R-1355	Indicator 62A
B.C.1206-A/B	Indicator A.S.B.3
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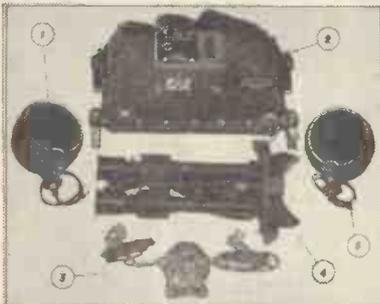
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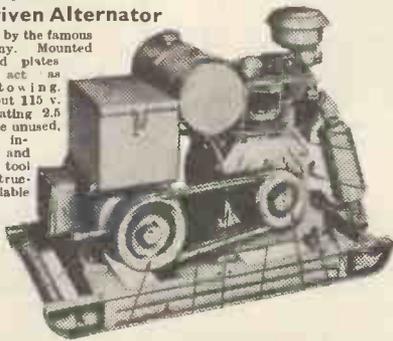


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For A.C. mains 200/250 v. Two speeds, 3½ and 1½ i.p.s. Fitted fully self-contained Amplifier and 7 x 4in. Speaker. In carrying case, 10½ x 9 x 6in., with detachable hinged lid. LISTED AT 29 Gns.
LASKY'S PRICE, including high quality crystal Microphone and one reel of Tape, Carr. & Insur., 15/- **17 Gns.**

"LINEAR" AMPLIFIERS

"DIATONIC" 10-14 watts 12 Gns.
"CONCHORD" 30 watt 15 Gns.
L45 4-5 watt Amplifier 25/19/6
LT45 Tape Deck Amplifier 12 Gns.
L50 50 watt Amplifier 19 Gns.
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L3/3 Stereo Amplifier 7 Gns.
All other types in stock.

**4-SPEED MIXER
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Brand new in maker's cartons
B.S.R. UA12. Wired for STEREO,
complete with stereo
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Model 121. Mk. II £10 10 0
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30-15,000 c.p.s.
Ideal for tape
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Desk Stand 1/6 extra

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RIBBON MIKE on table stand.
Famous make, high impedance.
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"ALFA" MULTI-RANGE. A.C.
and D.C. 3,333 ohms per volt.
Ohms ranges to 2 megs. Volts
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**BUILD THIS FINE 3-SPEED
TRANSISTOR RECORD PLAYER**

FOR **£9.19.6** Carr. 7/6

6-volt operation. For all L.P. and standard
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AMPLIFIER. 300 milliwatts output, using
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LOUDSPEAKER. 30 ohms, 7x4in.
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CARRYING CASE as illustrated, hand-
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**BUILD THE COSSOR
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**4-Transistor
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Uses 9 v. PP4 battery. Covers 190-550
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Originally nearly £20

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TRANSISTORS

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AUDIO, yellow/green spot, each 5/-.
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Suitable Output Transformer for above.
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LIST 9 GNS.

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FERRANTI 17in. type TR17/10, 6.3 v.
3 amp. heater. Brand new and unused
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17in. 90 degrees C.R. TUBES
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£8.19.6 (P. & P. 3/6)

D.C. Volts	A.C. Volts	D.C. Current	A.C. Current
150 mV.	7.5 V.	15 mA.	75 mA.
500 mV.	15 V.	30 mA.	150 mA.
1.5 V.	75 V.	150 mA.	750 mA.
3 V.	150 V.	300 mA.	1.5 Amps.
15 V.	300 V.	1.5 Amps.	7.5 Amps.
30 V.	600 V.	3 Amps.	15 Amps.
150 V.	750 V.	15 Amps.	
300 V.	1.5 KV.	30 Amps.	Resistance
750 V.			0-1000 ohms.
1.5 KV.			0-10 K ohms.

Thoroughly overhauled. Complete with batteries and instructions. An extremely robust meter at a very reasonable price.

SELENIUM BRIDGE RECTIFIERS. Funnel cooled. A.C. input 45 v. RMS. D.C. output 30 v. 10 amps. BRAND NEW. Boxed. 45/- Post 3/6.

MARCONI IMPEDANCE BRIDGE Type TF373. Measures, L, C & R at 1,000 cycles. Accuracy 1%. 0-100H; 0-100uF; 0-1MΩ each in 5 ranges. Power Factor and "Q." First-class condition, £35, carr. paid.

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AR88D MAINS TRANSFORMERS. Input 110-240 v. Output 345-0-345 v. 125 m/amps., 6.4 v., 4.5 amps., 5 v. 2 amps. 4 1/2 x 4 1/2 x 5 1/2 in. high. Wt. 12 lb. Potted. Tag ends. RCA BRAND NEW. Boxed. 29/6, post 3/6.

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SANGAMO-WESTON VOLTMETERS S61. Dual range 0-5 and 0-100 v. D.C. FSD 1 m/A. 3in. scale. Recent manufacture. Ideal for schools. Complete in super quality canvas carrying case, with test prods and leads. BRAND NEW. Boxed. 27/6. Post 2/6.

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Completely overhauled. In perfect working order. LOOK LIKE NEW. £21.
Later model with Noise Limiter, £25.
Carr. Eng. and Wales 30/- Send S.A.E. for full details.

RCA AR-88 SPEAKERS
A high quality 3 ohm unit fitted into heavy gauge black cracked steel cabinet, size 10 1/2 x 11 1/2 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. 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. 35/- OR less valves, 12/6. Post, either, 2/6.

LOUD Hailer EQUIPMENT
IDEAL FOR CROWD CONTROL, FACTORIES, FESTES, ETC. CONSISTS OF 4 SPEAKER UNITS AND CONTROL UNIT. COMPLETE WITH MICROPHONE, HEADPHONES AND SPARES. OPERATES FROM 12 VOLTS D.C. (OR 6 VOLTS D.C. WITH SLIGHTLY REDUCED OUTPUT), CONSUMING ONLY 3 AMPS. OUTPUT POWER 8 WATTS. ALL TESTED AND WORKING, BUT SLIGHTLY SOILED. A GENUINE BARGAIN. 24/19/6. CARRIAGE 25/6.

SIGNAL GENERATOR TYPE 54. Marconi 762A. Frequency 430 to 610 Mc/s. Square or Pulse Int. Mod., provision for Ext. Mod. Attenuation range +10 to -100 dB. Directly calibrated dials. As new, £35, carr. paid.

COMMUNICATIONS RECEIVERS R-1155B. A first class 10 valve Communication 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 re-aligned, and are in first class working order, ONLY £9/19/6.

A.C. MAINS POWER PACK OUTPUT STAGE. In handsome black-cracked 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 14 page illustrated booklet giving technical data and circuits etc. (FREE with each receiver.) Add 10/6 carriage for receiver, 5/- for power unit.

T.C.C. VISCONOL CONDENSERS. 8 mfd. 800 v. D.C. w/kg. at 71 deg. C. CP152V. Size 3 x 1 1/2 x 5in. high. BRAND NEW. Boxed. 8/6 each, post paid.

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Siemens High Speed, 1K+1KQ, 1 c/over 10/6

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Range	Type	Size	Price
25 Microamp.	D.C. M/C	2 1/2 in.	69/6
25 Microamp.	D.C. M/C	2 1/2 in.	59/6
50 Microamp.	D.C. M/C	3 1/2 in.	79/6
50 Microamp.	D.C. M/C	2 1/2 in.	59/6
100 Microamp.	D.C. M/C	3 1/2 in.	62/6
100 Microamp.	D.C. M/C	2 1/2 in.	42/6
1 Millamp.	D.C. M/C	3 1/2 in.	50/-
1 Millamp.	D.C. M/C	3 1/2 in.	69/6
200 Millamp.	D.C. M/C	2 1/2 in.	10/6
3 Amp.	Thermocouple	2in.	6/9
1 Amp.	Thermocouple	2in.	6/9
300 Volts	A.C. M/I	6in.	79/6
300 Volts	A.C. M/I	2 1/2 in.	25/-
500 Volts	A.C. M/I	2 1/2 in.	25/-
40 Amperes	D.C. M/C	2in.	7/8

LOUD RECTIFIERS. Full wave bridge. BRAND NEW. Salford 1 m/A. 8/6, 5 mA. 8/6. 8TC 2 mA. 5/6.

SIGNAL GENERATOR TF390G. These are complete with A.C. mains power pack and incorporate a 2 1/2 in. 50 microamp. meter for carrier level mounting. There are 4 ranges, 1.6-2.4 Mc/s., 8-16 Mc/s., 16-32 Mc/s., and 32-60 Mc/s. They are less their original calibration charts so guidance readings only are provided. In first class mechanical and working condition. £4/19/6. Carriage 10/6.

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This testmeter has exactly the same ranges as the Avo "D." The scale is even larger. Those we offer are in first class condition, completely overhauled and carefully tested prior to despatch. Complete with battery, test leads and instructions. £7/10/-, P. & P. 3/6.

ELECTROSTATIC METER. Dia. 6 1/2 in. reads 5-18.5 Kv. Manufactured 1953. Contained in wooden case 10 x 10 x 9 in. high. £9/19/6. Post paid.

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.

MARCONI TF987/I NOISE GENERATORS. Range 100 Kc/s. to 200 Mc/s. Determines noise factor of AM and FM receivers. Fully stabilised H.T. supply A.C. mains operation. Brand new and in original boxes. £15. Carr. 7/6.
MARCONI TF340 OUTPUT METERS. Perfect working order, £9/19/6. Carr. 7/6.

HEAVY DUTY SLIDER RESISTORS. 1.25Ω 20 A., 12/6, post 3/6. 1Ω 12 A., 8/6.
ZENITH ADJUSTABLE 25 Ω 4 A., 8/6. Post 2/6.

PRECISION RESISTORS. 1 Megohm. 1 1/2 watt wire wound, Ex-U.S.A. BRAND NEW. 10/6 per dozen.

D.C./A.C. CONVERTERS. Input 12 v. D.C. Output 230 v. 50 c/s. A.C. at 135 watts. Fitted with 0-300 v. A.C. 2 1/2 in. meter and slider resistor for voltage adjustment. In stout wooden carrying case with lid. Perfect working order. £9/19/6. Carr. 10/6.
24 v. Input 230 v. A.C. 50 c/s. 100 watts output. In grey metal case. BRAND NEW. 92/6. Carr. 7/6.

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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.
MIKE/HEADSET, all moving coil. As used on 19 set. BRAND NEW. 12/6. Post 2/-.

FERRANTI VOLTMETERS N5.
0-300 volts, 75-100 c/s. Moving iron, 6in. scale. Fl. mtg. Hermetically sealed, grade IN. Made 1955. BRAND NEW. Boxed. 79/6. Post 3/6.



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UNIVERSAL AVOMETER MODEL "D"

D.C. VOLTS	A.C. VOLTS	D.C. Current	A.C. Current
150 mv.	7.5 v.	15 ma.	75 ma.
300 mv.	15 v.	30 ma.	150 ma.
1.5 v.	75 v.	150 ma.	750 ma.
3 v.	150 v.	300 ma.	1.5 amp.
15 v.	300 v.	1.5 amp.	7.5 amp.
30 v.	600 v.	3 amp.	15 amp.
150 v.	750 v.	15 amp.	Resistance
300 v.	1,500 v.	30 amp.	1,000Ω
750 v.			10,000Ω
1,500 v.			



Supplied reconditioned as new, with internal battery, instructions and leads £8/19/6 each. P/P. 3/6.

WESTON MODEL 772 TESTMETER



A.C. VOLTS	D.C. CURRENT	A.C. CURRENT
2.5 v.	100 micro/a.	500 ma.
10 v.	1 ma.	1 amp.
50 v.	10 ma.	5 amp.
250 v.	50 ma.	RESISTANCE
1,000 v.	100 ma.	100 ohms
D.C. VOLTS	500 ma.	1,000 ohms
2.5 v.	OUTPUT METER	100k. ohms
10 v.		10 megohms
50 v.		
250 v.		
1,000 v.		

Supplied in perfect working order complete with internal batteries. £7/10/- P/P. 4/-.

BRAND NEW RCA EXTENSION LOUDSPEAKERS



Bin., 3 ohm Quality Speaker mounted in attractive black crackle case to match AR88 Receivers, etc.

45/- each. P/P 3/6.

8-RANGE SUB-STANDARD D.C. AMMETERS



Ranges 1.5, 3, 7, 15, 30, 60, 300 and 450 amps. Bin. mirror scale. Meter housed in polished teak case. Supplied complete with all shunts and leather carrying case. £15 each. P/P. 7/6.

FIELD TELEPHONES TYPE F. Generator

bell ringing. Supplied complete with batteries fully tested and complete with wooden carrying case 59/6 each. P/P. 3/6. 5/- pr.



PORTABLE PRECISION VOLTMETERS

Brand new instruments by famous manufacturer. In polished teak case. Moving iron instrument reading A.C. or D.C. volts on 2 ranges 0-160 v. or 0-320 v., Bin. mirror scale. Accuracy within 2%. £5/19/6 ea. P.P. 3/6.



METER BARGAINS

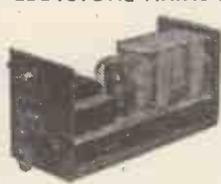
25 microamp D.C. M/C flush rd. 2 1/2 in.	69/6
25 microamp D.C. M/C. proj. rd. 2 1/2 in.	59/6
50 microamp D.C. M/C. proj. rd. 2 1/2 in.	49/6
100 microamp D.C. M/C. flush rd. 3 1/2 in.	62/6
500/0/500 microamp. D.C. M/C. proj. rd. 2 1/2 in.	19/6
1 milliamp D.C. M/C. flush eq. 2 in.	22/6
1 milliamp D.C. M/C. flush rd. 2 1/2 in.	25/-
1 milliamp D.C. M/C. flush rd. 3 1/2 in.	50/-
1 milliamp D.C. M/C. flush eq. 4 in.	69/6
200 milliamp D.C. M/C. flush rd. 2 1/2 in.	9/6
15 amp. D.C. M/C. Proj. rd. 2"	8/6
30 amp. D.C. M/C. flush rd. 2 1/2 in.	9/6
15 volt D.C. M/C. flush rd. 1 1/2 in.	10/6
120 volt D.C. M/C. flush rd. 3 1/2 in.	32/6
300 volt A.C. M/I. flush rd. 2 1/2 in.	25/-
300 volt A.C. M/I. rect. flush rd. 2 1/2 in.	25/-
500 volt A.C. M/I. flush rd. 2 1/2 in.	25/-

DON Mk. 5 FIELD TELEPHONES

Ideal for all inter-communication. Buzzer calling. Supplied fully tested, complete with batteries and instructions. 39/6 each, P/P. 3/6 ea., 5/- pr.



EDDYSTONE MAINS POWER PACKS



200/250 volts input. Output 175 volts 60 mA. and 12 volts 2.5 amps. Double choke and condenser smoothed. 5Z4 rectifier. Supplied as new and unused. 22/6 each. P/P. 3/6.

RCA PLATE TRANSFORMERS

Input 200/250 volts. Output 2,000/0/2,000 volts 500 mA. tapped 1,500/0/1,500 volts. Supplied brand new boxed, £6/10/- each. carriage 10/-.



BRAND NEW MEDRESCO HEARING AIDS



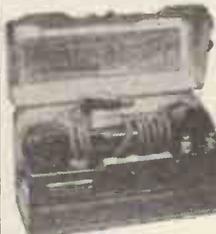
Fully tested, complete with earpiece, all necessary leads and battery pouch. Incorporates three sub-miniature valves and sensitive crystal microphone. Price only 32/6 each, plus 1/- P. & P. Batteries 5/- extra.

MARCONI TYPE TF340 OUTPUT POWER METERS



Meter calibration 50 MW/17DB F.S.D. Meter multipliers, 0.1-1-10-100. Impedance values, 25-30-40-50-60-80-100-125-150-200 ohms. Impedance multipliers, 0.1-1-10-100. Perfect condition. £9/19/6 each, 7/6 carriage.

FIELD TELEPHONES TYPE L. Generator



bell ringing. Light and very portable. Ideal for all installations. Supplied complete with batteries, fully tested. As new. 59/6 each. P/P. 3/- 5/- pr.

PARMEKO TABLE TOP TRANSFORMERS



Input 230 v. 50 c/s. Output 620/550/375/0/375/550/620 volts 250 mA. Also 2.5 v. 3 amp. windings. Size 6 1/2 x 6 1/2 x 5 1/2 in. Brand new only, 45/- each. P/P. 5/-.



COSSOR 339 DOUBLE BEAM OSCILLOSCOPES

Operation 110/200/250 volts A.C.
Ten position time base, 6 cps. to
250,000 cps. Amplifier 10 cps. to
2,000,000 cps. Perfect working order,

ONLY £15 EACH

Carriage 10/-.

G.E.C. SELECTEST MULTI-RANGE TESTMETERS



D.C. Volts	A.C. Volts	D.C. Current	A.C. Current
150 mv.	7.5 v.	15 ma.	75 ma.
300 mv.	15 v.	30 ma.	150 ma.
1.5 v.	75 v.	150 ma.	750 ma.
3 v.	150 v.	300 ma.	1.5 amp.
15 v.	300 v.	1.5 amp.	7.5 amp.
30 v.	600 v.	3 amp.	15 amp.
150 v.	750 v.	15 amp.	Resistance
300 v.	1,500 v.	30 amp.	1 K. ohm
750 v.	1,500 v.		10 K. ohm

Incorporated overload trip and special safety interlocking switches. Supplied in perfect condition with leads and battery at £7/10/- each. P/P. 3/6.

MARCONI TF410C VIDEO OSCILLATORS. Ranges 20 cps. to 30,000 cps. and 30 kc/s. to 5 Mc/s. Variable attenuator. 200/250 v. A.C. Reconditioned, perfect order, £35 each.

MARCONI TF-373 UNIVERSAL IMPEDANCE BRIDGE. Reconditioned to maker's spec. 1,000 c/s. Ranges: 100H, 100 mfd. 1 MEG. 100 Q. 200/250 v. A.C. operation. £35 each.

PADDED MOVING COIL HEADPHONES Good quality complete with moving coil hand mike. Brand new. 12/6 per set. P. & P. 2/-

PHOTO VOLTAGE AMPLIFIERS. These special units contain a 1 microamp. Tinsley mirror galvo and a double selenium photo cell. Brand new, £9/19/6 each. P/P. 7/6.

MARCONI TF-329 "Q" METERS. Range 0 to 500 Q. Frequency 50 kc/s. to 50 Mc/s. 200/250 volts A.C. operation. Reconditioned to maker's spec. £65 each.

MARCONI TF-428 B/I. VALVE VOLT-METERS 5 ranges A.C. and D.C. 1.5, 5, 15, 50 and 150 volts. Complete with internal H.F. probe. Operation 200/250 volts A.C. Brand new, £17/10/- each. P/P. 10/-.

AMERICAN SUPER LIGHTWEIGHT HEADSETS. Res. 50 ohms. Brand new, 15/- P/P. 1/6.

SOUND-POWERED TELEPHONE HANDSETS. No batteries required. 15/- each. P/P. 1/6.

LEACH 12 VOLT AERIAL C/OVER RELAYS. Double pole, 7/6 each. P/P. 9d.

MUIRHEAD PRECISION STUD SWITCHES. 4 bank, 4 pole. 24 positions. New, boxed, 17/6 each. P/P. 1/3.

CR.100 SPARES KITS. Contains 15 valves, resistors, pots, condensers, output trans., etc All brand new, 59/6 set. P/P. 3/6.

24 AMP. VARIAC TRANSFORMERS. 230 v. input. Variable output 185 to 250 volts. Can be used reversely giving 230 volts out with variable input. £12/10/- P/P. 10/-.

24 VOLT ROTARY CONVERTERS

Input 24 volts D.C.
Output 230 volts
A.C. 50 cycles, 100
watts. Housed in
metal carrying
case with Inlet/
outlet plugs.
Brand new, 92/6
each. P/P. 7/6.



R.1155 RECEIVERS

Standard Model B with improved geared drive, perfect order, £8/19/6 each, 7/6 P/P. Trawler Band Model L or N, £12/19/6 each. P/P. 7/6. Combined Power Pack and Audio Output Stage suit either model, 85/- extra.

MINE DETECTORS No. 4a

Complete equipment comprises Search Head, Amplifier Headset, Control Box, Telescopic Rods for Search Head, Search Head Test Unit and Test Depth Measure and Haversack. Operation is from a standard 60 v./1.5 v. combined dry battery. The unit will detect ferrous or non-ferrous metals to a depth of 24in. giving maximum signal but can be used at greater depths giving lower output. Ideal for tracing underground pipes or cables and any hidden metallic objects. Complete equipment supplied brand new in original transit cases complete with circuit and operating instructions.



PRICE
99/6 EACH

Carriage 10/6.

1,000 WATT MAINS ISOLATION TRANSFORMERS. 230 to 230 volts. Heavy duty, ex-Admiralty. New, boxed, £5 each. P/P. 10/-.

750 WATT AUTO TRANSFORMERS. Tapped from 110 to 230 volts. Fine heavy duty type, 69/6 each. P/P. 5/-.

AR.88 WAVECHANGE SWITCH ASSEMBLY. Brand new with screens, 17/6 each. P/P. 2/6.

MARCONI TF-517 SIGNAL GENERATORS. 10-18 Mc/s; 33-58 Mc/s; 150-300 Mc/s. 200/250 v. A.C. operation. 65/- each. FOR CALLERS ONLY.

ROTARY CONVERTERS

12 v. D.C. input
230 volt A.C. 150
watts 50 cycles output.
Housed in wooden
case and fitted with
voltage control slider
resistance switch, plugs
and A.C. mains volt-
age output check
meter. Supplied in
perfect condition, individually tested £9/19/6
each. P/P. 10/-.



EC 221 HETERODYNE FREQUENCY METERS

125 kc/s to 20 mc/s

Complete with all valves,
crystal, headset and in-
struction book, but less
calibration charts. 100%
condition.

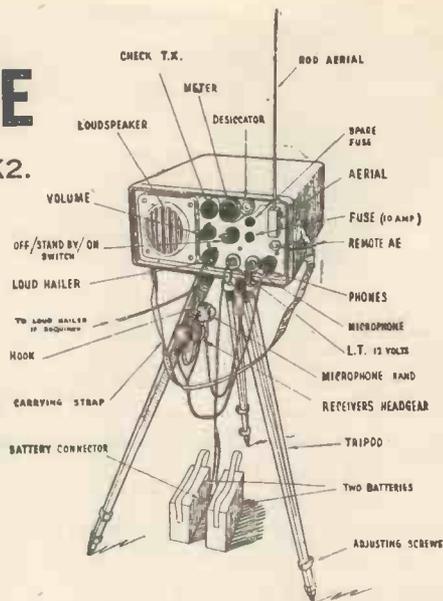
SPECIAL
PRICE **£14-10-0**
each
Carriage 7/6 extra.



Portable/Mobile

V.H.F RADIO TELEPHONE

TYPE W.S B44 MK2.



EXPORT ONLY

CRYSTAL CONTROLLED 60-95mc/s.

A modern 14-valve superhet receiver and AM transmitter using current series of B7g valves. Valve line-up: 2-CV136/7D9, 1-CV137/EAC91, 7-CV138/EF91, 4-CV416/6F17. Robust cast aluminium case includes 5in. loudspeaker. Internal vibrator pack (synchronous type) provides operation from 12-volt accumulators or vehicle or boat 12-volt supply, in fixed or mobile use. Available, less crystals and accessories, but with connecting plugs, ex-stock. Accessories and crystals for specified frequencies in the range 60-95 Mc/s can be supplied to order at extra cost.

Each unit is fully tested and in good condition. Price (including packing FOB London), £20 each. Special quotation for quantities up to 500 sets.

50 MICRO AMP MOVING COIL METERS*(Brand New & Boxed)*

Made on Government Contract by Famous British Maker

3½ in. Square—800 ohms resistance. 4 Scales operated by lever "Set-zero"—"0-3"—"0-30"—"0-300." Easily coupled to rotary range switch by cord or lever. Ideally suitable for transistor tester, output meter, volt-milliammeter.

A RANGE OF METER BOXES

Completely finished and enamelled, with all screws, sockets, etc., designed to take one or two meters and with provision for controls, caters for all kinds of applications of this meter.

Boxes to take one Meter, small 5/6, medium 7/6, large 10/6. Two Meters, small 9/6, large 15/6.

Circuits for many applications—free.



Complete with data and circuits

ONE METER **19'6** (plus post. 6d in U.K.)TWO METERS **35'-** (plus post. 1/- in U.K.)

TEST GEAR COMPONENTS (LONDON) LTD
15 ARCANY ROAD, SOUTH OCKENDON, ESSEX TEL: SOUTH OCKENDON 2610

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..... **£41.0.0**
H.P. Terms: Deposit £8/4/- and 12 months of £3/0/2.
- MODEL CR3/T. Incorporates the very popular 3-speed COLLARO Mk. IV "TRANSCRIBTOR" Deck, which has both upper and lower tape tracks..... **£49.10.0**
H.P. Terms: Deposit £9/18/- and 12 months of £3/12/7.
- 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 £3/12/7.

and NOW — WE INTRODUCE

TWO UNITS METICULOUSLY MATCHED TO CORRECTLY OPERATE

THE NEW GARRARD "MAGAZINE" TAPE DECK

- MODEL HF/G2P TAPE PREAMPLIFIER
- MODEL HF/G2A TAPE AMPLIFIER



Model HF/GR2

Based on the very successful MULLARD tape DESIGNS, incorporating only HIGH GRADE COMPONENTS and MULLARD VALVES.



Model HF/G2A-D

WE OFFER AS FOLLOWS:

- (a) MODEL HF/G2R PORTABLE TAPE RECORDER. Includes microphone, spool of L.P. tape and crystal H.P. TERMS: Deposit £6/12/-, 12 monthly payments £2/8/5. **£33.0.0**
- (b) MODEL HF/G2A/D, comprising AMPLIFIER and TAPE DECK. Includes spool of L.P. tape and loudspeaker. H.P. TERMS: Deposit £5/10/-, 12 monthly payments £2/0/4. **£27.10.0**
- (c) ASSEMBLED and TESTED AMPLIFIER MODEL HF/G2A. H.P. TERMS: Deposit £3, 12 monthly payments £1/2/-. **£15.0.0**
- (d) MODEL HF/G2PP PORTABLE PREAMPLIFIER. Complete in portable case (like HF/G2R). H.P. TERMS: Deposit £6, 12 monthly payments £2/14/-. **£30.0.0**
- (e) MODEL HF/G2P-D comprising PREAMPLIFIER and TAPE DECK. Includes spool of L.P. tape. H.P. TERMS: Deposit £5/4/-, 12 monthly payments £1/18/2. **£26.0.0**
- (f) ASSEMBLED & TESTED PREAMPLIFIER MODEL HF/G2P. H.P. TERMS: Deposit £2/16/-, 12 monthly payments £1/0/6. **£14.0.0**

Both Units form an entirely new "Easy to handle" presentation, each is completely self contained with power supply, Loudspeaker (Amplifier HF/G2A only) and all INPUT and OUTPUT sockets being incorporated on the chassis, which itself is constructed to allow for direct attachment to the tape deck (as shown in illustration). Thus the tape deck with the Amplifier (or Preamplifier) fixed to it form ONE COMPLETELY SELF-CONTAINED WORKING UNIT which requires only screwing into a Cabinet and Connecting to the Mains supply.

Model HF/G2A Amplifier

- A Complete Tape Amplifier—Incorporating . . .
- Magic Eye Level Indicator
- Volume Control.
- Superimpose Switch.
- Effective Tone Control.
- Monitoring Facilities.
- Extension Loudspeaker Socket.
- Inputs for recording from Mike, Gram. and Radio Tuner.
- Incorporates Loudspeaker and Power Supply on Chassis.

Model HF/G2P Preamplifier

Forms the Ideal "Link" to add High Quality Tape Recording facilities to existing Audio Installations, such as our MULLARD RANGE of Amplifiers and also admirably suitable to operate through the Pick-up Sockets of most Radio Receivers.

It incorporates:

- Magic Eye Level Indicator and Control.
- Superimpose Switch.
- Inputs for recording from Mike, Gram. and Radio.

BOTH UNITS CARRY MESSRS. GARRARD'S FULL RECOMMENDATION.

*As is usual with GARRARD products this Tape Deck is a Precision Engineered Unit of Excellent quality operating two tracks at 3 1/2 in./sec. speed. It is the "Easiest to Handle" Tape Deck, having only two controls and incorporates the new instantaneous Tape loading Magazine which makes tape loading as simple as putting on a Record.

!! RADIOGRAM CHASSIS !!

- ARMSTRONG MODEL A F 208. Complete AM/FM chassis. Separate Bass and Treble controls. **£23.2.0**
- ARMSTRONG "STEREO" TWELVE. The most complete AM/FM stereo chassis yet produced. **£37.16.0**
- ARMSTRONG "JUBILEE". An AM/FM chassis with nine valves and with push-pull output stage providing 6 watts. **£29.8.0**
- ARMSTRONG AM/FM "STEREO 44". Provision is made for Stereo and Monaural playback from pick-up or **£28.7.0**

RADIO TUNING UNITS

- The JASON "MERCURY" Mk. II Switched FM Tuner. Choice of 4 stations plus I.T.V. and B.B.C. T.V. sound transmissions. PRICES: KIT OF PARTS £10/10/- ASSEMBLED..... **£14.10.0**
 - DULCI MODEL FMT/2. A complete self-powered FM Tuner incorporating auto. freq. control. **£24.13.4**
 - ARMSTRONG "S.T.3." AM/FM Tuning Units. A self-powered tuner covering VHF, medium and long wavebands with automatic frequency control on VHF. **£27.6.0**
 - DULCI "B4/T" AM/FM Tuning Units. A 4-waveband self-powered tuner covering the FM transmission plus the long, medium and short wavebands. **£25.15.2**
- NEW HIRE PURCHASE TERMS are available on all above. Illustrated leaflets available—send S.A.E. (Carr. and Ins. 5/- extra).

STERN'S MK. II "fidelity" F.M. TUNING UNIT

(Plus 5/- carr. and ins.) **£14.5.0**
HIRE PURCHASE: Deposit PRICE £2/17/- and 12 months at £1/0/11. Incorporates the latest MULLARD PERMEABILITY TUNING HEART and the corresponding MULLARD VALVE LINE UP comprising EOC85, 2 type EF85s (or EF89s), EM54, Tuning Indicator, plus 2 type C.A. 79 Germanium Diodes. A really first-class Tuner very attractively presented and comparable to many offered at much higher prices. Power consumption is only 1.5 amps at 6.3 volts and 25 m.a. at 250 volts.



THE "ADD-A-DECK"

incorporating the NEW B.S.R. "MONARDECK" and MATCHED PREAMPLIFIER **£17.17.0** Deposit £3/12/-, 12 months £1/6/2 (plus 7/6 carr. and ins.)
Designed to operate through the Pick-up Sockets of the standard RADIO RECEIVER through which first-class results are obtained. It consists of a single speed Twin Track Tape Deck, incorporating matched Preamplifier, and operates at 3 1/2 in./sec. speed. It uses Sin. Tape Spools, thus providing up to 1 1/2 hours' playing time on L.P. Tapes or 1 hour on the standard 6 in. Tape Spools.
The equipment is supplied fully tested and completely assembled on an attractive wood plinth. It can therefore be "dropped" directly into an existing cabinet and only requires connections to the mains supply and the Pick-up Sockets, for which purposes "floating" leads are incorporated on the Preamplifier.



STERN'S 12 VOLT CAR RADIO

incorporating PRINTED CIRCUIT and POWER TRANSISTOR **£15.0.0**
A versatile design covering both LONG and MEDIUM WAVEBANDS, incorporating Transistor Output thus having very low battery consumption. Is operated direct off 12 volt car battery. We offer it on the UNIT ASSEMBLY BASIS . . . consisting of THREE SEPARATE, FULLY WIRED, ALIGNED AND TESTED UNITS ALL FOR Only 12 solder joints are required to finish the complete receiver.
Send 1/6 for manual containing complete data.



! HOME CONSTRUCTORS

YOU CAN BUILD THIS TUNING UNIT FOR ONLY **£10.10.0** (Plus 5/- carr. and ins.)
Send S.A.E. for descriptive leaflet, or Assembly Manual for 1/6.

Stern's "fidelity" TAPE EQUIPMENT

A SELECTION OF HIGH FIDELITY PORTABLE TAPE PRE-AMPLIFIERS

Adds "Hi-Fi" Tape Recording to your existing Audio Installation.

IN ALL MODELS WE INCORPORATE THE TYPE "C" PRE-AMPLIFIER

and offer it complete in portable case with...

- (a) The new "COLLARO" STUDIO 3 speed Deck. Deposit: £7/6/-, 12 months £2/13/6. **£36.10.0**
- (b) The COLLARO Mk. IV "Transcriptor" 3 Speed Deck. Deposit: £8/6/-, 12 months £3/0/11. **£41.10.0**
- (c) The new TRUVOX Mk. VI Tape Deck. Deposit: £8/14/-, 12 months £3/3/10. **£43.10.0**
- (d) The BRENNEL Mk. V 3 Speed Deck. Deposit: £10/6/-, 12 months £3/15/7. **£51.10.0**
- (e) The WEARITE MODEL 4A Tape Deck. Deposit: £12/4/-, 12 months £4/9/5. **£61.0.0**

STERN'S MULLARD TYPE "C" TAPE PRE-AMPLIFIER—ERASE UNIT

INCORPORATING THE NEW FERROXCUBE POT CORE PUSH-PULL OSCILLATOR and 3 SPEED TREBLE EQUALISATION by means of the latest FERROXCUBE POT CORE INDUCTOR.

PRICES INCLUDING SEPARATE SMALL POWER SUPPLY UNIT COMPLETE KIT **£14.0.0** ASSEMBLED AND TESTED **£17.0.0** OF PARTS

Deposit £3/8/- and 12 months of £1/4/11. Assembled unit only. ALSO AVAILABLE EXCLUDING POWER SUPPLY UNIT FOR

£11.15.0 and **£14.10.0** respectively. (Carr. and Ins. 5/- extra) Send S.A.E. for leaflet or 2/6 for Complete Assembly Manual. WHEN ORDERING PLEASE STATE MAKE OF TAPE DECK TO BE USED We present this "Hi-Fi" Pre-amplifier strictly to Mullard's specification etc., incorporating ONLY NEW HIGH GRADE COMPONENTS and the SPECIFIED NEW MULLARD VALVES. It comprises a COMPLETELY SELF-CONTAINED UNIT, all components and valves being contained in a well ventilated Box—Chassis neatly finished in Hammered gold with a very attractively engraved PERSPEX FRONT PANEL.

FOR PERMANENT HIGH FIDELITY INSTALLATIONS

WE ALSO OFFER (excluding Case) the following

- (a) The COLLARO "STUDIO" TAPE DECK and our Mullard Type "C" PE-AMPLIFIER and Power Unit Assembled and Tested. H.P. Terms: Deposit £6/10/- and 12 months at £2/7/8. **£32.10.0**
- (b) As above but TYPE "C" PRE-AMPLIFIER supplied as complete Kit of Parts. **£29.0.0**
- (c) The COLLARO Mk. IV TAPE DECK and the MULLARD Type "C" Pre-amplifier and Power Unit assembled, tested. H.P. Deposit £7 and 12 months £2/11/4. **£35.0.0**
- (d) As in (a) 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. H.P. Deposit £8 and 12 months £2/18/8. **£40.0.0**
- (f) As above but the Type "C" supplied as complete KIT OF PARTS. **£36.10.0**
- (g) The BRENNEL Mk. V Deck and the assembled Type "C" PRE-AMPLIFIER and POWER UNIT. **£46.0.0**
- (h) As above, but the Type "C" supplied as complete KIT OF PARTS. **£43.0.0**
- (i) The WEARITE 4A DECK with Type "C" assembled and tested. H.P. Deposit £11/4/- and 12 months £4/2/1. **£56.0.0**

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

STERN RADIO LTD.
DEPT. W 109 FLEET ST., LONDON, E.C.4
Telephone: FLEET STREET 5812/3/4

THE FINEST RANGE OF TAPE EQUIPMENT FOR THE HOME CONSTRUCTOR

YOU CAN BUILD A COMPLETE HIGH QUALITY TAPE RECORDER for **£36.0.0**

H.P. TERMS... Deposit £7/4/-, 12 months £2/12/10

FOR THIS WE SUPPLY—

COMPLETE KIT OF PARTS TO BUILD THE HF/TR3 TAPE AMPLIFIER.

THE NEW COLLARO "STUDIO" TAPE DECK, PORTABLE CARRYING CASE (as illustrated).

ROLA/CELESTION 10in. x 6in. P.M. LOUDSPEAKER. ACOS CRYSTAL MICROPHONE 1200ft. SPOOL E.M.I. TAPE.

Alternatively for those who prefer another type of TAPE DECK we will supply precisely as above—but IN PLACE of the COLLARO "STUDIO" DECK—WE INCLUDE—

- (a) The Mk. IV COLLARO "TRANSCRIPTOR" DECK ... H.P. TERMS... Deposit £8, 12 monthly payments of £2/18/2 (£1 extra if we are required to wire up the Transcriptor Switch Banks). **£39.15.0**
 - (b) The new TRUVOX Mk. VI DECK. H.P. Terms: Deposit £9, 12 months of £3/6/- (Carr. and Ins. on all above is 12/6 extra). **£45.0.0**
- For constructors with their own Cabinet—WE OFFER—
- (a) COMPLETE KIT to build the HF/TR3 Amplifier, together with the COLLARO "STUDIO" DECK. **£28.0.0**
 - (b) As above but HF/TR3 ASSEMBLED and TESTED. H.P. TERMS: Deposit £6/6/-, 12 months of £2/6/2. **£31.10.0**
 - (c) COMPLETE KIT to build the HF/TR3 together with the Mk. IV COLLARO "TRANSCRIPTOR" DECK (£1 extra if we are required to wire up Deck Banks) **£30.15.0**
 - (d) As above but HF/TR3 ASSEMBLED and TESTED. H.P. Terms: Deposit £7, 12 months at £2/10/5. (£1 extra if we are to wire up Deck Switch Banks) **£34.10.0**
 - (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 BRENNEL 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. H.P. Terms: Deposit £11, 12 months of £4/0/8. (Carriage and Insurance on each above is 10/- extra). **£55.0.0**

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 1200ft. SPOOL E.M.I. TAPE—ALL FOR **£9.0.0** (Carriage and Insurance 5/- extra).

WE HAVE THE NEW 2-SPEED TWIN TRACK TRUVOX Mk. VI Tape Deck in stock **£26.5.0** Deposit £5/5/- 12 months £1/18/8 It incorporates PRECISION REV. COUNTER and PAUSE CONTROL and fully maintains the general high standard of all Truvox equipment. The very popular COLLARO Tape Decks and the BRENNEL Mk. V Decks are also available.

THE MODEL HF/TR3 TAPE AMPLIFIER

Incorporating 3-SPEED TREBLEEQUALISATION by means of the latest FERROXCUBE POT CORE INDUCTOR PRICE FOR COMPLETE KIT OF PARTS FULLY ASSEMBLED AND TESTED **£12/15/-** **£16/10/-**

HIRE PURCHASE: Deposit £3/6/6 and 12 months at £1/4/2. A very high quality amplifier based on the very successful Type "A" design, completed in the MULLARD LABORATORIES. ONLY NEW HIGH-GRADE COMPONENTS are incorporated including MULLARD VALVES and a GILSON OUTPUT TRANSFORMER... other features are: Magic Eye Recording Head Indicator—Effective Tone Control—Monitoring and Extension Speaker Sockets—has own Power Supply and can be used as independent Amplifier for direct reproduction of Gram. Records or from Radic Tuner. Overall size 11 x 6 x 6in.—Truvox—Collaro—Brenell—please specify which Send S.A.E. for leaflet or 2/6 for Assembly Manual.



PLEASE ENCLOSE S.A.E. WITH ALL CORRESPONDENCE

STERN'S MULLARD DESIGNS

COMPLETE KIT OF PARTS

Designed by MULLARD—presented by STERNS strictly to specification

MULLARD "5-10" MAIN AMPLIFIER

For use with the MULLARD 2-stage pre-amplifier with which an undistorted power output of up to 10 watts is obtained. We supply SPECIFIED COMPONENTS AND NEW MULLARD VALVES including PARMEKO MAINS TRANSFORMER and choice of the latest Ultra-linear PARMEKO or the PARTRIDGE Output Transformer.

Price: COMPLETE KIT (Parmeko Output Trans.)..... **£10.00**

Alternatively we supply ASSEMBLED AND TESTED **£11.10**
ABOVE INCORPORATING PARTRIDGE OUTPUT TRANSFORMER £11/4/- extra.

MULLARD'S PRE-AMPLIFIER TONE CONTROL UNIT

Employing two EF86 valves and designed to operate with the Mullard MAIN AMPLIFIER, but also perfectly suitable for other makes. Specified strictly to MULLARD SPECIFICATION and incorporating:
● Equalisation for the latest R.I.A.A. characteristics.
● Input for Crystal Pick-ups and variable reluctance magnetic types.
● Input (a) Direct / from High Imp. Tape Head. (b) From a Tape Amplifier or Pre-Amplifier.
● Sensitive Microphone Channel

Price: COMPLETE KIT OF PARTS **£6.60** Alternatively we supply ASSEMBLED AND TESTED **£8.00**



COMPLETE MULLARD 5-10 AMPLIFIER

The popular and very successful complete "5-10" incorporating Control Unit providing up to 10 watts high quality reproduction. Specified components and new MULLARD VALVES are supplied including PARMEKO MAINS TRANSFORMERS and choice of the latest PARMEKO or PARTRIDGE ULTRA Linear Output Transformers.

Price: COMPLETE KIT, Parmeko Transformer..... **£11.10**

Alternatively we supply ASSEMBLED AND TESTED **£13.10**

Hire Purchase (Assembled Amp. only). Deposit £2/14/-, 12 months at 19/10. ABOVE incorporating PARTRIDGE OUTPUT TRANSFORMER £11/6/- extra.

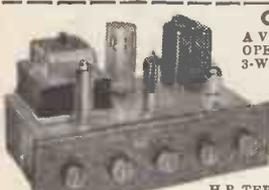


COMPLETE MULLARD 3-3

A VERY HIGH QUALITY AMPLIFIER DEVELOPED FROM THE VERY POPULAR 3-VALVE 3-WATT AMPLIFIER DESIGNED IN THE MULLARD LABORATORIES.

Price for COMPLETE KIT OF PARTS..... **£7.10**
(Plus 6/6 carriage and insurance). Alternatively supplied ASSEMBLED AND FULLY TESTED (Plus 6/6 carriage and insurance)..... **£8.19.6**

H.P. TERMS: Deposit £2 and 8 monthly payments of £1.



Our kit is complete to the MULLARD specification including supply of specified components, valves and PARMEKO OUTPUT TRANSFORMER. We also include switched inputs for 78 and L.P. records plus a Radio position. Extra power to drive a Radio Tuning Unit is also available.

COMPLETE STEREO AMPLIFIER

A thoroughly recommended design that very effectively meets the many requests for a low priced but good quality DUAL CHANNEL STEREO PHONIC AMPLIFIER.

Price: COMPLETE KIT OF PARTS **£8.10.0**

Alternatively ASSEMBLED AND TESTED..... **£10.10.0**

Two Mullard ECL82 Triode Pentode Valves are incorporated in the design, they form a "CLASS A" single ended output stage in each channel. The input sensitivity is 300 mV/mts, therefore when used with most STEREO Crystal Pick-ups, or Radio Tuning Units, an output of 2 watts per channel is achieved, or similarly when switched to MONAURAL Pick-up position a combined output of 4 watts is produced.



SPECIAL CASH ONLY OFFER !!

This very attractive PORTABLE AMPLIFIER CASE together with a good quality GRAM AMPLIFIER and a matched P.M. SPEAKER. ALL FOR ONLY **£8.7.6** (plus 7/6 carr. and ins.). The Amplifier consists of a 2-stage design incorporating the 3 modern 6V4 valves and has separate BASS and TREBLE CONTROLS. The Portable Case will also accommodate almost any make of Autochanger and is attractively finished in Grey Colour Resin—WE ALSO SUPPLY SEPARATELY:—

(a) The 2-stage (plus Rectifier) AMPLIFIER **£4 2 6**

(b) The PORTABLE CARRYING CASE **£3 17 6**

(c) 6in. P.M. SPEAKER..... **£3 18 6** (Carriage and Insurance 4/- extra).



"Hi-Fi" LOUDSPEAKERS

WE HAVE IN STOCK A COMPLETE RANGE BY GOODMAN'S WHARFEDALE W. B. STENTORIAN

ILLUSTRATED AND PRICED LEAFLETS ON REQUEST

!! HOME CONSTRUCTORS !!

A RANGE OF "EASY TO ASSEMBLE" PREFABRICATED CABINETS Designed by the W.B. "STENTORIAN" COMPANY for "Hi-Fi" Loudspeaker systems or to accommodate high quality equipment. The acoustically designed Bass Reflex Cabinets containing the very successful "Stentorian" Speakers give really first-class reproduction and are well recommended. Models are also available to accommodate high-quality Amplifiers, Pre-amplifiers, Tuning Units, Record Players, etc. All models are very easily assembled, in fact only a screwdriver is required. Fully illustrated leaflets are available including complete specifications of the various STENTORIAN LOUDSPEAKERS. Please enclose S.A.E.

Please enclose S.A.E. IF ILLUSTRATED AND DESCRIPTIVE LEAFLETS are required. . . . alternatively the COMPLETE ASSEMBLY MANUALS containing component Price List and practical Drawings, etc., are available at 1/6 each.

SPECIAL PRICE REDUCTIONS

(c) The COMPLETE KIT OF PARTS to build both the "5-10" Main Amplifier and the 2-Stage Pre-Amplifier Control Unit..... **£15.15.0**

(d) The "5-10" and the 2-Stage Pre-Amplifier both Assembled and Tested..... **£18.18.0**
H.P. TERMS: Deposit £3/16/- and 12 months of £1/7/8.

(e) The COMPLETE KIT OF PARTS to build the Dual Channel "3-3" Amplifier and the Dual Channel Pre-Amplifier Control Unit..... **£21.10.0**

(f) The Dual Channel "3-3" Amplifier and the Dual Channel Pre-Amplifier Control Unit both Assembled and Tested..... **£25.0.0**
H.P. TERMS: Deposit £5 and 12 months of £1/16/8.

(g) The COMPLETE KIT OF PARTS to build one "5-10" Main Amplifier (Parmeko Transformer) and the Dual Channel Pre-Amplifier Control Unit..... **£21.10.0**

(h) One "5-10" Amplifier (Parmeko Transformer) and the Dual Channel Pre-Amplifier both Assembled and Tested..... **£25.0.0**
H.P. TERMS: Deposit £5 and 12 months of £1/16/8.

(i) COMPLETE KIT OF PARTS to build two "5-10" Main Amplifiers (incorporating Parmeko Output Transformers) and the Dual Channel Pre-Amplifier Control Unit..... **£31.0.0**

(j) Two "5-10" Amplifiers (Parmeko Output Transformers) and the Dual Channel Pre-Amplifier Control Unit both Assembled and Tested..... **£36.0.0**

H.P. TERMS: Deposit £7/4/- and 12 months of £2/12/- Carriage and Insurance 7/6 extra.

Prices quoted are subject to £1/6/- extra for Partridge Trans.

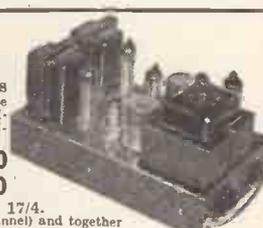
STEREO

3-3 MAIN AMPLIFIER

Comprises two "3-3" MAIN AMPLIFIERS on one chassis and is designed to operate with our DUAL CHANNEL PRE-AMPLIFIER for both STEREO PHONIC or MONAURAL operation.

Price: COMPLETE KIT OF PARTS..... **£10.0.0**
Alternatively ASSEMBLED AND TESTED..... **£11.15.0**

H.P. Terms: Deposit £2/7/-, 12 months at 17/4. Its output power is 6 watts (3 watts per channel) and together with our PRE-AMPLIFIER provides a first-class STEREO installation.



STEREO DUAL CHANNEL PRE-AMPLIFIER

This model incorporates two 2-valve Pre-Amplifiers (described above) combined into a Single Unit enabling it to be used for both STEREO PHONIC and MONAURAL operation. It is designed primarily to operate with our range of MULLARD MAIN AMPLIFIERS but will also operate equally well with any make of Amplifiers requiring an input of 250 mV.

Price: COMPLETE KIT OF PARTS..... **£12.10.0** Alternatively ASSEMBLED AND TESTED..... **£15.0.0**

H.P. Terms: £3 Deposit and 12 months of £1/2/- Perfectly suitable for MONAURAL only operation, with one "3-3" or one "5-10" MAIN Amplifier to which the second Main Amplifier can at any time be added thus very easily providing for both STEREO or MONAURAL reproduction.

Recommended combination for STEREO operation.

(a) The DUAL CHANNEL PRE-AMPLIFIER together with the Dual "3-3" MAIN AMPLIFIER.

(b) The DUAL CHANNEL PRE-AMPLIFIER together with two "5-10" MAIN AMPLIFIERS. Assembly Manual is available for 3/- or send S.A.E. for Descriptive Leaflet. When ordering please advise MAKE and MODEL OF AMPLIFIER in use.



!! RECORD PLAYERS !!

The LATEST MODELS are in Stock. Many at REDUCED PRICES!!!

Send S.A.E. for ILLUSTRATED LEAFLET

B.S.R. MONARCH UA8 4-spd Mixer Autochanger with Crystal Pick-up..... **£6.19.6**

The COLLARO "CONQUEST" 4-spd. Autochanger, Studio "O" Pick-up..... **£7.10.0**

The latest COLLARO "CONTINENTAL" 4-speed MIXER Autochanger, Studio "C" Pick-up..... **£8.10.0**

The NEW COLLARO model RP594, 4-speed Single Record Player, Studio Cartridge..... **£9.18.9**

The COLLARO 4-speed Single Record Player, incorporating the Studio "O" Pick-up..... **£6. 9.6**

THE NEW B.S.E. model UA12 is in stock. A "4" SPEED" MIXER AUTOCHANGER..... **£8. 7.6**

UA12 is also available incorporating the B.S.R. STEREO Pick-up, plays L.P. and 78 records..... **£10.10.0**

GARRARD R0210 4-speed Autochanger fitted with latest Crystal Pick-up..... **£10.10.0**

The latest GARRARD TRANSCRIPTION MOTOR "301" with Retroscopically marked turntable..... **£23.18.4**

The new GARRARD Model 4HF High Quality Single Record Player fitted with the latest T.P.A. 12 Pick-up arm and G.C.B. Crystal Cartridge..... **£18. 7.6**

GARRARD Model TA/MV, 11 Single Record Player fitted with high output Crystal Pick-up, detachable head..... **£8.10.0**

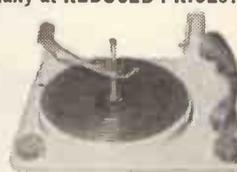
HIRE PURCHASE TERMS available on all units £8/19/6 and over Carriage and Insurance on each above 5/- extra.

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LONDON'S GREATEST DEALERS IN RADIO AND ELECTRONIC EQUIPMENT

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All ratings tropical and in perfect condition

No. 1. Pri. 210-230 v. Sec. 10 v. C.T. 5 A. and 5 v. C.T. 10A. Admiralty rating, 27/6, carr. 3/6.

No. 2. Pri. 230 v. Sec. tapped 4, 6, 11 v. 200 amps. £8/10/-, carr. 7/6.

No. 3. Pri. 200-250 v. Sec. 50 v. 30 A. £6/10/-, carr. 7/6.

No. 4. Pri. 200-240 v. Sec. 50 v. 20 A. £4/10/-, carr. 7/6.

No. 5. Pri. 200-250 v. Sec. tapped 28, 29, 30, 31 v. 21 A. £4/17/6, carr. 7/6.

No. 6. Pri. 100-250 v. Sec. two separate windings tapped 15, 16, 17 v. 4 A. 35/-, carr. 4/-.

No. 7. Pri. 220-240 v. Sec. three separate windings 6.5 v. 50 A., 6 v. C.T. 15 A., 6 v. C.T. 2.5 A. £4/19/6, carr. 7/6.

No. 8. Pri. 220-240 v. Sec. 6.3 v. 15 A. 25/-, p.p. 3/6.

No. 9. Pri. 220-240 v. Sec. four separate windings 3 x 5 v. C.T. 4 A., 4 v. 4 A., potted type. 32/6, p.p. 3/6.

No. 10. Pri. 220-240 v. Sec. three separate windings 3 x 6.3 v. C.T. 4 A., potted type. 29/6, p.p. 3/6.

No. 11. Pri. 200-240 v. Sec. 6.3 v. C.T. 3.25 A. 30 v. 1.2 A. 17/6, p.p. 4/-.

No. 12. Pri. 220-240 v. Sec. 45 v. 2 A. 17/6, carr. 3/6.

No. 13. Pri. 230 v. Sec. 50 v. 2 A., 6.3 v. 5 A., 6.3 v. 2 A., 6.3 v. 1 A., 6.3 v. 0.6 A., 5 v. 5.6 A., 5 v. 3 A. Brand new, 39/6, carr. 5/-.

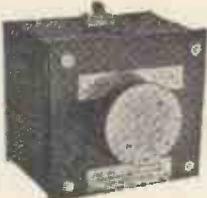
No. 14. Pri. 200-240 v. Sec. tapped 9.15 v. 4 A. 22/6, p.p. 2/6.

No. 15. Pri. 220-240 v. Sec. tapped 10, 17, 18 v. 10 A. 52/6, carr. 4/-.

JUST ARRIVED PARMEKO POTTED LT TRANSFORMERS No. 1. Pri. 230 v. Sec. 24 v. 2 A. Tropically rated. Mounted in metal case with fitted fuses and neon indicators. Size 8½ x 4 x 4in. 25/-, p.p. 3/6. No. 2. Pri. 230. Sec. 10 v. CT 10 A. and 4 v. 7 A. Brand new. 32/6, p.p. 3/6.

ADMIRALTY THREE-PHASE TRANSFORMERS Pri. 400-440 v. 50 cycles. Sec. 50 v. 6 amps. Completely tropicalised. Size 7½ x 14 x 5in. weight approx. 60 lb. Brand new in maker's cases. Price 85/- Carr. 7/6.

ADMIRALTY VOLTAGE CONTROLLERS 1,000 ohm 0.59/0.16 amps. Rotary switch type with 32 contacts. Completely enclosed with metal control handle. New in maker's carton at a fraction of manufacturer's price, 10/6 P.P. 3/6.



ADMIRALTY HEAVY DUTY D.P.O.C. 15 amp. Knife switches. Metal shrouded. New, 7/6 P.P. 2/6.

S.T.C. F.W. RECTIFIERS Brand new. Max. A.C. input 75 volts. Output 18 amps. £7/10/- Carr. 5/-.

L.T. CHOKES to smooth 12-24 v. 5 amps. Res. ½ ohm, 17/6 Carr. 5/-.

AMERICAN OHMITE RHEOSTATS 15 ohms, 2.24 A., 12/6 25 ohms 0.75 A., 15/6 350 ohms, 25 watts, 3/6 Tubular adjustable. Length 10½in., dia. 1½in. 2 ohms 6 amps. 7/6 100 ohms 1 A., 5/6 P.P. on all resistors 2/-.

NUTS, BOLTS, WASHERS Special bargain offer 5/- carton of 2, 4, 6 B.A. nuts, bolts and washers. P.P. 1/- SLEEVING, mixed bundle, 1¼-4 mil., various colours. Wonderful offer. 2/6 P.P. 9d.

THERMOSTATS A.C. 250 v 15 AMP 1½in. stem. Adjustable from 100-190 degrees F. Complete with sleeve, 22/6 P.P. 2/6.



WESTINGHOUSE L.T. SUPPLY UNITS Type No. 139. A.C. input. 200-250 volts. D.C. output, 36 volts, 18 amps. Continuous Rating at 50 deg. C. Fitted with Input and Output Fuses and Mains On/Off Switch. Size of cabinet. 26 x 19 x 14 inches. £17/10/-, Ex Warehouse.

SPECIAL PURCHASE !!

NIFE ALKALINE BATTERIES
6 VOLT, 75 A.H. TYPE LR7.
SUITABLE FOR ENGINE STARTING.
Five 1.2 v. cells crated and connected to give 6 v. Brand new and fully guaranteed. Size of crate 15½ x 12 x 6½in. £7/10/-, Carr. 15/-.

HEAVY DUTY AUTO TRANSFORMERS Tropically rated at 5 kVA Tapped 250, 240, 230, 220, 120, 115, 110, 105 volts. Completely enclosed in metal case. Size 23 x 14 x 11 inches. Weight approx. 2 cwt. Brand new £15 ex Warehouse.

We have London's largest selection of Auto Transformers from 60 watts to 15 kVA. Available from stock. Let us know your requirements.

ADMIRALTY L.T. SUPPLY UNIT No. 46 A.C. input tapped 110, 220, 230 v. D.C. output 24 volts 1 amp. tropically rated. Guaranteed. 2 amp. output completely smoothed with L.T. smoothing choke and condensers. Fitted input and output fuses and on/off switch. Built in metal case size 15 x 9½ x 8in, £32/6. Carr. 10/-.

A.M. D.C. SUPPLY UNIT. A.C. input, tapped 110, 200, 220, 240 volts/D.C. output 90 volts 1 amp tropically rated. Built in metal case 11 x 8 x 6in., 59/6. Carr. 7/6.

GRAHAM GEARED MOTORS. 115 volts A.C. ¼ h.p. variable speed gear box 0-166 R.P.M. Approx. size of unit 15 x 9½ x 8in. Fraction of maker's price. £8/10/- Carr. 10/-.

STEP DOWN TRANSFORMERS, 25/-.

WESTINGHOUSE DOUBLE WOUND STEP DOWN TRANSFORMERS. 250-230-210 v.—110 v. Tropically rated at 400 watts. But guaranteed to give 600 watts. Brand new, £5/10/- Carr. 7/6.

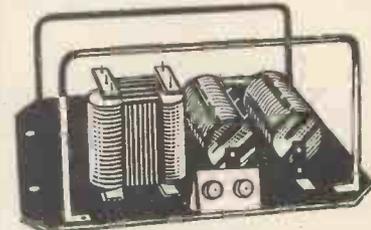
LATEST M.O.S. RELEASE. AMERICAN SEALED RELAYS. Brand new. 9,000 ohms. 1 CO. 1M 15/-; 7,500 ohms 1 CO. 1M 12/6; 7,000 ohms 1 CO 10/6; 270 ohms 1M 1B 7/6 all tag Eax, 5,500 ohms 2 CO. Octal Base 15/- 270 ohms 2 CO 8/6. P.P. 1/6 each.

PREPARMENT ELECTRICITY METERS. 1/2 in slot. A.C. 200-250 v. tariff set to your requirements. 5 amp. 69/6. 10 amp. 80/- 20 amp. 100/- Reconditioned and Guaranteed. Carr. 5/-.

BRAND NEW TELEPHONE CABLE. Twin D.8 one-mile drums, £7/10/-, carr. 15/-.
Twin D.3 500-yd. drums, 35/-, carr. 7/6.
Single D.3 one-mile drums, 85/-, carr. 7/6.
Single ¼-mile drums, 27/6, carr. 5/-.
Commando Assault Cable, P.V.C. covered, 1,000-yd. drums, 8/11, carr. 4/-.
Cartons of five drums, 42/6, carr. 7/6.

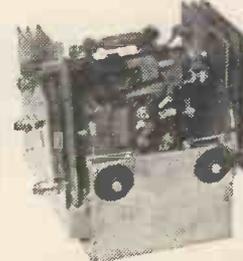
VENNER 14-DAY CLOCKWORK TIME SWITCHES. One make one break every 24 hours. Complete with key and mounting bracket. 1-amp. 230 v. contacts, 27/6. 5-amp. contacts, 32/6. P.P. 2/-.

L.T. SUPPLY UNIT No. 19 YA 8087. A.C. Input 100-250 v., D.C. output tapped 12/24 volts, continuous tropical rating, 3 amps. Built in metal case 17 x 7 x 6½in., with fuses and switch. An ideal L.T. supply unit for operating relays, contactors, battery charging, etc., in perfect condition, £3/17/6. Carr. 7/6.



G.E.C. L.T. SUPPLY UNIT. Type O.S. 1773. A.C. input 200-240 v., D.C. output 24 v. 15 amps. Built in metal case 20in. x 15½in. x 10in. Brand new in makers cases, £13/10/-, Ex Warehouse.

AMERICAN CARBON PILE VOLTAGE REGULATORS



Type Lilliput Minor Mk. II. Load 3/0.73 amps 11 volts. Supply voltage 19/25 v., with spare carbon pile. Brand new, 15/- P.P. 3/6.

A.M. THERMOMETERS. 20-210 deg F. Built in metal case. Size 10 x 1 in. Brand new 6/6. P.P. 1/6.

G.E.C. XPELAIR WINDOW EXTRACTOR FANS. 9 inch. A.C. 200-240 v. Brand new in maker's cartons. £9/19/6. Carr. 4/-.

ADMIRALTY 24 VOLTS 3 A.H. ACCUMULATORS

Suitable for low wattage lighting etc. Twelve 2 v. cells crated and linked. Brand new with charging instructions, 25/-, carr. 5/- Single 2 v. cells supplied separately, 2/6 P.P. 1/-.

A.M. L.T. SMOOTHING CHOKES. Resistance ½ ohm. Ideal for smoothing 12-24 volts D.C. 5 amps. Tropically rated. Unused, 17/6. P.P. 4/-.

RADIATOR THERMOMETERS. 100-220 deg. F., 2½in. dia., Complete with 3ft. capillary tube and unions, 15/- P.P. 2/6.

ADMIRALTY FILAMENT TRANSFORMERS. Pri. 230 v. Sec. 6.3 v. 5 a., 6.3 v. 0.8 a., and tapped HT winding 65, 130, 195 v. 85 M/A. Tropical rating in makers cartons 15/- P.P. 2/6.

BRAND NEW AMERICAN OIL FILLED CAPACITORS. 4 mfd. 4000 v. wkg, 17/6. 5 mfd. 1500 v. wkg, 7/6. 8 mfd. 1500 v. wkg, 10/- 8 mfd. 1000 v. wkg, 8/6. 10 mfd. 1500 v. wkg, 12/6. 16 mfd. 400 v. wkg, 7/6. P.P. on all capacitors 2/6.

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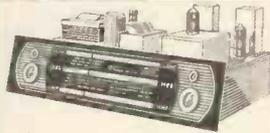


MODEL 1629 AM/FM RADIOGRAM CHASSIS BY FAMOUS MANUFACTURER
 PRICE £15.19.6 plus 7/6 p. & p.

Due to a fortunate bulk purchase we are able to offer these exceptionally good quality Radiogram Chassis at this ridiculously low figure. *Gram./on/off*. Star features of this Chassis are: plane key wavechange, internal Ferrite Rod Aerial for AM and Magic Eye Tuning Indicator, waveband coverage: Long Wave 1098-2027 metres, Medium Wave 188-647 metres.

3-WAVEBAND RADIOGRAM CHASSIS
 By Famous Manufacturer
 £10.19.6 plus 5/- p. & p.

A special offer for a limited period only of this Continental style Radiogram Chassis. Brief details: Long, Medium and Short wavebands covering 1007-1960 metres, 185-655 metres, 16-32 metres. Valve line-up ECH81, EBF80, ECL82. Mains voltage 200/250 v. A.C. Gramophone Pick-up Input. Dimensions 17 1/2 in. long, 6 in. high, 6 in. deep.



VHF/FM 87-101 Mc/s., Valve line-up ECC85, ECH81, EF89, EM61, EABC80, EL84, suitable for use on 200/250 v. A.C. mains. Dimensions 15 1/2 wide, 12 in. high, 4 1/2 in. deep.

TAPE DECKS

Latest BSR Monardeck. Single speed 3 3/4 i.p.s. Will take 5 1/2 in. spools. £19/19/6. P. & P. 5/-.

Collaro Studio Tape Transcrip. 3 speeds 1 1/2, 3 3/4, 7 1/2 i.p.s. 3 motors. Push-button controls. Will take 7 in. spools. 15 gns. P. & P. 7/6.

Collaro Mk. 4 Tape Transcrip. Twin track operation. 3 speeds, 3 3/4, 7 1/2, 15 i.p.s. Will take 7 in. spools. £17/19/6. P. & P. 7/6. Tape Recorder Amplifier, specially designed to match the Collaro Studio Tape Deck. £12/17/6. P. & P. 4/-.

Size 1 1/2 x 5 x 3 in., uses 3 valves, magic eye, contact cooled metal rectifier. Incorporates mike/gram/radio inputs, ext. l.s. jack, superimposing switch, with matching knobs.

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By well-known manufacturers, brand new, boxed and fully guaranteed.

1,800ft. on 7 in. spool... 32/6
 1,200ft. on 5 1/2 in. spool... 22/6
 Postage and packing 1/- per spool.

AMERICAN RECORDING TAPE

Manufactured by Ferrodynamic, brand new and fully guaranteed.

1,200ft. on 7 in. spool... 25/-
 1,800ft. on 7 in. spool... 35/-
 600ft. on 5 in. spool... 14/6
 Postage and packing 1/- per spool.

TAKE ADVANTAGE OF THESE

DRAMATIC PRICE REDUCTIONS

AVANTIC SP11 Stereophonic Amplifier, Technical details: power output (each channel) 10 watts peak, L.S. impedance, 4, 8 and 16 ohms, DUAL VOLTAGE—60 cycles, 6-position input selector, bass, treble, volume on/off controls, stereo reverse switch, phase reverse switch, stereo balance control, P.U. balance control. Dimensions 14 1/2 x 8 1/2 x 4 in. Original Price 28 gns. P. & P. 7/6. **OUR PRICE 19 gns.**

AVANTIC SP A21 Stereophonic Amplifier. Special feature of this Amplifier is high sensitivity permitting direct operation from magnetic Pick-up and high impedance tape replay Head, power output each channel 25 watts peak, rumble filter, L.S. impedance 4, 8 and 16 ohms, 6-position input selector, bass, treble, volume on/off controls. Dimensions 14 1/2 x 14 x 4 in. Original Price £48/10/-.

AVANTIC SP21 Stereophonic Pre-amp. Control Unit, this Unit was primarily designed for use with the Avantic DL7/35 Power Amplifier. Brief specifications, 6 inputs for each channel, 6 position input selector, bass, treble, volume control, on/off stereo/3D/reverse stereo switch, stereo phase switch, low pass filter. Power requirements 6.3 v. at 1.3 A. A.C., 350 v. at 5 mA D.C. Dimensions 14 1/2 x 9 x 4 in. Original Price £28/10/-.

AVANTIC PL621 book-shelf monaural Amplifier, power output 20 watts peak, 4, 8, or 16 ohms., 7-position selector switch, bass, treble, volume on/off, hum balance, separate switches high-pass, low-pass filter. Dimensions 14 x 8 1/2 x 4 1/2 in. Original Price 29 gns. P. & P. 7/6. **OUR PRICE 19 gns.**

AVANTIC BM611 VHF/FM/MW-AM Radio Tuner, a superb self-powered plus rectifier Tuner incorporating automatic frequency control and a Foster-Seeley discriminator, magic eye tuning operative on both bands. Ranges: VHF 88-108 Mc/s continuous; M.W. 545-1600 Kc/s. continuous. Controls on/off AM-FM Selector Switch, volume control; A. F.C. Tune-Hold Switch, Tuning Control. Power supply 200-250 v. A.C. Dimensions 14 1/2 x 10 1/2 x 4 in. Original Price £40. P. P. 7/6. **OUR PRICE £25**

AVANTIC DL7/35 Power Amplifier, designed to the highest possible standard to meet present day demands and when used in conjunction with the SP21 Pre-amp Control Unit perfection in stereo reproduction is achieved. Specifications: power output 54 watts peak; L.S. impedance, 4, 8 or 16 ohms, power inputs 105-250 v. Valve line-up GZ34, 2—EL34, ECC83, EF86. Dimensions 14 1/2 x 9 x 8 1/2 in. Original Price 30 gns. P. & P. 12/6. **OUR PRICE £24**

AVANTIC SL12-21 Speaker System employing 12 in. dia. P.M. L.S. and high frequency pressure Unit mounted in an acoustically designed enclosure, impedance 15 ohms, dimensions 38 x 18 1/2 x 15 1/2 in. Finish matt medium walnut with front and sides covered with fawn fabric, standing on small contemporary legs. Original Price 30 gns. P. & P. 20/-.

ALL THIS EQUIPMENT IS BRAND NEW AND IN MANUFACTURERS' ORIGINAL SEALED CARTONS, IT IS ALL DESIGNED TO GOPE WITH THE MODERN TREND OF BOOK-SHELF MOUNTING SO THAT EACH INDIVIDUAL UNIT CAN BE MATCHED, FINISHED IN BLACK AND GOLD. TECHNICAL DETAILS AND DESCRIPTIVE LITERATURE AVAILABLE.

SINGLE PLAYERS

- Collaro Junior 4 speed Player, complete with Pick-up £3 15 0
- Garrard 4SP 4 speed Player, complete with Pick-up and automatic stop ... £6 9 6
- Garrard TA Mk. 2, 4 speed Player, wired for stereo, with plug-in Head £8 10 0
- Philips AG2009, 4 speed Player, with diecast turntable and Microlit, wired for stereo £10 10 0

RECORD CHANGERS

- BSR UAB, 4-spd. £6 19 6
- BSR UA12, 4 speed, wired for stereo and complete with Stereo cartridge £8 19 6
- Collaro Conquest, 4 speed Changer £7 19 6
- Collaro RC457 latest type 4 spd. changer ... £8 10 0
- Garrard RC111 3 speed Changer £7 19 6
- Garrard RC120 Mk. 2 4 speed £8 19 6
- Garrard RC121/4D 4 speed £9 19 6
- Garrard RC121 Mk. 2 4 speed, wired for stereo and with plug-in Head ... £10 19 6

TRANSCRIPTION UNITS

- Garrard 301 £22 7 3
- Garrard 301 (Strobe turntable) £23 18 4
- Garrard 4HF (Stereo) £19 4 8
- Garrard 4HF (GC8) £18 9 9



THE MODEL FMA/1 FERGUSON FM TUNER

13 gns plus 3/- p. & p. This Tuner has been designed for use with Radio Receivers or Hi-Fi equipment. The Unit is completely self-contained being self-powered and housed in a hammered metal finished steel case, measurements 10 x 7 1/2 x 2 1/2 in. Brief technical specifications: Frequency coverage 87.8-100 Mc/s. (continuously). Valve line-up: 2—EF80, ECF80, 2 germanium diodes and metal rectifier, for operation on A.C. mains 200/250 v. 40-60 cycles.

THE SHIRA 6TR-A 6 TRANSISTOR POCKET RECEIVER complete with Earpiece and Plastic case. Battery extra 2/6. Plus 2/- P. & P.

This amazing Receiver is so small that it will fit snugly into a shirt pocket or ladies handbag, size being only 4 x 2 1/2 x 1 1/2 in. It includes 6 transistors and has an output of 60 mW. A battery will last a month at normal use of 2 or 3 hours per day. A built-in aerial is used and the selectivity of this tiny Radio leaves nothing to be desired. Medium waveband coverage only.

MULLARD TYPE 5-10 AMPLIFIER By Well Known Manufacturers PRICE £13.19.6 plus 5/- p. & p.

A high quality Amplifier and Pre-Amplifier based on the Mullard modified circuit, the Power Amplifier is built on a sturdy chassis and both Amplifier and Pre-amp. are bronze hammer finish. Brief technical details: Valve line-up E781, EF86, ECC83, 2—EL84, output 10 watts, output impedance 15, 7.5 and 4 ohms. Dimensions: Main chassis 10 1/2 x 7 1/2 x 6 in. Dimensions Pre-amp. 10 x 4 1/2 x 3 1/2 in.

SEND FOR FULL TECHNICAL DETAILS ON THE ABOVE

VALVES

Brand new, individually checked and guaranteed

AC/DD	2/6	E1524	6/6	FW4/500	6/6	PY82	8/-	ID8GT	6/-	6H6M	2/-	I2C8	7/6	816	30/-
AC/CP	4/6	EA50	5/6	H30	5/-	QP21	6/-	IE7GT	7/6	6H6GT	1/9	I2E1	22/6	829A	30/-
AC/PI	2/6	EA91	4/6	H63	3/6	QP25	5/3	IL4	3/9	6J5	3/6	I2H6	2/-	843	7/6
AC/SPENDD	4/-	EB34	4/6	HBC32	5/-	QQVO	6-40 45/-	ILDS	3/6	6I7	7/6	I2K8GT	9/-	861	15/-
AC6/PEN	5/-	EB91	1/3	KF35	5/-	QS75/20	6/9	IR5	6/9	6I5G	3/3	I2J5GT	3/6	866A	10/-
AC/SP3	4/6	EB91	3/7	KT2	4/-	QS95/10	6/9	IS5	6/-	6J6	4/6	I2SC7	4/6	872A	35/-
AL60	6/-	EBC33	6/6	KT31	8/-	QSI08/45	6/9	IT4	4/-	6K6GT	6/3	I2SG7	6/6	930	8/-
AR8	5/-	ECC52	3/-	KT33C	7/-	QSI50/15	6/9	2A3	8/-	6K7G	2/3	I2SH7	4/9	954	2/-
ARDD5	2/-	ECC32	4/-	KT44	7/-	R10	12/6	2A6	7/-	6K7GT	5/3	I2S17	6/-	956	2/-
ARP3	3/-	ECC81	6/6	KT63	6/-	REL21	25/-	2C34	2/6	6K8G	6/6	I2SK7	5/-	1619	5/-
ARP4	3/6	ECC82	6/6	KT241	9/-	RK34	2/6	2D4A	4/-	6L5G	6/6	I2SL7	7/-	1625	6/-
ARP12	2/9	ECC83	7/-	KTW62	7/6	SP2	4/-	2X2	4/-	6L6	9/-	I2SR7	6/-	1626	4/6
ARP21	5/6	ECC84	7/9	KTW63	6/6	SP4B	7/6	3A4	6/-	6L6G	6/6	ISD2	6/-	1629	4/6
ARP24	3/6	ECC91	4/-	L30	4/-	SP13C	4/6	3B24	3/-	6L34	4/6	ISR	7/6	1793	1/9
ARP34	4/6	ECL80	9/6	MH4	3/6	SP1	2/6	3E29	6/6	6N7G	6/6	30	5/-	7045	5/-
ATP4	2/9	EF22	7/3	ML4	4/-	SP61	2/-	(829B)	60/-	6N7GT	7/-	35T	30/-	8010AR	22/6
ATP7	5/6	EF32	5/6	ML6	6/-	SP210	4/-	3Q5GT	9/-	6Q7G	6/3	35Z4	5/-	8013A	10/-
AU1	5/-	EF36	3/6	MPT42	5/3	STV280/40	12/-	3V4	7/3	6R7G	7/6	35Z4GT	7/-	8020	6/-
AU4	5/-	EF39	4/6	MS/PEN	6/-	STV150A	4/-	4A1	4/6	6R7GT	8/-	39/44	6/-	9001	5/-
AW3	4/-	EF50	2/6	N34	8/-	T41	19/-	4D1	2/6	6SA7	8/-	53A	3/-	9003	5/6
BL63	6/-	EF52	5/6	NR15A	3/-	TP25	15/-	5U4G	5/-	6SC7G	5/6	58	6/-	9004	4/6
BT45	40/-	EF54	3/6	NT37	3/-	TT11	3/-	5V4	7/-	6SC7GT	6/-	59	6/-	9006	4/-
BT9B	40/-	EF55	6/6	(4033A)	10/-	U17	5/-	5Y3GT	6/9	6SG7	5/-	71A	4/6		
D41	3/3	EF70	4/-	OD3	5/-	U18	5/-	5Z4G	8/6	6SH7	5/-	77	6/-	Cathode Ray	
D42	4/-	EF80	6/9	P61	2/6	U27	8/-	5Z4G	8/6	6S17	6/9	78	7/-	Tubes:	
D77	4/3	EF85	6/10	PCC84	8/-	U52	5/-	6A6	5/-	6S5F	8/-	80	6/3	3BP1	25/-
DA30	12/6	EF86	9/-	PCC85	8/-	UL84	8/6	6A7	5/-	6S17G	6/8	82	5/6	38P1	35/-
DAF86	8/-	EF89	8/9	PCF80	8/-	UL85	8/6	6AC7	4/3	6SK7	5/6	83V	12/-	5CP1	42/6
DE75	15/-	EF91	4/10	PEN25	4/6	V248A	8/-	6AG5	4/6	6SL7GT	6/9	84	12/6	5FP7	45/-
DET19	2/6	EF92	5/-	PEN46	5/6	VR23	3/6	6AG7	8/-	6SN7GT	4/6	85A1	12/-	VCRX258	(with scanning coil)
DET20	2/6	EL32	3/9	PEN65	6/6	VR99	8/-	6A17	6/9	6SR7	6/6	89	6/-	210LF	3/-
DF70	9/-	EL35	9/-	PEN220A	3/-	VR105/30	7/6	6AM5	5/-	6SS7	5/6	210VPT 7 pin	2/6		
DF72	7/6	EL84	8/3	PENDD/1360	9/6	VR150/30	7/3	6AM6	6/3	6V6G	5/6	217C	17/6	Photo Tubes:	
DF96	8/-	EL91	7/6	PL1	11/-	VS110	4/-	6B8	5/6	6XA	5/6	446A	14/-	GS16	12/6
DH76	4/9	EM4	4/-	PL81	8/-	VT25	8/-	6B8G	2/6	6X5GT	6/6	705A	17/6	Special Valves:	
DK96	8/-	ESU208	8/-	PL82	8/-	VU111	3/3	6C4	4/6	723A/B	45/-	715B	97/6	2J31	45/-
DL72	7/6	EY51	7/6	PL83	9/-	VU120	3/3	6C5	6/-	7Q7	7/-	801	6/-	3A1/481	45/-
DL71	8/-	EY91	3/6	PM4DX	3/-	VU133A	3/-	6C6G	4/6	802	6/6	31192/E	£37/10	31170/E	£35
DL96	8/-	EZ40	7/6	PT25H	7/6	W31	7/-	6C8G	5/-	90Y	3/6	805	30/-	723AB	52/6
E1323	25/-	EZ80	7/6			Y63	5/-	6E5	5/-	102	8/6	807 AMER	5/3	ACT25	40/-
						Y66	8/-	6F5G	5/6	12AH7	7/-	807BR	3/9	CV91	60/-
						Z31	6/-	6F6	6/-	12AT7	6/6	808	8/-	CR3	45/-
						I A3	3/6	6F8G	6/6	12AU7	6/9	810	£3	VX7110	15/-
						I A5GT	5/6	6F12	4/6	12AX7	7/-	815	80/-	WL417A	15/-
						ICSGT	7/6	6G6G	3/-						

AND MANY OTHERS IN STOCK including Cathode Ray Tubes and Special Valves.

All U.K. orders below 10/- P. & P. 1/-; over 10/- 1/6; orders over £3 P. & P. free C.O.D 2/- extra. Overseas postage extra at cost.

BRAND NEW ORIGINAL SPARE PARTS FOR AR88 RECEIVERS.
Please write your requirements.

MOVING COIL ROUND HAND MICROPHONE No. 13. 2 1/2 in. diam. with press switch. 12/6. P. & P. 1/-.

PLATE TRANSFORMER. Input 190-210-230-250 v. Output 2,250-02,250 C.T. 400 mA, 13 x 9 x 6 1/2 in. Weight 75lb. £6/10/-; Carr. 10/-.

I.F. TRANSFORMERS. 4-5 Mc/s. American made in black crackle finish housing, 6/-; P. & P. 1/-.

HRO MAINS power pack, input 115/250 v. A.C. Output 250 v. 75 mA, and 6.3 v. 3.5 amps. £3, inc. carr

VARIOMETERS for W/S No. 19. Fully tested and working 12/6. P. & P. 2/6.

TRANSMITTER CABINET with door at back. 7 1/2 in. high x 29 in. wide. Rack fitting type. £17/10/-; Carr. £1.

FERRANTI TRANSFORMER. Oil cooled. 20/19.5 KVA, 3 phase, 50 cycles. Pri. 360-380-400-420-440 volts. Sec. 2700-2900-3100-3300-3500 volts. 2.1 amps. Voltage regulation by simple switch. Pri. and sec. Weight 1,150lb. Price £125. Carr. at cost.

FILAMENT TRANSFORMERS. Primary 0-190-210-230-250 v., 50 c/s. Sec. 1. 2.5 v. CT at 10 amps. 2. 2.5 v. CT at 10 amps. 3. 10.5 v. CT at 11 amps., 4,000 v. insulation. Price £21/9/-; P. & P. 5/-; Primary 0-190-210-230-250 v. 50 c/s. Sec. 1. 10 v. CT at 4.5 amps. 2. 10 v. CT at 4.5 amps., 4,000 v. insulation, £11/16/-; P. & P. 5/-; Primary 230 v. 50/60 c/s. 67 v/amps. Sec. 1. 6.3 v. 1-6 amps. 2. 6.3 v. CT 3 amps. 3. 6.3 v. CT 3 amps. 4. 6.3 v. CT 3 amps. £11/12/-; P. & P. 5/-.

LOW RESISTANCE HEADPHONES. brand new, type CLR 5/-; Balanced Armature, 7/6. P. & P. 1/-.

TELEPHONE HANDSET. Standard G.P.O. type, new, 12/-; P. & P. 1/6.

AVOMINORS in leather case with leads. Fully tested and guaranteed, with batteries. 2,000 v. D.C., £21/9/6. P. & P. 2/6.

NEW PRODUCT OF TAYLOR

Model 127A Pocket size meter. Sensitivity 20,000 o.p.v. D.C. 1,000 o.p.v. A.C.

20 ranges. D.C. current 50µA to 1 amp.

D.C. volts 0.3 v. -1,000 v. (25 kV. by probe).

A.C. volts 10 v. -1,000 v.

3 resistance ranges from 0-20 meg-ohms (self contained). Metre 40µA 3 1/2 in. arc. Accuracy D.C. 3%. A.C. 4% ohms 5%.

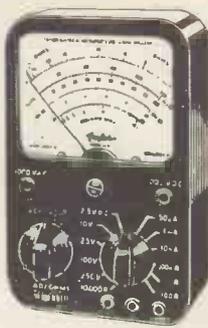
Dimensions 5 1/2 x 3 1/2 x 1 1/2 in. Weight 14 oz. Price £10 complete with instruction manual, test prods and clips. Leather case £11/12/- extra.

OUTPUT TRANSFORMER, in screening can giving 9 different ratios 10 : 1 up to 120 : 1 for battery receivers or any high resistance pentodes used as output valves, 6/6. P. & P. 1/6.

DRIVER TRANSFORMERS. Primary 500 ohms imp. Sec. to match two 805 in push-pull £11/7/6. P. & P. 5/-.

TRANSFORMERS. Relay supply. Primary 230 v. Sec. 0-27/29/31 v. at 0.5 amps., 15/-; P. & P. 5/-.

ROTARY TRANSFORMERS. 171 watt, 12 v. input, 1,600 v 110 mA. output, 30/-; P. & P. 7/6.



COMPLETE SET OF STRONG AERIAL RODS (American). Screw-in type MP49, 50, 51, 52, 53, total length 15ft. 10in., top diameter 0.615in., bottom diameter 0.185in., together with matched aerial base. MP37 with ceramic insulator, ideal for car or roof insulation. £2/10/-; post free.

AR88D and L.F. Receivers, completely overhauled and tuned, £60 and £57/10/- respectively. Completely rebuilt with P.V.C. wiring £85.

MODULATION TRANSFORMERS (U.S.A., Collins), primary imp 6,000 ohms. C.T., secondary 6,000 ohms, 20 W., 9/6 each, post free.

VIBRATOR UNIT. 12 v./160 v. 35 mAmps. Exceedingly well filtered and smoothed, excellent for car radios. New, including one 6X5G valve and vibrator. 17/6. P. & P. 5/-.

CARBON INSET MICROPHONE. G.P.O. type 2/6. P. & P. 1/-.

INSULATION TEST METER. Testing voltage adjustable up to 6,000 v. D.C. Mains supply 180/250 v. In wooden case £25. Carr. 10/-.

COSSOR DOUBLE BEAM OSCILLOSCOPES. 339A. Fully tested and working, £15. Carr. 10/-.

NO. 62 TRANSMITTER-RECEIVER. 1.6 12 mc/s in two ranges. Ideal for mobile use. Total 11 valves. Rx-A super with separate mixer and local oscillator. Tx uses QVO4-7 as power amplifier VFO or switched selected crystals. C.W., phone (grid modulation) metered for operation and valve testing, Pi output to match rod aerials or long wire "Press to send" operation from mike. Size 8 1/2 in. x 17 1/2 in. x 13 1/2 in. weighs only 29lbs. Completely self contained with internal power unit for 12 v. operation. Power consumption 4.4 amps. on send, 3.4 amps. on receive. As new condition, tested, complete with operation instructions. Price £27/10/-. Delivery included.

P. C. RADIO LTD.
170, GOLDHAWK RD.,
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PERSONAL CALLERS WELCOME

RI155 RECEIVERS

The famous Bomber Command Receiver known the world over to be supreme in its class. Covers 5 wave ranges: 18.5-7.5 Mc/s., 7.5-3.0 Mc/s., 1,500-600 kc/s., 500-200 kc/s., 200-75 kc/s., and is easily and simply adapted for normal mains use, full details being supplied. All sets thoroughly tested and in perfect working order before despatch, and on demonstration to callers. Fitted with latest type Super Slow Motion tuning assembly. Have had some use, but are in excellent condition. **ONLY £9/19/6.**

A.C. MAINS POWER PACK OUTPUT STAGE in black metal case to match receiver, enabling it to be operated immediately, by just plugging in, without any modification. Fitted with 8in. P.M. Speaker **£6/10/-**. DEDUCT 10/- IF PURCHASING RECEIVER AND POWER PACK TOGETHER.

Send S.A.E. for illustrated leaflet, or 1/3 for 14-page booklet which gives technical information, circuits, etc., and is supplied free with each receiver. Add carriage 10/6 for Receiver, 5/- for Power Unit.

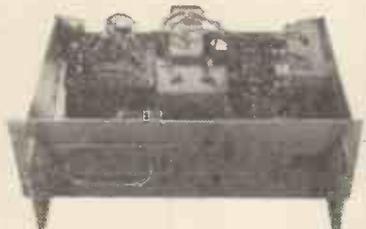
RCA RECEIVERS AR88D. Thoroughly re-conditioned and in perfect working order. Cover 500 kc/s.-31Mc/s. **ONLY £60** (carriage etc., 25/-).

CRYSTAL CALIBRATOR No. 10



A superb Crystal Controlled Wavemeter just released by the Ministry of Supply. Has directly calibrated dial for nominal coverage of 1.5-10.0 Mc/s. but may actually be used from 500 kc/s. up to 30 Mc/s. Complete with 500 kc/s. Crystal 2 valves type 1T4, 1 or 1R5 and 1 of CV296 (Neon Stabiliser), and Instruction Book. Size 7in. x 7in. x 4in., weight 5lb. Used but in first class condition. **ONLY £2/19/6.** Carr. 3/6.

POWER UNITS TYPE 234



Primary 200/250 v. 50 cycles. Outputs of 250 v. 100 mA., and 6.3 v. 4 amps. Fitted double smoothing. For normal rack mounting (or bench use) having grey front panel size 19in. x 7in. **BRAND NEW. Only 59/6.**

ALSO POWER UNIT TYPE 3. Specification as above, but has two meters mounted on front panel to read H.T. Current, and Voltage. **BRAND NEW. ONLY 79/6** (Carriage on either unit 7/6).

12 VOLTS AMERICAN DYNAMOTOR. Delivers 220 volts at 100 mills. Size 6 1/2 x 3 1/2 in. diameter. Ideal for running Radio and Electric Shaver, etc. from car battery. **ONLY 32/6.**

MARCONI SIGNAL GENERATOR TF 144G/7. Coverage: 85 kc/s.-2.5 Mc/s. and 8 Mc/s.-70 Mc/s. Complete, and in AS NEW CONDITION. **ONLY £95.**



SELECTEST TESTMETER DIII

Manufactured by General Electric Co., and has exactly the same ranges as the Avometer D, but with a rather larger mirror scale. Size 9in. x 7in. x 5in., with carrying strap. Thoroughly overhauled and in perfect order, with batteries and instructions. A real "snip" while they last. **ONLY £7/10/-** (postage, etc., 3/6).

UNIVERSAL AVOMETER 34 RANGE MODEL D

Ex-Air Ministry, but thoroughly reconditioned and checked. Supplied with internal batteries and instructions. Covers ranges as follows:

D.C. VOLTS	A.C. VOLTS	D.C. Current	A.C. Current
150 mV.	7.5 v.	15 mA.	75 mA.
300 mV.	15 v.	30 mA.	150 mA.
1.5 v.	75 v.	150 mA.	750 mA.
3 v.	150 v.	300 mA.	1.5 amp.
15 v.	300 v.	1.5 amp.	7.5 amp.
30 v.	600 v.	3 amp.	15 amp.
150 v.	750 v.	15 amp.	
300 v.	1,500 v.	30 amp.	Resistance
750 v.			1,000 Ω
1,500 v.			10,000 Ω

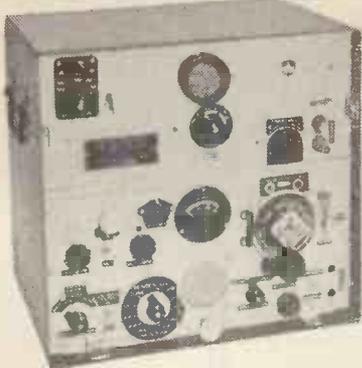
ONLY £8/19/6 (Postage, etc., 3/6).



CANADIAN RECEIVER No. 52

A magnificent 10 valve Receiver covering 1.75-16.0 Mc/s. (19-170 metres) in 3 switched bands. Has built-in 3 valve Crystal Calibrator employing dual 100/1,000 kc/s. Crystal to provide marker check points at 10-100-1,000 kc/s. Other refinements include Valve-check Voltmeter, Internal 3in. Speaker, R.F. and A.F. Gain Controls, Noise Limiter, R.F.O. Switch, Heterodyne Pitch Control, choice of Wide or Narrow Bandwidth, Speaker or Headphones and Manual or Automatic Volume Control on both C.W. or R.T. There are Past and Slow Tuning Controls, with additional Oscillator Control for Fine adjustment. In steel carrying case as illustrated, size 15in. x 12in. x 15in. First class condition, thoroughly checked and tested, and in perfect working order before despatch. Circuit supplied. Voltages required 12 volts L.T. and 160 volts H.T. **ONLY £11/19/6** (carriage etc. 15/-).

A suitable Power Pack, for use on 110-250 volts A.C. or 12 volts D.C., can be supplied (less outer case) for 50/-, plus 5/- carriage.



RCA 8in. P.M. SPEAKER



In heavy black crackled metal case, designed for use with AR 88 Receiver, or any set with 3 ohms Output. **BRAND NEW IN MAKERS' CARTONS. ONLY 45/-** (Post 3/6).

AMPLIFIER N24



Utilises 4 valves, 1 each 6Z4G, 6V6G, 6J7G, 6J5G and high quality components such as "C" Core Transformers and Block Paper Smoothing Condensers. A.C. Mains Pack for nominal 110 x 230 volts. Provision for 600 ohms or High Impedance Input. Output to 600 ohm Line. For normal use only requires changing Output Transformer. Output approximately 4 watts. Designed for Standard Rack Mounting, having grey front panel size 19in. x 7in. All connections to rear panel, front having "On/Off" Switch. Gain Control, Indicator Light. Fuses and Valves Inspection Panel. **BRAND NEW IN MAKER'S PACKING. ONLY £4/9/6** (carriage 10/6).

EHT TRANSFORMERS. 7 kV. (Rect.) with 2 v. 1 a., 89/6. 2.5 kV. (Rect.), with 2-0-2 v. 1.1 a., 2-0-2 v. 2a., (for VCR 97 tube, etc.), 47/6 (postage 2/- per trans.).

DOUBLE BEAM OSCILLOSCOPE TUBES

Type CV 1596 equivalent to Cossor O9D as used in oscilloscopes by Cossor (339 series). Hartley and Erskine (13 series). Listed at **£12/10/-**.

Our price £2/19/6 (carriage 5/6)

Brand New in makers' crates.

W 1191A WAVEMETER

Crystal controlled heterodyne frequency meter covering 100 kc/s. to 20 Mc/s. in 8 switched bands and is virtually the British BC221. Power requirements 2 v. L.T. and 40-60 volts H.T. Complete with Calibration Book, Crystal, Operating Valves and full set of spares. **BRAND NEW IN ORIGINAL TRANSIST CASES. ONLY £9/19/6** (carriage 15/-).

CANADIAN MOVING COIL PHONES. Low-resistance, fitted noise-excluding chamois ear muffs, and leather covered head-band. Lead terminates to jack plug. **BRAND NEW. ONLY 19/6** (Post 1/6).

CARRYING CASES, solid leather, **BRAND NEW.** Internal dimensions 8 1/2 in. H. x 8 1/2 in. W. x 4 1/2 in. D. Fitted lock and key, and shoulder strap. Ideal for Test Instrument, Camera and accessories, etc. **ONLY 35/-** (postage 2/-).

BC 342 RECEIVERS. A few only of these famous American sets covering 1.15-18.0 Mc/s. in six bands. Internal 115v. A.C. Mains pack. A super receiver in first class condition and perfect working order. **ONLY £25** (carriage 15/-).

Cash with order please, and print name and address clearly
PLEASE ADD POSTAGE OR CARRIAGE COSTS ON ALL ITEMS

HARRIS ELECTRONICS (LONDON) LTD.

Radio Corner, 138 Gray's Inn Road, London, W.C.1. Phone: TERMINUS 7937

Open until 1 p.m. Saturdays.

We are 2 mins. from High Holborn (Chancery Lane Station) and 5 mins. by bus from King's Cross.

R.S.C. HI-FI TAPE RECORDER KIT

OR DEPOSIT £5/7/8, and 12 monthly payments of 42/-.
Cash price if settled in 3 months.

Build a high quality recorder in the £70 class for only

25 1/2 GNS.
Carr. 17/6.



Can be assembled in 1/2 to 1 hour.
MERELY CONNECT AMPLIFIER TO DECK AND ASSEMBLE IN CABINET. INCORPORATING THE LATEST COLLARO STUDIO TAPE TRANSCRIPTION. THE LINEAR LT45X HIGH QUALITY FULLY ASSEMBLED TAPE AMPLIFIER. A HIGH FLUX 7x4in. LOUDSPEAKER, Reel of Best Quality TAPE, Spare Tape Spool, a Portable Cabinet, size approx. 16x13x9in., finished in two-tone rexine, and connection diagram for wiring amplifier to transistor.

FEATURES INCLUDE

★ 3 SPEEDS. ★ FREQUENCY RESPONSE 50-11,000 c.p.s. ★ SWITCHED NEGATIVE FEEDBACK EQUALIZATION FOR EACH SPEED. ★ OUTPUT 4 WATTS. ★ MAGIC EYE RECORDING LEVEL INDICATOR. ★ 3 MOTORS. Fast rewind. ★ TAPE MEASURING AND CALIBRATING DEVICE. ★ TAKES FULL 7in. DIAMETER REELS OF TAPE. ★ NEGLIGIBLE HUM. ★ ENTIRELY EFFECTIVE AUTOMATIC ERASURE.
Full descriptive leaflet supplied on receipt of S.A.E.

HI-FI 10 WATT AMPLIFIERS

BRAND NEW BUT IN SLIGHTLY SOILED CONDITION

£5-19-9
Carr. 7/6

A REMARKABLE OPPORTUNITY

Push-pull output. Latest high efficiency Mullard valves. Dual separately controlled inputs, for mike and gram. Separate bass and treble controls. High sensitivity. Output for 15 ohm loudspeaker. Guaranteed, tested, and in perfect working order.

VALVES! Full range at really competitive prices. All Guaranteed!

SUPERHET RADIO FEEDER UNIT

Design of a high quality Radio Tuner Unit (specially suitable for use with any of our Amplifiers). A Triode Heptode F/charger is used. Pentode I.F. and double Diode Second Detector, delayed A.V.C. is arranged so that A.V.C. distortion is avoided. The W. Ch. Sw. incorporates Gram-position. Controls are Tuning, W. Ch. and Vol. Output will load most Amplifiers requiring 500 mV input depending on Ae location. Only 250 v. 15 mA. H.T. and L.T. of 6.3 v. 1 amp. required from amplifier. Size of unit approx. 9-0-7in. high. Send S.A.E. for illustrated leaflet. Total building cost is £4/15/-. Point-to-Point wiring diagrams and instructions 2/6.



METERS

0-50 micro-ammeters, 2 1/2in. scale, scaled 0-100. 39/6.
0-500 micro-amp., 3 1/2in. scale, scaled in decibels. 59/6.
Ferranti Multimeters, D.C. and A.C., complete in carrying case, 59/6.
Meter Rectifiers 0-5 mA. 11/3.

ACOS HI-FI CRYSTAL 'MIKES'

Mic 40 hand or Desk type
25/9 (Listed 45/-)
39-1 Stick type
39/6 (Listed 5 Gns.)
Limited number.

R.S.C. BATTERY TO MAINS CONVERSION UNITS

Type BMI. An all-dry battery eliminator. Size 5 1/2 x 4 1/2 x 2 1/2in. approx. Completely replaces batteries supply 1.4 v. and 90 v. where A.C. mains 200-230 v. 50 c/s. is available. Suitable for all battery portable receivers requiring 1.4 v. and 90 v. This includes latest low consumption types. Complete kit with diagram 39/9 or ready for use 46/9.
Type BM2. Size 8 x 5 1/2 x 2 1/2in. Supplies 120 v. 90 v. and 60 v. 40 mA. and 2 v. 0.4 v. to 1 amp. fully smoothed. THEREBY COMPLETELY REPLACING BOTH H.T. BATTERIES AND H.T. 2 v. ACCUMULATORS when connected to A.C. mains supply 200-230 v. 50 c/s. SUITABLE FOR ALL BATTERY RECEIVERS normally using 2 v. accumulator.
Complete kit with diagrams and instructions. 49/9 or ready for use 59/6.

BUILD A PORTABLE BATTERY OPERATED RECORD PLAYER FOR ONLY £8/19/6. Portable Cabinet, Garrard 45 r.p.m. motor and pick-up unit, all parts for transistor amplifier, and circuit diagrams. Parts sold separately.

PARMEKO RE-ENTRANT LOUDSPEAKERS. Horn type for factory or outdoor use. Highly efficient, will handle up to 10 watts. Matching 15 ohms or 200 ohms. Brand New. Boxed. 59/6. Carr. 5/6.
R.C.A. RE-ENTRANT LOUDSPEAKERS, 20 watts with tapped transformer giving matching for 3, 15, or 600 ohms. Only 6 Gns.

THE SKY FOUR T.R.F. RECEIVER



A design of a 3 valve 200-250 v. A.C. mains L. and M. wave T.R.F. receiver with selenium rectifier. For inclusion in cabinet illustrated or walnut veneered type. It employs valves 6K7, 6P6 and is specially designed for simplicity in wiring. Sensitivity and quality are well up to standard. Point-to-Point wiring diagram. Instructions and parts list 1/9. This receiver can be built for a maximum of £4/19/6 including cabinet. Available in brown or cream bakelite or veneered walnut.

EXTENSION SPEAKERS. Handsome walnut veneered cabinets. All standard 2-3 ohms. 6in. 29/9; 8in. 35/6.

R.S.C. A12 STEREO AMPLIFIER KIT

4 GNS.

A complete kit of parts to construct a good quality 3 + 3 watt (total 6 watt) stereo amplifier providing really life-like reproduction. Suitable for use with all stereo pick-up heads at present available. Ganged volume and tone controls. Preset balance control. Outputs for matching 2-3 ohm speakers. For 200-250 v. A.C. mains. Astonishing value.

W.B. "STENTORIAN" HIGH FIDELITY P.M. SPEAKERS

HF1012, 10 watts, 15 ohms (or 3 ohm) speech coil. Where a really good quality speaker at a low price is required, we highly recommend this unit with an amazing performance. £4/10/9. Please state whether 3 ohm or 15 ohm required.

SELENIUM RECTIFIERS

We can quote special prices for quantities of 12 to 10,000 of most types. Special types made to order.

L.T. Types	H.T. Types H.W.
2/6 v. 1 a. h.w. ... 1/9	120 v. 40 mA. ... 3/9
6/12 v. 1 a. h.w. ... 2/8	250 v. 60 mA. ... 3/11
Following F.W. (Bridge)	250 v. 60 mA. ... 4/11
6/12 v. 2 a. ... 3/11	250 v. 80 mA. ... 6/11
6/12 v. 2 a. ... 6/11	250 v. 250 mA. ... 12/9
6/12 v. 3 a. ... 9/9	Contact Cooled
6/12 v. 4 a. ... 12/3	50 v. 80 mA. ... 6/11
6/12 v. 5 a. ... 14/6	250 v. 75 mA. ... 8/11
6/12 v. 6 a. ... 15/6	F.W. (Bridge)
6/12 v. 10 a. ... 25/9	
6/12 v. 15 a. ... 35/9	

JACK PLUGS. Standard type complete with 4ft. screened lead. 1/11 each.
JUNCTION TRANSISTORS. R.F. Type, 11/6. Audio type, 5/9. Power type Goltop V15/10P 2 watts, 17/9. OC71, 10/-, OC72 17/-, XB102 10/-, XB104 10/-, XA101, OC44, XA102 17/6, and many other types.
RECORDING HEADS. Baird Record Playback and Erase (Housed in one container), 9/6 pr.

All Battery Chargers and Kits for 200-230-250 v. 50 c/s. A.C. Mains

HEAVY DUTY CHARGER KIT

6/12 v. variable charge rate up to 8 amps. Consisting of Mains Trans., F.W. (Bridge) Selenium Rectifier, 0-7 amp. meter, multi-position switch with knob, fuses, fuse-holders, panels, plugs, and circuit. Only 59/6. Post 4/6.

ASSEMBLED CHARGERS

6 v. 1 a. 19/9
6 v. 2 a. 29/9
6/12 v. 1 a. 29/9
6/12 v. 2 a. 38/9
6/12 v. 4 a. 56/9
Above ready for use with mains and output leads. Cases well ventilated and finished in stoved blue hammer. Carr. & pkg. 3/6.

CHARGER TRANSFORMERS

200-230-250 v. 50 c/s.
0-9-15 v. 1 1/4 a. 12/9
0-9-15 v. 2 1/4 a. 15/9
0-9-15 v. 3 a. 16/9
0-9-15 v. 5 a. 19/9
0-9-15 v. 6 a. 23/9

TANNOY RE-ENTRANT LOUDSPEAKERS. 8 watt
7.5 ohms 22/9
Or a pair for 2 Gns.

BATTERY CHARGER KITS

Consisting of Mains Transformer F.W. Bridge, Metal Rectifier well ventilated steel case. Fuses, fuse-holders, grommets, panels and circuit. Carr. 2/9 extra.
6 v. or 12 v. 1 amp. 24/9
As above, with ammeter ... 32/9
6 v. 2 amps. 25/9
6 v. or 12 v. 2 amps. 31/6
6 v. or 12 v. 2 amps. 42/9 (inclusive of ammeter)
6 v. or 12 v. 4 amps. 53/9
6 v. or 12 v. 4 amps. with variable charge rate selector and ammeter 59/9
CHARGER AMMETERS
0-1.5 amp., 0-3 amp., 0-4 amp., 0-7 amp., 0-25 amp., 0-60 amp. 8/9

ASSEMBLED CHARGER

6 v. or 12 v. 2 amps. Fitted Ammeter and selector plug for 6 v. or 12 v. Louvered metal case, finished attractive hammer blue. Ready for use with mains and output leads. Double Fused. Only Carr. 3/9. **49/9**
As above, but for 3 amp. charging. Only 59/6. Carr. 3/9

ASSEMBLED 6 v. or 12 v. 4 amps.



Fitted Ammeter and variable charge selector. Also selector plug for 6 v. or 12 v. charging. Double fused. Well ventilated steel case with blue hammer finish. Ready for use with mains and output leads. Carr. 5/- Or Deposit 13/3 and 5 monthly payments of 13/3.

As above, but for 6 amp. charging 4 GNS. Carr. 5/-. Or Deposit 16/- and 5 monthly payments of 16/-. The 6 amp. model only is slightly store soiled and is being offered at well below usual price.

VIBRATORS. Oak and Wearing, synchronous 7-pin, 2 v 7/8, 6 v. 8/3, 12 v. 4-pin non-synchronous 7/9.
2 v. 16 A.H. EX. GOVT. ACCUMULATORS. New Boxed. Only 5/6 each, 3 for 15/-, plus 3/6 carr.

EX. GOVT. MAINS TRANSFORMERS

All 200-250 v. 60 c/s. input.
Fr. 0-110-200-230-250 v., 275-0-275 v. 100 mA., 6.3 v 7 a., 5 v. 3 a. 22/9
250 v. 60 mA., 6.3 v. 2 a. 10/11
300-0-300 v. 60 mA. 6.3 v. 2 a. 11/9
265-0-265 v. 150 mA., 6.3 v. 1 1/2 a., 5 v. 3 a., 5 v. 3 a. 29/11
250-0-250 v. 100 mA., 6.3 v. 2 a., 5 v. 2 a. 18/9
0-24-26-28 v. 15 amps. A.C. conservative Govt. rating (marked with D.C. rating after rectification) 69/8. Carr. 15/-
0-10-20-25 v. 24 a. (Govt. rating) 79/6. Carr. 16/-
AUTO 500 watts 0-215-220-225-230-235-240 v. 29/9 Carr. 7/6. 50 watts, 0-110/120/230/250 v. 8/11

D.C. SUPPLY KITS. Suitable for electric trains. Consists of mains trans. 200-250 v. 60 c.p.s.; 12 v. 1 amp. selenium rect. (F.W. Bridge); 2 fuseholders, 2 fuses, charge direction switch, variable speed regulator, partially drilled steel case and circuit. Very limited number, 33/9.

EX. GOVT. SMOOTHING CHOKES

200 mA., 3-5 H., 50 ohms. Parmeko 8/9; 100 mA., 5 H., 100 ohms 3/11; 150 mA., 10 H., 50 ohms 9/9; 80 mA., 20 H., 900 ohms 5/9; 120 mA., 12 H., 100 ohms 8/9; 50 mA., 50 H., 1,000 ohms 6/9; 100 mA., 10 H., 100 ohms 6/9; 60 mA., 5-10 H., 250 ohms 2/11.

EX. GOVT. CASES. Well ventilated, black crackle finished, undrilled cover. Size 14x10x8 1/2in. high. IDEAL FOR BATTERY CHARGER OR INSTRUMENT CASE. COVER COULD BE USED FOR AMPLIFIER. Only 9/9, plus 2/9 post.

WAYNE KERR SIGNAL GENERATORS. Type CT53. 3.9 to 300 megacycles. Suitable for aligning V.H.F. Radio or T.V. receivers. Output 1 micro-volt to 10 milli-volts. Worth approx. £100. Limited number at 19 Gns., with charts.

P.M. SPEAKERS. 2-3 ohm 2 1/2in. Perdio 21/9. 5in. Goodman 17/9. 7x4in. R.A. Elliptical 19/9. 6in. Rola 19/9. 8in. Rola 19/9. 8in. Goodman 25/9. 8x6in. Elac with high flux magnet 25/9. 10in. R.A. 23/9. 10x6in. Elliptical Goodman 29/9. 12in. R.A. 29/11. 12in. R.A. 3 or 15 ohms. 10 watts, 12,000 lines, 59/6.

TWEETERS, 4in. Plessey, 3 ohms, 18/9. R.A. 15 ohms 25/9

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

HIGH FIDELITY PUSH-PULL UNIT EMPLOYING SIX VALVES. EF86, EF86, ECC83, 6X4, 6X4. Separate Control Pre-Amp. stages are incorporated. Sensitivity is extremely high. Only 12 millivolt input is required for full output. **THIS ENSURES THE SUITABILITY OF ANY TYPE OR MAKE OF MICROPHONE OR PICK-UP.** Separate Bass and Treble controls give both "lit" 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 purpose. **AN OUTPUT SOCKET WITH PLUG IS INCLUDED FOR SUPPLY OF 300 v. 20 mA. and 6.3 v. 1.5 A. FOR A RADIO FEEDER UNIT.** Price in kit form with easy-to-follow wiring diagrams.



Or Factory built with 12 months' following wiring diagrams. **ONLY 11 Gns.** ON ASSEMBLED UNITS. DEPOSIT 31/9 and 9 monthly payments of 31/9. Carr. 10/-

Cover as illustrated 18/9 extra. Type 807 output valves are used with High Quality Sectionally wound output transformer specially designed for Ultra Linear operation. Negative feedback of 20 D.B. in main loop. **CERTIFIED PERFORMANCE FIGURES ARE EQUAL TO MOST EXPENSIVE UNITS AVAILABLE.** Frequency response ± 3 D.B. 20-20,000 c/s. Tone Controls ± 12 D.B. at 50 c/s. ± 12 D.B. to -6 D.B. at 12,000 c/s. Hum and noise 70 D.B. down. Good quality reliable components used. Chassis finished blue hammer. Overall size 12 x 9 x 9 in. approx. Power consumption 150 watts. For A.C. mains 200-250 v. 50 c/s. Outputs for 3 and 15 ohm speakers. **EQUALLY SUITABLE FOR THE CONNOISSEUR OR FOR LARGE HALLS, CLUBS OR OUTSIDE FUNCTIONS, IDEAL FOR USE WITH MUSICAL INSTRUMENTS SUCH AS STRING BASS, ELECTRIC ORGAN, GUITAR, etc.** POE DANCE BANDS, GARRISON THEATRES, 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.

LINEAR L45 MINIATURE 4/5 W. QUALITY AMPLIFIER. Suitable for use with any record playing unit and most microphones. Negative feedback 12 D.B. Bass and Treble controls. For A.C. mains input of 200-250 v. 50 c/s. Output for 9/3 ohm speaker. Three miniature Mullard valves. Size only 6 x 5 x 5 1/2 in. high. Chassis fully isolated from mains. Guaranteed 12 months. **Only £5/19/6** Or Deposit 22/- and 5 monthly payments of 22/- . Send S.A.E. for leaflet.

GL3A MINIATURE 3 WATT GRAM AMPLIFIER
For 200-250 v. 50 c/s. A.C. mains. Overall size only 11 1/2 x 2 1/2 x 5 1/2 in. Fitted Vol. and Tone Controls with mains switch. Designed for use with any kind of single player or record changing unit. Output for 2-3 ohm speaker. Guaranteed 12 months. **Only 59/6.**

R.S.C. A7 3-4 WATT QUALITY AMPLIFIER. Spec. exactly as A5 below with exception of output voltage. Complete kit of parts, diagrams and instructions £3/15/-, carr. 9/6.

R.S.C. A5 4-5 WATT HIGH GAIN AMPLIFIER

A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high-fidelity pick-up heads in addition to all other types of pick-ups and practically all mikes. Separate Bass and Treble controls are provided. These give full long playing record equalisation. Hum-level is negligible being 71 D.B. down. 16 D.B. of negative feedback is used. H.T. of 300 v. 28 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 22/- extra, plus 3/6 carriage. Or Deposit 22/- and five monthly payments of 22/- for assembled unit.

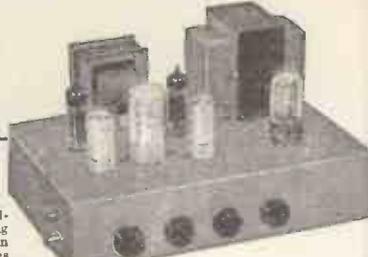


R.S.C. TRANSFORMERS Fully Guaranteed. Interleaved and Impregnated.

MAINS TRANSFORMERS. Primaries 200-250-250 v. 50 c/s.	
FULLY SHROUDED UPRIGHT MOUNTING	
200-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	17/6
300-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	25/9
300-0-350 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.	33/9
425-0-425 v. 200 mA., 6.3 v. 4 a., 5 v. 3 a.	49/9
TOP SHROUDED DROP-THROUGH TYPE	
280-0-280 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a.	18/9
350-0-350 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a.	18/9
230-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9
300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9
300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a., 6.3 v. 2 a., 5 v. 2 a.	29/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	29/9
FRAMED DROP-THROUGH TYPE	
250-0-250 v. 100 mA., 6.3 v. 2 a.	19/9
300-0-300 v. 150 mA., 6.3 v. 2 a., 5 v. 2 a.	27/9
ELIMINATOR TRANSFORMERS. Primaries 200-250 v. 50 c/s.	
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. Primaries 200-250 v. 50 c/s.	
6.3 v. 1.5 a.	7/9
6.3 v. 2 a.	7/9
6.3 v. 2 a.	7/9
0-4-6.3 v. 2 a.	7/9
6.3 v. 6 a.	17/6

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, 6Y3. 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** "Lit" and "Cut." Frequency response ± 3 D.B. 30-30,000 c/s. Six negative feedback loops. Hum level 60 D.B. down. **ONLY 23 millivolts INPUT required for FULL OUTPUT.** Suitable for use with all makes and type 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 plus provides 300 v. 30 mA. and 6.3 v. 1.5 a. For supply of a **RADIO FEEDER UNIT.** Size approx. 12.9-in. For A.C. mains 200-250 v. 60 c/s. Output for 3 and 15 ohm speakers. Kit is complete to last unit. Chassis is fully punched. Full instructions and point-to-point wiring **ONLY 8 Gns.** Carr. diagrams supplied. (Or factory built 45/- extra). **ONLY 8 Gns.** Carr. 10/- If required louvered 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 AMPLIFIER



JUNIOR 5 WATT. High Quality Output. Separate Bass and Treble "cut" and "boost" controls Sensitivity 15 mv. High Flux 8in. /speaker. Input sockets for Radio/Tape or Gram Pick-up and Mike /Instrument Pick-up. Handsome strongly made cabinet (size approx. 14 x 14 x 7in.). Finished in satin walnut and fitted carrying handle. **£8/19/6** Carr. 7/6. Or Deposit £1 and 9 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, a 12in. P.M. for Bass notes, and 1 7/4 in. elliptical for Treble. Cabinet is well made and finished satin walnut. Size approx. 18 x 18 x 8in. 15 Gns. Plus 10/- carr. **TERMS.** DEPOSIT. 34/9, and 9 monthly payments 34/9. Both models for 200-250 v. A.C. mains.

STAR GALAXY 4-SPEED MIXER AUTO-CHANGERS. Brand new, cartoned. Turnover sapphire stylus. Many exclusive features. Unique design motor virtually free from rumble For 200/250 v. A.C. mains. Limited number tested and guaranteed. **£5/19/6.** Carr. 4/6.

COLLARO CONQUEST 4-SPEED AUTO-CHANGERS. With studio pick-up with turnover head. **BRAND NEW.** Cartoned. Latest model. For 200-250 v. A.C. mains. **£7/19/6.** Carr. 4/6.

B.S.R. MONARCH AUTO-CHANGERS. Type UA8, 4 speed T/O Pick-up with sapphire stylus **£7/19/6.** Carr. 4/6.

COLLARO JUNIOR. 4-speed Single Players with HIFI T/O crystal pick-up head, **£3/19/6.**

LOUDSPEAKERS IN POLISHED WALNUT FINISHED CABINET. Gauss 12,000 lines. Speech coil 3 ohms or 15 ohms. Only £4/19/6. Carr. 6/-. **TERMS:** DEPOSIT 11/- and 9 monthly payments of 11/-.

12in. 20 WATT 15,000 line /speakers 15 ohms, in Cabinet finished as above. Size 18 x 18 x 8in. **£7/19/6** or Deposit 17/9 and 9 monthly payments of 17/9.

ACOS HGF59 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 GC3 19/9.

ACOS HIGH FIDELITY PICKUPS. GP34 with HGF59/52 Cartridge. Turnover sapphire stylus, cream finish. Limited number at approx. half price. Only 29/11.

Push-pull 8 watts 6V8 to 3 ohms	5/9
Push-pull 8 watts EL84 to 15 ohms	8/9
Push-pull 10-12 watts 6V8 to 3 or 15 ohms	18/9
Push-pull 10-12 watts to match 6V8 to 3-6 or 15 ohms	17/9
Push-pull EL84 to 3 or 15 ohms	17/9
Push-pull Ultra Linear for Mullard 610	27/9
Push-pull 15-18 watts, sectionally wound, 6L6, KT66, etc., to 3 or 15 ohms.	23/9
Push-pull 20 watt high-quality sectionally wound, 6L6, KT66, etc., to 3 or 15 ohms	47/9
SMOOTHING CROKES	
250 mA., 5 H., 100 Ω 11/9	80 mA. 10 H., 350 Ω 5/6
150 mA., 7-10H, 250 Ω 11/9	60 mA., 10 H., 400 Ω 4/11
100 mA., 7-10H, 200 Ω 8/9	1 amp. 0.5 Ω L.T. type 6/6
PARMEKO MAINS TRANSFORMERS. Fully shrouded	
450-0-450 v. 120 mA., 6.3 v. 4 a., 5 v. 3 a.	29/9
500-0-500 v. 120 mA., 6.3 v. 4 a., 5 v. 3 a.	31/9



PLESSEY DUAL CONCENTRIC 12in. P.M. SPEAKERS

(15 ohms), consisting of a high quality 12in. speaker of orthodox design supporting a small elliptical speaker ready wired with choke and condensers to act as tweeter. This high fidelity unit is highly recommended for use with our A11 or any similar amplifier. Rating is 10 watts. Gauss 12,000 lines. Price only **£5/17/6** Or Deposit 13/6 and 9 monthly payments of 13/6.

R.S.C. MANCHESTER, LEEDS & BRADFORD (LEEDS) LTD.

Open to callers at the following branches:—
5-7 Court (Mecca) Arcade, Leeds. 1.
54-56 Morley Street (above Alhambra), Bradford.
8-10 Broad Street (Market St.), Manchester, 2.
TERMS: C.W.O. or C.O.D. No C.O.D. under £1. Postage 1/9 extra on all orders under £2. 2/9 extra under £5 unless carriage stated. Trade supplied. Post orders to Mail Order Dept.
29-31 Moorfield Road, Leeds, 12.

C.R.T. ISOLATION TRANSFORMERS

For Cathode Ray Tubes having Heater/Cathode short circuit and for C.R. Tubes with falling emission. Full 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/- each Type B. Mains input. Low capacity. Multi Output 2, 3, 6, 10 and 13 volts. Optional boost 25% and 50%. Suitable for all Cathode Ray Tubes, 21"-

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

WIRE-WOUND RESISTORS { 1/3 1/6 3/- } 25 ohms-10,000 ohms. 15,000 ohms -50,000 ohms, 5 w. 1/9; 10 w. 2/3

WIRE-WOUND POTS, 3 w. WIRE-WOUND POTS, 4 w. Pre-set Min. T.V. type Standard size Pots, long Knurled Slotted knob, Spindle High Grade. All values 100 ohms to 50 K. 3/- ea., 30 K., 50 K., 4/- Dillo, 1 w. Carbon Track W/W EXT. SPEAKER 30 K. to 2 Meg. 3/- CONTROL 10Ω, 3/- O/P TRANSFORMERS. Heavy duty 50 mA., 4/6. Multi-range push-pull, 7/6. Miniature 3V4, etc., 4/6. Hygrade Push-pull 10 watts, 15/6. MULLARD "610" 6k or 8k 30/- L.F. CHOKES 15/10H 60/65 mA., 5/- 10H 85 mA., 10/6. 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. 4a. Rectifier 6.3 v. 1 a., tapped 5 v. or 4 v. 2 a. DILLO 250-0-350 22/6 MINIATURE 220 v. 90 mA., 6.3 v. 1 a. 10/8 MIDGET, 250 v. 45 mA., 6.3 v. 2 a. 15/8 SMALL, 220-0-220 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. 1 1/2 a., 7/6; 3 amp. 10/8 GENERAL PURPOSE LOW VOLTAGE. Outputs 3, 4, 6, 8, 9, 10, 12, 15, 18, 24 and 30 v. 22/6

ALADDIN FORMERS and cores, 1 1/2 in., 8d.; 1 in., 10d. 0.3in. FORMERS 5937 or 808 and Cans TV1 or 2, 1/2 in. sq. x 2 1/2 in. or 1 1/2 in. sq. x 1 1/2 in., 2/- with cores.

SLOW MOTION DRIVES. Epicyclic ratio 6:1, 2/3. SOLON. Midget Soldering Iron, 230 v. 25 w., 24/- REMLOY INSTRUMENT IRON. 230 v. 25 w., 17/6. MAINS DROPPERS. 3 x 1 1/2 in. 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 1 x 1 1/2 in.

ACOS CRYSTAL STICK MIKE 39-1. Bargain 37/6.

MIKE TRANSF. 60:1, 3/9 ea., 100:1 Potted 10/6. LOUSPEAKERS P.M. 3 OHM. 5in. Rola, 17/6 6in. x 4in. Rola, 18/- 7in. x 4in. R.A., 21/- 10in. x 6in. Rola, 27/6 8in. Plessey, 19/6 6 1/2in. 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, 105/- 12in. Baker foam suspension 15 wt. 35 ohm, 88. 12in. 15 ohm Plessey 10 wt. 45/-

I.F. TRANSFORMERS 7/6 pair 465 kc/s. slug tuners miniature can 2 1/2 x 1 1/2 in. High Q and good bandwidth. By Fry Circuit. Data sheet supplied.

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CRYSTAL DIODE G.E.C. 2/- GEX34, 4/- 40 Circuits, 3/- E.R. HEADPHONES. 4,000 ohms, brand new, 15/- pair. SWITCH CLEANER Fluid, squirt sprout, 4/3 1in. TWIN GANG CONDENSERS. 365 pf. Miniature, 1 1/2 in. x 1 1/2 in., 10/- .0005 Standard with trimmers, 9/-; less trimmers, 8/- Midget 7/6; Single 50 pf., 2/6; 100 pf., 150 pf., 7/- Solid dielectric 100, 300, 500 pf., 3/6. VALVE HOLDERS. Fax. mt. Oct. 4d. EP50, EA50, 6d. B12A CRT. 1/3. Eng. and Amer. 4, 5, 6, 7 pin. 1/- MOULDED Muds or Int. Oct. 6d. B7G, B8A, B8G, B9A, 9d. B7G with can, 1/6; B12A, 1/3. B9A with can, 1/9. CERAMIC EP50, B7G, B9A, Oct. 1/-; B7G, B9A Cans, 1/9. SPEAKER FRET. Gold Cloth 17in. x 25in., 5/- 25in. x 35in., 10/- Tygan 64in. wide, 10/- ft. 27in. wide, 5/- ft. Samples 8A-E

WAVECHANGE SWITCHES 2 p. 2-way, 3 p. 2-way; short spindle 2/6 5 p. 4-way, 2 wafer, or 3 p. 11-v. 3 wafer long spindle 3/6 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

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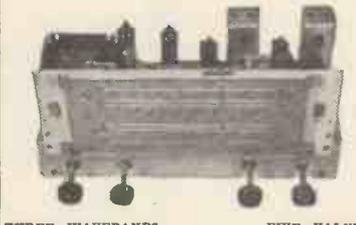
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PRINTED CIRCUIT BATTERY PORTABLE KIT

Medium and long wave. Powerful output from 6in. high Flux Speaker. T.C.C. Printed circuit and condensers. All components of finest quality clearly identified for assembly with full instructions. Osmor Ferrite Aerial and Coils, Rexine covered attache case type cabinet. Size 12in. x 8in. x 4in. Batteries used B126 (L5512) and AD35 (L5040), 10/- extra. Details and instructions 1/9 (free with kit). Mains Unit ready made for above 39/6. Same size as batteries, sold separately.

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THREE WAVEBANDS S.W. 16 m.-50 m. M.W. 200 m.-500 m. L.W. 800 m.-2,000 m. 12-month Guarantee. A.C. 200/250 v. 4-way switch. Short-Medium-Long-Gram. A.V.C. and Negative Feedback, 4.2 watts. Chassis 13 1/2 in. x 5 1/2 in. x 2 1/2 in. Glass Dial Size 10 x 4 1/2 in. horizontal or vertical. Two Pilot Lamps. Four Knobs. Walnut or Ivory. Aligned and calibrated. Chassis isolated from mains.

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Gascode circuit using Valve ECC84, 17db gain. Kit 29/5 less power; or 49/6 with power pack. Plans only 6d. Also Band 1 version same prices. (PCC84 Valve if preferred)

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3B4	2/6	6BJ7M	6/6	EBC41	5/6	HY124	3/6
3V4	4/6	6BN7	6/6	EBF80	5/6	PT1	9/6
5U4	7/6	6V6G	6/6	ECC84	9/6	PCC84	9/6
6Y3	7/6	6X4	7/6	ECP80	9/6	PCF80	9/6
6Z4	9/6	6X5	6/6	ECH42	10/6	PLC82	11/6
6AM6	5/6	12A6	7/6	ECL80	10/6	PN25	6/6
6BE6	7/6	12AT7	8/6	ECL82	10/6	PL82	10/6
6BG6	9/6	12AU6	8/6	ECP80	9/6	PT80	7/6
6BW6	9/6	12AX7	8/6	EF41	9/6	PY81	9/6
6D6	6/6	12BA6	8/6	EP50	5/6	PY82	2/6
6FG6	7/6	12BE6	8/6	EF80	8/6	8P61	3/6
6HG6T	3/6	12K7	6/6	EP86	14/6	UB41	9/6
6J5	5/6	12Q7	6/6	EP82	5/6	UCB42	9/6
6K4	5/6	12SD7	6/6	EP82	5/6	UCB2	5/6
6J7G	6/6	35Z4	7/6	EL41	9/6	UL41	9/6
6K6GT	6/6	80	9/6	EL84	8/6	UY41	8/6
6K7G	5/6	807	5/6	EZ40	7/6	U22	2/6
6K8G	7/6	954	1/6	EZ80	7/6	U22	8/6

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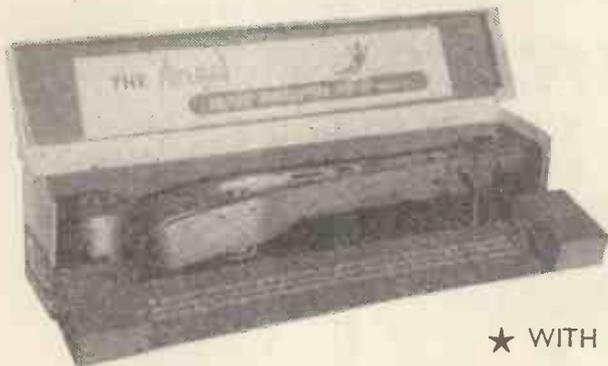
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The world famous E.M.I. Angel Transcription P.U.

SPECIFICATION

Physical
 Length 15½ inches (40.32 cms.)
 Height 2½ inches (6.41 cms.)
 With 2½ inches (6.03 cms.)
 Centre of base to stylus tip 12 inches (30.73 cms.) Approx. overall.
Stylus
 A diamond stylus is fitted to the 33½/45 r.p.m. head supplied
Head Impedance
 1 ohm (measured at 1,000 c.p.s.)
Frequency Response
 For a constant recorded velocity the frequency response is sensibly level within the following limits: with micro-groove stylus 20—16,500 c.p.s. With standard stylus 20—20,000 c.p.s.
Distortion
 Measured at 400 c.p.s., the total harmonic distortion is less than 5% for a recording level of +20 db referred to 1 cm./sec. r.m.s. transverse velocity.
Sensitivity
 80 mV at secondary of transformer provided from a recording level of +10 db referred to 1 cm./sec. r.m.s. velocity.
Weight at Stylus Point
 Variable from 3—10 grammes as required.



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A PICKUP FOR THE CONNOISSEUR ORIGINALLY PRICED AT £17/10/-. WE CAN OFFER THE LAST REMAINING FEW AT

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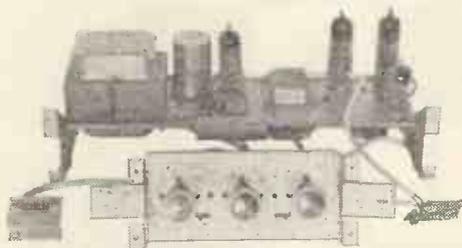
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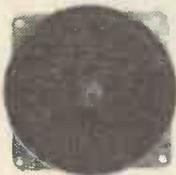
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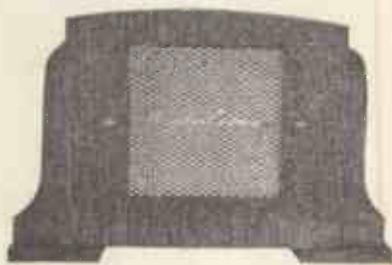
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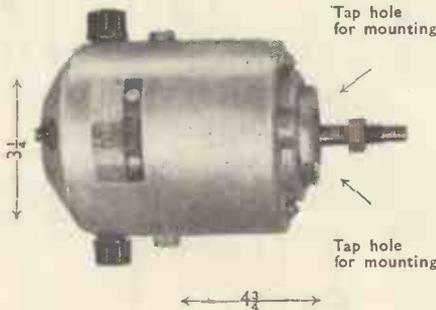
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400 MILLIWATTS OUTPUT

To build yourself Medium and Long Waves—Push-Pull Superhet A.V.C. Perfect Car Radio reception. Size 10in. x 6 1/2in. x 4 1/2in. at base tapering to 4in. at top.

Very attractive two-tone grey Vynild covered cabinet with black and gold printed escutcheon plate, cream and gold knobs, handle and cabinet fittings. ★ Weight—complete with long-life 7 1/2 volt battery—4 1/2 lb. ★ 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, 3 1/2in. above Cabinet when fully extended.

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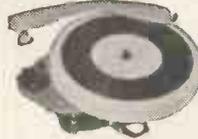
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B.S.R. TU9. 4-speed single-record unit with separate lightweight pick-up fitted with T.C.8H. crystal insert and sapphire styli. An ideal unit for a small portable gramophone. Brand new and fully guaranteed. **SPECIAL PRICE:** 75/- plus 2/6 P. & P. or motor and turntable only at 42/6 plus 2/6 P. & P. or Pick-up only at 27/6 plus 1/6 P. & P.

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ONLY 66/19/6 plus 3/6 P. & P. **GARRARD RC120/4H.** 4-speed autochanger with GC2 Insert. Brand New, fully guaranteed. **68/19/6.** P. & P. 3/6.

JUST ARRIVED!
LATEST B.S.R. UA14. 4-speed. Attractive appearance. Wired for stereo. Fully guaranteed. **67/19/6,** plus 3/6 P. & P.

B.S.R. UA8 MONARCH. 4-speed Mixer Autochanger, complete with turnover crystal insert and Sapphire Styli. Few only, now at **66/19/6** plus 3/6 P. & P. Brand new and fully guaranteed.

THE LATEST COLLARO "CONQUEST." 4-speed autochanger in cream with Studio "O" insert. Brand new, fully guaranteed, **67/19/6** plus P. & P. 3/6.

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No. 38 AFV WALKIE-TALKIE. A wonderful offer. This famous trans-receiver 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.

LATEST COLLARO STUDIO TAPE TRANSCRIBOR. 3 motors, 3 speeds, 1 1/2, 3 1/2, 7 1/2 i.p.s., takes 7in. spools. Push-button controls, **65/15/-** plus 5/- P. & P. Usual H.P. facilities.

TAPE RECORDER AMPLIFIER for use with Collaro Studio Transcrip- tor. Size 1 1/2 x 5 x 3in. Uses 3 valves, magic eye, contact cooled metal rectifier. Incorporates mike/gram/radio inputs, ext. i.s. jack, superimposing switch, **62/12/-.** Complete with matching knobs (Gold/Black). Circuit etc. Post 3/6.

LATEST B.S.R. "MONARDECK." Single speed Tape Deck. Takes 5 1/2in. spools—3 1/2 i.p.s. At **69/19/6** only plus 5/- P. & P.

TRANSISTORS!!!
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RED SPOT (Audio/Experimental App- lication) 5/- ea.
WHITE SPOT, R.F. up to 2.5 Mc/s 5/- ea.
Attractive discounts for bulk pur- chases. The above is a selection only. Full range in stock by all leading manufacturers. Let us have your enquiries.

(ALL POST FREE)

FRUSTRATED EXPORT Not repeatable! **L. M. and S.W. SUPER- HET 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 2 1/2in. x 10 1/2in. x 10 1/2in. These cabinets are slightly soiled owing to storage, but each is guaranteed un- used, in serviceable condition, tested prior to despatch. Price **65/19/6** only plus P. & P. 7/6, plus 27/6 for A.C. Mains Conversion Components if required. **OUTSTANDING BUY!**

12 CHANNEL TV TURRET TUNER (By famous manufacturer).

Brand new, **NOT** surplus or ex-equipment. **35 Mc/s. I.F. FCC 84** and **PCF 80** valves. Com- plete with coils: Band I Channels 1 to 5. Band III Chan- nels 6 to 11. In manufacturer's original carton. Fully guaranteed at only **39/6** plus 2/6 P. & P.

AMPLIVOX HEADSET SPECIAL (not surplus). As used in up-to-date ships, aircraft, etc. Excellent quality super lightweight, low impedance, magnetic headphones complete with button microphone attached and plastic ear moulds. Absolutely brand new. **45/-** pair. Plus 1/6 P. & P.

ACOS MIC 39-1. Crystal stick micro- phone. List price 5 gns. Our price **39/6** plus 1/6 P. & P.
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SUPER MAGNETIC RECORDING

TAPE SPECIAL!!! Trade enquiries invited First delivery Famous American Ferrodynam- ics Acetate Base High Quality Recording Tape. An enthusiasts's "must." Brand new (NOT SUB-STANDARD), 5in. 600ft. 16/-, 5in. 900ft. 18/6, 5 1/2in. 1,200ft. 23/6, 7in. 1,200ft. 25/-, 7in. 1,800ft. 35/-. Professional quality "MYLAR" Du Pont 5in. 1,200ft. 37/6. 7in. 1,800ft. 44/-. 7in. 2,400ft. 60/-, each on plastic spool. P. free.



DECCA PORTABLE AMPLIFIER. As supplied in famous DECCA-MATIC III. Complete with small cream knobs. Full range tone and volume controls. Employs ECL82 valve. Size 3 x 3 1/2 x 8 1/2in. Only **59/6** plus 2/6 P. & P. **SPECIAL CELESTION** 8 x 6in. elliptical high flux loudspeaker 30/- plus 1/- P. & P. to fit.

VERY ATTRACTIVE PORTABLE CABINET in two-tone rexine covering for accommodating the above items and ancillary equipment. **75/-** plus 5/- P. & P.
Note. If the above three items are purchased together they will be supplied at the special inclusive price of **67/2/6** plus 6/6 P. & P.

EXTRA SPECIAL OFFER!!!

A small three-valve **PORTABLE RE- cord-PLAYER AMPLIFIER** mounted on baffle 12 x 7in., with High Flux 6 1/2in. Loudspeaker. Valve line-up ECC83, EL84, EZ80. Incorporates separate bass and treble controls. Max. output 3 watts. Will match all types of high impedance pick-up. Ready to use, **65/12/6.** P. & P. 3/6.
NEW STYLE CABINET finished in two-tone Leatherette. Will accom- modate above Amplifier and Baffle without modification, also most types of Ancillary Equipment. Overall size 18 x 13 1/2 x 8 1/2in. Fitted with carrying handle, **63/9/6** plus 5/- P. & P.
NOTE. If both items purchased together they will be supplied at a special inclusive price **68/7/6** plus 6/6 P. & P.



TWO-TRANSISTOR PERSONAL PORTABLE. 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. 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, Deaf-aid type earpiece, wiring wire and even solder, **ONLY 69/6** or complete with single standard High Resistance earphone at **ONLY 62/6.** Plus 1/6 P. & P. Parts price list and Easy Lay-out Plans 2/- post free.

SUPER PERSONAL PORTABLE. A wonderful

little set that you can take anywhere. Ideal for camp- ing, picnics, 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/-.** 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.



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BLOCK PAPER TYPES. 0.002 mfd., 15,000 V.P.K., 100 amps. discharge at 500 times per second, size 1 1/2 x 9 x 3 1/2 in., ceramic insul., 25/6 each, 3/- post. 0.65 mfd., 16 kV. wkg. at 71 deg. C., ceramic insul., size 1 1/2 x 12 x 8 in., 30/- each, 5/- post. 10 mfd., 1,500 v. wkg., 15/- each, 3/6 post. 8 mfd., 1,300 v. wkg., 11/6 each. 8 mfd., 600 v. wkg., 5/- each. 6 mfd., 600 v. wkg., 5/6 each. 4 mfd., 600 and 750 v. wkg., 4/6 each. 4 mfd., 1 kV., 5/6 each. 4 mfd., 2 kV. wkg., 6/6 each.



POWER UNITS

100-250 volt A.C. Input, 24 v. at 3 amps. or 12 v., twice at 3 amps. each winding. Continuous tropical rating switched and fused, etc., in metal case that fits 19in. rack, size 10 x 7 x 7 in. Brand new £3/15/-, carr. 7/6 (with circuit).

SMOOTHING UNIT

for the above power supply 2 chokes and 0-1 mA meter. (grade 1) in metal case, same as the p.u., £2, carr. 7/6.



RANGE CONVERTOR

(part of R20 6 Rec.), 115-600 kc/s, on three bands large dial with a Mullhead slow motion drive. Valves EF39, A8TH2, the set can be used with R107, R208, and many other types of receivers 32/6 each. Carr. 7/6

GRAHAM GEARED MOTORS

115 volts A.C., 1/6th H.P., variable speed box 0-106. Size of unit 1 1/2 x 9 x 8 in. £3/10/-. Carr. 10/-
Transformers to operate this unit 35/- each.

SILICA GEL in 16 oz. bags, 5 for 5/- Post 2/-

WIRELESS SET NO. 19, Mk. 2. Two trans./Recs. in one case. "A" set 2-8 Mc/s R/T and CW. "B" set 240 Mc/s. Input. 15 valves 500 microamps meter Variometer, Control box 3B, all leads, key and plug assembly. No. 1 headset Microphone and headphones M/C, and 12-volt rotary power unit. All mounted on the rack, the complete station, £3/10/- Carr. £1

RF DRIVER UNIT. Freq. 100-136 Mc/s, valves 2, 4304CB/c; 2, CV1079; 1, CV1052; 0-100 mA., meter 3 1/2 in. scale, 3 slow motion drives and G.O. section, fits any 19in. rack. Brand new in maker's cases. No charge for case or packing. Price £3 each. Post 10/-

RACKS. 5ft. high, takes 19in., panels at £2, 5/- carr.

MOVING IRON METERS. 0-100 amps., 6in. scale, at £2; 90-150 v., 4in. scale at 35/-, 3/- post.

VENTILATING UNIT. Motor 115 v. 1/20th H.P., A.C., £3 each.

AMERICAN L.T. TRANSFORMERS. Potted type, finished in black crackle and very conservatively rated. (1) 230 v., Input 2 x 0.3 volts CT., at 3 amps. and 6.3 volts at 3 amps. output, 18/3 each. (2) 230 volt input, 2 x 6.3 volts at 3 amps., and 6.3 volts CT., at 3 amps. output, 17/6 each. (3) 230 volts input, 28 volts at 2 amps. and 2 volts at 1 amp., 12/6 each. (4) 230 volts input, 3 x 6.3 volts at 3 amps. CT. 1, 6.3 volts 3 amp., 22/6 each. (All these transformers are new and boxed, please include postage 3/6 each).

MODULATION TRANSFORMERS as used in the BC 640, 40 watts, modulate two, 81 1/2, 39/6 each, brand new, boxed, 3/- post.

AMERICAN COMPUTERS AN-II-70A. Single parallax. Contains 8 relays 10 k., 2 change-over plat. contacts, 8 relays 300 ohms, 2 change-over silver contacts (all d.c. are small type), 9 x 6V6 small GT., 3 x 6X5 GT., and 2 6SN7. Seven small D.C. motors 27 v. 6 relsyn motors, 10 small micro switches. Plus gears, condensers, ball bearings and pots, etc. This unrepeatable bargain, £10 each.

DOUBLE PARALLAX AN-II-70-9. Similar to the above but larger etc. weight 140lbs. Brand new £12/10/- each. Carr. £1.

G.P.O. BREAST MICROPHONES. No. 1 YA 2196 7/6 each. Post 1/6.

DESK TELEPHONES (standard type No. 1) complete with the handset and cord ready to connect to line £2/15/- each, post 3/6, or £5 a pair.

DIPOLE AERIALS vertical H., span 72 inches easy fixing brackets and 25ft. co-ax cable, 37/6 each, carr. 5/- each (new).

120 VOLT BATTERIES (Mfines H.T. units) Cap 6 amps. made up from Nickel Iron Cells Unused, 50/- each, carr. 5/- each.

G.P.O. GENERATORS, as used for ringing 80 to 100 volts output Max., 7/6 each, 1/6 post. New.

VARIABLE RESISTORS, 8 ohms 10 amps. 18/6 each, 3/- post.

25FT. AERIAL MASTS. Heavy galvanised steel tubes, four sections, tapered 2 1/2 to 1 inch. No guy ropes needed, £12/10/- each. Wt. 2 cwt.

RECEIVERS. Type 71 (part of the 1143 TR) 100-130 mc/s. Manual and Xtal controlled, 8xVR91, 3xVR53 and 1xEL32. 25/- each, post 3/6.

TRANSMITTER UNIT. Type 60 for the above, 20/-

ROTARY TRANSFORMERS. Type 52, 24 v. D.C., input 250 v. d.c., at 50 ma. and 6.5 v. at 2.5 amps. in neat box with smoothing, 25/- each, 3/6 post.

APR5 RECEIVERS uhf., 1,000 to 6,000 mc/s., and P58 receivers 300 to 600 mc/s. Also LZ signal gen., freq. meter BC 1277A, all in stock.

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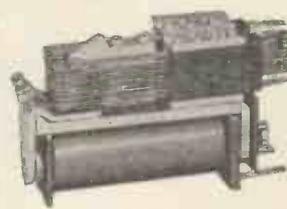
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BUILT UP TO YOUR REQUIREMENTS

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COMPONENT PARTS ALL PLATED

Yokes, 3/- each. Top plates, 3d. each. Fixing Screws (with Armatures, 9d. each. Bottom Plates, 3d. insulators), 2d. each. Adjustable, 1/3 each. each. Buffer Blocks, 6d. Spindles, 1/- each. Armature Screws, adjustable, 4d. each.

BUILD UPS CONTACTS

	Silver	Platinum		Up to	100 Ohms	3/-	5/-
1. C/O	1/3	4/-	..	500	..	4/-	6/-
2. C/O	2/6	8/-	..	1,000	..	5/-	7/-
3. C/O	3/6	12/-	..	5,000	..	6/6	8/6
4. C/O	4/6	16/-	..	10,000	..	9/-	—
6. C/O	6/6	24/-	..	20,000	..	14/-	—
8. C/O	8/6	32/-	..	40,000	..	16/-	—

Other build ups to order; all types of relays built to your specification. 80,000 " to order *Slugged coils extra.

COIL VALUES

SIEMENS HIGH SPEED C/O RELAYS

250 + 250 ohm Twin Coils 6/6 1,000 + 1,000 ohms Twin Coils 10/6
850 + 850 " " 8/6 1,700 + 1,700 " " 17/6

G.E.C. MINIATURE SEALED RELAYS

No.	Ohms	Build Ups	Voltage	Price
Z530001	40	4 C/O	6 v.	17 6
Z530005	2	2 C/O	1.3 v.	12 6
Z530006	40	2 C/O	6 v.	15 0
Z530008	670	2 C/O	24 v.	19 6
Z530010	40	2 C/O 2K	7 v.	17 6
Z530014	2	1 C/O	1.3 v.	10 6
Z530015	40	1 C/O	6 v.	12 6
Z530016	180	1 C/O	12 v.	19 6
Z530018	2,500	1 C/O	48 v.	£1 2 6
Z530019	2	2 C/O 2K	1.3 v.	14 6
Z530020	2	4 C/O	1.3 v.	16 6
Z530021	2	2M	1.3 v.	10 6
Z530022	2	1M 1B	1.3 v.	12 6
Z530023	2	2B 2M	1.3 v.	12 6
Z530024	40	2M	6 v.	12 6
Z530025	40	1M 1B	6 v.	12 6
Z530026	40	2B 2M	6 v.	15 0
Z530027	180	2M	12 v.	17 6
Z530028	180	1M 1B	12 v.	17 6
Z530030	670	2M	24 v.	17 6
Z530031	670	1M 1B	24 v.	17 6
Z530034	2,500	1M 1B	48 v.	£1 2 6
Z530480	670	2B 2M	24 v.	19 6
Z530430	5,000	2 C/O	48 v.	£1 9 6
Z530429	2,500	2 C/O	48 v.	£1 2 6

S.T.C. MINIATURE SEALED RELAY

4184GD 700 2C 24 19 6
4190HC 170 2C 12 17 6

1/6 Post & Packing on all relays.

Send for lists



ROTARY TRANSFORMERS

Delivery ex stock. Quotations on application.

H.T. 31
Input 11.5 v.
Output 250 v. at 120 mA.

H.T. 32
Input 11.5 v.
Output 490 v. at 65 mA.

AS SUPPLIED TO GOVERNMENT DEPARTMENTS AND LEADING MANUFACTURERS. NEW AND BOXED.

ROTARY TRANSFORMERS

Made by DELCO

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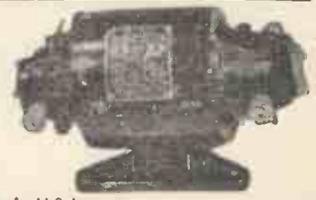
TYPE 2, 37/6. P. & P. 3/6.

Type 1. Dual voltage 12 or 24 v., input 265 v., 120 mA, output; 500 v., 26 mA. output.

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Both types dual output. Made in U.S.A.

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£10 GEIGER COUNTER

Circuit embodies U.K.A.E.A. patent. Specially moulded case. Currently being supplied throughout the world. Three ranges—highly sensitive—light—portable—visual and audible response—plus output socket. Ideal for introduction to radiation measurement and nucleonic circuitry. Specially written 40-page instruction manual supplied. Batteries £2/15/3 extra.

KIT of Parts £4.17.6

Identical Parts. Guaranteed Performance. Manual and printed circuit plates for battery pack supplied (assembled pack £2/15/3 extra). Fully illustrated assembly instructions. Spares and Service permanently available.

REMOTE VIEWING UNIT APS4

Attractive modern American black crackle case housing a fully mu-metal shielded 3in. CRT and two 6J6 B7G miniature valves with all leads contained in a protective 3-foot flexible hose terminating in a large multi socket. Miniature potentiometer is cable driven from knob by front face. Oblong aperture with tinted screen and graticule. Ideal for convenient positioning of monitor screen when bench space is limited. 3 FP7 CRT (Long Persistence green-yellow trace, 6.3 v. heaters) and valves worth the price. 25/- carriage-paid.



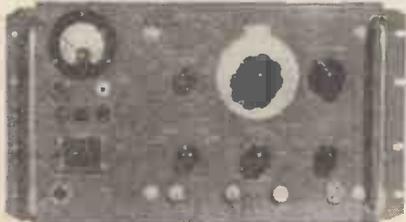
VARIABLE SPEED HYDRAULIC GEARBOX

This specially made oil-filled casing houses a 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 ½in. 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.

SCOPE UNIT T.S. 74 £4/10/- delivered free

A basic scope with brilliance and focus controls on front panel which also contains X-plate terminals, gain control and two-speed timebase switch. Immediately behind the panel is a separate screened compartment that houses two VR65 and a VR92 (tunable input receiver—convert to input amplifier) and a signal generator (3xVR65 and VR135) modulated at two frequencies over its 155 to 255 mc/s range. Substantial EHT and HT power pack (VU120 and 5Z4G) at rear, plenty of free room, four high-voltage pre-set pots, two full length tag boards, 12 valves plus VCRI39A.

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



A few with superficial damage offered unguaranteed and less cables, etc. for £12.10.0 plus 15/- carriage.

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 1000 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 2µ Sec.
 - Seven B7G Valves, Potted "C" core transformers, Paper capacitors, Stabilised HT.
 - Selected spare oscillator, pre-aged spare monitor, 100µA meter.
 - Mains, HT, Bias and Filament supplies fully RF filtered.
 - Combined cabinet/rack mounting case, Pressure sealed, Desiccator, Panel Mains voltage adjustment, Triple fused, in fact, "the lot"!
- Offered straight from Service use, complete with calibration book, cables, circuit diagram and principal technical information, checked serviceable and fully guaranteed **£17.10.0**
Plus 15/- for careful packing and carriage.

ETCH YOUR OWN PRINTED CIRCUIT KITS 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.

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. Brand new, individually tested, fully guaranteed.

DEAF AID VEST POCKET RADIO 55/-

Three modern low-consumption miniature valves in a very sensitive hi-fidelity circuit that only requires the addition of a simple tuned input circuit and a crystal diode to bring your favourite programme in loud and clear. Pre-wound aerial coil on hi-Q ferrite rod. Conversion takes less than an hour without previous experience and using only ordinary tools. Brand new in original pack with latest type crystal earpiece and detachable plastic ear mould plus all conversion parts. Sensitive crystal microphone suitable for immediate use with tape recorder becomes spare on conversion to radio. Kit of parts sold separately—Deaf Aid 40/-, Conversion parts 15/-, batteries 5/-, post free.

1-95-A FIELD STRENGTH METER 100-156 Mc/s

Self contained, tunable-input, valve-voltmeter with telescopic aerial and battery-fed diode rectifier and pentode amplifier for measuring field strength, presence of modulation, and approximate frequency of transmitter. Compensating circuit for state of 1½ and 45 volt batteries. In attractive black crackle case. Brand new. NOW ONLY £2/5/- plus 5/- packing and carriage.

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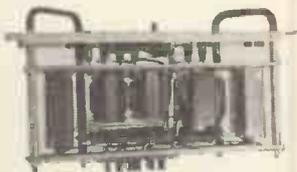
Modern, portable, battery operated, 5-valve Signal Generator with alternative crystal or master oscillator, either optionally modulated by 1,000 c/s Hartley oscillator. Large directly calibrated dial with precision slow motion drive. Five step and variable attenuator. Supplied with matching black crackle carrying case for 6 and 135 volt batteries with 10ft. supply cable and metal cased 1 mA. test meter for checking crystal resonance, etc. Brand new. £2/17/6 plus 7/6 packing and carriage

SIGNAL GENERATOR AND WAVEMETER

Type W.1649. Frequency of signal generator: 140 to 240 mc/s. Accuracy ± 0.5 mc/s. Frequency of heterodyne wavemeter: 155 to 255 mc/s. Accuracy ± 0.2 mc/s. Containing VR.135 and 4-VR.91. 5 meg. crystal. Retractable aerial. Power requirements: 6.3 v. and 120 v. Unit housed in copper lined wooden case. Size: 15½in. x 13in. x 14½in. In good used condition. £2/10/- plus 10/- packing and carriage.

Admiralty Type 107 Rectifiers BIAS RELAY POWER PACK for £1

Unit in totally enclosed rack mounting case. A.C. input 100, 110, 200, 210 up to 250 volts. D.C. output +50/0/-50 V. and 20 V. A.C. for pilot light. Spare A.C. outlets 80-0-80. Twin 9 Henry smoothing chokes and twin 8 uf paper capacitors with 15 k. bleeders. Two 500 mA. mains fuses and three 250 mA. output fuses. Full wave metal rectifier. Circuit diagram inside case. Size 19in. long by 3½in. high. Neat solid job, ready made to fit and forget. £1 carriage paid.



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MEDIUM AND LONG WAVE FULL TUNING

- ★ Plessey Printed Circuit
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- ★ Printed Circuit marked with Component Numbers
- ★ All Components Guaranteed

COMBINED PORTABLE/CAR RADIO

Total Cost of all Components
£11.10.0 P.P. 3/6
 including Cabinet, Battery, Transistors, Car Radio, AVC and all necessary items.



WHEREVER YOU ARE



"FIRST CLASS IN EVERY WAY"

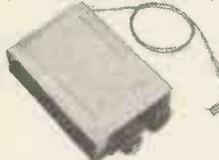
A highly sensitive and selective portable fully tunable on medium and long waves. Performs equally well as a car radio. Low running costs, good looks and ease of construction combine to produce a radio equal to commercial receivers in the 20 gns. class.

★ All components available separately. CALL FOR DEMONSTRATION ★

NEW FREE ILLUSTRATED LEAFLET AND PRICES

MAJOR-3

(3-Transistor Pocket Radio)



- ★ 5-stage Reflex Circuit.
- ★ No Aerial or Earth required.
- ★ Min. Volume Control.
- ★ 3 Ediswan Transistors.
- ★ Medium Wave Tuning.
- ★ Size 4½ x 3 x 1½in.
- ★ Personal phone included.

All parts sold separately.

TOTAL 87/6 P.P. 1/6. BOOKLET FREE

★ NO AERIAL—NO EARTH ★ RECEPTIONS GUARANTEED ANYWHERE

MAJOR-2

(2-Transistor Pocket Radio)



- ★ 4-stage reflex. Medium wave; tunable.
- ★ Very sensitive. No aerial or earth required.
- ★ Complete illustrated layout.
- ★ Over 6 months on one battery. 4½ x 3 x 1½in.
- ★ Weight only 4 oz.
- ★ Personal phone included.

TOTAL 69/6 POST 1/6

FREE BOOKLET: All components sold separately.

★ NO AERIAL—NO EARTH ★ RECEPTIONS GUARANTEED ANYWHERE

8-IN. RCA SPEAKER

8in. R.C.A. Speakers in black crackle cabinets. Brand new sealed in cartons. 45/-. P.P. 2/6.

MARCONI No. 19 SET CRYSTAL CALIBRATOR

CRYSTAL CONTROLLED OSCILLATORS: 10 Kc/s., 100 Kc/s. and 1 Mc/s. Output up to 20 Mc/s. On/Off MODULATOR. With handbook. Un-used. ONLY 79/6. P.P. 2/6.

QUARTZ CRYSTALS FROM 5/- EACH

From 6 Kc/s-47 Mc/s. FT243, FT241, 10XJ and BTG. All types for all purposes. Send for free list.

PACKARD BELL PRE-AMPLIFIER

Low Impedance Mic. Pre-Amp. 6SL7GT and 28D7. Complete in screened box with leads, jack-plugs and handbook. BRAND NEW IN CARTONS, 12/6. P.P. 2/-.

WALKIE/TALKIE TYPE 38 TRANSMITTER/RECEIVER

Complete with 5 valves. In new condition. These Sets are sold without Guarantee, but are serviceable (7 to 9 Mc/s), 22/6. P.P. 2/6. Headphones 7/6 pair, Junction Box 2/6, Throat Mike 3/6, Canvas Bag 4/-, Aerial Rod 2/6.

★★★ SPECIAL PURPOSE VALVES AND INDICATORS ★★★

805 35/-	803 35/-	1625 5/-	QS150/15 10/-	1838 25/-	ACR10 ... 35/-
813 65/-	35T 15/-	2050 12/6	QS1207 ... 10/-	5800 45/-	23D 35/-
832 30/-	866A 10/-	2051 12/6	QS1208 ... 10/-	6004 17/6	FW4/500 10/-
832A 35/-	872A 15/-	8582 15/-	STV/280/40 15/-	CK5785 ... 8/6	807 7/6
829B 40/-	RG1250 ... 10/-	OD3W ... 10/-	STV/280/80 25/-	QVO4/7 15/-	6C4 5/-
837 12/6	19G3 15/-	OA2 10/-	CV188 ... 6/-	2AP1 25/-	CV277 ... 15/-
446A 12/6	WL860 ... 30/-	OA3 10/-	7475 6/-	VCR139A 35/-	5692 30/-
446B 12/6	TZ40 35/-	OB2 10/-	CMG25 ... 12/6	3BP1 30/-	866A 12/6
705A 15/-	TT15 45/-	OB3 10/-	868 10/-	3FP7 12/6	5839 35/-
2K25 65/-	CV129 ... 45/-	VS110 ... 6/-	9005 15/-	3AP1 30/-	5840A ... 30/-
725A 35/-	CV2161 ... 25/-	VR105/30 6/-	GS18 10/-	DG7/5 ... 45/-	5931 35/-
726A 15/-	CV100 ... 15/-	VR150/30 6/-	9005 15/-	VCR517C 30/-	5932 30/-
726B 15/-	CV85 15/-	QS75/20 10/-	9005 15/-	5FP7 ... 20/-	1632 6/-
723A/B ... 55/-	GUI 10/-	QS105/45 10/-		VCR97 ... 40/-	5R4GY ... 15/-

Free complete list on request. Bulk order enquiries invited.

PYE "SCALAMP" GALVANOMETER (TYPE 2000)

Limited Quantity of these Brand New and Guaranteed Instruments.

Only £15 P.P. 5/-

SPECIFICATION:
 200/250 volt 50 c/s. supply or 4 volt 1 amp. dry cell.

SENSITIVITY (Typical) 32.5 mm./µA: 1.45 uV/mm. Period 2 secs: 850 ohms damping. Complete details supplied with each unit.



VHF TRANS/RECEIVER

TYPE 1986

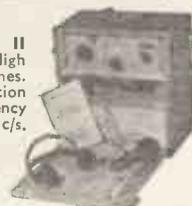
★ 10-CHANNEL CRYSTAL CONTROL-LED

- ★ 124.5 to 156 Mc/s COVERAGE
- ★ 9.72 Mc/s IF; BAND WIDTH 23 Kc/s COMPLETE UNIT WITH 21 VALVES, 24 VOLT POWER UNIT BUILT IN. INCLUDES CIRCUIT DIAGRAM, GOOD NEW CONDITION. LIMITED QUANTITY. ONLY £7/19/6. CARRIAGE 10/6.

TRANSMITTER/RECEIVER

Army Type 17 Mk. II

Complete with Valves, High Resistance Headphones. Handmade and instruction Book and circuit. Frequency Range 44.0 to 61 Mc/s. Range approximately 3 to 8 miles. Power requirements: Standard 120 v. H.T. and 2 v. L.T.



Ideal for Civil Defence and communications. BRAND NEW 45/- P.P. 5/-
 44-61 Mc/s. Calibrated Wavemeter for same, 10/- extra.

CRYSTAL MICROPHONES

Acos 39-1 Stick Mic. with stand 39/6, P.P. 1/6
 Acos 40 Desk Mic. 25/-, P.P. 1/6

NEW PURCHASE! THE "AVO-MINOR"



AC/DC volts, 0-500 volts, D.C. mA., 0-500 mA., RESISTANCE 0-20 K. COMPLETE WITH LEADS AND LEATHER CASE 79/6 P.P. 2/- Limited quantity.

GATHODE-RAY TUBES (IDEAL FOR 'SCOPES)

2AP1	2in.	25/-
VCR139A	2½in.	35/-
3BP1	3in.	30/-
3FP7	3in.	12/6
3AP1	3in.	30/-
Mullard DG7/5	2½in.	45/-
5FP7	5in.	20/-
VCR517C	6in.	30/-
VCR97	6in.	40/-

Screens for VCR97 P.P. 2/- any type. ALL GUARANTEED. FREE LIST and Data on request.

HENRY'S (Radio) LTD.

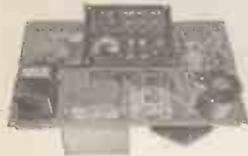
Opposite Edgware Road Tube Station. PADDINGTON 1008/9.

5 HARROW ROAD, EDGWARE ROAD, PADDINGTON, LONDON, W.2. OPEN MONDAY to SAT. 9-6. THURS. 1 o'clock.

FREE LISTS BY RETURN VALVES, TUBES, TX/RX, STANDARD AND MINIATURE COMPONENTS

Get Finest Value from IRONGATE—England's Leading Equipment Wholesalers
Bulk Buying means LOWEST PRICES. All Equipment is in TIP-TOP condition

VOLTAGE REGULATOR—115v.



Relay and motorised Variac control. Suitable for hand or automatic control. Mains Input Range 100/120 v. Separate meters for Input and output reading.

Contains complete overload cut-out (switch type) and sensitive 4in. moving coil (meter reading type). Handling capacity 8 amps. £35. Delivered Free.



ATTRACTIVE INSTRUMENT CABINET
LIMITED QUANTITY ONLY

7ft. x 2ft. grey enamel finish. For housing and protecting equipment. Standard 19in. rack mounting (heavy angle side channels). Sliding ball-bearing runners. 2 door (front and back) position action locking chrome handles. Carr. 30/-. **£26.10.0**



WORLD FAMOUS TELEPHONES
"F" TYPE IN ATTRACTIVE CASE

The best portable telephone ever made. With a range of up to 5 miles is ideal for



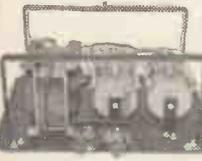
factories, building sites, farms, civil engineering projects, outside broadcast units and offices. 2 perfect sets (SUPERIOR QUALITY) in individual carrying cases, complete with long life batteries, bells, magneto and 100ft. telephone cable.

£7.10.0 per pair. Carr. 7/-.

TELE "F" HIGH POWER as above, but complete, with amplifier, £6/10/- each. Carr. 12/6

D3 STRANDED TELEPHONE CABLE. New Mile Drum 85/- Carr. 17/6.

ENGLAND'S LARGEST STOCKS OF TELEPHONE EQUIPMENT



G.E.C. L.T. SUPPLY UNIT

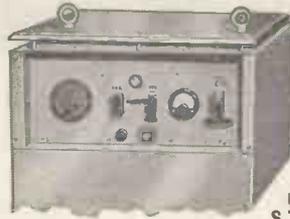
OUTPUT: 24 volts 10 amps D.C. INPUT: 200/250 volts A.C. New and in original cases.

£13.10.0
 Carr. 9/6.



ROTARY CONVERTORS. 12 v. D.C. input. 230 volts A.C., 150 watts, 50 cycles output. Housed in wooden case and fitted with voltage control slider resistance switch, plugs and A.C. mains voltage output check meter. Supplied in perfect condition, individually tested, £9/19/6 each. P. & P. 10/-.

HEAVY DUTY 20 AMP. L.T. SUPPLY UNIT



by S.T.C.

Normal cost over £100

Essential equipment for Electronic Engineering, research laboratories, schools. Ideal for battery charging, etc. Guaranteed for 20 amps. Output: D.C. Variable up to 20 amps. and 24 v. or trickle charge 125/350/700 ampere hours.

Input: A.C. 100/260 volts 45/65 cycles. Size: 16 x 24 x 32in. high.

In attractive Grey Cabinet. **£22-10-0**

ex Warehouse

(Circ. diags. and instr. loaned for 10/- deposit).

CONSTANT VOLTAGE TRANSFORMERS

FERRANTI 7½-KVA MOVING COIL. Stabilized output voltage in the range 200-250 v. Plug-board tapplings. The selected output voltage is constant with ±1% at all loads 0 to 30/87½ amps. when the supply voltage is varying over the range +8% to -12%.

- Frequency compensated 45-55 and 54-66 c/s.
- Excellent output wave-form.
- Can be used with a variable transformer.
- Unused. Complete with spares and instruction book at a fraction of the normal cost, only £65.
- A.C. MAINS STABILIZER.



AUTO TRANSFORMERS

3KVA Air Cooled (100% under-rated). GUARANTEED 230/250 tapped, 12 amps. 6 KVA 105/120 tapped, 28.5 amps. Made by well-known manufacturer and housed in strong metal case. Weight: 2 cwt. Brand new, in original maker's cases.

PRICE £15.0.0 Carr. 25/-.

EXPORT ONLY

Just released by the Ministry of Supply, "88" SETS. Manufactured by E. K. Cole. The latest miniature Walkie Talkie—3,000 available. £10 each.

"22" SETS ALSO—300 available only. New condition £10 each.

Enquiries are invited for Bulk supply at reducing low prices.

Greater-than-ever-Values

BARGAIN DISPOSALS

26B RECTIFIER UNITS. £10 each. Carr. 17/6.

80 REPERFORATORS 7TR £20 each. Carr. 30/-.

1,000,000 YARDS !!

SCREENED WIRE FLEX

FOR ONLY 3d. per yard

For Immediate Delivery—priced far below cost.

Specification: Close braided 14/0048 in. Covered .024 p.v.c. Tinned Copper. Screened. Assorted colours. Applications: Microphone leads, pick-up leads, etc.

ON MAKER'S REELS. 220 yd. REELS (min. quantity), 55/- P. & P. 5/- TEN REELS £25. Carr. Paid.



SUPER POWER AMPLIFIER

Multiple Speaker System



Output: 30 to 60 watts. Valves: Four 6L6, Parallel Push-Pull. Input: 200-250 volts.

Leads, hand microphone, plugs and spares included. In robust wooden transit case 17½ x 15½ x 21½in. Will take up to 20 Speakers.

£22/10/- Carr. 17/6.

Speakers 18/6 each extra. 3/6 carr.

P.A. SYSTEM (EX GOVT.)

Complete with amplifier unit, 4 speakers, microphone, headphones and all spares packed in wooden cases. 6 or 12 volts D.C. handling capacity 8 watts. Ideal for cars, boats, factories, etc. £7/10/0. Carr. 30/-

AERIAL MASTS

IMPROVED TYPE 50 MK.II 36ft. HIGH



Kits comprise—six 2½in. dia. Tubular Steel Sections of 6ft. length, top-section and base Pickets, Guys and Fittings. YOU can purchase this normally expensive MAST for a fraction of its cost. Please add £1 for (returnable) wooden carrying case. The MAST is particularly suitable to take aerials for Tx., Rx., F.M. and TV (especially COMMERCIAL) and has many other uses. Extra 6ft. sections can be supplied at 17/6 per section.

£8.10.0 only Carr. 13/6

U.S.A. Type 45ft. TELECOM AERIAL MAST. (7 sections, 6ft. 8in. x 2½in., guys, etc.) This entirely complete set in carrying case 12½ Gns. Carr. 17/6. Or 2 sets for £25. Carr. extra. British Manufacture only.

ARMY TYPE 32ft. MASTS similar to above but 10 lin. screw-sections, suitable for permanent lightweight installation. Kit in canvas bag, £3/15/- Carr. 7/6.

Limited Quantity **36ft. TELESCOPE MASTS** Finest quality brass. Non-rusting. Base diameter 2½in. Complete with hand-winding winch for easy, rapid extension; and cable-wire bracing stays. One of the best masts ever produced. **£35** each. Carr. £1/10. Winds down to 9ft.

STILL NO DEPOSIT ON OUR CREDIT SALES

STEREO RECORD PLAYER CABINET WITH EXTENSION SPEAKER CABINET



at the amazing offer of **99/6**

Portable 1960 Show Model in two-tone colours. Extension speaker cabinet secured in lid. Size 18x14x8 1/2 in. high. This stereophonic player complete, retails at 35 gns. in the shops today. Ins. & carr. (with order), 5/6, or initial payment plus ins. & carr. of 6/1 and 19 weekly payments of 4/11.



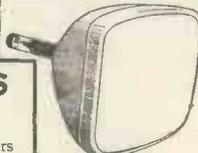
79/9
cash or **5/4**
initial payment

RECORD PLAYER CABINET R.P.8.

Balance at 3/11 a week for 10 weeks. This contemporary cabinet in two-tone grey rexine is ideal for the modern home. Added attraction is the cream plastic speaker fret. Press button lid; lock. Fittings for screw-in legs. Internal measurements 14 1/2 x 18 x 8 1/2 in. deep. Takes a Garrard 121 Mk. 2 or B.S.R. U.A.12; 9 1/2 x 4 1/2 in. elliptical speaker; our Mk. D2 portable amplifier. Carr. & ins. 5/6.

T.V. CHASSIS FOR SPARES ALL THIS FOR ONLY 9/6

58 resistances including 7 variable controls. 54 condensers including electrolytics. Coils 7 I.F. and R.F. transformers. 13 valve holders (8-B8A, 2-B7G and 3-octal), 4 transformers-Mains-Output-Line-Frame. Chokes 250 m/a. Metal rectifiers, 300 volts at 250 m/a. Fuse panel, scanning coils, focus magnets. Plugs, sockets, switch, chassis screws, tag strips, etc. I.F. strip can be separated. Power pack can be used without dismantling. These chassis have been used, but were working when stored. 6 page circuit and instructions showing position of each component. Carr. 7/6.



TERMS AVAILABLE OVER 20 WEEKS

REPLACEMENT, REBUILT T.V. TUBES. 12 months guarantee.

21" TUBE £8.10.0 **£2** allowed
17" TUBE £7.10.0 **£2** on old tube

12" 14" 15" TUBES £5.10.0
£1 allowed on old tube.

B.S.R. MONARCH U.A.8. 4-SPEED AUTOCHANGER

£6.19.6
OR TERMS



4-speed Autochanger. Incorporating auto and manual control complete with turnover crystal P.U. and Sapphire stylus, P. & Ins. 5/6 or initial payment 8/1, plus P. & Ins. and 19 weekly payments of 6/11. T.U.9 B.S.R. 4-speed single player £4/9/6. Collaro Conquest 4-speed single player £6/19/6. Collaro Conquest Stereo autochanger 9 gns. P. & P. on each above 5/6.

EXTENSION SPEAKERS only 19/9



This superbly finished, polished oak cabinet fitted with 8in. P.M. speaker W.B. or Goodmans of the highest quality, will sound and look ideal in any part of your home. Standard matching to any receiver (2-5 ohms). Switch and flex included. Ins. & carr. 3/9.

DE LUXE TAPE RECORDER CABINET 29/9

Beautifully made Tape Recording Cabinet. Size: 13x10 1/2 x 7in. Covered in two-tone coloured rexine cloth. Stylish design. Carrying handle with detachable lid with lock and key. Easily adapted to Record Player Cabinet. Exceptional value at this very low price. P. & P. 4/6.

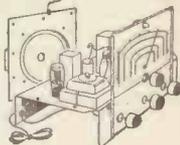


ELLIPTICAL SPEAKERS 9 1/2" x 4 1/2" 19/6

SUPER CHASSIS

3/11 per week

Five-valve superhet chassis including 8in. P.M. speaker and valves. Four control knobs (tone, volume, tuning, w/change, switch). Four wavebands with position for gram. P.U. and extension speaker. A.C. Ins. & carr. 5/6, Cash price **79/6**



AMPLIFIERS ALL PORTABLE 12 MONTHS GUARANTEE

MK. D.1. 59/6



Brand new. Latest design with printed circuit. Dimensions 7x2 1/2 x 5in. A.C. only. Mains isolated 3 watts output. Incorporating EL84 as high gain output valve. Volume and tone controls. Knobs 2/6 extra. P. & P. 3/6.

MK. D.2. 79/6

Printed circuit. Latest design. Dimensions 7x2 1/2 x 5in. A.C. only. Mains isolated. 4 watts output. Incorporating the latest ECL82 triode pentode output valve, giving high undistorted output. Volume and tone controls. Knobs 2/6 extra. P. & P. 3/6.

MK. D.3. 89/6

As above but with 3 controls, incorporating a special tone connector circuit for extra base and top boost, giving a tone of reproduction seldom heard on a very expensive amplifier. Must be heard to be appreciated. Knobs 3/6 extra. P. & P. 3/6.

RECORD PLAYER CABINET R.P.2.

59/6
CASH OR **4/1**
initial payment



DUKE & CO. (LONDON) LTD.

621/3, Romford Road, Manor Park, E.12 ILF. 6001/3

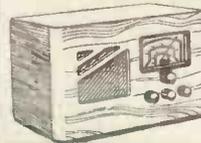
NO DEPOSIT INTEREST FREE

20 OR 36 WEEKS TO PAY Send for a FREE catalogue.

SUMMER SALE! BARGAIN! 17" T.V.'s complete. 19 gns.

Cash, or terms over 20 weeks. (NO interest charged). Initial payment £1/0/7 and 19 weekly payments of 19/11. Carr. & Ins. 30/- 1TV/BBC. Beautifully styled polished cabinets. These are table models with the option of contemporary legs, legs fitted (2 gns. extra). 17in. rectangular tube guaranteed for 12 months. Valves and chassis guaranteed for 3 months (chassis salvaged but reconditioned). Where possible personal collection is advised.

HOME RADIO — 79/6



A.C. OR UNIVERSAL

A.C. or Universal Mains. Five valve octal superhet. 3 waveband receiver. P.U. In attractive wooden cabinet. 9 1/2 x 18 1/2 x 1 1/2 in. Ins. and carr. 4/6.

SALVAGED VALVES. 3 MONTHS GUARANTEE

9d each. 6AC7, 6SA7, 6SG7, 6SH7, 6SJ7, 12BE6, EF36, EF37, EF50, SP41, SP61, T41.
2/9 each. 6F1, 6F12, 6F13, 6F14, 6F15, 6K7, 6LD20, 10F1, PEN45, PEN46, U22, UF41.
7/9 each. 5U4, 5Y3, 6A8, 6K8, 6Q7, 6U6, EABC80, EBC33, ECC81, EL38, EZ40, KT36, EZ80.
Post, packing and insurance, 1 valve 7d., 6 valves 1/6., 12 valves 2/6.

Balance at 2/11 a week for 10 weeks. Made by a famous manufacturer. In polka dot cloth with clipped lid and carrying handle. Size 16" x 14 1/2 x 8 1/2" deep. Carr. & Ins. 4/8. Will take B.S.R. Monarch 4-speed Autochanger, 7in. x 4in. Elliptical speaker and our Mk. D.2 Portable Amplifier,

Wilkinsons

EST. 1921

METERS GUARANTEED

F.S.D.	Size	Type	Price
50 Microamps	2½ in.	MC/FR	70/-
100 Microamps	2½ in.	MC/FR	60/-
100 Microamps	3½ in.	MC/FR	70/-
500 Microamps	2 in.	MC/FR	22/6
500 Microamps	2 in.	MC/FR	22/6
1 Milliamp	2 in.	MC/FS	27/6
1 Milliamp	2½ in.	MC/FR	35/-
30 Milliamps	2½ in.	MC/FR	12/6
100 Milliamps	2½ in.	MC/FR	15/-
200 Milliamps	2½ in.	MC/FR	12/6
500 Milliamps	3½ in.	MI/FR	30/-
5 Amperes	2 in.	MC/FS	27/6
15 Amperes	2 in.	MC/FR	12/6
25 Amperes D.C.	2½ in.	MI/FR	7/6
50 Amperes	4 in.	MI/F/FR	65/-
30-0-30 Amp	2 in.	MC/FR	15/6
50-0-50 Amp	2 in.	MC/FS	12/6
10 Volts	2 in.	MCR/FS	25/-
50 Volts	3½ in.	MC/FS	45/-
300 Volts	2½ in.	MI/FR	25/-



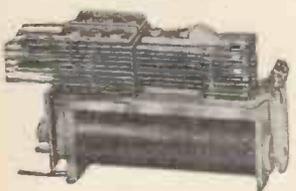
Postage on meters 1/6



Complete list available

METER RECTIFIERS 250µA 1 M.A., 5 M.A., F.W. bridge, 8/6, post 6d
CROSS POINTER METERS. 2 separate 100 microamp movements, 22/6.
MICROAMMETER. 250 F.S.D. 3½ in. F.R. Sangamo Mod. S37. Scaled for valve voltmeter. Circuit available free, 55/-, post 1/6.
UNI-PIVOT GALVANOMETER by Cambridge Instruments, 50-0-50 microamps, dia. 4in. Knife pointer, mirror scale. Complete with leather carrying case. Ideal for laboratory use, £10, carriage 3/-.
PORTABLE VOLTMETER. 0-100 volts A.C./D.C., accuracy within 2%, 8in. mirror scale, knife pointer, in polished case. A precision moving iron instrument at a very low price, £4/19/6, post 3/6.
RADIOACTIVITY MEASURING INSTRUMENTS. Philips Type 1092B. A portable self-contained unit in haversack! Scaled 0 to 10 million counts per hour, using Mullard Geiger Counter MX115, £16/10/-, cpe. 15/-.
WHEATSTONE RESISTANCE BRIDGE 1 to 10,000 ohms, plug type, £5, carriage 7/6.
OSCILLOSCOPE No. 11 with high-class amplifier. All normal controls 230 volts. £12/10/-, carriage 15/-.
AVO TEST BRIDGES, 220/240 volt A.C. Measure capacities from 5 pf. to 50 mfd. and resistances from 5 ohms to 50 megohms. Valve voltmeter range 0.1 to 15 volts and condenser leakage test. Full working instructions supplied with instrument. £9/19/6, post 3/-.
WAVE-CHANGE INDICATOR UNIT. Admiralty patt. 2415, £7/10/-.
OSCILLOSCOPE. Type 43. With 3½ in. C.R.T. 138A, 4—017, 3—VR54, 5Z4, VU120. Brand new with usual controls, power pack and leads. Suitable for 230 volts, £10/10/-, carriage 12/6.
FREQUENCY METERS. 45-55 Cycles per second 230 volts, 6in. dia. Flush Round. Brand new in maker's box, £10/10/-, post 3/6.

RELAYS P.O. TYPE 3000



Built to your own specification
 Keen Prices
 Quick Delivery
 Contacts up to 8-Changeover

MINIATURE RELAYS:

Siemens High Speed Sealed.		S.T.C. and G.E.C. Sealed.	
2.2Ω × 2.2Ω	H96A 15/6	2Ω	2 C.O. 4184GA 18/6
145Ω × 145Ω	H96C 19/6	700Ω	2 C.O. 4184GD 19/6
500Ω × 500Ω	H96D 22/6	2500Ω	1 make HD4186EE 22/6
1700Ω × 1700Ω	H96E 25/-	2700Ω	2 C.O. 4184GE 21/6
Siemens High Speed Open		180Ω	2 m 2 b M1087 19/6
100Ω × 100Ω	H85N 15/-	870Ω	4 C.O. M1092 21/6
850Ω × 850Ω	H85W 15/-	2500Ω	1 C.O. M1022 22/6
1000Ω × 1000Ω	H95A 17/6	5000Ω	2 C.O. M1052 25/-

ERICSSON SEALED. Highly sensitive. 7000Ω 1 C O 24 v. 25/-.
 Comprehensive range available from stock.

SWITCHES. 1 hole fixing, 3 amp. 250 volt. 1/6 each, 12/- doz.

RACKS—POST OFFICE STANDARD. 6ft. high with U-channel sides drilled for 19in. panels, heavy angle base, 4ft. 10in. in stock.

P.M. SPEAKERS. AXIOM 150 DUAL CONE 12in. 15 WATTS 15 OHMS FULLY DUSTPROOF, £7/19/6, POST 7/6.

PYE 10in. PORTABLE 3 OHMS 50/-, CARR. 7/6. 3in. ROUND. PLESSEY SEALED TYPE WITH PROTECTIVE GRILLE 19/6, POST 1/6. ELAC 5in. ROUND, 3 OHMS, 15/6, POST 1/6.

JACK PLUGS. Cylindrical bakelite screw-on cover, 2 contact 2/6, post 8d.

SOCKETS. One hole fixing for above, 3/6, post 6d.

TERMINAL BLOCKS. 2-way 4/- doz. or box of 50 for 15/-, 3-way 6/- doz., 50 for 22/6, post 1/6.

VARIAC. Type 200 CUH. Infinitely variable 0-270 volts, 2.5 amps. In case with 0-250 volt-meter and 0-1 ammeter with own input and output leads, £12/10/0, carriage 7/6.



Your Own Telephone 75/-



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 8d. per yard or 2-core at 3d. per yard extra. Price 75/- set, post 3/6.

TELEPHONE SET "TELE-F." This is the best known portable telephone ever made, it has a built-in generator for ringing the other instrument and requires only twin wire between the sets. The set of two instruments and batteries in carrying case, £7/10/0, post 7/6. Twin flat P.V.C. wire 3d. yard.

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

ROTARY CONVERTERS. Input 12 D.C. Output 230 A.C. 50 cy. 135 watts. In fitted case with variable resistance, 0/300 voltmeter. The ideal job for T.V. and tape recorders where A.C. mains are not available. £10, carr. 15/-. Special connectors, one fitted with 6ft. heavy duty flex and clips for D.C. side, 10/- set, post 1/-. **ROTARY CONVERTER,** input 12 v. or 24 v. D.C., output 230 v. A.C., 135 watts, £8/10/-, carriage 7/6.

BATTERIES. Portable Lead Acid type, 6 volts 125 ampere hours. In metal case 16in. x 18in. x 11in. (Two will make an ideal power supply for our 12 volt Rotary Converters.) Uncharged £6/10/- each, carriage 15/-. 24 volts 85 ampere, £14 each, carriage 15/-.

GEARED CAPACITOR MOTORS. 220-240 v. 50 cy. 30 watts, 300 r.p.m., also spindle for 1425 r.p.m. A powerful and useful motor 75/-, post 3/6.

BARTLETT DRYING OVEN. Interior dimensions 18in. x 15in. x 15in. Automatic temperature control. 230/250 volts A.C. 1500 watts.

BAIRD & TATLOCK HOT AIR OVEN. Interior dimensions 14½ in. x 12in. x 12in. Copper framed. Double Jacketed "Stablic." 110/115 volts 14.8 amps, with adjustable temperature control.

KEY SWITCH LOW CAPACITANCE. 2 C.O. locking, 7/6 each. 4 C.O. Non-locking, 10/6 each. 6 C.O. locking/2 C.O. locking, 17/6 each.

T.C.C. CONDENSERS. 0.1 Mfd. 31 kv. 75/- each, 1 Mfd. 10 kv. 45/- each.

SOLENOIDS suitable for remote control, mechanical indicators, etc. 12 v. D.C., 400 M.A., 30Ω, 3½ in. arm, ½ in. movement, 5/- each, post 1/6.

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



MAGNETIC COUNTERS

Counting to 9999.
 2-6 v. D.C., 15/- each, post 1/6.
 75-230 v. D.C. 15/- each, post 1/6.
 HIGH SPEED TYPE No. 100c. 35/-, post 1/6.

VEEDER-ROOT MAGNETIC COUNTER. General purpose type with zero reset. 800 counts per minute up to 999,999. 48 volt D.C. 55/-, post 2/6.

THERMOSTAT SATCHWELL, 12in. stem 0/250 volt A.C./D.C. 15 amps. A.C. 10 to 90 degrees cent. 25/-, post 2/6.

ROOM THERMOSTAT. Adjustable between 45 and 75 deg. Fahr., 250 v. 10 amp. A.C. Ideal for greenhouses, etc., 35/-, post 2/-.

THIS MONTH'S SPECIAL OFFER

TANNOY LOUD HAILER with 180 ohm line transformer and condenser. Impedance 7.5 ohms. Capacity 8 watts. Complete in slope front wood, case, power microphone and built-in switch. 27/-, post 5/6.

NIFE BATTERIES. Nickel Cadmium 12 volt 18 ampere hours crated and connected alkaline filled. Brand New £4 each, carriage 10/-. Also available 2.4 volt 10 ampere hours, 20/- each, post 3/6.

TRANSFORMER Single Phase 250-115 volts 50 cycles 5 KVA double wound, £30, carriage extra.

TERMINAL STRIPS with ceramic supports from 2 to 24 ways @4d. per way.

HIT RECORDER by SAAB aircraft including five-figure High-speed magnetic counter with zero reset, relays and valves etc. £7/10/0, post 3/6.

FANS INDUSTRIAL TYPE 230/240 volt A.C. Capacity Motor, 16-inch blades in housing, adjustable louvres, filter. Brand New, £25, carr. extra.

EXTENSION SPEAKER in cabinet 9in. x 8in. x 4in. Permanent Magnet. 3 ohms. Ready for use, 25/-, post 2/6.

MEGGER CIRCUIT TESTING OHM METERS. 0-1000 ohms and 100 ohms—200K ohms INF, complete with spikes and leads. Brand New, 97/6, post 2/6.

L. WILKINSON (CROYDON) LTD.
 19 LANSDOWNE RD. CROYDON SURREY
 Phone: CRO 0839 Grams: WILCO CROYDON



FOR VALVES, TUBES AND COMPONENTS - BY RETURN POST SERVICE

Table listing various electronic components such as valves (e.g., EBL32, EL33, EL34), tubes (e.g., KTW63, KTZ41, MH41), and other parts with their respective prices and specifications.

TELEVISION TUBES REGUNDED, 12 MONTHS' GUARANTEE

MW31/74 £5/10/-; CRM152B £6; CRM123 £5/10/-; MW36/24 £5/10/-; CRM141 £5/10/-; MW43/69 £6; GRM171 £6. Carriage and insurance 10/- extra. Allowance on old tube if returned.

AUTOMATIC CHANGER UNITS

Monarch UA8 4-speed automatic record changers with Fulfi turnover crystal cartridge, £6/19/6. Carr. 3/6. The new B.S.R. Model UA12, 4-speed Mixer Automatic record changer, fitted with latest type turnover cartridge, OUR PRICE £8/8/-, Carriage 3/6. Collaro Conquest, 4-speed fully mixing changer complete with Studio "O" Crystal cartridge, £7/19/6. Carriage 3/6. Garrard RC120/D Mk. II, 4-speed unit, manual control to enable records to be played singly, £8/17/6. Carriage 3/6. EMI Single Record Player, 4-speed, fitted with stereo cartridge, £6/19/6. Postage and packing 3/6.

HEAT TRANSFORMERS

All 240 v., input, 4 v. 3 amp., 10/-; 6.3 v. 1 1/2 amp., 6/9; 6.3 v. 3 amp., 10/-; 12.6 v. 3/4 amp., 5/9; 5 v. 2 amp., 10/-; 2 v. 3 amp., 8/3.

Latest COLLARO STUDIO TAPE TRANSCRIBOR

3 motors, 3-speed 1 1/2, 3 1/2, 7 1/2 i.p.s., takes 7in. spool. Push button controls. PRICE £15/15/-. Tape extra. Carriage and Insurance 5/6.

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

3 1/2 i.p.s., takes 5 1/2 in. spools. Simple controls, £9/19/6. Tapes extra. Carr. and Insurance 5/6.

ACOS MICROPHONES

Acos Mic. 39/1. Crystal Stick Microphone for use as hand, desk or floor stand units for high quality recording, broadcasting and public address work. List price £33/-. OUR PRICE 39/6. With table stand 47/6. With floor stand adaptor 52/6, postage 1/6.

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.

CO-AXIAL CABLE

semi-air-spaced 75 ohms, 6d. yd.

ACOS CRYSTAL PICK-UPS

Turnover Head (2 sapphire styli), 29/11. P.P. 2/6.

Dubilier Type C41, centre tapped, 500K, less switch, potentiometer, 6/6 each.

Claroast Potentiometers for Stereophonic Amplifiers, etc. 50 K x 50 K Log, 100 K x 100 K Log, 500 K x 500 K A/Log, 1 Meg x 1 Meg. Log, 250 K x 250 K Log, 1 Meg. x 1 Meg. Linear, 500 K x 500 K Linear. All 6/6 each.

17in. new T.V. Tube, equivalent to Mullard MW 43/69, fully guaranteed, £7, carr. and ins. 10/-.

Fold-Away Microphone, can be used as a hand or desk unit. High sensitivity, giving good results on a wide range of equipment. 19/6, post 1/6.

PUBLICATIONS

Wireless World Valve Data Book 5/-, post 4d. Data TV Fault Finding Book, 5/-, post 4d. Mullard Circuits for Audion Amplifiers 8/6, post 4d. Short Wave Receivers for the Beginner 6/-.

PICK-UP CRYSTAL CARTRIDGES

Table listing various crystal cartridges with their type numbers, remarks, and prices. Includes models like ER58, GP55, GC2/PA, GC2, TC8M, TC8H, HGP37-1, and 73-1.

SCOTCH RECORDING TAPE

1,200ft. reels Standard 23/-; 1,800ft. reels, Extra Play, 37/6.

CATALOGUE

Our 1960 catalogue is now available, please send 1/- in stamps for your copy.



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 add 3/- unless otherwise stated. Minimum C.O.D. fee and postage 3/-. For full terms of business see inside cover of our catalogue. Personal shoppers 9 a.m. to 5 p.m. Mon. to Friday. Saturday 10 a.m. to 1 p.m.

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Due to the overwhelming success of Model B-5 we now introduce two brand new models—B-10 and B-20. All three have an input voltage of 230 v. with a continuously regulated variable output from 0-260 volts.

These Variable Transformers are of advanced mechanical design, offering long life, moderate temperature rise, high efficiency and linear output voltage, incorporating direct reading dial with large white numerals for output voltage selection of the highest accuracy.

All Models are supplied totally enclosed complete with shrouded input and output terminals and laboratory tested prior to despatch.

MODEL B-5
Current Rating 5 amps.

£9.0.0

MODEL B-10
Current Rating 10 amps.

£18.5.0

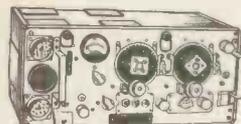
MODEL B-20
Current Rating 20 amps.

£32.10.0



ALL FULLY GUARANTEED

WIRELESS SET No. 19 Mk. II



This famous Transmitter-Receiver, incorporates "A" Set—TX/RX covering 2-8 Mc/s. (37.5-150 metres). "B" Set—VHF TX/RX covering 230-240 Mc/s. (1.2-1.3 metres) and intercom. amplifier. Complete with 15 valves, 500 micro-amp. check and tuning meter, circuits, and instruction book. In used condition, 65/-, Carr. 10/-.

Set—VHF TX/RX covering 230-240 Mc/s. (1.2-1.3 metres) and intercom. amplifier. Complete with 15 valves, 500 micro-amp. check and tuning meter, circuits, and instruction book. In used condition, 65/-, Carr. 10/-.

INSTANT VALVE FILAMENT TESTER MODEL VT 41. Pocket-size battery operated GIVES INSTANT CHECK OF:

- All Radio Valves.*
- All T.V. Valves.*
- All T.V. and Radio Fuses.
- Circuit Continuity.
- All Pilot Lamps.
- Has built-in miniature 7- and 9-pin valve straighteners and battery test.

*International Octal, B.8, B.9, B.7 Battery and Mains types. Beautifully styled—precision made. Supplied complete. Fully guaranteed. **ONLY 30/-**, P. & P. 2/6.

POCKET MULTIMETER

Brand new. 2,500 o.p.v. Multi range 6/30/120/300/1,200 v. D.C., ditto D.C. 0-1 k., 0-1 meg-ohm; 400 micro-A., 12 mA., 300 mA.; -00 to +65 db., 1 1/2 in. Large clear dial. Leads supplied.

ONLY 70/-, P. & P. 2/6.

COMMUNICATION RECEIVER R.206

Frequency range 550 kc/s.-30 Mc/s. on 6 frequency ranges. Panel Controls: two speed, backlash free, tuning control. Frequency range selector. Very fine osc. vernier tuning control. Aerial trimmer. L.F. Gain. H.F. Gain. I.F. Bandwidth switch; 0.7, 2.5 or 8 kc/s. A.V.C. switch. B.F.O. control. 900 c/s. filter switch. Transient interference limiter. Aerial, earth, muting, phones and line inputs. Designed for use with an external A.C. or D.C. power supply. Receiver dimensions 25 x 13 x 13 1/2 in. Supplied complete with A.C./D.C. power unit with internal speaker. Original cost over £175. Very limited quantity offered at only **£22/10/-**, carr. 50/-.

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Manufactured by Electrothermal, we offer the following values: 100K, 400K, 500K, all $\pm 1/2\%$ 1 watt, 1/9 each; 20/- per dozen.

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AR88 RECEIVER. 540 kc/s. to 32 Mc/s. Complete in working order. **£40**, carr. 30/-.

D.M.34 DYNAMOTOR. America's finest little dynamotor offering 12 v. in with 220 v. out at 80 mA. With suppression and smoothing mounting base. Size 4 1/2 x 2 1/2 x 2 1/2 in. Original packing. **ONLY 35/-**, P. & P. 3/6.

T.C.S. TRANSMITTER

Designed for mains or mobile use covering 1.5-12 Mc/s. (160-80-40 metre bands) consisting of a VFO, Buffer, Doubler, PA with an internal push-pull modulator. Provision for VFO or crystal control. Output 40 watts phone, 100 watts C.W. Complete with aerial and plate current meters. Less loading coil. **ONLY £7**, carr. 15/-.

PORTABLE TRANS/RECEIVER No. 18

A self-contained Trans/Receiver for Telephone and C.W. Range approx. 10 miles. Frequency 6-9 Mc/s. (50-33.3 metres). Valve line-up: 3 ARP-12, 1 AR-8, 1 ATP4. Complete with aerial, H.T. and L.T. meter and all accessories. Weight 20lb. Size 8 x 10 x 17in. **Only 80/-**, Carr. 10/-.



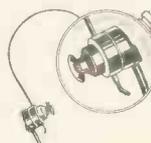
LEAD ACID ACCUMULATORS (unspillable). 2 volts 16 A.H. Ideal for 6 volts and 12 volts supply. Brand new original cartons. Size 4in. x 7in. x 2in. **5/6** each



P. & P. 1/6.
3 for 15/-, P. & P. 3/6.
6 for 27/6, P. & P. 5/-.

AMERICAN LIGHTWEIGHT HEAD SET They're High and Low Impedance!

These H.S.30 phones are the smallest used by the U.S. Air Force. 250 Ω impedance 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 4,000 Ω . **ONLY 15/-**, P. & P. 2/6.



Complete HEADPHONE AND MICROPHONE ASSEMBLY. A must for every Constructor and "Ham", consists of moving coil, padded headphones and "press to talk" microphone. **10/-**, P. & P. 3/6.



HOOVER ROTARY TRANSFORMERS. 12 v. input, 500 v. output at 65 mA. or 6 v. input, 250 output at 75 mA. **ONLY 10/6** each. P. & P. 2/-.



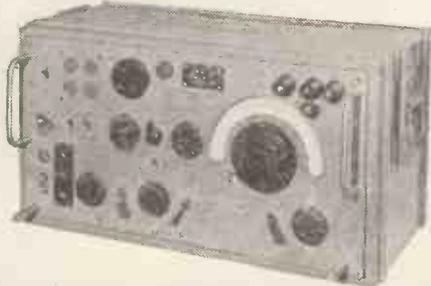
ALL BAND RECEIVER R.107 AMATEUR—SHIPPING—BROADCAST

This magnificent 9-valve 3-wave band receiver gives world-wide reception over 1.2-17 Mc/s (18-250 metres). The sensitivity is 1 microvolt on C.W., and 2-6 microvolts on R.T. Panel controls include Bandwidth switch ("Wide" or "Narrow"), choice of AVC and BFO, Audio Filter, R.F. Gain, Aerial Trimmer. Has built-in Output stage with internal speaker. Headphones sockets. Incorporates internal A.C. mains power unit (100-250 v. A.C.) and 12 volts D.C. Vibrator pack. Size 24 x 13 x 17in. These sets are extensively tested prior to despatch.

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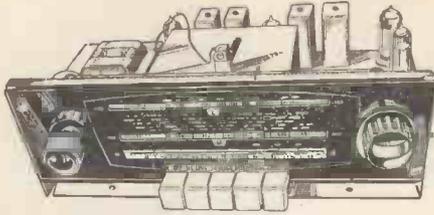
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Carr. 20/- (England and Wales), rest of U.K. extra.



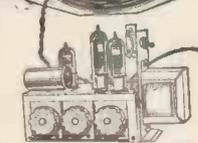
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BRAND NEW AM/FM (V.H.F.) CHASSIS AT £13.6.8. (P. & P. 10/-)



Why buy a F.M. Tuner at the same price?
Tapped input 220-225 v. and 226-250 v. A.C. ONLY.
Chassis size 15 x 6 1/2 x 5 1/2 in. high. New manufacture.
Dial 1 1/4 x 4 in. in gold and black.
Pick-up. Extension Speaker, Ac., E.L. and Dipole sockets. Five "plano" 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., ECC81, 8F89, EAB080, EL84, ECC85. Speaker and Cabinet to fit chassis, 47/6.
10 x 6 in. ELLIPTICAL SPEAKER, 20/-.

TERMS—(Chassis) £4 13/8 down—10/- carr.—and 6 Monthly Payments of 30/-
or with Cabinet and Speaker £5 9/2 down and 7 Monthly Payments of 32/-
3-VALVE AMPLIFIER (INCL. RECT.)
Capable of giving 6 watts. Mains and output transformers. Valves ECC81, EL84 and Rect. 3 Controls. volume, bass and treble. On/Off switch. Fully guaranteed. Chassis size 6 1/2 x 3 x 2 1/2 in.; with 7 x 4 in. elliptical speaker or 6 in. round (Goodmans) state which.
ONLY 67/-, (3/- P. & P.).



**STUPENDOUS OFFER!
13-CHANNEL TUNER**
I.F. 34-38 Mc/s. complete with valves PCF80 and PCC84 Removed from chassis but in working order.
15/- (2/6 P. & P.) Knobs 2/6 extra. Some tuners less valve 7/6.



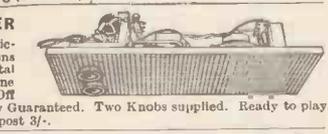
50 SILVERED MICA AND CERAMIC CONDENSERS, 10/- 50 RESISTORS, 5/- ALL NEW.

NEW WAXED TUBULARS, 350 v. or above, 3 of each. .001, .002, .005, .01, .02 .05, .1 mF. Total 21 for 4/6. post paid.

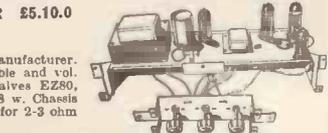


NEW ITA AND BBC TUNER
By well-known manufacturer for superhet TVs with 35-38 Mc/s. I.F. For all areas; covers all 13 channels. Switch gives BBC and two ITA selections. Suits G.E.C. sets BT4543, 4544, 5146, 5147, 5343, 5642 and 6641 without alteration. Fully guaranteed and instructions can be provided free. Has ITA and BBC co-axial sockets and separate gain controls. WITH VALVES PCF80 and PCC84, 22/6 (P. & P. 3/-). Some without valves at only 12/6 (P. & P. 3/-).

GRAMOPHONE AMPLIFIER
with 5 in. SPEAKER. On Fabric-covered Baffle 12 1/2 in. x 5 in. Mains and Output Transformers. Metal Rectifier. ECC82 Valve. Tone and Volume Controls. On/Off switch. Plenty of Volume. Fully Guaranteed. Two Knobs supplied. Ready to play. Usual for Stereo. ONLY 57/-, post 3/-.



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(3/6 P. & P.)
Brand new by famous manufacturer. 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 x 3 1/2 x 3 1/2 in. With o.p. trans. for 2-3 ohm speaker.



FULLY BUILT BATTERY OPERATED TRANSISTOR RECORD PLAYER FOR £7.19.6
(3/6 P. & P.)
Built and tested. Cossor printed circuit 4-transistor amplifier: Garrard 45 r.p.m. battery player type BA1; speed control; Cabinet size 11 x 9 x 3 in.; less than 8 1/2 lb. Requires two Eveready AD28 batts. State colour—red/cream or blue/cream.



LISTEN WITHOUT INTERFERENCE
Fully built V.H.F./F.M. Set. Wired, aligned and tested. Six Mullard valves, 88-99 Mc/s. Metal (Blue and grey) cabinet 12 x 7 1/2 x 6 in. ONLY £8/8 (4/- carr.). Cheap room dipole 10/-, 300 ohm twin feeder, 6d. yd.



With 12 months' guarantee. Delivery by return. C.O.D. 2/- extra. Terms: Cash with order or one-third down and balance plus 7/6 (up to £7/10/0) in four equal monthly payments. Balance over £7/10/0 add 1/- in £1 and pay in not more than 6 monthly payments. See special terms for A.M.-F.M. chassis. All new goods unless stated. Send 6d. for 16-page catalogue.

GLADSTONE RADIO 58A HIGH ST., CAMBERLEY, SURREY. Tel. 22791
or callers to 3 Church Road, Bristol 5 Tel. 51207 (Camberley closed Sat.)
247, New Road, Copnor, Portsmouth, Hants.
(Portsmouth and Bristol closed Wednesday afternoon)

BENSON'S BETTER BARGAINS

TRANSFORMERS, potted, "C" core; Input 230 v. Outputs—6.3 v., 0.3 A. (1 A. actual), twice, 8/6; Outputs—510-0-510 v. 275 mA., 375-0-375 v. 83 mA., 5 v. 3 A., 6.3 v. 7 times (17 A.), 45/-.

CONDENSERS, block, paper, & mfd. 250 Vv. 4/-; 600 Vv. 6/-; 4 mfd. 2 kvVv. 7/6; 600 Vv. 3/6. Switch fuse splitter, DP. 15 A. 15/-.

Panel fuseholders, 1/3; Panel Lampholders (indicators), 1/6.

POWER UNITS. Input A.C. 115/250 v. Outputs: D.C. 330 v., 120 mA. and 6.3 v. A.C. twice. Potted trans. and LF choke, new (post 3/6), 30/-.

MONITOR 575, triggered oscilloscope, comprising Indicator 248 and Power Unit 675. Valves VCR138a, 3/EF50, 2/ECC33, 5/EF55, EF37A, 6V6, 3/EA5 and 2/5U4G, VU120A. Two units each 12 x 9 x 18 in., black finish. 230 v. A.C. input, with 18-way cable and mains cable and circuit. Cathode probe unit extra, 17/6, £8/10/- (Rail 20/-).

INDICATORS. Type 101 with VCR530 and 2/EB91, 2/EF91, 2/R10, new cond., 30/- (post 7/-). Type 1 with VCRX263, 2/EF52, 5/6J6, 1/6V6, 1/EV51, 2/EB91, 3/EF91, RF EHT Generator and 28 kc/s. xtal, 45/- (Rail 7/6).

HEADPHONES, CLR, 7/6. GR100 Noise Limiter assemblies, with valve, 3/6.

NEW M.C. METERS, 3 1/2 in. round flush, 50µA, 70/-; 200µA, centre zero, 50/-; 1 mA, centre zero, 45/-; 1 mA, 55/-; 2 1/2 in. 1 mA, 22/6; 2 in. 300 mA, each 8/6. 2 1/2 in. M.I. 20 v. A.C., 8/6; 300 v. A.C. 2 1/2 in., 15/-.

VIBRATORS, Mallory G634C 12 v. 4-pin, 7/6; 6 v. 5-pin reversible, 7/6. R1155B, good condition, tested with handbook. 27/10/- (Rail 10/-).

DRIVES: slow-motion Admiralty 200:1 ratio, scaled 0-100, 5/6. R1155 S.M. "N" type, new, 10/6.

VIBRAPAK, 6 v. D.C. to 250 v. 60 mA, smoothed case, 22/6. 12 v. to 250 v. 60 mA, 21/- (p.p. 3/6).

DYNAMOTORS (post 3/6). 12 v. to 250 v. 65 mA, 11/6; 6 v. to 250 v. 60 mA, 11/6.

ROTARY CONVERTERS. Input 24 v. D.C. Output 50 v., 4 a., 50 c/s., 40/- (Rail 7/6).

CATHODE RAY TUBES. New: VCR 139A or VCR 138, each 30/-; Potentiometers, miniature wirewound, 60, 100Ω, 600Ω, 1k and 2k, each, 1/-.

CHOKES, LF 10H 200 mA, 8/6; 100H 60 mA., 8/6, 9H 100 mA, 5/6; Potted 10H 100 mA, 7/6; "C", 5H 400 mA, 10/6, 10H 250 mA, 12/6; 10H 50 mA, 6/-.

R.F. 27, good cond., 18/- (p.p. 3/6).

METAL RECTIFIERS, 240 v. 100 mA., 4/-; 240 v. 30 mA. 3/6; 600 v. 30 mA. 5/6; 240 v. 80 mA. 5/6; 1,000 v. 30 mA. 7/6, 350 v. 2 a. 20/-.

Mic. Inserts, G.P.O. carbin, 2/6.

CONTROLS. Camera Type 35; a timing device, new 10/6. (post 3/6).

COMMAND Receivers, medium-wave (520-1,500 kc/s), 6 valves; new, 97/6; used 82/6. Conversion data for above to CAR RADIO, 12 v., with circuit, 1/6.

RELAYS, potted, small, 1,700+1,700Ω, hi-speed Sp c/o, 10/6. 2,500Ω 2 make, 6/-.

TEST SET 263, 9280-9480 mc/s. with waveguides, 50µA and 1.5 mA, meters, £5/10/- (Carr. 10/-).

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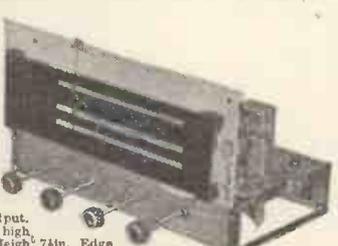
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★ At this drastically reduced price. The famous R.C.A. orthophonic amplifier. 12-20 watt output. Distortion: harmonic less than .1% at 10 watts/700 c.p.s. Noise Level: 85 D.B. below rated output. Frequency Response: within .2 D.B., 20/25,000 c.p.s., within .5 D.B., 10/60,000 c.p.s. Feedback: 40 D.B. total. Output Impedance: 3.4 ohms, 7 ohms and 15 ohms. Spare Power: 395 v./-5 M.A. and 6.3 v. 2.5 amps. for pre-amp, radio tuner and tape amp. A.C. Input: 100/150 v. and 200/250 v. Valve Line-up: two EF86, two KT66, one GZ32. Dimensions: 16½ x 8 x 7½ in. Weight: 32lb.
★ Complete with circuit and instructions £18/19/6 plus 10/- crating and carriage.

★ **THE JUNIOR RCA 5-8 WATT PUSH/PULL AMPLIFIER** ★
★ A compact Amplifier complete with plug-in Power Pack, valve line-up HY90, 2-19AQ5 and 12AX7, separate bass and treble control, suitable for Speakers of 15 ohms impedance and two 3-ohm tapings for Tweeters. For use on A.C. mains, tapping 115-150 and 210-250 can also be supplied with Power Pack suitable for AC/DC mains. PRICE COMPLETE WITH ESCUTCHEON AND KNOBS, £6/19/6, 3/3 post and pkg.

THE VERDIK "QUALITY TEN"

10 watt push-pull ultra linear hi-fi amplifier with hi gain pre-amp. Mic., radio, gram and tape inputs, bass and treble controls. Beautifully finished. Control panel in gold lettering on grey green. Fully guaranteed. Original price 23 gns. Our price £14/19/6. P. & P. 7/6.

SPECIAL OFFER

2 valve 3 watt printed circuit amplifier made by famous manufacturer, completely assembled, needs output T x F and speaker, at the very low price of 39/6, plus 2/6 post and pkg.

BRAND NEW AND GUARANTEED
7in. reels of 1,200ft. P.V.C. base tape, 21/-, plus 1/6 post and pkg.
5in. reels of 600ft. P.V.C. base tape, 14/6, plus 1/6 post and pkg.
4in. reels of 300ft. P.V.C. base tape, 9/6, plus 1/- post and pkg.
7in. reels of 1,800ft. L.P. P.V.C. base tape, 32/6, plus 1/6 post and pkg.
5½in. reels of 1,200ft. P.V.C. base tape, 25/-, plus 1/6 post and pkg.
Brand new E.M.I. 7in. take-up spools in polythene bag, 3/9 each post free, 6 for 20/-.

The New American Audio Tape with plastic base. Also supplied in green or blue at no extra cost.
3in. reel 150ft. ... 6/- 4in. reel 300ft. ... 10/6
5in. reel 600ft. ... 18/- 7in. reel 1,200ft. ... 30/-

Post and packing 1/- per spool.
HI-FIDELITY TAPE HEADS

Made by famous manufacturer. Brand new. Upper or lower track, record/play-back, high impedance giving up to 12,000 c.p.s. at 7½ I.P.S. output 5 m/volts at 1 KC at 7½ I.P.S. Erase heads low impedance.
Only 39/6 per pair. Post 1/- State upper or lower track.

THE NEW "INSTANT" BULK TAPE ERASER
Can erase a spool of magnetic tape in a few seconds. Demagnetises oxide deposits on tape heads. Only 27/6, post free.

THE NEW TAPE EDITING BLOCK.
For standard ½ in. mag. tapes. Can be fixed to tape deck. Only 7/6, 6d. post and pkg. The new Acos telephone adaptor can be attached to any recorder. 21/- post free.

BIGGEST SCOOP OF THE YEAR

Due to Huge Purchases of the Famous

AVANTIC BEAM-ECHO EQUIPMENT

We can offer the following HI-Fi Amplifiers brand new in sealed cartons.

DL7-35 POWER AMPLIFIER. 54 watt output peak, intermod distortion .7% at 20w. output, freq. response 5c/s to 30 K/c/s ± .0 DB. Load imp. 4, 8 or 16 ohms., switch selected; hum and noise level—85DB relative to 20w. output. Multi voltage input. Makers price 30 gns. **OUR PRICE £34.** 12/6 packing and carr.

SPA21 STEREO AMPLIFIER. Combined twin channel power amp. and pre-amp. unit. Designed for stereo or monaural reproduction. Direct operation from magnetic p/up and hi impedance tape replay head. 25 w. peak output each channel. Frequency response 40 c/s—15 K/c/s. ± 1 DB. Loudspeaker 4, 8 and 16 ohms. Tape output, 50m/v. Continuously variable bass and treble controls. Volume and loudness control. Inputs for tuner, tape, p/ups etc. Manufacturers price £48/10/0. **OUR PRICE £29/10/0.** Carriage and packing 12/6.

VHF/FM/MW RADIO TUNER BM611. Shelf styled to match with any of the other Avantico units. Using 8 valves plus rectifier, A.F.C. control, Foster Seeley discriminator ensuring drift-free performance, magic eye tuning on both bands, 88-108 M/cs. Makers price £40. **OUR PRICE £25.** Plus 7/6 post and packing.

STEREO AMPLIFIER. Combined twin channel amplifier and pre-amp control unit. P/pull output, for each channel. 10 watts peak each channel, loudspeaker imp. 4, 8 and 16 ohms. Tape output 100 M/V. Multi voltages, continuously variable bass and treble controls. Stereo balance control, stereo reverse and phase reverse. Makers price 28 gns. **OUR PRICE 19 gns.** Carriage and packing 7/6.

PL6-21 AMPLIFIER AND PRE-AMP. Combined unit. Compactly designed and fully enclosed. Ideal for shelf mounting for monaural reproduction. 30 watt peak power. Intermod distortion 1% at 10w., output impedance 4, 8 and 16 ohms. Radio, tape, p/up, etc. inputs. Separate bass and treble controls. High and low pass filter. **Our price £19/19/0.** Carriage and packing 7/6.

ANOTHER SNIP FOR TAPE RECORDER CONSTRUCTORS

The new Collaro studio tape deck using 3 motors, 3 speeds at 1½, 3½ 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, super imposing 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/-.

ANOTHER OF OUR AMAZING SCOOPS

A snip for the Constructor



Build this Cossor Pocket 4-Transistor Superhet Receiver.

Circuit description: 4 transistors (OC44, OC45, OC45, OC72), two OA70 diodes, two AGC systems, coverage 190-550 metres. Power output 30 m/w. Ferrite slab aerial, 2½ in. moving coil speaker, printed circuit, attractive tuning control knob, leatherette case 6 x 3½ x 1½ in. All components including theoretical and point-to-point diagram for easy construction. **ONLY £7/19/6.** Post & Pkg. 2/6. All parts available separately, 9 v. PP4 battery 2/-. Maker's original price nearly £20.

BRAND NEW TV TUBES, CHEAPER THAN REBUILDS

All brand new in famous maker's cartons. (1) 17in. rectangular aluminumized 6.3 HRTS. .3A 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 14kV; ion trap; external conducting coating; B12A base. £7/9/6. Crating and carriage 12/6.
(3) Ferranti T12/44 12in. magnetic white fluorescence; 4 v. heater; max. anode 10 kV. As used in many TV receivers. Original price £17/15/-. **OUR PRICE £2/19/6.** Crating and carr. 12/6.
(4) Ferranti 9in. Tube, round white fluorescence, 4 v. heater, max. anode voltage 7 kV. **OUR PRICE £2/5/-.** Crating and carr. 11/6

SOMETHING NEW FOR THE SERVICE MAN!

THE POCKET VALVE FILAMENT TESTER

Battery operated, it gives instant check on radio and TV valves, pilot lamps, fuses, continuity of circuit; also built-in 7 and 9 pin valve straightener. The ideal precision instrument for service engineer or amateur constructor. Finished in grey hammer case with gold panel. Fully guaranteed and ready for use. **OUR PRICE 30/-.** Post and packing 2/-.



SOMETHING NEW FOR THE CONSTRUCTOR

Etch your own printed circuits; complete kit with instructions comprising 3 laminate sheets, copper faced etching bath, 4 bottles, etchant, resist solvent and cleanser and brush. 19/6 complete. P. & Pkg. 1/6.

PORTABLE BATTERY ELIMINATOR

Housed in two containers which are to replace AD35 and B126 Batteries. 37/6, Plus 2/- P. & P. Only suitable for use with Dk96 Series valves.

EDDY'S (NOTTM) LTD

172 ALFRETON ROAD NOTTINGHAM

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1R5	6/-	6SH7M	4/3	ECL80	7/6
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6BE6	5/11	955	3/6	EZ80	6/-
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6C6	4/-	AZI	12/6	PCL82	11/3
6CH6	9/-	DAF96	7/9	PEN36C	8/6
6D2	3/6	DF96	7/9	PL81	9/-
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6FG6	5/11	DK96	7/9	PL83	7/3
6H6	1/11	DL96	7/9	PY80	6/11
6J5G	2/6	DM70	7/6	PY81	6/-
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6K7G	1/11	ECC83	6/11	UF41	8/-
6K7M	7/6	ECC84	8/11	UF42	7/3
6K8G	5/6	ECC85	7/11	UL41	7/3
6LB6	7/3	ECF80	9/6	UY41	6/3
6SA7M	5/9	ECF82	9/6		

Guaranteed New or Surplus Valves—By Return Post

SPECIAL OFFER!

CAR RADIO KITS

Seven Transistors. Long and Medium Waves 2 Watts output. R.F. Stage and automatic gain control. Complete Kit with cabinet 10½ gns. Speaker extra 17/11. P. & P. 5/-. Please state voltage. Size 7¾ x 7¼ x 2½ in.

VIBRATORS. 12 volt 4 pin, 4/11. Post 1/-.

GERMANIUM DIODES 8d. each, 7/- doz. Post 6d.

CONDENSERS. Tubular Wire End (not ex. govt.). 8 mfd. 450 v. 1/9, 8-8 450 v. 2/6, 16 mfd. 450 v. 2/9, 16-16 450 v. 3/9, 32 mfd. 450 v. 3/9, 32-32 350 v. 4/-. Post 1/-.

TRANSISTORS. Red spot 3/11, white spot 4/11. Post 6d.

NIFE ACCUMULATORS. Midget single unit. Size 3 x 2½ x ¾ in. 8 amp. hrs. 1.25 volts. Weight 13 ozs., 1/11 each. Post and Packing 1/6. One only. Add 9d. each cell.

Any parcel insured against damage in transit for only 6d. extra per order. All uninsured parcels at customers' risk. Postage and packing 6d. per valve extra. Over £3 free. C.O.D. or C.W.O. only. C.O.D. charge 3/- extra. S.A.E. with all enquiries.

BRING YOUR DUODE RIGHT UP TO DATE



Now is the time for all who own older Barker and Duode Units to have them brought right up to 1960 standards.

No Barker or Duode unit is ever entirely dead so long as its magnet system is intact. This principle applies to all models made since 1947. At a very reasonable cost a new 1960 frame, cone and drive assembly with foam suspension is fitted, the magnet checked, re-magnetised if necessary, and the whole tested to the latest standards.

Why not use this unique, economical service—or if you still do not own a Duode, send for details of the new models.

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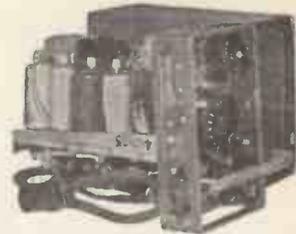
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SOUTHERN RADIO'S SPECIAL BARGAINS

TRANSMITTER - RECEIVER

TYPE 38 MK II

* WALKIE-TALKIE



Complete in Metal Carrying Case. 9in. X 6½in. X 4in. Weight 6lb. Frequency 7.3 to 9 Mc/s. Five valves, £12/6. Post paid.

These TX-Rs are in NEW CONDITION, but owing to demand they are not tested by us and carry no guarantee, but should prove SERVICEABLE.

ATTACHMENTS for Type "38" Transreceivers. ALL BRAND NEW. Headphones 15/6; Throat Microphones 4/6; Junction Boxes 2/6; Aerials, No. 1 2/6; No. 2 5/-; Webbing 4/-; Haversacks 5/-; Valves—A.R.P. 12 4/6; A.T.P.4 3/6; Set of FIVE VALVES 19/- the set. **SPECIAL OFFER No. 2:**

"38", as above, complete with set of external attachments, 42/6, post paid.

SPECIAL OFFER No. 3:

Transmitter-Receiver "38" Mk. II. Brand new with complete set of external attachments including Webbing, Haversacks and Valves 57/6 post paid. Fully guaranteed.

CONDENSERS. 100 assorted mica; Tubular, etc., 15/- NEW.

CONTACTOR TIME SWITCHES. 2 impulses per sec., in case, 11/6.

REMOTE CONTACTOR. For use with above, 7/6.

LUFBRA HOLE CUTTERS. Adjustable ½in. to 3½in. For Metal, Plastics, etc., 7/-.

MAGNETS. Strong Bar type, 2 x ½in., 1/6 each.

MORSE TAPPERS. Midget type 2/9; Standard, 3/6; Heavy type on base, 5/6. ALL BRAND NEW

MORSE PRACTICE SET. TAPPER with BUZZER on base. Complete with battery, 12/6. BRAND NEW.

PACKARD-BELL AMPLIFIERS. Complete. BRAND NEW, with valves, relay, etc., etc., 17/6 each.

QUARTZ CRYSTALS. Types F.T.241 and F.T.243. 2-pin ½in. spacing. Frequencies between 5,675 kc/s. and 8,650 kc/s. (F.T.243), 20 Mc/s. and 38.8 Mc/s. (F.T. 241, 54th Harmonic), 4/- each. ALL BRAND NEW. TWELVE ASSORTED CRYSTALS, 45/-.

HOLDERS for both types 1/- each. Customers ordering 12 crystals can be supplied with lists of frequencies available for their choice.

RECORDING BLANKS. Brand new. "Emidisc." Ready for cutting. 13in. 6/- each or 15 complete in metal case 14.

RESISTANCES. 100 assorted useful values. New wire end 12/6. NEW.

SPECIAL OFFER. 12 ASSORTED METERS. Slightly damaged. Mainly broken cases (perfect movements). Including 3 BRAND NEW Aircraft Instruments. 12 for 45/-.

STAR IDENTIFIERS. Type I A-N Covers both Hemispheres, 5/6.

T1154 TRANSMITTERS. Complete in transit case. New condition, £25/-.

TEST METERS D.C. PORTABLE 0-5,000 ohms 0-6mA 0-1.5v and 3v. In case 3½in x 3½in x 2½in. Voltage range can easily be extended by addition of resistances to suit individual requirements. BRAND NEW, 12/6.

ATTACHMENTS for "18" Transreceivers. ALL BRAND NEW. Headphones 15/6; Hand Microphone 12/6; Aerials 5/-; Set of 6 Valves 30/-.

TRANSPARENT MAP CASES. Plastic 14in. X 10½in. Ideal for Maps, Display, etc., 5/6. Post or carr. extra. Full list Radio Books, etc., 3d

SOUTHERN RADIO SUPPLY, LTD.

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More than meets the eye



It looks good but there is more in it than meets the eye—enough to make the discerning purchaser feel that he must have Savage Massicore regardless.

Generous design—no compromises on quality—conscientious workmanship—that is what you get when you buy a Massicore Transformer.

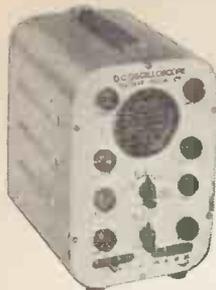


SAVAGE TRANSFORMERS LIMITED

NURSTEED ROAD, DEVIZES, WILTS. Telephone: Devizes 932

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 I/P and CRT. Brightness Modulation. A.C. mains 200/250 v. £19/19/- plus P. & P. 7/6, or 50/- deposit, plus P. & P. 7/6 and 12 monthly payments of 33/4.

FULL 12 MONTHS' GUARANTEE INCLUDING VALVES AND TUBE

ALIGNMENT ANALYSER TYPE MC12

A.C. MAINS, 200/250 volts. Provides—"WOBBULATOR" (SWEEP FREQUENCY) OPERATION, for FM/TV alignment linear frequency sweep up to 12 Mc/s. From 400 Kc/s.—50 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.F. terms 25/- deposit and 6/- P. & P. and 6 monthly payments of 21/6.



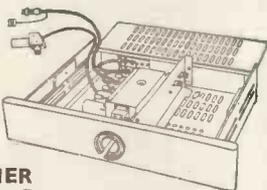
CHANNEL TUNER

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.

22/6 Plus 3/6 P. & P.

HEATER TRANSFORMER

To suit the above, 200-250 v., 6/- Plus 1/6 P. & P.



B.S.R. MONARCH UA8 with FUL-FI HEAD



4-speed plays 10 records 12in., 10in., or 7in. at 16, 33, 45 or 78 r.p.m. Intermixes 7in., 10in. and 12in. records of the same speed. Has manual play position; colour brown. Dimensions: 12 1/2 in. x 10 1/2 in. Space required above baseboard 4 1/2 in., below baseboard 2 1/2 in. Fitted with Ful-Fi turnover crystal head. £8/19/6, 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 circuit diagram.

29/6 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/-.

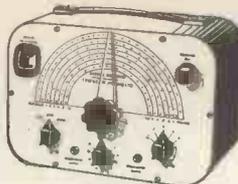
WOLSEY 3-ELEMENT FOLDED DIPOLE

I.T.V. Aerial less mounting bracket for external use, complete with 12 yds. of coaxial cable. 15/- 4 element, 17/6; P. & P. on above, 3/6.

BATTERY RECHARGE 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

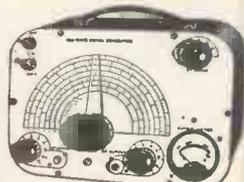


£6/19/6

Covering 100 Kc/s.—100 Mc/s. on fundamentals and 100 Mc/s. to 200 Mc/s. on harmonics. Metal case 10in. x 6 1/2 in. x 5 1/2 in., 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 magno-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 6 1/2 in. x 4 1/2 in. Size of scale 6 1/2 in. x 3 1/2 in. 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

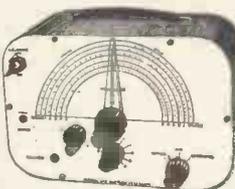


Or 25/- deposit and 4 monthly payments 21/6. P. & P. 5/- extra.

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.



F.M. TUNER UNIT

By famous German manufacturer. Coverage 88—100 Mc/s. Complete with ECC85. Size 4in. x 2in. x 2in.

25/- Plus P. & P. 1/6.

Circuit diagram free with unit. 1/-

10.7 Mc/s. I.F. and Discriminator Coil 4/- pair

3-TRANSISTOR POCKET RADIO

Plus GERMANIUM DIODE ON PRINTED CIRCUIT

Size 3 1/2" x 4" x 7/8"

Incorporating Ferrite Rod Aerial. Tuneable over medium and long waves.

Kit of parts. 39/6 Plus 1/6 P. & P.

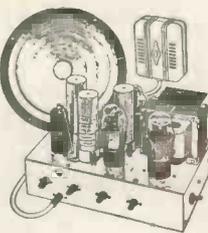
Circuit diagram 1/6 free with kit.

8 WATT PUSH-PULL AMPLIFIER

COMPLETE WITH CRYSTAL MIKE AND 8in. LOUDSPEAKER

A.C. mains 200/250 v. Size 10 1/2 in. x 6 1/2 in. x 2 1/2 in. 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 Hft. 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 8in. or I.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.

BUILT POWER SUPPLY UNIT, A.C. Mains 200-250 v., D.C. output, 250 v. at 75 ma., also 6.3 v. 2 amp. heater winding, 21/- Plus 3/6 P. & P.

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

23, ACTON HIGH STREET, LONDON, W.3

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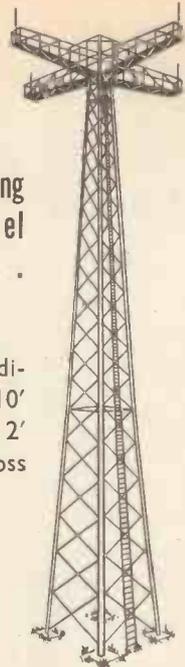
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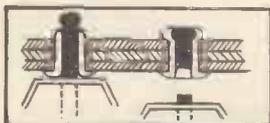
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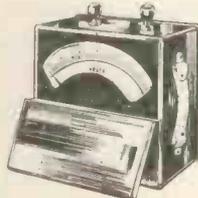
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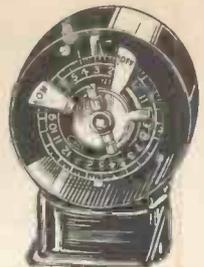


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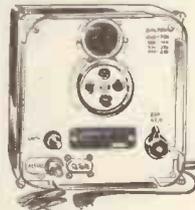
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There is a vacancy at our Feltham Laboratories for a Technical Specification Writer. Candidates must have a background of electronics and be able to write clearly and concisely. The post involves the preparation of technical reports for publications and entails close liaison with engineering teams. Initial salary will be determined by qualifications and experience and it is Company practice to review salaries annually on the basis of ability and potential.

Ref. S/10/1

FIELD ENGINEERS

Engineers are required by the Field Services Division of the Company to engage in trials in the field of complex prototype electronic equipment developed by E.M.I. Electronics Ltd. Sound practical knowledge of the operations and maintenance of radar or communication equipment is necessary. The posts may involve periods away from base and a willingness to live away from home is essential. Starting salaries are based on qualifications and experience and it is Company practice to review salaries annually on the basis of ability and potential.

Ref. P/8/22

INTERMEDIATE ENGINEER

An Intermediate Engineer is required to take engineering responsibility for the development programme of a telemetry sender. The post involves circuit design, engineering to extreme environmental conditions and technical liaison with customers. A degree with considerable relevant experience is essential. Preferred age 26-31.

Ref. P/6/15

TECHNICAL ASSISTANT

A Technical Assistant is required to assist in the development, construction and testing of a wide range of electronic equipment. Some experience of the use of Electronic Test Gear and bench tools and an ability to understand circuit diagrams is essential.

Ref. P/4/235

Please write, giving full details and quoting the appropriate reference numbers, to:

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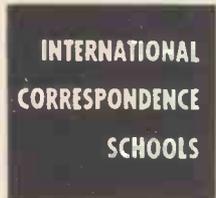
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Session 1960/61

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Enquiries should be addressed to The Head of the Department of Physics.

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The successful applicant will be responsible to the Chief Engineer and will be required to give advice on and to organise the planning, development, operation and maintenance of the transmission side of the commercial Television service, which is to employ the C.C.I.R. 625 lines system.

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The successful applicant will be stationed at Salisbury, Southern Rhodesia, but will be required to travel from time to time in connection with television installation in other centres.

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Write to the Crown Agents, 4 Millbank, London, S.W. 1. State age, name in block letters, qualifications and experience and quote M2A/50827/WF.

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Enquiries, mentioning this publication and quoting Reference No. B11/6/5, should be addressed to the High Commissioner for New Zealand, 415 Strand, London, W.C.2. Further details and application forms will then be supplied. Completed applications must be lodged in London not later than 22nd July, 1960.

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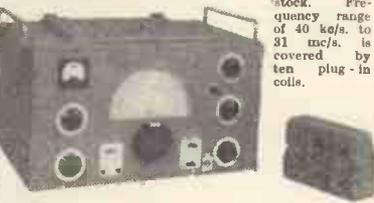
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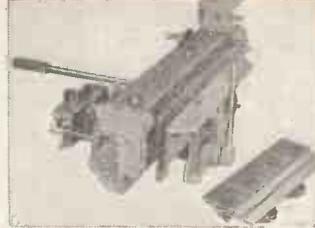
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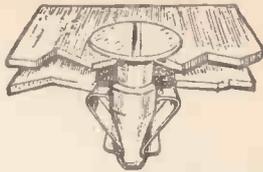
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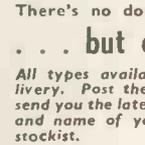
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SITUATIONS VACANT

SENIOR engineer required to work in Applications section of valve development laboratory. MINIMUM qualification H.N.C. Previous experience in testing and designing test gear for medium and high power radio transmitting valves, and experience with R.F. heating. APPLY to Personnel Department, Associated Electrical Industries, Ltd., Cosmos Works, Brimsdown, Enfield, Middx. [9102

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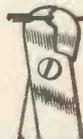


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POLICE Department, Government of Northern Rhodesia, requires a radio maintenance technician on agreement for one tour of 3 years with prospect pensionable employment. Salary according to experience in scale £745 rising to £1,260 a year. Prospects of promotion to tele-communications officer (maximum salary £1,315) and chief telecommunications officer (maximum salary £1,490). Married accommodation with heavy furniture available immediately at sub-economic rent, e.g., on salary of £745 rent is £45 a year. Free passages. Liberal leave on full salary. Candidates should be between 22 and 35 years, of good physique, and possessing maths. and physics at G.C.E. "O" level standard. They should have sound knowledge of installation and maintenance of modern low and medium power V.H.F. static and mobile equipment, H.F. transmitters and receivers including S.E.B. and petrol generator and diesel electric sets. Knowledge of installation and maintenance of teleprinters an advantage.—Write to The Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, qualifications and experience, and quote M2A/50829/WF. [9104]

I NSTRUCTOR (Telecommunications) Sierra Leone Government Technical Education Department. APPLICATIONS are invited for the above post from candidates between the ages of 22 and 45 years possessing either:— (a) FULL Technological Certificate in Telecommunications, specialising in radio transmission; or (b) C. & G. Teachers' Certificate in a technical subject; or (c) UNITED Kingdom Ministry of Education Certificate as well as specialist qualification. SALARY for candidates possessing qualification (a) in scale (including Inducement Addition) £960 rising to £1,528 a year; for candidates possessing qualification (b) or (c) in scale (including Inducement Addition) £966 rising to £1,666 a year. Commencing point in salary scale will depend on age, qualifications and experience. APPOINTMENT will be on contract for three years of 10/12 months in first instance. Gratuity at rate of 15% of total salary drawn. Outfit allowance £60. Children's allowance £48-£288 a year. Free passages. Liberal leave on full salary.

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MEN with a knowledge of the basic principles of radio and radar are required in the Meteorological Office. AFTER short initial training, those appointed will maintain and operate radio and radar equipment, including facsimile apparatus; opportunities to serve overseas and in the United Kingdom; starting salary for radio (Meteorological) technician, London, £690 at 25 or over, rising annually to £820, subject to deductions for each year below age 25; provincial salary £40 to £50 lower; good promotion prospects, overtime, allowances, night duty, etc.—Apply to Meteorological Office (M.O.10 R/M/T), Victory House, London, W.C.2. [9134]

PART-TIME advertising and office manager required by London hi-f dealers; age immaterial; experience important.—Box 6676 [0133]

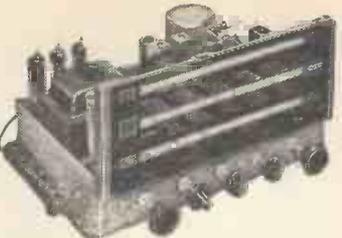
THE Scientific Civil Service needs men and women for pensionable posts as (a) senior scientific officers and (b) scientific officers in all major scientific fields, including: PHYSICS ENGINEERING CHEMISTRY METEOROLOGY MATHEMATICS and BIOLOGY.

SOME particular vacancies include physicists/electrical engineers for research in the application of servo-control for machine tools, physical chemists, chemists for research in high polymers, botanist for study of bryophyta, physiologist for work at the Institute of Aviation Medicine, mineralogist to work on meteorites (petrologist with sound knowledge of physics preferred), and zoologists to specialise in the taxonomy of the porifera and in serological and other histo-chemical techniques applicable in zoology and anthropology. QUALIFICATIONS: normally first or second class honours degree in science, mathematics or engineering, or equivalent attainment; additionally, for (a), at least 3 years' relevant (e.g. post-graduate) experience; normal age limits: (a) between 26 and 32, (b) between 21 and 29, with extension for regular Forces service and Overseas Civil Service; selection by interview; London salaries (men): (a) £1,233-£1,460, (b) £655-£1,150; provision for starting pay above minimum; promotion prospects.—Write Civil Service Commission, 17, North Audley St., London, W.1 for application form, quoting (a) S/53/60, (b) S/52/60. [9145]

ELECTRICAL test personnel are required by Tannoy Products, Ltd., Sound Equipment Designers and Engineers; good all-round knowledge and previous experience essential.—Apply Tannoy Products, Ltd., Norwood Rd., S.E.27. [9148]

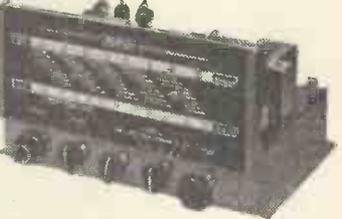


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APPLICATIONS are invited from suitably qualified persons to assist in the installation and to be responsible with his assistants for the subsequent running and maintenance of these machines; applicants should have had some practical experience in electrical or electronic engineering and be interested in the design and construction of measuring instruments and ancillary equipment for use with this apparatus. SALARY according to qualifications and experience within the scale £1,140 to £1,550 plus London weighting.

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SALES engineer required for well-established public company distributing world-famous components to radio and electronic industries; technical background and good personality essential.—Apply, Box 0059. [9117]

RADIO service engineer for bench work in Bermuda, familiarity with transistor radios and American television techniques advantageous; salary commensurate with ability.—Riihluoma's, Hamilton, Bermuda. [9113]

SENIOR Engineer required for Relay Service in Bideford; permanent position for the right man; accommodation arranged.—Bideford Relay Ltd., 29, Bridgeland Street, Bideford, North Devon. [9135]

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TECHNICAL assistant with knowledge of radio, communications or P.A. practice, able to make up complete equipment from basic requirements. Apply Personnel Manager, Phoenix Telephone & Electric Works, Ltd., The Hyde, Hendon, N.W.9. [9155]

LOUIS NEWMARK, Ltd., leading company in the design of auto pilots for helicopters, are expanding their facilities at their Development Laboratories at New Addington, Croydon, and have the following vacancies to be filled immediately.

ENGINEERS and Assistant Engineers with degree or H.N.C. and experience in the field of light electrical engineering, electronics, electro mechanical devices or semi-conductors, to work on the development, installation and flight testing of automatic pilots.

SALARY commensurate with experience; pension scheme.—Apply in writing, giving full particulars to Personnel Officer, Louis Newmark, Ltd., Prefect Works, Purley Way, Croydon, Surrey, or 'phone Mr. Barkham, Lodge Hill 3441. [0333]

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JUNIOR wireless telegraphy operator required by Falkland Islands Government for service at Government wireless station, South Georgia, on agreement for 1 tour of 24-30 months in first instance; salary in scale £420 rising to £520 a year; free passages; liberal leave on full salary.

CANDIDATES, preferably single, must be able to transmit and receive morse at 25 words a minute and should be familiar with H.F. and M.F. transmitters and receivers; P.M.C. certificate and/or ability to read reports in International Meteorological Code an advantage. Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, qualifications and experience, and quote M2A/51018/WF. [9114]

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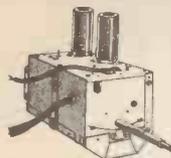
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COILWINDING. Senior engineer required to take charge of design small audio transformers. Knowledge of current transistor practice an advantage. Excellent prospects. Applicant would be required to work at Rickmansworth.—Full details to Colne Electric, Ltd., Bury Lane, Rickmansworth. [9099]

TELESURANCE, Ltd., require young man for technical work on R.F. relay systems; sound practical relay or T.V. servicing experience essential; must possess clean driving licence and be prepared to travel; attractive conditions offered and car provided.—Apply to 14, Windmill St., London, W.1. (Ref. REP) [9157]

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JUNIOR Electronic Development Engineer, familiar with general industrial electronics and with a working knowledge of sheet metal and light engineering practice; salary scale £650-£800 depending on ability; staff position, pension scheme, sick club, holidays honoured.—Write Grundy & Partners, Ltd., 3, The Courtyard, Teddington, Middlesex. [9142]

OVERSEAS Oil Exploration Company with world-wide seismic parties offers permanent career to electronic technicians. Work consists in maintaining and operating electronic recording equipment under field conditions. Live generally in camp. Qualification: H.N.C. or equivalent essential, with practical experience in electronics. Home leave every two years.—Box No. 5829. [0331]

VACANCY for trainee Cyclotron Operator for medical radioisotope production, age under 40, applicant should have experience in maintenance of electronics or Post-Office telephone equipment or high vacuum plant.—Apply stating age and full details of experience to Senior Cyclotron Engineer, Medical Research Council, Hammersmith Hospital, Duane Rd., London, W.12. [9110]

PHILIPS ELECTRICAL, Ltd. (Medical X-ray Division) require an Engineer for the service and installation of X-ray equipment; candidates with O.N.C. (Electrical) or Electronics experience would be considered. Applications, with full details, should be addressed to the Personnel Officer (Medical X-ray Division), 45, Nightingale Lane, Balham, S.W.12. [9141]

UNIVERSITY OF ABERDEEN.—Technician required for Medical Physics Laboratory, Foresterhill; some experience as electronics mechanic desired; National Certificate in Electrical Engineering or Applied Physics an advantage; wage on age scale to £615 at 28, with supplement by relevant qualifications.—Apply in writing by 30th June, 1960, to the Secretary, Marischal College, Aberdeen. [9123]

TEST engineers.—Applications are invited from test engineers with previous industrial experience of testing radio communications, receivers and transmitters; successful applicants will be offered positions on the company's permanent staff; starting salaries commensurate with qualifications and experience.—Apply in writing, giving full details, to Personnel Officer, Reddon, Ltd., Broomhill Rd., S.W.18. [0252]

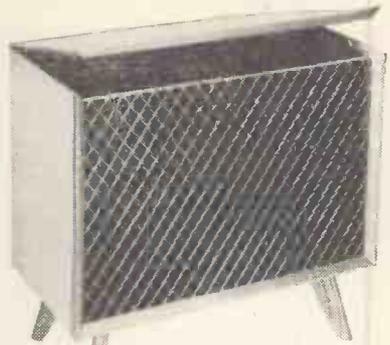
TAPE-RECORDING equipment service engineer is required for the tape-production department of E.M.I., Ltd.; experience in tracing faults in audio electronic equipment is essential, although preference will be given to engineers who have gained their experience in the tape recording field; age 25-35 years.—Please write, giving full details and quoting Ref. SS/7/3, to Personnel Manager, E.M.I., Ltd., Hayes, Middlesex. [9119]

MEDICAL RESEARCH COUNCIL have a vacancy for an Electronics Technician to assist in the maintenance and construction of electronic equipment at their Environmental Radiation Research Unit, Leeds. Experience as a radar fitter in the R.A.F. would be suitable qualification. Salary within the range £595 to £720 or £710 to £870, depending on qualifications, age, and experience. Applications, giving details of previous experience and the names of two referees, should be sent to The Secretary, Department of Medical Physics, University of Leeds, The General Infirmary, Leeds, 1. [9137]

INTERNATIONAL AERADIO, Ltd., has periodic vacancies overseas for Radio Technicians. City and Gull's Intermediate Telecoms. an advantage but not essential if applicant has considerable experience. Installation/maintenance 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]

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CIRCUIT Designers and Circuit Laboratory Engineers required for design and testing of automatic telephone exchange systems and other similar projects. Candidates should have had previous experience of this work and preferably have at least an O.N.C. or an intermediate group C & G certificate. Knowledge of Crossbar Switching or totalisators would be an advantage. Good salary paid to selected applicants. Pension scheme after qualifying period.

WRITE giving full details of qualifications and experience to the Personnel Manager, Ericsson Telephones, Limited, Beeston, Nottingham, quoting Ref. DA/1. [0160]

TELEVISION engineers who possess sound theoretical knowledge, and some years of practical experience are invited to apply for permanent, pensionable positions with well established rental company in Middlesex and Surrey; there are vacancies for design and workshop engineers; three weeks' annual holiday is given; excellent conditions and equipment; top rates of pay.—Telephone Mr. Powditch, Puratone Rental Service, Kingston 9468 for immediate appointment. [0313]

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BRITISH RELAY WIRELESS, Ltd., have vacancies for engineers to carry out the installation and maintenance of television and audio relay main repeater stations in the London area. Applicants should have held a technical standard equivalent to City and Guilds Intermediate Certificate with suitable practical experience.—Applicants should write, giving details of experience and qualifications, to The London Area Engineer, British Relay Wireless, Ltd., 9-13, Camberwell Rd., London S.E.5. [9105]

ELECTRONIC engineers, Ekco Electronics, Ltd., Southend-on-Sea, Essex, have vacancies for electronics engineers, based at Southend for installation and service laboratory duties; work is in connection with industrial nucleonic systems, nucleonic counting equipment and general nucleonic instrumentation; permanent progressive posts in expanding organization; requirements, good theoretical electronic background, preferably with fault-finding experience; salary commensurate with ability.—Please write, stating age, qualifications and experience, to Personnel Manager. [9149]

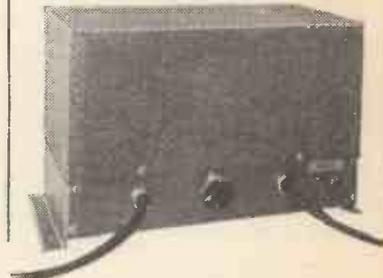
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NATIONAL ENGINEERING LABORATORY (D.S.I.R.), East Kilbride, Glasgow, requires experimental officer/asst. E.O.s. for development of electronic instrumentation for use in research on elasticity and lubrication; experience in electronics or telecommunications essential. Quals.: G.C.E. "A" level in two science or science and maths. subject or equiv., over 22, pass degree, H.N.C. in electrical engineering or equiv. generally expected. Salary range: A.E32 (men) £392 10s (age 19) to £530; E.O. (min. age 26) £954-£1,165.—Forms from Ministry of Labour, Technical and Scientific Register (K), 26, King St., London, S.W.1. quoting D.350/OA. Closing date 11th July, 1960. [9122]

GOVERNMENT OF NORTHERN IRELAND, Wireless Technician (Male). Applications invited for pensionable post in Ministry of Home Affairs; candidates must be British subjects ordinarily resident in United Kingdom: Qualifications—good general education; sound theoretical and practical knowledge of Radio Engineering and some years' experience in maintenance of radio equipment. Preference for ex-Servicemen. Salary scale—£525 (age 21)—£640 (age 25 and over)—£795; successful candidate with special qualifications or experience may enter at salary above minimum. Application forms, obtainable from Secretary, Civil Service Commission, Stormont, Belfast, must be returned by 8th July, 1960. [0518]

PATENT examiners and patent officers.—Pensionable posts for men or women for work on the examination of patent applications, age at least 21 and under 29 (36 for examiners), with extension for regular Forces service and overseas civil service; qualifications: normally first or second class honours degree in physics, chemistry, engineering or mathematics, or equivalent attainment, or professional qualification, e.g. A.M.I.C.E., A.M.I.-Mech.E., A.M.I.E.E., A.R.I.C.; London salary (men) £655-£1,460; provision for starting pay above minimum; promotion prospects.—Write Civil Service Commission, 17, North Audley St., London, W.1. for application forms, quoting S/128/60. and stating date of birth. [9143]

ALUMINIUM LABORATORIES, Ltd. (The Research and Technical Organisation of the International ALCAN Group of Companies) require a Physicist having a good working knowledge of basic electronic techniques, or an Electronics Engineer with a sound knowledge of physics, to work on instrumentation problems associated with the production of aluminium sheet, extrusions and castings, every opportunity will be given to the successful candidate to exercise initiative in carrying out his work, which will include the development and application of new measuring techniques; a university degree or an equivalent qualification would be an advantage, as would experience in research and development work. For further details please apply to the Personnel Officer, Southam Rd., Banbury, Oxon. [9109]

ASSISTANTS (scientific).—Pensionable posts for men or women at least 17½ and normally under 26 on 1-10 with appropriate educational or technical qualifications (normally G.C.E. with passes at O or A level in 4 distinct subjects including English language and a scientific or mathematical subject, or O.N.C. or equivalent qualifications) and at least 2 years' experience in either (i) engineering or physical sciences, or (ii) chemistry, biochemistry or metallurgy, or (iii) biological sciences, or (iv) geology, meteorology, or skilled work in laboratory crafts such as glass-blowing; starting salary (men, London) £247/10 (at 17½) to £550 (at 25 or over); maximum (London) £715; promotion prospects: 5-day week generally.—Write Civil Service Commission, 17, North Audley St., London, W.1. for application form, quoting S/59/60. [9146]

THE Scientific Civil Service needs men and women for pensionable posts as (a) experimental officers, and (b) assistant experimental officers in mathematics, physics, meteorology, chemistry, metallurgy, biological sciences, engineering, miscellaneous (geology, library and technical information services); candidates must, on 31.12.60, be at least 26 and normally under 31 for (a), and at least 18 and normally under 28 for (b); qualifications should normally include H.S.C. or G.C.E. or equivalent, or H.N.C. or university degree; provisional admission if taking examinations in 1960: men's salary scale (London) (a) £1,005-£1,233; (b) £397/10 (at 18) to £710 (26 or over) rising to £880; promotion prospects: further education facilities.—Write Civil Service Commission, 17, North Audley St., London, W.1. for application form, quoting S/94-95/60. [9144]

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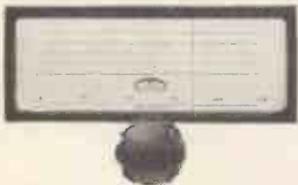
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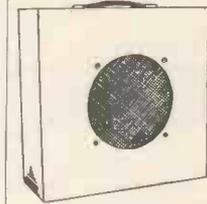
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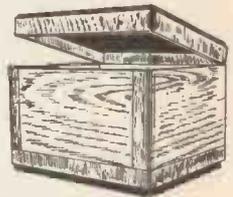
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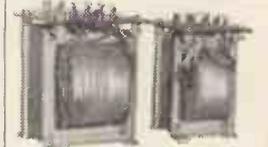
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